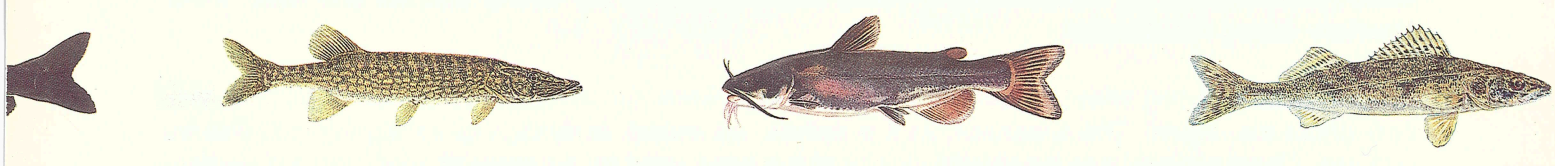
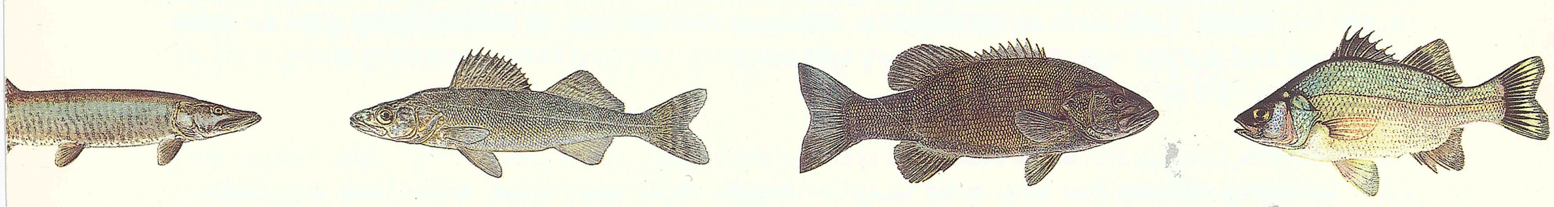
1996 Site Environmental Report

Safety and Environmental Protection Division
Brookhaven National Laboratory





FRESHWATER FISHES OF LONG ISLAND

Bluegill: Abundant in many of our waters, easy to catch throughout the year and a scrappy fighter, bluegill are often the first fish caught by a beginning angler. A member of the group of fish called panfish, bluegill are excellent eating. Look for these fish around cover in weedy lakes and ponds, with larger fish typically found deeper than smaller fish. Bluegills are most caught with live baits such as earthworms but can also be caught on small artificial lures.

Pumkinseed: Like its close relative the bluegill, the pumpkinseed sunfish is one of the most popular fish with young and beginning anglers because of its abundance in most waters and willingness to hit just about any small bait or lure. Its bright and varied coloration make the pumpkinseed one of the most attractive freshwater fish species. Look for pumpkinseed in the same location as bluegill.

Black Crappie: One of the tastiest freshwater fish, black crappie are very popular with anglers, particularly in the spring when large concentrations move into shallow water areas to spawn. Look for crappie around vegetation, brush and other cover. Crappies tend to be a bit more finicky than other panfish, but are commonly caught on small minnows, tube jigs and twister tails. Hooks can be easily pulled through their soft mouths by an overzealous angler, hence their nickname "papermouth".

White Perch: White perch are common in the coastal waters of New York City and Long Island, and it is in these waters that these fish grow to their largest sizes. White perch congregate in coastal streams during the spring to spawn but can also be found in these waters in good numbers in the late fall and winter. On Long Island, landlocked white perch often become overabundant adversely impacting other more desirable species. White perch are commonly caught on small minnows, worms, shrimp, as well as small spoons, spinners or flies.

Largemouth Bass: New York's most popular gamefish, largemouth bass are common in our weedy lakes, ponds and rivers and can be caught on a variety of natural baits or any artificial baits specifically designed for this scrappy fighter. Look for these fish around "structure" such as downed trees, lily pads, submerged weedbeds and rocks. Given our relatively mild climate, bass can grow to trophy proportions in our waters if anglers practice catch and release.

Smallmouth Bass: Relatively uncommon on Long Island, significant populations of smallmouth bass are only found in Fort Pond, Fresh Pond (Shelter Island) and Lake Success (private). Smallmouths or bronzebacks, as they are sometimes called, are most well known for their incredible fights they put on when hooked. Look for smallmouths in rocky shallows during the spring and fall and deep water structure during the summer.

Chain Pickerel: Long Island's native predator, chain pickerel can be found in shallow, weedy waters throughout the region. The waterwolf, as it is sometimes known, is famous for its torpedo-like attacks on lures. Chain pickerel can be caught on any of the lures used for largemouth bass, but are particularly fond of spoons and spinnerbaits. Some of the largest chain pickerel in the state are found in Long Island.

Walleye: These popular gamefish have been stocked in Lake Ronkonkoma since 1994 and Fort Pond since 1996. Walleyes are related to yellow perch and share many of their habits. Walleye can be caught on natural baits such as earthworms, minnows and leeches, or artificial baits such as swimming plugs and curlytail jigs. Walleye are very light sensitive with best fishing occurring during overcast days and low light periods.

Yellow Perch: Long Island waters produce some of the largest yellow perch in the state. Yellow perch are a schooling species that tend to be found in deeper, more open water areas near vegetation or

(Continued inside back cover)

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Brookhaven National Laboratory

Site Environmental Report for Calendar Year 1996

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PREFACE

The U.S. Department of Energy Order 5400.1, "General Environmental Protection Program", establishes the requirement for environmental protection programs. These programs ensure that the Department of Energy's operations comply with applicable federal, state, and local environmental laws and regulations, executive orders, and departmental policies. Brookhaven National Laboratory established a plan for implementing this Order, which is described in the Environmental Monitoring Plan. This plan is updated annually.

The Brookhaven National Laboratory's Site Environmental Report is prepared annually pursuant to Department of Energy Order 5400.1 to summarize environmental data, characterize the Brookhaven National Laboratory Site, demonstrate compliance status, assess the impact of Brookhaven National Laboratory's operations on the environment, and document the efforts made by Brookhaven National Laboratory's Management to mitigate environmental impacts. More detailed environmental compliance, monitoring, surveillance, and study reports may be of value; therefore, to the extent practical, these additional reports are referred to in the text.

This report is prepared for the Department of Energy by the Safety and Environmental Protection Division at Brookhaven National Laboratory; the document is the responsibility of the Environmental Protection Office of the Division. This Office is responsible for preparing the sampling plan, collecting environmental and facility samples, interpreting the results, performing impact analysis of the emissions and effluents from Brookhaven National Laboratory, and compiling the information presented here.

Although this report is written to meet Department of Energy requirements and guidelines, it is also intended to meet the needs of the public. The Executive Summary was written with a minimum of technical jargon, and a condensed version of this Site Environmental Report, titled the Summary Report, also has been prepared for public distribution. The Appendices give a list of acronyms, abbreviations, and other useful information.

Inquiries about this report and the Summary Report may be sent to the Public Affairs Office, Brookhaven National Laboratory, Upton, New York 11973 (516 344-2345).

ABSTRACT

This report documents the results of the Environmental Monitoring Program at Brookhaven National Laboratory and summarizes information about environmental compliance for 1996. To evaluate the effect of Brookhaven National Laboratory's operations on the local environment, measurements of direct radiation, and of a variety of radionuclides and chemical compounds in the ambient air, soil, sewage effluent, surface water, groundwater, fauna, and vegetation were made at the Brookhaven National Laboratory site and at adjacent sites. The report also evaluates the Laboratory's compliance with all applicable guides, standards, and limits for radiological and non-radiological emissions and effluents to the environment.

Areas of known contamination are subject to Remedial Investigation/Feasibility Studies under the Inter Agency Agreement established by the Department of Energy, Environmental Protection Agency and the New York Department of Environmental Conservation. Except for identified areas of soil and groundwater contamination, the environmental monitoring data has continued to demonstrate that compliance was achieved with the applicable environmental laws and regulations governing emission and discharge of materials to the environment. Also, the data show that the environmental impacts at Brookhaven National Laboratory are minimal and pose no threat to the public nor to the environment.

This report meets the requirements of Department of Energy Orders 5484.1, Environmental Protection, Safety, and Health Protection Information reporting requirements and 5400.1, General Environmental Protection Programs.

ACKNOWLEDGMENT

Many individuals assisted in collecting data, and preparing this report. The editors express their gratitude to all these individuals. However, the following individual efforts require special acknowledgment.

Monitoring and surveillance data were obtained through the combined efforts of the Environmental Protection Office and the Analytical Services Laboratory. Special recognition is reserved for the dedication and professionalism of the Sampling & Analysis Staff: M. Bero, R. Lagattolla, and L. Lettieri; and, the Analytical Laboratory Staff: C. Decker, R. Gaschott, P. Hayde, A. Meier, L. Muench, J. Odin, S. Scarpitta and M. Surico.

The editors further extend their appreciation to the following additional contributors of the main sections of this report, which included review of data, preparation of text, and, in some cases, participation in the collection of data. These individuals are:

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W. Gunther and Staff, principally R. Howe and A. Harris; Office of Environmental Restoration; Comprehensive Environmental Response Compensation and Liability Act; and V. Cassella, Meteorology, Department of Applied Science.

Finally, the authors would like to extend a special thanks to Rosemary Taylor for her infinite patience and quality of work in typing, reviewing, and finalizing this report.

Contributions from other Agencies

The Laboratory acknowledges the continued support of the New York State Department of Environmental Conversation, Fisheries Bureau, in the collection of fish samples from the Peconic River and adjacent fresh water bodies; and the Suffolk County Department of Health Services for the collection of potable water samples for adjoining communities, and collection of vegetation and fruit samples from local farms.

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EXECUTIVE SUMMARY

The Brookhaven National Laboratory's (BNL) Environmental Monitoring Program is conducted by the Safety & Environmental Protection (S&EP) Division and the Environmental Restoration Program is conducted by the Office of Environmental Restoration (OER). The Environmental Monitoring Program is designed to determine whether BNL facility operations have met the requirements of applicable environmental and effluent control standards. The program is also used to assess the impact of BNL operations on the environment. The program includes monitoring for both radiological and non-radiological parameters. This report summarizes the data for external radiation levels, radioactivity in air, rain, potable water, surface water, groundwater, soil, vegetation, fauna, aquatic biota, water quality, metals content, organic compounds in groundwater, surface water, and potable water. The Environmental Restoration Program was established in 1991 to identify, characterize, mitigate, and eliminate, as appropriate, areas of soil and groundwater contamination that resulted from past chemical and radiological spills, discharges, and waste handling activities. This report summarizes the data collected during Environmental Restoration activities in 1996 including those related to soil, groundwater, surface water, and private potable water quality.

Analytical results are reviewed by the S&EP Division and OER staff and, when required by permit conditions, transmitted to the appropriate regulatory agencies through the Department of Energy (DOE). Data summaries for Calendar Year (CY) 1996 are presented in the text of the Site Environmental Report (SER).

Airborne Effluents

The most significant radioactive airborne effluents generated at BNL originate from the High Flux Beam Reactor (HFBR), Brookhaven Linear Accelerator (LINAC) Isotope Production Facility (BLIP), and the Medical Research Reactor (MRR). Argon-41 (half-life = 1.8 hours), oxygen-15 (half-life = 123 seconds), and tritium (half-life = 12.3 years) were the predominant radionuclides released. In 1996, 1,707 Ci (63.2 TBq) of argon-41 were released from the MRR; 30 Ci (1.1 TBq) of oxygen-15 were released from the BLIP Facility, and a combined total of 53.1 Ci (2.0 TBq) of tritium in the form of water vapor were released from the HFBR and Evaporator Facility. Much smaller quantities of airborne radioactive effluents, typically in the milli- to microcurie range, were released from the Hazardous Waste Management Facility (HWMF) Incinerator, Alternating Gradient Synchroton (AGS) Facility, AGS Booster.

Liquid Effluents

Liquid discharge limits for non-radiological parameters are subject to conditions listed in BNL's State Pollutant Discharge Elimination System (SPDES) Permit No. NY-0005835, issued by the New York State Department of Environmental Conservation (NYSDEC). Discharge concentrations for radionuclides are governed by the DOE Derived Concentration Guides (DCGs). Since such liquid discharges have the potential of contaminating the sole-source aquifer underlying the Laboratory site, administrative controls maintain all liquid discharges at or below concentrations prescribed by the Safe Drinking Water Act (SDWA) and DOE Orders.

All STP effluents met the radiological limits specified the DOE in Order 5400.5, "Radiation Protection of the Public and the Environment." The principle radionuclide detected at the Sewage Treatment Plant (STP) Peconic River Outfall was tritium. The total annual release of tritium to the Peconic was 1.3 Ci (48 GBq) and the annual average tritium concentration was 1,348 pCi/L (50 Bq/L), or 7% of the 20,000 pCi/L (740 Bq/L) SDWA limit. Other beta/gamma-emitting radionuclides were detected on an infrequent basis throughout the year at levels that were small fractions of the applicable concentration guidelines.

Non-radiological parameters are monitored at the effluent of the STP in accordance with the conditions of the SPDES permit. These parameters include residual chlorine, metals, volatile organic compounds including 1,1,1-trichloroethane (TCA), methylene chloride, toluene, and 2-butanone, pH, temperature, Biochemical Oxygen Demand (BOD_5), flow, suspended and settleable solids, fecal coliform bacteria, and ammonia-nitrogen. Although the compliance rate exceeded 99%, there were twenty permit deviations; five for removal of total suspended solids (TSS), one each for iron, ammonia, maximum and average Fecal coliform and average BOD_5, two for silver, and eight for BOD_5 removal. The exceedances for BOD_5 and TSS removal were attributed to their low concentration in the influent to the STP and the high degree of removal required under BNL's SPDES permit. With the exception of a single average BOD_5 excursion, all effluent concentration of BOD_5 and TSS were within SPDES limitations. To avoid SPDES permit excursions for average BOD_5 and TSS, the sample frequency was increased to twice per month. The two silver digressions resulted from the imposition of stricter SPDES effluent limitations which has necessitated implementing better source controls for waste waters generated from photo developing, and from silver plating electrical contacts.

Liquid effluent discharged to the on-site recharge basins contained only traces of radioactivity. Radioactive material in water discharged to the recharge basins was detected infrequently, and then only at small fractions of the applicable concentration guidelines.

The BNL SPDES permit requires monthly and quarterly monitoring of discharges to the BNL recharge basins. Monitoring includes monthly reporting of flow, pH, and oil and grease, with quarterly reporting for organic and inorganic contaminants. Except for a single pH excursion at recharge basin HTw (Outfall 006A), all discharges complied with the SPDES limitations. Measurements of pH at this location slightly exceeded the upper limit of 8.5 SU due to the increased addition of sodium hydroxide to the BNL's potable water system. In an effort to reduce the potential for corroding BNL's water distribution system, a study conducted in 1995 recommended raising the pH of the potable water to 8.0 SU. Fluctuations in the control of pH in the potable water system most likely caused the elevated reading at the recharge basins due to the high volume of cooling water that is discharged from BNL facilities.

External Radiation Monitoring

An array of thermoluminescent dosimeters (TLDs) are used to monitor external gamma radiation levels at 24 locations on-site and 25 locations off-site. The average annual on-site integrated dose for 1996 was 66 ± 6 mrem (0.66 ± 0.06 mSv), while the off-site integrated dose was 67 ± 7 mrem (0.67 ± 0.07 mSv). These levels are typical of those measured throughout the northeastern part of the United States (NCRP, 1987) and verify that airborne emissions from the Laboratory had no impact on the external radiation levels of the surrounding area. (The difference between the on-site and off-site integrated exposure is within the statistical variation of the measurements and does not represent a true difference.)

Atmospheric Radioactivity

Air sampling was performed throughout the year to monitor airborne radionuclide concentrations. Monitoring was performed for the analysis of particulates, radioiodines and tritiated water vapor. Particulate samples were also collected weekly for the New York State Department of Health (NYSDOH) for analysis at their independent laboratory. Naturally-occurring radionuclides and tritium were detected most frequently in the collected samples. Gross alpha and gross beta activity levels were consistent with those measured in Albany, NY (a location used as a control area by the NYSDOH in their state-wide environmental radiation monitoring program), indicating that ambient radiological air quality at BNL is comparable to that across New York State (NYS).

The maximum annual average tritium concentration was 6 pCi/m^3 (0.2 Bq/m^3), measured at the southwest site boundary. This level represents < 0.01% of the DOE concentration guidelines for airborne tritium. Normal trace levels of cosmogenic and terrestrial radionuclides such as beryllium-7, and bismuth-211 were detected sporadically throughout the year. Other beta/gamma-emitting nuclides were detected at extremely low levels, close to the detection limit of the analytical method and at concentrations less than 1% of DOE guidelines.

Surface Water

***Radiological Analyses*:** Water samples were collected at several stations along the length of the Peconic River from the BNL STP Outfall to Riverhead. Two Peconic sampling stations on BNL property are used when river flow is available: Location HMn, 0.8 km downstream of the STP Outfall, and Location HQ at the site boundary, adjacent to North Street. A third location, HMs which is located along a typically dry tributary that runs parallel and south of the main river flow was also sampled in 1996 due to heavier than normal rainfall. This tributary receives storm water run-off from several areas of the Laboratory and is characterized by discoloration and low pH, due to contribution of tannic acid from the decay of leaves and other organic matter.

River samples from Location HMn showed detectable levels of tritium and cesium-137 resulting from discharges at the STP. Annual average values for tritium were less than 7% of the level specified by the SDWA. Observed cesium-137 concentrations at Location HMn are consistent with levels measured at the STP Outfall and are the result of continued leaching of historically deposited material in the STP sand filter beds. While measurable just above the detection limit, cesium-137 levels were small fractions (typically, less than 1%) of the DOE Guide. Tritium was not detected farther downstream of the Peconic due to persistent low water table conditions that cause the river to recharge directly to groundwater before leaving the BNL site. Trace levels of cesium-137 and strontium-90 were detectable farther downstream at levels which may reflect residual material from previous historical releases. These levels are far below applicable drinking water standards and pose no threat to aquatic life or users of the river.

***Non-radiological Analyses*:** Surface water samples were collected from the Peconic River and from the Carmans River as an off-site control location. These samples were analyzed for water quality parameters (i.e., pH, temperature, conductivity, and dissolved oxygen), anions (i.e., chlorides, sulfates, and nitrates), metals, and Volatile Organic Compounds (VOCs) during CY 1996.

All water quality parameters were consistent with the off-site control location and with historical data. Except for iron, analytical data for metals showed all parameters to be consistent with historical data and all concentrations were below the New York State Drinking Water Standard (NYS DWS). Iron was prevalent at or above the drinking water standard in all locations due to its high concentration within native soils and groundwater. Low concentrations of chloroform were detected in samples collected at Location HMn and is most likely present as a chlorination by-product. Trace quantities of TCA and benzene were detected at Locations HR (Riverhead) and HH (Carmans River). Due to the location of these monitoring facilities, the presence of these contaminants cannot be attributed to BNL operations.

Aquatic Biological Surveillance

The Laboratory, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies. In 1996, an extensive fish sampling program was conducted at Donahue's Pond, Forge Pond, Swan Pond, Upper Twin Pond (Wantagh), Fresh Pond (Montauk), and the Carmans River. Brown bullhead, bluegill, carp, rainbow trout, yellow perch, chain pickerel, golden shiner, pumpkinseed and large mouth bass species were collected and analyzed for radioactive content. The fish type which was collected uniformly from all locations was the *brown bullhead*, a bottom feeding fish which is a good indicator species for sedimentary radionuclide uptake. Concentrations of cesium-137 in fish from Peconic River-fed water bodies were not significantly different from water bodies which are not connected to the Peconic. In fact, fish from Fresh Pond in Montauk consistently showed higher cesium-137 concentrations than those from Donahue's Pond, indicating that there are wide variations in local background cesium levels, probably resulting from world-wide fallout from the above ground nuclear testing.

Previous studies have found that fish from the Peconic River system contain elevated levels of man-made radionuclides above those attributable to fallout. In recent years, due to greatly reduced fresh contributions from the BNL STP, these levels have been seen to decline steadily. In light of the Fresh Pond data, cesium concentrations in brown bullhead in the Peconic River system appear to be comparable to other local waters which receive no discharges from BNL. 1996 was the first year in which fish were collected from this location.

To evaluate potential dose from fish consumption from the Peconic River system, fish seen to contain the highest concentrations of cesium-137 and strontium-90 were used; in this case, the pumpkinseed species. The maximum committed effective dose equivalent delivered to a person ingesting 7 kilograms of fish from the Peconic River is 0.45 mrem (4.5 μSv). This is less than 1%

of the dose typically received by a U.S. citizen annually from natural, internally-deposited radionuclides.

Shellfish such as clams and mussels were also collected from a number of local water bodies including Peconic Bay, Flanders Bay and Lloyd Harbor. No man-made radionuclides were observed in any of the collected samples while naturally-occurring radionuclides like potassium-40 were found at consistent concentrations at all sample locations.

Radiological Analysis of Local Fauna

In 1996, an extensive deer sampling program was initiated in cooperation with the NYSDEC Wildlife Branch. In this program licensed hunters were approached by the NYSDEC at the established check points for samples of deer meat and/liver. This program provided the Laboratory with samples from many off-site locations near the Laboratory and elsewhere on the Island. Samples of deer meat were also collected from on-site locations from deer kills on-site. These samples were analyzed for radiological content. Deer taken on BNL property were found to contain cesium-137 concentrations at levels that are above those taken from off-site. This is caused by deer grazing in areas where elevated cesium-137 levels have been found in BNL soils. Strontium-90 analysis of the same samples did not show a difference in levels between on-site and off-site deer meat samples.

Radiological Analysis of Local Vegetation

Soil and vegetation were collected from off-site locations as part of the Soil and Vegetation Sampling Program, and analyzed for radioactive content. This program is a cooperative effort between BNL and the Suffolk County Department of Health Services (SCDHS). Samples from local farms situated adjacent to BNL were collected in July and October 1996. All radionuclides detected in these samples were of natural origin, from application of fertilizers, or fallout-related. No nuclides attributable to Laboratory operations were detected.

Radiological Analysis of Soils and Sediments

Soil and sediment samples were collected from the Peconic River, Carmans River (background), Peconic Bay, Flanders Bay, Lloyd Harbor (a background location), and farms in the vicinity of the Laboratory. Radiological analysis shows that natural radionuclides are uniformly prevalent in the local marine environment and the terrestrial environment. Man-made radionuclides which were detected are indicative of worldwide fallout patterns; cesium-137 concentrations in sediment from Peconic River-fed bodies were comparable to those observed at control locations.

Potable Water Supply

The Laboratory's potable water supply wells are screened from a depth of about 15 m to about 26 m in the Upper Glacial aquifer. During 1996, Well Nos. 10, 11, and 12 were used to supply drinking water at BNL. Water samples collected from these wells were analyzed for radioactivity, metals, organics, and water quality; the results are discussed next. Improvements to the Water Treatment Plant (WTP) continued throughout 1996; consequently, Wells 4, 6 and 7 remained out of service.

***Radiological Analyses*:** On-site potable wells were sampled for radioactive content. Analysis for gross alpha activity, gross beta activity, tritium, gamma-emitting radionuclides and strontium-90 was performed. All gross activity results were typical of environmental levels and below all drinking water limits. Neither tritium nor strontium-90 were detected in any sample. Cesium-137 was detected in Wells 11 and 12 at less than 1 pCi/L (0.04 Bq/L), essentially at the limit of detection, making its positive identification questionable. (The drinking water standard for cesium-137 is 120 pCi/L.)

***Non-Radiological Analyses*:** As required by the SDWA, the BNL potable water supply is analyzed for numerous analytical parameters including volatile organics, metals, pesticides, etc. Metals analyses of potable water showed silver, cadmium, chromium, iron, manganese, mercury and lead to be non-detectable in all well water samples. Low concentrations of copper, sodium, and zinc were detected in well-water samples but at concentrations below their respective NYS DWS. Sodium was detected in all potable wells in concentrations ranging from 9.6 to 15.5 mg/L which is well within the recommended drinking water guidelines of 20 mg/L.

To demonstrate compliance with federal and state Drinking Water Standards for organic compounds, potable water is sampled quarterly for Principal Organic Compounds (POCs) and annually for Synthetic Organic Compounds (SOCs) and sent to an off-site NYSDOH certified laboratory. The POC analysis includes halogenated and nonhalogenated organic compounds while the SOC analysis includes chlorinated and non-chlorinated pesticides. The POC analyses detected organic compounds in all potable wells, but with the exception of Well 11, all concentrations were less than the NYSDOH-prescribed drinking water standard. The maximum concentration of TCA in untreated water collected from Well 11 (7.6 μg/L) exceeded the NYSDOH standard of 5 μg/L. To lower the concentration of POCs in water pumped from Wells 10, 11, and 12, these wells are equipped with activated carbon adsorption vessels. A review of analyses for treated water showed all organic compounds to be within the NYS DWS. There were no SOCs detected in these water samples.

Groundwater Surveillance

Groundwater surveillance data are compared to New York State Ambient Water Quality Standards (NYS AWQS), and DOE DCGs for radionuclides, in this report. The DCG for a given radionuclide represents the concentration which would cause a committed effective dose equivalent of 100 mrem (1 mSv) if an individual were to consume two liters of the liquid per day for one year. Comparison of data to these concentrations permits evaluation of discharge limit impacts and provides a historic framework to evaluate past practices. Comparison of surveillance well data to Environmental Protection Agency (EPA), NYSDEC, and NYSDOH reference levels provides a mechanism to evaluate the radiological and non-radiological levels of contamination relative to current standards.

During 1996, 260 groundwater surveillance wells were monitored by the S&EP Division and the OER. Groundwater samples were collected for non-radiological and radiological analyses during nearly 480 individual sampling events . Non-radiological analyses typically consisted of 1) determining water quality parameters, such as pH, conductivity, chloride, sulfate, and nitrate concentrations; 2) metals concentrations; and 3) VOC concentrations. Radiological analyses consisted of measuring for gross alpha and gross beta, tritium, and gamma spectroscopy. Strontium-90 analyses were also conducted on samples collected in areas with historical Sr-90 contamination.

***Non-radiological Analyses*:** Water-quality analyses conducted on groundwater samples collected site wide show that the pH of groundwater typically ranges from 5.5 to 6.5, which is below the lower limit of the NYS AWQS of 6.5 to 8.5. Chloride, sulfate, and nitrate concentrations in most areas of the site were typically below the NYS AWQS. However, metals and VOCs in groundwater exceed NYS AWQS in a number of areas across the site. In several areas of the BNL site, iron is typically detected above NYS AWQS. In some cases, the high iron levels appear to reflect natural background (or ambient) concentrations within the Upper Glacial aquifer. In areas such as the Current Landfill, however, high iron and sodium levels are related to materials disposed there. During 1996, VOCs were detected above NYS AWQS at the Current and Former Landfill areas, Hazardous Waste Management Facility, AGS research facility area, Waste Concentration Facility, Supply and Material area, former Chemistry Department area, western sector, southern boundary and North Shirley residential areas, Building 650, Central Steam Facility, Sewage Treatment Plant and Peconic River area, and the former Upland Recharge-Meadow Marsh Experimental area.

***Radiological Analyses*:** Several areas of known surface radiological contamination have introduced man-made radionuclides into the groundwater underlying the Laboratory. These areas include the HWMF, the "Current" and "Former" Landfills, the AGS, the WCF, Building 650, the HFBR and the STP. The most common radionuclides which have been introduced from these facilities include tritium, cesium-137, strontium-90, and sodium-22. Often these radionuclides are present below applicable drinking water standards, but concentrations have been found above these standards downgradient of the HWMF (strontium-90 and tritium), "Current" and "Former" Landfills (strontium-90), HFBR (tritium), WCF (strontium-90), and Building 650 (strontium-90).

Environmental Restoration

During 1996, the BNL Environmental Restoration Program made significant progress in its ongoing efforts to characterize and remediate contaminated soil and groundwater resulting from past spills, releases and disposal practices. The highlights of accomplishments in 1996 include: (1) Free public water hookups to approximately 800 homes in the North Shirley/East Yaphank area as a precautionary measure, (2) Capping of an eight-acre landfill, (3) construction and operation of a groundwater cleanup system at the southern boundary that pumps and treats groundwater contaminated with common chemical solvents, (4) removal and off-site shipment/disposal of sixty-four thousand gallons of low-level sludge from a settling tank located at the BNL STP, (5) signing of BNL's first Record of Decision (ROD) by DOE, EPA, and NYSDEC for an area near the center of the site contaminated with chemicals and radioactivity, (6) initiation of testing the effectiveness of several promising technologies in various areas of BNL, such as, air sparging, vitrification, phytoremediation,

Public Dose Estimates

Brookhaven National Laboratory is subject to the requirements of Title 40 CFR Part 61, Subpart H, a section of the Clean Air Act. This EPA Rule establishes national policy regarding the airborne emission of radionuclides. It specifies the monitoring and reporting requirements for various types of radionuclides and establishes the public dose limit for the airborne pathway as 10 mrem (0.1 mSv) per year. The committed effective dose equivalent to the maximally exposed individual resident at the site boundary from the air pathway was calculated to be 0.07 mrem (0.7 μSv) using the EPA CAP88-PC dose model.

Using DOE Order 5400.5 dose conversion factors, the maximum individual committed effective dose equivalent from the drinking water pathway (in off-site wells containing tritium) was calculated to be 0.1 mrem (1 μSv).

The maximum individual committed effective dose equivalent from the fish consumption pathway (for fish from Donahue's Pond) was estimated using as 0.5 mrem (5 μSv). (It is important to note that fish taken from distant control locations showed higher concentrations than those collected from the Peconic-fed Donahue's Pond. This indicates that there is no extra contribution from past BNL effluents to individual dose from this pathway.)

The potential dose resulting from the consumption of deer meat containing BNL-related radionuclides was also evaluated in 1996. An additional committed effective dose equivalent of 0.8 mrem would be received by an individual consuming deer meat (from on-site animals) at an annual rate of 2 kilograms per year. (On-site sport hunting is not permitted, though deer may migrate off-site.)

These doses represent less than 1% of the maximum individual annual dose limit of 100 mrem (1 mSv) and just 0.4% of the radiation received annually (excluding radon exposure) from natural background sources. These maximum credible doses demonstrate that in 1996, BNL's radiological effluents had no impact on the health of the public or environment in the surrounding area.

Quality Assurance Program

The QA Program developed by BNL provides policies, responsibilities, and guidance procedures to the Divisions and Departments for complying with DOE Order 5700.6C, Quality Assurance. The S&EP Division adopted or adapted these program elements into the S&EP Division Management System Manual (BNL, 1994) and established responsibilities, methods, and controls for conducting its operations. The Environmental Protection Office and ASL integrated both these QA elements and specific environmental QA requirements cited in DOE Order 5400.1 into their sampling, analysis, and data handling activities. The implementing procedures on Environmental Monitoring, Radiation Measurements, Analytical Chemistry, and Regulatory Programs, in conjunction with the S&EP Division Management System Manual and the S&EP QA Procedures

(BNL, 1988), comprised the QA Program for the environmental surveillance and effluent monitoring programs.

One objective of the Environmental Protection QA Program was to ensure that performance was reviewed and evaluated. To that end the S&EP Division QMT, in conjunction with the Environmental Protection Office and Analytical Services Laboratory established a program of internal checks or assessments and external audits to verify the effectiveness of the environmental sampling, analysis, and database activities. Chapter 10 provides an assessment of the environmental and effluent data presented in this SER by summarizing the results of the Analytical Services Laboratory internal quality control program and external performance evaluation programs. Overall, the laboratories produced acceptable results in 91% of the independent inter-laboratory comparisons they participated in during 1996. The Analytical Services Laboratory internal quality control program maintained the analytical processes within their respective acceptance limits in all but a few isolated instances. When encountered, unacceptable results were investigated and corrective actions were implemented to improve the analytical program. Independent audits by outside agencies were conducted during 1996 to verify the effectiveness of the program, determine compliance to requirements, and provide suggestions for improvements.

1997 Environmental Highlights

1. In January 1997, tritium was detected at concentrations that exceeded federal drinking water standards in a monitoring well located immediately south (downgradient) of the HFBR. The presence of tritium at nearly two times the drinking water standard resulted in an intensive 60-day campaign to identify the source of the tritium, characterize the extent of the tritium contamination, and install a groundwater pumping system a the leading edge of the tritium plume. Delineation of the tritium plume was accomplished through the installation of over 120 temporary groundwater characterization wells, 70 permanent monitoring wells, and two horizontal wells under the HFBR. BNL was able to characterize the tritium plume and begin pumping from the leading edge of the plume within the 60-day time frame. In addition to the groundwater investigation, BNL conducted an intensive evaluation of all HFBR components that had the potential to release tritium into the environment. As a result of this evaluation, the HFBR's Spent Fuel Pool was found to have been leaking at a rate of 6 to 9 gallons per day, and was determined to be the primary source of the tritium detected in the groundwater. Details on this investigation have been summarized in a number of published reports prepared by the DOE, the US General Accounting Office (GAO), and BNL. Groundwater data gathered during this investigation will also be reported in the SER for 1997, which will be published in late 1998.

2. The GAO, the New York State Attorney General, and DOE's Office of Environment Safety and Health (EH) investigated and prepared reports on the HFBR tritium leak and related issues.

3. To ensure that all potential sources of groundwater contamination on the Laboratory site are properly identified and characterized, the Laboratory initiated a comprehensive

Facility Review Project to review the operational history of all current and former BNL research and support facilities. Significant accomplishments of the of the Facility Review Project during 1997 are:

a) A comprehensive review of nearly 650 current buildings and structures and 150 former buildings was conducted to look for sources of potential groundwater contamination. The Facility Review Team consisted of personnel from BNL, DOE-BHG, the Suffolk County Department of Health Services, twenty eight specialists from 12 DOE facilities, and many BNL retirees.

b) Twenty-one significant findings from Priority I facilities and 14 significant findings from Priority II facilities were identified and corrective actions were initiated.

4. The BNL Environmental Restoration Program continued its aggressive site cleanup efforts. Over $20 million was spent on activities such as: the excavation of nearly 12,000 cubic yards of contaminated soils and hazardous materials from 55 waste disposal pits; the installation and operation of two groundwater pump and treat systems; the installation and operation of an innovative air sparging and soil vapor extraction system; continued biological and sediment monitoring along the Peconic River; and the continued characterization of several groundwater contamination plumes.

5. The US Environmental Protection Agency (EPA) conducted a comprehensive "Multimedia Audit" of the Laboratory's compliance with environmental regulations.

6. The Laboratory invited regulatory experts from EPA, NYSDEC, and the SCDHS to participate with BNL in addressing the environmental issues that arose in 1997.

7. The Agency for Toxic Substance and Disease Registry conducted a comprehensive Groundwater Consultation and found that the local public health is not affected by any of BNL's groundwater contamination problems.

8. BNL began to develop and implement a series of Integrated Safety Management initiatives designed to improve Work Planning, Self Assessments, Prioritization of ES&H needs, Occupational Illness and Injury performance, Environmental Management Systems, and Work Smart Standards.

1. INTRODUCTION

1.1 Site Mission

Brookhaven National Laboratory is managed by Associated Universities Inc. (AUI) under DOE Contract No. DE-AC02-76CH00016. Associated Universities, Inc. was formed in 1946 by a group of nine universities whose purpose was to create and manage a Laboratory in the Northeast to advance scientific research in areas of interest to universities, industry, and government. On January 31, 1947, the contract for BNL was approved by the Manhattan District of the Army Corp of Engineers and BNL was established on the former Camp Upton Army site.

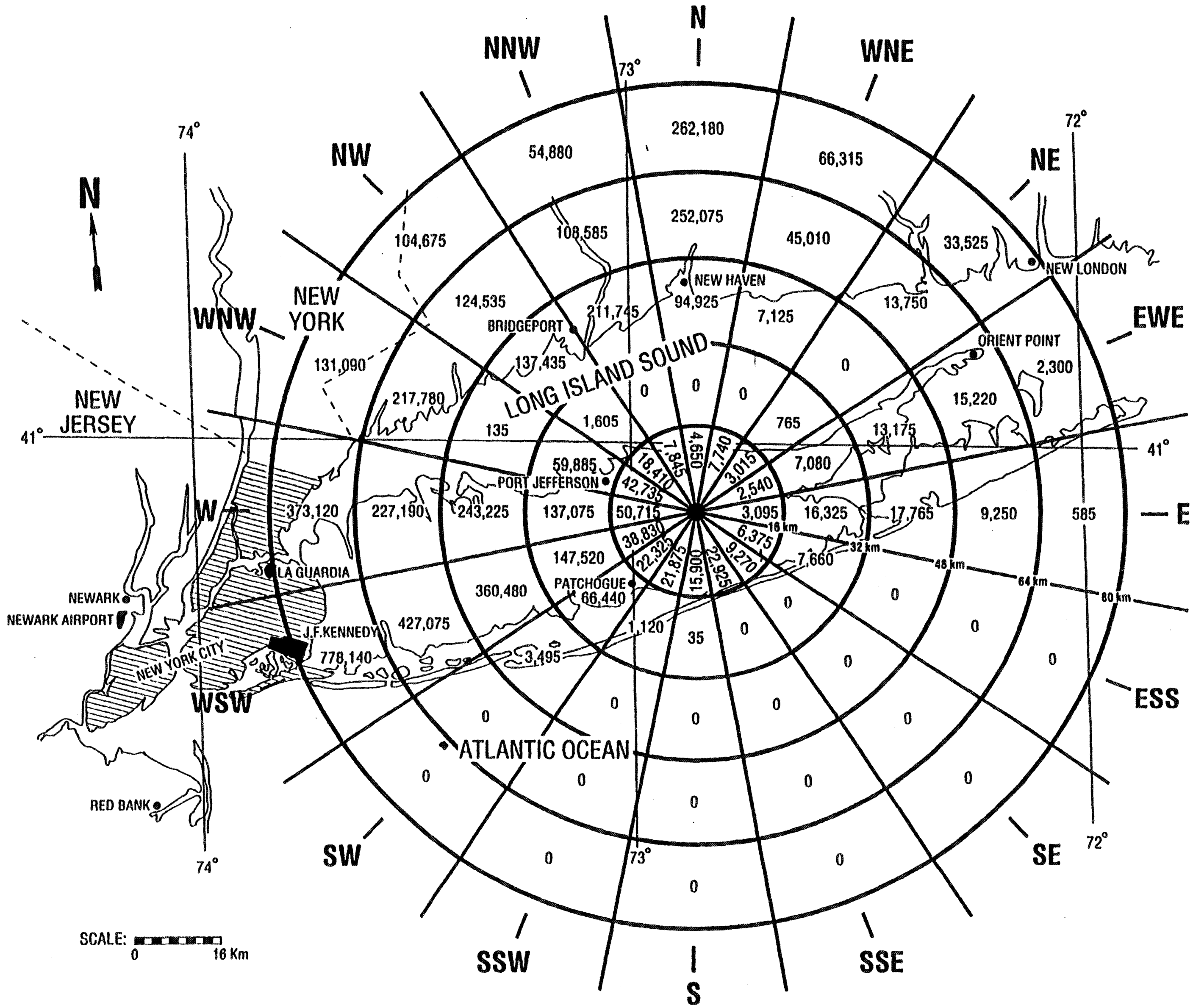
The Laboratory carries out basic and applied research in the following fields: high-energy nuclear and solid state physics; fundamental material and structural properties and the interactions of matter; nuclear medicine, biomedical and environmental sciences; and selected energy technologies. In conducting these research activities, it is Laboratory policy to protect the health and safety of employees and the public, and to minimize the impact of BNL operations on the environment.

1.2 Site Characteristics

Brookhaven National Laboratory is a multi-disciplinary scientific research center located close to the geographical center of Suffolk County, Long Island, about 97 km east of New York City. About 1.34 million persons reside in Suffolk County (LILCO, 1996) , and about 0.42 million in Brookhaven Township, within which the Laboratory is situated. Approximately eight thousand persons reside within a half km of the Laboratory's boundaries. The distribution of the resident population within 80 km of the BNL site is shown in Figure 1-1, and that within 0.5 km is shown in Figure 1-2. Although much of the land area within a 16 km radius is either forested or cultivated, there has been an increase in residential housing development in the rural areas surrounding BNL (Figure 1-3), though there have been no major construction projects since 1978. However, detailed plans for two shopping centers, a corporate park, and several thousand single- and multiple-family dwellings are proposed within a 15 km area of BNL, predominately on the north, south, and west boundaries.

Figure 1-4 shows the Laboratory site. It consists of 21.3 square kilometers (2,130 hectares [ha]), with most principal facilities located near the center. The developed area is approximately 6.7 square kilometers (670 ha), of which about 2.02 square kilometers (202 ha) were originally developed for Army use, and about 0.81 square kilometers (81 ha) are occupied by various large, specialized research facilities. Outlying facilities occupy about 2.22 square kilometers (222 ha), these include the STP, research agricultural fields, housing, and fire breaks. The balance of the site is largely wooded.

The terrain of the site is gently rolling, with elevations varying between 36.6 and 13.3 m above sea level. The land lies on the western rim of the shallow Peconic River water-shed. The marshy



RESIDENT POPULATION 1996 WITHIN A 80 km RADIUS OF BNL

FIGURE 1-1

BROOKHAVEN NATIONAL LABORATORY
LOCAL AND 0N-SITE POPULATION DISTRIBUTION
1996

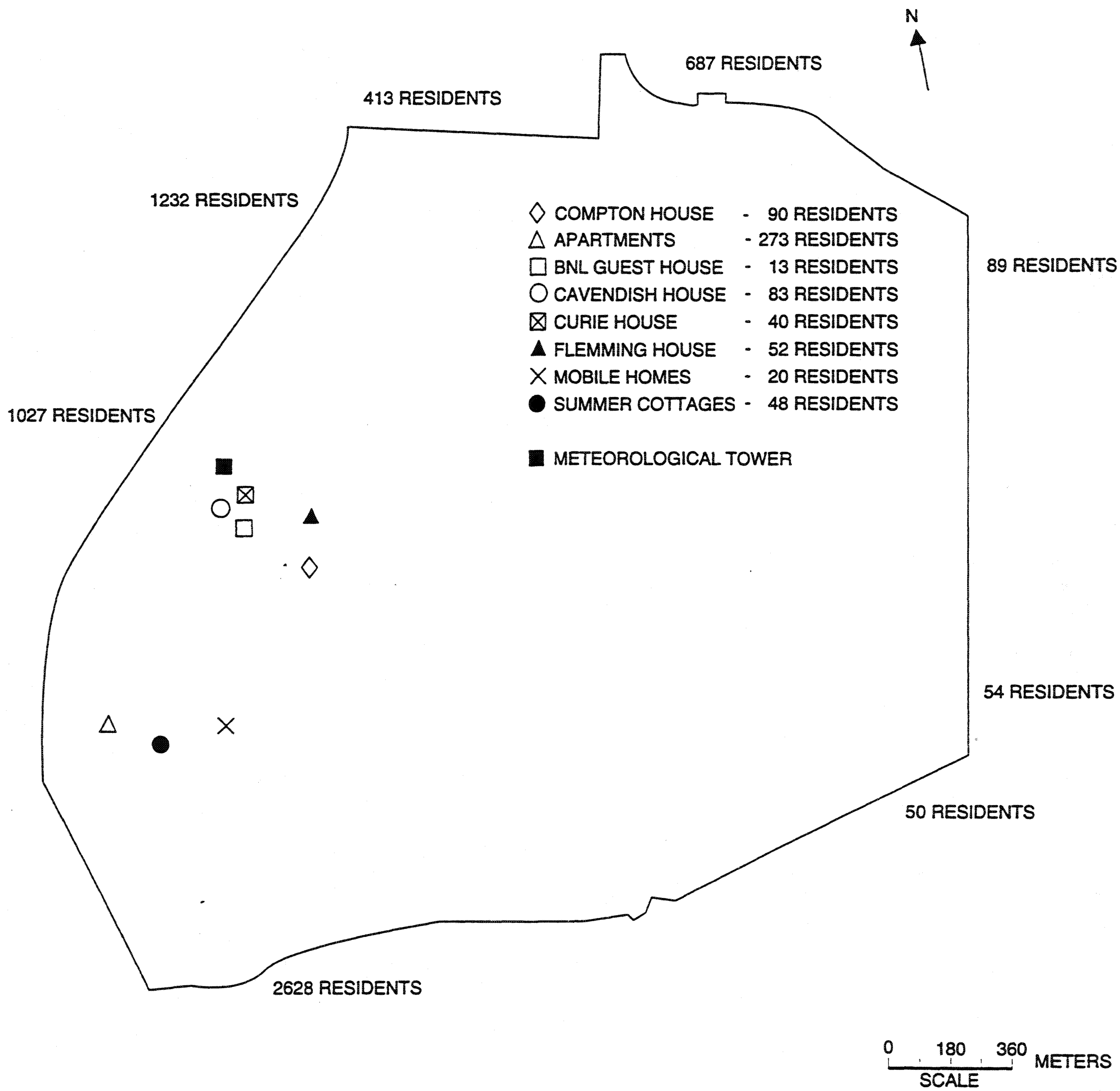
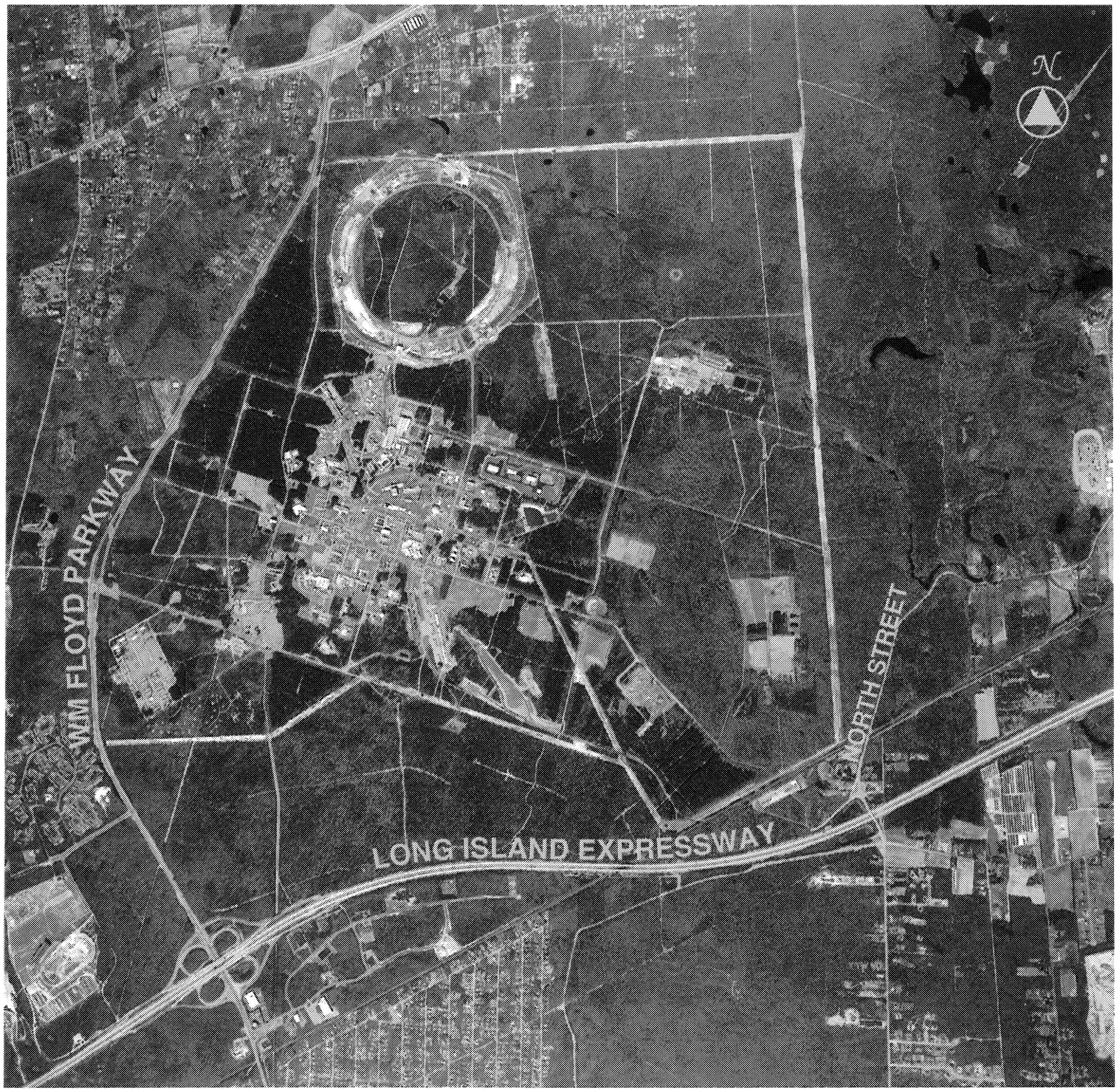
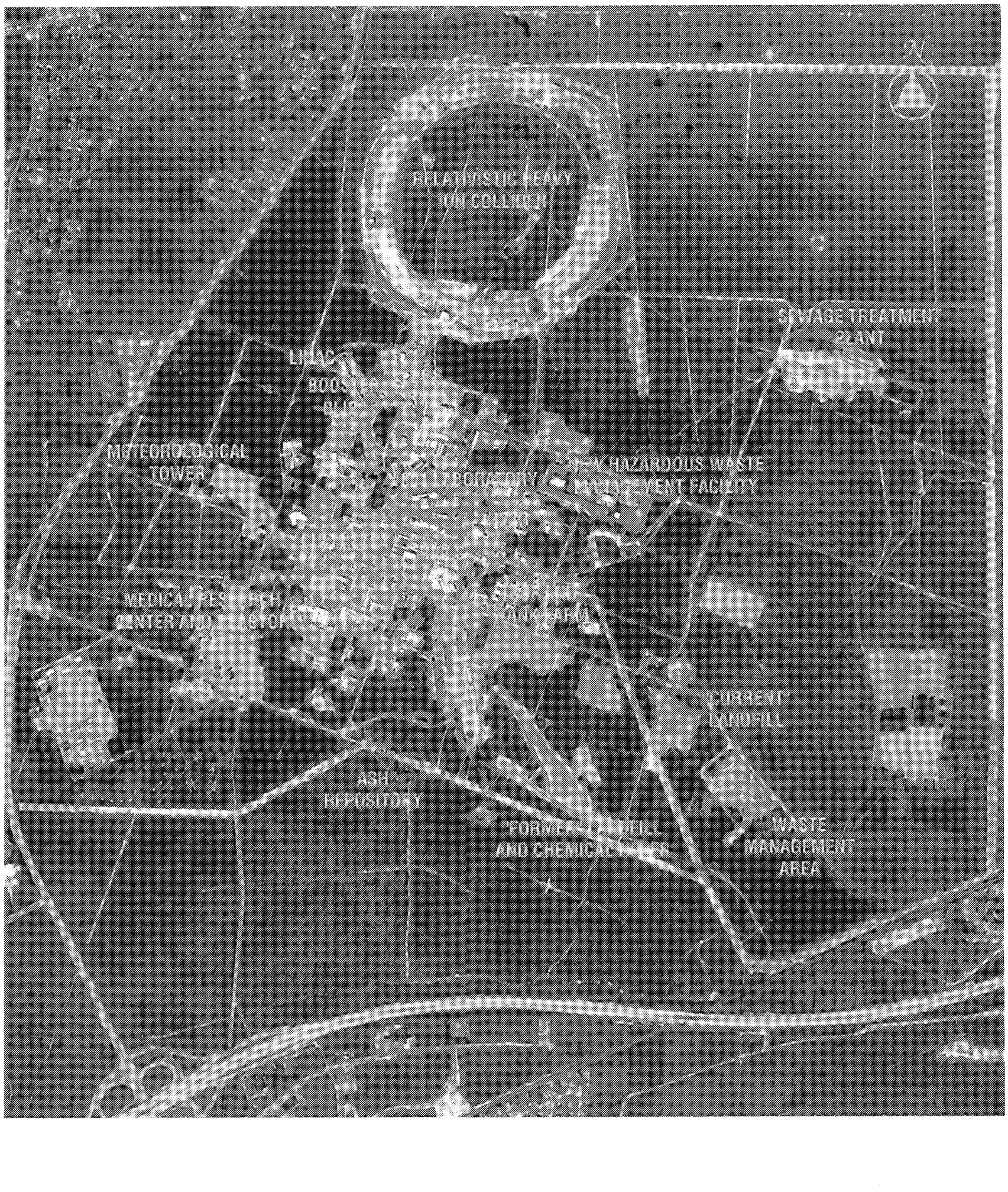


Figure 1-2

BROOKHAVEN NATIONAL LABORATORY
SURROUNDING COMMUNITIES



BROOKHAVEN NATIONAL LABORATORY
MAJOR FACILITIES



areas in the north and eastern sections of the site are a part of the Peconic River headwaters. The Peconic River both recharges to, and receives water from, the groundwater aquifer depending on the hydrological potential. In times of drought, the river water typically recharges to groundwater (i.e., an influent stream) while with normal to above-normal precipitation, the river receives water from the aquifer (i.e., an effluent stream). Thus, the river on-site is classified as an intermittent river. In 1996, the Peconic River bed on-site was in a recharge mode, consequently, no flow left the site.

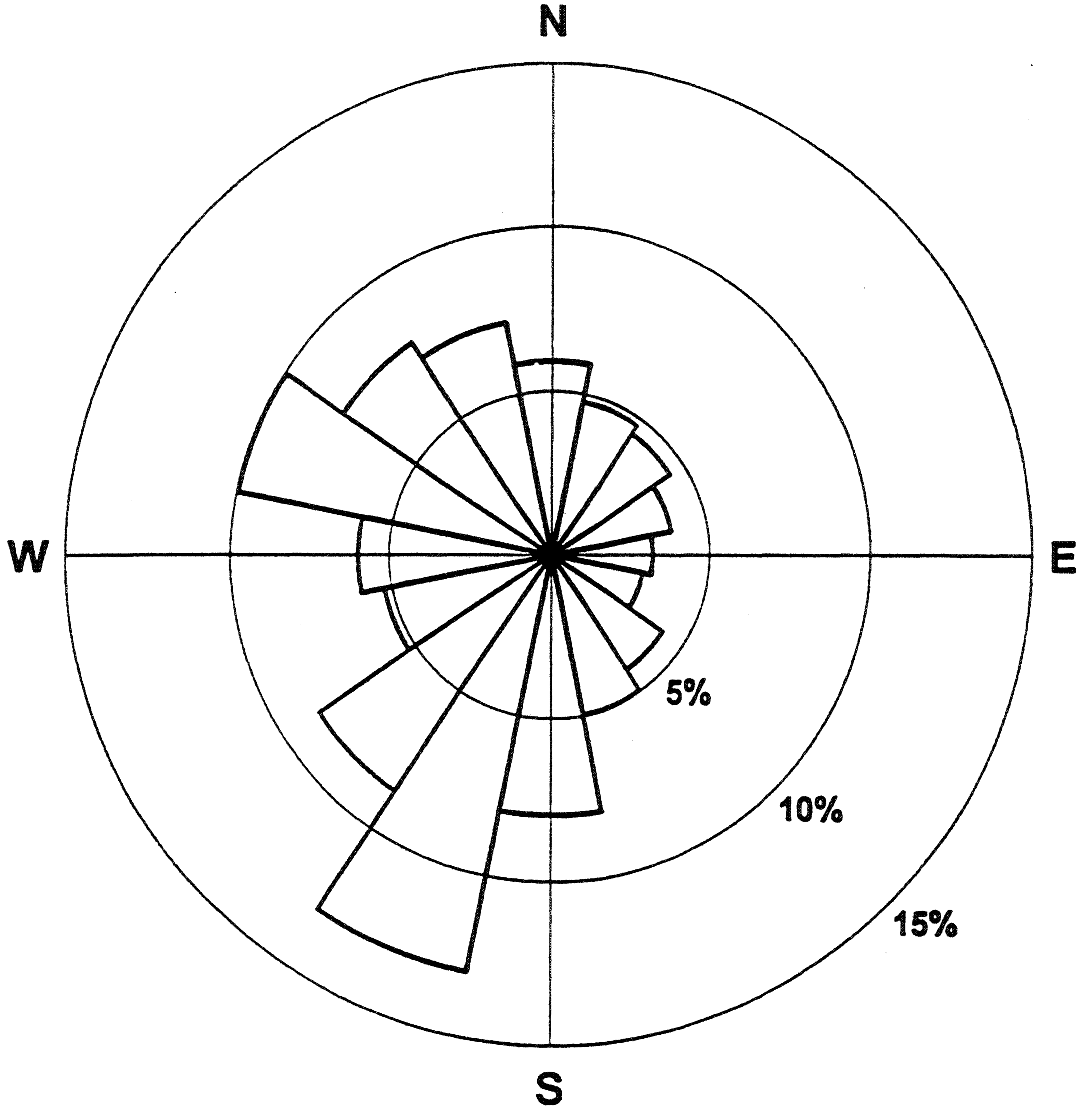
The Laboratory uses approximately 14 million liters of groundwater per day to meet potable water needs plus heating and cooling requirements. Approximately 74% of the total pumpage was returned to the aquifer through on-site recharge basins. About 19% is discharged into the Peconic River. Human consumption, evaporation (cooling tower and wind losses) and cesspool plus line losses account for the remaining seven percent of water consumption.

In terms of meteorology, the Laboratory can be characterized as a well-ventilated site, like most eastern seaboard areas. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions during the spring and fall (Nagle, 1975; Nagle, 1978). Figure 1-5 shows the 1996 annual wind rose for BNL (measurements taken at a height of 88 m (288 ft.). The average temperature in 1996 was 10.6 °C and the range was -6.9 °C to 29.10 °C. Monthly minimum, maximum, and average temperature data is shown graphically in Figure 1-6.

Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits (referred as the Upper Glacial Aquifer), which are between 31 - 61 m thick, are generally composed of highly permeable glacial sands and gravels (Warren et al., 1968). Water penetrates these deposits readily and there is little direct run-off into surface streams, unless precipitation is intense. The total precipitation for 1996 was 153 cm, which is about 30 cm above the 40-year annual average. Figures 1-7 and 1-8, respectively, present the 1996 monthly and historic precipitation data. On the average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration, and the other half percolates through the soil to recharge groundwater (Koppelman, 1978).

Many factors affect groundwater flow in the vicinity of BNL. The main groundwater divide lies approximately 2 - 3 km north of BNL, and runs parallel to the Long Island Sound. East of BNL is a secondary groundwater divide that defines the southern boundary of the area contributing groundwater to the Peconic River. South of these divides, the groundwater moves southward to Great South Bay and to Moriches streams. In general, the groundwater from the area between the two branches of the divide moves eastward to the Peconic River. North of the divide, groundwater moves northward to Long Island Sound. The pressure of a higher water table to the west of the BNL area generally inhibits westward movement. Variability in the direction of flow on the BNL site is a function of the hydraulic potential and is further complicated by the presence of near-surface clay deposits that accumulate perched water at several places within the site, and by the pumping/ recharge of groundwater that is part of BNL's daily operations. In general, groundwater in the northeast and northwest sections of the site flows towards the Peconic River. On the western portion of the site, groundwater flow tends to be towards the south, while along the southern and southeastern sections of the site the flow tends to be towards the south to

Figure 1-5. Annual Wind Rose for Calendar Year 1996.



Notes:

1. The arrow heads formed by the wedges indicate the direction that the wind blew *towards*. This diagram indicates that the predominant wind direction in 1996 was towards the north-northeast.
2. Each concentric circle represents a 5% frequency, so wind blew towards the NNE approximately 13% of the time in 1996.
3. Wind rose is based on data collected at a height of 88 meters (289 ft.) above ground level.

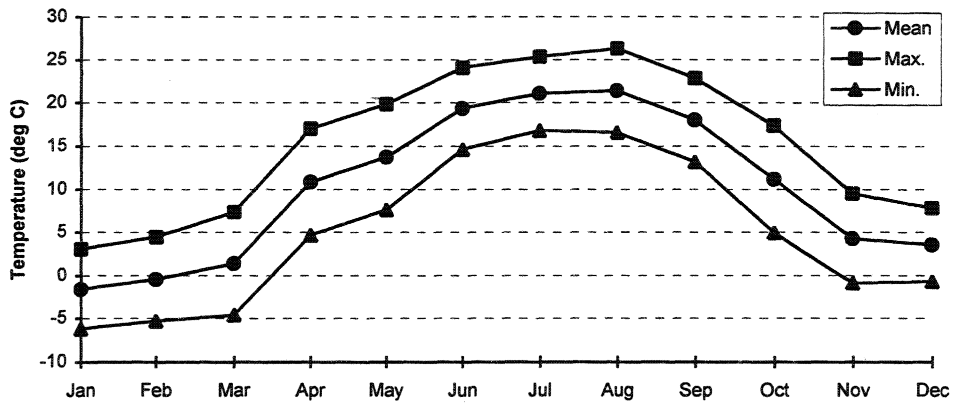


Figure 1-6 1996 Monthly Temperature Trend

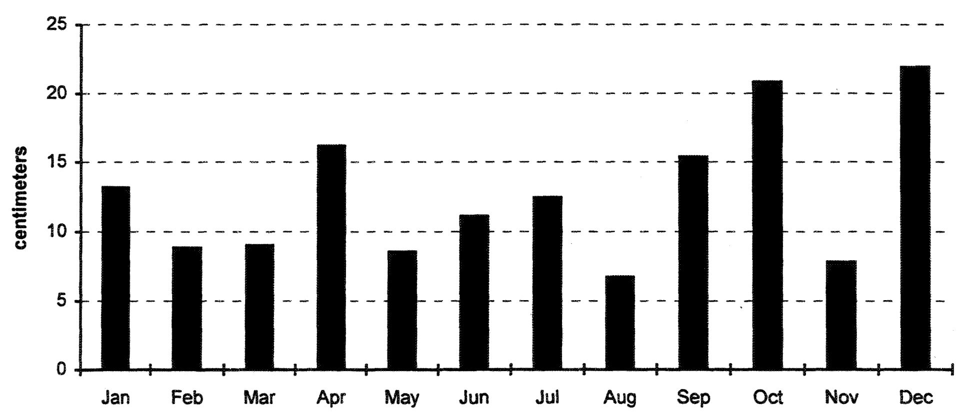


Figure 1-7 1996 Monthly Precipitation

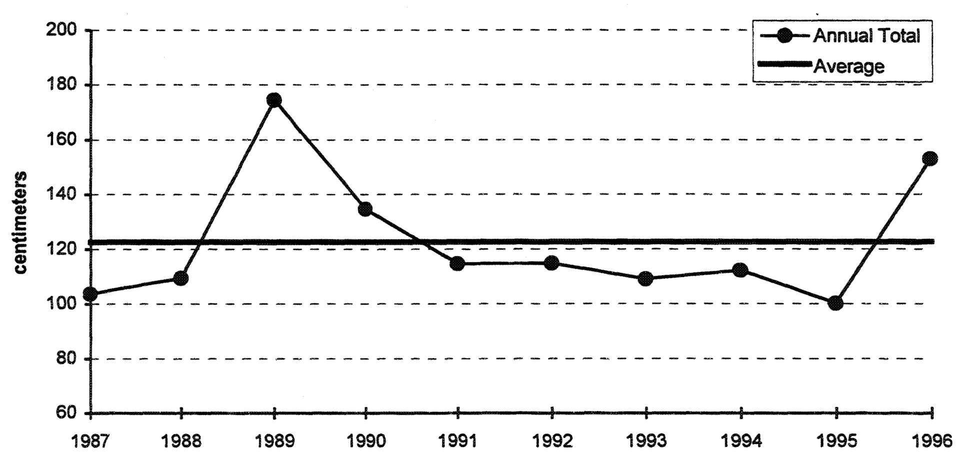


Figure 1-8 10 Year Precipitation Trend

southeast. Figure 1-9 depicts the typical groundwater table configuration for the BNL site. In all areas of the site, horizontal groundwater velocity ranges from 22 to 30 cm/d (Warren et al., 1968). The site occupied by BNL was identified by the Long Island Regional Planning Board and Suffolk County as being over a deep-flow recharge zone for Long Island (Koppelman, 1978). This finding implies that precipitation and surface water which recharges within this zone has the potential to replenish the lower aquifer systems (Magothy and Lloyd) lying below the Upper Glacial Aquifer. It is estimated that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which the BNL site contributes to deep flow recharge has been evaluated (see Geraghty and Miller, 1996b). In coastal areas, these lower aquifers discharge to the Atlantic Ocean or the Long Island Sound.

The Laboratory is located in a section of the Oak/Chestnut forest region of the Coastal Plain. Because of the general topography and porous soil, there is little surface run-off or open water. Upland soils tend to be drained excessively, while depressions form small pocket wetlands. Hence, a mosaic of wet and dry areas on the site are correlated with variations in topography and depth to the water table. Without fires or other disturbances, the vegetation normally follows the moisture gradient closely. In actuality, vegetation on-site is in various stages of succession which reflects the history of disturbances to the area, the most important having been land clearing, fire, local flooding, and draining.

Mammals endemic to the site include species common to mixed hardwood forests and open grassland habitats. At least 180 species of birds have been observed at BNL, a result of its location within the Atlantic Flyway and the scrub/shrub habitats which offer food and rest to migratory songbirds. Open fields bordered by hardwood forests at the recreation complex provide excellent hunting areas for hawks. Pocket wetlands with seasonal standing water provide breeding areas for amphibians. Permanently flooded retention basins and other watercourses support aquatic reptiles. The banded sunfish (*Eanneacanthus obesus*) is one NYS species of "special concern", which has been confirmed as inhabiting the Peconic River on-site (Scheibel, 1990; Corin, 1990). It occurs in New York solely within the Peconic River system. In addition, recent ecological studies at the BNL site have indicated that the NYS endangered eastern tiger salamander (*Ambystoma tigrinum*) uses BNL's vernal ponds and some recharge basins as breeding areas. Part of the Peconic River which occurs on BNL property has been designated as "scenic" in accordance with the NYS's Wild, Scenic, and Recreational River Systems Act (WSRRSA). The wide variety of wildlife resources at BNL attest to Laboratory planning practices which have clustered development to minimize habitat fragmentation, particularly in environmentally sensitive areas such as the Peconic River corridor. Fragmentation of habitats represents the greatest threat to wildlife on Long Island today.

1.3 Existing Facilities

A wide variety of scientific programs are conducted at Brookhaven, including research and development in the following areas:

1. The fundamental structure and properties of matter;
2. The interactions of radiation, particles, and atoms with other atoms and molecules;

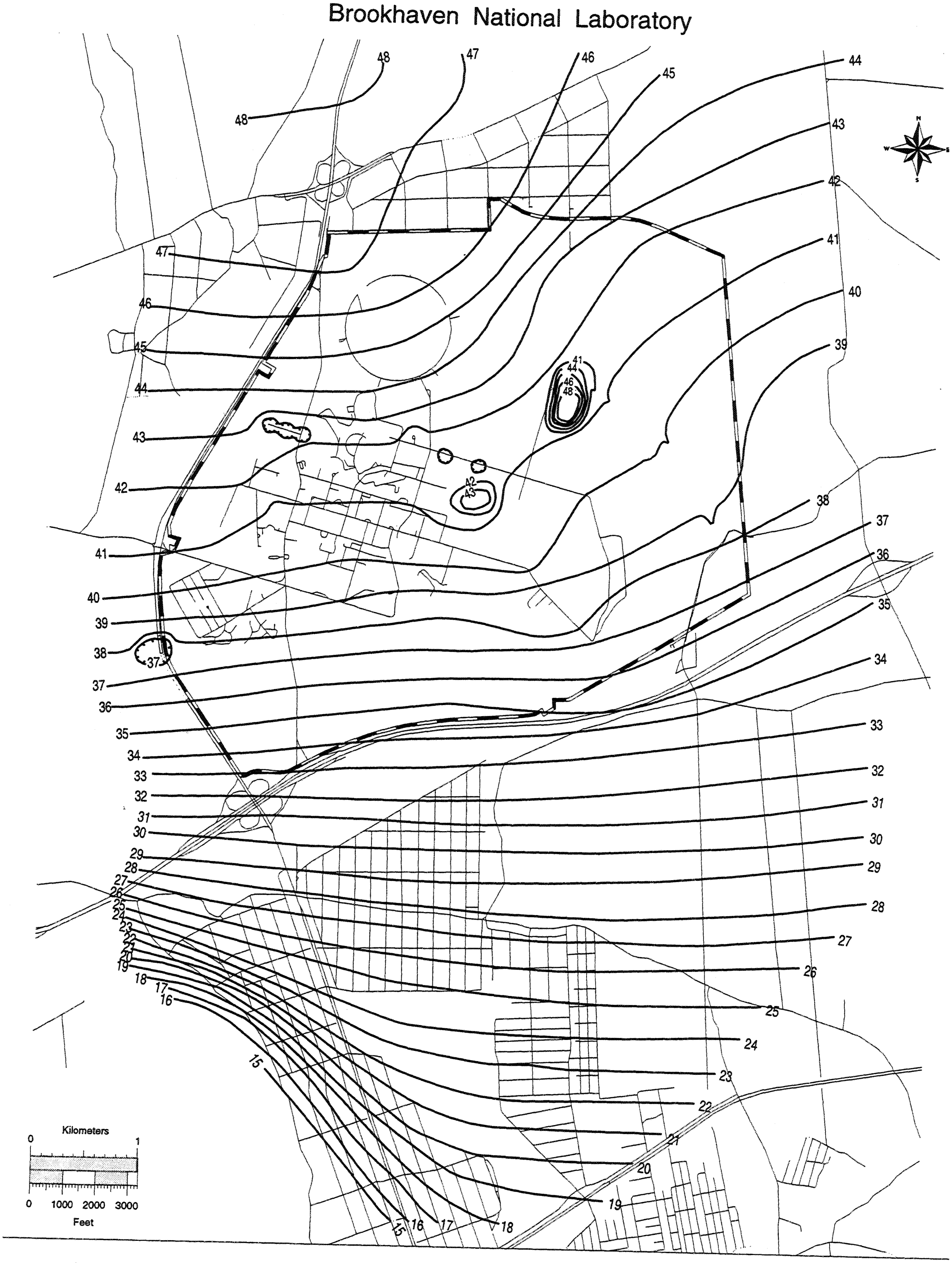


Figure 1-9. Water Table Map for BNL (ft AMSL) June 1996

3. The physical, chemical, and biological effects of radiation;
4. The production of special radionuclides and their medical applications;
5. Energy- and nuclear-related technology; and
6. The assessment of energy sources, transmission, and uses, including their environmental and health effects.

The major scientific facilities operated at the Laboratory to carry out the above programs are described below:

1. The High Flux Beam Reactor (HFBR) is fueled with enriched uranium, moderated and cooled by heavy water. In the past, this facility operated at a routine power level ranging from 40 to 60 MW thermal. Since May 1991, it has operated at a level of 30 MW (thermal).

2. The Medical Research Reactor (MRR), an integral part of the Medical Research Center (MRC), is fueled with enriched uranium, moderated and cooled by light water, and is operated intermittently at power levels up to 3 MW (thermal).

3. The Alternating Gradient Synchrotron (AGS) is used for high energy physics research and accelerates protons to energies up to 30 GeV and heavy ion beams to 15 GeV/amu.

4. The 200 MeV Linear Accelerator serves as a proton injector for the AGS and also supplies a continuous beam of protons for radionuclide production by spallation reactions in the BLIP.

5. The Tandem Van de Graaff and Cyclotron facilities are used in medium energy physics investigations, as well as for producing special nuclides. The heavy ions from the Tandem Van de Graaff can also be injected into the AGS for physics experiments.

6. The National Synchrotron Light Source (NSLS) utilizes a linear accelerator and booster synchrotron as an injection system for two electron storage rings which operate at energies of 750 MeV vacuum ultraviolet (VUV), and 2.5 GeV (x-ray). The synchrotron radiation produced by the stored electrons is used for VUV spectroscopy and for x-ray diffraction studies.

7. The Heavy Ion Transfer tunnel connects the coupled Tandem Van de Graaff and the AGS. The interconnection of these two facilities permits intermediate mass ions to be injected into the AGS where they can be accelerated to an energy of 15 GeV/amu. These ions then are extracted and sent to the AGS experimental area for physics research.

8. The AGS Booster is a circular accelerator with a circumference of 200 meters that receives either a proton beam from the Linac or heavy ions from the Tandem Van de Graaff. The Booster accelerates proton particles and heavy ions before injecting them into the AGS ring. This facility became operational in 1992.

9. The Radiation Therapy Facility, operated jointly by the BNL Medical Department and State University of New York at Stony Brook, is a high-energy dual x-ray mode linear accelerator for radiation therapy of cancer patients. This accelerator was designed to deliver therapeutically useful beams of x-rays and electrons for conventional and advanced radiotherapy techniques.

Additional programs involving irradiations and the use of radionuclides for scientific investigations are carried out at other Laboratory facilities including those of the MRC, the Biology Department, the Chemistry Department, and the Department of Applied Technology (DAT). Special purpose radionuclides are developed and processed for general use under the joint auspices of the Department of Applied Science (DAS) and the Medical Department.

2. COMPLIANCE SUMMARY

It is the policy of BNL to operate and maintain the site in compliance with applicable federal, state, or local regulations and DOE Orders. This section provides a brief summary of the compliance status for existing facilities and operations during CY 1996.

2.1 Environmental Permits

A variety of processes and facilities at BNL operate under regulatory permits. These permits include one SPDES permit, an Major Petroleum Facility (MPF) license, two Resource Conservation Recovery Act (RCRA) permits (one for the existing HWMF; one for the new Waste Management Facility), a certificate from the NYSDEC registering tanks storing bulk quantities of hazardous substances, eight National Emission Standards for Hazardous Air Pollutants (NESHAPs) authorizations, 62 Certificates to Operate (CO) air emission sources from NYSDEC, and 15 applications pending with NYSDEC either for renewing existing COs, canceling existing COs, or COs for new air-emission sources. Table 2-1 provides information regarding the type and status of all environmental permits issued to the DOE through December 31, 1996.

In May 1996, NYSDEC renewed the permits for 25 sources. This action was taken to facilitate the Title V permit process. The remaining permitted sources are being evaluated by NYSDEC to determine whether the need to be included in the Laboratory's Title V permit either as exempt or trivial sources.

2.2 Groundwater Compliance Monitoring

Groundwater monitoring at the (MPF) and the Current Landfill is required by NYSDEC permits or Inter Agency Agreement (IAG) approved monitoring plans, respectively. The MPF currently operates under NYSDEC License No. 01-1700. Groundwater in the MPF area is monitored in accordance with the requirements listed in the NYSDEC License. The CY 1996 compliance monitoring results for the MPF are described in Section 2.3.4.

The Current Landfill was operated until December 1990 under NYSDEC Permit No. 52-S-20. Although the Current Landfill ceased operation in accordance with the Long Island Landfill Law, BNL continued to monitor the groundwater under the requirements specified in the NYSDEC permit until December 1995, when the extent of groundwater contamination in that area had been fully investigated and the landfill was capped. Since January 1996, groundwater monitoring at the Current Landfill has been conducted as part of the post-closure monitoring program prescribed in the IAG approved Operations and Maintenance Plan. As required under the Current Landfill Operations & Maintenance Plan, BNL submitted the first annual Environmental Monitoring Report to the NYSDEC in early 1997 (BNL, 1997). These groundwater data are summarized in Chapter 8, Groundwater Protection.

Table 2-1
BNL Site Environmental Report for Calendar Year 1996
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
134	blueprint machine	NYSDEC-Air Quality	472200 3491 13401	11-29-97(7)
197	degreaser tank	NYSDEC-Air Quality	472200 3491 19702	02-01-98
197	acid metal cleaning	NYSDEC-Air Quality	472200 3491 19703	03-22-96(7)
197	welding shop	NYSDEC-Air Quality	472200 3491 19704	04-01-00
197	fiche duplicator	NYSDEC-Air Quality	472200 3491 19705	09-30-98
197	cleaning room hoods	NYSDEC-Air Quality	472200 3491 19706	01-07-98
197	cleaning room hoods	NYSDEC-Air Quality	472200 3491 19707	01-07-98
197	epoxy coating/curing exhaust	NYSDEC-Air Quality	472200 3491 19708	06-08-98
206	cyclone G-10	NYSDEC-Air Quality	472200 3491 20601	04-01-00
207	belt sander	NYSDEC-Air Quality	472200 3491 20701	04-01-00
208	lead melting	NYSDEC-Air Quality	472200 3491 20801	11-29-97(7)
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802	11-29-96(7)
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803	11-29-96(8)
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804	11-29-96(8)
244	cyclone collector	NYSDEC-Air Quality	472200 3491 24401	01-28-99
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202	11-29-96(8)
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203	11-29-96(8)
423	stage II vapor recovery	NYSDEC-Air Quality	472200 D365 WG	09-27-95(1)
423	welding hood	NYSDEC-Air Quality	472200 3491 42305	05-15-01
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	05-15-01
458	paint spray booth	NYSDEC-Air Quality	472200 3491 45801	04-23-97
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46201	11-29-96(8)
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202	11-29-96(8)
473	vapor degreaser	NYSDEC-Air Quality	472200 3491 47301	03-22-96(9)

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1996
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
479	cyclone G-10	NYSDEC-Air Quality	472200 3491 47905	04-01-00
490	Inhalation Toxicology Facility	NYSDEC-NESHAPs	472200 3491 49001	05-15-01
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49002	05-15-01(2)
490	lead alloy melting	NYSDEC-Air Quality	472200 3491 49003	05-15-01
490	milling machine/block cutter	NYSDEC-Air Quality	472200 3491 49004	05-15-01
493	incinerator	NYSDEC-Air Quality	472200 3491 493AO	Cancellation(3)
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	Canceled
510	metal cutting exhaust	NYSDEC-Air Quality	472200 3491 51002	09-30-98
510	calorimeter enclosure	U.S. EPA - NESHAPS	BNL-689-01	None
526	polymer mix booth	NYSDEC-Air Quality	472200 3491 52601	04-01-00
526	polymer weighing	NYSDEC-Air Quality	472200 3491 52602	04-01-00
535B	plating tank	NYSDEC-Air Quality	472200 3491 53501	04-01-00
535B	etching machine	NYSDEC-Air Quality	472200 3491 53502	04-01-00
535B	PC board process	NYSDEC-Air Quality	472200 3491 53503	05-15-01
535B	welding hood	NYSDEC-Air Quality	472200 3491 53504	09-30-98
555	scrubber (1)	NYSDEC-Air Quality	472200 3491 55501	04-01-00
555	scrubber (2)	NYSDEC-Air Quality	472200 3491 55502	04-01-00
610	combustion unit	NYSDEC-Air Quality	472200 3491 6101A	05-15-01
610	combustion unit	NYSDEC-Air Quality	472200 3491 61004	Cancellation(4)
610	combustion unit - ALF	NYSDEC-Air Quality	472200 3491 61005	05-15-01
610	combustion unit	NYSDEC-Air Quality	472200 3491 61006	05-15-01
610	combustion unit	NYSDEC-Air Quality	472200 3491 61007	09-30-95(5)
630	stage II vapor recovery	NYSDEC-Air Quality	472200 D366 WG	09-27-95(1)
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001	11-29-96(10)

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1996
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002	11-29-96(10)
703	machining exhaust	NYSDEC-Air Quality	472200 3491 70301	05-15-01
705	building ventilation	U.S. EPA - NESHAPS	BNL-288-01	None
820	accelerator test facility	U.S. EPA - NESHAPS	BNL-589-01	None
901	tin lead solder	NYSDEC-Air Quality	472200 3491 90101	04-01-00
902	spray booth exhaust	NYSDEC-Air Quality	472200 3491 90201	09-30-98
902	belt sander	NYSDEC-Air Quality	472200 3491 90202	05-15-01
902	sanding, cutting, drilling	NYSDEC-Air Quality	472200 3491 90203	05-15-01
902	brazing/solder exhaust	NYSDEC-Air Quality	472200 3491 90204	05-15-01
902	painting/soldering exhaust	NYSDEC-Air Quality	472200 3491 90205	05-15-01
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301	11-29-96(6)
903	cyclone G-10	NYSDEC-Air Quality	472200 3491 90302	04-01-00
903	brazing process exhaust	NYSDEC-Air Quality	472200 3491 90303	09-30-98
905	vapor degreaser	NYSDEC-Air Quality	472200 3491 90501	03-22-96(7)
905	belt sander	NYSDEC-Air Quality	472200 3491 90502	06-18-95(4)
905	machining exhaust	NYSDEC-Air Quality	472200 3491 90503	05-15-01
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101	11-29-96(4)
919A	sandblasting	NYSDEC-Air Quality	472200 3491 91901	04-23-97
919A	sandblasting	NYSDEC-Air Quality	472200 3491 91902	04-23-97
919A	solder exhaust	NYSDEC-Air Quality	472200 3491 91903	05-15-01
922	cyclone exhaust	NYSDEC-Air Quality	472200 3491 92201	04-01-00
923	electronic equip. cleaning	NYSDEC-Air Quality	submitted 3-93,	status pending
924	spray booth exhaust	NYSDEC-Air Quality	472200 3491 92401	09-30-98
924	magnet coil production press	NYSDEC-Air Quality	472200 3491 92402	05-15-01

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1996
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
924	machining exhaust	NYSDEC-Air Quality	472200 3491 92403	05-03-98
930	electroplating/acid etching	NYSDEC-Air Quality	472200 3491 93001	05-15-01
930	bead blaster	NYSDEC-Air Quality	472200 3491 93002	05-15-01
930	ultrasonic cleaner	NYSDEC-Air Quality	472200 3491 93003	02-01-97(7)
	spray aeration project	NYSDEC-Air Quality	submitted 10-89,	status pending
AGS Booster	accelerator	U.S. EPA - NESHAPS	BNL-188-01	None
RHIC	accelerator	U.S. EPA - NESHAPS	BNL-389-01	None
	radiation therapy facility	U.S. EPA - NESHAPS	BNL-489-01	None
	radiation effects/neutral beam	U.S. EPA - NESHAPS	BNL-789-01	None
CSF(a)	major petroleum facility	NYSDEC-Water Quality	1-1700	03-31-97
STP(b) & RCB(c)	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005835	03-01-00
HWMF(d)	waste management	NYSDEC-Hazardous Waste	NYS ID No. 1-4722-00032/00021-0	08-31-98
WMF (e)	waste management	NYSDEC-Hazardous Waste	1-4722-00032/00102-0	07-12-05
BNL Site	chem tanks-HSBSRC	NYSDEC	1-000263	07-27-97

(a) Central Steam Facility.
(b) Sewage Treatment Plant.
(c) Recharge basins.
(d) Hazardous Waste Management Facility
(e) New Waste Management Facility (under construction).
HSBSRC = Hazardous Substance Bulk Storage Registration Certificate.

*Note: Renewal application submitted more than 30 days prior to expiration date; process can continue to operate under provisions of the NYS Uniform Procedures Act.
(1) Renewal submitted 9-6-95, NYSDEC indicates source subject to registration only.
(2) Process not in service.
(3) Process no longer in use, cancellation requested 11-13-90, status pending.
(4) Cancellation requested 9-95, status pending.
(5) Operating under permit to construct extended 4/24/96 until NYSDEC approves stack test results and certificate to operate application.
(6) Cancellation requested 3-93, status pending.
(7) Source Removed or decommissioned. Cancellations requested with 1996 Annual Emissions Statement.
(8) Source with past due expiration dates are being evaluated by NYSDEC as possible exempt and trivial sources which would not need to be renewed pursuant to Part 201 provisions.
(9) Source currently out of service. If returned to service, an aqueous cleaning solution will be used in place of Freon 113 and methylene chloride to clean vacuum components.
(10) Source out of service to be replaced by new equipment in new Hazardous Waste Management Facility which will be permitted with NYSDEC.

2.3 Clean Water Act

2.3.1 SPDES Permit

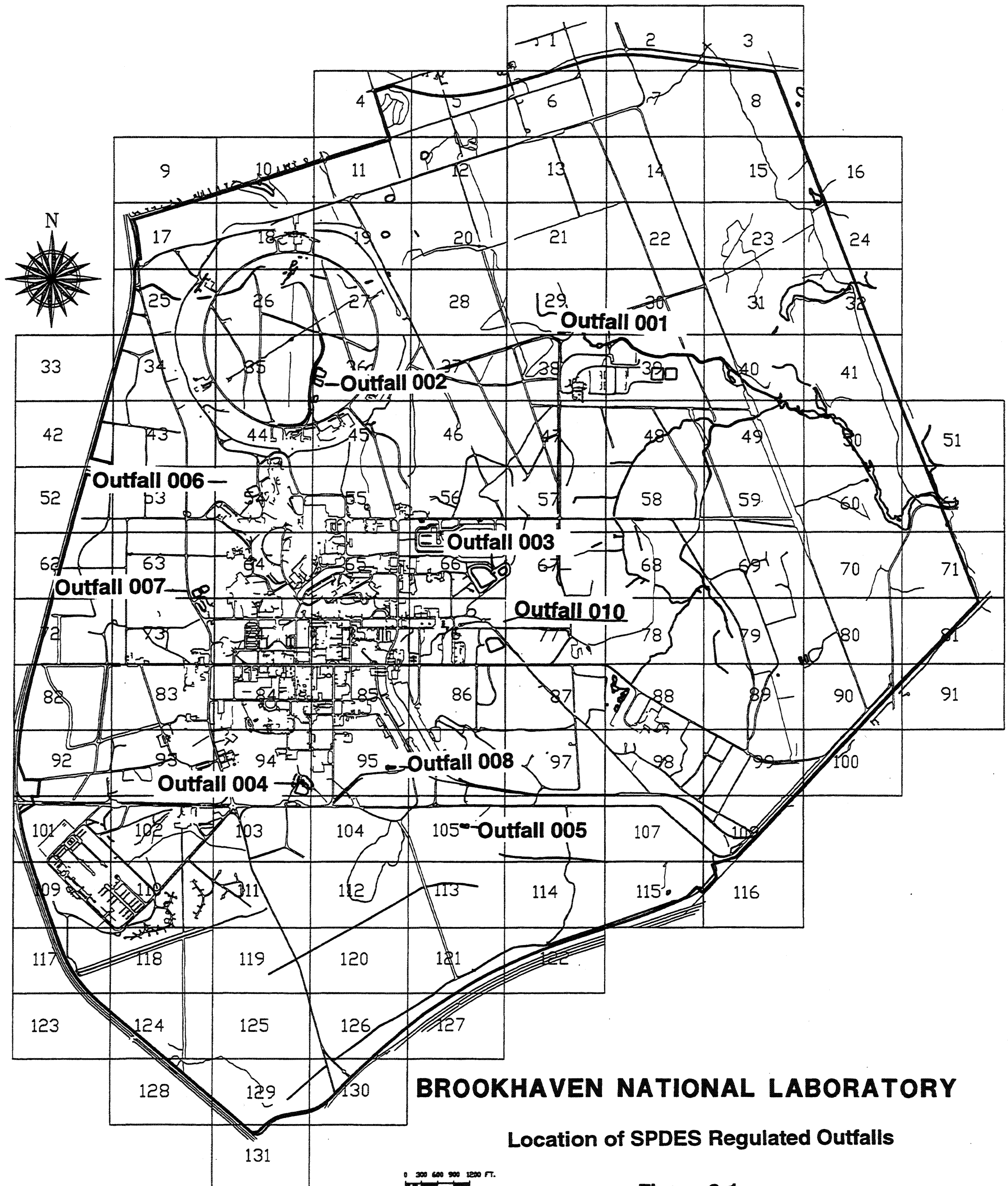
Sanitary, process-waste waters and non-contact cooling waters which are discharged from BNL's operations are regulated by an SPDES permit issued by the NYSDEC. Specifically, effluents discharged to seven recharge basins, the Peconic River, and storm water emanating from the CSF are currently governed by monitoring requirements and effluent limitations contained in the SPDES permit. Deviations from the permit's limitations or monitoring requirements which occurred during 1996 are described in the subsequent sections of this chapter. Figure 2-1 provides locations for each outfall.

During 1996, the Laboratory successfully negotiated a SPDES permit modification with the NYSDEC. This modification was necessary to resolve previous concerns regarding the inability to consistently meet BOD_5 and TSS removal requirements, and to establish alternate effluent limitations for 2,2-dibromo-3-nitrilo-propionamide (DBNPA) in discharges to Outfall 003. A request for a permit modification was presented to the NYSDEC in April 1996 and was approved on December 9, 1996. The BOD_5 and TSS removal modification involved adoption of a Schedule of Compliance for improving the BOD_5 and TSS removal efficiencies of the STP process, in lieu of the 85% removal requirement. An increase in the effluent limitation for DBNPA from 0.1 to 0.5 mg/L was granted since an analytical method was not available which could achieve the lower effluent limit. Although never detected in BNL discharges, to maintain consistency with the NYS guidance for discharges to groundwater, the NYSDEC modified the effluent limitation for bromodichloromethane from 0.005 to 0.05 mg/L for waste waters discharged to Outfall 002 as part of the permit modification.

2.3.1.1 Recharge Basins, SPDES Outfalls 002, 003, 004, 005, 006A, 006B, 007, 008 and 010

The Laboratory maintains seven recharge basins for the discharge of process cooling waters, storm water runoff and, in the case of recharge basin HX (Outfall 007), water-filter backwash from the WTP. Cooling water is discharged to basins HN (Outfall 002), HO (Outfall 003), HP (Outfall 004), HS (Outfall 005) and HT (Outfalls 006A and 006B) and storm water is discharged to basins HN, HO, HS, HT, HW (Outfall 0008) and the CSF (Outfall 010). The BNL SPDES permit requires monitoring of these discharges monthly for flow, pH, and oil and grease, and quarterly for the numerous additional analytical parameters listed in Table 2-2. In addition, storm water discharged to Outfall 008 must also be analyzed monthly for volatile organic compounds. There are no monitoring requirements for Outfall 009, which consists of numerous discharges to ground surfaces (e.g., air-compressor condensate, steam condensate, miscellaneous residential cesspools).

Discharges of water to recharge basins are considered Class GA groundwater discharges and are regulated by the NYSDEC, as stipulated in 6 NYCRR Part 703.6. While groundwater discharge regulations limit the pH for these effluents to 6.5 to 8.5 Standard Units (SU), the Laboratory successfully negotiated an open-ended lower limitation for pH, since the pH of natural



BROOKHAVEN NATIONAL LABORATORY

Location of SPDES Regulated Outfalls

Figure 2-1

groundwater and storm waters are typically less than 6.5 SU. During 1996, there was one excursion of the upper pH limitation reported for Outfall 006A. In addition to cooling tower blowdown and storm water runoff, this Outfall receives a high volume of non-contact cooling water which was determined to be one of the leading causes of this excursion. In June 1995, the Laboratory completed a study of its potable water system and undertook corrective actions to reduce the corrosion potential of the potable water and minimize the dissolution of lead into the potable water distribution system. These actions included increasing the pH of the system to a minimum of 8.0 SU. The increase in potable water pH, which is used as make up water in the cooling tower, combined with the increased concentration of corrosion control agents resulting from the evaporative losses of the tower, was deemed the contributing causes to this excursion. Administrative controls to limit the pH of the water to 8.0 SU at the well head have resulted in better control of the pH within the distribution system and reduced the potential to exceed the SPDES permit restrictions. All remaining parameters were found to be within the limitations of the SPDES permit during CY 1996.

Outfall 004, which receives once-through cooling water from the MRR, began receiving discharge from the MRR (i.e., Process Well 105) in May 1996. Process Well 105 was equipped with an activated carbon adsorption system in 1993 for abating TCA contamination, but was not restarted until 1996 due to instrumentation problems. Although previous analyses have shown TCA concentrations in excess of effluent standards in the water pumped from Well 105, analysis of the well water in 1996 has shown all concentrations to be well within standards both prior to and post carbon adsorption. This well is monitored quarterly under the provisions of the SPDES permit and is also monitored quarterly under the S&EP Environmental Monitoring program. The analytical data collected under the BNL EM program is discussed in Chapter 8.

Outfall 007, which receives water filter backwash from the WTP remained out of service during 1996 to permit construction of major improvements to the WTP process. These improvements included the construction of dual air-stripping towers for VOC abatement and construction of a new clearwell and wet well. Former analog control systems were also replaced with a computerized control system. The SCDHS inspected the WTP modifications on several occasions during 1996 and has approved the restart of this facility. The Laboratory is, however, in the process of refurbishing two of the three wells which supply water to the WTP; consequently, the WTP will not commence operations until the refurbishment is completed. Completion of the well refurbishment is expected some time in mid 1997.

2.3.1.2 STP Effluent, SPDES Outfall 001

In accordance with the BNL SPDES permit, twenty-seven (27) parameters are reported in the monthly Discharge Monitoring Report (DMR) which is submitted to both the NYSDEC and SCDHS. Samples are collected by BNL personnel in accordance with BNL's SOPs and QA protocols. Sixteen parameters (nitrogen, metals, organics, BOD_5, total suspended solids, fecal coliform, and cyanide) are analyzed by NYSDOH certified contractor laboratories. The remaining parameters (i.e., flow, settleable solids, residual chlorine, pH) are recorded/analyzed by the STP operators. Table 2-3 summarizes the 1996 DMR analytical data for Outfall 001. This data shows the SPDES permit discharge limits were exceeded twenty times at the STP effluent discharge point during 1996; eight for BOD_5 removal, five for TSS removal, two for Table 2-2 silver, and one

Table 2 - 2
BNL Site Environmental Report for Calendar Year 1996
Summary of Analytical Results for Waste Water Discharges to Outfalls 002 - 010 (1)

Analyte		Outfall 002	Outfall 003	Outfall 004	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No. of exceedances
Flow	N	Cont. Recorder	Cont. Recorder	Cont. Recorder	Cont. Recorder	Cont. Recorder	Cont. Recorder	Cont. Recorder	12	12		
MGD	Min.	0.11	1.7	0.02	0.058	0.038	0.055	NF	0.004	0.00005		
	Max.	0.34	4.3	0.19	0.017	0.34	0.38	NF	8.7	1.4		
pH	Min.	6.5	6.5	5.6	6.4	6.5	6.7	NF	6.3	6.2		
SU	Max.	8.5	8.3	6.4	8	8.7	8.4	NF	7.7	7.9	8.5	1
Oil and	N	12	12	NR	12	12	12	NR	12	12		
Grease	Min.	< 1	<1	NR	<1	<1	<1	NR	<1	<1		
mg/L	Max.	2	1.7	NR	3.4	3.9	4.1	NR	6.9	10.7	15	0
	Avg.	<1	<1	NR	<1	<1	<1	NR	1.1	1.3		
Copper	N	NR	NR	NR	4	NR	NR	NR	NR	NR		
mg/L	Min.	NR	NR	NR	<0.005	NR	NR	NR	NR	NR		
	Max.	NR	NR	NR	0.048	NR	NR	NR	NR	NR	1	0
	Avg.	NR	NR	NR	0.03	NR	NR	NR	NR	NR		
Zinc	N	NR	4	NR	NR	NR	NR	NR	NR	NR		
mg/L	Min.	NR	0.015	NR	NR	NR	NR	NR	NR	NR		
	Max	NR	0.062	NR	NR	NR	NR	NR	NR	NR	5	0
	Avg.	NR	0.043	NR	NR	NR	NR	NR	NR	NR		
Iron (total)	N	NR	NR	NR	NR	NR	NR	0	NR	NR		
mg/L	Min.	NR	NR	NR	NR	NR	NR	NF	NR	NR	NA	0
	Max.	NR	NR	NR	NR	NR	NR	NF	NR	NR		
	Avg.	NR	NR	NR	NR	NR	NR	NF	NR	NR		
Iron (dissolved)	N	NR	NR	NR	NR	NR	NR	0	NR	NR		
mg/L	Min.	NR	NR	NR	NR	NR	NR	NF	NR	NR		
	Max.	NR	NR	NR	NR	NR	NR	NF	NR	NR	NA	0
	Avg.	NR	NR	NR	NR	NR	NR	NF	NR	NR		
Chloroform	N	4	NR	NR	NR	NR	NR	NR	NR	NR		
ug/L	Min.	ND	NR	NR	NR	NR	NR	NR	NR	NR		
	Max.	ND	NR	NR	NR	NR	NR	NR	NR	NR	7	0
	Avg.	ND	NR	NR	NR	NR	NR	NR	NR	NR		

Notes

NA: Not Applicable.
NR: Analysis is Not Required
ND: Analyte was Not Detected
NF: There was no flow recorded to Outfall 007 for the duration of 1996.
1. See Figure 2-1.

Table 2-2 (continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Analytical Results for Waste Water Discharges to Outfalls 002 - 010[1]

Analyte		Outfall 002	Outfall 003	Outfall 004	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No.of exceedances
Bromo-	N	4	NR	NR	NR	NR	NR	NR	NR	NR		
dichloromethane	Min.	ND	NR	NR	NR	NR	NR	NR	NR	NR		
ug/L	Max.	ND	NR	NR	NR	NR	NR	NR	NR	NR	5	0
	Avg	ND	NR	NR	NR	NR	NR	NR	NR	NR		
1,1,1-trichloroethane	N	4	4	4	NR	NR	NR	NR	12	NR		
ug/L	Min.	ND	ND	ND	NR	NR	NR	NR	ND	NR		
	Max.	ND	ND	ND	NR	NR	NR	NR	ND	NR	5	0
	Avg.	ND	ND	ND	NR	NR	NR	NR	ND	NR		
1,1-dicloroethylene	N	NR	NR	NR	NR	NR	NR	NR	12	NR		
ug/L	Min.	NR	NR	NR	NR	NR	NR	NR	ND	NR		
	Max.	NR	NR	NR	NR	NR	NR	NR	ND	NR	5	0
	Avg.	NR	NR	NR	NR	NR	NR	NR	ND	NR		
Dibromo-nitrilo-	N	NR	4	NR	NR	NR	NR	NR	NR	NR		
propionimide	Min.	NR	ND	NR	NR	NR	NR	NR	NR	NR		
mg/L	Max.	NR	ND	NR	NR	NR	NR	NR	NR	NR	0.1	0
	Avg.	NR	ND	NR	NR	NR	NR	NR	NR	NR		
Hydroxyethylidene-	N	4	4	NR	4	4	4	NR	NR	NR		
diphosphonic Acid	Min.	ND	ND	NR	ND	ND	ND	NR	NR	NR		
mg/L	Max.	ND	ND	NR	0.11	0.47	0.07	NR	NR	NR	0.5	0
	Avg.	ND	ND	NR	0.05	0.19	0.04	NR	NR	NR		
Tolyltriazole	N	4	4	NR	4	4	4	NR	NR	NR		
mg/L	Min.	ND	ND	NR	ND	ND	ND	NR	NR	NR		
	Max.	ND	ND	NR	ND	0.09	ND	NR	NR	NR	0.2	0
	Avg.	ND	ND	NR	ND	0.02	ND	NR	NR	NR		

Notes

NA: Not Applicable.
NR: Analysis is Not Required
ND: Analyte was Not Detected
NF: There was no flow recorded to Outfall 007 for the duration of 1996.
1. See Figure 2-1.

BNL Site Environmental Report for Calendar Year 1996
Summary of Analytical Results for Waste Water Discharges to Outfall 001 (1)

Analyte	Min.	Max.	Avg.	Monitoring Frequency	SPDES Limit	No. of Exceedances
Max. Temperature Degrees Farenheit	50	79	65.5	Daily	90	0
pH SU	6.1	7.3	NA	Cont. Recorder	Min.: 5.8 Max.: 9.0	0 0
Avg. 5 day BOD mg/L	<2	15	3.9	Monthly	Avg.: 10	1
Max. 5 day BOD mg/L	<2	15	5.8	Monthly	Max.: 20	0
% BOD Removal	-275	91	32	Monthly	85	8
Avg. Total Suspended Solids (TSS) mg/L	<1	5.5	1.8	Monthly	Avg.:10	0
Max. Total Suspended Solids (TSS) mg/L	<1	15.8	3.8	Monthly	Max.:20	0
% TSS Removal	40	95	80	Monthly	85	5
Settleable Solids mg/L	0	0	0	Daily	0.1	0
Ammonia Nitrogen mg/L	< 0.05	2.7	0.8	Monthly	2	1
Total Nitrogen mg/L	3.1	7.5	5.3	Monthly	NA	NA
Cyanide ug/L	<10	20	< 10	Twice Monthly	100	0
Copper mg/L	0.046	0.145	0.076	Monthly	0.15	0
Iron mg/L	0.145	0.737	0.273	Monthly	0.37	1
Lead mg/L	< 0.0021	0.008	0.004	Monthly	0.015	0
Nickel mg/L	0.0041	0.023	0.007	Monthly	0.11	0
Silver mg/L	0.005	0.023	0.011	Monthly	0.015	2
Zinc mg/L	0.009	0.067	0.032	Monthly	0.1	0

Notes:
ND: Analyte was Not Detected in the samples.
NA: Not Applicable
1. See Figure 2-1.

Table 2-3 (continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Analytical Results for Waste Water Discharges to Outfall 001 [1]

Analyte	Min.	Max.	Avg.	Monitoring Frequency	SPDES Limit	No. of Exceedances
Toluene ug/L	<5	<5	<5	Twice Monthly	50	0
Methylene Chloride ug/L	<5	19	8.6	Twice Monthly	50	0
1,1,1-Trichloroethane ug/L	<5	<5	<5	Twice Monthly	50	0
2-Butanone ug/L	<5	<5	<5	Twice Monthly	50	0
Max. Flow MGD	0.786	1.8	1.082	Cont. Recorder	Max. 2.3	0
Avg. Flow MGD	0.607	0.986	0.824	Cont. Recorder	NA	0
Residual Chlorine mg/L	0.02	0.08	0.051	Daily	0.1	0
Avg. Fecal Coliform MPN/100 ml	<1	400	56	Monthly	200	1
Max Fecal Coliform MPN/100 ml	<1	1200	146	Monthly	400	1

Notes

NA: Not Applicable
1. See Figure 2-1.

each for ammonia, iron, BOD_5 (avg.), fecal coliform (max.), and fecal coliform (avg.).

As previously discussed, the original SPDES permit issued in 1995, required that the Laboratory document an 85% removal efficiency for TSS and BOD_5 for the STP process. While the STP discharge consistently complied with the numerical effluent limitations, the low BOD_5 and TSS associated with the BNL waste water stream made consistent attainment of the removal requirement nearly impossible. Review of Table 2-3 shows the BOD_5 removal efficiencies to range from a low of -275% (i.e., the effluent concentration was approximately three times the concentration of the influent stream) to a high of 91%. The range in TSS removal was between 40% and 99%. To improve the overall performance of the STP process, two projects were initiated in 1996. The first is the continuation of the STP upgrades project. The upgrades project was delayed for approximately a year due to public concerns regarding dewatering operations. The project design was modified to circumvent groundwater pumping requirements and was restarted. This project provides for construction of an aerobic activated sludge treatment system which will aid in the removal of BOD_5, TSS and ammonia. This project will also provide for the construction of an ultra-violet (UV) disinfecting system and other process improvements. The construction modifications are expected to be complete by September 1997. For mitigating the high volume of non-contact cooling water and increasing the BOD_5 and TSS concentrations in the influent stream, the Laboratory proposed a schedule for rerouting some of the cooling water from the sewer system to the site storm water collection system. A Schedule of Compliance was adopted into the SPDES permit in December 1996 which provided the time table for achieving these reductions. During the Schedule of Compliance period, BOD_5 and TSS removal requirements were waived. Reduction of cooling water discharges will be completed in phases with the first phase expected to be completed by December 31, 1997. Approximately 10% of the cooling water load is expected to be removed from the sewer collection system under the first phase of this project.

Two excursions of the silver limitation occurred during 1996; one in January (22 µg/L), and the second in May (23 µg/L). Investigation into possible sources of silver contamination identified two processes in which silver plating of electrical buss bars was being conducted with the rinse waters discharged to the sanitary sewer. Since strict source controls were implemented for these discharges, no silver exceedances have been observed. Other pollution prevention measures which targeted silver bearing wastes included the procurement and installation of digital, photographic equipment at Building 197. This equipment replaced the conventional wet processing of photographic film and paper and eliminated a source of hazardous waste as well as a contributor of contaminants (i.e., silver, nitrogen, phenols) to the sanitary sewer system.

The excursions for BOD_5 (avg.), ammonia nitrogen occurred simultaneously in January 1996. The ammonia exceedance has been attributed to decreased biological activity within the sandfilters due to lower ambient temperatures. The increased BOD_5 concentration may also be attributed to decreased biological activity and the higher ammonia concentration, since oxidation of ammonia will impart a BOD load. The exceedances for iron and fecal coliform also occurred simultaneously but in May. Review of the data shows iron, and fecal coliform to be significantly higher than the typical analyses for this discharge. Since all subsequent analyses showed all parameters to be within effluent standards, there was no apparent reason for the original observations. The possibility of contaminated glassware used during sample collection was suspected. To circumvent future excursions of this nature, use of dedicated collection containers was implemented for this discharge.

In addition to monitoring the point-source discharges, the Laboratory is also required to monitor and report effluent concentrations for process wastes discharged to the STP. This program includes quarterly monitoring of photo-developing waste waters generated at Buildings 197 and 118, and rinse waters from plating and metal-cleaning operations at Buildings 535 and 197 respectively. These processes are monitored for pollutants which are specific to these operations and include metallic elements, semi-volatile and volatile organic compounds, phenols, cyanides; flow and pH are also monitored. In addition, discharges of boiler blowdown and discharges from the Building 902 cooling tower are also analyzed quarterly for flow and pH. The analytical data for 1996 shows these discharges to be insignificant contributors to the STP collection system.

The biomonitoring program specified in the SPDES permit is a Chronic Tier II Test using fathead minnows (Pimephales promelas) and water fleas (*Ceriodaphnia dubia*) as the test organisms. Chronic toxicity testing is conducted by exposing the test organisms to varying concentrations (i.e., 100%, 50%, 25%, 12.5% and 6.25%) of the STP effluent for a period of seven days. During this period, survival and growth, or rate of reproduction, are monitored. The data is then compared to a control group. The SPDES permit required that four rounds of toxicity testing be conducted with all data transmitted to the NYSDEC for review. The fourth and final round of the toxicity testing program was conducted in February 1996. This test showed a No Observable Adverse Effective Concentration (NOEC) of 50%. This result along with the three results collected in 1995 showed an overall NOEC of 71%. While the desired result for the STP discharge should be at least 96%, in June 1996 the NYSDEC temporarily waived the requirement to conduct additional testing and follow-up investigation to determine the source of toxicity in light of the STP upgrades project. Once all construction is complete, a new round of toxicity testing will be conducted to determine if the improved treatment process reduces the toxicity of the STP effluent. However, in an effort to identify the contributors to the exhibited toxicity, the Laboratory has continued to conduct periodic toxicity testing in conjunction with full scale chemical analysis of aliquot samples. These tests have proved inconclusive since analytical results have been almost identical for samples which elicit a toxic response and those which do not. Copies of the analytical results for all toxicity tests have been provided to both the NYSDEC and the SCDHS.

2.3.2 SPDES Inspections and Audits

Up until January 1993, quarterly inspections of the STP were performed by the SCDHS. Due to reduced state funding for monitoring and inspecting local sewage treatment plants, none were conducted by the SCDHS in CY 1996.

2.3.3 National Pollution Discharges Elimination System (NPDES) Analytical Quality Assurance

The Laboratory participates in the NPDES Laboratory Performance Evaluation Program administered by the EPA. In April 1996, proficiency check samples were received from the EPA and subsequently forwarded to the three laboratories responsible for the specific analyses. The respective analytical parameters performed by each Laboratory are listed below:

Laboratory Name and Address	Analytical Parameters
NYTEST Environmental Inc. Port Washington, NY	Copper, Lead, Iron, Nickel, Zinc, BOD_5, Total Suspended Solids, Ammonia-N, Nitrate-N, Total Kjeldahl Nitrogen, Cyanides, Oil and Grease and Total Phenolics
BNL STP Operations Lab Upton, NY	pH, Total Residual Chlorine
Cosper Environmental Inc. Bohemia, NY	Tier II Chronic Toxicity

The analytical data for the proficiency check samples were forwarded to the EPA designated facility on October 3, 1996. Comments regarding the results of this program were not received from the EPA until January 1997. One parameter (BOD_5) failed to meet the acceptability criteria established by the EPA. The Laboratory responsible for this analysis was requested to respond to this finding.

2.3.4 Major Petroleum Facility

The BNL CSF supplies steam for heating and cooling to all major areas of the Laboratory through an underground distribution system. The MPF, the storage area for the fuels used at the CSF, operates under license (No. 01-1700) issued by the NYSDEC which is renewed annually. The current license was issued by NYSDEC on March 20, 1996, and expires on March 31, 1997. A renewal application was filed in December 1996.

The NYSDEC is required by Article 12 of the Navigation Law to protect and preserve the lands and waters of NYS from all discharges of petroleum, and specifically, from major petroleum storage facilities. To fulfill this responsibility, all major petroleum storage facilities are required to be registered with the NYSDEC and must have a license to operate. The license is contingent on several conditions including groundwater monitoring, periodic submittal of engineering evaluations and reports for secondary containment systems, and updates to Facility Response Plans and Spill Prevention Control and Counter Measures (SPCC) Plans.

All major petroleum storage facilities are required to install groundwater monitoring wells. The license has general conditions which include regular testing of monitoring wells for floating and dissolved product. Typically the facility owner can test for floating products; however, testing for dissolved product must be performed by an NYSDOH certified laboratory.

Five groundwater wells, one upgradient and four downgradients, are used for regulatory compliance monitoring of BNL's MPF. The well authorized for use by the NYSDEC as upgradient of the MPF is designated as Well 76-25 and is located immediately upgradient (within 50 feet) of Tanks 611A and 611B. The four downgradient wells are designated as 76-16, 76-17, 76-18, and 76-19. Figure 8-8 shows their locations. The well casings are constructed of polyvinyl chloride (PVC) and are four inches in diameter; they have PVC screens which are 20 feet long and straddle the water table.

In accordance with conditions of the MPF license, regulatory compliance samples were collected from these wells twice during 1996 and submitted to a NYSDOH certified laboratory. The NYSDEC required analyses for these wells include polynuclear aromatics and base-neutral extractable compounds listed in EPA Method 625. The analytical results were transmitted to the NYSDEC in accordance with the MPF permit requirements. Another condition of the MPF license is that these wells are monitored monthly for floating products; none were found during CY 1996.

In addition to the MPF compliance samples, these wells were also monitored twice during CY 1996 as part of the BNL routine EM program. The analytical results are discussed in Chapter 8 of this report.

The MPF license also required that by December 31, 1996, BNL submit an updated Spill Prevention Control and Counter-Measures (SPCC) Plan. A copy of the updated Plan was filed with the NYSDEC on December 27, 1996. Copies of berm integrity test reports which were conducted in late 1995 and early 1996 were included in this update.

A project was implemented in 1995 to bring all tanks and fuel-handling facilities associated with the MPF into compliance with county and state regulations for petroleum storage facilities. This project included installing epoxy coatings on the internal tank bottoms for four tanks, installing double bottoms on two tanks, upgrading above and underground piping systems and construction of a fuel off-loading facility. Copies of plans and specifications were sent to both the SCDHS and the NYSDEC for their review and comments. As stipulated in the 1996 MPF License, construction of the fuel off-loading facility was completed by December 31, 1996. While this project also included the cleaning and dismantling of MPF Tanks 611A and 611B, actual completion of the dismantling portion of the project carried on into early 1997.

2.3.4.1 Spill Prevention, Control, and Countermeasures Plan

Brookhaven National Laboratory has had an SPCC Plan since the early 1980s. This Plan had a complete listing of all oil storage tanks, with their capacity and building numbers. In the mid 1980s, direction from NYSDEC led to including only those storage tanks associated with the MPF and the Motor Pool Fuel Storage area (Building 326) in the SPCC storage-tank listing. This Plan was revised in 1982, 1983, 1985, 1987, 1990, 1993 and 1996. All revisions have been submitted to the NYSDEC.

As a direct result of the Exxon Valdez, the American Trader, and other waterway disasters, Congress enacted the Oil Pollution Act of 1990 (OPA-90). This Act significantly modified many of the provisions of the Clean Water Act (CWA). One requirement is that facility owners/operators must prepare plans outlining their response capability to a "Worst Case Discharge (WCD)" which is defined as the " . . . largest foreseeable discharge in adverse weather conditions." These terms were described in the legislative history to mean " . . . a case that is worse than either the largest spill to date or the maximum probable spill for the facility type. The mechanism by which a facility expects to respond to the WCD must be outlined in a Facility Response Plan (FRP). The FRP also contains information about the oil-recovery capabilities of the facility and any associated Oil Spill Response Organizations contracted by that facility. Congress mandated that regulations implementing FRP requirements must be issued not later than August 18, 1992. The original statutory deadline for submitting the FRP was February 18, 1993.

Draft regulations outlining the requirements of the FRP were not issued until February 17, 1993; however, recognizing the necessity to comply with the statutory requirements of OPA-90, BNL contracted with an engineering consulting firm to prepare the FRP. This plan was submitted to EPA on February 18, 1993.

On July 1, 1994, the EPA finalized the regulations outlining FRP content requirements and on October 28, 1994 the Laboratory received notification from the EPA requesting revisions to the February 1993 FRP. The revisions included submitting worksheets with calculations of the WCD and oil-spill response capabilities and documenting training programs. The revised FRP was prepared by BNL and submitted to the EPA in January 1995. In addition, as required by the 1994 OPA-90 revisions, all previous FRPs had to be revised by February 28, 1995 to meet the content requirements outlined in the July 1994 final regulations. In December 1994, BNL contracted with an engineering firm to prepare these revisions. A revised FRP was submitted to the EPA on February 23, 1995. No further guidance was received from the EPA during 1996 concerning the content of the FRP.

2.3.5 Oil/Chemical Spills

It is the policy of BNL to provide prompt and accurate notification of unexpected environmental releases of oil and/or chemicals as required by Federal, State, or local regulations. Anyone discovering a release is required to immediately report it to the BNL emergency telephone number. This number is monitored 24 hours per day, seven days per week by both BNL's Police Group and the S&EP Fire Rescue Group. The S&EP Fire Rescue Group is the Laboratory's first responder. They assess the situation, and initiate measures for control and containment, while other specialists such as industrial hygienists and environmental compliance personnel, respond to provide additional support.

During 1996, members of the S&EP Division responded to a total of 56 incidents involving the release of oil or chemicals. Table 2-4 summarizes these incidents giving the date each incident occurred, the material involved, the amount released, and a brief explanation of the corrective actions taken. Twenty-three of these incidents required EPA, NYSDEC, and SCDHS notifications. These spills were cleaned up, and the contaminated absorbent and affected soil were sent off-site for approved disposal. The remainder of these incidents involved very small quantities of material which were typically contained on asphalt, concrete, or other impervious surfaces (Table 2-4). Cleanup procedures were implemented and there were no environmental impacts from these occurrences. Notifications to off-site regulatory agencies are made based upon the type, quantity, and location of material spilled. For releases of petroleum products, in May 1996 the NYSDEC adopted new deminimus quantities for releases. Releases which are known to be less than five

Table 2-4
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
96-01 1/25/96	Mercury	< 1 oz.	No	During the transfer of items that had been stored in Bldg. 424, a small amount of mercury was observed in a seam of the concrete floor in Bldg 209. Plans to recover the material were delayed indefinitely when the area where the mercury was observed became inaccessible after were moved into the building.
96-02 2/7/96	Sulfuric Acid	1 gal.	No	A battery used for the auxiliary well drive exploded due to over-charging. Fire/Rescue presonnel applied soda ash to the spill in order to neutralize the acid. All residual soda ash and battery components were drummed for disposal via the Hazardous Waste Management Group.
2/7/96 96-03	Chlorine	< 1 lb.	No	Mechanical equipment failure resulted in the release of a very small quantity of chlorine gas inside building 634 (Potable Well 10). A screw within the chlorine metering device (v-notch chlorinator) corroded. Corrosion of the screw broke the vacuum which automatically shut down the metering device. This discovery prompted an examination of the chlorinators at the other five potable wells on-site. Two units were rebuilt in place and the three remaining units were sent back to the factory for repairs.
96-04 3/25/96	Diesel Fuel	2 gals	Yes	Roughly 2 gals. of diesel fuel spilled when a contractor, overfilled the fuel tank of a front end loader while refueling. The contractor took the contaminated soil which had been placed in two 55 gallon drums offsite for disposal.
4/22/96 96-05	No. 2 Fuel Oil/Waste Water	15 gals	Yes	During cleaning of an old pipeline, approximately 15 gallons of No. 2 fuel and water was released to the ground. The contractor responsible for the release immediately removed and drummed all contaminated soils. All contaminated soils were disposed off-site via the contractor.
4/25/96 96-06	Hydraulic Oil	8 Ounces	Yes	During the placement of a new ground water monitoring well south of the former landfill, a hydraulic line on the mast of a contracted drill rig burst. Most of the oil fell on the drill rig and was cleaned immediately by the contractor. When the rig was later moved a small area of oil contaminated soil was discovered. The contractor recovered this soil and placed it in a bag which was later transferred to a drum for off-site disposal

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
5/03/96 96-07	No. 2 Fuel	1.5 gals	Yes	A contractor removing old fuel supply lines at the CSF was responsible for the release of oil during cutting of one of the fuel lines. The lines were supposed to have been emptied by a previous contractor but were not. The contractor immediately placed a bucket beneath the leaking line and shoveled all contaminated soil into 55 gallon drums for disposal.
5/08/96 96-08	Hydraulic Oil	<3 Gals.	No	Approximately 3 gals. of hydraulic oil spilled, after a gasket on one of the hydraulic pumps of a crane failed. The spill was discovered after the crane operator moved the rig. Plant Engineering (PE) personnel used absorbent pads to cleanup product that had spilled onto the crane decking and onto the concrete pavement beneath the vehicle. PE mechanics replaced the defective gasket before the crane was moved from the spill area.
5/17/96 96-10	Hydraulic Oil	12 gals.	Yes	A hydraulic line on a Jacobsen lawnmower developed a leak which resulted in the discharge of approximately 12 gallons of hydraulic oil in the roadway between Buildings 703 and 423 (½ mile). Grounds personnel were immediately dispatched to apply spill absorbent to the road to absorb and residual oil. A street sweeper was used to remove the residual spill absorbent. A small quantity of oil was spilled to soil. All contaminated soil was removed and drummed for off-site disposal.
96-11 6/10/96	Hydraulic	< 1 quart	No	A hydraulic line on a piece of heavy equipment ruptured releasing less than one quart of fluid onto pavement. PE personnel used absorbent pads and spill absorbent to cleanup the spillage. These materials were picked up and sent to the BNL HWMF for off-site disposal.
96-12 6/11/96	Hydraulic Oil	< ½ Pint	No	During delivery of cement to a construction project, a small amount of hydraulic fluid leaked from the truck. Fire/Rescue personnel responded and immediately applied Speedy-dry to the spill. The contaminated media was then recovered by PE for off-site disposal.
6/13/96 96-13	Gasoline	Unknown	Yes	During construction modifications to the Building 493 Transformer yard, gasoline contaminated soils were discovered. Approximately ½ of a 55-gallon drum of contaminated soils were recovered for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
6/24/96 96-14	Lubricating Oil	< ½ Pint	No	A small amount of lubricating oil leaked from a manlift that was being used to install a wall unit air conditioner in Bldg. 130. PE personnel used spill absorbent to recover the product that accumulated on the pavement beneath the equipment. Contaminated absorbent material and rags were recovered for off-site disposal.
6/26/96 96-15	Hydraulic Oil	2 gals	No	A hydraulic line on a backhoe split while being operated at the transfer station south of Princeton Ave. The equipment operator placed a bucket beneath the vehicle to capture the leaking oil. The recovered oil and some contaminated loose sand & gravel from beneath the vehicle were placed into a 55 gallon drum for off-site disposal.
7/1/96 96-16	Diesel Oil	10 gals.	Yes	During a monthly inspection and test of the emergency generator in Bldg. 423, oil spilled when a float switch in the day tank failed to shut off. Spill absorbent was used to absorb product on the floor around the emergency generator and along a 100 foot path of stained asphalt adjacent to Bldg. 423. Contaminated absorbent and soil recovered by PE Personnel was placed into 55 gallon drums for off-site disposal.
7/2/96 96-17	Diesel Oil	1 gal.	No	Approximately one gallon of diesel oil spilled when the drain cock on the fuel line broke on a small emergency generator being tested outside Bldg. 918. Spill absorbent was used to absorb the spilled material on the pavement and absorbent pads were used to clean residual oil from the casing of the generator. All contaminated materials were drummed for off-site disposal.
7/11/96 96-18	Transformer Oil	3-5 gals.	No	During a semi-annual inspection of back-up transformers stored on the pavement outside of Bldg. T-88, PE Electric Utilities Group staff noted a stained area of pavement beneath and extending approximately 36 feet down gradient from the transformer. It appeared that the spill resulted from a slow leak from a drain valve at the base of the transformer. There was no evidence the valve was leaking at the time the inspection was conducted, none-the-less the valve was tightened. Spill absorbent was applied to the stained area to absorb any residual product. The absorbents were drummed for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
96-19 7/11/96	Oil (Dielectric)	3-4 gallons	No	During routine inspection of the equipment storage yard East of Building 924 an old high voltage power supply was discovered which had filled with water and spilled to the pavement. PE Grounds personnel were notified immediately and the spilled oil was cleaned up within two hours of discovery. All contaminated soils and other debris was collected for off-site disposal.
7/17/96 96-20	Transformer oil	< 5 gal.	Yes	During routine inspection of the Building 928 transformer yard, oil staining of ballast was noticed. Further inspection revealed several small leaks from pump gaskets and one from a petcock valve. PE personnel excavated and containerized the stained ballast for off-site disposal and AGS technicians temporarily secured the leaks.
7/17/96 96-21	Sulfuric Acid	< ½ gal.	No	During routine replacement of an emergency light, acid cell battery, the battery was dropped resulting in the release of sulfuric acid to the concrete floor in Building 707. The acid was absorbed, neutralized and containerized for off-site disposal.
7/24/96 96-22	Hydraulic Oil	2-3 gals.	Yes	Hydraulic oil was released when a pump gasket blew on a mobile crane as it was being moved on a service road northwest of Bldg. 933. Fire/Rescue personnel responded and used oil absorbent pads to clean up spilled product. Pads and contaminated soil were placed in a 55 gallon drum for off-site disposal.
7/30/96 96-23	Motor Oil	< 8 ounces	Yes	During work to replace underground piping leading to the Bldg. 707 Pump House , a PE front end loader began to leak motor oil. Once the leak was discovered, a plastic tray was placed beneath the oil pan and Fire/Rescue personnel used absorbent pads to capture residual oil on the pavement. Pads and a small amount of contaminated soil were recovered and placed in a bag for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
8/6/96 96-24	Zep Pride-E	~1 gal.	No	Plastic containers which had leaked during shipment, caused staining of cardboard shipping boxes at the T-89 warehouse loading dock. The material pooled on diamond plate and was collected using spill absorbent. Absorbent materials and contaminated debris was colected ans was disposed of through HWM
8/9/96 96-26	No. 2 Fuel Oil	2 gal	No	During refueling of the T-30 storage tank, a failed transfer hose resulted in the release of 2 gallons of No. 2 fuel to the pavement outside the building. All spillage was contained and removed using spill absorbents.
8/7/96 96-25	Lubricating oil	< ½ gallon	No	A portable tank containing A/C lubricating oil was found to be leaking after it's delivery to the Central Steam Plant. Spill absorbent pads were used to contain and absorb all spillage and the tank was pumped to prevent further releases. The apparent cause of the leak was due to overfilling.
8/12/96 96-27	Hydraulic Fluid	1 to 2 gal.	No	A forklift developed a hydraulic leak near the Bldg. 902 loading door. The leak resulted in a spray of fluid in the immediate area. The forklift was driven to the rear of building where additional leakage occurred until repairs were made. All spilled product was contained on asphalt and spill absorbent was applied to absorb residual oil. PE personnel cleaned up and disposed of the contaminated absorbents via the HWM.
8/12/96 96-28	Compressor Oil	< 1 gal.	No	Compressor oil leaked from a pump fitting on a new Helium Chiller which was in temporary storage outside Bldg. 934. Spill absorbent was used to adsorb oil deposited on the pavement beneath the unit. All contaminated materials were containerized for off-site disposal. RHIC technicians subsequently checked the fittings to ensure the leak had been stopped.
8/19/96 96-29	Motor Oil	≅ 1 pint	No	During excavation for footings for a stanchion, motor oil began to leak from a front end loader. The contractor placed a plastic tarpaulin under the vehicle to capture dripping oil. The vehicle was removed from the site by the contractor for repairs.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
8/20/96 96-30	Asphalt Roofing Sealer	< 5 gallons	No	A 5 gallon can of roofing sealer fell from the back of a contractor's vehicle. Impact with the road caused the can to open and spill it's contents to the roadway. Fire/Rescue personnel immediately applied spill absorbent to absorb any free standing liquid. PE removed and containerized the contaminated absorbent.
8/23/96 96-31	Diesel Fuel	< ½ pint	No	Prior to refilling the diesel fuel tank of a portable welder, the fuel truck operator witnessed fuel dripping from the equipment. Fire/Rescue responded to the incident and applied spill absorbent to the spill. Investigation of the release showed that the fuel return line had dislodged from the fuel injector pump. All contaminated materials were drummed for off-site disposal.
8/27/96 96-32	Motor Oil	< 5 gallons	No	After picking up a load of trash from Building 630 (public service station) oil was witnessed dripping from the back of the BNL garbage truck. While the garbage truck was too full to properly inspect, a container of motor oil must have been disposed in the trash which was breached upon compaction of the garbage. All spillage was cleaned-up using spill absorbent. The remaining load of trash was transported to the Town of Brookhaven Landfill after all free liquid was drained from the truck.
8/27/96 96-33	Hydraulic Oil	< 1 pint	Yes	During excavation of a potable water main extension to Building 1004, a contractor's backhoe developed a hydraulic fluid leak. All oil contaminated soils were removed and placed into a 55 gallon drum for off-site disposal.
9/3/96 96-34	Hydraulic Oil	< 8 oz.	No	A contractor's backhoe developed a hydraulic fluid leak near Building 1004A; only two small spots were evident on the pavement. Grounds crew applied absorbent to the affected areas. All contaminated absorbents were containerized for off-site disposal.
9/9/96 96-35	Hydraulic Oil	< ½ pint	No	The spill resulted from a failed hydraulic line on a self-propelled manlift. Oil was contained on a rock ballast parking area outside Building 1004A. All oil stained rock was removed and placed into 55 gallon drums for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
9/9/96 96-36	Transformer Oil	< 5 gallons	No	Oil was spilled to the pavement after the BNL contracted scrap metal dealer, drained precipitation from an excessed transformer destined for scrap disposal. Free oil was absorbed using spill absorbent. All oil, stained debris and absorbent was collected for off-site disposal.
9/10/96 96-37	Hydraulic Oil	< 1 gallon	No	After riggers had used a crane to move two transformers into the transformer yard adjacent to Bldg. 914, a leak in the hydraulic line was noticed by the equipment operator. The operator He immediately reported the incident and Fire/Rescue personnel applied Spill absorbent to affected areas of the pavement. Absorbent pads were placed on the deck of the vehicle to adsorb leaking product. Buildings & Grounds personnel recovered the contaminated absorbent for off-site disposal.
9/12/96 96-38	Diesel Oil	≈ 6 ounces	Yes	A small amount of residual fuel, which remained in a fuel line, spilled onto the ground when the fuel line was connected from the fuel storage tank to the generator on an air sparger. Less than one half drum of contaminated soil was recovered by a BNL subcontractor.
9/18/96 96-39	Dielectric Oil	< 1 lb	No	On September 18, after an oil sheen was observed on materials stored in a roll off container destined for the Brookhaven Landfill that was located in the Bldg. 210 scrap yard, the EPO was notified out of concern that the oil might contain PCBs due to the presence of capacitors among the scrap wastes. To prevent additional rainwater from entering the container, Buildings and Grounds personnel provided a tarpaulin to cover the roll off container. As a precautionary measure, oil absorbent pigs were placed at the base of the container down gradient of the roll off to prevent migration of oil contaminated water that might escape the container. Wipe samples of visibly stained segments of wood scraps were taken for PCB analysis. Results from the analysis of the wipes showed the presence of elevated levels of Arochlor-1242 and Arochlor-1248. With the exception of a large rectangular PVC board which was cleaned, sampled and treated as uncontaminated waste, all of the waste materials within the roll off were broken up and placed into 55 gallon drums for disposal as PCB contaminated materials. Thirty-six drums of waste material were generated. Post clean-up wipe samples of the interior surfaces of the roll-off and tools used during the clean-up were analyzed for PCBs to insure that clean-up standards were satisfied before the roll off and tools were released for use elsewhere.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
9/24/96 96-40	Hydraulic Oil	~ 5 gal.	Yes	While transferring soil to a berm located on the south side of Bldg. 1005, the bed of a dump truck overturned, severing a hydraulic connection. Approximately five gallons of hydraulic oil was lost to surface soil before a valve was sealed by the Fire/Rescue personnel. The affected soil was removed and drummed by the PE Division for proper disposal.
9/26/96 96-41	Transmission fluid	1 - 2 qts.	No	An off-site vehicle experiencing mechanical problems pulled into the parking lot adjacent to the Main Gate guard booth. Transmission fluid was found to have leaked onto the asphalt surface of the lot. Absorbent was applied to the spill and PE personnel removed the material for disposal.
10/2/96 96-42	Hydraulic Fluid	Unknown	Yes	A subcontractor's employee, accidentally discharged hydraulic fluid onto the ground west of Bldg. 1005H while he was making repairs to a backhoe. The employee intentionally tried to cover-up the spill by placing ballast material atop the stained soil. PE personnel excavated the contaminated soil for off-site disposal.
10/17/96 96-43	Cutting Oil	≈ 1 gal.	Yes	Cutting oil leaked onto the ground from a roll-off container opposite Bldg. 479, when a load lugger containing machine shop cuttings and residual cutting fluid was inadvertently dumped into the container with other scrap metal. After moving the roll-off container, PE personnel removed the contaminated soil and adsorbent materials used to capture pooled liquid.
10/17/96 96-44	Antifreeze	≈ 1 gal.	No	Approximately 1 gallon of antifreeze was discovered beneath a private vehicle parked in the lot at the corner Railroad St. and Brookhaven Avenue. Fire/ Rescue personnel applied Spill absorbent onto the pooled product when they arrived at the scene. After the vehicle owner moved the vehicle, PE personnel recovered the absorbent material and placed it into a drum for off-site disposal.
10/24/96 96-45	Diesel Fuel	< 1 gallon	Yes	The spill resulted from a failed fuel injection line on a portable diesel powered pump. Oil contaminated soil was removed and placed into 55 gallon drums for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
11/8/96 96-46	No. 2 & 6 fuel oil	10 - 15 gal.	Yes	During cleaning operation of oil lines connected to Bldg. 611B, Tank #T-2, an improperly secured coupling failed after line pressurization. A spray discharge of No.2 and No.6 fuel oil resulted. All oil was deposited within the base of the tank containment area. All contaminated ballast was containerized by the contractor and disposed off-site.
11/12/96 96-47	No. 6 fuel oil	<2 gal.	No	Oil leaks occurred at the base of fuel oil transfer lines at Bldg. 610, Tanks 9 and 10. All leaks were contained within the secondary containment berm. All affected material was cleaned by PE personnel and removed for disposal.
11/13/96 96-48	No. 6 Fuel Oil	10 gallons	Yes	Oil was released from the Tank 10 heat exchanger when an operator removed a cap and valve from the exchanger. The operator was attempting to drain water from the heat exchanger to avoid freeze-up of residual water. The operator was not aware that under a new piping configuration, oil was contained in the shell side. Oil was sprayed onto the sidewall of the tank and within the containment area. The tank sidewall was cleaned and oil stained rocks were removed for off-site disposal.
11/16/96 96-49	Gasoline	5 gal.	Yes	A Safeguards and Security vehicle caught fire at approximately 0400 hrs. After extinguishing the fire, gasoline was discovered to be leaking from a melted fuel line. Fire personal placed containers under the leak and recovered approximately 3 gallons of fuel. The Fire/Rescue personnel also applied Spill absorbent around the vehicle to minimize the amount of fuel/water mixture migrating from the asphalt onto soil. After moving the vehicle, PE personnel removed the contaminated soil and absorbents.
11/25/96 96-50	Petroleum Product	unknown	Yes	Contaminated soil was discovered north of Bldg. 815 loading docks during excavation of underground piping. The spill is historic in nature; consequently, the date of the occurrence and specific material therefore are unknown. All contaminated material was collected for off-site disposal.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
12/6/96 96-51	Hydraulic Fluid	< 1 qt.	No	Oil sheen was noticed in the storm water runoff from Cornell Ave. Investigation showed a contractor's truck to be leaking from a hydraulic valve. A bucket was placed beneath the leak and oil absorbents were applied to the oil sheen and affected pavement. Inspection of the storm water outfall failed to show evidence of a sheen.
12/09/96 96-52	Motor Oil	< 1 gal	Yes	Approximately 1 gallon of motor oil spilled as a roofing subcontractor attempted to repair a motor on a lift conveyor he was using to transfer gravel material to the roof. Fire/Rescue personnel used absorbent pads and spill absorbent to recover the spilled product. After the lift assembly motor was jacked in place, subcontractor personnel assisted by the general contractor recovered contaminated soil and absorbent materials for off-site disposal.
12/09/96 96-53	Hydraulic Fluid	<1/2 gal	No	A hydraulic line on the contractor's backhoe ruptured releasing hydraulic fluid onto the pavement adjacent to Bldg. 1005H. Fire/Rescue personnel spread absorbent pads atop the spilled product. Contractor personnel placed a bucket beneath the line to capture leaking fluid. Absorbent materials which were used to recover spilled product along with ballast material that had been contaminated were placed into a drum for off-site disposal.
12/9/96 96-54	No. 2 Fuel Oil or Diesel	Unknown	Yes	During removal of a propane tank, contaminated soils were encountered. Approximately 60 yards of contaminated soils were excavated for off-site disposal. To determine the extent of residual contamination, soil samples were collected from the sidewalls of the excavation. All analytical results were provided to the NYSDEC for review.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
12/12/96 96-55	Ethylene Glycol	≈ 1 gal	Yes	During the evacuation drill, two vehicles collided at the intersection of Brookhaven Ave and Technology St.. Both vehicles came to rest on the lawn to the north of Bldg. 193. The impact from the collision cracked the radiator of one vehicle causing a slow leak of radiator fluid. Fire/Rescue personnel used absorbent pads to recover some of the spilled product and placed a plastic container beneath the radiator to recover the leaking fluid. The spill area was covered in plastic until the vehicle was towed the following morning. PE personnel recovered and containerized the contaminated soil for off-site disposal
12/16/96 96-56	Fuel Oil	1-2 gal	No	Absorbent pads and spill absorbent were placed on the spilled product from a fuel oil delivery truck. The subcontractor assisted PE personnel with clean up for off-site disposal. Oil was spilled on cement and was cleaned up in less than 2 hours

*Reportable to offsite agencies.

gallons, are contained or under the control of the responsible party, have not and will not reach soils and groundwater, and are cleaned up within two hours of discovery are not reportable to the NYSDEC. Releases of hazardous substance in quantities equal to, or greater than, their reportable quantity must be reported to the National Response Center under the requirements of Comprehensive Environmental Response, compensation & Liability Act (CERCLA). Such releases are also subject to reporting to the NYSDEC as mandated in the NY Navigation Law, and to the SCDHS as specified in the Suffolk County Sanitary Code (SCSC).

2.4 Clean Air Act

2.4.1 Conventional Air Pollutants

During 1996, a variety of BNL emission sources were evaluated with respect to NYS and Federal permitting requirements. The applicable regulations for these sources are the Codes, Rules and Regulations of the State of New York, Title 6, Chapter III, Part 200, New York State Air Pollution Control Regulations and the CAA. The sources reviewed and their current permit status are summarized below.

No. of Actions	Status/Comments
1	In March 1996, the aqueous cleaning system recommended by DOW Environmental Advanced Cleaning Systems for the new Centralized Cleaning Facility was evaluated to determine whether a permit to construct would have to be filed with NYSDEC. Under then proposed revisions to 6 NYCRR Part 201, the aqueous cleaning system that was to be installed was considered a trivial source exempt from permit filing requirements since the three cleaning solutions selected had volatile organic compound contents of two percent or less by volume. However, since the proposed revisions to Part 201 were pending approval by the NYS Board of Review, a draft application was prepared. A decision was made not to submit the application, when it became clear that construction of the new facility would not begin until after the revisions to Part 201 were approved.
1	In May 1996, an equivalency application was prepared and submitted to NYSDEC Bureau of Eastern Remedial Action in Albany for the air stripper designed to remove volatile organic compounds from contaminated groundwater in Operable Unit 1. BNL received confirmation that the application had been approved in September 1996.
1	In June 1996, EPA Region II extended their approval to waive the construction permit and emissions-testing requirements of 40 CFR 61 Subpart C for the machine cutting of beryllium crystals. An extension to the waiver approved by EPA earlier in the year was requested in April 1996 after it became apparent that time limitations might hinder the completion of the anticipated cutting. The waiver request was first made in December 1995. As preparation for the work proceeded, it became apparent that costs associated with emissions monitoring

and cleaning of the electric discharge machine which would be used to cut the crystals were prohibitive for the quantity of machining that was required. As a result, a decision was made to outsource the work to a beryllium machining operation in Woodbury, New York.

2.4.2 Employee Trip-Reduction Plan

In September 1996, the New York State Department of Transportation (NYSDOT) announced they were repealing the Employee Travel Reduction Program rules (17 NYCRR Part 68) that were promulgated in April 1994. This action came on the heels of a congressional bill that was passed in December 1995 which makes the CAA Employee Travel Reduction Program a voluntary program for affected states. By this action, the Laboratory is no longer obligated to implement the commute option strategies identified in its Employee Trip Reduction Compliance Plan and the Laboratory was relieved of commitments to conduct a follow-up employee commute survey and to prepare a Compliance Plan Update for November of 1996. Despite this action, the S&EP Division continues to manage a ride matching database which was developed to help find suitable rideshare partners for employees interested in carpooling. Furthermore, the Laboratory continues to subsidize the cost of a defensive driver course for participants in ridesharing partnerships.

In September, the Laboratory finally received word from NYSDOT that the contract for the Long Island Regional Improving Commute Grant that the Laboratory had applied for to help support the introduction of several Employee Commute Options Program initiatives had been approved. The grant program was started to provide nonprofit and government-owned or operated facilities with financial assistance to develop innovative strategies to help the employer meet CAA requirements for employee travel reduction. Due to the delay in the release of grant funds and NYSDOT's anticipated decision to repeal the Employee Travel Reduction Program rules, the Laboratory canceled its plans to introduce a pilot on-site shuttle bus service. As a result, only a portion of the available funds from the grant will be used by the Laboratory to cover expenses from the various employee travel reduction initiatives that were introduced to employees in 1994 and 1995.

2.4.3 Reasonable Available Control Technology (RACT) Requirements

In March 1994, the Laboratory submitted a compliance plan to NYSDEC that identified how the Laboratory intends to meet the reasonable available control technology requirements of 6 New York Code of Rules and Regulations (NYCRR) Subpart 227-2. The NYSDEC later approved the NO_x RACT compliance plan in June 1994. Most of the milestones of the plan were satisfied by the Laboratory during 1995. One remaining milestone of the plan was the demonstration that NO_x emissions from the Central Steam Facility (CSF) Boiler 7 meet the NO_x reasonable available control technology compliance limit.

On May 1 and May 2, 1996, in conformance with Special Condition III of the Permit to Construct issued for CSF Boiler 7 and the emissions testing requirements of 40 CFR Subpart Db and 6 NYCRR Subpart 227-2 three 60-minute test runs for NO_x emissions were performed under peak firing conditions. On May 2, additional test runs were completed at moderate and low fire conditions to obtain comparative NO_x emissions at expected operating loads. Meanwhile, total suspended particulate (TSP), inhaleable particulates (PM-10), carbon monoxide (CO), and volatile organic compounds (VOCs) emissions were measured during three two-hour test runs done on

May 1. In conformance with Subpart Db and 6 NYCRR Subpart 227-2 requirements, performance testing of the continuous emissions monitoring systems (CEMS) for NO_x and opacity was also conducted. Results from this performance testing confirmed that the CEMS for both pollutants were performing as desired.

The emissions test results demonstrated that the NO_x RACT emission standard of 0.30 lbs/MMBTU and emission limits for CO and VOCs as established in the Permit to Construct for CSF Boiler 7 were satisfied. Unfortunately, the test results showed that the 40 CFR Subpart Db emissions limit for particulates (0.10 lbs/MBtu) was exceeded. On December 12 and 13th, the emissions tests for TSP and PM-10 were repeated, after the boiler manufacturer made adjustments to the damper control settings in the combustion chamber to improve the performance of the boiler. The results of these second set of tests confirmed that CSF Boiler 7 emissions complied with TSP and PM-10 Subpart Db emissions limits.

The CSF operating plan which was submitted to NYSDEC In March 1995, describes how the Laboratory intends to operate the CSF boilers to ensure that the NO_x emissions standard is satisfied. In May 1995, the CSF began burning low sulfur and low nitrogen No. 6 oil, to meet the emissions standard. In 1996, NO_x emissions from Boiler No. 6 have averaged 0.248 lbs/MMBTU as measured by the boiler's continuous emissions monitoring system (CEMS). During the peak ozone period from May 1 to September 15, compliance with the 0.30 lbs/MMBTU NO_x emissions limit is demonstrated by calculating the 24-hour daily arithmetic average rate of NO_x emission. Outside this period, the 30-day rolling average CEM emissions rate is used to establish compliance.

2.4.4 Phaseout of Halon Fire Suppression Systems

Based on recommendations in the 1994 Hughes Associates, Inc. study of existing Halon 1301 fire suppression systems, the Halon fire suppression system in Trailer 111 serving Building 960 was removed from service during 1996. A second Halon fire suppression system in Trailer 156, which is the monitoring center for linear accelerator beam line experiments, was also removed from service after the system accidentally discharged when a heat detector in the trailer was damaged during the removal of equipment from the trailer. Requests for funding for the replacement of several Halon 1301 systems with either FM-200 or Inergen gaseous fire suppression systems were made in 1996. Both FM-200 and Inergen are inert gas mixtures which have been considered acceptable substitutes by EPA because they pose no environmental risk due to ozone depletion or global warming. A request for funding was also made to purchase a recovery unit that can be used alternately to recover Halon 1301 from stationary storage vessels or Halon 1211 from unserviceable portable fire extinguishers.

2.4.5 Ozone Depleting Refrigerants

In 1996, construction was completed on a new 3.2 million gallon chilled water storage tank at the Chilled Water Facility. Since construction was completed, cooled water from the tank has been used to meet comfort cooling needs to Building 725 during peak energy demand periods in the summer. This addition which provides increased cooling capacity for the site should enable BNL to retire additional low efficiency comfort cooling units as funds become available for new building connections.

2.4.6 National Emissions Standards for Hazardous Air Pollutants (NESHAPs)

2.4.6.1 Radioactive Airborne Effluent Emissions Governed by NESHAPs

In 1996, BNL was in compliance with 40 CFR 61, Subpart H NESHAPs regulations. The maximum off-site dose due to airborne radioactive emissions from the Laboratory was far below the specified 10 mrem annual effective dose equivalent limit. The site boundary dose resulting from airborne emissions, as calculated using the EPA CAP88-PC model, was 0.07 mrem (0.7 μSv). All airborne effluent release data and dose calculations were transmitted to both DOE and EPA, fulfilling the June 30 annual reporting requirement.

2.4.6.2 Asbestos Emissions

Since 1993, BNL emissions have complied with 40 CFR 61 regulations on airborne fiber releases. During 1996, the EPA region II was notified on two occasions that operations required NESHAPs formal notification. Formal annual notification for nonscheduled small renovations for 1995 was made to both DOE and EPA in compliance with the reporting requirements. An estimated amount of total friable asbestos material was projected to be removed in small removal operations at 634 square feet of surface material, and 1,627 linear feet of pipe insulation.

2.4.6.3 NESHAPs Maximum Available Control Technology (MACT) Requirements

In August 1996, BNL evaluated all current and proposed metal cleaning operations to determine applicability of 40 CFR 63 NESHAPs Subpart T. The provisions to this subpart apply to all individual batch vapor, in-line vapor, in-line cold, and batch cold solvent cleaning machines that use any solvent containing 1,1,1-trichloroethane (methyl chloroform), methylene chloride, perchloroethylene, trichloroethylene, carbon tetrachloride, or chloroform or any combination thereof, in concentrations greater than five (5) percent by weight. None of the thirteen parts cleaning operations that were evaluated used any of the halogenated solvents that trigger the engineering control provisions of this subpart. The results of the evaluation were transmitted to the NYSDEC regional office.

2.4.7 Air Toxics

The NYSDEC a guidance document called Air Guide-1 in their evaluations of permit applications to insure that new sources that release toxic air contaminants are adequately controlled to prevent the exceedance of federal or state emissions standards. Air Guide-1 offers two different approaches for the review of air permit applications, the screening analysis procedure and an AIR Guide-I software program that uses more refined dispersion modeling techniques to estimate potential impacts of a source on downwind receptors. The screening analysis procedures are used by the NYSDEC during reviews of most permit applications.

The simple screening approach is usually the first step in an ambient impact evaluation. This approach relies upon emissions data and stack information provided by the applicant and plugs this information into a series of equations that take into account meteorological data from National Weather Service readings taken in Albany to derive worst case ambient concentrations at downwind receptor locations. The screening method formulas predict the maximum potential annual impact and the maximum short term (i.e., 8-hour average) impact of a source. The predicted ambient concentrations of each pollutant are then compared to their respective allowable annual guideline concentrations (AGCs) and the short-term guideline concentrations (SGCs) listed for each pollutant. If predicted ambient impacts fall below the AGC and SGC, the NYSDEC will usually approve the application without imposing any pollution control requirements. If the predicted annual or short term concentration of any pollutant exceeds its AGC or SGC, a less conservative dispersion model may be warranted or engineering controls may be required.

To ensure that emissions from new sources do not cause adverse impacts on potential on-site or off-site receptors, BNL performs an AIR Guide-1 screening analysis on all new emission sources which emit toxic contaminants and includes the analysis with permit and equivalency applications.

2.5 Suffolk County Sanitary Codes

There are more than 300 storage facilities at BNL which are regulated under the Suffolk County Sanitary Code Articles 7 and 12. Since Suffolk County and BNL signed an agreement in 1987, the Laboratory has made significant progress toward bringing all storage facilities into compliance with these requirements. A description and status of the activities conducted during 1996 is given below:

No. of Actions	Status/Comments
9	Nine existing storage tanks were removed from the ground as part of BNL ongoing program of tank closures. These tanks included the following facilities. At Building 911, a single, 50 gallon gasoline storage tank formerly used for a gasoline powered generator was identified in the Westinghouse transformer yard. At Building 193 a single walled 1000 gallon fuel oil tank was encountered during construction of a new electrical substation. A former diesel fuel storage tank located at Building 815 which supplied fuel for a generator was removed and replaced by a SCAT tank. Three 1,000 gallon fuel oil tanks were removed at Building T-30 and a new 4,000 gallon SCAT tank was installed. Three 550 gallon underground storage tanks associated with low-level radioactive waste water hold up were removed. These tanks were located at Buildings 490, 927A and 462.
3	Three existing indoor above grade storage tanks were disconnected from service at Building 815. These tanks were formerly used for intercepting waste waters generated in laboratories using radioactive materials. The waste water was held and analyzed prior to discharge to the BNL sewer system. Since there are no longer any activities which can contribute radiological contaminants to this waste water steam, the tanks were deemed unnecessary and were

removed from service.

14 Plans and specifications for upgrading twelve indoor tanks used to store water-treatment chemicals were approved by the SCDHS. This project included removing eight tanks (BNL ID#s 490-13, 490-14, 490-15, 490-16, 576-01, 576-02, 576-03, & 634-01), installing two new storage tanks (BNL ID#s 576-04 & 634-03), and equipping four tanks with secondary containment and overfill protection (BNL Identification Numbers 490-11, 490-12, 635-01, & 637-01). Construction was completed in mid 1996.

10 Plans and specifications were submitted to the SCDHS and approved for construction. Facilities included the three tanks located in the AGS well houses (Buildings 915, 916 and 917), the five process tanks at the new Centralized Degreasing Facility (Building 498) and the two chemical feed tanks at the OER Groundwater Treatment Plant (Building 598). Construction of all three facilities was completed during 1996.

4 Plans and specifications for construction of the new Waste Management Facility were submitted and approved. This facility includes four buildings three of which have associated facilities regulated under Article 12. The facilities include the RCRA, Mixed Waste and Reclamation buildings. Article 12 regulated activities include drum storage, underground storage tanks and piping, and process tanks.

1 Upgrades to the Building 801 to 811 waste transfer piping were completed and inspected by the SCDHS. The piping system was pressure tested and found to meet all requirements.

In addition to these activities, routine meetings with the SCDHS were held throughout the year to discuss progress in attaining compliance with SCSC Article 12. A General Plant Project was funded in 1996 which should bring most remaining storage facilities into compliance with SCSC Article 12 by the end of CY 1998. The project will provide for tank removals, upgrades and new installations. In January 1996 SCDHS inspectors conducted comprehensive walk-through inspections of storage facilities registered in the summer of 1994.

2.6 Safe Drinking Water Act (SDWA)

2.6.1 Applicability to Brookhaven National Laboratory

The Laboratory maintains six wells and two water-storage tanks for supplying potable water to the Laboratory community. Safe Drinking Water Act Requirements pertaining to the distribution and monitoring of public water supplies are promulgated under Part 5 of the New York State Sanitary Code which is enforced by the SCDHS as the agent for the NYSDOH. These regulations are applicable to any water supply which has at least five service connections or regularly serves at least 25 individuals. The Laboratory supplies water to a population of approximately 3,500 and must, therefore, comply with these regulations.

2.6.2 Potable Water Monitoring Requirements

The potable water supply used at BNL was obtained from three wells (Potable Wells 10, 11 and 12) during 1996. Due to construction of major improvements to the WTP, Potable Wells 4, 6 and 7 were not used for consumptive purposes in 1996. The annual minimum monitoring requirements for potable water suppliers are specified by the SCDHS. In response to these requirements, the Laboratory prepares a Potable Water System Sampling and Analysis Plan which outlines sampling procedures and provides a schedule for annual monitoring of BNL's potable water system. The content of the BNL Sampling and Analysis Plan was found acceptable by the SCDHS. Routine monitoring of the potable wells and the potable water distribution system by BNL exceeded the prescribed minimum monitoring requirements. The monitoring requirements for 1996 included; monthly bacteriological analyses, quarterly analyses for POCs, an annual analysis for SOCs and Pesticides, semiannual inorganic chemicals analyses and annual micro-extractables and asbestos analyses. Monitoring requirements for CY 1995 and 1996 were similar. Potable water samples were collected by BNL personnel and analyzed by an NYSDOH certified contractor laboratories using standard methods of analysis. All analytical data was submitted to the SCDHS as required by Chapter I, Part 5, of the NYS Sanitary Code. Table 2-5 summarizes the bacteriological, inorganic, radiological and asbestos analytical data. Table 2-6 summarizes the POCs, SOCs, pesticides and micro-extractables analytical data. While the Potable Water Sampling and Analysis Plan did not require radiological analysis of water samples, water samples wee routinely collected as part of the Environmental Monitoring Program. The analytical results of these samples is discussed in Section 8.1.1.1 of this report.

All reported bacteriological, SOCs, pesticides, micro-extractables, and asbestos data collected during CY 1996 was within the NYS DWS.

Table 2-6 shows that the water from Potable Well 11 exceeded the NYS DWS for TCA. Volatile organic compounds, particularly TCA, caused the shutdown of Potable Wells No. 4, 10, and 11 in the past; consequently, Potable Wells 10, 11 and 12 were equipped with activated carbon-adsorption devices to abate POCs. Analysis of untreated water samples collected from Potable Well 11 showed the concentrations of TCA to be greater than the NYS DWS of 5 µg/L, and ranged from a minimum of 3.7 to a maximum of 6.3 ug/L. However, concentrations of TCA in treated water samples showed all samples to be less than the NYS DWS.

Monitoring of the BNL potable water system for lead and copper continued during CY 1996. Since analytical results for 1995 showed all facilities to be within the Federal Action Levels for Lead and Copper, monitoring for 1996 was reduced to twenty locations, sampled annually. All analytical results again show the BNL potable water system to be in compliance with the Action levels. As required by the Federal Lead and Copper Rule, the Laboratory has completed a "desk top" study of the potable water distribution system to identify measures which would reduce the water's corrosion potential. This study was submitted to the SCDHS by July 1, 1995. This study suggested increasing the dosing rates of sodium hydroxide at Wells 10, 11, and 12, and lime at the WTP. By increasing the alkalinity of the water, dissolution of lead into the domestic water system would be reduced. Increased dosing of sodium hydroxide at Wells 10, 11, and 12 commenced in September 1995. Recommendations for adding more lime at the WTP will be implemented upon restart of this facility. One outcome of the increased pH of the potable water

Table 2 - 5
BNL Site Environmental Report for Calendar Year 1996
Potable Water Wells and Potable Distribution System,
Bacteriological, Inorganic Chemical and Radiological Analytical Data [1,3]

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	Potable Distribution Sample	NYS Drinking Water Standard	
Total Coliform	ND	ND	ND	ND	ND	ND	ND	Negative	
Color	30	40	20	<5	<5	<5	<5	15	Units
Odor	2	2	0	0	0	0	0	3	Units
Cyanide	<10	<10	<10	<10	<10	<10	<10	NS	ug/L
Conductivity	115	88	140	107	117	127	142	NS	umhos
Chlorides	24	15	25	15	17	11.9	22	250	mg/L
Sulfates	7.5	7.1	7.8	7.8	8.8	8.3	10.2	250	mg/L
Nitrates	0.3	0.2	0.3	0.6	0.7	0.3	0.3	10	mg/L
Ammonia	<0.02	0.03	< 0.02	<0.02	<0.02	<0.02	<0.02	NS	mg/L
pH	5.6	6	6	6.2	6.1	6.5	8.4	NS	SU
Methylene Blue Active Substances	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	NS	mg/L
Antimny	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	6.0	ug/L
Arsenic	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	50	ug/L
Barium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.0	mg/L
Beryllium	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	4.0	mg/L
Cadmium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	ug/L
Chromium	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	mg/L
Fluoride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.2	mg/L
Iron	3.3	3.7	1.4	<0.02	<0.02	0.03	0.03	0.3	mg/L
Lead	5.7	1.7	<1.0	<1.0	<1.0	<1.0	<1.0	15	ug/L
Manganese	0.07	0.2	0.04	<0.01	<0.01	<0.01	<0.01	0.3	mg/L
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.0	ug/L
Nickel	<0.04	0.18	<0.04	<0.04	<0.04	<0.04	<0.04	0.1	mg/L
Selenium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	10.0	ug/L
Sodium	13.2	9.4	15.4	10.3	11.5	13.9	22.4	NS	mg/L
Thallium	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	2.0	ug/L
Zinc	0.03	0.04	0.04	0.03	0.02	0.02	<0.02	5.0	mg/L
Gross α Activity	NR	NR	NR	NR	NR	NR	NR	15	pCi/L
Asbestos	NR	NR	NR	NR	NR	NR	<0.02	7	M.Fibers/L
Calcium	NA	NA	NA	NA	NA	NA	9.5	NS	mg/L
Alkalinity	NA	NA	NA	NA	NA	NA	44	NS	mg/L

1. This table contains the maximum concentration (minimum pH value) reported by the contractor laboratory.
2. Due to constructing improvements to the WTP, Well 4, 6 and 7 were not used for potable water distribution for the duration of 1996.
3. See Figure 4 - 11.

(ND): Not Detected
(NS): DWS Not Specified
(NR): Analysis Not Required
(NA): Analysis Not Available

Table 2-6
BNL Site Environmental Report for Calendar Year 1996
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<------				µg/L			------>
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	5
Chloromethane	ND	ND	ND	ND	ND	ND	ND	5
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	2
Bromomethane	ND	ND	ND	ND	ND	ND	ND	5
Chloroethane	ND	ND	ND	ND	ND	ND	ND	5
Fluorotrichloromethane	ND	ND	ND	ND	ND	ND	ND	5
1,1-dichloroethene	ND	ND	ND	ND	ND	0.8	ND	5
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	5
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND	5
1,1-dichloroethane	ND	ND	ND	ND	ND	0.6	ND	5
cis-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND	5
2,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5
Bromochloromethane	ND	ND	ND	ND	ND	ND	ND	5
1,1,1-trichloroethane	ND	ND	ND	ND	0.9	6.3	ND	5
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	5
1,1-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	5
trichloroethane	ND	ND	ND	ND	ND	ND	ND	5
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5
Dibromomethane	ND	ND	ND	ND	ND	ND	ND	5
trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5
cis-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND	5
Trihalomethanes	1.6	25.3	ND	7.1	3.4	0.5	ND	100
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	5
1,3-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	5
Bromobenzene	ND	ND	ND	ND	ND	ND	ND	5

Table 2-6 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<----------				µg/L			---------->
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	5
1,2,3-trichloropropane	ND	ND	ND	ND	ND	ND	ND	5
2-chlorotoluene	ND	ND	ND	ND	ND	ND	ND	5
4-chlorotoluene	ND	ND	ND	ND	ND	ND	ND	5
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
1,2-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	5
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
Benzene	ND	ND	ND	ND	ND	ND	ND	5
Toluene	ND	ND	ND	ND	ND	ND	ND	5
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	5
m-xylene	ND	ND	ND	ND	ND	ND	ND	5
p-xylene	ND	ND	ND	ND	ND	ND	ND	5
o-xylene	ND	ND	ND	ND	ND	ND	ND	5
Styrene	ND	ND	ND	ND	ND	ND	ND	5
Isopropylbenezene	ND	ND	ND	ND	ND	ND	ND	5
n-propylbenzene	ND	ND	ND	ND	ND	ND	ND	5
1,3,5-trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	5
tert-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5
1,2,4-trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	5
sec-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5
p-isopropyltoluene	ND	ND	ND	ND	ND	ND	ND	5
n-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5

Table 2-6 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<----------				µg/L			---------->
Alachlor	ND	ND	ND	ND	ND	ND	ND	2
Simazine	ND	ND	ND	ND	ND	ND	ND	50
Atrazine	ND	ND	ND	ND	ND	ND	ND	3
Metolachlor	ND	ND	ND	ND	ND	ND	ND	50
Metribuzin	ND	ND	ND	ND	ND	ND	ND	50
Butachlor	ND	ND	ND	ND	ND	ND	ND	50
Lindane	ND	ND	ND	ND	ND	ND	ND	0.2
Heptaclor	ND	ND	ND	ND	ND	ND	ND	0.4
Aldrin	ND	ND	ND	ND	ND	ND	ND	5
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	0.2
Dieldrin	ND	ND	ND	ND	ND	ND	ND	5
Endrin	ND	ND	ND	ND	ND	ND	ND	0.2
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	40
Toxaphene	ND	ND	ND	ND	ND	ND	ND	3
Chlordane	ND	ND	ND	ND	ND	ND	ND	2
Total PCB's	ND	ND	ND	ND	ND	ND	ND	0.5
Propachlor	ND	ND	ND	ND	ND	ND	ND	50
2,4,5,-TP (Silvex)	ND	ND	ND	ND	ND	ND	ND	10
Dinoseb	ND	ND	ND	ND	ND	ND	ND	50
Dalapon	ND	ND	ND	ND	ND	ND	ND	50
Pichloram	ND	ND	ND	ND	ND	ND	ND	50
Dicamba	ND	ND	ND	ND	ND	ND	ND	50
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	1
Hexachlorcyclopentadiene	ND	ND	ND	ND	ND	ND	ND	5
Di(2-ethylhexyl)Phthalate (2)	ND	ND	ND	ND	ND	ND	ND	50
Di(2-ethylhexyl)Adipate	ND	ND	ND	ND	ND	ND	ND	50
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	5
Benzo(A)Pyrene	ND	ND	ND	ND	ND	ND	ND	50
Aldicarb Sulfone	ND	ND	ND	ND	ND	ND	ND	NS

Table 2-6 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Potable Water Wells, Analytical Data for Principal Organic Compounds,
Synthetic Organic Compounds Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<----------				µg/L			---------->
Aldicarb Sulfoxide	ND	ND	ND	ND	ND	ND	ND	NS
Aldicarb	ND	ND	ND	ND	ND	ND	ND	NS
Oxamyl	ND	ND	ND	ND	ND	ND	ND	50
3-Hydroxycarbofuran	ND	ND	ND	ND	ND	ND	ND	50
Carbofuran	ND	ND	ND	ND	ND	ND	ND	40
Carbaryl	ND	ND	ND	ND	ND	ND	ND	50
Total Aldicarbs	ND	ND	ND	ND	ND	ND	ND	NS
Glyphosate	ND	ND	ND	ND	ND	ND	ND	50
Diquat	ND	ND	ND	ND	ND	ND	ND	50
Ethylene Dibromide	ND	ND	ND	ND	ND	ND	ND	0.05
Dibromochloropropane	ND	ND	ND	ND	ND	ND	ND	0.2

ND: Not detected at minimum detection limit.
NS: DWS Not Specified
Notes: For compliance determination with NYSDOH standards, potable wells were analyzed quarterly during the year by H_2M Labs, Inc., a NYS certified contract Laboratory.

The minimum detection limits for POC analytes are 0.5 µg/L. Minimum detection limits for SOCs, Pesticides and Micro-extractables are compound specific and in all cases are less than the NYSDOH drinking water standard.

All concentrations contained in Table 2-6 are the maximum values reported by the contractor laboratory.

1. See Figure 4-11.

2. Trace quantities of Di(2-ethylhexyl)phthalate were detected in the composite samples prepared from Wells 4, 6 and 7, and Wells 10, 11 and 12. All detected concentrations were less than one-half the NYSDWS.

system has been the periodic exceedance of waste water discharges to on-site recharge basins. Initial attempts to maintain a pH of 8.0 throughout the distribution system resulted in higher pH readings at points closest to the well. The increased pH of potable water used in non-contact cooling water systems resulted in effluents which exceeded NYS guidelines for discharges to groundwater. To mitigate the increased pH, a policy to control the pH at the well to 8.0 was established.

The SCDHS inspected the BNL potable water supply system in November 1996. This inspection included walk-through examinations of the WTP, WTP support facilities and potable well support facilities. The SCDHS inspector noted that all operations were satisfactory. Water samples collected during this visit showed that all analytical parameters met the NYS DWS.

2.6.3 Cross-connection Control

The NYSDOH is authorized under Public Health Law 201 to supervise and regulate the sanitary aspects of potable water supplies. Cross-connection control (CCC) is the means by which the hazards of industrial or non-potable uses of the water supply are minimized. CCC consists of installing backflow prevention devices to prevent potentially contaminated water mixing with the potable supply in the event of low system pressure. There are two categories of CCC devices. Primary devices consist of check-valves (CV), double check-valves (DCV), or reduced pressure zone (RPZ) devices which are typically installed between the facility's water connection and the potable water distribution system. These devices protect the main potable supply from contamination from facility operations, but they do not protect the facility's internal plumbing. Secondary devices which may also consist of CV, DCV, RPZ or vacuum breakers protect internal plumbing systems. The degree of hazard posed by the occupancy determines which device is warranted.

The Laboratory has had an active CCC program since 1985. This program includes the installing of both primary and secondary CCC devices and maintaining testing of these devices annually required by state regulations. Maintenance and testing devices is managed by the Plant Engineering, Maintenance Management Center and all testing is done with NYS-certified backflow prevention device testers. Annual test reports are transmitted to the SCDHS periodically throughout the year. During 1996, annual test reports were submitted for 110 CCC devices.

2.6.4 Underground Injection Control

Discharge of waste water by underground injection is regulated under Part C of the SDWA as codified under 40 CFR Part 144. Under the SDWA, an Underground Injection Control (UIC) program must be developed by each State, for which the Administrator determines that underground injection could pose a threat to a drinking water source. The goal of the UIC program is to prevent the discharge of contaminants into the subsurface which could jeopardize groundwater quality. While all States have been deemed subject to these regulations, a NY State program has not been developed since, in the opinion of the State, the existing SPDES program established under the CWA should meet the intent of the SDWA requirements. Due to NYS reluctance to promulgate a new program, the Laboratory is subject to the EPA UIC program.

Under the EPA program, UIC devices are subject to permitting, sampling and analysis and closure, if deemed necessary. The EPA program defines five types of UIC wells: Class I and IV wells are used for the injection of hazardous wastes, Class II wells are used for gas, oil or hydrocarbon recovery operations, Class III wells are used in extraction of minerals, and Class V wells are wells not covered by Class I, II, III and IV. Class V wells have been generically defined as a well used for the injection of a fluid not regulated under the previous well classes and which is deeper than its widest surface dimension. Class V wells include sanitary and other waste water disposal systems including but not limited to; drywells, cesspools, Septic tanks, leach fields etc. Of the five classes of UIC wells, only Class V wells are located at BNL.

As with much of the Long Island community, in the absence of a central sanitary and storm-water sewer system, discharge of sanitary and process waste waters and storm-water run-off to cesspools, leaching pools, drywells etc. is common-place. The Laboratory maintains in excess of 200 UIC devices for the discharge of these type waste waters. In 1991, the Laboratory was cited by the EPA for operating numerous Class V UIC wells which may have received industrial discharges and were, consequently, subject to UIC permitting. In response to this citation, an inventory of Class V UIC wells was provided to EPA along with a description of each of the wells and their status. To address those UIC wells which were potentially subject to Class V UIC permitting, a program was established to phase out the use of these devices by redirecting these discharges into the BNL sanitary sewer. During 1996 major efforts were expended to eliminate discharges of potential industrial wastes to Class V wells and, where applicable, closure of the wells. This project involved the rerouting of floor and/or sanitary drains from Buildings 463, 481, 575, 815, 912, 912A, 913A, 913B, 913D, 913E, 914, 922, 925, 927, 928, 929, 960, 961, 962, and 964 to the BNL STP. These drains formerly discharged to either the BNL storm water system or UIC wells. The scope of work for this project consisted of the evaluation of the existing drainage system, design of an alternate waste water disposal system and construction. Upon construction completion, each of the former UIC wells was sampled to determine impact on local groundwater. Copies of the analytical reports were provided to the SCDHS, which provides local enforcement for the EPA, in early 1997.

2.7 Toxic Substance Control Act (TSCA)

2.7.1 TSCA Program at BNL

The use and disposal of specific substances, such as polychlorinated biphenyls (PCBs), is regulated under the TSCA. The requirements under this Act include labeling, inspections, record keeping, immediate notification, and cleanup upon discovery of spills, and proper disposal. The Laboratory issued a Safety, Environment, and Administrative Procedures Manual (SEAPPM) for PCB management in 1992. This SEAPPM formalized BNL's policy and identified specific responsibilities to ensure that PCBs are managed in accordance with TSCA requirements. The S&EP Division maintains a database of all Department and Division PCB equipment to ensure proper tracking and record-keeping; and is updated as information is supplied by the various Departments and Divisions. In addition, the annual PCB Report for CY 1995, prepared in accordance with the requirements of TSCA, is retained on file at S&EP Division. A copy was also submitted to the DOE-Brookhaven Group.

2.8 NYSDEC Bulk Chemical Storage Registration

Because improper storage and handling of hazardous substances are serious threats to New York's water supplies and to public safety, the New York State Legislature passed Article 40 of the Environmental Conservation Law (ECL), the Hazardous Substances Bulk Storage Act of 1986. This law required the NYSDEC to develop and enforce State regulations governing the sale, storage, and handling of hazardous substances to minimize leaks and spills. A closely related law, ECL Article 37, requires the NYSDEC to issue a list of substances defined as hazardous.

The NYSDEC implemented these hazardous substances bulk storage laws through five sets of Chemical Bulk Storage (CBS) regulations, as follows:

- **6 NYCRR 595** - Releases of Hazardous Substances - Reporting, Response, and Corrective Action.
- **6 NYCRR 596** - Registration of Hazardous Substance Bulk Storage Tanks.
- **6 NYCRR 597** - List of Hazardous Substances.
- **6 NYCRR 598** - Standards for Storing and Handling Hazardous Substances.
- **6 NYCRR 599** - Standards for Constructing New Hazardous Substance Storage Facilities.

Owners of regulated storage tanks were responsible for registering these tanks with the NYSDEC by July 15, 1989. In accordance with Part 596, BNL submitted application forms for the registration of Hazardous Substance Bulk Storage Tanks on July 13, 1989. The regulated tanks are used primarily to store water treatment chemicals. The NYSDEC issued a Hazardous Substance Bulk Storage Registration Certificate in August 1989. In accordance with the NYS regulations, this certificate has been renewed every two years. The Laboratory submitted its most recent renewal request to NYSDEC in July 1995. The application included revisions to reflect existing conditions; thus, seven of the tanks previously included are no longer in service. The Certificate was issued by NYSDEC and has an expiration date of July 27, 1997. Modifications to the Bulk Storage permit in 1996 included the installation of the new hypochlorite storage tank at the BNL STP. Three smaller tanks were removed as a result of this installation. The three tanks will be deleted from the Bulk Storage permit in 1997.

2.9 Resource Conservation and Recovery Act (RCRA)

2.9.1 Facility Upgrades

Construction of a new Waste Management Facility (WMF) progressed throughout 1996. The facility consists of four separate buildings, including a hazardous waste storage facility (RCRA Building), a mixed waste storage facility (Mixed Waste Building), a radioactive waste processing and storage facility (Reclamation Building), and an office/administrative building (Operations Building). The Operations Building was completed in October 1996, and Hazardous Waste

Management staff occupied the building. The RCRA Building was completed in late 1996, while the Mixed Waste and Reclamation Building are scheduled for completion by February 1997. Operations (waste storage and handling) will not commence until the buildings have been authorized by successfully completing the Operational Readiness Review conducted by both BNL and DOE. This is scheduled to occur in the fall of 1997.

Numerous safety and environmental protection features have been incorporated into the design of the facility, including large capacity secondary containment, a subsurface geomembrane liner, fire protection, segregated storage, security and access control. The new facility will provide BNL with state of the art storage and management capabilities for radioactive, mixed, and hazardous wastes.

2.9.2 RCRA Part B Permit (6 NYCRR Part 373 Permit) and RCRA Closure

The two Part 373 Permits BNL received during 1995 remained active during 1996. The permit for the existing hazardous waste management facility (NYSDEC Permit #1-4722-00032/00021-0) became effective on 04/05/95 and expires on 08/31/98. In the fall of 1996, the planning process was initiated to implement the Closure Plan for the existing facility as HWM transitions to the new WMF in 1997. The RCRA Closure process applies to the hazardous and mixed waste storage facilities, specifically buildings 483 (drum storage facility), 448 (labpack storage facility), 360 (ignitable labpack storage), 361 (ignitable labpack storage), 444 (mixed waste storage) and 368 (ignitable mixed waste storage).

The Part 373 Permit for the new facility (NYSDEC Permit #1-4722-00032/00102-0) became effective 07/13/95 and expires on 07/12/05.

2.9.3 90-Day Accumulation Areas and Satellite Areas

Hazardous waste generator training programs have played an important role in emphasizing regulatory compliance, as well as the importance of pollution prevention/waste minimization. In 1996, hazardous waste generator training was given on a site-specific basis (generator training was provided at department or division's building). The generator training includes modules on hazardous waste identification, satellite accumulation, and pollution prevention/waste minimization. This training was well-received, and will continue to be offered on an annual basis. Additionally, for the convenience of the Laboratory staff, a computer based training module has been developed for the RCRA generator training course. 90-Day Hazardous Waste Accumulation Area training was given at each actual accumulation areas for each respective 90-Day Area manager and his or her designee; this training will be offered annually.

A new ESH Standard, 6.2.2 Radioactive Waste Management, was written and circulated for review in 1996. The standard incorporates requirements for radioactive and mixed waste management from the point of generation to transfer to the WMF. The standard was submitted to the Lab Safety Committee in December 1996, and approval is anticipated in Spring of 1997.

2.9.4 Facility Audits

The State inspection of BNL's hazardous waste management program was conducted by the NYSDEC in June 1996. There were no findings or violations resulting from the inspection.

Hazardous Waste Management (HWM) staff periodically participate in the Departmental/Divisional self inspection program (Tier I Inspections). Participation provides a chance for compliance staff to interact with Departmental staff and provide guidance on specific issues. Internal audits and inspections of 90 Day Storage Areas have revealed an increased awareness of requirements and an increased level of compliance. Minor problems are still being identified at Satellite Areas.

Departments and Divisions conducted self-assessments of their ESH programs during 1996. An ESH Profile was developed by S&EP Division to assist in this effort. HWM provided a trend analysis of waste generation for each Department and Division, showing generation statistics for radioactive, mixed, hazardous and industrial waste. Additionally, a compliance summary was included in the ES&H Profile.

2.9.5 RCRA/TSCA Waste Moratorium

BNL's program for certification of nonradioactive hazardous wastes was approved by DOE on June 20, 1996. The program incorporates the use of analytical procedures for materials that can be representatively sampled and the use of standard survey techniques for difficult to sample materials. Release criteria were based on the EPA Practical Quantitation Limits (PQL's) for the analytical program and the limits specified in DOE Order 5400.5 Table IV-1 (plus an activation check) for the survey program. Approval of BNL's process, combined with the already approved Process Knowledge Certification program, have enabled BNL to determine whether wastes are nonradioactive, and to handle them accordingly.

2.9.6 Pollution Prevention Program

BNL has begun implementation of a comprehensive pollution prevention program to reduce the quantity and toxicity of wastes generated on-site. The program is described in the BNL Waste Minimization and Pollution Prevention Plan.

The program is structured to evaluate and reduce waste generation, including radioactive, mixed, hazardous, and solid waste on a Department by Department basis. Processes and waste streams are targeted for pollution prevention opportunity assessments based on a number of priorities, including (but not limited to) environmental risk, health risk, cost, and possibility of success. Opportunities identified are then targeted for funding and implementation.

BNL is beginning to have successful results from the effort and investment in pollution prevention activities. Efforts in vehicle maintenance operations have reduced hazardous waste generation to zero since 1995. This was accomplished mainly through product substitution and planning. The conversion to digital photography was implemented during 1996, utilizing the funding provided by the DOE Return-On-Investment program. Photographic waste generation has begun to decline as a result, with even more substantial declines expected as the conversion is fully implemented. In late 1996, BNL was awarded additional funding from the DOE Return-On-Investment program for implementation of pollution prevention opportunities to reduce radioactive waste water generation and for volume reduction of solid radioactive waste.

Construction of the redesigned cleaning process utilized for cleaning ultra-high vacuum parts of the NSLS was initiated in 1996 based on the results of a pollution prevention opportunity assessment conducted in 1995. The new process, which was proven to achieve the desired cleanliness specification, eliminates the use of harsh acids and will likely eliminate hazardous waste generation from this operation. The process is scheduled for start up in summer of 1997.

BNL is continuing the process of evaluating processes for pollution prevention opportunities. In 1996, assessments were conducted on the mercury waste stream, the battery waste stream and aerosol can waste stream. The assessments were completed and identified several cost-effective opportunities which will be scheduled for implementation in 1997-1998.

2.9.7 Waste Disposal

During 1996, BNL shipped the following quantities and types of wastes to licensed, off-site disposal facilities:

- Hazardous Waste: **79 tons**
- Industrial Waste: **100 tons**
- Mixed Waste (Radioactive Hazardous Waste): **106 cubic feet**
- Radioactive Waste: **15,745 cubic feet**

2.9.8 Federal Facilities Compliance Act (FFCA) Mixed Waste Site Treatment Plan

The FFCA, passed by Congress in 1992, requires DOE sites to work with DOE and local regulatory agencies to develop plans for treatment and disposal of mixed wastes. The plan is required to identify treatment technologies and disposal facilities, and includes a schedule for disposal of accumulated mixed wastes.

During 1996, BNL made its first shipments of mixed waste to commercial facilities for treatment and disposal. Approximately 20,000 pounds of lead mixed waste was encapsulated at Envirocare of Utah utilllizing a process developed at BNL. Incineration was utilized to destroy 2.58 m3 of ignitable waste at DSSI in Kingston, TN.

The NYSDEC continued to work with BNL and DOE's Brookhaven Group towards developing an acceptable consent order. During this process, BNL continued to investigate possible treatment options to facilitate the compliant treatment and disposal of mixed waste.

2.9.9 Mixed Waste Inventory Report

In 1996, BNL updated its Site Treatment Plan to reflect current mixed waste inventory. BNL also responded to other data requests from DOE on specific types of mixed waste (i.e. PCB mixed waste)to help schedule for their treatment. These updates provide DOE with information on the types and quantity of mixed wastes in storage, progress made in treating these wastes, and identifies problems encountered in arranging for treatment.

2.9.10 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

On November 21, 1989, BNL was included on the National Priorities List of the EPA. This is the list of hazardous waste sites that are considered high priority for cleanup under the federal Superfund Program known as CERCLA.

In 1991, BNL established the Office of Environmental Restoration (OER) to oversee the Laboratory's Superfund activities. It is OER's responsibility to remediate areas of known contamination, and to identify, characterize, mitigate, and eliminate, as appropriate, other areas of potential contamination.

In May 1992, IAG among the DOE, the EPA, and the NYSDEC, became effective to insure compliance with CERCLA, the corrective action requirements of (RCRA), the National Environmental Policy Act (NEPA), as well as corresponding New York State regulations. In particular, the IAG will insure that environmental impacts associated with past activities at BNL are thoroughly and adequately investigated so that appropriate response actions can be formulated, assessed, and implemented.

In 1996, there are currently twenty-eight Areas of Concern (AOCs) at the BNL site. They consist of both active facilities, such as the STP, the HWMF and inactive facilities, such as the former landfills, cesspools, and radioactive waste storage tanks. The AOCs have been grouped and prioritized into Operable Units (OUs) and Removal Actions (RAs); the initial prioritization is documented in BNL's Response Strategy Document (RSD). The response action prioritization process has been dynamic and is responsive to the new characterization data, risk assessments, regulatory input, and public input.

The highlights of accomplishments in 1996 include: (1) Free public water hookups to approximately 800 homes in the North Shirley/East Yaphank area as a precautionary measure, (2) Capping of an eight-acre landfill, (3) construction and operation of a groundwater cleanup system at the southern boundary that pumps and treats groundwater contaminated with common chemical solvents, (4) removal and off-site shipment/disposal of sixty-four thousand gallons of low-level sludge from a settling tank located at the BNL STP, (5) signing of BNL's first Record of Decision (ROD) by DOE, EPA, and NYSDEC for an area near the center of the site contaminated with chemicals and radioactivity, (6) initiation of testing the effectiveness of several promising technologies in various areas of BNL, such as, air sparging, vitrification, phytoremediation, (7) holding two public meetings, and (8) development of a World Wide Web page on BNL's Superfund cleanup.

The following is a summary of activities on the OUs and RAs by month:

January 1996

Operable Unit I/VI: Specifications for the Former Landfill cap were prepared.

OU I Engineering Evaluation/Cost Analysis was submitted to Administration Record. A public notice was published announcing the document's availability and public comment period. Related fact sheets were distributed to the public.

A public notice for review and comment of the "Engineering Evaluation/Cost Analysis" (EE/CA) was published.

A public meeting was held on January 16, 1996 at BNL to discuss the findings of the OU I EE/CA, and to seek public comments regarding the remedies evaluated and the preferred remedy (groundwater extraction and treatment via air stripping and public water hookups).

Operable Unit III: Sampling of the permanent on-site monitoring wells was initiated.

Operable Unit IV: Preparation and review of the Record of Decision, including responses to public comments, continued.

February 1996

Operable Unit I/VI: Review of the draft Remedial Investigation/Risk Assessment (RI/RA) Report by EPA/NYSDEC continued. Preparation of the draft Feasibility Study (FS) Report continued.

A presentation to the Community Work Group regarding the public water hookups and a briefing on the "Groundwater EE/CA" was held at BNL.

A Suffolk County legislator hosted a meeting to brief elected officials on the public water hookup project and BNL groundwater contamination. Two question-and-answer sessions (February 5 and 6, 1996) were offered BNL employees regarding OU I groundwater issues. Also, four fact sheets regarding this project were published.

Operable Unit II/VII: Remedial investigation related field work was completed.

Operable Unit III: Sampling of the permanent on-site wells was completed.

Operable Unit V: Dewatering and solidification of the STP Imhoff Tank sludges was initiated.

March 1996

Operable Unit I/VI: EPA and NYSDEC comments on the draft OU VI Focused Feasibility Study were received.

Operable Unit III: Evaluation of actions to accelerate the cleanup of the OU III contamination along the southern boundary continued.

Operable Unit IV: Record of Decision was signed by DOE, EPA, and NYSDEC. The selected remedy consisted of: (1) treatment of chemically contaminated soils using soil vapor extraction, (2) treatment of groundwater contaminated with organic compounds using a combination of air sparging and soil vapor extraction, and (3) fencing around areas with radiological soil contamination. This is the first completed ROD for BNL.

Operable Unit V: Dewatering and solidification of the Imhoff Tank sludge was completed.

April 1996

Operable Unit I/VI: Further evaluation of *in-situ* Vitrification technology for the Chemical / Animal / Glass Holes was initiated.

Operable Unit IV: A public notice of availability for OU IV "Record of Decision" and "Responsiveness Summary" was published. Also, an ROD was put in the Administrative Record.

Operable Unit III: Monitoring well installation to determine the nature and extent of off-site contamination continued. Permanent monitoring wells were installed by BNL and temporary monitoring wells were installed by the SCDHS.

Removal Action II: The final Closeout Report for the removal of Building 650 underground storage tanks was submitted to the Administrative Record.

Removal Action III: Draft Closeout Report for the Cesspool removal action was prepared.

Removal Action V: The 90% design for the groundwater pump and treatment system was submitted to EPA and NYSDEC.

Suffolk County Water Authority continued work on the extension of the water mains in the area south of BNL and the hookup of private residences.

May 1996

Operable Unit I/VI: Final Focused Feasibility Study for OU VI was submitted to EPA and NYSDEC.

Fieldwork for capping of the Former Landfill commenced. Installation of methane monitoring wells and groundwater monitoring wells was completed.

Evaluation of alternatives for remediation of the chemical/animal/glass holes continued.

Operable Unit IV: Preparation of a draft Remedial Design Work Plan was initiated.

Operable Unit V: Review of the draft RI/RA Report by DOE continued.

Removal Action III: Draft Closeout Report for the Cesspools Removal Action was submitted to EPA and NYSDEC.

Removal Action V: Procurement activities for the construction of the groundwater pump and treatment system continued.

Sitewide Activities: Sitewide groundwater model was presented to DOE, EPA, and NYSDEC.

June 1996

Operable Unit I/VI: Two pilot studies were conducted at the chemical/animal/glass holes. One involving innovative grouting technique and the second to evaluate in-situ vitrification (ISV).

Operable Unit III: An integrated Site Strategy Workshop was held to examine ways to accelerate the remediation process at BNL, including groundwater remediation.

Operable Unit IV: The Remedial Design Work Plan was submitted to EPA and NYSDEC for review.

Removal Action V: In-well sparging pilot study was initiated on-site to learn the effectiveness of this innovative technology on groundwater contaminated with volatile organics.

July 1996

Operable Unit I/VI:	OU I/VI RI/RA Report was released to the Administrative Record for public comment. A fact sheet and a copy of the public notice were distributed to the mailing list.
	A public notice for review and comment of OU I/VI "Remedial Investigation /Risk Assessment" was published and this document was put in the Administrative Record.
	A public notice of availability for Removal Action 6 "Former Landfill Action Memorandum" was published and this document was put in the Administrative Record.
Operable Unit II/VII:	Draft OU II/VII RI/RA Report was submitted to DOE for review.
Operable Unit III:	Preparation of the draft RI/RA Report and the pre-design study report for the pump and treat system at the south boundary continued,
Interagency Agreement Schedules Update Report for Site Removal and Remedial Actions:	A public notice for review and comment was published. Schedules update report for site removal and remedial actions.

August 1996

Operable Unit I/VI:	Activities related to the capping of the Former Landfill continued.
	A community relations plan was developed for OU VI.
	Two DOE press releases were issued: "DOE Reports Results of Groundwater Tests" and "DOE Announces Free Public Water Hookups".
	A summary sheet titled "Remedial Investigation and Risk Assessment of the Southeast Area of the Laboratory".
Operable Unit III:	Draft OU III RI/RA Report was submitted to DOE for review.
Operable Unit IV:	Design of the OU IV remediation system was initiated.
Removal Action V:	Construction of the groundwater extraction and treatment system

commenced.

September 1996

Operable Unit I/VI: Draft Feasibility Study for OU I/VI was submitted to DOE.

A public notice of availability for the "Action Memorandum for Public Water Hookups" and this document was put in the Administrative Record. The first of two OU VI poster sessions was held. An OU VI presentation was made to the Community Work Group.

Operable Unit II/VII: Draft RI/RA Report for OU II/VII was submitted to EPA and NYSDEC for review.

Operable Unit III: Pre-design work on the OU III pump and treat system continued as well as initial construction.

Operable Unit V: Waste shipments to Envirocare of Utah for disposal were made for the Imhoff Tanks sludges.

October 1996

Operable Unit I/VI: Phytoremediation study for radiologically contaminated soils continued at the Hazardous Waste Management Facility.

Physical construction of the Former Landfill cap was completed.

FS Report/PRAP were reviewed by DOE and BNL.

Approximately 150 notices regarding the second OU VI poster session were delivered to homes in the area surrounding the potentially affected community. The second OU VI poster session was held. A public notice for review and comment of OU VI's "Focused Feasibility Study" (FFS) and "Proposed Remedial Action Plan" (PRAP) was published.

Operable Unit III: Preparation of a Remedial Design Work Plan for the OU III pump and treat system was initiated.

Operable Unit IV: The Remedial Design Work Plan was finalized.

Operable Unit V: Preparation of the draft Feasibility Study Report continued.

Removal Action V: Construction of the groundwater treatment plant continued.

Bioremediation pilot study for groundwater continued and a draft report was prepared and reviewed.

Brookhaven Graphite Research Reactor (BGRR): Planning for a limited characterization of the BGRR area was initiated.

November 1996

Operable Unit I/VI: A public meeting was held to present the nature and extent of OU VI Ethylene Dibromide (EDB) contamination, and to seek public comments on the alternatives evaluated and the preferred remedy which included public water hookups.

Preparation of the Closeout Report for the Former Landfill continued.

Preparation of design Specifications for the excavation/disposal of the Chemical/Animal/Glass Holes continued.

A notification of the public meeting was sent to the mailing list. A public meeting was held to discuss the findings of OU VI's FFS and PRAP.

Operable Unit II/VII: Review of the draft RI/RA Report by EPA and NYSDEC continued.

Operable Unit III: Design of the groundwater pump and treat system continued. Procurement of material and services was initiated.

Operable Unit V: Draft FS Report was submitted to DOE for review.

Removal Action V: In-well sparging pilot study was completed.

December 1996

Operable Unit I/VI: EPA/NYSDEC continued review of the FS Report and PRAP.

Operable Unit II/VII: EPA/NYSDEC comments on the draft RI/RA Report were received.

Operable Unit III: Characterization of nature and extent of groundwater contamination on-site and off-site continued.

Revised draft Action Memorandum for the pump and treat system was submitted to DOE.

Progress was made on the procurement of construction and electric contractor services, preparation of Health and Safety Plans, and design documents for the OU III pump and treat system.

Operable Unit IV: Pre-final design documents were submitted to DOE, EPA, and NYSDEC for review.

Removal Action V: Startup and testing of the RA V groundwater pump and treat system was initiated.

Brookhaven Graphite Research Reactor (BGRR): Planned characterization activities at the BGRR area were completed.

2.10 Superfund Amendments and Reauthorization Act (SARA) of 1986

The SARA regulations requires BNL to compile and submit Tier I (or the more detailed Tier II) reports to the State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), and the responding fire organization. For BNL, the responding fire organization is the S&EP Fire and Rescue Group. Under Federal SARA regulations, BNL is required to submit the Tier II report only if requested by the SERC, LEPC, or Fire Rescue Group. In 1991, the SERC requested that BNL submit the Tier II report for 1990 and each year thereafter. The report lists the average and maximum daily amounts of each chemical on-site which exceeds the threshold listed in the current EPA List of Lists. The Tier II report for CY 1996 was sent in February 1997 to the Fire Response Group, and to DOE-BHO office for transmittal to the SERC and LEPC.

Submission of Form R, the Toxic Chemical Release Inventory (TRI) Reporting Form to EPA is required by Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). This report provides the public with information on releases of listed toxic chemical in their communities, and provides EPA with release information to assist them in determining the need for future regulations.

On July 25, 1996, BNL submitted Form R for Reporting Year 1995 to the EPCRA Reporting Center and to the New York State Emergency Response Commission. Two chemicals were included: chlorine, and methanol. For CY 1996, the following compliance information is provided:

EPCRA 302-303: Planning Notification YES [X] NO [ ] NOT REQUIRED [ ]

EPCRA 304: EHS Release Notification YES [X] NO [ ] NOT REQUIRED [ ]

EPCRA 311-312: * MSDS/Chemical Inventory	YES [X]	NO [ ]	NOT REQUIRED [ ]
EPCRA 313: TRI Reporting	YES [X]	NO [ ]	NOT REQUIRED [ ]

* Material Safety Data Sheet

2.11 National Environmental Policy Act

A total of 94 projects were reviewed for compliance with 10 CFR 1021 in CY 1996. Environmental Evaluation Forms were completed for 17 projects which were eventually found by DOE to be categorically excluded actions and 77 projects were identified as falling under pre-existing NEPA documentation. Two requests for generic categorically excluded activities were submitted: renewal of a categorical exclusion on routine maintenance activities at reactor facilities; and benchtop research activities. No determination has been issued to date on the latter action. No Environmental Impact Statements were authorized, recommended, or completed during the calendar year.

2.12 Federal Insecticide, Fungicide, and Rodenticide Act

Brookhaven National Laboratory has two programs where insecticides, herbicides, and pesticides are used. As per regulatory requirements, both users, the Biology Department and the PE Division, maintain a log of applications made and a log of the inventory at each facility. Key personnel are trained and certified by the NYSDEC in the handling and application of these chemicals. Annual training for these personnel is required to maintain certification. The applicator's log books are available for inspection and verification by the regulatory agencies when required. Annual reports indicating the types and quantities of pesticides used are submitted to the NYSDEC by each certified applicator.

2.13 Endangered Species Act

No new findings on endangered species were noted in 1996.

2.14 National Historic Preservation Act

There were no activities affecting cultural or historic resources were conducted during CY 1996.

2.15 Floodplain Management

During 1996, no new construction actions were contemplated near or within the 100-year floodplain. Construction of the STP upgrades was restarted in November 1996. As part of the redesign of this system, dewatering activities planned as part of the original construction project were displaced by the addition of a wetwell and ejector pumps. Consequently, impacts to the 100 year floodplain were averted.

2.16 New York Wild, Scenic, and Recreational River Systems Act

The portion of the Peconic River that flows through BNL is classified as "Scenic" under New York's WSRRSA. During 1996, no new activities were conducted that would be impacted by the requirements of the WSRRSA. As previously stated, construction of the STP upgrades project recommenced in November 1996. These upgrades were authorized under a 1994 NYSDEC WSRRSA permit. This project includes the construction of; dual modular aeration treatment tanks, blower building and interconnecting piping, sludge pumping station, wetwell and ejector pumps, and the replacement of the chlorine disinfection system with a system that relies upon UV light for bacteria control. In addition to process improvements, this project also includes an addition to the main control building, installation of two new generators, and electrical upgrades. The project is expected to be completed by October 1997.

2.17 Protection of Wetlands

Other than the construction of STP upgrades discussed in Section 2.15, no activities were conducted during CY 1996 which impacted the wetlands nor their buffer zones.

2.18 Environmental Compliance Audits

2.18.1 Radian Tier III Assessment

Periodically, independent contractors are retained to conduct reviews of Laboratory programs to ensure compliance with applicable regulations. In June 1996 the Radian International Corporation was retained to conduct a review of the Laboratory's Environmental Monitoring and Permitting Programs. The findings of this review were published in August 1996. The purpose of this assessment was to evaluate programs associated with the CWA, SDWA, CAA, Radiological NESHAPs, and the environmental surveillance and Laboratory programs. Seventeen observations and recommendations were presented in this report. Many of the recommendations were already being addressed prior to Radian's review. Fourteen of the findings are based upon regulatory requirements and three remaining issues are based in DOE Orders. A plan to address these findings was developed which is being tracked by the BNL S&EP Division.

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 Policy

Brookhaven National Laboratory is committed to environmental compliance and accountability, and towards this resolution has developed the following policy for environmental protection monitoring:

- Design and operate a program to aid in dose assessment,
- Determine trends in environmental radiological and nonradiological levels,
- Evaluate the impact of Laboratory operations on the environment,
- Identify and quantify potential problems and provide a basis for corrective action, and
- Address government and public concerns about site operations.

3.1.1 Environmental Regulations

The BNL environmental monitoring program is designed to ensure that human health is adequately protected, to reflect environmental stewardship, and to verify that state and federal regulatory requirements for radiological and nonradiological programs are being met. These requirements are stated in DOE Order 5400.1 (General Environmental Protection Program) and 5400.5 (Radiation Protection of the Public and the Environment), NESHAP, CERCLA, RCRA, CAA, CWA, and in NEPA. Compliance with these requirements is monitored by EPA, NYSDEC, NYSDOH, SCDHS, and by DOE. Brookhaven National Laboratory's compliance activities for CY1996 are presented in Chapter 2.

3.1.2 Objectives

The objectives of BNL's environmental monitoring program incorporate the requirements of DOE Order 5400.1, "General Environmental Protection Program," and DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance." These objectives are to:

- Assess actual or potential exposures to critical groups and populations to radioactive and nonradioactive materials resulting from normal site operations or from accidents;
- Ensure that discharges comply with authorized limits and regulatory requirements;
- Verify the adequacy of effluent controls in facilities;
- Notify proper officials of unusual or unforeseen conditions and, where appropriate, to activate a special environmental monitoring program;

- Communicate accurate, effective environmental monitoring and surveillance results to DOE, other government agencies, and the general public;
- Maintain an accurate continuous record of the impact of the BNL operations on the environment;
- Determine radioactive concentrations and nonradioactive contaminants in environmental media to assess the immediate and long-term consequences of normal and accidental releases;
- Distinguish between environmental contaminants and effects from BNL operations and those from other sources;
- Evaluate and revise the environmental monitoring program in response to changing conditions dictated by facility operations and/or environmental analysis results;
- Provide site-specific data for risk assessments for human populations near BNL;
- Determine the long-term buildup of site-released contaminants and predict their environmental trends;
- Establish a baseline of environmental quality so that trends in the physical, chemical, and biological condition of environmental media can be characterized;
- Identify and quantify new or existing environmental quality problems and to evaluate the need for remedial actions or mitigating measures; and
- Pinpoint exposure pathways in which contaminants are accumulated and transmitted to the public.

To meet these objectives, approximately 6,000 samples are collected and 100,000 analyses are performed annually for radioactive and nonradioactive contaminants.

3.2 Program Organization

The Laboratory has three organizations involved in carrying out the tasks outlined above. These are:

a. **The Office of Environmental Restoration:**

This office was established in April 1991 in response to BNL being listed on the National Priority List (NPL) on November 21, 1989. The NPL is a list of hazardous waste sites that are considered high priority for cleanup under the federal Superfund Program, officially known as CERCLA. In May 1992, an IAG between the DOE, the USEPA, and the NYSDEC became effective to insure compliance with CERCLA, the corrective action requirements of the RCRA, the NEPA, as well as corresponding NYS regulations. In particular, the IAG is intended to ensure that environmental impacts associated with past activities at BNL are thoroughly investigated so that appropriate response actions can be formulated, assessed, and implemented. It is mandated that all actions have the approval of the IAG signatories. The OER reports directly to the Associate Director for Reactor Safety and Security, and has prime responsibility to remediate areas of known contamination, as well as identify, mitigate, and eliminate other areas of potential contamination. The activities of the OER in this process consists of identifying areas of concern, ranking them in order of priority, conducting RI/FS, conducting characterization studies, identifying preferred remediation processes, and preparing and finalizing a ROD on the area of concern. When the preferred remedial alternative is approved by the IAG signatories, the OER designs and implements remedial action and initiates programs for operating and maintaining areas as required. Simultaneously, the OER maintains an active, integrated public involvement program throughout this process.

b. **The S&EP Division's Environmental Protection Office (EPO):**

In May 1996, this Office was formed by the restructuring of the former Environmental Management Section (EMS) which was comprised of the Environmental Protection Group, the Sampling and Analysis Group and the Hazardous Waste Management Group. The EPO merged the activities of the former Environmental Compliance Group and the Field Sampling Group while the Hazardous Waste Management Group was reestablished as the Hazardous Waste Management (HWM) Section. The Analytical part of the Sampling and Analysis Group was merged into the Facility Support Services Section and was renamed the Analytical Services Laboratory (ASL).

The Environmental Protection Office and HWM Section staff write the Annual SER, and other routine regulatory reports required by the various environmental permits issued by the Regulatory Agencies which oversee the Laboratory's operations.

The purpose and mission of the EPO is to support the Departments/Divisions in implementing and complying with environmental requirements, and performing environmental surveillance. The office fulfills its mission in the following ways:

- Developing environmental ES&H SEAPPMs,
- Assisting the Departments/Divisions in complying with laws and regulations and the permit processes,
- Preparing permit applications and renewals,
- Conducting the BNL Environmental Monitoring program,
- Reviewing Safety Analysis Reports (SARs), performing Engineering Design Reviews (EDR), and participating in Operational Readiness Reviews (ORR) and Tier II Appraisals,
- Interacting with federal, state, and the local regulatory community, and commenting on proposed regulations,

- Responding to oil and chemical spills.

c. **The S&EP Division's Hazardous Waste Management Section:**

In May 1996, the HWM Section was organized into one group and one team: the Operations Group, and the Training and Procedures Team. The purpose and mission of the HWM Section is to support the Departments/Divisions in implementing and complying with waste management program standards, and properly managing the Laboratory's hazardous wastes. The section fulfills its mission in the following ways:

- Developing waste management ES&H SEAPPMs;
- Operating an efficient waste-management facility;
- Providing QA, training, and Conduct of Operations (CO) support to waste operations;
- Reviewing Safety Analysis Reports (SARs), performing Engineering Design Reviews (EDR), and participating in Operational Readiness Reviews (ORR) and TIER II Appraisals;
- Interacting with federal, state, and local regulatory community, and commenting on proposed regulations.

3.2.1 Environmental Protection Office

The EPO assists and advises the Laboratory in all areas of regulatory compliance, and submits compliance reports and permit applications to the regulatory agencies. This Office also provides technical oversight and assistance in conducting environmental monitoring and reviewing data for determining the impact on the environment from Laboratory operations. Reports based on review and assessment of data are also prepared and submitted to requesting Departments and Divisions. The Office also is responsible for the annual Environmental Monitoring Plan (EMP) that outlines the sampling program conducted by the S&EP Division and the OER. The EMP specifies the sampling location, sample media, sampling frequencies and types of analyses needed; and updates it regularly in collaboration the QA Office (S&EP Division). The Office also reviews projects for environmental impacts and provides audit support to the Laboratory's ES&H and Environmental Restoration Programs. These safety and environmental reviews are undertaken for new construction projects as well as modifications to existing facilities to assure that basic safety and environmental protection requirements are satisfied. In addition, these reviews ensure that all necessary permits are obtained and that new construction or modifications comply with federal, state, and local regulations. Approximately 100 such reviews were performed during CY 1996. Several members of the EPO are emergency responders, and are on 24-hour call in the event of an oil/chemical spill at BNL.

3.2.1.1 Field Sampling Team

The Field Sampling Team is responsible for implementing the EMP, collecting the samples, and submitting them to the ASL for appropriate radiological and non-radiological analysis. In addition, the Team also responds to emergency situations when required, and performs special sampling requests from other BNL organizations.

3.2.2 Hazardous Waste Management Section

Hazardous Waste Management activities are directed by the Operations Group. Radioactive, hazardous, and mixed wastes generated at BNL are transported to the HWMF for processing, storage, packaging, and preparation before off- site disposal. The HWMF has areas dedicated to the safe storage of each type of waste, and all waste tracking and documentation is maintained at the HWMF. The HWMF received the final RCRA Part B Permit on April 5, 1995. In addition to the operational aspects of maintaining waste-storage facilities, the HWM supports BNL's hazardous waste management program in the following areas:

- Regulatory Compliance Program;
- Waste Minimization and Pollution Program;
- Quality Assurance Program;
- Training and Procedures Program; and
- Special sample analyses.

3.2.3 Supporting Groups

The Instrumentation and Calibration Group (Occupational Safety and Health Section) maintains monitoring equipment located in facility stacks, and at liquid effluent discharge points. The assigned QA staff oversees the functions of the EPO in terms of the directives on QA pertaining to environmental sampling, analytical processes, and documentation, which include review of data. The Analytical Services Laboratory analyses all samples (facility and environmental) for radiological and non-radiological parameters.

3.3 Regulatory Agencies

The NYSDOH monitors the ambient air quality on-site, and the NYSDEC participates jointly with BNL in the aquatic and terrestrial radioecological sampling. These samples are also analyzed by these agencies and the data is published in their departmental annual reports.

3.4 Environmental Programmatic Changes in 1996

In 1996, the Laboratory initiated the following new programs in support of the Site Environmental Monitoring Program, and the Environmental Restoration Program:

1. Brookhaven National Laboratory, in conjunction with the NYSDEC, expanded its Peconic River surveillance program. In addition to the expansion of sampling in the Peconic River and adjoining fresh water bodies (which was initiated in 1995), in 1996 samples of clams, mussels, sediments, and sea water were collected from

the Peconic Estuary and other areas along the coast line (which serve as background locations as they are not influenced by the flow of the Peconic River) and analyzed for radioactivity. This sampling enables the Laboratory to examine the potential impact on the estuarine and marine fauna, if any, of BNL releases through the intermittent Peconic River's off-site flow ultimately reaching the Peconic Bay at the mouth of the Peconic River.

2. As part of the ongoing hydrogeological site characterization project and facility monitoring programs, additional groundwater monitoring wells were installed, and the water sampled and analyzed. A program that coordinates the S&EP Division and OER groundwater sampling schedule was instituted to prevent duplication of effort, and to provide a mechanism for independent verification of sampling and analyses.

3.5 Environmental Restoration

As indicated in Sections 2.9.10 and 3.2.a, the OER has full responsibility for conducting environmental restoration activities as required under the IAG. Chapter 2 (Compliance Summary), Section 2.9.10 summarizes the OER's work.

3.6 Waste Minimization and Pollution Prevention Programs

The BNL Waste Minimization and Pollution Prevention (Wmin/P2) Plan establishes the Wmin/P2 program at BNL. The plan combines the requirements for a Wmin Plan and a Pollution Prevention Awareness Plan required under DOE Order 5400.1, and lays out a strategy for implementation of a formal waste minimization and pollution prevention program at BNL. The plan also contains information on Waste Minimization accomplishments.

The pollution prevention program at BNL focuses on identifying cost-effective waste reduction opportunities, and then implementing them. Waste reduction opportunities are identified by formal Pollution Prevention Opportunity Assessments (PPOAs), Waste Minimization Working Groups, and employee suggestions. Funding for implementation is sought through the ES&H Management Plan, the High Return on Investment Program, or through internal funding sources. In 1996, the following pollution prevention projects were implemented;

I. PPOAs were conducted on three waste streams.

   A. The lab-wide usage of mercury was evaluated for opportunities, resulting in a plan to replace mercury thermometers and other instrumentation (e.g., manometers) with non-mercury substitutes (e.g., alcohol and pentane based thermometers, thermo-couples, etc.).

B. The lab-wide generation of aerosol cans contaminated with toxic or hazardous materials was evaluated, resulting in several recommendations to reduce the number of cans requiring management as hazardous waste.

C. The lab-wide generation of hazardous waste batteries was evaluated, resulting several recommendations that will result in reduction of this waste stream.

II. As a result of a PPOA of Photographic Waste completed in 1995, BNL applied for and was awarded funding from the High Return on Investment program, to convert much of the traditional wet photographic processes in Photography and Graphic Arts to digital processes. The project was implemented during 1996 and is now starting to greatly reduce the quantity of photographic hazardous waste.

III. A proposal to fund the recommendations of the PPOA of AGS low level radioactive waste water (conducted in 1995) was prepared and submitted to the High Return on Investment program. The project seeks to retro-fit and/or replace ion exchange vessels to allow resins to be easily removed and disposed of as LLW instead of regenerating the resins. Implementation will result in significant reductions in LLW water.

IV. A proposal to purchase an activated metal waste compactor for the AGS LLW stream was submitted to the High Return on Investment program for funding. The compactor opportunity was identified by the Wmin/P2 Working Group in AGS and will result in significant volume reduction of the active metal waste stream (the largest LLW stream at BNL).

V. The BNL Wmin/P2 program continued to target the use of TCA on-site. The volume of TCA waste generated in 1996 was only approximately 20 lbs, representing a 99% reduction since 1990.

VI. The PPOA of the NSLS Acid Cleaning process was successful in developing a new process that utilizes ultrasonic cleaning and mild organic acid/detergent based cleaning solutions. The process, when implemented in the new Centralized Degreasing Facility, will eliminate the use of hydrofluoric and nitric acids and is not expected to generate hazardous wastes.

3.7 Public Outreach

The Public Outreach program is a part of BNL's environmental program conducted by S&EP Division, OER, and Public Affairs Office. Brookhaven National Laboratory's staff are involved in public meetings, the Speakers Bureau, Summer Tour programs, and Office of Education Programs (OEP), thus opening up communication channels with the public. Local newspaper articles, television segments, and pieces in the BNL Bulletin are used to inform staff and public groups about environmental activities. The OEP has also promoted Environmental awareness through tours, lectures to students and other groups, teacher workshops, and various exhibits.

In 1996, a wide range of outreach activities focused on environmental issues at BNL. Environmental remediation under the federal Superfund program, and the related initiative by DOE to provide public water hookups to local residents, presented many opportunities for outreach. Several public meetings were held to discuss groundwater contamination in the southern and southeastern portions of the site. A newly established newsletter, <italic>cleanupdate</italic>, informed the community of current and future remediation plans and accomplishments, including the above topics as well as remediation plans for soil and groundwater contamination near the BNL Steam Plant, the capping of a former landfill and remediation options for former waste disposal pits. Press releases and Brookhaven Bulletin articles accompanied each major event in the Superfund calendar. All public documents were placed in several local libraries. As well, local elected officials cooperated in a BNL-DOE effort to encourage homeowners in the hookup area to participate in the program.

The newly-formed Community Work Group served as a focal point for on-site discussions with the community on a range of environmental issues. Lab staff also attended numerous meetings of local civic organizations. In the face of mounting public interest, BNL conducted public tours of the High Flux Beam Reactor, and held public forums on groundwater and the planned sewage treatment plant upgrade. The Lab was also host to meetings on pine barrens research and pollution prevention, sponsored jointly by BNL and governmental agencies.

The environment was the main focus of the Summer Sunday public tour program, and BNL staff gave numerous invited talks at schools and community organizations. BNL also presented exhibits at local Earth Day celebrations and a special forum at Southampton College. And, through the Community Summer Science Program, local high school students assisted research on the pine barrens ecosystem on the BNL site. More information can be obtained by contacting the BNL Public Affairs Division at (516) 344-2345.

3.8 Environmental Audits

3.8.1 Tier III Assessment

In June 1996, the Radian Corporation conducted a Tier III independent technical review of the BNL Environmental Monitoring and Permitting programs. The Tier III appraisals are the highest category of environment, safety and health self-assessment program at BNL and are performed to provide constructive management consultation of ES&H functional programs. The scope of the 1996 Radian Tier III included a review of the Laboratory programs dealing with Clean Water, Safe Drinking Water, Air Emissions, Radionuclide NESHAPs, Environmental Surveillance and Environmental Laboratory. The overall conclusion of the appraisal was that the Laboratory programs were in general, mature and complete, staffed with qualified personnel, and adequate for the functional disciplines evaluated. While several findings were cited in the final report, the recommendations did not reveal any programmatic issues. A corrective action plan has been prepared to address these findings.

3.8.2 Other Assessments

A number of other audits, assessments, and/or appraisals of the environmental functions were conducted in 1996. They include the following:

- NYS Department of Health Environmental Laboratory Approval Program, July (radiological analytical operations) and August (non-radiological analytical operations), 1996; and
- S&EP Division Internal QA Audits: Analytical Services Contract QA audit, April, 1996; Procurement QA audit, September 1996.
- Tier I and Tier II assessments of BNL Departments/Divisions.

The findings from the above assessments are tracked and reported to the appropriate level(s) of management by the S&EP Division, Planning and Program Review Team.

3.9 Site Environmental Performance Measures Program

At the start of Fiscal Year (FY) 1996, DOE implemented a new Prime Contract with Associated Universities, Inc., (AUI) which contained a number of performance measures in the environmental, safety, and health arena. The measures were implemented contractually by Articles 6 and 7, with Appendix B to the contract containing the actual Performance Objectives, Criteria, and Measures. They were developed by DOE, AUI, and BNL by reviewing past experience and operations at the Laboratory. The following represent a summary of the performance measures associated with BNL's environmental protection activities in CY1996:

1. **Waste Generation Reports:**

- **<u>Hazardous Waste</u>:** Figure 3-1 shows the hazardous waste generation (measured in metric tons) for the period CY 1993 to CY 1996. The bars show routine hazardous waste, non-routine hazardous waste and TSCA (or PCB) waste. Routine waste is defined as waste from on-going operations. Examples of non-routine waste: construction/demolition, environmental restoration. Legacy wastes, and newly identified wastes. The routine waste streams are wastes that BNL has an ability to reduce using pollution prevention techniques.

  As can be determined from the chart. BNL has reduced generation of routine hazardous waste by 52% from 1993 through 1996. The BNL Pollution Prevention program has aggressively targeted hazardous wastes that are particular problems for the BNL site. An example of this effort is the targeting of the solvent TCA, a common groundwater pollutant on Long Island. Since 1990, BNL has reduced generation of TCA by 99%.

- **<u>Low Level Radioactive Waste</u>:** Figure 3-2 shows low level radioactive waste (LLW) generation (measured in cubic feet) for the period CY 1993 through 1996. LLW is tracked as four waste streams, routine liquid and solid, and non-routine liquid and solid. The routine waste is from on-going operations, while the non-routine waste is as defined above. As can be seen from the chart, routine LLW generation fluctuates considerably. The variability can often be traced to activities at the AGS, the largest generator of routine LLW at BNL. The non-routine LLW generation is seen rising sharply in 1996 and is expected to continue to increase as the environmental restoration of BNL proceeds from the investigation phase to the clean-up phase. The routine LLW stream (both liquid and solid) has been targeted for reduction by the BNL Pollution Prevention program since 1995. Major investments were made in FY97 that should help BNL reduce the volume of routine LLW requiring disposal. This waste stream will continue to rank high for pollution prevention funding.

- **Mixed Waste:** Figure 3-3 shows mixed waste (hazardous waste mixed with low level (radioactive waste) generation (measured in cubic feet) for the period calendar year 1993 through 1996. Mixed waste is tracked as routine and non-routine waste. The routine waste is from on-going operations, while the non-routine waste is as defined above. As can be determined from the chart, BNL has reduced generation of routine mixed waste by approximately 50% from 1993 through 1996. The BNL Pollution Prevention program continues to actively target mixed waste for opportunities due to the difficulty and cost of mixed waste disposal. The non-routine generation rates are related to environmental restoration projects, specifically the removal of storage tanks and disposal of mixed waste sludges held therein.

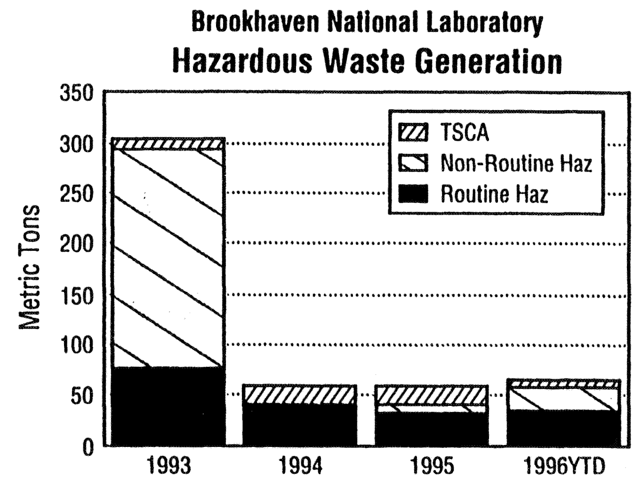
- **Industrial Waste:** Figure 3-4 shows industrial waste (e.g. waste oils, oily soil, etc) generation (measured in metric tons) for the period calendar year 1993 through 1996. Industrial waste is tracked as routine and non-routine waste. The routine waste is from on-going operations, while the non-routine waste is as defined above. Large quantities of non-routine industrial wastes have been generated by environmental restoration projects in the past two years. The waste from these projects was mostly petroleum contaminated soils as a result of past spills. BNL is evaluating recycling opportunities (use for asphalt manufacture) for petroleum contaminated soils and hopes to implement this opportunity in FY98.

2. **SPDES Compliance:**

Another Performance Measure established in 1996 was compliance with SPDES parameters as an indicator of satisfactory performance. A ranking scheme was developed which associated a numerical score with a SPDES permit exceedance. The total score for the year was then used to determine overall performance. For example, to determine the score given to a specific exceedance, *first*, the was parameter evaluated for toxicity, toxic elements (e.g., inorganic or volatile organic pollutants) was assigned a higher score than non-toxic elements; *second,* the ratio of the concentration of the exceeding parameter to the SPDES limit was evaluated, high concentration discharges were therefore assigned a higher score. Finally repeat offenses were penalized heavier, that is, given more points. The overall performance for this indicator is still under evaluation. Since the BOD and TSS removal excursions are not necessarily indicators of poor performance and since the effluent concentration for both parameters complied with numerical limits, the Laboratory has not considered these in the calculation of the performance indicator for 1996. Under this assumption, and considering the remaining permit excursions detailed in Chapter 2, the total score for 1996 was 23, which placed this Performance Measure in an *Excellent* category. If the BOD and TSS removal excursions are considered, the performance is rated marginal.

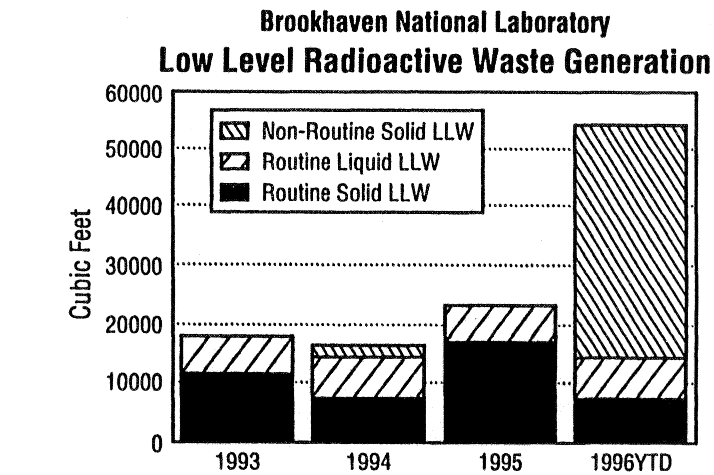
3. **Solid Waste Sent to Landfill:**

The amount of solid waste sent to the off-site landfill is a general indicator of the effectiveness of both the waste minimization and material recycling efforts at BNL. For FY 1996, BNL sent 855 tons of solid waste to the landfill. This was considered unsatisfactory. This measure was somewhat flawed in its implementation because it does not take into account the amount of programmatic or operational activity that occurs on-site. That is, the measure does not adjust if on-site is higher or lower. This increase (over FY 95 - 769 tons) was not due to any reduction in recycling efforts or results. In FY 1996, 58.7% of waste was recycled. This was, in fact, a 5.6% increase over FY 1995. Additional programs, such as a new mixed paper recycling program and reminders to employees to recycle, have helped in the recycling effort. BNL will continue its recycling efforts as well as looking for additional opportunities for solid waste reduction.



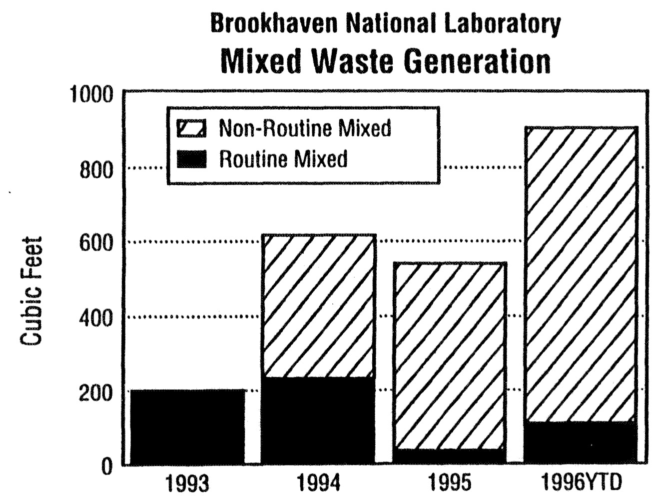
	1993	1994	1995	1996YTD
TSCA	11.3	16.9	17.1	6.9
Non-Routine Haz	218	0	8.7	12.1
Routine Haz	74.3	41	31.9	35.6

Figure 3-1



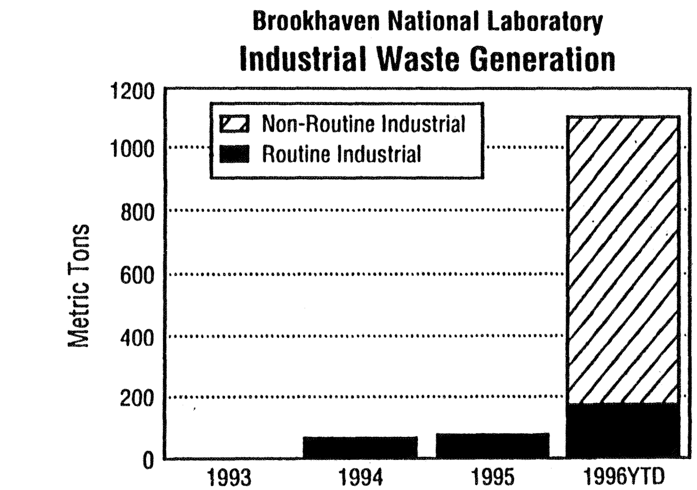
	1993	1994	1995	1996YTD
Non-Routine Solid LLW	0	1921	0	39123
Routine Liquid LLW	7415	7415	6391	7380
Routine Solid LLW	11158	7097	16949	7645

Figure 3-2



	1993	1994	1995	1996YTD
Non-Routine Mixed	0	385	501	830
Routine Mixed	202	232	36	65

Figure 3-3



	1993	1994	1995	1996YTD
Non-Routine Industrial	–	0	0	926
Routine Industrial	–	60	70	171

Figure 3-4

4. RADIOACTIVITY

To define radiation, it is necessary to discuss the atom. The atom, the basic constituent of all matter, is one of the smallest units into which matter can be divided. It is composed of a tiny central core of particles, or *nucleus*, surrounded by a cloud of negatively charged particles called *electrons*. Most atoms in the physical world are stable, meaning that they are non-radioactive. However, some atoms posses an excess of energy which causes them to be physically unstable. In order to become stable, an atom rids itself of this extra energy by casting it off in the form of radiation. Radiation is the emission of a charged particle or electromagnetic wave from the atom. The three most important types of radiation are described in the following section.

4.1 Types of Radiation

Alpha α — An alpha particle is identical in make-up to the nucleus of a helium atom. Alpha particles have a positive charge, and have little or no penetrating power in matter. They are easily stopped by materials such as paper and have a range in air of only an inch or so. Naturally occurring radioactive elements such as radon emit alpha radiation.

Beta β — Beta radiation is composed of particles which are identical to electrons. As a result, beta particles have a negative charge. Beta radiation is slightly more penetrating than alpha, but may be stopped by materials such as aluminum foil. They have a range in air of a few inches. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

Gamma γ — Gamma radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much smaller wavelength. It is more penetrating than alpha or beta radiation, and is capable of passing through dense materials such as concrete. X-rays are essentially a form of gamma radiation.

4.2 Nomenclature

Throughout this report, radioactive elements (also called radionuclides) are referred to by a name followed by a number, e.g., potassium-40. The number following the name of the element is called the mass of the element and is equal to the total number of particles contained in the nucleus of the atom. Another way to specify the identity of potassium-40 is by writing it as K-40, where 'K' is the chemical symbol for potassium as it appears in the standard Periodic Table of the Elements. This type of abbreviation is used throughout many of the data tables in this report.

4.3 Sources of Radiation

Radioactivity and radiation are part of the earth's natural environment. Human beings are exposed to radiation from a variety of common sources, the most significant of which are listed below.

Cosmic Primarily consists of charged particles which originate in space, beyond the earth's atmosphere. This includes radiation from the sun and secondary radiation generated by the entry of charged particles into the earth's atmosphere at high speeds and energies. Radioactive elements such as hydrogen-3 (tritium), beryllium-7, carbon-14, and sodium-22 are produced in the atmosphere by cosmic radiation.

Terrestrial Released by radioactive elements present in the soil since the formation of the earth about five billion years ago. Common radioactive elements contributing to terrestrial exposure include isotopes of potassium, thorium, actinium, and uranium.

Internal Internal exposure occurs when radionuclides are ingested or inhaled. Radioactivity in food occurs through the uptake of terrestrial radionuclides by plant roots. Human ingestion of natural radionuclides occurs when plant matter or animals that consume plant matter are eaten.

Radon Radon is a naturally-occurring radionuclide that is generated by the decay of uranium ores in the soil. It is by far the greatest contributor to an individual's radiation dose. Exposure occurs through the inhalation of radon decay products in the atmosphere. The level of exposure varies greatly from person to person depending on the quality of home insulation (which determines the degree to which the radon concentration will build up), the presence of a basement, ventilation rate, and geographic location.

Medical Millions of people every year undergo medical procedures which utilize radiation. Such procedures include chest and dental x-rays, mammography, thallium heart stress tests, tumor irradiation therapies and many others.

Man-Made Sources of man-made radiation include consumer products such as static eliminators (containing polonium-210), smoke detectors (containing americium-241), cardiac pacemakers (containing plutonium-238), fertilizers (containing isotopes of the uranium and thorium decay series), tobacco products (containing polonium-210 and lead-210) and many others.

4.4 Dose Units

The amount of energy that radiation deposits in body tissue, when corrected for human risk factors, is referred to as dose equivalent or, more generally, as dose. Radiation doses are measured in units of *rem*. Since the rem is a fairly large unit, it is convenient to express most doses in terms of *millirem*. A millirem, abbreviated mrem, is equal to 0.001 rem. To give a feeling for the size and importance of a 1 mrem exposure, the following Figure indicates the number of mrem received by an individual in one year from natural sources. These values represent typical values for residents of the United States, giving a total of 295 mrem.

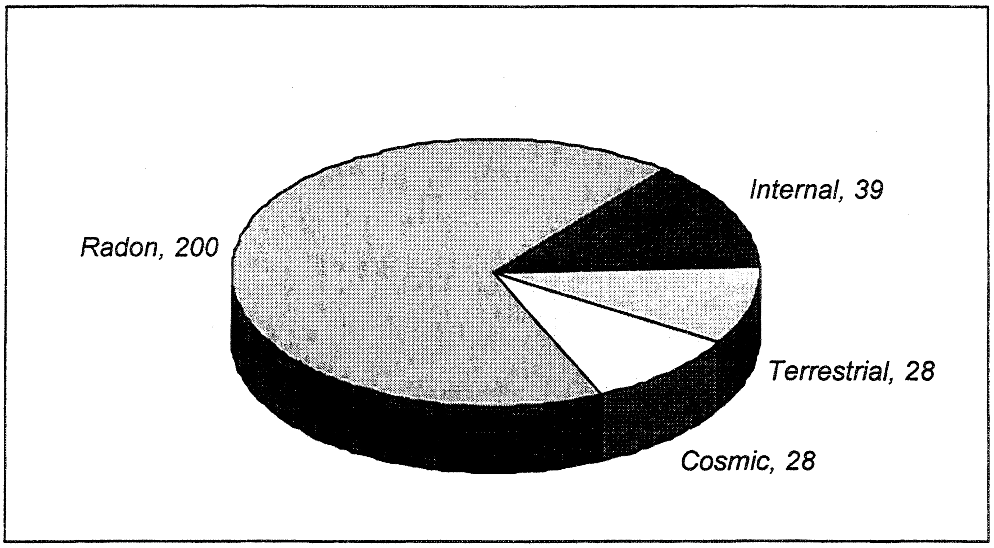


Figure 4-1 Typical annual dose due to natural sources (mrem).

Note that the alternate unit of dose measurement, commonly used internationally and increasingly in the United States is the Sievert, abbreviated Sv. One Sv is equivalent to 100 rem. Likewise, 1 millisievert (mSv) is equal to 100 mrem.

4.5 Understanding Radiological Analysis Results

The following section deals with radiological parameters for which various effluents are evaluated. These parameters include gross alpha activity, gross beta activity, tritium and strontium-90 content, and gamma-emitting radionuclides. The quality of environmental air, water and soil can be assessed in several ways when dealing with radioactive material. The analyses most commonly used to measure radioactivity in these media are described below.

Gross Alpha Many naturally-occurring radionuclides contained in environmental media emit alpha radiation. The alpha particles emitted by these radionuclides have many different energies, measured in electron volts, or eV. Frequently, analysis equipment is used which measures all alpha particle activity simultaneously, without regard to their particular energy. Hence, this is a gross alpha activity measurement. It is valuable as a screening tool to indicate the magnitude of radioactivity that may be present in a sample.

Gross Beta This is the same concept as described above, except that it applies to the measurement of beta particle activity.

Tritium Due to the nature of the radiation emitted from the tritium atom, a special analysis known as liquid scintillation counting is required to quantify it. See Section 4.8.2 for further details.

Gamma Spectroscopy This is an analysis technique which identifies specific radionuclides, unlike a gross analysis which measures overall activity without identifying the source. It measures the specific energy of a radionuclide's gamma radiation emissions. The energy of these emissions is unique for each nuclide, acting as a 'fingerprint' to identify a specific nuclide.

It is possible for a radiological measurement to result in a negative number. Every sample which is analyzed for radioactive material is compared to an instrument background, which is the number of radiation events observed in a blank sample. Since naturally-occurring radiation cannot be completely isolated in a sample measurement, the instrument background must be subtracted from the sample analysis. When measuring very low levels of radiation (such as those encountered in environmental media), where only a few radiation events are counted, it is common for the sample result to be below the instrument background. When the background is subtracted, a negative net value results, signifying that the sample was found to contain no detectable radioactive material.

4.6 Scientific Notation

Since many of the numbers used in measurement and quantification in this report are either very large or very small, many zeroes are required to express their value. Because this is inconvenient, scientific notation is used as a kind of numerical shorthand. Scientific notation is based on the principle of representing numbers in multiples of ten. For example, the number one million could be written as 1,000,000. Alternatively, this number could be written in scientific notation as 1×10^6. That is, "one times ten raised to the sixth power." Since even this shorthand can be cumbersome, it can be reduced even further by using the capital letter E to stand for 10^x, or "ten raised to the power of some value x." Using this notation, 1,000,000 would be represented as 1E6. Scientific notation is also used to represent very small numbers like 0.0001, which can be written as 1×10^{-4} or 1E-4. A minus sign on the power of ten represents a decimal value.

4.7 Prefixes

Another method of representing very large or very small numbers without the use of many zeroes is to use prefixes to represent multiples of ten. For example, the prefix milli- means that the value being represented is one thousandth of a whole unit, so that one milligram is equal to one thousandth of a gram. Other common prefixes used in this report are shown in Table 4-1.

Table 4-1 Common Measurement Unit Prefixes

Prefix	Multiplier		Prefix	Multiplier	
milli (m)	1×10^{-3}	1E-3	kilo (k)	1×10^{3}	1E3
micro (μ)	1×10^{-6}	1E-6	mega (M)	1×10^{6}	1E6
nano (n)	1×10^{-9}	1E-9	giga (G)	1×10^{9}	1E9
pico (n)	1×10^{-12}	1E-12	tera (T)	1×10^{12}	1E12

4.8 Radionuclides of Environmental Interest

4.8.1 Strontium-90

Strontium-90 is a beta-emitting radionuclide with a half-life of 28 years. It is found in the environment as a result of commercial power reactor operations, and, more importantly, nuclear weapons fallout. (*Fallout* refers to the deposition of radionuclides on soils and water bodies as a result of being dispersed high into the earth's atmosphere during nuclear explosions.) Because strontium-90 released during weapons testing has such a lengthy half-life, it can still be detected in the environment today. Additionally, nations which were not signatories of the Nuclear Test Ban Treaty of 1963 have conducted tests which have contributed to the global strontium-90 inventory. This radionuclide was also released as a result of the 1986 Chernobyl accident in the former Soviet Union.

Strontium-90 emits beta radiation only, which cannot be detected by gamma spectroscopy. It can only be detected by means of a chemical analysis specific to strontium-90 (see Appendix C for description), followed by measurements of beta particle emissions. This is why it is reported as a separate parameter in the tables of this report. The level of sensitivity for detecting strontium-90 using state of the art analysis methods is quite low (less than 1 pCi/L), which makes it possible to detect strontium-90 at levels which are indicative of the environmental sources described above.

No processes on the BNL site actively release strontium-90 during their operation. When strontium-90 is detected on the BNL site at levels above those associated with fallout and other background sources, it is due to historic landfill practices of the 1950s and 60s or the former operation of the Brookhaven Graphite Research Reactor, which was permanently decommissioned in 1968.

4.8.2 Tritium

Among the radioactive materials that are used or produced at Brookhaven National Laboratory, tritium has received the greatest amount of public attention. Tritium, the common name for the isotope hydrogen-3, exists in nature and is formed when cosmic radiation from space interacts with the gaseous element *nitrogen* in the earth's upper atmosphere. Approximately 4 million Ci (1.5E5 TBq) per year is produced in the atmosphere in this way, with the total global quantity being about 70 million Ci (2.6E6 TBq) at any given time (NCRP, 1979). Human activities such as nuclear power reactor operations and nuclear weapons testing have also released tritium into the environment. Commercially, tritium is used in such products such as self-illuminating exit signs and wrist watches ('exit' signs may contain as much as 20 Ci [740 GBq] of tritium). It also has many uses in medical and biological research as a labeling agent in chemical compounds and is frequently used in universities and other research settings.

Tritium has a physical half-life of 12.3 years and a biological half-life of about 10 days, meaning that 50 percent of any tritium in the body is eliminated in approximately 10 days. When an atom of tritium decays, it releases a beta particle, causing transformation of the tritium atom into stable (non-radioactive) helium. This beta radiation is of a very low energy when compared to the emissions of other radioactive elements and it is easily stopped by the body's outer layer of dead skin cells; only when taken into the body can tritium cause any significant exposure. Because of it's low energy radiation and short residence time in the body, the health threat posed by tritium is very small for most credible exposures.

Environmental tritium is found in two forms: gaseous elemental tritium and tritiated water (or water vapor), in which at least one of the hydrogen atoms in the H_2O water molecule has been replaced by a tritium atom. Hence, its short hand notation *HTO*. All tritium released from BNL sources is in the form of HTO. Since tritium is incorporated directly into the water molecule, absorbed or ingested HTO passes through the body as water does, preventing accumulation in the body over time.

Of the sources mentioned above, the most significant contributor to tritium in the environment has been above-ground nuclear weapons testing. In the early 60s, the average tritium concentration in surface streams in the United States reached a value of 4,000 pCi/L (148 kBq/L) (NCRP, 1979). Approximately the same concentration was measurable in precipitation. Today, the level of tritium in surface waters in New York State is below 200 pCi/L (7.4 kBq/L) (NYSDOH, 1993), less than the detection limit of most analytical laboratories.

4.8.3 Cesium-137

Cesium-137 is a man-made, fission-produced radionuclide with a half-life of 30 years. It is found in the general environment as a result of past above-ground nuclear weapons testing. and can be observed in the upper levels of environmental soils at very low concentrations, of around 1 pCi/g (0.4 Bq/g) or less. It is a beta-emitting radionuclide, but can be detected by gamma spectroscopy by the gamma emissions of it's decay product, barium-137m.

4.9 Definition of Radiological Terms

The following terms are used throughout this report where radiation and radioactive material are discussed:

Activation	The process by which a non-radioactive material is made radioactive through exposure to a field of neutrons or high energy particles.
Activation Product	An element which has become radioactive through the process of activation.
Activity	Synonym for radioactivity.
Background Radiation	Radiation present in the environment as a result of naturally-occurring radioactive materials, cosmic radiation, or fallout radionuclides deposited on the earth as a result of above-ground weapons testing.
Becquerel	A quantitative measure of radioactivity, abbreviated *Bq*. This is an alternate measure of activity used internationally and with increasing frequency in the United States. One Bq of activity is equal to one nuclear decay per second. All references to quantities of radioactive material in this report are made in curies, followed in parentheses by the equivalent in Bq.
Derived Concentration Guide (DCG)	The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by a single pathway (e.g. air inhalation/immersion, water ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). Established by DOE Order 5400.5, "Radiation Protection of the Public and Environment".
Curie	A quantitative measure of radioactivity, abbreviated *Ci*. One Ci of activity is equal to 3.7×10^{10} Bq (see *radioactivity*).
Effective Dose Equivalent	A normalized value which allows the inter-comparison of doses to various parts of the body. It is equal to the sum of the doses to different organs of the body multiplied by their respective weighting factors. Also referred to as the "whole body" dose, or simply "dose."
Fallout	Radioactive material made airborne as a result of above-ground nuclear weapons testing that has been deposited on the earth's surface.
Half-Life	The time required for the activity of a radioactive sample to be reduced by one half.

MDL	Minimum Detection Limit. This is the lowest level to which an analytical parameter can be measured with certainty in the Laboratory. While results below the MDL are sometimes measurable, they represent values which have a reduced statistical confidence associated with them (less than 95% confidence).
Radioactivity	The spontaneous transition of an atomic nucleus from a higher energy to a lower energy state. This transition is accompanied by the release of a charged particle or electromagnetic wave from the atom. Also known as *activity*.
Radionuclide	A radioactive element.
Rem	The unit by which human radiation exposure is measured. This is a risk-based value used to estimate the potential health effects to an exposed individual or population. Because the rem is a relatively large unit, doses are usually specified in millirems, abbreviated *mrem*. One mrem is equal to 0.001 rem. Typical exposure to natural sources of radiation in the environment results in a dose of 200 to 400 mrem per year. See also Section 4.4.
Sievert	The alternate unit of measuring human radiation exposure used internationally and with increasing frequency in the United States, is the Sievert, abbreviated *Sv*. One sievert is equal to 100 rem.
Stable	Non-radioactive.
TLD	Thermoluminescent Dosimeter. A device used to measure radiation exposure to occupational workers or radiation levels in the environment.

5. AIRBORNE EFFLUENTS

5.1 Airborne Effluent Emissions - Radioactive

The following Sections describe the primary radioactive effluents released to the atmosphere in 1996 and the facilities which produced them. Facility locations within the BNL site are shown in Figure 5-1.

5.1.1 BMRR

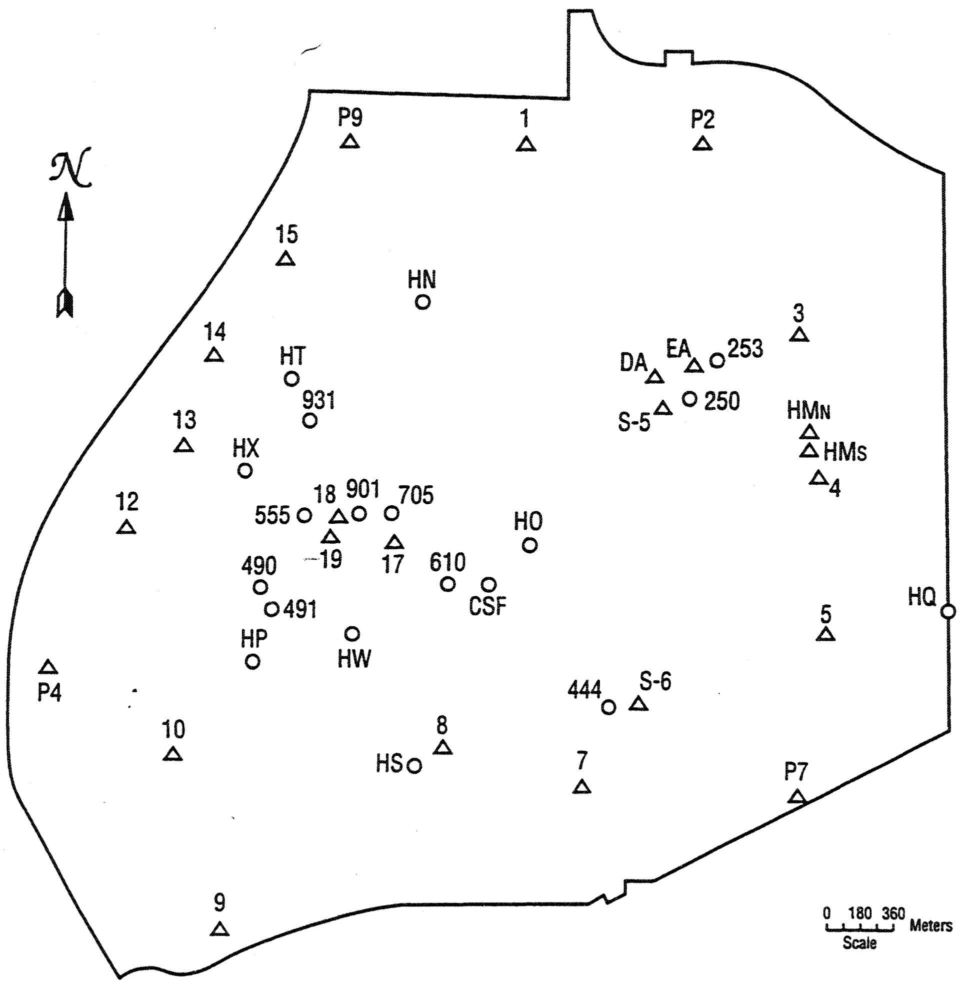
To cool the neutron reflector surrounding the core of the BMRR reactor vessel, air from the interior of the containment building is used. When air is drawn through the reflector, it is exposed to a neutron field which causes the natural argon gas in the air to become radioactive. This radioactive form of argon is known as argon-41. It is a chemically non-reactive (inert) gas with a short half-life of 1.8 hours. After passage through the reflector, the air is routed through a charcoal and high efficiency particulate air (HEPA) filtering system to remove any particulate matter. (HEPA filters have a removal efficiency of 99.97% for particles greater than 0.3 micrometers in diameter). Following the filter bank, the air is exhausted to a 150 ft. (46 meter) stack adjacent to the containment building. A real time monitor is in place to monitor all airborne radioactive effluents. Data from this monitor is used to confirm expected release rates and maintain annual release inventories.

In 1996, the BMRR released 1,707 Ci (66 TBq) of argon-41 as an airborne effluent. (Other radionuclides were released in trace quantities in the microcurie range, (see Table 5-1). Argon-41 consistently constitutes the greatest fraction of all radionuclide activity released from the BNL site. However, due to the short half-life and inert properties of argon, BMRR effluent consistently results in maximum off-site dose of less than 0.1 mrem (1 μSv) to a single individual. This is approximately 0.03% of the dose that would be received annually by an individual from natural sources (including radon and its decay products).

5.1.2 HFBR

The HFBR uses heavy water to cool the reactor fuel and moderate neutrons used in the fission process. (Heavy water, or D_2O, is water which is composed of a non-radioactive isotope of hydrogen known as deuterium.) Heavy water flowing in the core is exposed to a dense neutron field which activates the deuterium atoms in the water to produce tritium (half-life = 12.3 years). The rate at which the tritium concentration builds in the primary cooling water is dependent upon the reactor power level and the amount of time elapsed since the last reactor shutdown or coolant change out. This, in turn, determines the amount of tritium which may eventually be released as airborne effluent. The primary mechanism by which tritium is transferred from the interior coolant system to the atmosphere is depressurization of the reactor vessel and evaporative losses during maintenance and refueling operations. Tritiated water vapor is thus released from reactor systems to building air exhaust where it is routed to the facility's 320 ft. (98 meter) stack.

Brookhaven National Laboratory
Effluent Release Points and On-site Environmental Monitoring Stations



△ Environmental Monitoring Stations

Air
1 thru 16 Perimeter Stations
S-6 Waste Management Area
S-5 Sewage Treatment Plant
17, 18, 19 Center of Site

Water
DA Sewage Treatment Plant Influent
EA Sewage Treatment Plant Effluent
HM Peconic River, 0.5 mi. Downstream From Treatment Plant
HQ Peconic River, Site Boundary

o Designation	Effluent Release Point
250	Sand filter Beds
253	Peconic R. Stream Bed
491	BMRR
555	Chemistry Bldg.
705	HFBR
931	BLIP
444	Waste Management Incinerator
610	Steam Plant
CSF	Storm Water Outfall
HN	Recharge Basin
HO	Recharge Basin
HP	Recharge Basin
HS	Recharge Basin
HT	Recharge Basin
HX	Recharge Basin
HW	Recharge Basin

FIGURE 5-1

Table 5-1
BNL Site Environmental Report for Calendar Year 1996
Airborne Radionuclide Releases by Facility

Facility	Nuclide	Ci* Released	Facility	Nuclide	Ci* Released
HFBR	Ar-41	3.4E-06	**BMRR**	Ar-41	1.7E+03
	Ba-128	7.6E-06		Ba-128	6.9E-07
	Br-82	1.1E-03		Ba-140	1.0E-05
	Cl-38	1.5E-04		Br-82	4.7E-05
	Co-60	1.8E-07		Ce-144	3.6E-07
	Cs-137	9.5E-08		Hg-203	7.7E-06
	H-3	4.8E+01		I-131	4.7E-07
	Hg-203	1.2E-06		I-133	2.9E-07
	I-123	2.9E-07		La-140	3.6E-05
	I-125	7.9E-06		Ti-44	7.1E-06
	I-129	2.0E-05		Xe-133	3.7E-06
	Rb-83	1.4E-07		Xe-135	1.4E-06
	Rb-84	1.9E-07			
	Re-188	9.3E-07	**Evaporator**	H-3	4.8E+00
	Sc-47	8.1E-08	**Facility**	Co-57	4.0E-06
	Se-75	5.3E-08		Co-60	1.0E-06
	Sr-85	6.7E-08		Cs-134	9.2E-07
	Tl-208	1.2E-07		Cs-137	1.2E-04
	Xe-133m	3.6E-07		I-133	4.8E-06
	Xe-135	8.6E-06		Mn-54	8.8E-06
	Zn-69m	1.7E-07		Na-22	2.3E-05
				Rb-83	3.5E-06
BLIP	I-126	1.3E-08			
	Rb-83	3.5E-09	**Incinerator**	H-3	1.1E-03
	Rb-84	4.4E-09		Sr-85	2.0E-06
	Se-75	1.6E-09		I-125	3.0E-05
	H-3	8.4E-03		Co-57	2.0E-07
	O-15	3.0E+01		Sc-47	5.0E-07

* 1 Ci = 3.7E+10 Bq.

Concentrations of HTO in the air effluent are sampled by a silica gel absorbent as they are released.

In 1996, 48 Ci (1.8 TBq) of airborne HTO was released from the HFBR (Table 5-1). While this constitutes the second largest source of total airborne activity released from BNL, tritium is a very minor contributor to off-site dose.

Other radionuclides are also released from the HFBR in very small quantities, typically in the millicurie to microcurie range, annually. These nuclides are primarily released during the purge of the helium "cover gas" present above the surface of the reactor vessel's cooling water. Any fission products which have been transferred from the cooling water to the cover gas may be released during a routine depressurization purge. Any radionuclides present are passed through charcoal and HEPA filters to remove the greatest fraction possible prior to atmospheric release.

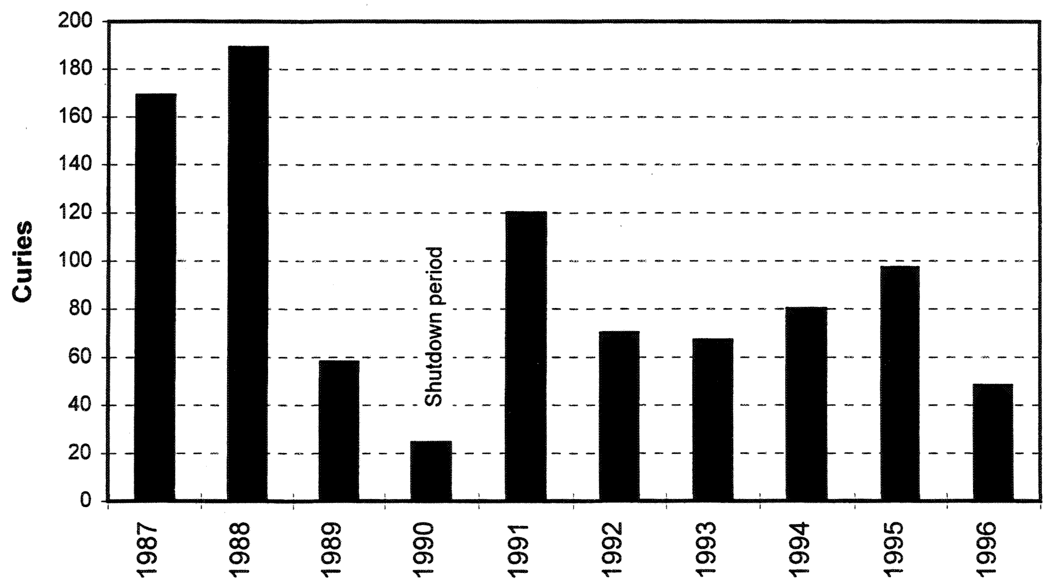


Figure 5-2 HFBR airborne tritium emissions, 10 year trend.

5.1.3 BLIP

Protons from the LINAC are sent via an underground beam tunnel to the BLIP Facility where they strike various target metals. These metals, which become activated by the proton beam, are then processed at Building 801 for use in radiopharmaceutical development and production. The targets are cooled by a continuously recirculating water system. During irradiation, several radioisotopes are produced in this cooling water, the most significant of which is gaseous oxygen-15, a radionuclide with a very short half-life of 123 seconds.

The BLIP facility underwent significant upgrades between 1994 and 1996 in support of the Brookhaven Isotope Research Center (BIRC) program. In an effort to determine any possible changes in the airborne effluent emission rates that theses changes may have caused, measurements were conducted in July. These measurements indicated a smaller oxygen-15 production rate than measurements made prior to the BIRC upgrades. As a result, the calculated annual source term release for this facility has decreased as compared to previous years. A total of 30 Ci (1.1 TBq) of oxygen-15 was released as an airborne effluent in 1996 (Table 5-1).

5.1.4 Tritium Evaporator Facility

First proposed in 1985, the Tritium Evaporator Facility was constructed to reduce the total amount of tritiated water released to the Peconic River. Since the proposal followed the promulgation of the NESHAPs, the facility was evaluated for compliance with the Rule prior to construction. Following submission of an application to construct the facility, formal approval from the EPA Region II was awarded (Approval No. BNL-288-01).

Liquid waste generated on-site which contains residual radioactive material is processed at the Building 811 WCF. At the WCF, suspended solids are removed from the liquid along with a high percentage of radionuclides using a reverse osmosis process. The only radionuclide which is not removed during this process is tritium. The tritiated water which remains following the waste concentration process is delivered to the Evaporator where it is converted to steam and released as an airborne effluent. This method is preferable to release via surface water because (1) there is virtually no potential to influence the underlying aquifer, and (2) the potential dose from tritium to a single individual via groundwater is further reduced. The effluent is directed to the same 98 meter stack used by the HFBR for building air exhaust. In 1996 4.8 Ci (178 GBq) of HTO was released as an airborne effluent from the evaporator facility (Table 5-1).

Since the waste concentration process does not remove all other radionuclides with complete efficiency, nuclides other than tritium are released at much lower activity levels (see Table 5-1 for a listing). The activity values listed in the Table are estimated since facility emissions are tracked by an inventory system in place of in-line monitoring. Liquid shipments to the Evaporator are sampled and analyzed prior to delivery to determine radionuclide concentrations. The total emissions for a water tanker delivery are calculated by computing the product of the concentration and total volume evaporated. This method is very conservative since some fraction of the chemically reactive radionuclides bind to the interior surfaces of the boiler system; hence, airborne releases and projected doses from this facility are likely to be overestimated.

5.1.5 Other Facilities

Airborne radionuclides are also released from Building 801 and the Waste Management Incinerator (see Table 5-1 for isotopes and quantities). These quantities are very small, typically in the millicurie to microcurie range, annually. These isotopes are not significant contributors (less than 2%) to the site perimeter dose via the airborne pathway. Under the 40 CFR 61, Subpart H airborne effluent monitoring criteria, Building 801 requires only "periodic, confirmatory" sampling to demonstrate compliance. While monitoring at this facility is usually continuous, the sample collection frequency was reduced in 1996. Samples collected from this building did not contain BNL-produced radionuclides.

Another potential source of airborne radionuclide emissions is the AGS Booster facility. The Booster receives protons and heavy ions from the LINAC and Tandem Van De Graaf Facilities to increase their intensity for delivery to the AGS. BNL possesses a NESHAPs approval from EPA Region II for this facility (Approval No. BNL-188-01). Air activation in the Booster beam tunnel can occur under certain operating conditions, creating short half-life radioactive species of elements found in air (such as carbon, nitrogen, and oxygen). These air activation products may then be exhausted from the beam tunnel via the ventilation system. Using the most conservative assumptions regarding beam loss, particle energy and ventilation, this facility is capable of producing at maximum an additional 0.02 mrem (0.2 μSv) individual dose at the site boundary. In actual practice, it is much less than this value.

5.1.6 New Sources Evaluated in 1996

5.1.6.1 Tandem Van de Graaff Facility

The Van de Graaff facility gas storage vessel contained nitrogen insulating gas and trace quantities of tritium. Prior to its scheduled removal in 1996, the remaining contents of the vessel were emptied and routed to a line connected to a 21 meter tall exhaust stack. The venting caused an estimated release of 66 μCi of tritium to the atmosphere. Maximum estimated off-site dose for this operation, as calculated by CAP88-PC, is 3E-9 mrem.

5.1.6.2 Inhalation Toxicology Facility

Two laboratories in the Inhalation Toxicology Facility (ITF) are designated "Radioactive Materials Laboratories" for use by the Microbiology Group, Biosystems and Process Sciences Division in the Department of Applied Science. Compounds of uranium-238, uranium-232, thorium-232, and sodium-22 are used in a lab hood setting. Activities which could create airborne effluents include dissolution of radioactive compounds in water, vacuum filtration, dilution and preparation of stock solutions. No more than 0.5 nCi of any compound could be released. Maximum estimated off-site dose for this operation, as calculated by CAP88-PC, is 5.6E-4 mrem.

Under a separate operation, work with leachate containing very small quantities of plutonium-239 was performed in a HEPA filtered hood. Total activity handled was estimated at 1.3 μCi. This is much less than the 40 CFR 61 Appendix E, Table 1 Annual Possession Quantity for Pu-239, in liquid form (2.5 mCi), used to demonstrate compliance. The maximum off-site dose projected for this operation, using conservative release assumptions, was 6E-6 mrem.

5.1.6.3 OU I Air Stripper

As part of the Operable Unit I remediation effort, groundwater contaminated with volatile organic compounds (VOCs) are pumped from below ground and transported to the stripping unit. This water has also been shown to contain tritium at levels below the 40 CFR 141 drinking water standard of 20,000 pCi/L. VOCs are expelled into the atmosphere in the form of an airborne effluent where they will disperse at acceptable, pre-determined concentrations. Airborne tritiated water is also released by this operation. Under conservative assumptions, the maximum off-site dose was calculated to be 2E-5 mrem using CAP88-PC.

5.2 Airborne Effluent Emissions - Nonradioactive

Nonradioactive emissions are generated from a variety of processes at BNL. Most of these are defined by NYS air law as minor sources and include processes such as welding/soldering, degreasing, sandblasting, machining, painting and parts cleaning. Boilers at the CSF account for the majority of nonradioactive air emissions at the Laboratory. The CSF located along the eastern perimeter of the developed portion of the BNL site. The CSF supplies steam for heating and cooling to all major facilities through the underground steam distribution and condensate grid.

The combustion units at the CSF are designated as Boiler Nos. 1A, 5, 6 and 7. Boiler 1A is a Babcock and Wilcox FM unit that was installed in 1962, and has a heat input of 56.7 MMBtu/hr. Boiler 5 is a Combustion Engineering VU-60 unit installed in 1965 that has a heat input of 225 MMBtu/hr. Boiler No. 6 is a Combustion Engineering 28-A-14 unit, installed in 1984, with a heat input of 147 MMBtu/hr. Boiler No. 7 with a heat input of 147 MMBtu/hr, is a new Babcock & Wilcox FM-117-8-97 unit. Boiler Nos. 6 and 7 are subject to the New Source Performance Standard, 40 CFR Subpart Db, and are equipped with continuous emissions monitors for NO_x. Boiler No. 7 emissions are also continuously monitored for opacity in accordance with Subpart Db requirements. All four boilers are monitored for O_2 and CO_2. Emissions from these boilers are reported on a quarterly basis to the NYSDEC.

After a shakedown period which lasted into the spring, Boiler No. 7 underwent emissions testing in May 1996 while burning residual fuel with a fuel bound nitrogen content of less than 0.3 percent. Test results confirmed that NO_x emissions met the NO_x RACT emission standard of 0.03 lbs/MMBTU. The results also demonstrated that carbon monoxide and non-methane volatile organic compound emissions were below the emissions limits established in the permit to construct issued by the NYSDEC in 1993. Because the May test results revealed exceedances of the 0.10 lbs/MMBtu total suspended particulate emissions standard, particulate emissions testing was repeated in December 1996. Results from the second set of tests confirmed that total suspended particulate emissions were below the Subpart Db emissions limit. The results along with an application for a permit to operate the boiler have since been transmitted to the EPA and the NYSDEC for approval. The tests were required as a condition of the construction permit issued in 1993 and BNL's NO_x RACT Compliance Plan approved by the NYSDEC in June 1994.

In June 1995, the NYSDEC issued a permit to the Laboratory, which allowed the DAS to use the former inhalation toxicology facility in Building 490 to fabricate GVF-12.7 fireproofing test panels as part of a Cooperative Research and Development Agreement. Since the fabrication process involves the mixing and spray application of an asbestos material, exhaust systems for each of the project's three hoods were designed to exceed pollution control requirements established by NESHAPs 40 CFR Subpart M. Exhausts from each processing step pass through a series of fabric prefilters and two HEPA filters before their release to the atmosphere. To satisfy Subpart M monitoring requirements, each process hood exhaust has been visually monitored on a daily basis for evidence of visible emissions of asbestos. In addition, prefilters and HEPA filters associated with each hood are inspected at least once per week to ensure that they are functioning properly. This is accomplished by visually inspecting the clean side of prefilters, recording the pressure drop readings across each filter and comparing these readings with the filter manufacturer's recommendations. Since panel fabrication and testing began in August 1995, DAS has prepared quarterly reports which document the inspections of emission filter devices and the monitoring of exhausts for visible emissions. To date no visible emissions of asbestos have been observed.

6. LIQUID EFFLUENTS

6.1 Policy

The basic policy of liquid effluent management at the Laboratory is to minimize the volume of liquids requiring processing prior to on-site release or solidification for off-site burial at a licensed facility (ERDA, 1997). Accordingly, liquid effluents are segregated by the generator at the point of origin on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

6.2 Liquid Waste Management

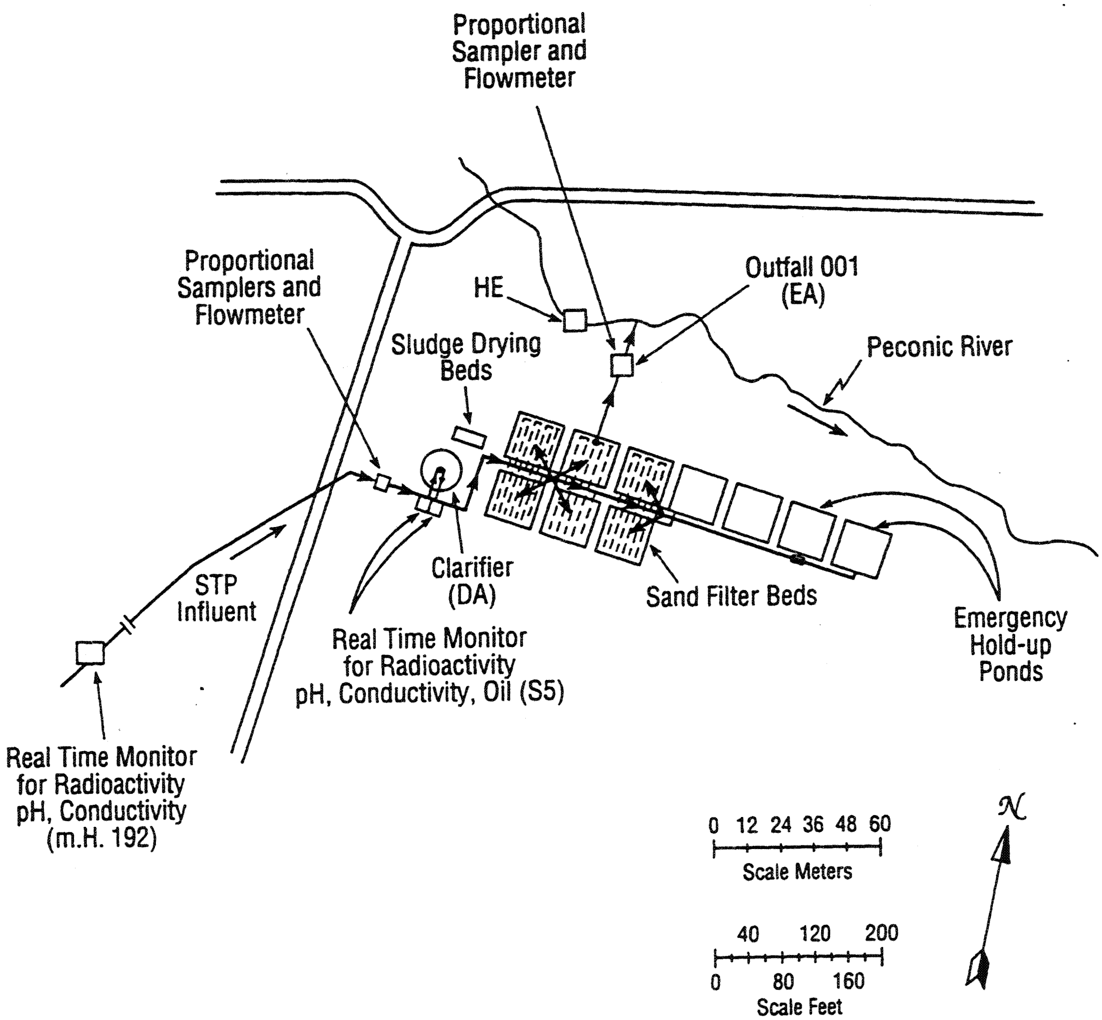
Liquid chemical wastes are collected by the Hazardous Waste Management Operations Group (OG). These wastes are packaged in accordance with Department of Transportation (DOT), EPA, NYSDEC and DOE regulations for licensed off-site disposal.

The OG collects small quantities of low-level liquid radioactive waste from waste accumulation areas throughout the site. Depending on the radionuclides in the water and their concentrations, wastes are either directly solidified at the HWMF or processed at the WCF. Buildings where large volumes (up to several hundred liters) of low-level liquid radioactive waste are generated have dual waste handling systems. These systems are identified as 'known radioactive' (D-waste) and 'potentially radioactive' (F-waste). All D-waste liquids are collected for disposal through the WCF. F-waste liquid streams are sampled and analyzed. The results are compared to DOE, SPDES and BNL sanitary release criteria. If the radionuclide concentrations in the liquid meet the criteria, it may be released to the sanitary waste system. Otherwise, the liquid is transferred to the WCF for processing. In 1996, a total of 93,863 gallons (355,541 liters) of wastewater was evaluated for radioactive content and acceptability for release. Total activity of all approved releases was 0.01 mCi (0.4 MBq) gross alpha, 0.17 mCi (6.3 MBq) gross beta, and 0.52 mCi (19.2 MBq) of tritium.

6.2.1 Sanitary System Effluents

Primary treatment of the sanitary waste stream to remove settleable solids and floatable materials is provided by a 950,000 liter clarifier at the STP. The liquid effluent flows from the clarifier onto sand filter-beds, where approximately 85% of the water is recovered by underlying tile fields, then released into a small stream that contributes to the headwaters of the Peconic River. This release is a SPDES-permitted discharge. The Peconic River is an intermittent stream within the BNL site. Off-site flow occurs during periods of sustained precipitation, typically in the spring. Due to the low rate of precipitation, only minor flow was recorded at the BNL boundary during the spring 1996. Increased precipitation later in the year resulted in more significant flow off-site, especially in late December.

The effluent not collected by the tile fields, approximately 15%, recharges directly to groundwater under the filter beds and/or evaporates. Figure 6-1 shows a schematic of the STP and its related



Sewage Treatment Plant - Sampling Stations.

FIGURE 6-1

sampling arrangements. Real-time monitoring of the clarifier influent for radioactivity, pH, and conductivity, takes place at two locations: about 1.8 km upstream of the STP and as the influent is about to enter the clarifier. The upstream station gives about one-half hour of advanced warning to the STP operator that waste water which may exceed BNL effluent release criteria or SPDES limits has entered the sewer system. Effluent leaving the clarifier is monitored a third time for radioactivity. Influent/effluent that does not meet BNL and/or SPDES effluent release criteria is automatically or manually diverted to one of two lined hold-up ponds. Diversion continues until the effluent quality meets the permit limitations or release criteria. The requirements for treating the effluent diverted to the holding pond are evaluated and it is reintroduced into the sanitary waste stream at a rate which ensures compliance with BNL SPDES limitations or administrative release criteria. The total combined capacity of the two holding ponds exceeds 26.5 million liters or approximately eight days of flow.

Solids separated in the clarifier are pumped to a digester where they are reduced in volume by anaerobic bacteria. Periodically a fraction of the sludge is emptied into a self-contained drying bed for moisture reduction. The drying bed uses solar energy to dry the watery sludge to a semi-solid cake. The dried sludge is then containerized for off-site disposal.

As discussed in Chapter 2, construction of sanitary system improvements were restarted in 1996. Improvements include the construction of dual aerobic treatment tanks with integral secondary clarifiers, installation of a lift station and replacement of the hypochlorite disinfection system with an ultraviolet light system. Construction of the new plant should be completed by September 30, 1997.

6.2.1.1 Sanitary System Effluent - Radiological

The STP is sampled at the output of the clarifier (location "DA") and at the Peconic River Outfall (location "EA"). At each location, samples with a volume proportional to the total water flow through the Plant are collected on a daily basis. These samples are analyzed for gross alpha, gross beta and tritium activity. Samples from these locations are also composited on a monthly basis and analyzed for gamma-emitting radionuclides and strontium-90.

Gross activity measurements are used as a screening tool for detecting the presence of radioactivity without identifying the specific radionuclide(s) causing the activity. The SDWA limits the total gross alpha activity in drinking water to 15 pCi/L (0.5 Bq/L)(including radium-226, but excluding radon and uranium)(40 CFR 141). The Act also stipulates a 50 pCi/L (2 Bq/L) screening level for gross beta activity, above which radionuclide-specific analysis is required. Annual average gross alpha and beta activity in the outfall stream has remained consistent with background levels for many years. This continued to be the case in 1996. Average gross alpha and beta activity at the STP Outfall was 0.7 ± 2.5 pCi/L (0.02 ± 0.09 Bq) and 3.6 ± 7.7 pCi/L (0.1 ± 0.3 Bq/L), respectively. See Tables 6-1 and 6-2 for complete data.

Gamma spectroscopy analysis detected beta/gamma-emitting radionuclides at DA and EA sporadically throughout the year, although at levels that were close to or below the minimum detection limits of the analysis system (see Tables 6-3 and 6-4). The presence of cesium-137 at location EA is due to the continued leaching of very small amounts of cesium-137 from the sand

Table 6-1
BNL Site Environmental Report for Calendar Year 1996
Gross Activity and Tritium Detected in STP Influent

	Flow (liters)	Gross Alpha Average	Gross Alpha Maximum	Gross Beta Average	Gross Beta Maximum	Tritium Average	Tritium Maximum
		← (pCi/L) →					
STP Clarifier							
January	7.92E+07	1.1 ± 1.5	2.2 ± 2.2	2.1 ± 6.3	9.78 ± 5.7	1,127 ± 482	1,760 ± 324
February	7.71E+07	1.1 ± 11.4	26.3 ± 1.8	1.3 ± 5.8	< 7.8	909 ± 436	1,410 ± 305
March	9.01E+07	0.5 ± 1.8	3.6 ± 2.0	5.0 ± 9.5	23.4 ± 6.74	688 ± 436	1,110 ± 285
April	1.11E+08	0.8 ± 2.3	3.2 ± 1.9	2.3 ± 5.7	< 8.2	708 ± 550	1,620 ± 320
May	1.01E+08	0.4 ± 2.6	3.3 ± 1.9	2.3 ± 4.9	< 7.9	976 ± 1,228	3,310 ± 336
June	1.02E+08	0.1 ± 2.1	< 3.1	3.4 ± 8.9	13.20 ± 6.38	805 ± 478	1,390 ± 272
July	1.10E+08	0.2 ± 1.9	< 2.7	3.0 ± 11.0	18.2 ± 6.6	1,300 ± 2,204	5,990 ± 437
August	1.13E+08	1.1 ± 1.9	2.8 ± 1.5	6.9 ± 44.8	109.0 ± 10.6	984 ± 614	1,680 ± 312
September	1.02E+08	1.0 ± 2.4	2.9 ± 2.0	3.2 ± 6.0	9.1 ± 4.89	1,759 ± 2,104	3,890 ± 382
October	7.98E+07	0.5 ± 2.8	3.35 ± 1.7	5.6 ± 9.2	21.1 ± 6.27	1,125 ± 910	1,980 ± 295
November	7.18E+07	0.1 ± 3.8	< 2.1	6.3 ± 19.4	44.9 ± 7.7	876 ± 726	1,640 ± 335
December	7.32E+07	0.1 ± 1.6	< 3.4	3.9 ± 8.5	13.6 ± 5.79	1,410 ± 1,000	2,320 ± 379
Annual Avg.		0.8 ± 2.0		4.6 ± 16.3		1,112 ± 1,262	
Total Processed	1.11E+09 L	1.1 mCi		4.1 mCi		1,181 mCi	
SDWA Limit (Annual Avg.)		15		50		20,000	

Notes:
1. Maximum values reported with 2σ (95%) confidence interval.
2. Average values calculated as arithmetic mean of individual measurements ±2 standard errors of the mean.

Table 6-2
BNL Site Environmental Report for Calendar Year 1996
Gross Activity and Tritium Detected in STP Effluent

	Flow (liters)	Gross Alpha Average	Gross Alpha Maximum	Gross Beta Average	Gross Beta Maximum	Tritium Average	Tritium Maximum
		← (pCi/L)					→
STP Outfall							
January	8.03E+07	0.9 ± 2.2	2.8 ± 2.0	1.7 ± 4.5	< 8.8	1,152 ± 424	1,570 ± 329
February	6.96E+07	0.1 ± 2.4	2.5 ± 1.7	2.1 ± 5.8	8.8 ± 5.3	837 ± 352	1,140 ± 274
March	7.35E+07	0.8 ± 1.5	2.9 ± 1.8	4.1 ± 6.4	11.0 ± 5.2	1,121 ± 1,154	2,140 ± 332
April	9.39E+07	0.7 ± 1.8	2.1 ± 1.4	2.1 ± 7.0	8.8 ± 5.4	1,153 ± 1,524	3,700 ± 403
May	7.81E+07	0.6 ± 2.2	2.4 ± 1.6	2.4 ± 5.3	< 7.9	1,494 ± 1,782	3,660 ± 321
June	8.31E+07	0.3 ± 2.3	2.6 ± 1.7	3.7 ± 3.5	< 8.1	981 ± 400	1,330 ± 232
July	8.26E+07	0.7 ± 2.5	3.3 ± 1.9	4.1 ± 9.9	15.5 ± 6.0	1,620 ± 1,710	4,990 ± 412
August	8.94E+07	1.2 ± 2.8	4.8 ± 2.4	2.8 ± 6.8	11.0 ± 5.3	1,352 ± 1,302	3,980 ± 372
September	8.09E+07	0.9 ± 1.6	2.6 ± 1.5	6.4 ± 8.2	12.8 ± 5.5	1,991 ± 2,222	4,660 ± 398
October	8.20E+07	0.8 ± 2.2	< 3.1	5.1 ± 8.8	19.3 ± 6.2	1,311 ± 1,440	2,750 ± 337
November	6.86E+07	1.3 ± 4.0	9.2 ± 3.1	5.8 ± 9.1	19.1 ± 5.8	1,412 ± 828	2,290 ± 330
December	6.59E+07	0.4 ± 1.9	< 3.1	2.8 ± 6.9	8.5 ± 5.2	1,747 ± 976	2,560 ± 380
Annual Avg.		0.7 ± 2.5		3.6 ± 7.7		1,348 ± 1,462	
Total Release	9.48E+08 L	0.9 mCi		6.5 mCi		1,275 mCi	
SDWA Limit (Annual Avg.)		15		50		20,000	

Notes:
1. Maximum values reported with 2σ (95%) confidence interval.
2. Average values calculated as arithmetic mean of individual measurements ±2 standard errors of the mean.

Table 6-3
BNL Site Environmental Report for Calendar Year 1996
Gamma-Emitting Radionuclides Detected in STP Influent

	Flow (L)	Be-7	Co-57	Co-58	Co-60	Cs-137	I-131	Mn-54	Na-22	Sr-90
		(pCi/L)								
STP Clarifier										
January	7.92E+07	ND	ND	ND	0.02 ± 0.01	0.88 ± 0.15	ND	0.02 ± 0.02	0.06 ± 0.02	< 0.13
February	7.71E+07	ND	ND	ND	ND	0.07 ± 0.05	ND	ND	ND	0.70 ± 0.09
March	9.01E+07	0.83 ± 0.42	ND	ND	ND	0.08 ± 0.04	ND	ND	0.04 ± 0.03	< 0.21
April	1.11E+08	ND	ND	ND	ND	ND	ND	ND	ND	0.33 ± 0.09
May	1.01E+08	ND	ND	ND	ND	ND	ND	ND	ND	0.28 ± 0.13
June	1.02E+08	0.93 ± 0.29	ND	0.07 ± 0.03	ND	ND	ND	ND	ND	0.68 ± 0.08
July	1.10E+08	0.57 ± 0.23	ND	ND	0.02 ± 0.01	0.05 ± 0.02	ND	ND	0.04 ± 0.01	< 0.14
August	1.13E+08	0.35 ± 0.27	ND	ND	ND	ND	ND	ND	0.03 ± 0.02	< 0.19
September	1.02E+08	ND	0.03 ± 0.02	ND	ND	0.04 ± 0.02	ND	0.07 ± 0.03	ND	0.23 ± 0.09
October	7.98E+07	0.85 ± 0.65	ND	ND	ND	ND	ND	0.07 ± 0.03	ND	< 0.67
November	7.18E+07	ND	ND	ND	ND	0.22 ± 0.20	ND	ND	ND	< 0.64
December	7.32E+07	ND	ND	ND	ND	0.05 ± 0.03	ND	ND	ND	< 1.04
Annual Average		0.29 ± 0.37	< 0.01	0.01 ± 0.02	0.02 ± 0.00	0.11 ± 0.24	ND	0.01 ± 0.03	0.01 ± 0.02	0.25 ± 0.33
Total Processed	1.11E+09	0.34 mCi	< 0.01 mCi	0.01 mCi	< 0.01 mCi	0.11 mCi	ND	0.01 mCi	0.02 mCi	0.21 mCi
DOE Order 5400.5 DCG[1]		1,000,000	100,000	40,000	5,000	3,000	3,000	50,000	10,000	1,000
SDWA Limit[2]		40,000	4,000	1,500	200	120	120	2,000	400	8

[1]Derived Concentration Guide. Concentration which, if ingested 2 L/day for 1 year, would result in an individual committed effective dose of 100 mrem.
[2]Concentration required to produce Safe Drinking Water Act limit of 4 mrem/yr.

Notes:
1. Maximum values reported with 2σ (95%) confidence interval.
2. Average values calculated as arithmetic mean of individual measurements +/- 2 standard errors of the mean.

ND = Not Detected.

Table 6-4
BNL Site Environmental Report for Calendar Year 1996
Gamma-Emitting Radionuclides Detected in STP Effluent

	Flow (L)	Be-7	Co-57	Co-58	Co-60	Cs-137	I-131	Mn-54	Na-22	Sr-90
		(pCi/L)								
STP Outfall										
January	8.03E+07	0.85 ± 0.26	0.07 ± 0.02	0.03 ± 0.03	0.04 ± 0.01	0.03 ± 0.02	1.08 ± 0.31	0.09 ± 0.03	ND	< 0.12
February	6.96E+07	ND	ND	ND	ND	0.62 ± 0.12	ND	ND	ND	0.77 ± 0.12
March	7.35E+07	ND	ND	ND	ND	0.59 ± 0.12	ND	ND	0.12 ± 0.05	<0.11
April	9.39E+07	ND	ND	ND	ND	0.54 ± 0.10	ND	ND	0.07 ± 0.03	0.15 ± 0.06
May	7.81E+07	ND	ND	ND	ND	0.54 ± 0.10	ND	ND	0.04 ± 0.02	0.13 ± 0.08
June	8.31E+07	0.25 ± 0.16	ND	ND	ND	0.70 ± 0.12	ND	0.03 ± 0.02	ND	< 0.14
July	8.26E+07	ND	ND	ND	ND	0.86 ± 0.15	ND	ND	0.13 ± 0.03	0.36 ± 0.10
August	8.94E+07	ND	ND	ND	ND	0.88 ± 0.15	ND	ND	0.10 ± 0.03	0.70 ± 0.10
September	8.09E+07	ND	ND	ND	ND	1.11 ± 0.19	ND	ND	0.18 ± 0.04	0.17 ± 0.11
October	8.20E+07	ND	ND	ND	ND	1.01 ± 0.23	ND	ND	0.13 ± 0.07	1.36 ± 0.83
November	6.86E+07	ND	ND	ND	ND	0.93 ± 0.18	ND	ND	0.44 ± 0.09	< 0.62
December	6.59E+07	ND	ND	ND	ND	0.83 ± 0.25	ND	ND	0.18 ± 0.16	0.97 ± 0.62
Annual Average		0.09 ± 0.24	0.01 ± 0.02	< 0.01	< 0.01	0.72 ± 0.28	0.09 ± 0.3	0.01 ± 0.02	0.12 ± 0.12	0.45 ± 0.41
Total Release	9.48E+08	0.09 mCi	0.01 mCi	< 0.01 mCi	< 0.01 mCi	0.68 mCi	0.09 mCi	0.01 mCi	0.11 mCi	0.36 mCi
DOE Order 5400.5 DCG[1]		1,000,000	100,000	40,000	5,000	3,000	3,000	50,000	10,000	1,000
SDWA Limit[2]		40,000	4,000	1,500	200	120	120	2,000	400	8

[1]Derived Concentration Guide. Concentration which, if ingested 2 L/day for 1 year, would result in an individual committed effective dose of 100 mrem.
[2]Concentration required to produce Safe Drinking Water Act limit of 4 mrem/yr.

Notes:
1. Maximum values reported with 2σ (95%) confidence interval.
2. Average values calculated as arithmetic mean of individual measurements +/- 2 standard errors of the mean.

ND = Not Detected.

filter beds which were deposited during an unplanned sanitary release in June, 1988 (Miltenberger et al., 1989). The SDWA specifies standards for radium-226, radium-228, tritium and strontium-90, and an annual dose limit of 4 mrem (0.04 mSv) via the drinking water pathway from all radionuclides combined. For radionuclides other than tritium, radium and strontium-90, DOE Derived Concentration Guides (DCGs) are used to determine the concentration of the nuclide which, if continuously ingested over a calendar year, would produce an effective dose equivalent of 4 mrem (0.04 mSv). These limit values are shown at the bottom of Table 6-3 under SDWA Limit. The average cesium-137 concentration in the STP effluent was found to be less than 1% of the drinking water standard.

Samples of the STP outfall are also collected and composited for strontium-90 analysis on a monthly basis. Again, as with the gamma-emitting nuclides, the concentrations observed were either near or below the minimum detection limit for the analysis. The results which were above the typical 0.1 pCi/L (4 mBq/L) detection limit are consistent with concentrations seen in control locations which are not influenced by BNL effluents. Throughout the year, strontium-90 analysis of the samples collected at DA and EA indicated concentrations far below the SDWA limit of 8 pCi/L (0.3 Bq/L).

Tritium detected at the STP originates from three sources: (1) HFBR sanitary system releases, (2) small, infrequent batch releases (see Section 6.2), and (3) the release of tritiated distillate generated by the on-site liquid waste concentration process. A plot of 1996 tritium concentrations recorded in the STP effluent is presented in Figure 6-2. A 10 year trend plot of annual average tritium concentrations measured in the Peconic is shown in Figure 6-4.

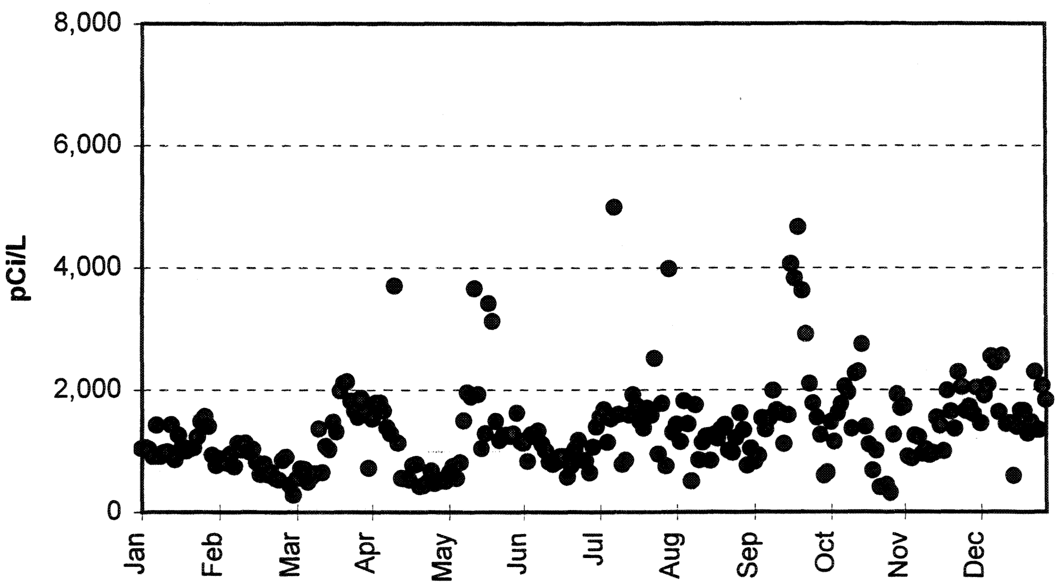


Figure 6-2 Tritium concentrations in STP effluent, 1996.

In addition to the airborne releases discussed in Section 5.1, tritium is also released from the HFBR via the liquid pathway. Tritiated water vapor accumulates at low levels inside the containment building as a result of vessel depressurizations during open fuel handling or other operations which require the opening of primary coolant systems. Liquid releases of tritium occur when the building's air handling system condenses HTO in the air. Some of this condensate enters the sanitary waste system and is transported to the STP. The tritium released by this pathway constitutes less than 2% of the total HTO released from the HFBR.

Radioactive liquid wastes are processed for volume reduction at the Waste Concentration Facility. This process allows the separation of radioactive materials from liquid wastes, minimizing the volume of radioactive waste to be disposed of. Due to its physical characteristics, the only radionuclide which cannot be removed by this process is tritium. Prior to the commissioning of the Tritium Evaporator Facility in 1995, the resultant tritiated distillate was transported to the STP hold-up ponds where it was released to the sand filter beds under conditions which ensured compliance with all applicable water quality standards. Some distillate from the period prior to the commissioning of the Tritium Evaporator Facility remained in these ponds in 1996 and was released by this method.

Under the current version of the SDWA, the average annual tritium concentration in drinking water must not exceed 20,000 pCi/L (740 Bq/L) (40 CFR 141). The NYSDEC has adopted the same standard (6NYCRR). In 1996, the annual average tritium concentration as measured at the Peconic River Outfall was 1,348 pCi/L (50 Bq/L), or 7% of the Drinking Water Standard. (It is important to note that although drinking water standards are applied for comparison purposes, the Peconic River is not used as a source of potable water.) A total source term of 1.3 Ci (48 GBq) of tritium was released during the year. This is the lowest annual release of tritium to the Peconic River observed since routine measurements began in 1966 (see Figure 6-3).

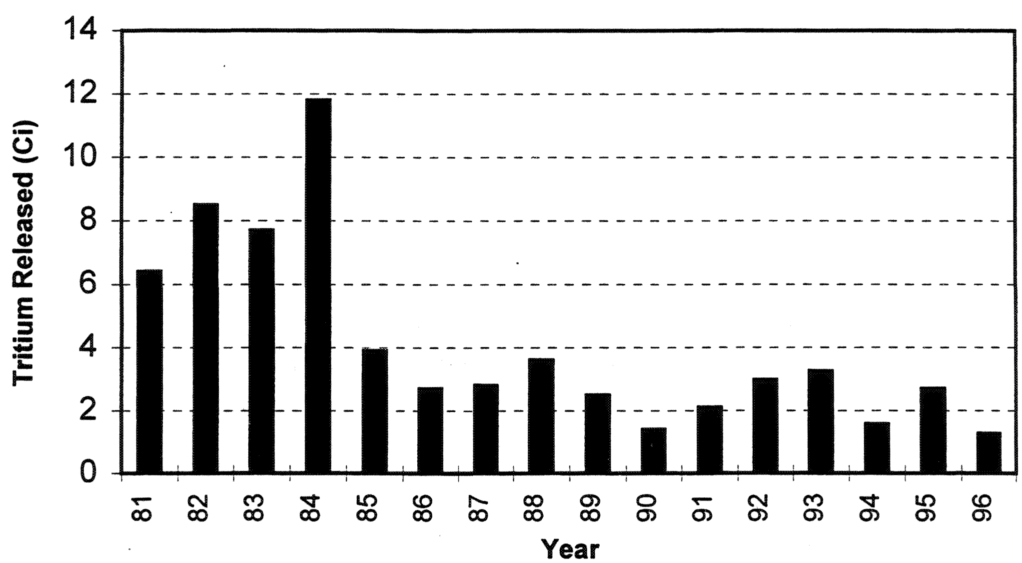


Figure 6-3 Tritium Released to Peconic River, 15 year trend.

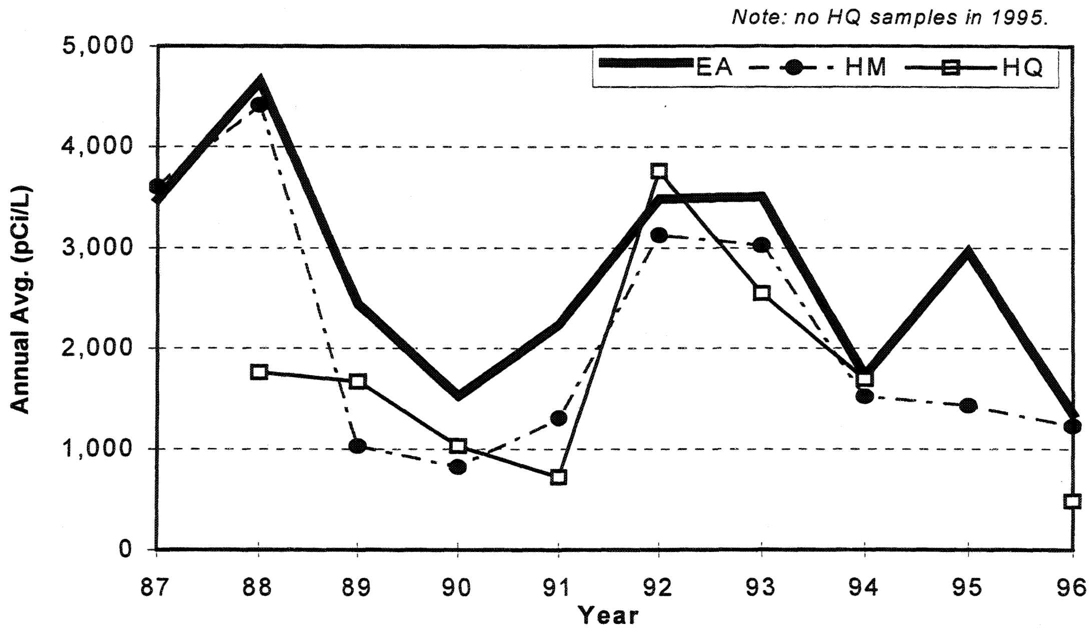


Figure 6-4 STP/Peconic River annual average tritium concentrations, 10 yr. trend.

6.2.1.2 Sanitary System Effluent - Non-radiological

The effluent from the Laboratory STP discharges into the Peconic River at location EA (Outfall 001) and is subject to the conditions of the SPDES Permit No. NY-0005835, which is issued by the NYSDEC. Monthly DMRs are submitted to the NYSDEC and SCDHS which provide detailed analytical results and information about the operational performance of the STP. The BNL SPDES compliance program is discussed in detail in Chapter 2.

In addition to collecting and analyzing the STP effluent samples for SPDES compliance purposes, the S&EP Division monitored locations DA and EA routinely during 1996. Daily samples were collected, composited by the S&EP Division's ASL, and analyzed monthly for metals and weekly for nitrates, chlorides and sulfates. In addition, location EA was monitored daily for field-measured parameters including pH, conductivity, temperature, dissolved oxygen, and chlorine residual. Daily influent and effluent logs were also maintained by the STP operators for flow, pH, temperature, settleable solids, and chlorine residual.

Table 6-5 summarizes the water quality and metals analytical results for these samples. Comparison of the effluent data to the SPDES effluent limitations shows that all analytical parameters were within SPDES effluent limitations. In contrast to the routine compliance results, there were no silver nor iron exceedances in any of the monthly composite samples prepared and analyzed by BNL. This supports the position that the concentration of these inorganic elements was typically within effluent limits, and higher concentration exhibited during SPDES sampling events were very infrequent. All other data corresponds well with the compliance data reported in Chapter 2 (Table 2-3).

Table 6-5
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant (STP) (a)
Average Water Quality and Metals Data

	STP Clarifier Effluent				STP Outfall			
	N	Minimum	Maximum	Average	N	Minimum	Maximum	Average
pH (SU) (b)	256	6.2	8.2	NA	258	6	7.5	NA
Conductivity (umhos/cm)				(c)	258	134	383	261
Temperature (C)	258	14	25	20	258	3	26	16
Results in mg/L								
Dissolved Oxygen	NA	NA	NA	NA	258	5.3	13.6	8.5
Chlorides	NA	NA	NA	NA	27	31.4	48	36.5
Nitrate (as N)	NA	NA	NA	NA	27	< 1	6.8	3.4
Sulfates	NA	NA	NA	NA	27	13.7	18.9	15.6
Chlorine Residual	NA	NA	NA	NA	258	0	0.08	0.02
Silver	12	<0.025	<0.025	<0.025	12	<0.025	<0.025	<0.025
Cadmium	12	<0.0005	<0.0005	<0.0005	12	<0.0005	<0.0005	<0.0005
Chromium	12	<0.005	<0.005	<0.005	12	<0.005	<0.005	<0.005
Copper	12	<0.05	0.07	< 0.05	12	< 0.05	0.066	0.042
Iron	12	0.22	0.51	0.34	12	0.13	0.25	0.18
Manganese	12	<0.05	<0.05	< 0.05	12	<0.05	<0.05	<0.05
Mercury	5	<0.0002	< 0.0002	<0.0002	5	<0.0002	0.0004	<0.0002
Sodium	12	28.4	38.5	33	12	34.5	41.7	37.4
Lead	12	0.003	0.014	0.005	12	<0.002	0.0027	<0.002
Zinc	12	0.033	0.18	0.053	12	<0.02	0.029	< 0.02

N: No. of samples
NA: Not Applicable or Not Analyzed
(a): The locations of the monitoring stations are shown on Figure 6-1.
(b): The pH and temperature values reported are those recorded by the SEP Field Samping Team and are based upon analysis of daily
(c): Continuously monitored by STP operators.

Figures 6-5 through 6-10 plot five year trends for the maximum monthly concentrations of copper, iron, lead, silver, nickel, and zinc in the STP outfall as reported in the DMRs; the SPDES permit limits are also shown. Due to the inclusion of nickel in the SPDES permit in 1995, the trend plot only contains analytical results for CY 1995 and 1996. As can be seen from this plot, nickel concentrations within the STP discharge have been consistently well below permit limits.

6.2.2 Assessments of Process-Specific Waste Water

To prevent violation of SPDES permit limitations and the release of waste waters which exceed groundwater effluent standards, the Laboratory requires that process waste waters suspected of containing contaminants at concentrations which may exceed one or both of these standards be held, characterized, and authorized by S&EP Division before disposal.

The SPDES permit includes requirements for the quarterly sampling and analysis of process-specific waste waters discharged from the photographic developing operations in Buildings 118 and 197B, the printed-circuit-board fabrication operations conducted in Building 535B, and the metal cleaning operations in Building 197C. These operations were sampled and analyzed for chemical contaminants, such as inorganic elements (i.e., metals), cyanide, and volatile and semi-volatile organic compounds. All analytical results were reported in the quarterly DMR reports provided by the NYSDEC.

Analytical results for the photodeveloping operations conducted in Buildings 118 and 197B show that silver from Building 197B exceeded the BNL SPDES permit limitation established for the STP discharge. Silver concentrations in this discharge ranged from non-detectable to 169 ug/L. To reduce the impact of silver on the STP, as well as reduce the quantity of silver bearing hazardous wastes, procurement and installation of digital photographic equipment was completed in late 1996. It is anticipated that replacement of wet photodeveloping processes with digitally produced photos will reduce the silver bearing waste stream by up to 75%. While the instantaneous concentration of silver discharged from the photodevelopers is not expected to change, a net decrease in the total mass of silver discharged to the STP should be realized due to less frequent use of these devices.

Efforts have continued to replace the Building 197C Acid Cleaning Facility with an environmentally acceptable alternative. Following recommendations developed by the DOW Advanced Cleaning Systems Division, design and construction of an alternate cleaning process commenced. The new process replaces the strong acids and bases formerly used to clean the aluminum, stainless and copper components used in experimental beam lines, with mild phosphate, borate and inorganic acid solutions. The goal of this project is to eliminate the hazardous waste streams generated by the former Acid Cleaning Facility and produce a waste stream that is amenable to sewer release.

Process waste waters, which were not evaluated for incorporation into the SPDES permit or were not expected to be of consistent quality, were held for characterization by S&EP before release to the sewer. Typical waste waters which are routinely evaluated are ion-exchange column regeneration wastes, primary closed-loop cooling water systems, and other industrial waste waters. To determine the method to dispose of them, samples are analyzed for contaminants

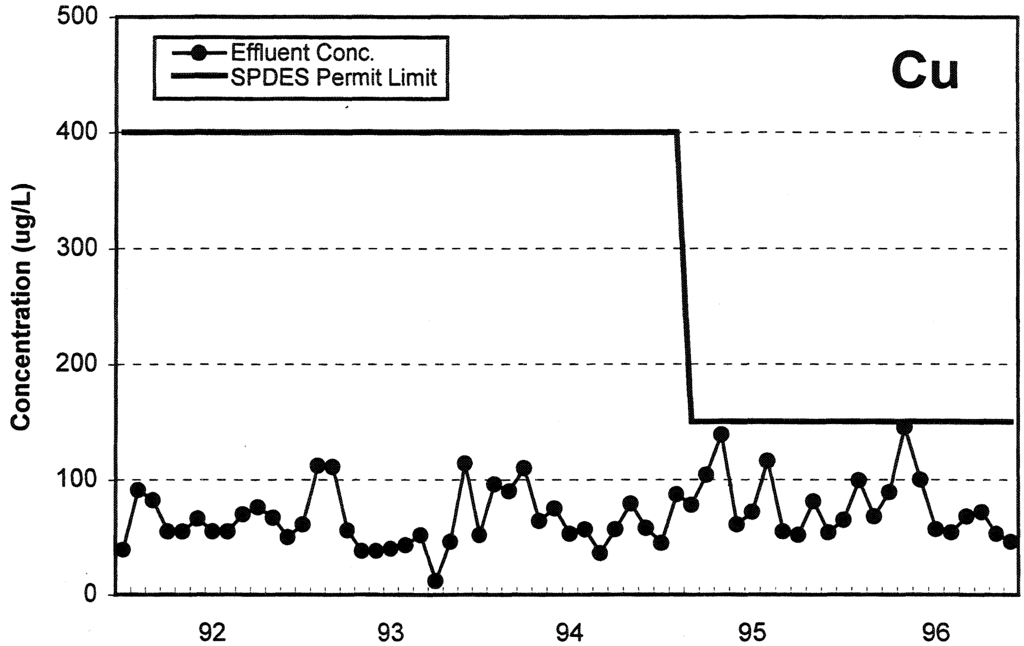


Figure 6-5 Maximum effluent concentration of copper discharged from the STP, 1992-1996.

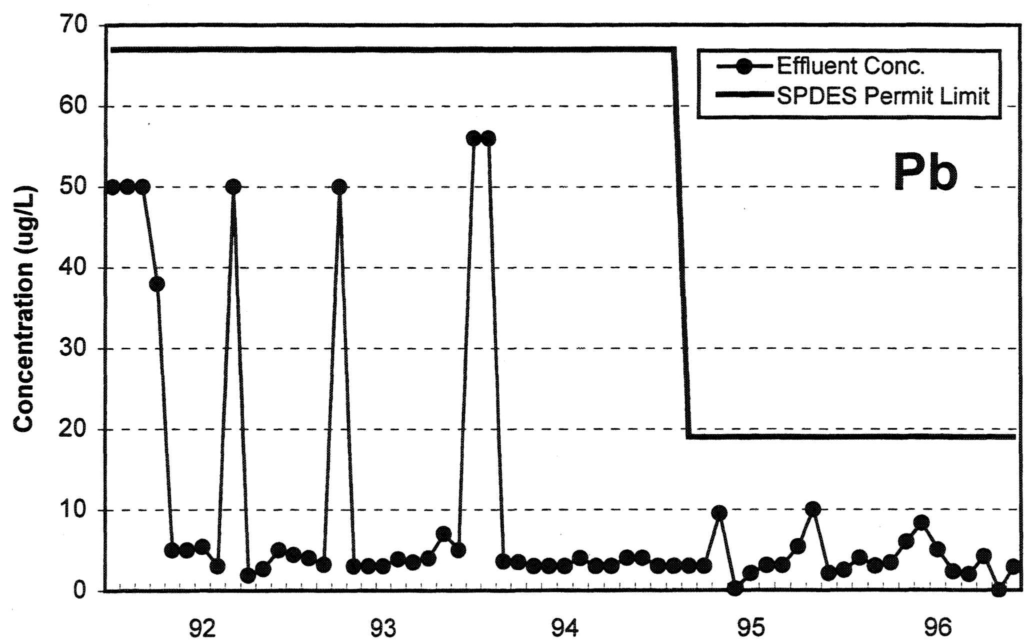


Figure 6-6 Maximum effluent concentration of lead discharged from the STP, 1992-1996.

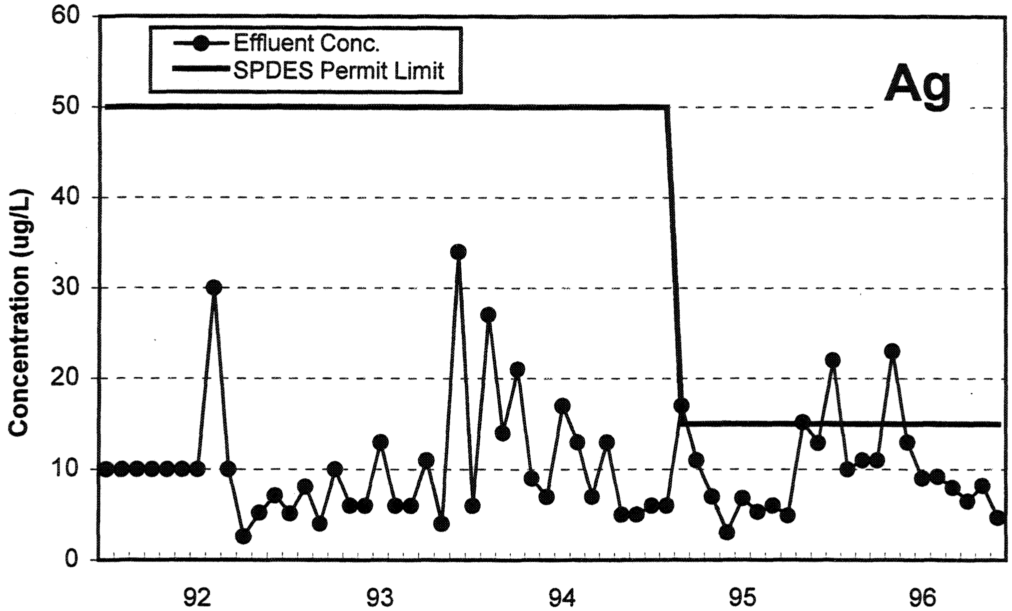


Figure 6-7 Maximum effluent concentration of silver discharged from the STP, 1992-1996.

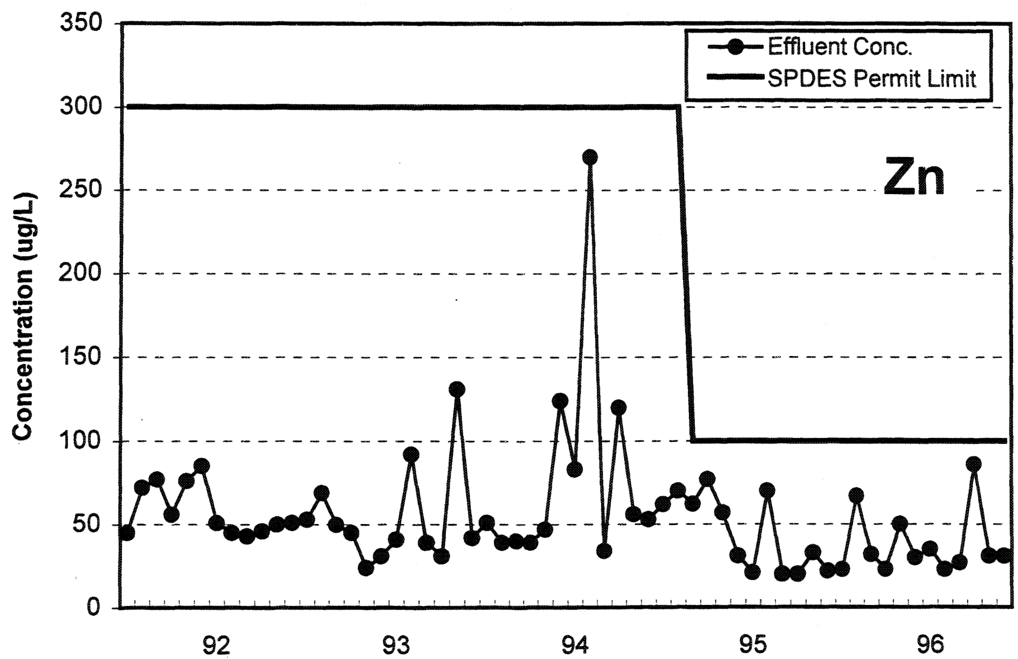


Figure 6-8 Maximum effluent concentration of zinc disharged from the STP, 1992-1996.

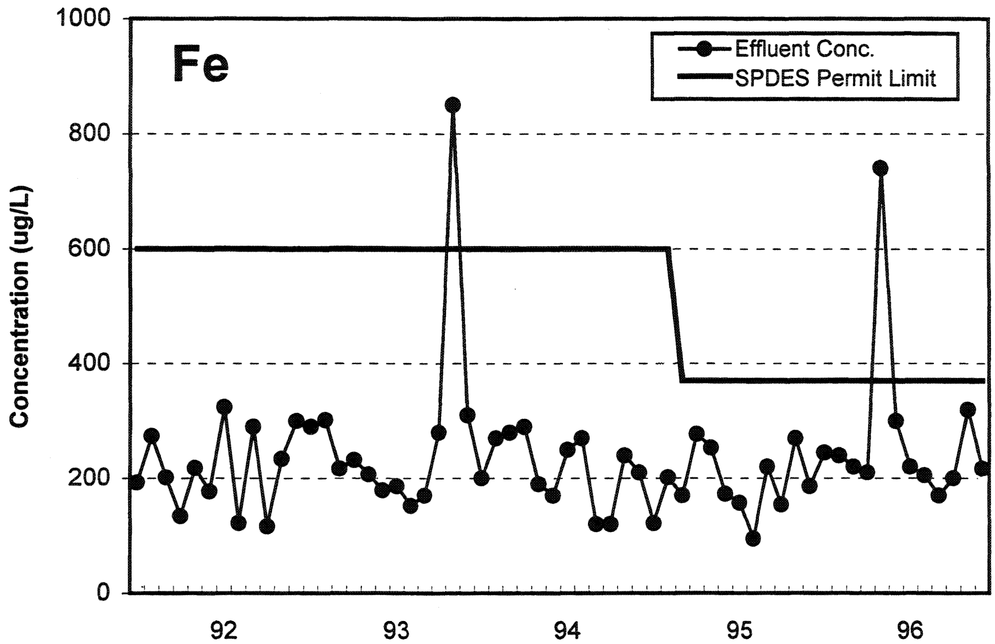


Figure 6-9 Maximum effluent concentration of iron discharged from the STP, 1992-1996.

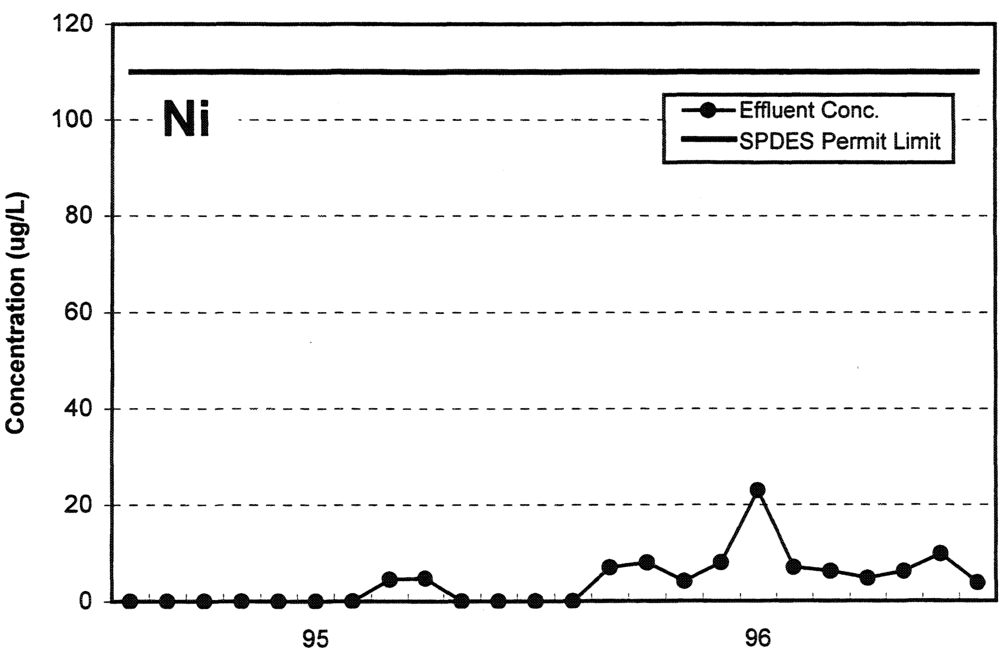


Figure 6-10 Maximum effluent concentration of nickel discharged from the STP, 1992-1996.

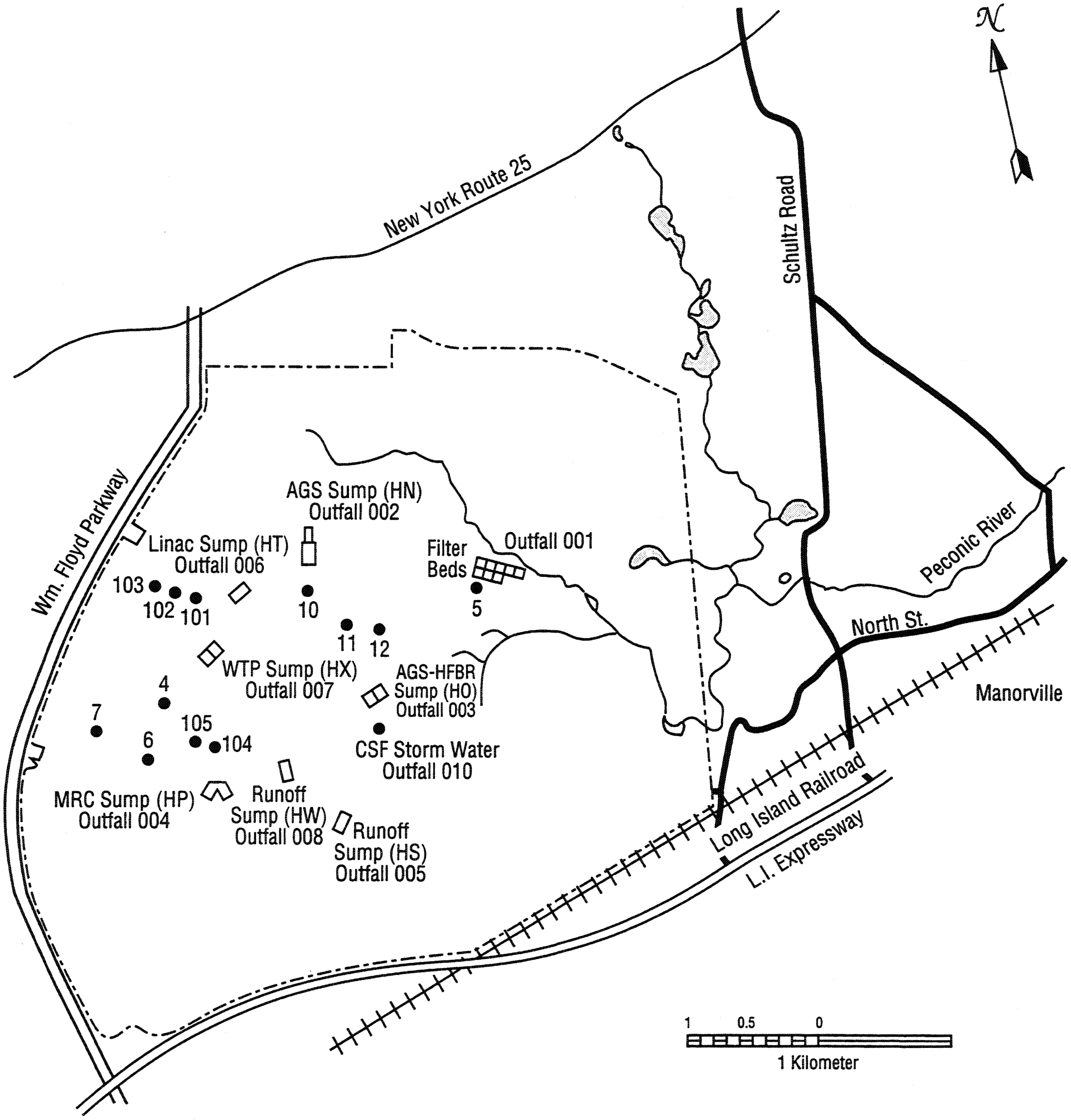
specific to the process. The analyses then are reviewed and the concentrations compared to the SPDES effluent limitations. If the concentrations are within standards, authorization for sewer disposal is granted; if not, alternate means of disposal are evaluated. In all instances, any waste which contains hazardous levels of chemical contaminants or elevated radiological contamination is remanded to the HWM OG for disposal guidance.

6.2.3 Recharge Basins

Figure 6-11 depicts the locations of BNL's recharge basins. An overall schematic of water use at the Laboratory is shown in Figure 6-12. After use in once through heat exchangers and process cooling, approximately 10.3 MLD of water was returned to the aquifer through on-site recharge basins or cesspools; 0.84 MLD to Basin HN (Outfall 002); 8.15 MLD to Basin HO (Outfall 003); 0.07 MLD to Basin HS (Outfall 005); 0.72 MLD to Basin HT (Outfall 006); 0.16 MLD to Basin HX; and, 0.35 MLD to Basin HP (Outfall 004) which receives discharges from the MRR. The cooling of the MRR was accomplished in 1996 using once through well water supplied by Well 105. This well had been previously equipped with activated carbon for mitigation of VOCs. Monitoring of the well water has shown all contaminants to be within discharge requirements. Recharge Basins HN and HT receive once-through cooling water discharges generated at the AGS as well as cooling tower blow-down and storm water run-off. Recharge Basin HS receives predominantly storm water run-off and minimal cooling tower blow-down from the NSLS. Basin HX receives WTP-filter backwash water. Recharge Basin HO receives cooling water and cooling tower discharges from the AGS and HFBR, and storm water run-off. A polyelectrolyte and dispersant is added to the supply of AGS cooling-and process-water to keep the ambient iron in solution. Approximately 5.8 MLD of water used to cool the main heat exchangers at the AGS was discharged to the HO Basin. The HFBR secondary-cooling-system water recirculates through mechanical cooling towers and was treated with inorganic polyphosphate and tolytriazole to control corrosion and deposition of solids. The blow-down from this system, combined with once-through cooling water used at the Cold Neutron Facility and the Cyclotrons, was also discharged to the HO Basin. In addition, several other recharge basins are used exclusively for discharging storm water run-off; these include Basin HW (Outfall 008) and the CSF storm water outlet.

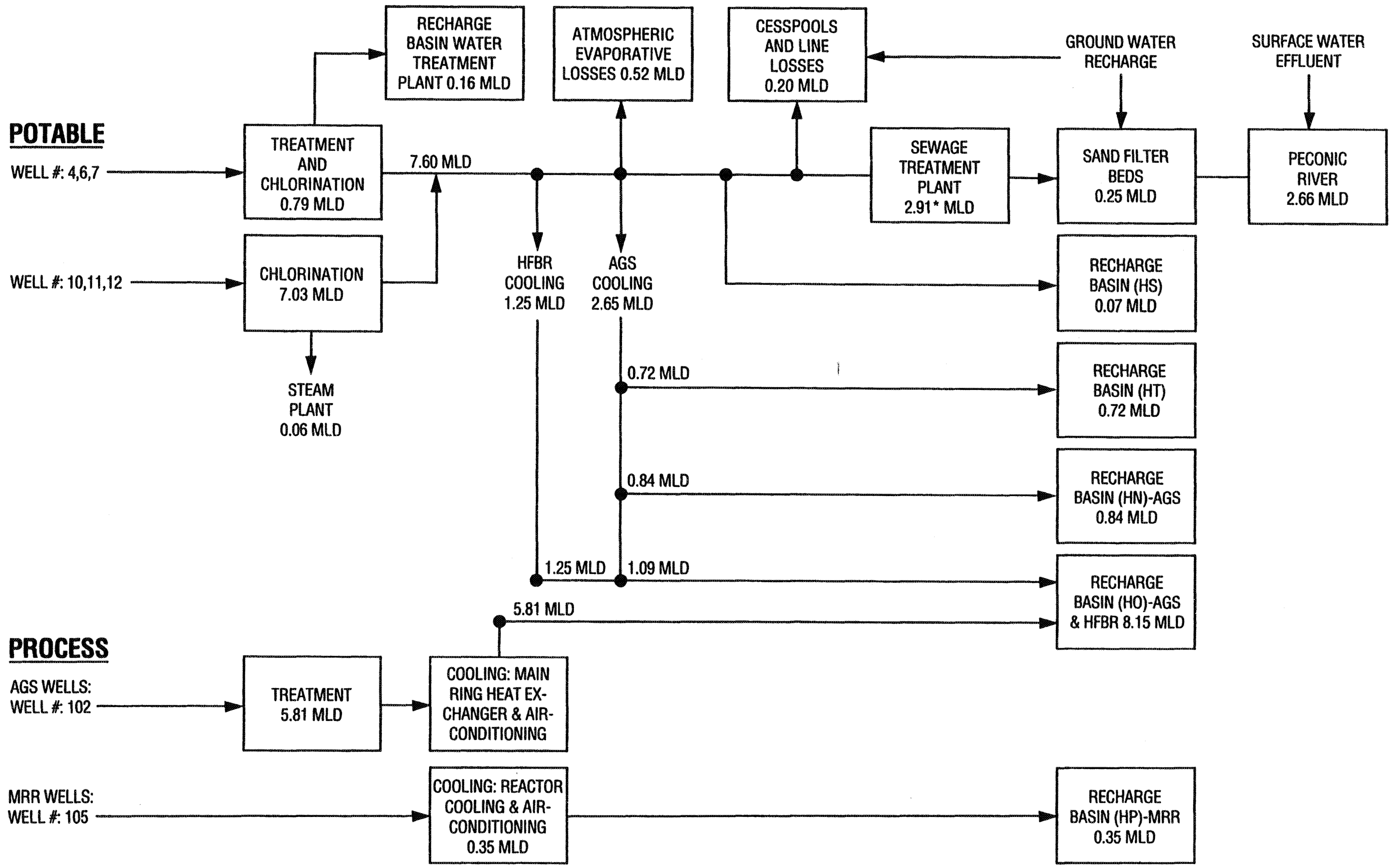
Each of the recharge basins are permitted point source discharges under the Laboratory's SPDES permit. To facilitate monitoring of these discharges, each was equipped with flow monitoring stations which became operational in 1995. Weekly recordings of flow are maintained by the S&EP Division, along with records of pH, conductivity etc. The specifics of the SPDES compliance monitoring program are provided in Chapter 2. To supplement the SPDES program, samples are also collected routinely and analyzed under the environmental monitoring program.

During 1996, water samples were collected from Basins HN, HO, HP, HS, HT, HW, and the CSF storm water outfall. As required by the BNL SPDES permit, each recharge basin was sampled monthly and quarterly for SPDES-specified parameters. Under the environmental monitoring program, each of the recharge basins was monitored for radiological, water quality, VOCs, and metallic constituents in 1996. A description of this monitoring program follows.



On-Site: Potable and supply wells and recharge sumps.

Figure 6-11



NOTE: WELLS #101 AND #103 WERE NOT OPERATING.

***THIS ALSO INCLUDES STORM RUN-OFF THROUGH THE SANITARY SYSTEM (0.20).**

BROOKHAVEN NATIONAL LABORATORY SCHEMATIC OF WATER USE AND FLOW FOR 1996.

Figure 6-12

6.2.4 Recharge Basins - Radiological Analyses

All recharge basins are sampled from one to four times annually for gross activity, gamma-emitting radionuclides and tritium. Basin HN was the only basin found to contain radionuclides attributable to Laboratory operations. This basin receives primary magnet cooling water from the AGS. Water in the primary magnet system contains radionuclides created by the interaction of charged particles produced at the AGS and elements in the water. Metal corrosion products present in the system also become activated, leading to the production of such radionuclides as beryllium-7, chromium-51, cobalt-58 and -60. Radiological results for water samples collected at the recharge basins are presented in Tables 6-6 and 6-7. All detected gamma-emitting radionuclide concentrations were far below applicable DCGs.

6.2.5 Recharge Basins - Non-radiological Analyses

To determine the overall impact of these discharges on the environment, the analytical data for samples collected from the recharge basins was compared to groundwater discharge standards promulgated under 6NYCRR Part 703.6. Samples were collected monthly for water quality parameters and quarterly for metals and VOCs and analyzed by the S&EP ASL. The water quality and metals data are summarized in Tables 6-8 and 6-9, respectively. For VOCs, low concentrations (i.e., 3 ppb or less) of chloroform were detected in the samples collected from Basins HO, and HT. Chloroform probably is present in these samples as a potable-water chlorination by-product. Concentrations of TCA were also detected at low levels in two samples collected at Basin HN. In a sample collected in March, TCA was detected at 13 ug/L which exceeds the state groundwater discharge standard of 5 ug/L. A sample collected in September showed TCA to be present at 2.7 ug/L. A third sample collected in December showed TCA to be non-detectable. There have been no positively identified sources which could explain the earlier findings but both observations occurred during precipitation events; samples collected during SPDES monitoring activities showed no signs of TCA. There were no other VOCs detected in these discharges.

The analytical data in Tables 6-8 and 6-9 shows all parameters, except for iron to comply with the respective groundwater discharge standards. Iron was found present in one or more samples collected from each recharge basin at concentrations which exceed discharge standards. Iron is present in these discharges due to discharge of groundwater used in once through heat exchangers at the AGS and BMRR and due to discharge of storm water run-off. Storm water run-off contains a significant concentration of suspended solids washed from road surfaces and landscaped areas. Native soils contain high concentration of iron (6,000 - 10,000 mg/Kg) which when dissolved act as significant contributors to the elevated iron observations. The pH measured at several of the recharge basins was at or slightly exceeded the NYS ambient water quality standards most likely due to the high pH of the BNL potable water system. Based upon recommendations prepared in response to a 1995 contravention of lead action levels, the pH of the potable water system was increased to 8.0 SU. The goal of the higher pH and resultant alkalinity is to reduce the dissolution of lead from potable water components. However, the increased pH when combined with the evaporative losses from the cooling towers, leads to even

Table 6-6
BNL Site Environmental Report for Calendar Year 1996
Gross Activity and Tritium in Recharge Basin Water

Basin	Collection Date	Gross Alpha	Gross Beta	Tritium
		←	(pCi/L)	→
HN	8-Mar-96	< 0.8	4.2 ± 1.3	< 389
HN	13-Jun-96	< 0.6	17.4 ± 1.9	< 421
HN	18-Sep-96	2.2 ± 1.5	< 9.2	< 379
HN	16-Dec-96	< 0.7	2.0 ± 1.1	< 578
HO	8-Mar-96	< 0.8	1.9 ± 1.2	< 389
HO	17-Jun-96	0.5 ± 0.3	1.9 ± 1.0	< 418
HO	27-Sep-96	1.3 ± 0.3	3.8 ± 1.2	< 503
HO	16-Dec-96	< 0.7	2.4 ± 1.1	< 578
HP	11-Mar-96	0.8 ± 0.4	2.0 ± 1.1	< 305
HS	7-Mar-96	0.9 ± 0.5	2.6 ± 1.1	1,310 ± 238
HS	11-Jun-96	< 0.5	< 1.5	< 392
HS	17-Sep-96	4.1 ± 2.1	< 9.2	< 379
HS	18-Sep-96	2.6 ± 1.6	< 9.2	382 ± 223
HS	17-Dec-96	< 0.7	1.7 ± 1.1	< 578
HT	7-Mar-96	< 0.6	< 1.6	< 318
HT	13-Jun-96	< 0.6	1.6 ± 1.0	< 421
HT	18-Sep-96	5.2 ± 2.0	< 9.2	< 379
HT	16-Dec-96	< 0.7	2.0 ± 1.1	< 578
40 CFR 141 SDWA limit		15	50 (a)	20,000

Notes:
1. All values reported with 2σ (95%) confidence interval.
2. Basin locations are shown in Figure 2-1.

(a) Screening level above which analysis for individual radionuclides is required.

Table 6-7
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Recharge Basin Water

Basin	Collect Date	Be-7	Co-56	Co-58 (pCi/L)	Cr-51	Na-22
HN	8-Mar-96	4.9 ± 3.2	ND	ND	ND	ND
HN	13-Jun-96	112.0 ± 24.2	1.2 ± 0.7	2.6 ± 1.0	29.3 ± 20.7	1.8 ± 0.8
HN	18-Sep-96	ND	ND	ND	ND	ND
HN	16-Dec-96	ND	ND	ND	ND	ND
HO	16-Dec-96	ND	ND	ND	ND	ND
HO	17-Jun-96	ND	ND	ND	ND	ND
HO	27-Sep-96	ND	ND	ND	ND	ND
HO	16-Dec-96	ND	ND	ND	ND	ND
HP	11-Mar-96	ND	ND	ND	ND	ND
HS	7-Mar-96	ND	ND	ND	ND	ND
HS	11-Jun-96	ND	ND	ND	ND	ND
HS	17-Sep-96	ND	ND	ND	ND	ND
HS	18-Sep-96	4.3 ± 1.6	ND	ND	ND	ND
HS	17-Dec-96	ND	ND	ND	ND	ND
HT	7-Mar-96	ND	ND	ND	ND	0.2 ± 0.1
HT	14-Jun-96	ND	ND	ND	ND	ND
HT	18-Sep-96	ND	ND	ND	ND	ND
HT	16-Dec-96	ND	ND	ND	ND	ND
DOE Order 5400.5 DCG[1]		40,000	10,000	40,000	1,000,000	10,000
SDWA Limit[2]		1,600	400	1,600	40,000	400

[1]Derived Concentration Guide. Concentration which, if ingested 2 L/day for 1 year, would result in an individual committed effective dose of 100 mrem.

[2]Concentration required to produce Safe Drinking Water Act limit of 4 mrem/yr.

Notes:
1. All values reported with 2σ (95%) confidence interval.
2. ND = Not Detected.

Table 6-8
BNL Site Environmental Report for Calendar Year 1996
Water Quality Data for On-Site Recharge Basins

Location (a)		pH SU	Temperature C	Conductivity umhos/cm	Chlorides mg/L	Sulfates mg/L	Nitrate as N (b) mg/L
HN	N	17	16	4	4	4	4
(RHIC Recharge)	Minimum	6.8	3.6	45	14	6.3	<1.0
	Maximum	8.1	22.5	257	29.3	19.9	<1.0
	Average	NA	15.5	138	14.8	8.2	<1.0
HO	N	17	16	4	4	4	4
(HFBR-AGS)	Minimum	6	3.5	136	20.7	13	<1.0
	Maximum	8.5	25.5	154	31.1	42.3	<1.0
	Average	NA	15.8	146	23.4	21.4	<1.0
HP	N	5	5	1	1	1	1
(BMRR)	Minimum	5.6	12.8	170	25.4	13	<1.0
	Maximum	6.4	20.8	170	25.4	13	<1.0
	Average	NA	15.1	170	25.4	13	<1.0
HS	N	15	14	4	4	4	4
(Storm Water)	Minimum	6.1	0.2	26	< 4	< 4	<1.0
	Maximum	7.6	23.2	280	7.5	< 4	<1.0
	Average	NA	10.8	150	< 4	< 4	<1.0
HT (c)	N	33	31	8	7	7	7
(LINAC)	Minimum	6.9	3.1	130	6.7	4.4	<1.0
	Maximum	8.6	27.7	228	23	16.3	< 1.0
	Average	NA	19	168	14.6	8.9	<1.0
HW	N	16	15	3	4	4	4
(Weaver Rd.)	Minimum	6.3	0.6	36	< 4	< 4	<1.0
	Maximum	8	22.7	41	6.5	5	<1.0
	Average	NA	13.1	37.7	< 4	< 4	<1.0
CSF	N	13	12	0	4	4	4
(Storm Water)	Minimum	6.2	2.3	NA	< 4	< 4	<1.0
	Maximum	7.7	23.4	NA	47	6.8	<1.0
	Average	NA	12.7	NA	12.9	4.6	<1.0
NYSDEC Effluent Standard		6.5 - 8.5	(d)	(d)	500	500	20
Typical MDL		NA	NA	10	4	4	1

N: No. of samples
MDL: Minimum Detection Limit
NA: Not Applicable
(a): The location of the recharge basins is provided on Figure 6-11.
(b): The holding times specified by the USEPA were exceeded for the majority of the nitrate analyses.
(c): Recharge Basin HT is comprised of two discharge structures; consequntly twice as many readings have been recorded.
(d): No effluent standard specified.

Table 6-9
BNL Site Environmental Report for Calendar Year 1996
Metals Data for On-Site Recharge Basins

Location (a)	N		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
HN (RHIC)	4	Min.	<0.025	<0.0005	<0.005	< 0.05	0.09	<0.0002	<0.05	13.8	<0.002	< 0.02
		Max.	<0.025	<0.0005	<0.005	0.067	1.7	<0.0002	0.21	37.8	0.013	0.12
		Avg.	<0.025	<0.0005	<0.005	< 0.05	0.7	<0.0002	0.05	22	0.003	0.047
HO (AGS/HFBR)	4	Min.	<0.025	<0.0005	<0.005	<0.05	0.08	<0.0002	< 0.05	17.5	<0.002	0.024
		Max.	<0.025	<0.0005	<0.005	<0.05	2	< 0.0002	0.37	42.9	0.003	0.091
		Avg.	<0.025	<0.0005	<0.005	<0.05	1.4	<0.0002	0.22	24.8	<0.002	0.053
HP (BMRR)	1	Value	<0.025	<0.0005	<0.005	<0.05	8.6	<0.0002	0.18	14.2	<0.002	0.022
HS (STORM WATER)	4	Min.	<0.025	<0.0005	<0.005	<0.05	0.26	<0.0002	<0.05	< 1	0.004	0.044
		Max.	<0.025	0.0005	<0.005	<0.05	2.5	<0.0002	<0.05	8.1	0.014	0.078
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.88	<0.0002	<0.05	3.3	0.009	0.061
HT (b) (LINAC)	7	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.2	<0.002	0.024
		Max.	<0.025	<0.0005	<0.005	< 0.05	0.65	<0.0002	<0.05	33.2	0.013	0.06
		Avg.	<0.025	<0.0005	<0.005	< 0.05	0.11	<0.0002	<0.05	19.1	0.003	0.037
HW (WEAVER RD.)	4	Min.	<0.025	0.0005	<0.005	<0.05	0.5	<0.0002	<0.05	1.3	<0.002	0.04
		Max.	<0.025	0.0008	0.019	<0.05	2.1	<0.0002	<0.05	8.7	0.018	0.11
		Avg.	<0.025	0.0007	< 0.005	<0.05	1.2	<0.0002	<0.05	4.9	0.013	0.06
CSF (STORM WATER)	4	Min.	<0.025	< 0.0005	<0.005	<0.05	0.3	<0.0002	<0.05	3.6	0.002	< 0.02
		Max.	<0.025	0.0008	0.008	<0.05	6.6	<0.0002	0.12	30.8	0.016	0.077
		Avg.	<0.025	< 0.0005	< 0.005	<0.05	2.5	<0.0002	<0.05	11.9	0.01	0.035
NYSDEC fluent Limitation			0.1	0.02	0.1	1	0.6	0.004	0.6	(c)	0.05	5
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

N: No. of samples.
MDL: Minimum Detection Limit.
(a): Locations of recharge basins are shown on Figure 6-11.
(b): Recharge Basin HT is comprised of two discharge structures, hence twice as many samples are collected and analyzed.
(c): No effluent standard specified.

further increased pH of the cooling tower discharges. Methods to better control corrosion control additives and rates of cooling tower discharge have been implemented to prevent recurrence.

No water samples were collected from Basin HX in 1996 since this facility was not in operation. Construction of WTP improvements continued in 1996, preventing the collection of water samples from these facilities. A discussion of these improvements is provided in Chapter 8.

7. ENVIRONMENTAL SURVEILLANCE

7.1 Policy

It is DOE policy to conduct its operations in an environmentally responsible manner and comply with applicable environmental regulations and standards. At BNL, a wide variety of environmental activities are conducted to demonstrate compliance with federal, state, and local regulations. This chapter summarizes the results of the Environmental Monitoring Program, which consists of: the collection and analysis of samples of air, water, soil, sediment, vegetation, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for the purposes of demonstrating compliance with applicable standards, assessing radiation exposure to members of the public, and assessing effects, if any, on the local environment.

7.2 External Radiation Monitoring

BNL conducts measurements of environmental background radiation through a network of dosimeter units placed at the site boundary. These units, called thermoluminescent dosimeters, or TLDs, measure gamma radiation which originates from cosmic and terrestrial sources (see Section 4.1 for discussion) as well as any contribution from Laboratory operations. Dysprosium-doped calcium fluoride (CaF_2:Dy) type TLDs are used. There are a total of 24 locations on-site which have TLDs in place (see Figure 7-1). In addition to the dosimeters located on Laboratory property, 25 off-site locations are also monitored (see Figure 7-2). These off-site measurements provide background comparison values and verification that Laboratory operations have had no impact on the ambient radiation levels of the surrounding area.

Each TLD is exposed for one calendar quarter. The annual external radiation dose quoted for each location is the summation of four separate measurements. Where the total number of samples collected is less than four, theft, vandalism, or loss of the unit due to other reasons has occurred. For ease of comparison, all individual measurements have been summed and normalized to a 365 day exposure period to calculate a single annual value. All 1996 TLD data are summarized in Table 7-1.

The average annual off-site external radiation dose value was 67 ± 7 mrem (0.67 ± 0.07 mSv) (the error term represents the 1 X the standard deviation of the sample population). This is consistent with the value of 66 ± 6 mrem/yr (0.66 ± 0.06 mSv/yr) measured in 1995. The average on-site external radiation dose rate was 66 ± 6 mrem/yr (0.66 ± 0.06 mSv/yr). These average values are statistically indistinguishable and are

1996 External Dose Values.

On-Site Average:	*66 ± 6 mrem*
Off-Site Average:	*67 ± 7 mrem*

(+/- 1 standard error of the mean.)

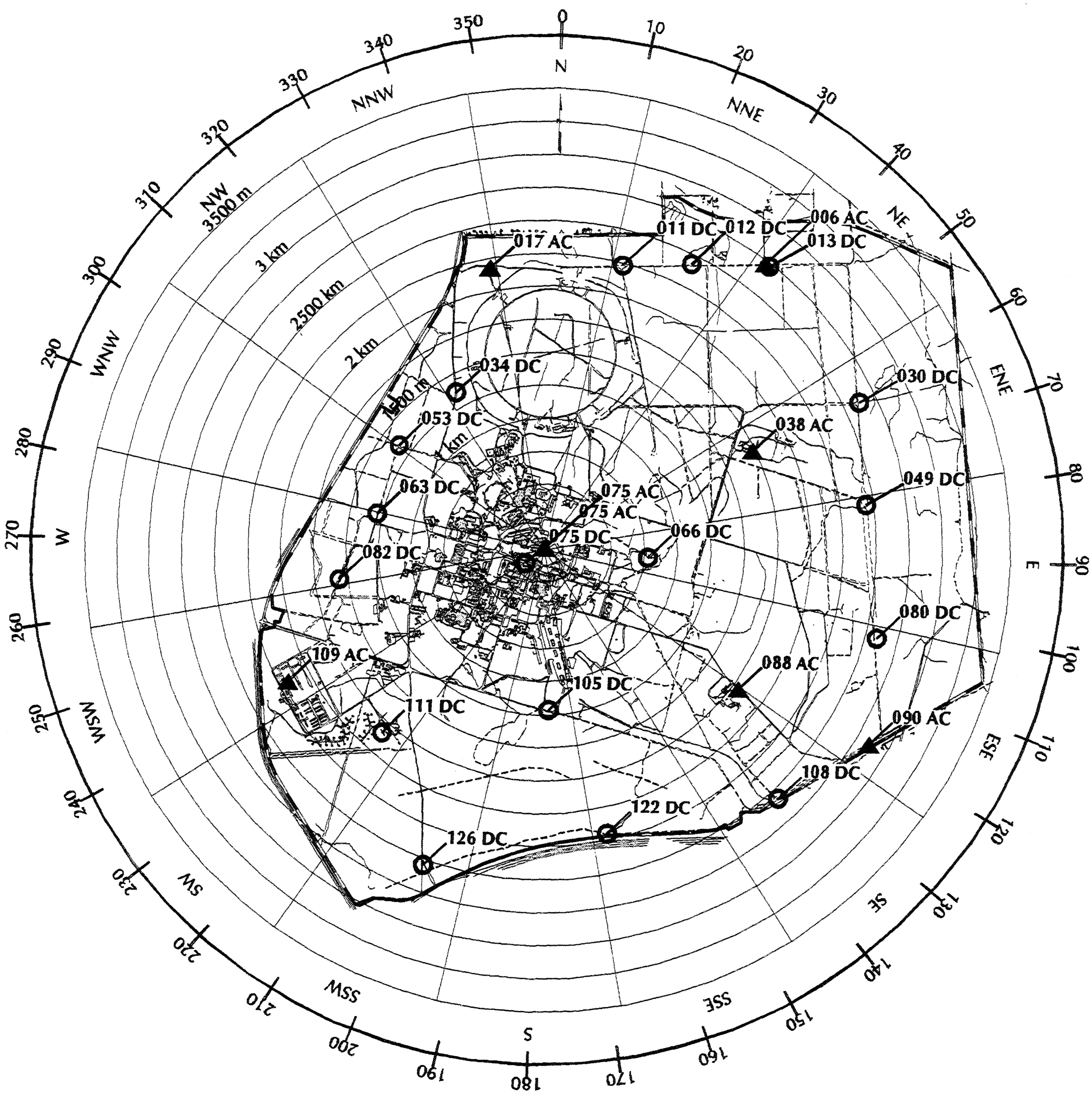


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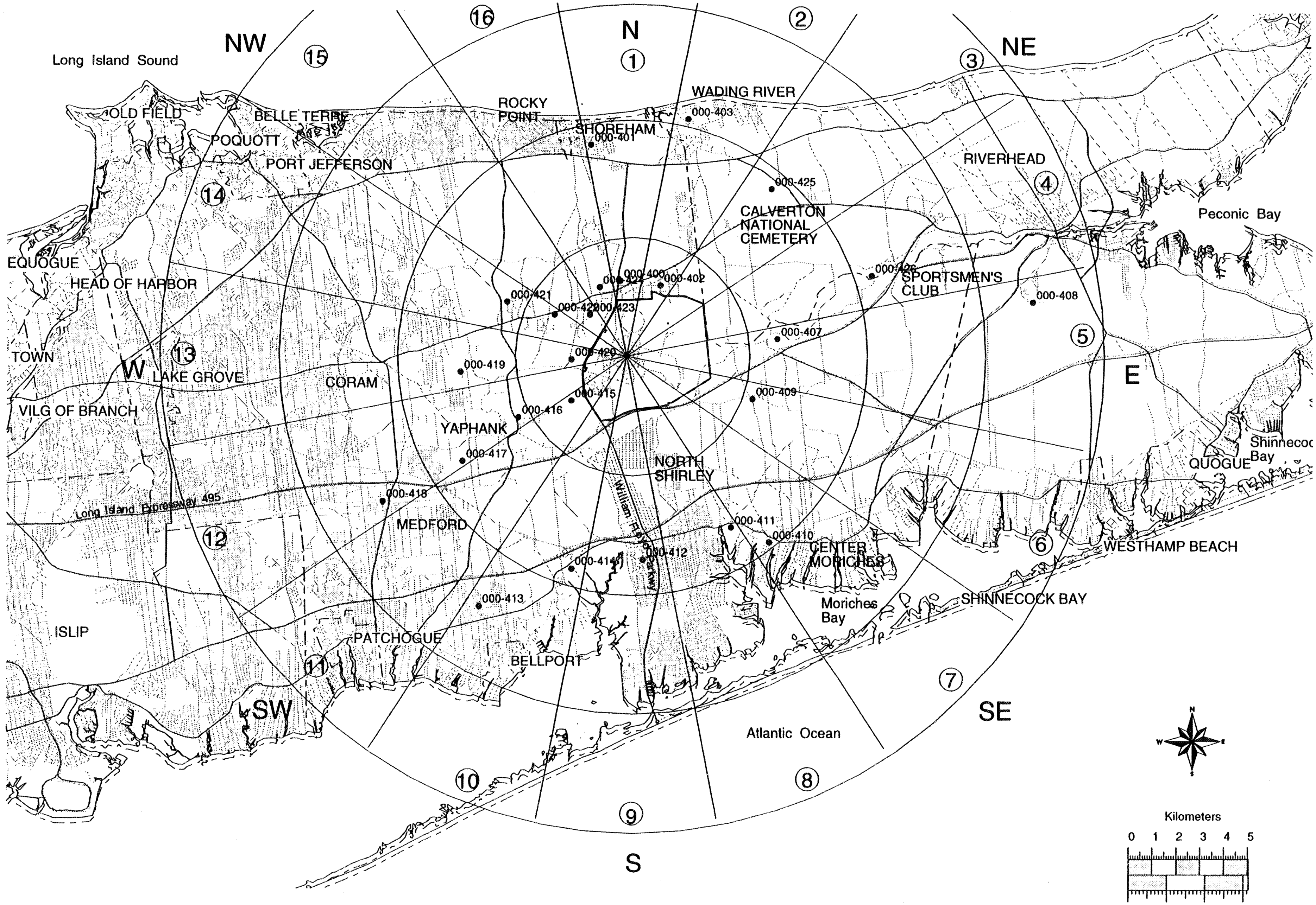
Figure 7-1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SHOREHAM
WADING RIVER
RIVERHEAD
Peconic Bay
CALVERTON NATIONAL CEMETERY
SPORTSMEN'S CLUB
EQUOGUE
HEAD OF HARBOR
TOWN
LAKE GROVE
VILG OF BRANCH
CORAM
YAPHANK
MEDFORD
NORTH SHIRLEY
Long Island Expressway 495
William Floyd Parkwy
CENTER MORICHES
Moriches Bay
SHINNECOCK BAY
WESTHAMP BEACH
QUOGUE
Shinnecoc Bay
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Figure 7-2

Table 7-1
BNL Site Environmental Report for Calendar Year 1996
On-Site Annual Exposure Measurements

Station (Grid-ID)	**No. of TLDs Collected**	**Exposure Period** (Days)	**Annual Dose*** (mrem/yr)
On-Site Locations			
011-400	4	373	59
013-400 (P9)	4	373	61
017-400 (P2)	4	373	55
030-400	4	373	61
034-400	4	373	66
034-401	4	373	71
037-400	4	373	72
038-450 (S5)	4	373	65
049-400	4	373	59
053-400	4	373	70
063-400	4	373	71
066-400	4	373	55
073-400	4	373	67
074-450 (Bldg. 197)	4	373	77
074-451 (Bldg. 907)	4	373	65
080-400	4	373	72
082-400	4	373	73
090-400 (P7)	4	373	66
105-400	4	373	70
108-450	4	373	70
109-400 (P4)	4	373	60
111-400	4	373	65
122-400	4	373	63
126-400	4	373	69

Average Value = 66 mrem
Median Value = 66 mrem
Population Standard Deviation = 6 mrem

* Dose rate normalized to a 365 day year.

Table 7-1 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Off-Site Annual Exposure Rate Measurements

Station (Grid-ID)	**No. of TLDs Collected**	**Exposure Period** (Days)	**Annual Dose*** (mrem/yr)
Off-Site Locations			
000-400	4	377	63
000-401	4	372	61
000-402	3	291	68
000-403	4	367	76
000-404	1	90	74
000-405	1	90	72
000-407	4	363	65
000-408	4	372	63
000-409	4	364	62
000-410	4	364	64
000-411	4	379	67
000-412	4	366	77
000-413	4	380	70
000-414	4	365	73
000-415	4	377	46
000-416	4	367	67
000-417	4	370	67
000-418	4	380	69
000-419	4	373	64
000-420	4	365	53
000-421	4	371	81
000-422	3	280	66
000-423	4	368	64
000-424	1	91	64
000-425	3	261	67
000-426	2	170	73

Average Value = 67 mrem
Median Value = 67 mrem
Population Standard Deviation = 7 mrem

* Dose rate normalized to a 365 day year.

within the normal background exposure range typical of the northeastern part of the United States (NCRP, 1987). Note that the measurements recorded from the TLD program do not include exposure due to internally deposited radionuclides or inhaled radon progeny.

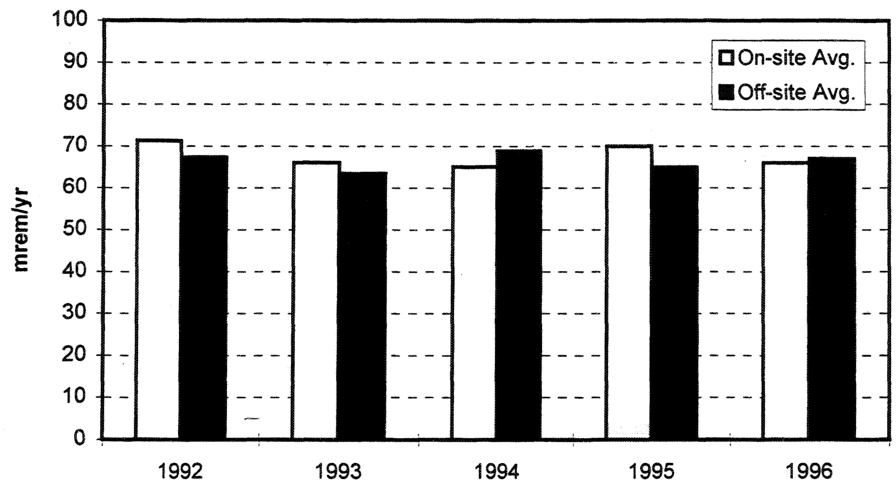


Figure 7-3 Environmental TLD measurements, 5 year trend.

7.3 Airborne Radiological Monitoring

As part of the environmental air monitoring program, six stations are in place around the BNL site which sample the air for (non-tritium) radioactive content. Glass fiber filter paper is used to capture airborne particulate matter and triethylene-diamine charcoal cartridges are used to collect radioiodines. Filter paper is collected weekly and analyzed for gross alpha and beta activity using a proportional counter and composited monthly for analysis of gamma-emitting radionulcides using a gamma spectroscopy system. Filter samples are analyzed for gross alpha and beta activity one week following collection to allow for the decay of short-lived radionuclides generated by atmospheric radon. This decay period prevents the activity measurement from being biased high by these natural products. Charcoal cartridges are collected monthly.

In addition to these samples, the NYSDOH receives duplicate filter samples which are collected at Station P7 in BNL Grid 090 (southeast boundary). These samples are also collected on a weekly basis and are analyzed by an independent NYSDOH Laboratory. Analysis results are reported annually in a document called "Environmental Radiation In New York State".

Table 7-2
BNL Site Environmental Report for Calendar Year 1996
Gross Activity Detected in Air Particulate Filters

Sample Station	Grid Location		Gross Alpha (pCi/m^3)	Gross Beta (pCi/m^3)
P2	017	N	52	52
		NBD	43	1
		Max.	0.006 ± 0.002	0.033 ± 0.003
		Avg.	0.001 ± 0.002	0.014 ± 0.025
P4	109	N	53	53
		NBD	48	3
		Max.	0.005 ± 0.001	0.038 ± 0.011
		Avg.	0.001 ± 0.002	0.014 ± 0.024
P7	090	N	51	51
		NBD	43	3
		Max.	0.011 ± 0.004	0.151 ± 0.013
		Avg.	0.002 ± 0.006	0.032 ± 0.086
P9	006	N	52	52
		NBD	43	1
		Max.	0.005 ± 0.001	0.027 ± 0.002
		Avg.	0.001 ± 0.001	0.012 ± 0.025
S5	038	N	53	53
		NBD	47	3
		Max.	0.005 ± 0.001	0.031 ± 0.009
		Avg.	0.001 ± 0.002	0.014 ± 0.025
S6	088	N	53	53
		NBD	45	2
		Max.	0.007 ± 0.002	0.034 ± 0.003
		Avg.	0.001 ± 0.002	0.013 ± 0.024

N = Number of samples collected.
NBD = Number of samples below detection limit.

Table 7-3
BNL Site Environmental Report for Calendar Year 1996
Gamma-Emitting Radionuclides Detected in Air Particulate Filters

Station (Grid)		Be-7	Bi-211	K-40	Ra-226	Rb-83	Rb-84
		(pCi/m^3)					
P2 (006)	Max.	1.730 ± 0.410	0.052 ± 0.034	0.017 ± 0.011	ND	ND	0.008 ± 0.003
	Avg.	0.202 ± 0.832	0.003 ± 0.026	0.003 ± 0.006			0.001 ± 0.004
	NTD	9	1	3	0	0	1
P4 (109)	Max.	0.193 ± 0.057	ND	0.016 ± 0.013	ND	ND	0.007 ± 0.003
	Avg.	0.106 ± 0.118		0.002 ± 0.010			0.001 ± 0.004
	NTD	8	0	1	0	0	1
P7 (090)	Max.	1.010 ± 0.223	ND	0.056 ± 0.051	ND	0.007 ± 0.002	0.007 ± 0.002
	Avg.	0.180 ± 0.574		0.005 ± 0.010		< 0.001	< 0.001
	NTD	9	0	3	0	1	1
P9 (006)	Max.	0.158 ± 0.035	ND	0.012 ± 0.012	ND	ND	ND
	Avg.	0.092 ± 0.108		0.001 ± 0.008			
	NTD	9	0	1	0	0	0
S5 (038)	Max.	0.169 ± 0.035	ND	0.008 ± 0.008	0.017 ± 0.016	ND	ND
	Avg.	0.083 ± 0.148		0.001 ± 0.006	0.001 ± 0.008		
	NTD	8	0	2	1	0	0
S6 (088)	Max.	0.218 ± 0.044	ND	0.011 ± 0.010	ND	ND	
	Avg.	0.121 ± 0.148		0.002 ± 0.008			
	NTD	7	0	2	0	0	0

Notes:

NTD = Number of times this radionuclide was detected at this location.
ND = Not Detected.

1. Maximum values reported with 2σ (95%) confidence interval.
2.. Average values calculated as arithmetic mean of individual measurements +/- 2 populationstandard deviations.
3. All station air filters collected once per week. Analysis for gamma-emitting radionuclides based on monthly composites of four weekly samples. Therefore, analysis for gamma-emitting radionuclides was performed 12 times during the year for each sample station.

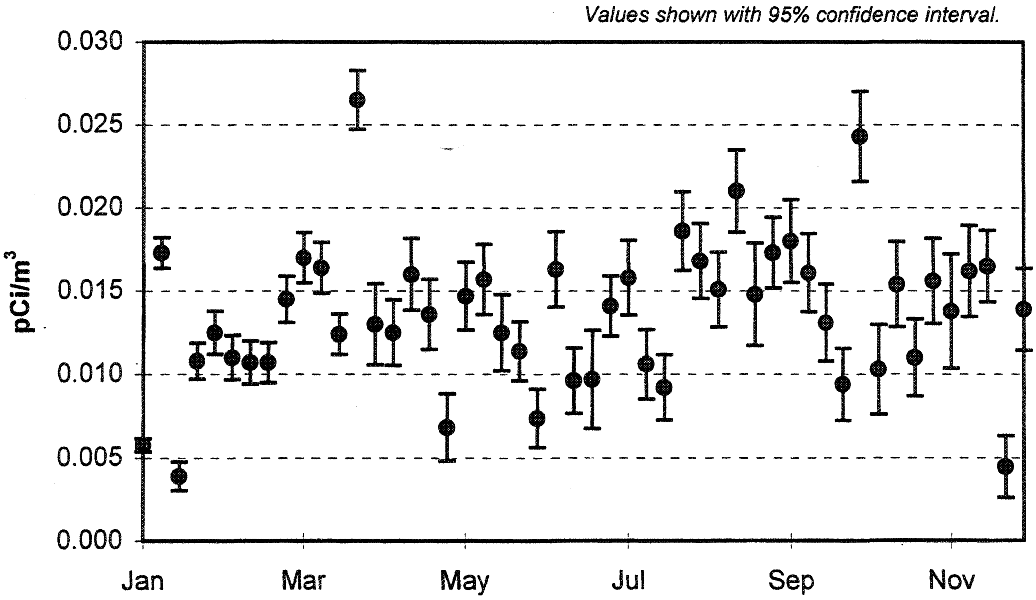


Figure 7-4 Air Particulate Gross Beta Values at Station P4, 1996.

Particulate filter analysis results are reported in Table 7-2 and 7-3. Annual average gross alpha activity measurements ranged from 0.001 to 0.002 pCi/m^3 (< 0.07 to 0.11 mBq/m^3), while gross beta results ranged from 0.012 to 0.032 pCi/m^3 (0.44 to 1.18 mBq/m^3). Typical gross beta activity results are plotted in Figure 7-4 for Station P4 (WSW sector), showing a seasonal variation of concentrations within a range representative of natural background. (Gross alpha activity is not plotted because the vast majority of results are below the analytical detection limit.) Measurable activity is primarily due to radionuclide decay products associated with natural uranium and thorium. As part of their state wide monitoring program, the NYSDOH collects air samples in Albany, NY, a control location uninfluenced by nuclear facilities (NYSDOH, 1993). The EPA also provides data of this nature on a national level as part of its Environmental Radiation Monitoring System (EPA, 1996). Data issued by both of these agencies indicate results similar to those obtained at BNL, demonstrating that radiological air quality is consistent with that observed across NY state and the nation.

With a few exceptions, gamma-emitting radionuclides were rarely detected in the monthly composite filter samples. The radionuclides most routinely observed were beryllium-7 and potassium-40. Beryllium-7 is a naturally-occurring nuclide produced in the earth's atmosphere via the bombardment of cosmic radiation, while potassium-40 is a primordial nuclide, present in the environment since the formation of the earth. Other naturally-occurring radionuclides detected on an infrequent basis (one or two times per year) include bismuth-211, and radium-226. These are all members of the natural uranium, thorium, or actinium decay chains. Other radionuclides detected at least once during the year include rhubidium-83, and rhubidium-84, all at levels far below the airborne DCGs and close to the detection limits of the system.

7.3.1 Airborne Tritium Monitoring

Airborne tritium in the form of tritiated water vapor (HTO) is monitored throughout the BNL site. Twenty monitors are located at or near the property boundary (see Figure 5-1). HTO is collected by using a pump that draws air through a column of silica gel. Silica gel is a water-absorbent medium which serves to retain moisture present in the atmosphere. The absorbed water is then recovered in the Analytical Services Laboratory and analyzed using liquid scintillation techniques.

Table 7-4 lists the number of samples collected at each location, the minimum value observed, the maximum value observed, and the annual average concentration. While each location showed a maximum value at some point in the year which was above the typical detection limit of about 4 pCi/m^3 (0.15 Bq/m^3), the vast majority of all sample results were below the detectable level. This demonstrates that there is no significant increase in ambient tritium concentrations beyond the site boundary as a result of Laboratory operations. With the exception of Location 006, all annual average concentrations were below the typical detection limit. The maximum concentration recorded in a single measurement occurred at the station located in BNL Grid 126, the Laboratory's southern boundary. The calculated airborne concentration was 47 pCi/m^3 (1.7 Bq/m^3). By comparison, the DOE (DCG) for tritium in air is 100,000 pCi/m^3 (3.7 kBq/m^3). The airborne DCG is the concentration of a radionuclide in air which, if inhaled at that level for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to the exposed individual. Only eight out of 47 samples collected at the Grid 126 station showed results above the MDL during 1996.

7.4 Precipitation Sampling

As part of the environmental monitoring program, precipitation samples are collected approximately once a month at Stations P4 and S5 (located in BNL Grids 109 and 038) and analyzed for radioactive content (see Table 7-5 and Figure 5-1). Gross alpha activity measurements for samples collected at both stations indicated average values below the typical minimum detection limit. Gross beta activity was occasionally measurable at levels at or slightly above typical MDLs, although gamma spectroscopy analysis confirms that the activity observed was due to terrestrial or cosmogenic radionuclides like potassium-40, bismuth-211, and thallium-208. Tritium values for the precipitation samples were near or below the minimum detection limit for all 24 samples, indicating that the Laboratory's airborne emissions have no impact on local rainwater or snowfall.

Table 7-4
BNL Site Environmental Report for Calendar Year 1997
Ambient Airborne Tritium Measurements

BNL Grid Location	Wind Sector	Samples Collected	Maximum (pCi/m^3)	Average (pCi/m^3)
006	NE	47	12.7 ± 2.2	2.3 ± 6.1
011	NNE	45	15.7 ± 2.3	0.7 ± 8.8
012	NNE	45	6.2 ± 2.0	0.8 ± 6.3
013	NE	7	< 4.1	0.6 ± 4.7
017	NNW	47	10.5 ± 1.6	1.1 ± 6.0
030	ENE	43	8.8 ± 2.5	0.2 ± 6.9
034	NNW	41	10.1 ± 2.1	0.6 ± 6.8
049	E	43	31.6 ± 4.4	0.4 ± 12.6
053	NW	43	20.5 ± 3.1	0.8 ± 10.4
063	W	47	16.0 ± 2.8	1.1 ± 8.6
066	E	46	46.0 ± 13.7	2.2 ± 15.5
075	SW	42	22.7 ± 2.7	6.1 ± 13.4
080	ESE	50	24.7 ± 2.9	0.2 ± 7.7
082	W	46	21.1 ± 3.5	0.5 ± 9.0
090	ESE	48	23.8 ± 2.8	1.9 ± 9.9
105	S	35	13.8 ± 2.0	1.0 ± 8.3
108	SE	49	33.0 ± 2.4	0.6 ± 15.8
109	WSW	50	44.9 ± 3.5	3.1 ± 16.5
111	SW	50	9.4 ± 2.4	0.4 ± 7.3
122	SSE	47	25.4 ± 2.8	0.6 ± 11.0
126	SSW	47	47.1 ± 4.9	1.5 ± 17.2
			Average =	2.7 ± 19.0

Notes:

1. Maximum values reported with 95% confidence interval.
2. Average values reported as arithmetic mean with +/- 2 population standard deviations.
3. Typical minimum detection limit = 4 pCi/m^3.

Table 7-5. Radiological Analysis of Precipitation, 1996.

Station	Grid	Compass Sector		Alpha	Beta (pCi/L)	Tritium
P4	017	WSW	Max.	3.0 ± 2.2	19.1 ± 6.1	< 288
			Avg.	0.7 ± 0.8	3.2 ± 9.7	< 377
			N	11	11	12
S5	038	ENE	Max.	1.3 ± 0.6	7.3 ± 1.3	< 328
			Avg.	0.4 ± 0.4	1.1 ± 8.2	< 377
			N	11	10	12

N = Number of samples collected.

7.5 Terrestrial and Ecological Radioactivity Studies

BNL maintains a soil and vegetation sampling plan for the site. This plan includes a semi-annual fauna sampling program which was initiated in 1992. In 1992 and 1993 samples were collected which included a wide variety of on-site species such as fox, raccoon, rabbit, skunk, opossum, and muskrat. On-site fauna sampling was again conducted in 1996, but was limited to the deer population. Similarly, an on-site soil and vegetation collection program was also initiated in 1993. This plan calls for sampling every four years, so on-site sampling was not conducted in 1996. However, as part of a cooperative effort between BNL and the SCDHS, vegetation, fruit and soil samples from farms in the vicinity of the Laboratory are collected annually.

7.5.1 Radiological Analysis of Deer

In 1996, an extensive off-site deer sampling program was initiated with the NYSDEC Wildlife Branch. In this program, licensed hunters were approached by the NYSDEC at check points for meat and liver samples. This program supplied samples from many off-site locations near the Laboratory and elsewhere on Long Island. Samples of deer from the BNL site were also analyzed for comparison. (All on-site samples were obtained from deer killed in automotive incidents.) Samples were analyzed for gamma-emitting radionuclides and strontium-90. Results are shown in Table 7-6. It is clear that the deer taken on BNL property contain cesium-137 concentrations at levels that are above those taken from off-site. (Strontium-90 analysis of the same samples indicate that there was no difference in concentration levels between on-site and off-site deer meat samples.) This is most likely the result of deer grazing in areas where elevated cesium-137 levels are known to exist in BNL soils. Cesium contained in these soils is available for transfer to above-ground plant matter via root uptake where it then becomes available for consumption.

Table 7-6
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Deer Flesh

Sample Location	Sample Type	K-40	Cs-137 (pCi/g, wet)	Sr-90
On-Site				
BNL, on-site	Deer, Hind	2.86 ± 0.57	1.01 ± 0.18	< 0.03
BNL, on-site	Deer, Liver	2.11 ± 0.41	0.65 ± 0.12	< 0.04
BNL, on-site	Deer, Hind	2.70 ± 0.44	5.14 ± 0.88	< 0.05
BNL, on-site	Deer, Hind	3.34 ± 0.56	6.66 ± 1.12	< 0.06
BNL, on-site	Deer, Liver	3.30 ± 0.91	2.53 ± 0.50	< 0.02
BNL, on-site	Deer, Liver	3.06 ± 0.92	2.11 ± 0.40	< 0.10
BNL, on-site	Deer, Liver	3.07 ± 0.65	1.56 ± 0.28	< 0.04
BNL, on-site	Deer, Hind	3.01 ± 0.51	5.61 ± 0.95	0.04 ± 0.01
BNL, on-site	Deer, Hind	3.68 ± 1.15	11.74 ± 2.27	< 0.03
BNL, on-site	Deer, Liver	2.45 ± 0.89	3.36 ± 0.88	< 0.03
Off-Site				
Yaphank	Deer, Liver	1.33 ± 0.37	0.44 ± 0.09	< 0.04
Southampton	Deer, Hind	2.41 ± 0.47	ND	< 0.02
East Hampton	Deer, Liver	3.00 ± 0.59	0.15 ± 0.04	(a)
Hubbard Park	Deer, Liver	2.62 ± 1.63	0.35 ± 0.14	< 0.02
Mattituck	Deer, Liver	3.77 ± 1.07	ND	< 0.02
North Sea	Deer, Hind	2.01 ± 0.38	ND	< 0.04
Watermill	Deer, Liver	2.14 ± 0.39	0.08 ± 0.02	< 0.02
Shelter Island	Deer, Liver	3.06 ± 0.76	0.10 ± 0.04	< 0.03
Shelter Island	Deer, Hind	2.25 ± 0.39	0.90 ± 0.16	< 0.03

ND = Not Detected.
(a) Sample not processed for this analyte.

The maximum and average concentration of cesium-137 detected in on-site deer samples was 12.3 and 5.8 pCi/g (0.5 and 0.2 Bq/g), respectively. The average ccesium-137 concentration seen in deer meat samples collected from nearby areas (not on BNL property) was 0.3 pCi/g (0.01 Bq/g).

7.5.2 Radiological Analysis of Vegetation

In July and October 1996, vegetation and soil samples were collected from farms surrounding BNL and locations further away from the Laboratory. These samples were analyzed by the BNL ASL for gamma-emitting radionuclides and Strontium-90. Results are shown in Table 7-7. No radionuclides attributable to Laboratory operations were detected. Cesium-137 and Strontium-90 detected in soil and vegetation samples are typical of levels due to fallout observed in the United States (Golchert and Kolzow 1994).

7.5.3 Radiological Analysis of Soils and Sediments

Soil and sediment samples were collected from the Peconic River, Peconic Bay, Flanders Bay, Lloyd Harbor, Carmans River, and Farms in the vicinity of the Laboratory. (Lloyd Harbor and the Carmans River were used as control locations.) These samples were analyzed for gamma-emitting radionuclides and strontium-90. Results are presented in Table 7-8. The data confirmed the presence of natural radionuclides such as potassium-40 and lead-212 at uniform levels in the marine and terrestrial environments sampled. Cesium-137, a globally distributed radionuclide, was detected in all sediment samples. Concentrations in sediments collected from the Peconic River system did not significantly differ from those collected at the control location of the Carmans River. Strontium-90 was not found above the detection limit in any sediment sample.

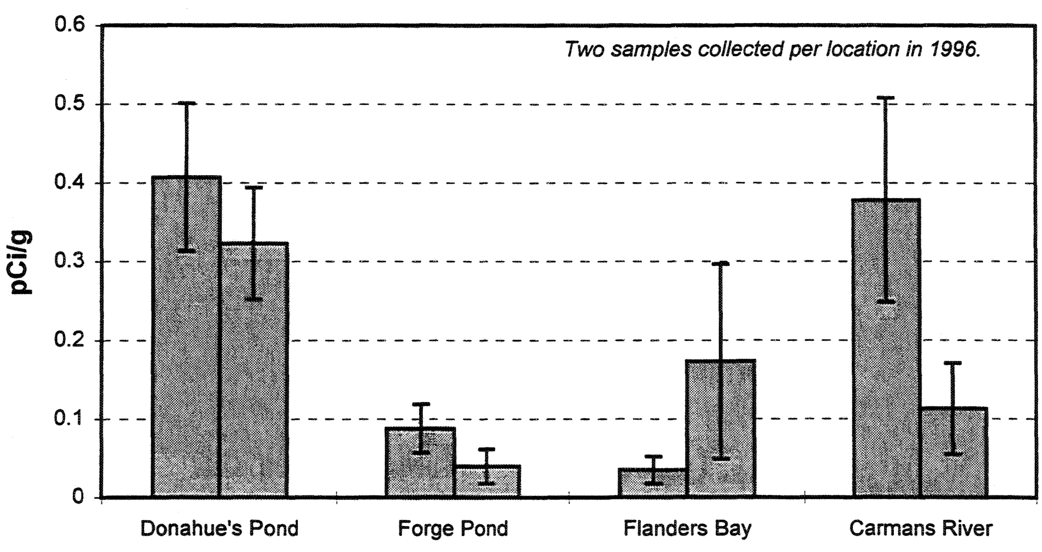


Figure 7-5 Comparison of Cesium-137 in local river sediments.

Table 7-7
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Vegetation Samples

Sample Location	Sample Date	Sample Type	K-40	Cs-137	Sr-90
			←	(pCi/g, wet)	→
Farm A	18-Jul-96	String Beans	2.50 ± 0.67	ND	0.015 ± 0.003
22.4 km (14 mi.)		Onion Leaves	3.18 ± 0.64	ND	0.017 ± 0.004
east-northeast of BNL site.		Carrot Leaves	6.59 ± 1.10	ND	0.040 ± 0.008
		Lettuce	2.34 ± 0.43	ND	0.012 ± 0.003
		Lettuce	2.90 ± 1.80	ND	(a)
		Zuchini	1.31 ± 0.66	ND	(a)
		Zuchini	1.62 ± 0.32	ND	0.007 ± 0.001
		Corn Husk	2.02 ± 0.44	ND	0.027 ± 0.010
		Corn Hull	2.42 ± 0.80	ND	0.033 ± 0.015
		Cabbage	2.99 ± 0.63	ND	(a)
		Cabbage	3.17 ± 0.56	ND	0.030 ± 0.006
		Cabbage	2.77 ± 0.50	ND	(a)
Farm B	25-Oct-96	Eggplant	3.16 ± 1.73	ND	(a)
~ 5 km (3 mi.)		Eggplant	2.86 ± 1.27	ND	< 0.015
east-southeast of BNL site.		Eggplant	2.82 ± 0.62	ND	(a)
		Eggplant	3.03 ± 0.56	ND	(a)
		Eggplant	3.64 ± 0.90	ND	(a)
Farm C	25-Oct-96	Corn Kernels	ND	ND	< 0.057
~ 6.4 km (4 mi.) southwest of BNL site.					
Lower Lake, Yaphank	29-Aug-96	Aquatic Vegetation	1.03 ± 0.20	0.014 ± 0.007	0.010 ± 0.005
Donahue's Pond	29-Aug-96	Aquatic Vegetation	0.66 ± 0.13	0.050 ± 0.011	0.020 ± 0.005

Note: *Detected strontium-90 concentrations reflect residual material present in soil/sediment due to global fallout.*

(a) Sample not analyzed for this analyte.

ND = Not Detected.

Table 7-8
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Soils and Sediments

Sample Location	Sample Date	Sample Type	Cs-137	Sr-90	K-40	Pb-212	Ra-226	Ac-228	Th-232
			(pCi/g, wet)						
Flander's Bay	12-Apr-96	Sediment	0.04 ± 0.02	< 0.007	5.36 ± 0.89	0.38 ± 0.05	ND	0.78 ± 0.11	0.42 ± 0.10
Flander's Bay	12-Apr-96	Sediment	0.17 ± 0.12	< 0.013	0.01 ± 0.003	0.72 ± 0.27	ND	ND	ND
Peconic River*	12-Apr-96	Sediment	ND	< 0.008	5.89 ± 1.52	0.65 ± 0.14	2.02 ± 1.28	ND	ND
Peconic River*	12-Apr-96	Sediment	0.06 ± 0.02	< 0.008	3.54 ± 0.64	0.36 ± 0.06	0.58 ± 0.30	0.46 ± 0.07	ND
Lloyd Harbor	1-Apr-96	Sediment	0.03 ± 0.02	< 0.015	7.74 ± 1.30	0.41 ± 0.07	1.19 ± 0.55	0.41 ± 0.07	ND
Northport Bay	1-Apr-96	Sediment	0.02 ± 0.01	< 0.010	2.08 ± 0.38	0.18 ± 0.03	ND	0.20 ± 0.04	0.24 ± 0.08
Northport Bay	1-Apr-96	Sediment	0.03 ± 0.01	< 0.012	0.00 ± 0.00	0.15 ± 0.03	0.25 ± 0.19	0.15 ± 0.03	1.14 ± 0.06
Carmans River	26-Apr-96	Sediment	0.38 ± 0.13	< 0.020	2.93 ± 1.18	4.77 ± 2.40	ND	ND	ND
Carmans River	26-Apr-96	Sediment	0.11 ± 0.06	< 0.020	1.77 ± 0.84	0.21 ± 0.09	ND	ND	ND
Donahue's Pond	23-Apr-96	Sediment	0.41 ± 0.09	< 0.019	1.53 ± 0.69	0.21 ± 0.06	ND	ND	ND
Donahue's Pond	23-Apr-96	Sediment	0.32 ± 0.07	< 0.010	1.03 ± 0.34	0.19 ± 0.04	ND	ND	ND
Forge Pond	24-Apr-96	Sediment	0.09 ± 0.03	< 0.024	2.71 ± 0.54	0.43 ± 0.07	ND	0.47 ± 0.08	0.63 ± 0.16
Forge Pond	24-Apr-96	Sediment	0.04 ± 0.02	< 0.024	2.46 ± 0.49	0.66 ± 0.10	0.98 ± 0.52	0.65 ± 0.09	0.56 ± 0.16
NYS Game Farm	16-Jul-96	Soil	0.28 ± 0.06	< 0.035	3.98 ± 0.78	0.63 ± 0.11	1.02 ± 0.65	0.76 ± 0.12	0.68 ± 0.20
Farm C	18-Jul-96	Soil	ND	< 0.046	5.94 ± 1.52	0.70 ± 0.15	1.60 ± 1.05	0.94 ± 0.24	0.82 ± 0.42
Farm B	25-Oct-96	Soil	0.38 ± 0.15	< 0.044	7.95 ± 2.14	1.45 ± 0.35	3.45 ± 2.89	ND	ND
Farm B	25-Oct-96	Soil	ND	< 0.044	7.10 ± 2.32	0.90 ± 0.25	ND	ND	ND
Farm B	25-Oct-96	Soil	0.22 ± 0.06	< 0.035	6.37 ± 1.18	0.87 ± 0.13	2.10 ± 0.93	0.88 ± 0.13	0.92 ± 0.27
Farm A	18-Jul-96	Soil	0.16 ± 0.08	< 0.047	7.78 ± 1.55	1.12 ± 0.18	ND	1.16 ± 0.18	1.23 ± 0.37

ND= Not Detected, * Samples collected at the mouth of the River.

Table 7-9. Radionuclides in on-site Peconic sediments, OU V results.

Location ID	BNL Grid	Am-241	Co-60	Cs-137	Sr-90
		◄	(pCi/g)		►
AOC4-PR03-SD01	39	0.73	ND	0.62	ND
AOC4-PR04-SD01	40	ND	ND	2.49	ND
AOC4-PR07-SD01	49	ND	ND	8.27	3.91
AOC4-PR09-SD01	49	1.57	0.43	11.2	ND
AOC4-PR11-SD01	61	ND	0.49	13.6	ND

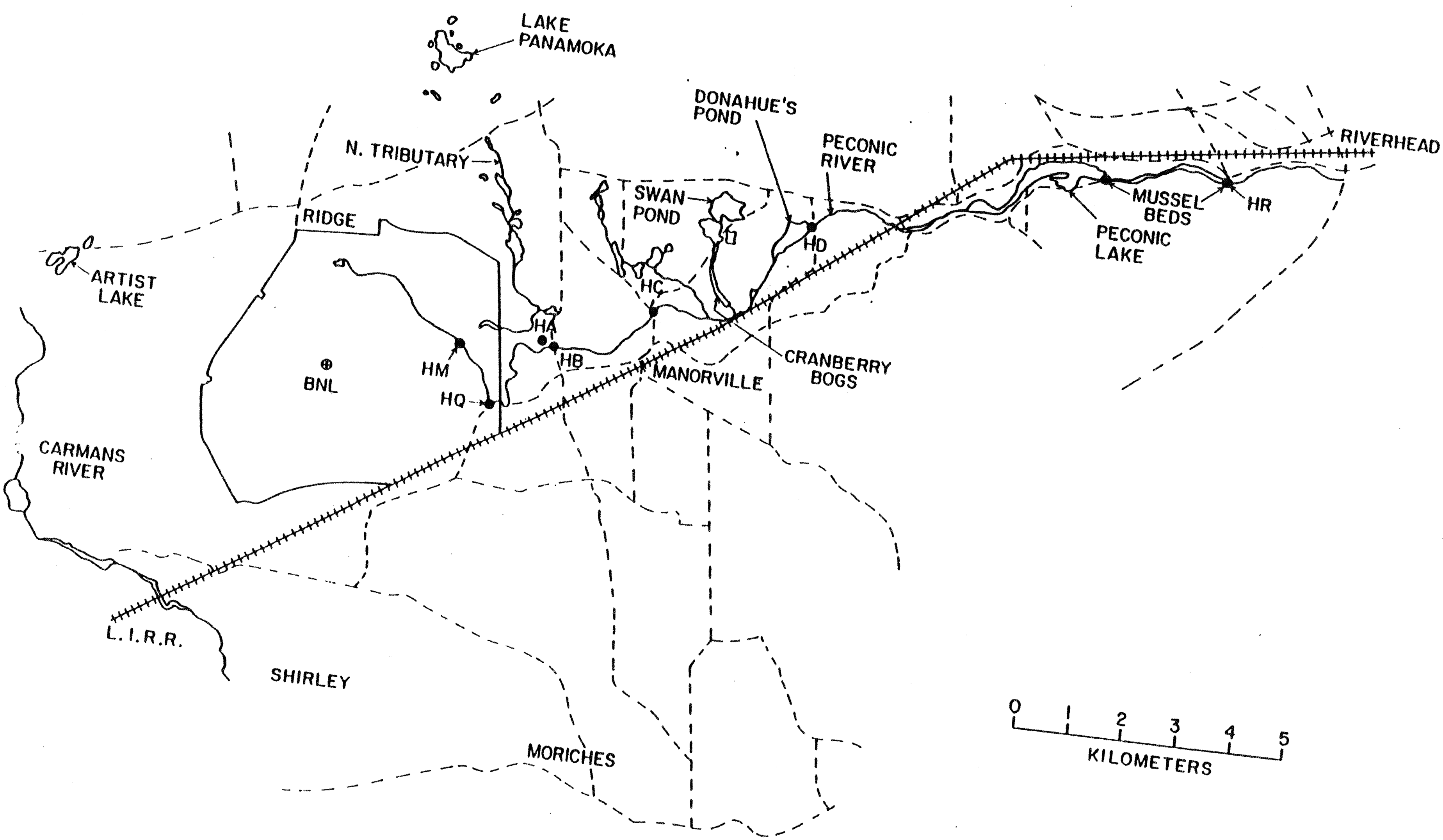
ND = Not Detected. Confidence Intervals not included in report.

The 1996 report issued by the New York State Department of Health (see Section 7.8.2) reported similar analytical results for Donahue's Pond and Forge Pond, though they collected additional samples from the Peconic River in the Manorville area. For sediment samples collected in March of 1996, they reported the detection of americium-241 (0.05 ± 0.009 pCi/g), cobalt-60 (0.009 ± 0.004 pCi/g), and cesium-137 (0.28 ± 0.02 pCi/g). This data suggests that radionuclides originating with past BNL discharges to the Peconic River are detectable only in the area immediately downstream of the BNL Sewage Treatment Plant. Sediment samples from portions of the Peconic River which are on BNL property were collected in 1995 in support of the Operable Unit V Remedial Investigation. Analysis of these samples also confirms the presence of low levels of cobalt-60, cesium-137, americium-241 (strontium-90 was also detected) at concentrations greater than those reported in Manorville by the NYSDOH (see Table 7-9 for selected results). The data demonstrates a pattern consistent with downstream dilution.

7.6 Peconic River Surveillance - Non-radiological Analyses

The Peconic River was sampled at six locations during 1996; three on-site (Sampling Locations HMn, HMs and HQ) and four off-site (Sampling Locations HA, HB, HC, and HR). In addition, the Carmans River was also sampled (Location HH) as an off-site control location. These samples were analyzed for water quality parameters (i.e., pH, temperature, conductivity, and dissolved oxygen), anions (i.e., chlorides, sulfates, and nitrates), metals, and VOCs routinely during 1996.

A summary of water quality and metals analytical data for these surface waters is given in Tables 7-10 and 7-11, respectively. Location HMn which is located downstream of the BNL STP has characteristics very similar to the STP discharge. All water quality and metal parameters, were well within the BNL SPDES effluent standards and/or NYS AWQS for a Class C water system. Location HQ, which is located at the site boundary, also had similar characteristics to the STP discharge. The pH, however, at location HQ was typically lower than that recorded at the STP and HMn most probably due to groundwater contributions and rainwater run-off. Location HMs a typically a dry tributary of the Peconic River which flows parallel to Station HMn, experienced flow during 1996 due to significantly higher rates of precipitation during later periods



Peconic River Sampling Stations.

Figure 7-6

Table 7-10
BNL Site Environmental Report for Calendar Year 1996
Water Quality Data for Surface Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location (a)		pH SU	Conductivity umhos/cm	Temperature C	Dissolved Oxygen mg/L	Chlorides mg/L	Sulfates mg/L	Nitrates as N mg/L
Peconic (On-site)	HMn	N	151	151	151	151	24	24	24
		Minimum	6	109	0.9	4.7	27.3	12.2	< 1.0
		Maximum	7.3	340	24.8	13	46	18.4	6.2
	HMs	N	3	3	3	0	3	3	3
		Minimum	3.5	67	5.1	NA	4	< 4.0	< 1.0
		Maximum	4.1	92	9.8	NA	7.3	< 4.0	< 1.0
		Average	NA	82.7	8	NA	5.9	< 4.0	< 1.0
	HQ	N	14	14	14	14	5	5	5
		Minimum	5.4	71	1.8	5.4	11.1	5.7	< 1.0
		Maximum	7.2	216	16.3	13.5	27.7	11.4	< 1.0
Peconic (Off-site)	HA	N	4	4	4	0	4	4	4
		Minimum	4.8	53	6.2	NA	6.4	< 4.0	< 1.0
		Maximum	5.8	87	20.2	NA	8.6	20.4	< 1.0
		Average	NA	67	12.9	NA	7.3	10.2	< 1.0
	HB	N	4	4	4	0	4	4	4
		Minimum	5	51	6.3	NA	8.3	< 4.0	< 1.0
		Maximum	6.2	82	23	NA	8.7	17.2	< 1.0
		Average	NA	68	14.8	NA	8.5	5.8	< 1.0
	HC	N	4	4	4	0	4	4	4
		Minimum	5.5	57	5.8	NA	9.2	< 4.0	< 1.0
		Maximum	6.5	80	27.2	NA	11.7	15.1	< 1.0
		Average	NA	70	16.5	NA	10.2	6.7	< 1.0
	HR	N	6	6	6	0	6	6	6
		Minimum	6.1	83	2.8	NA	12.7	8.9	<1.0
		Maximum	7.1	124	27	NA	21.2	16.4	<1.0
		Average	NA	107	12.6	NA	16.2	12.1	<1.0
Carmans	HH	N	4	4	4	0	4	4	4
		Minimum	6.6	154	8.1	NA	24.7	10	<1.0
		Maximum	6.9	160	22.2	NA	26.3	11.3	1.5
		Average	NA	156	13.9	NA	25.2	10.5	1.0'
NYS AWQS (b)			.5 - 8.	(c)	(c)	(c)	250	250	10
	Typical MDL		NA	10	NA	NA	4	4	1

N: No. of samples
NA: Not Applicable
MDL: Minimum Detection Limit
(a): The Peconic and Carmans Rivers sample locations are shown on Figure 7-4.
(b): AWQS: Since there are no Class C Surface Water Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for Ground Water is provided, if specified.
(c): No AWQS specified.

Table 7-11
BNL Site Environmental Report for Calendar Year 1996
Metals Concentration Data for Surface Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location (a)		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
Peconic	HMn	N	12	12	12	12	12	5	12	12	12	12
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.09	<0.0002	<0.05	26.4	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	0.058	0.22	0.0004	< 0.05	39.4	0.007	0.029
		Average	<0.025	<0.0005	<0.005	<0.05	0.16	<0.0002	<0.05	34.1	<0.002	< 0.02
	HMs	N	3	3	3	3	3	1	3	3	3	3
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.2	<0.0002	<0.05	3.1	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	< 0.05	0.55	<0.0002	< 0.05	3.9	0.004	0.04
		Average	<0.025	<0.0005	<0.005	<0.05	0.36	<0.0002	<0.05	3.6	<0.002	0.022
	HQ	N	2	2	2	2	2	0	2	2	2	2
		Minimum	< 0.025	<0.0005	<0.005	<0.05	< 0.075	NA	<0.05	22.7	<0.002	0.036
		Maximum	0.025	0.0006	<0.005	< 0.05	< 0.075	NA	< 0.05	31.3	< 0.002	0.059
		Average	<0.025	<0.0005	<0.005	<0.05	< 0.075	NA	<0.05	27	<0.002	0.048
	HA	N	4	4	4	4	4	4	4	4	4	4
		Minimum	< 0.025	< 0.0005	< 0.005	< 0.05	0.43	< 0.0002	0.054	4.3	< 0.002	0.022
		Maximum	< 0.025	< 0.0005	< 0.005	< 0.05	3.7	< 0.0002	0.13	5.8	< 0.002	0.034
		Average	< 0.025	<0.0005	<0.005	<0.05	1.4	<0.0002	0.09	5.2	<0.002	0.028
	HB	N	4	4	4	4	4	4	4	4	4	4
		Minimum	< 0.025	< 0.0005	< 0.005	< 0.05	< 0.075	< 0.0002	0.069	5.5	< 0.002	< 0.02
		Maximum	< 0.025	< 0.0005	< 0.005	< 0.05	9	< 0.0002	0.17	6.1	< 0.002	0.029
		Average	< 0.025	<0.0005	<0.005	<0.05	3.7	<0.0002	0.11	5.8	<0.002	< 0.02
	HC	N	4	4	4	4	4	4	4	4	4	4
		Minimum	< 0.025	< 0.0005	< 0.005	< 0.05	0.36	< 0.0002	0.09	5.9	< 0.002	< 0.02
		Maximum	< 0.025	< 0.0005	< 0.005	< 0.05	3.2	< 0.0002	0.16	6.9	< 0.002	0.045
		Average	< 0.025	<0.0005	<0.005	<0.05	1.8	<0.0002	0.13	6.5	<0.002	< 0.02
	HR	N	6	6	6	6	6	6	6	6	6	6
		Minimum	< 0.025	< 0.0005	< 0.005	< 0.05	0.38	< 0.0002	0.07	8.2	< 0.002	< 0.02
		Maximum	< 0.025	< 0.0005	< 0.005	< 0.05	1.5	< 0.0002	0.27	17.1	0.003	0.054
		Average	< 0.025	<0.0005	<0.005	<0.05	0.82	<0.0002	0.15	16.6	<0.002	< 0.02
Carmans	HH	N	4	4	4	4	4	4	4	4	4	4
		Minimum	< 0.025	< 0.0005	< 0.005	< 0.05	0.3	< 0.0002	0.055	15.9	< 0.002	< 0.02
		Maximum	< 0.025	< 0.0005	< 0.005	< 0.05	1	< 0.0002	0.33	17.1	< 0.002	0.045
		Average	< 0.025	<0.0005	<0.005	<0.05	0.56	<0.0002	0.14	16.6	<0.002	< 0.02
NYSDEC SPDES Limit or AWQS			0.015	0.001	0.09	0.15	0.37	0.0002	(b)	(b)	0.019	0.1
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

N: No. of samples
AWQS: Ambient Water Quality Standard for Class C Surface Water
MDL: Minimum Detection Limit
(a): The Peconic and Carmans River sample locations are shown on Figure 7-4.
(b): There are no SPDES limits or AWQS specified for these compounds.

of the year. This discharge has been characterized by very low pH, low inorganics and water quality parameters. As this discharge is comprised of predominantly storm water with some groundwater exfiltration, the low pH is explained by contributions of natural products (i.e., tannic acid from decay of leaves) and the low pH of groundwater and storm water.

Locations HA, HB, HC, and HR are at various points along the Peconic River, off-site and down stream of BNL. Again, with the exception of pH, all water quality parameters are consistent with the NYS AWQS, off-site control location, and/or with historical data. The low pH values recorded at the river stations may be attributed to the natural low pH of groundwater and storm water. All metal parameters were consistent with historical data and the background Carmans River Station. All concentrations of metals, except iron, were well below the SPDES effluent limitations established by the NYSDEC for discharges to the Peconic River and/or NYS AWQS. Iron was above the SPDES limits at all off-site locations, most probably due to the naturally high concentrations of iron in groundwater and native sediments.

During 1996, all surface waters were analyzed for VOC contamination by the S&EP Division analytical Laboratory. With the exception of low concentrations (i.e., 3 ug/L or less) of chloroform detected at location HMn and HMs, no VOCs were detected above the Laboratory detection limit of 2 ug/L in samples from the Peconic or Carmans River stations. Trace (i.e., < 1 ug/L) concentrations of TCA and benzene were detected at river stations HR and HH. Due the location of these facilities, the presence of these contaminants cannot be attributed to BNL operations. The low level detection of TCA and benzene at these locations has been witnessed for several years prior to 1996.

7.7 Peconic River Surveillance - Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at seven locations: Station HMn, 790 meters downstream of the STP Outfall; Station HMs, a typically dry tributary of the Peconic River running parallel to the point of STP Outfall, Station HQ, 2.1 km downstream from the STP; Location HA and HB, 5 km downstream; Location HC, 7 km downstream; and Location HR in Riverhead, 21 km downstream from the STP Outfall. The Carmans River (Location HH) in North Shirley, was also sampled as a control location, not influenced by BNL liquid effluents. Sampling points along the Peconic River are identified in Figure 7-6. Routine samples at Location HM were collected three times per week. (Since February 1995, this location has been equipped with a Parshall flume allowing flow proportional sampling and volume measurements to be made by an automated system.) All other sites were grab sampled either as flow allowed (in the case of HMs and HQ), or quarterly (HMs, HA, HB, HC, HH). HR was sampled seven times during the year.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Table 7-12. Average gross beta activity at Station HMn was close to the minimum detection limit, and consistent with levels observed at the Carmans River control location. Cesium-137 levels were slightly higher closer to the STP Outfall, though close to the limit of detection. Cesium-137 levels observed at Station HMn are consistent with those measured at the STP Outfall (see Section 6.2.1.1). These levels are small fractions of the applicable DCGs.

Table 7-12
BNL Site Environmental Report for Calendar Year 1996
Gross Activity and Tritium Analysis of the Peconic River

Sample Station	Geographic Location		Alpha	Beta (pCi/L)	Tritium
HMn*	Peconic River,	N	152	151	152
	0.7 km from STP	Max.	3.8 ± 2.0	11.8 ± 5.5	3,920 ± 408
	On-Site	Avg.	0.6 ± 2.8	2.5 ± 6.5	1,227 ± 1,160
HQ*	Peconic River,	N	16	16	16
	BNL Site	Max.	2.3 ± 2.2	7.6 ± 5.4	1,520 ± 345
	Boundary	Avg.	0.5 ± 2.0	2.8 ± 5.2	482 ± 749
		Collect Date			
HMs	Peconic River	17-Apr-96	< 0.6	< 5.2	< 334
	Tributary	3-Dec-96	< 4.0	< 7.6	< 377
	On-Site	17-Dec-96	< 3.5	< 8.2	< 578
HA	Peconic River	21-Mar-96	< 0.1	1.9 ± 1.0	< 341
	Off-Site	12-Jun-96	< 0.1	2.0 ± 1.1	< 421
		19-Sep-96	< 2.7	< 7.5	< 379
		13-Dec-96	< 3.5	< 8.2	< 578
HB	Peconic River	21-Mar-96	< 0.6	1.0 ± 1.5	< 341
	Off-Site	12-Jun-96	< 0.6	1.2 ± 1.6	< 421
		9-Sep-96	< 2.1	< 8.2	< 379
		13-Dec-96	< 3.5	< 8.2	< 578
HC	Peconic River	21-Mar-96	< 0.6	2.4 ± 1.0	< 341
	Off-Site	12-Jun-96	1.9 ± 0.6	3.1 ± 1.1	< 421
		9-Sep-96	< 2.1	< 8.2	406 ± 241
		13-Dec-96	< 3.5	< 8.2	< 578
HR	Peconic River,	16-Jan-96	< 0.7	3.4 ± 1.1	< 412
	Riverhead	13-Feb-96	0.7 ± 0.3	2.8 ± 1.0	< 405
		21-Mar-96	< 0.6	2.9 ± 1.1	< 341
		12-Apr-96	< 0.8	< 2.4	< 362
		11-Jun-96	< 0.5	2.3 ± 1.0	< 392
		9-Sep-96	0.5 ± 0.3	1.8 ± 1.1	< 379
		13-Dec-96	< 3.5	< 8.2	< 578
HH	Carmans River	21-Mar-96	< 0.6	(a)	< 341
	(Control Location)	11-Jun-96	< 0.5	1.5 ± 1.0	< 392
		9-Sep-96	1.0 ± 0.4	< 1.6	502 ± 247
		13-Dec-96	< 0.7	2.0 ± 1.1	< 578
SDWA Limit			15	50 (screening)	20,000

* Due to the large number of individual samples, the data for these locations has been summarized.
(a) Analysis voided based on QA review.
N = Number of samples analyzed.

Table 7-13
BNL Site Environmental Report for Calendar Year 1996
Gamma-Emitting Radionuclides and Sr-90 Analysis of Peconic River

Sample Station	Geographic Location	Collect Date	Be-7	Cs-137	K-40 (pCi/L)	Na-22	Sr-90
HMn	Peconic River,	29-Feb-96	ND	0.83 ± 0.15	2.91 ± 0.85	0.10 ± 0.04	0.41 ± 0.05
	0.7 km from STP	31-May-96	ND	0.55 ± 0.13	3.50 ± 0.80	0.18 ± 0.10	0.74 ± 0.06
	On-Site	31-Aug-96	ND	1.00 ± 0.18	3.71 ± 0.81	0.24 ± 0.10	0.34 ± 0.21
		31-Dec-96	ND	0.89 ± 0.16	2.85 ± 0.71	0.24 ± 0.06	4.63 ± 1.23
HMs	Peconic River,	17-Apr-96	ND	ND	ND	ND	NS
	Tributary, On-Site	3-Dec-96	ND	0.17 ± 0.14	ND	ND	NS
HQ	Peconic River,	31-May-96	ND	2.18 ± 0.59	7.26 ± 5.92	ND	NS
	BNL Site	6-Dec-96	6.90 ± 3.18	1.47 ± 0.35	ND	0.32 ± 0.15	NS
	Boundary	31-Dec-96	ND	ND	14.50 ± 5.62	ND	0.84 ± 0.69
HA	Peconic River	21-Mar-96	ND	0.91 ± 0.46	ND	ND	0.49 ± 0.09
	Off-Site	12-Jun-96	ND	0.24 ± 0.21	ND	ND	0.19 ± 0.14
		19-Sep-96	ND	0.32 ± 0.16	1.99 ± 1.65	ND	0.25 ± 0.11
		13-Dec-96	ND	0.23 ± 0.19	2.44 ± 2.39	ND	NS
HB	Peconic River	21-Mar-96	ND	ND	ND	ND	0.41 ± 0.09
	Off-Site	12-Jun-96	ND	0.24 ± 0.13	ND	ND	< 0.19
		9-Sep-96	ND	ND	ND	ND	< 0.47
		13-Dec-96	ND	ND	3.29 ± 2.62	ND	NS
HC	Peconic River	21-Mar-96	ND	ND	ND	ND	0.38 ± 0.11
	Off-Site	12-Jun-96	ND	0.25 ± 0.12	ND	ND	< 0.22
		9-Sep-96	ND	0.15 ± 0.11	2.76 ± 1.79	ND	0.60 ± 0.27
		13-Dec-96	ND	ND	ND	ND	NS
HR	Peconic River,	16-Jan-96	ND	ND	ND	ND	< 0.31
	Riverhead	13-Feb-96	ND	ND	ND	ND	0.25 ± 0.14
		21-Mar-96	ND	ND	ND	ND	NS
		12-Apr-96	ND	ND	ND	ND	0.16 ± 0.13
		11-Jun-96	ND	ND	2.45 ± 1.86	ND	0.39 ± 0.16
		9-Sep-96	ND	ND	ND	ND	< 0.33
		13-Dec-96	ND	ND	2.28 ± 1.89	ND	NS
HH	Carmans River	21-Mar-96	ND	ND	ND	ND	< 0.1
	(Control Location)	11-Jun-96	ND	ND	ND	ND	< 0.1
		9-Sep-96	ND	ND	ND	ND	< 0.1
		13-Dec-96	ND	ND	ND	ND	< 0.4
DOE Order 5400.5 DCG			1,000,000	3,000	7,000	10,000	8(a)

Notes:
1. Values reported with 2σ (95%) confidence interval.
2. ND = Not Detected.
3. NS = Not sampled for this analyte.
4. DCG = Derived Concentration Guide, the concentration of a radionuclide would produce an individual dose of 100 mrem if ingested at a rate of 2 liters per day for for one year.

(a) Safe Drinking Water Act limit shown.

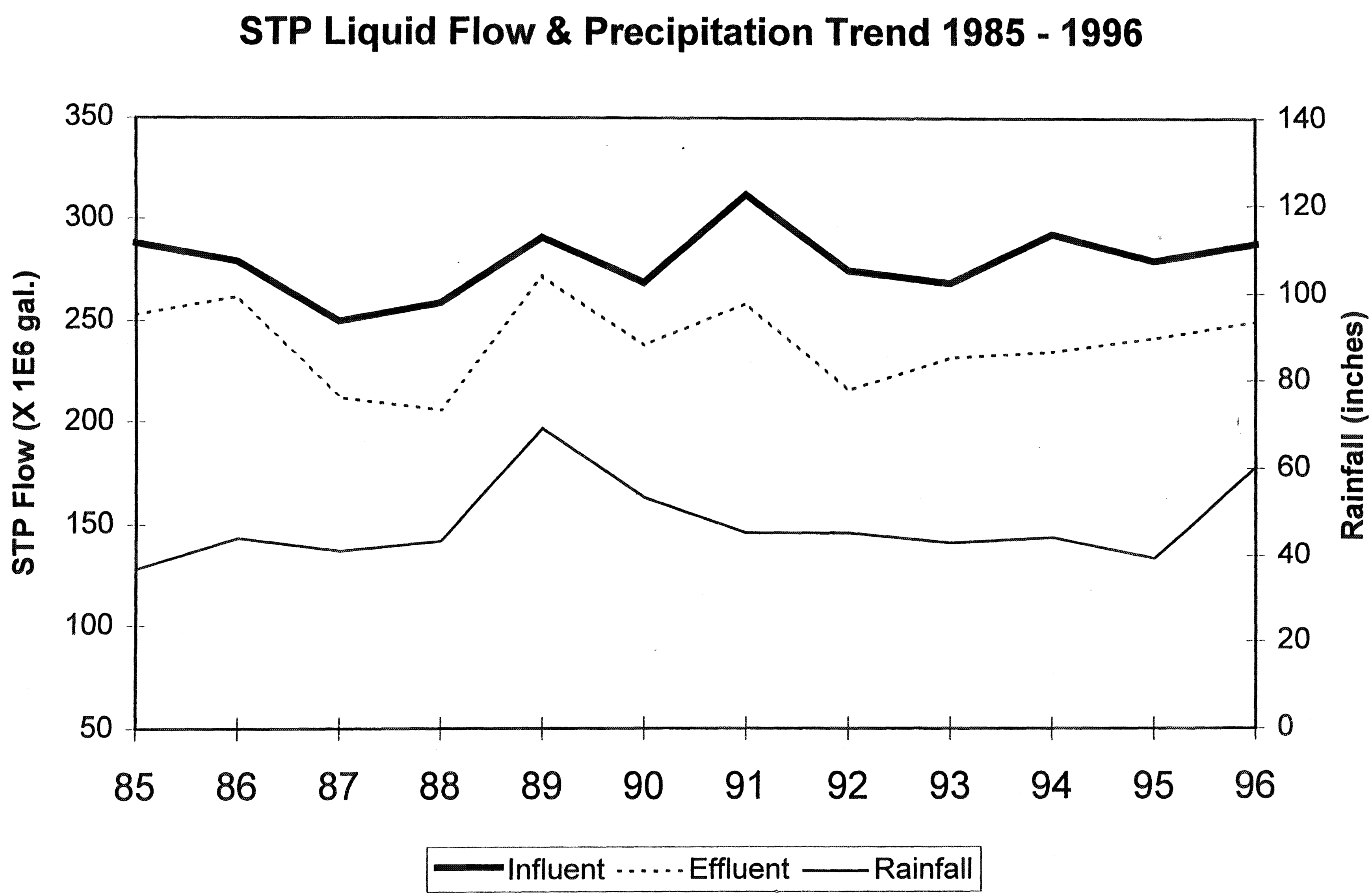

STP Liquid Flow & Precipitation Trend 1985 - 1996
STP Flow (X 1E6 gal.)
350
300
250
200
150
100
50
Rainfall (inches)
140
120
100
80
60
40
20
0
85
86
87
88
89
90
91
92
93
94
95
96
Influent
Effluent
Rainfall

Figure 7-7

Samples at Station HQ were collected whenever flow conditions permitted. Collection occurred in April, May, June and December of 1996 for tritium and gross activity analysis. Gamma spectroscopy analysis was performed on samples collected in May and December. Tritium, the most significant indicator of BNL discharges was detectable at both on-site stations, HMn and HQ. However, due to continued on-site recharge of the Peconic, no tritium was observed downstream beyond these stations. Figure 7-7 provides a ten year review of liquid discharge volumes to the Peconic River and flow estimates for the Peconic River on-site. The data indicate that there has been no measurable flow at the site boundary since 1983. Between 1985 and 1996, water levels at Station HQ have been below the conduit which transports water from the BNL site to the weir at Station HQ.

In Peconic River samples collected at Riverhead (Location HR), gross alpha and gross beta activity values were indicative of background levels (NYSDOH, 1993). No man-made gamma-emitting radionuclides were detected.

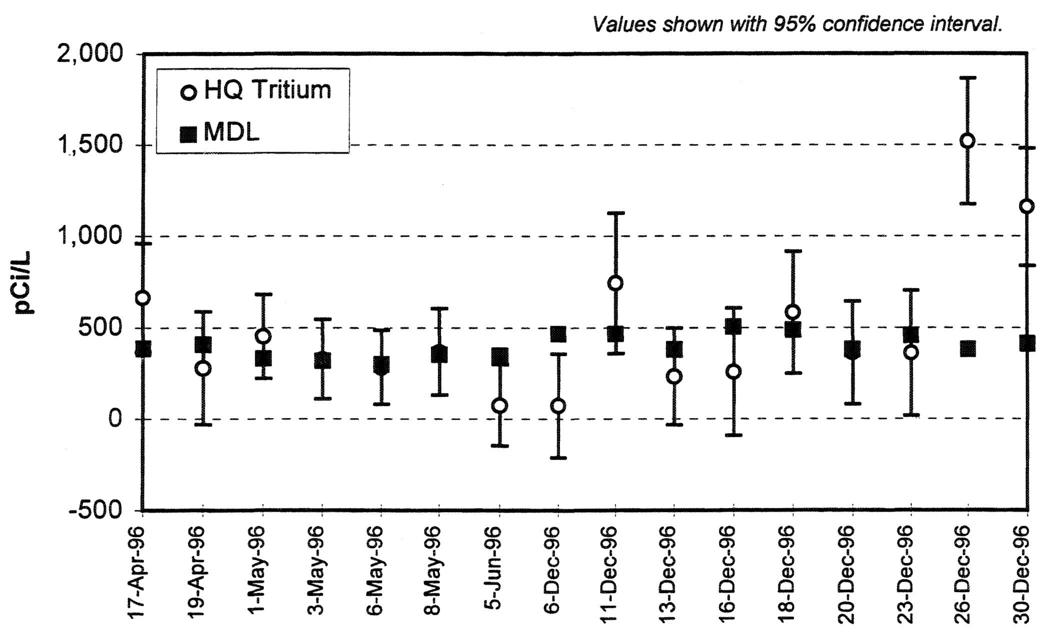


Figure 7-8 Tritium values in the Peconic River at the BNL Site Boundary (Station HQ).

7.8 Aquatic Biological Surveillance

7.8.1 Radiological Analysis of Local Fish

The Laboratory, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies. The program was significantly expanded in 1996 to include a greater number of sampling location,

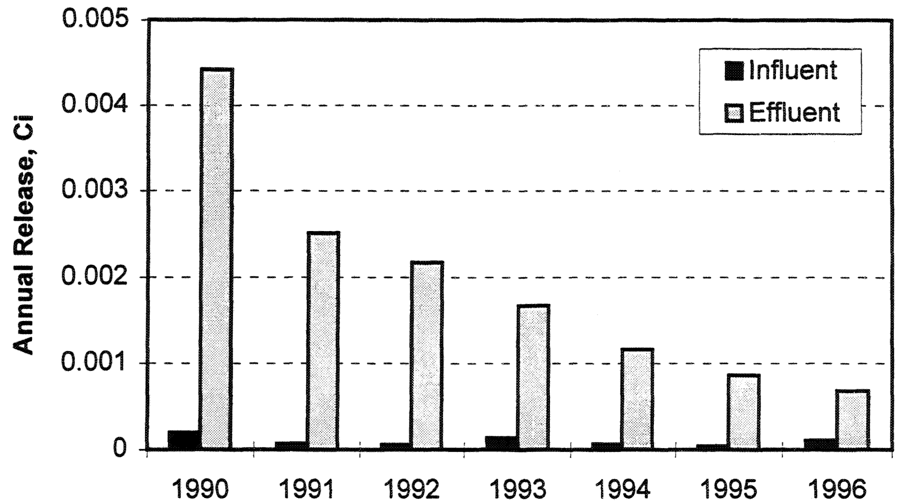


Figure 7-9 Cesium-137 trend in STP influent and effluent.

types of fish caught and analyses performed. Fish samples were collected at Donahue's Pond, Forge Pond, Swan Pond, Upper Twin Pond (Wantagh), Fresh Pond (Montauk), and the Carmans River (see Figure 7-6). Upper Twin Pond, Fresh Pond and the Carmans River are not connected to the Peconic River system and are, therefore, used as control locations to indicate environmental background conditions. Brown Bullhead (*Ictalurus nebulosus*), Golden Shiner (*Notemigonus crysoleucas*), Chain Pickerel (*Esox niger*), Large Mouth Bass (*Micropterus salmoides*), Blue Gill (*Lepomis macrochirus*) and Yellow Perch (*Perca flavescens*) species were collected. Gamma spectroscopy and strontium-90 analysis was performed on these samples. Specific information regarding the sampling point, species collected and analytical results are presented in Table 7-14

Fish analyses were performed separately on the flesh and skin, the viscera and bones, and the whole fish. Segregating the analyses in this way provides important information regarding the localization of radionuclides in certain parts of the fish Segregated analysis also allows more realistic dose calculations to be performed, e.g., strontium-90 behaves biologically as calcium and localizes in bone. However, bones are usually discarded when fish are eaten, eliminating the most significant source of strontium and reducing the potential dose due to consumption.

Cesium-137 and strontium-90 are detectable throughout the environment of the northern hemisphere as a result of global fallout. This is most evident when examining analysis results from the control locations of Fresh Pond in Montauk, Swan Pond and the Carmans River. This must be considered when attempting to distinguish BNL-related radionuclide levels from existing environmental levels. Previous studies which used only Swan Pond and the Carmans River as control locations have found that fish from the Peconic River system contained elevated levels

Table 7-14
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Fish

Sample Loaction and Fish Type	K-40	Cs-137 (pCi/g, wet)	Sr-90
Fresh Pond, Montauk*			
Brown Bullhead (whole fish)	2.30 ± 0.77	0.27 ± 0.07	0.62 ± 0.04
Brown Bullhead (flesh and skin)	4.06 ± 2.54	0.66 ± 0.24	0.11 ± 0.01
Brown Bullhead (viscera and bones)	1.65 ± 1.18	0.28 ± 0.10	1.10 ± 0.06
Bluegill - whole fish	2.66 ± 0.64	0.56 ± 0.11	0.90 ± 0.05
Bluegill (viscera and bones)	2.90 ± 0.78	0.45 ± 0.10	1.78 ± 0.08
Bluegill (flesh and skin)	4.28 ± 1.54	0.69 ± 0.17	0.40 ± 0.02
Upper Twin Pond, Wantagh*			
Rainbow trout (flesh and skin)	3.21 ± 0.62	0.03 ± 0.02	0.38 ± 0.02
Rainbow trout (viscera and bones)	1.34 ± 1.27	ND	0.06 ± 0.03
Carp (whole)	5.14 ± 3.57	ND	(a)
Bluegill (whole fish)	2.33 ± 0.59	ND	0.05 ± 0.02
Bluegill (viscera and bones)	2.00 ± 0.55	ND	0.17 ± 0.04
Bluegill (flesh and skin)	3.46 ± 0.79	ND	0.05 ± 0.01
Donahue's Pond			
Bluegill (whole fish)	2.59 ± 1.29	0.17 ± 0.12	0.33 ± 0.03
Yellow Perch (viscera and bones)	4.21 ± 2.12	0.89 ± 0.26	0.40 ± 0.05
Yellow Perch (flesh and skin)	3.19 ± 0.61	0.76 ± 0.14	0.30 ± 0.04
Chain Pickerel (flesh and skin)	3.50 ± 0.61	0.68 ± 0.12	< 0.04
Chain Pickerel (viscera and bones)	2.97 ± 0.84	0.39 ± 0.10	0.36 ± 0.04
Golden Shiner (whole)	1.59 ± 0.33	0.07 ± 0.02	0.36 ± 0.03
Golden Shiner (flesh and skin)	2.60 ± 0.46	0.16 ± 0.03	0.30 ± 0.03
Golden Shiner (viscera and bones)	2.07 ± 0.38	0.10 ± 0.02	0.83 ± 0.06
Chain Pickerel (Viscera and bones)	2.00 ± 0.40	0.34 ± 0.06	0.39 ± 0.04
Chain Pickerel (flesh and skin)	3.15 ± 0.72	0.77 ± 0.15	0.05 ± 0.01
Brown Bullhead (whole fish)	1.87 ± 0.37	0.11 ± 0.03	0.18 ± 0.01
Brown Bullhead (viscera and bones)	1.48 ± 0.29	0.19 ± 0.04	0.66 ± 0.05
Brown Bullhead (flesh and skin)	3.07 ± 0.52	0.46 ± 0.08	< 0.01
Pumpkinseed (viscera and bones)	6.49 ± 5.32	ND	0.93 ± 0.06
Pumpkinseed (flesh and skin)	3.19 ± 2.28	0.47 ± 0.20	0.32 ± 0.02
Yellow perch (whole)	3.19 ± 0.78	0.26 ± 0.07	0.24 ± 0.03
Golden shiner (whole)	1.55 ± 0.31	0.11 ± 0.03	0.37 ± 0.03

* These are Control Locations which receive no discharges from BNL.

Table 7-14 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Fish

Sample Loaction and Fish Type	K-40	Cs-137	Sr-90
	←	(pCi/g, wet)	→
Forge Pond			
Black Crappie (flesh and skin)	3.59 ± 0.85	0.32 ± 0.08	< 0.03
Black Crappie (viscera and bones)	2.77 ± 0.61	0.18 ± 0.05	0.42 ± 0.04
Chain Pickerel (whole)	1.33 ± 0.26	0.09 ± 0.02	0.04 ± 0.01
Chain Pickerel (viscera and bones)	3.76 ± 1.52	0.42 ± 0.15	0.21 ± 0.05
Chain Pickerel (flesh and skin)	5.03 ± 1.45	0.31 ± 0.09	< 0.04
Golden Shiner (flesh and skin)	3.82 ± 0.85	0.10 ± 0.03	0.15 ± 0.03
Golden Shiner (viscera and bones)	3.43 ± 0.80	0.09 ± 0.04	0.40 ± 0.05
Brown Bullhead (whole fish)	1.97 ± 0.49	0.05 ± 0.03	0.16 ± 0.03
Brown Bullhead (whole fish)	1.92 ± 0.38	0.08 ± 0.02	0.30 ± 0.05
Brown Bullhead (viscera and bones)	1.65 ± 0.30	0.07 ± 0.02	0.31 ± 0.04
Brown Bullhead (flesh and skin)	2.97 ± 0.50	0.16 ± 0.03	< 0.03
Golden shiner (whole)	0.02 ± 0.01	ND	0.22 ± 0.02
Chain Pickerel (flesh and skin)	3.34 ± 0.70	0.19 ± 0.05	(a)
Chain Pickerel (Viscera and bones)	2.51 ± 0.63	0.11 ± 0.04	0.28 ± 0.04
Bluegill (viscera and bones)	2.28 ± 0.63	0.06 ± 0.03	0.42 ± 0.03
Bluegill (flesh and skin)	3.85 ± 1.47	0.16 ± 0.11	(a)
Pumpkinseed (viscera and bones)	2.88 ± 1.48	ND	0.35 ± 0.03
Pumpkinseed (flesh and skin)	3.27 ± 0.64	0.13 ± 0.04	(a)
Brown Bullhead (flesh and skin)	2.88 ± 0.54	0.14 ± 0.03	(a)
Brown Bullhead (viscera and bones)	1.09 ± 0.46	0.05 ± 0.03	0.38 ± 0.04
Swan Pond*			
Bluegill (flesh and skin)	2.59 ± 0.77	0.09 ± 0.05	(a)
Bluegill (viscera and bones)	2.14 ± 0.55	0.05 ± 0.04	0.35 ± 0.04
Pumpkinseed (whole)	3.32 ± 1.97	ND	(a)
Pumpkinseed (flesh and skin)	5.47 ± 1.92	ND	(a)
Pumpkinseed (viscera and bones)	1.99 ± 0.59	0.05 ± 0.04	0.25 ± 0.04
Yellow perch (whole)	2.80 ± 0.57	0.12 ± 0.03	0.12 ± 0.03
Yellow Perch (flesh and skin)	2.63 ± 0.72	0.15 ± 0.04	(a)
Yellow Perch (viscera and bone)	ND	0.14 ± 0.09	0.17 ± 0.04
Brown Bullhead (whole fish)	1.54 ± 0.40	0.04 ± 0.02	0.11 ± 0.02
Brown Bullhead (flesh and skin)	2.77 ± 0.58	0.07 ± 0.02	< 0.04
Brown Bullhead (viscera and bones)	1.90 ± 0.37	0.04 ± 0.02	0.31 ± 0.04
Yellow perch (whole)	2.60 ± 0.47	0.17 ± 0.04	0.12 ± 0.02
Yellow Perch (flesh and skin)	4.60 ± 1.67	ND	0.07 ± 0.03
Yellow Perch (viscera and bone)	3.45 ± 1.39	0.14 ± 0.08	0.21 ± 0.04

Table 7-14 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Radiological Analysis of Fish

Sample Loaction and Fish Type	K-40	Cs-137	Sr-90
	←	(pCi/g, wet)	→
Swan Pond (cont.)*			
Large Mouth Bass (viscera and bones)	1.76 ± 0.34	0.08 ± 0.02	0.19 ± 0.03
Large Mouth Bass (flesh and skin)	2.69 ± 0.46	0.15 ± 0.03	0.06 ± 0.02
Brown Bullhead (whole fish)	1.60 ± 0.38	ND ± ND	0.25 ± 0.03
Brown Bullhead (flesh and skin)	3.03 ± 0.56	0.05 ± 0.02	< 0.04
Brown Bullhead (viscera and bones)	3.74 ± 1.00	0.05 ± 0.04	0.22 ± 0.03
Carmans River*			
Golden shiner (whole)	1.86 ± 0.67	ND	(a)
Bluegill (viscera and bones)	2.69 ± 0.62	ND	0.10 ± 0.03
Bluegill (flesh and skin)	2.54 ± 0.47	0.03 ± 0.01	(a)
Bluegill (whole fish)	2.96 ± 1.36	ND	0.07 ± 0.02
Brown Bullhead (flesh and skin)	2.97 ± 1.07	ND	(a)
Brown Bullhead (viscera and bones)	1.92 ± 0.40	0.03 ± 0.01	0.11 ± 0.02
Brown Bullhead (whole fish)	1.89 ± 0.36	0.02 ± 0.01	< 0.03
Pumpkinseed (whole)	3.54 ± 1.52	ND	(a)
Large Mouth Bass (whole)	2.39 ± 0.58	ND	< 0.04
Bluegill (whole fish)	2.09 ± 0.52	ND	0.06 ± 0.03
Bluegill (flesh and skin)	2.61 ± 0.53	0.02 ± 0.02	< 0.05
Bluegill (viscera and bones)	3.75 ± 2.11	ND	0.10 ± 0.04
Brown Bullhead (whole fish)	3.51 ± 0.89	0.05 ± 0.04	< 0.04
Brown Bullhead (flesh and skin)	3.30 ± 0.64	0.05 ± 0.03	0.06 ± 0.02
Brown Bullhead (viscera and bones)	1.79 ± 0.55	ND	(a)
Eel (whole)	1.77 ± 0.33	0.05 ± 0.01	0.06 ± 0.03
Eel (whole)	3.25 ± 0.57	0.04 ± 0.01	< 0.05
Rainbow Trout (whole)	2.84 ± 0.97	ND	(a)

Notes:
(a) Sample was not analyzed for this analyte.
ND = Not Detected.
* These are Control Locations which receive no discharges from BNL.

of man-made radionuclides attributable to past BNL operations. Data obtained from sampling and analysis in 1996 shows that cesium-137 levels in the brown bullhead species (collected uniformly at all locations) is highest in fish taken from Fresh Pond. This data is shown graphically in Figure 7-10. For cesium-137, concentrations are consistently highest in the flesh and skin of the fish; they are higher than those found in an analysis of the whole fish because the entire mass of the fish is used in the measurement. This has the effect of reducing the overall activity per unit volume. The same pattern is also visible in the strontium-90 data, except that the highest concentrations occur in the viscera and bones, as expected.

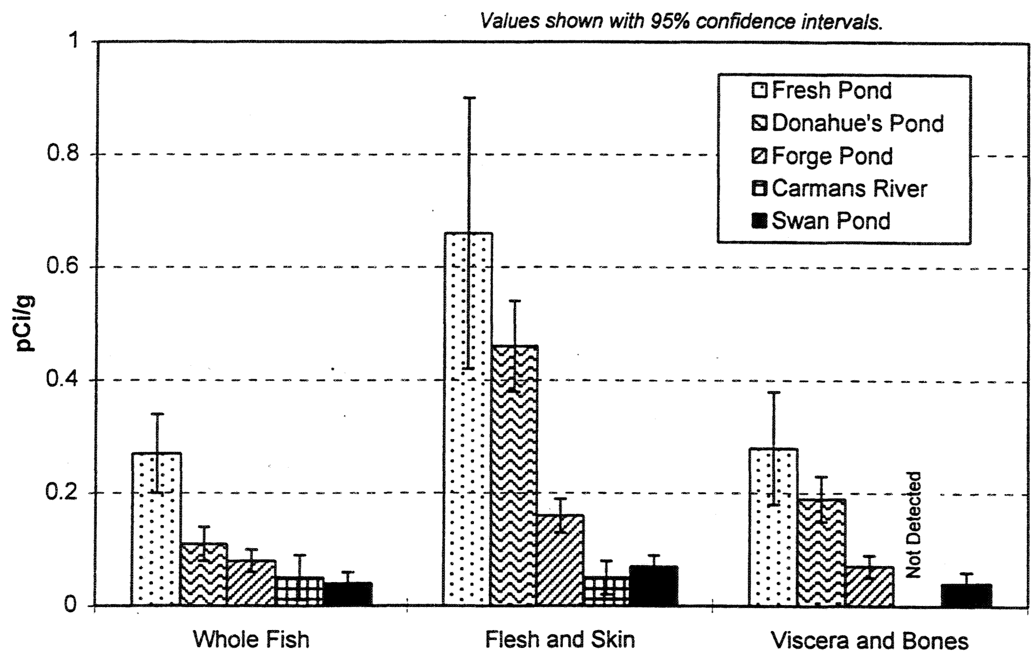


Figure 7-10 Cesium-137 concentrations in the *Brown Bullhead* species in local waters.

Though it is clear that BNL operations have contributed to radionuclide levels in the Peconic River system, most of these radionuclides (with the exception of tritium) were released between the late 1950's and early 1970's. In light of the Fresh Pond data, present day cesium and strontium concentrations in fish in the Peconic River system now appear to be within the range of variability seen in local waters which receive no discharges from BNL. This is explainable when considering the lack of significant new discharges of cesium and strontium, time elapsed for radioactive decay, and sediment turnover (covering).

Independent measurements of Peconic River fish near Manorville have also been conducted by the NYSDOH since 1973. The results of this program show cesium-137 concentrations which have steadily decreased with time in a manner consistent with the removal and decay mechanisms mentioned above (NYSDOH, 1996).

7.8.2 New York Sate Peconic River Special Study

In April of 1996, a member of the Suffolk County Legislature requested an evaluation of BNL's impact on the Peconic River. This request was forwarded from the SCDHS to the NY State Department of Health (NYSDOH) Bureau of Environmental Radiation Protection. The Bureau reviewed information pertaining to radiation measurements of Peconic River fish and sediments gathered since the 1970s. The results of this review were published in September, 1996 in a report entitled "Radioactive Contamination in the Peconic River."

The report contained the following conclusions:

- Peconic River sediments contain concentrations of cobalt-60, americium-241, and cesium-137 above levels which can be attributed to global fallout. Liquid effluents from BNL are responsible for or have contributed to the observed radionuclide concentrations.

- Average concentrations of cesium-137 and strontium-90 are higher in fish from Peconic waters than in control samples, though the concentrations have been observed to steadily decrease since measurements began in the early 1970s (see Figure 7-11). This decrease is most likely due to reduced radiological discharges by BNL, radioactive decay, and sedimentation processes in which earlier deposits are covered by new sediment which has a lower radioactivity content.

- Clams and mussels from Peconic waters show measurable concentrations of cesium-137 and strontium-90. Due a lack of control samples, the fraction of activity attributable to BNL contributions could not be estimated.

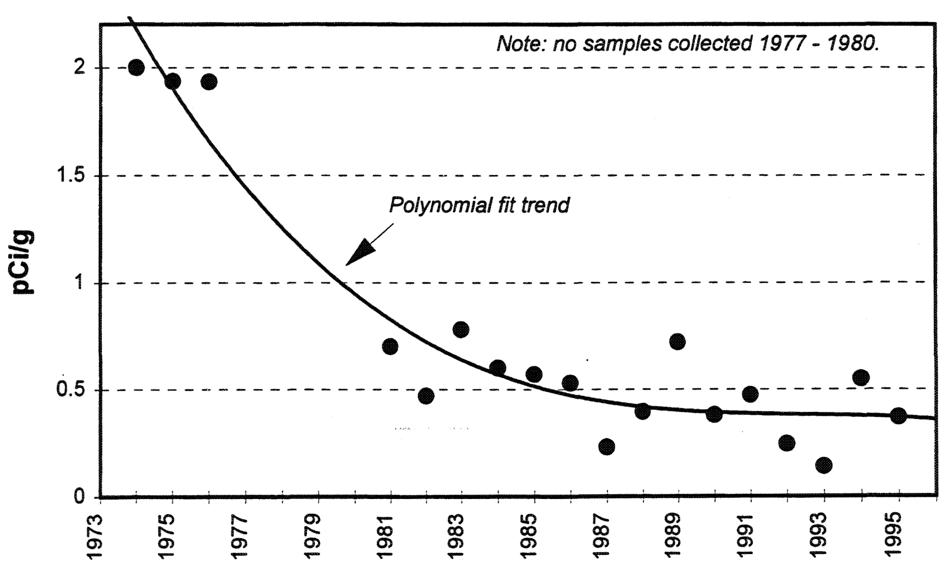


Figure 7-11 Average cesium-137 concentrations in fish (multiple species) taken from Donahue's Pond (1974 - 1995), NYSDOH data trend.

- The average 50 year committed effective dose equivalent due to eating whole fish from the Peconic River was calculated to be 0.4 mrem for each year fish was eaten between 1973 and 1994. This dose is based on background-subtracted concentrations of cesium and strontium.
- Individual radiological doses received from Peconic River fish consumption are well below the NYCRR 16 annual public dose limit of 100 mrem and the 10 mrem/yr NYSDEC limit above which environmental remedial action is required.
- All annual average radionuclide levels in Peconic River waters have been well below the environmental discharge limits specified in Part 16 of the NY State Sanitary Code [NYCRR 16].

7.8.3 Radiological Analysis of Shellfish

Clams, mussels, and sediment samples were collected from the Peconic Bay and Flanders Bay in 1996. Samples from these locations indicate whether or not BNL discharges to the Peconic River system have resulted in a measurable contribution to shellfish radionuclide uptake. Similar samples were also collected from Lloyd harbor and the Northport Bay; these locations represent background areas which are not influenced by the Peconic River system. All samples were analyzed for gamma-emitting radionuclides and strontium-90. Table 7-15 summarizes the analytical results. Only naturally-occurring radionuclides such as potassium-40 were observed. Neither cesium-137 nor strontium-90 were detected in any of the collected samples. This data

Table 7-15. Radiological Analysis of Local Mussels and Clams.

Sample Location	Sampling Date	Sample Type	Cs-137	Sr-90 (pCi/g, wet)	K-40
Peconic Bay	29-Mar-96	clams	ND	< 0.012	1.29 ± 0.32
Peconic Bay	29-Mar-96	mussels	ND	< 0.012	1.26 ± 0.76
Northport Bay	01-Apr-96	clams	ND	< 0.011	1.75 ± 0.89
Northport Bay	01-Apr-96	clams	ND	< 0.011	ND
Peconic River (mouth)	12-Apr-96	clams	ND	< 0.012	1.09 ± 0.32
Peconic River (mouth)	12-Apr-96	clams	ND	< 0.010	1.08 ± 0.28
Peconic River (mouth)	12-Apr-96	clams	ND	< 0.012	1.09 ± 0.46
N. of Cusogue Beach	20-Aug-96	clams	ND	< 0.010	ND
Moriches Inlet	11-Aug-96	clams	ND	< 0.008	ND
Flanders Bay	12-Apr-96	snails	ND	< 0.008	1.14 ± 0.31
Flanders Bay	12-Apr-96	clams	ND	< 0.010	1.24 ± 2.57
Lloyd Harbor	01-Apr-96	clams	ND	< 0.006	1.13 ± 0.92
Lloyd Harbor	01-Apr-96	mussels	ND	< 0.009	1.31 ± 0.32

ND = Not Detected.

indicates that there are no detectable BNL-produced radionuclides present in shellfish collected from either Peconic or Flanders Bay.

7.8.4 Chronic Toxicity Tests

The Chronic Toxicity Testing program begun in 1993 for the STP effluent was continued in 1996 with the collection and bioassay analysis of three effluent samples. As required by BNL's SPDES permit, this program consisted of quarterly, seven-day Tier II Chronic Toxicity Tests of the BNL STP effluent. Two fresh water organisms, waterfleas (*ceriodaphnia dubia*) and fathead minnows (*pimphales promelas*), were used for testing. The animals, in replicates of ten, were exposed to varying concentrations of the STP effluent (i.e., 100%, 50%, 25%, 12.5%, 6.25%) for seven days. During the test, the size of fish and/or rate of reproduction was measured and compared to untreated animals (i.e., controls). All test results were transmitted to the NYSDEC as part of routine DMR submission.

Formal performance of the chronic toxicity program, as required by the BNL SPDES permit, was completed in February 1996. The results of this test showed a No Observable Adverse Effect Concentration (NOEC) of 50% for both species, with survival being the controlling parameter. These test results were forwarded to the NYSDEC for review and evaluation along with the three previous reports conducted in 1995. Of the four tests conducted, two showed there to be no toxicity exhibited (i.e., a NOEC of 100%) and two showed a NOEC of 50%. To determine the overall results of the four tests, the geometric mean of the four chronic toxicity test values is calculated. The geometric mean is termed the Maximum Allowable Waste Concentration (MAWC). The MAWC for the four tests was calculated to be 71%. The MAWC is compared to the actual flow contribution of the BNL STP discharge to the Peconic River to determine the overall impact of the discharge on the receiving water. Since the BNL STP discharge comprises the bulk of the Peconic River flow on-site (96%), the minimum MAWC should be 96%. Since the MAWC was less than the actual discharge contribution, a Toxicity Reduction Evaluation should have been warranted. However on June 10, 1996, the NYSDEC notified the Laboratory that since major STP upgrade activities were on-going, the Toxicity Reduction requirements were suspended pending completion of construction and performance of additional toxicity tests with the new STP process on-line. It is anticipated that testing will resume upon completion of the STP upgrades which are tentatively scheduled to be finished by September 30, 1997.

The exact cause of the intermittent toxicity is unknown. Side-by-side comparison of SPDES monitored analytes between tests showing toxicity and those which did not, has shown all parameters to be in equivalent concentrations. While not required by permit condition, to better understand the reason for the exhibited toxicity, additional testing was conducted in September and December. In addition to the routine SPDES monitoring parameters, comprehensive chemical analysis of the waste water effluent was conducted in an effort to identify the agents responsible for the toxicity. Analysis was conducted for volatile and semi-volatile organic compounds, pesticides, herbicides, full inorganics, phosphates, sulfates, etc. In both tests, no toxicity was exhibited and no chemical parameters were identified outside the parameters already identified in the BNL SPDES permit. Testing was, therefore, inconclusive. Copies of the additional test reports were also supplied to the NYSDEC for their review.

7.8.5 Operable Unit V Fish Tissue Bioaccumulation Study

As part of the OU V Remedial Investigation, a human health and ecological risk assessment was performed in 1996. Fish obtained from within OU V boundaries were collected to determine the potential for the bioaccumulation of contaminated sediments containing inorganic materials, pesticides, PCBs, and radionuclides. A total of fourteen samples were collected from three locations: the STP Outfall ("PR02"), west of the eastern firebreak ("PR22"), and 1 km downstream of the STP Outfall ("PR06"). Species collected include the following: creek chubsucker (*Erimyzon oblongus*), chain pickerel (*Esox niger*), brown bullhead (*Ictalurus nebulosus*), common shiner (*Notropis cornutus*), and pumpkinseed (*Lepomis gibbosus*). For complete details, see "Operable Unit V Fish Tissue Bioaccumulation Study Report", IT Corporation, December 9, 1996.

7.8.5.1 Inorganic Analyses

The following inorganics were analyzed for: cadmium, copper, lead, nickel, silver and mercury. Mercury was detected in all fourteen samples at concentrations ranging from 0.32 to 1.6 mg/kg dry weight. The highest levels were observed in the predator fish (chain pickerel). The lowest levels occurred in first order consumers (common shiner) and intermediate levels were detected in bottom feeders. Only twelve of the fourteen samples were sufficiently large to be analyzed for the additional five inorganic constituents. Cadmium, nickel and silver were not detected in any of the collected tissue samples. Copper and lead were detected in seven out of twelve samples. Copper levels ranged from < 0.80 to 2.0 mg/kg. Lead concentrations varied from < 0.08 to 0.14 mg/kg.

7.8.5.2 Pesticide and PCB Analyses

Four samples were analyzed for pesticides and PCBs. Samples were tested for Endosulfan I, Endosulfan II, Endosulfan sulfate, chlordane, and 4,4'-DDE, but none was detected. All samples were found to contain 4,4'-DDD at concentrations ranging from 15 to 23 ug/kg. Aroclor-1254 was also detected in all four samples at levels between 1,000 to 1,400 ug/kg.

7.8.5.3 Radionuclide Analyses

Three samples were analyzed for radionuclide content. Tritium was detected in all three samples at concentrations ranging from 0.36 to 0.52 pCi/g (13 to 19 mBq/g). Cesium-137 was also detected in all three samples at levels between 0.39 to 0.53 pCi/g (14 to 20 mBq/g). Strontium-90 was detected in only one sample (PR06) at 0.45 pCi/g (17 mBq/g). Americium-241 was not detected in any of the samples.

8. GROUNDWATER PROTECTION

Groundwater protection at BNL is addressed by both prevention and minimization of new environmental emissions, and active remediation in areas where past disposal practices have impacted groundwater quality. All remediation work is carried out under the IAG between the DOE, EPA, and NYSDEC.

The strategy for protecting groundwater at the BNL site has the following elements:

1. Reviewing engineering designs and conducting environmental assessments for new and existing facilities to ensure that potential environmental impacts are fully evaluated and reduced to acceptable levels;

2. Upgrading existing facilities to reduce the risk of accidental release of contaminants to the environment (i.e., upgrading underground storage tanks, replacing of deteriorated sewer lines, constructing new waste management facilities using best available environmental prevention technologies);

3. Responding promptly and remediating spills to prevent contaminants migrating to surface waters and groundwater;

4. Conducting groundwater and surface water monitoring programs at active facilities that have the potential to impact the environment, so that potential accidental contaminant releases are detected quickly;

5. Conducting groundwater monitoring programs at inactive chemical and radioactive materials storage and disposal sites and spill areas to assess the distribution and movement of existing groundwater contamination;

6. Conducting environmental restoration in areas where soils and groundwater were contaminated by chemicals and radionuclides by past accidental spills, storage, and disposal;

7. Developing waste minimization practices to reduce the volume and toxicity of all wastes, and using best management practices to manage and properly dispose of generated wastes; and,

8. Developing a Pollution Prevention Awareness Program to ensure that employees are cognizant of their responsibilities for the proper storage, use, and disposal of chemicals in the work place.

8.1 Groundwater Surveillance

Groundwater quality at BNL is routinely monitored through a network of approximately 220 on-site and 40 off-site surveillance wells. Surveillance wells are generally used to monitor specific facilities where degradation of the groundwater is known or suspected to have occurred, to fulfill permit requirements, and to assess the quality of groundwater entering or leaving the site at BNL boundaries. Monitored facilities and/or areas include the following: the STP/Peconic River Area, Meadow Marsh-Upland Recharge Area, HWMF, Current Landfill, Former Landfill, Ash Repository, CSF/MPF, AGS, WCF, Supply and Materiel, and several other smaller facilities.

Groundwater quality is also routinely monitored at six active potable supply wells and five process supply wells. Figures 8-1 through 8-14 show the wells located in specific areas of concern. In addition to groundwater quality assessments, measurements of water levels are collected from over 500 on-site and off-site wells to assess variations in directions and velocities of groundwater flow.

8.1.1 Potable Water and Process Supply Wells

During 1996, approximately 13.7 MLD were pumped from the BNL potable and process-water supply network. This network consists of six potable supply wells (Wells 4, 6, 7, 10, 11, and 12) and six secondary cooling/process water supply wells (Wells 5, 9, 101, 102, 103, and 105); all are screened entirely within the Upper Glacial aquifer. To permit construction of treatment system modifications at the Water Treatment Plant, only wells 10, 11, and 12 supplied drinking water in 1996. Well 102 was used for secondary cooling water at the AGS, and Well 9 supplied process water to the Biology Department's fish house. Well 105, which was retrofitted with an activated carbon adsorption system in 1993 to mitigate volatile organic contaminants, was returned to service in 1996 and supplied secondary-cooling water to the Medical Department Research Reactor. Well 5, which was formerly used to supply non-potable water to the STP area, was permanently abandoned in 1996.

The radiological sampling data discussed in Section 8.1.1.1 is compared to DOE Derived Concentration Guides (DCGs) to determine compliance with the SDWA. Also, because the Upper Glacial aquifer underlying Nassau and Suffolk Counties has been designated a "Sole Source" aquifer, the data are compared to the EPA and New York State Drinking Water Standards.

Grab samples were obtained quarterly from Potable Wells 10, 11 and 12 and analyzed for radioactivity, water quality indices, metals, and VOCs. Regulatory compliance samples were collected and analyzed in accordance with the BNL Potable Water System Sampling Plan. The results of these analyses are discussed in Chapter 2.

Process Supply Well Nos. 9, 102, and 105 were used periodically during 1996 and were analyzed for water quality, inorganic and organic contaminants routinely in 1996. Water chemistry analyses (i.e., pH and conductivity) were also performed for Well 102 by the AGS facility operators, as needed, to meet their operational requirements.

Table 8-1. Potable and Process Well Radiological Results

Well No.	Collect Date	Alpha	Beta	Tritium	Co-60	Cs-137	Sr-90
		←		(pCi/L)			→
Potable Wells							
10	27-Feb-96	< 0.7	< 1.6	< 388	ND	ND	< 0.3
	27-Jun-96	0.5 ± 0.3	< 1.3	< 404	ND	ND	NS
	27-Sep-96	< 0.7	< 1.6	< 503	ND	ND	< 0.3
11	27-Feb-96	< 0.7	< 1.6	< 388	0.76 ± 0.46	ND	< 0.3
	27-Jun-96	0.3 ± 0.2	1.7 ± 0.9	< 404	ND	0.12 ± 0.06	NS
	27-Sep-96	0.7 ± 0.3	< 1.6	< 503	ND	ND	< 0.5
12	27-Feb-96	< 0.7	< 1.6	< 388	ND	0.17 ± 0.11	< 0.3
	27-Jun-96	0.2 ± 0.2	1.3 ± 0.8	< 404	ND	ND	NS
	27-Sep-96	0.5 ± 0.3	< 1.6	< 503	ND	ND	< 0.3
Process Wells							
9	27-Feb-96	< 0.7	< 1.6	< 388	ND	ND	< 0.2
	27-Jun-96	0.4 ± 0.2	< 1.3	< 404	ND	ND	NS
	27-Sep-96	< 0.4	< 1.6	< 503	ND	ND	< 0.3
102	27-Feb-96	< 0.7	< 1.6	< 388	ND	2.30 ± 1.51	< 0.3
	1-Jul-96	0.5 ± 0.3	3.3 ± 1.1	< 405	ND	ND	NS
105	11-Mar-96	< 0.6	2.7 ± 1.2	< 305	ND	ND	< 0.2
	1-Oct-96	0.4 ± 0.3	3.1 ± 1.1	< 454	ND	ND	< 0.2
SDWA limit		15[(a)]	50[(b)]	20,000	200[(c)]	120[(c)]	8

(a) Excluding radon and uranium.
(b) Screening level above which analysis for individual radionuclides is required.
(c) Based on 4% of the DOE Order 5400.5 DCG.

NS = Not Sampled for this analyte.
ND = Not Detected.

8.1.1.1 Radiological Analyses

Potable and process well water was sampled and analyzed for gross alpha and gross beta activity, tritium and strontium-90; results are listed in Table 8-1. Nuclide-specific analysis using gamma spectroscopy is also performed, supplementing the requirements of the SDWA which does not strictly require this analysis. Gross activity levels were consistent with those of typical background environmental water samples. Neither tritium nor strontium-90 were observed above the MDL in any of these wells. Gamma-emitting radionuclides were detected in four samples, all at levels significantly below applicable drinking water standards (compare with the SDWA limits listed at the bottom of Table 8-1). The gamma-emitting radionuclide concentrations indicated in potable wells 11 and 12 were near the detection limit of the analysis method. Radionuclide concentrations at these levels pose no threat to the safety or health risk to individuals who drink or use site water.

8.1.1.2 Non-radiological Analyses

Three wells (Potable Wells 10, 11, and 12) were used to supply potable water to the BNL community during CY 1996. The NYSDOH governs the quality of potable water supplies and requires that the water purveyor routinely monitor the supply for organic, bacteriological, and inorganic constituents. The NYSDOH requirements (under authority of the SDWA) are implemented by the SCDHS. Monitoring requirements for 1996 included quarterly analysis for POCs, monthly bacteriological analyses, annual analyses for asbestos, micro-extractables, SOCs and pesticides, and semi-annual inorganic and lead and copper analyses. Potable water samples were collected by BNL personnel and analyzed by a NYSDOH certified contractor Laboratory using standard methods of analysis. All analytical data was submitted to the SCDHS as required by Chapter I, Part 5 of the NYS Sanitary Code. The full details of the potable water compliance sampling and analysis program are discussed in detail in Chapter 2.

Potable Wells 4, 6 and 7, which are typically used to supply water to the BNL Water Treatment Plant (WTP), remained out of service in 1996 to permit continued construction of WTP improvements. Water obtained from Wells 4, 6 and 7 contains naturally occurring iron at concentrations which exceed drinking water guidelines. The water is treated at the WTP using a conventional lime softening process to precipitate the iron from solution. This water also contains elevated levels of VOCs which must also be treated to render the water fit for consumptive purposes. Improvements at the water treatment plant were initiated in 1995 to improve the efficiency of VOC removal as well as update WTP controls from analog to digital. This project included the construction of dual 10 foot diameter by 35 foot tall air stripping towers each with a rated capacity of 2,400 gallons per minute for the mitigation of volatile organic compounds. In addition the project also included construction of a new clearwell, and wetwell. Construction continued throughout 1996; consequently, the WTP and Wells 4, 6, and 7 were not sampled. Restart of the WTP is expected to occur in the summer of 1997.

In addition to the requirements of NYSDOH compliance monitoring, the S&EP Division maintains a supplemental sampling and analysis program for the BNL potable water supply. During 1996, the S&EP Division monitored these wells for metals, water quality parameters, and VOCs. All analyses were conducted by the S&EP Division ASL using EPA-approved methods. Tables 8-2, 8-3, and 8-4 summarize all the data collected during 1996.

The water-quality data show that nitrates, sulfates, and chlorides are well within the limits established in the NYS DWS (Part 5 NYS Sanitary Code). The pH values in these wells ranged from 6.1 - 6.6 and are typical of natural Long Island groundwater. To reduce the corrosivity of the groundwater Wells 10, 11, and 12 are equipped with metering pumps which add sodium hydroxide to maintain the pH of the potable water effluent at approximately 8.

The majority of metals including silver, cadmium, chromium, iron, mercury, manganese and lead were not detected in the Laboratory's potable supply wells. Copper, and zinc were detected at levels below their respective NYS DWS. Sodium was detected in all wells at ambient concentrations and are well within drinking water guidance values. It should be noted that due to relocation of the BNL ASL, mercury analyses were limited in 1996 due to the absence of adequate ventilation necessary for rigorous digestion techniques.

Table 8-2
BNL Site Environmental Report for Calendar Year 1996
Potable Water and Process Supply Wells
Water Quality Data

Well No. (a)		pH SU	Conductivity umhos/cm	Chlorides mg/L	Sulfates (c) mg/L	Nitrate as N (c) mg/L
10	N	3	3	3	3	3
	Minimum	6.2	112	13.5	10.9	<1.0
	Maximum	6.5	128	14.9	12.4	< 1.0
	Average	NA	120	14.2	11.6	<1.0
11	N	3	3	3	3	3
	Minimum	6.1	129	16.6	11.8	<1.0
	Maximum	6.1	130	17.9	12.8	<1.0
	Average	NA	130	17	12.2	<1.0
12	N	3	3	3	3	3
	Minimum	6.6	119	16.1	11	<1.0
	Maximum	6.8	140	21.1	12.3	<1.0
	Average	NA	131	18.4	11.8	<1.0
102	N	2	2	2	2	2
	Minimum	6.4	132	20.3	8.7	<1.0
	Maximum	6.4	148	25.1	8.9	<1.0
	Average	NA	140	22.7	8.8	<1.0
9	N	3	3	3	3	3
	Minimum	6.6	116	18.2	11	<1.0
	Maximum	6.7	121	18.7	11.8	<1.0
	Average	NA	118	18.5	11.3	<1.0
105	N	3	3	2	2	2
	Minimum	5.6	155	20.6	13.8	< 1.0
	Maximum	6.5	192	28.5	16.1	< 1.0
	Average	NA	177	24.6	15	< 1.0
NYSDWS		(b)	(b)	250	250	10
Typical MDL		NA	10	4	4	1

N: No. of samples
NA: Not Applicable
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 6-11.
(b): No standard specified.
(c): Holding times for nitrates and sulfates were typically exceeded.

Table 8-3
BNL Site Environmental Report for Calendar Year 1996
Potable and Process Supply Wells
Metals Data

Well No. (a)		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
10	N	3	3	3	3	3	1	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.6	<0.002	<0.02
	Maximum	<0.025	< 0.0005	<0.005	< 0.05	<0.075	<0.0002	<0.05	11.1	<0.002	0.025
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	10.3	<0.002	< 0.02
11	N	3	3	3	3	3	1	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.4	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	0.054	<0.075	<0.0002	<0.05	12.1	< 0.002	< 0.02
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.7	<0.002	< 0.02
12	N	3	3	3	3	3	1	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	12.4	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	15.5	<0.002	< 0.02
	Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	14.2	<0.002	<0.02
9	N	3	3	3	3	3	2	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	0.28	<0.0002	<0.05	11	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	0.32	<0.0002	<0.05	12	<0.002	0.021
	Average	<0.025	<0.0005	<0.005	<0.05	0.3	<0.0002	<0.05	11.3	<0.002	<0.02
102	N	2	2	2	2	2	0	2	2	2	2
	Minimum	<0.025	<0.0005	<0.005	0.054	4	NA	0.41	13	0.006	<0.02
	Maximum	<0.025	<0.0005	<0.005	0.074	4.2	NA	0.43	17	0.006	< 0.02
	Average	<0.025	<0.0005	<0.005	0.064	4.1	NA	0.42	15	0.006	< 0.02
105	N	2	2	2	2	2	1	2	2	2	2
	Minimum	<0.025	<0.0005	<0.005	< 0.05	0.4	<0.0002	< 0.05	14.4	< 0.002	0.024
	Maximum	<0.025	<0.0005	<0.005	0.1	3	<0.0002	0.07	16.8	0.021	0.93
	Average	<0.025	<0.0005	<0.005	0.05	1.7	<0.0002	< 0.05	25.6	0.011	0.48
NYSDWS		0.05	0.01	0.05	1.3	0.3	0.002	0.3	(b)	0.015	5
Typical MDL		0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

N: No. of samples
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 6-11.
(b): No standard specified.

Table 8-4
BNL Site Environmental Report for Calendar Year 1996
Potable Water and Process Supply Wells
Volatile Organic Compound Data

Well No. (a)		Chloroform ug/L	1,1 Dichloroethylene ug/L	1,1,1 - Trichloroethane ug/L
10	N	3	3	3
	Minimum	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	< 2.0
	Average	<2.0	<2.0	<2.0
11	N	3	3	3
	Minimum	<2.0	<2.0	7.3
	Maximum	<2.0	<2.0	7.6
	Average	<2.0	<2.0	7.5
12	N	3	3	3
	Minimum	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0
9	N	3	3	3
	Minimum	2.3	<2.0	16
	Maximum	3.4	7.8	20.1
	Average	2.9	6.7	17.4
102	N	1	1	1
	Minimum	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0
105	N	3	3	3
	Minimum	<2.0	<2.0	<2.0
	Maximum	2.7	<2.0	4.2
	Average	2.1	<2.0	3.6
NYSDWS		100	5	5
Typical MDL		2	2	2

N: No. of samples
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 6-11.

During the second or third month of each quarter, BNL collects samples which are analyzed on-site by S&EP ASL for ten organic compounds consisting of volatile halogenated aliphatic hydrocarbons and aromatic hydrocarbons. These samples serve both as a quality control on the contractor laboratory and as an additional source of organic data used in trend analysis of water quality. Water samples are collected from the well head before treatment. The data show that only TCA was detected in the potable wells. The concentration of TCA in Well 11 typically exceeds the NYS DWS; however, this well was fitted with a carbon-adsorption treatment system during CY 1992 which effectively reduces the concentration of TCA to well below the NYS DWS. All remaining nine organic compounds were not detected in water samples collected during CY 1996.

Process Wells 9, 102, and 105 were also sampled and analyzed during CY 1996. Well 102 is used solely for supplying cooling water to the AGS, Well 9 supplies fresh water to the fish tanks housed in Building 463 (Biology Dept.), and Well 105 provides once-through cooling water for the BMRR. Tables 8-2 and 8-3 show that the concentrations of water-quality and inorganic elements are within ambient levels. Ambient groundwater quality in the western half of the BNL developed site is characterized by low pH and elevated concentrations of iron. Consequently, iron is present wells 4, 6, and 7 at concentrations which exceed NYS AWQS and are characterized by low pH. Concentrations of VOCs in Well 9, which is located within a known AOC (OU III), contained concentrations of TCA and DCE which exceed the NYS DWS. This water is not used for drinking and the concentrations present do not interfere with the fish experiments conducted in Building 463.

8.2 Groundwater Monitoring

Groundwater monitoring is an integral part of BNL's Environmental Monitoring Program (to fulfill DOE Orders and NYS permits) and the Environmental Restoration Program (to fulfill CERCLA monitoring requirements under the IAG). These programs include monitoring at active waste processing and temporary storage facilities to comply with RCRA, waste-treatment facilities, operational monitoring around accelerators, and in areas of known or suspected soil and groundwater contamination. During 1996, 260 surveillance wells were monitored during nearly 480 individual sampling events. The locations of all BNL groundwater monitoring wells are presented in Figures 8-1 through 8-14. A complete listing of all wells sampled during CY 1996 is provided in Appendix D.

Most groundwater monitoring wells on the site are two to four inches in diameter, and typically constructed of PVC material. A few wells are constructed of stainless steel materials. The majority of the wells used for the groundwater monitoring program were installed after the mid-1980s, following the appropriate RCRA and CERCLA protocols. Groundwater samples are collected following documented sampling procedures based on EPA guidelines (EPA, 1987). The analytical techniques used are described in this report (see Appendix C), and in the BNL Site EMP (Naidu et al., 1996). Comparing analytical data from the surveillance wells to NYS DOH and DOE reference levels provides a way to evaluate the potential impact of radiological and non-radiological levels of contamination. The groundwaters underlying the BNL site are designated as Class GA fresh groundwater by NYS. Non-radiological data for groundwater samples collected from surveillance wells (which are not utilized for drinking water supply) are usually compared to NYS DOH Ambient Water Quality Standards (6NYCRR 703.5). However, in the case of EDB, the more stringent NYSDWS is applied (10NYCRR Subpart 8-1). Radiological data are compared to both NYS AWQS (for tritium) and DOE DCGs for beta/gamma-emitting radionuclides.

8.2.1 Non-radiological Analyses

8.2.1.1 Operable Unit I

Current Landfill Area: The Current Landfill operated from 1967 through 1990, when it was closed in accordance with the Long Island Landfill Law. The landfill was used to dispose of putrescible garbage, sludge containing precipitated iron from the potable WTP, and anaerobic digester sludge from the STP. The STP sludge contained low concentrations of radionuclides, and possibly also metals and organic compounds. The Laboratory also disposed of limited quantities of laboratory wastes containing radioactive and chemical material. As a result of these disposal practices, the Current Landfill is a source of groundwater contamination. Permanent closure (i.e., capping) of this landfill was completed in November, 1995. The full extent of groundwater contamination and assessment of remedial alternatives was evaluated as part of the OU I RI/FS. As part of the OU I Groundwater Removal Action (RA V), a groundwater treatment system has been designed and will began operation in late December, 1996.

The surveillance well network at the Current Landfill consists of 41 shallow to deep Upper Glacial aquifer wells (Figures 8-8 and 8-11). During 1996, 19 of the groundwater surveillance wells were sampled for water quality, VOCs, and metals (Tables 8-5 to 8-7). Ten wells were sampled as part of the post-closure monitoring plan for the Current Landfill, and nine wells were monitored at the site boundary, at the location of the RA V extraction wells. Water quality data from wells located at the Current Landfill indicate that the pH typically was below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.2. Although all water quality parameters were within NYS AWQS, elevated conductivity levels were detected in wells located directly downgradient of the landfill. Average conductivity for the upgradient Well 87-09 was 146 μmhos/cm, whereas the average conductivities for wells directly downgradient ranged from 113 to 899 μmhos/cm. Eight surveillance wells downgradient of the Current Landfill had average iron concentrations ranging from 0.71 to 51.6 mg/L, which exceeded the NYS AWQS of 0.3 mg/L. Upgradient Well 87-09 had an average iron concentration slightly above the NYSAWQS with an average concentration of 0.71 mg/L. The elevated conductivity values in downgradient wells probably were related to these high iron concentrations. Sodium was detected above NYS AWQS in four wells with maximum concentrations ranging between 21.1 mg/L and 64 mg/L. All other metals concentrations were below their applicable NYS AWQS. Groundwater analyses for VOCs indicate that nine permanent and three temporary downgradient wells had concentrations of organic contaminants above NYS AWQS during 1995; VOCs were not detected in upgradient Well 87-09. In wells directly downgradient of the Current Landfill: DCA was detected in two wells at maximum concentrations of 16.5 and 47.1 μg/L; chloroethane was detected in five wells at maximum concentrations ranging between 17 μg/L and 180 μg/L; and benzene was detected in five wells at maximum concentrations ranging from 3.1 μg/L to 8 μg/L. In downgradient wells located near the site boundary, TCA was detected in four wells at maximum concentrations ranging from 7.2 μg/L to 15 μg/L; DCA was detected in three wells at maximum concentrations ranging from of 11.7 μg/L to 68

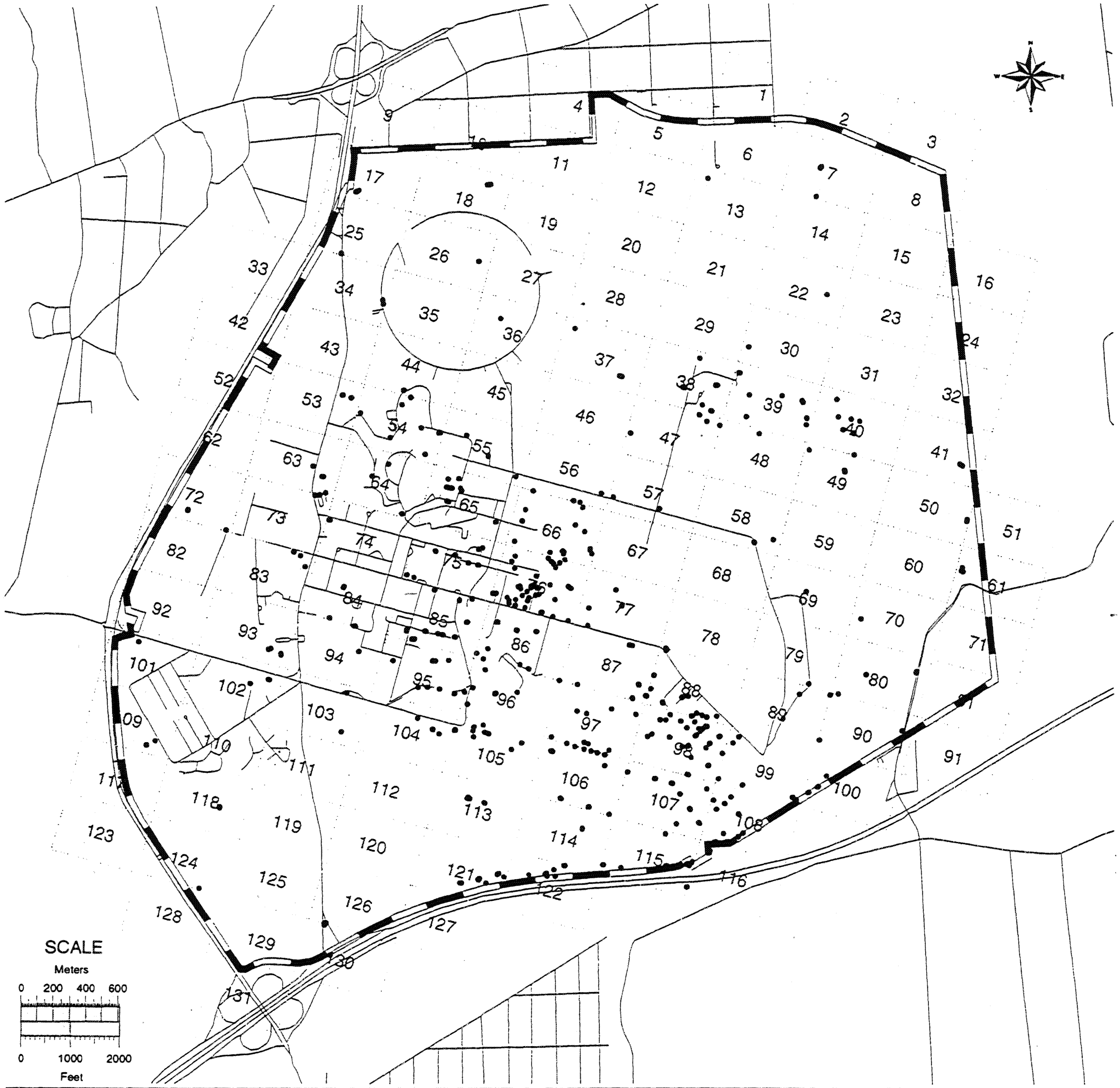
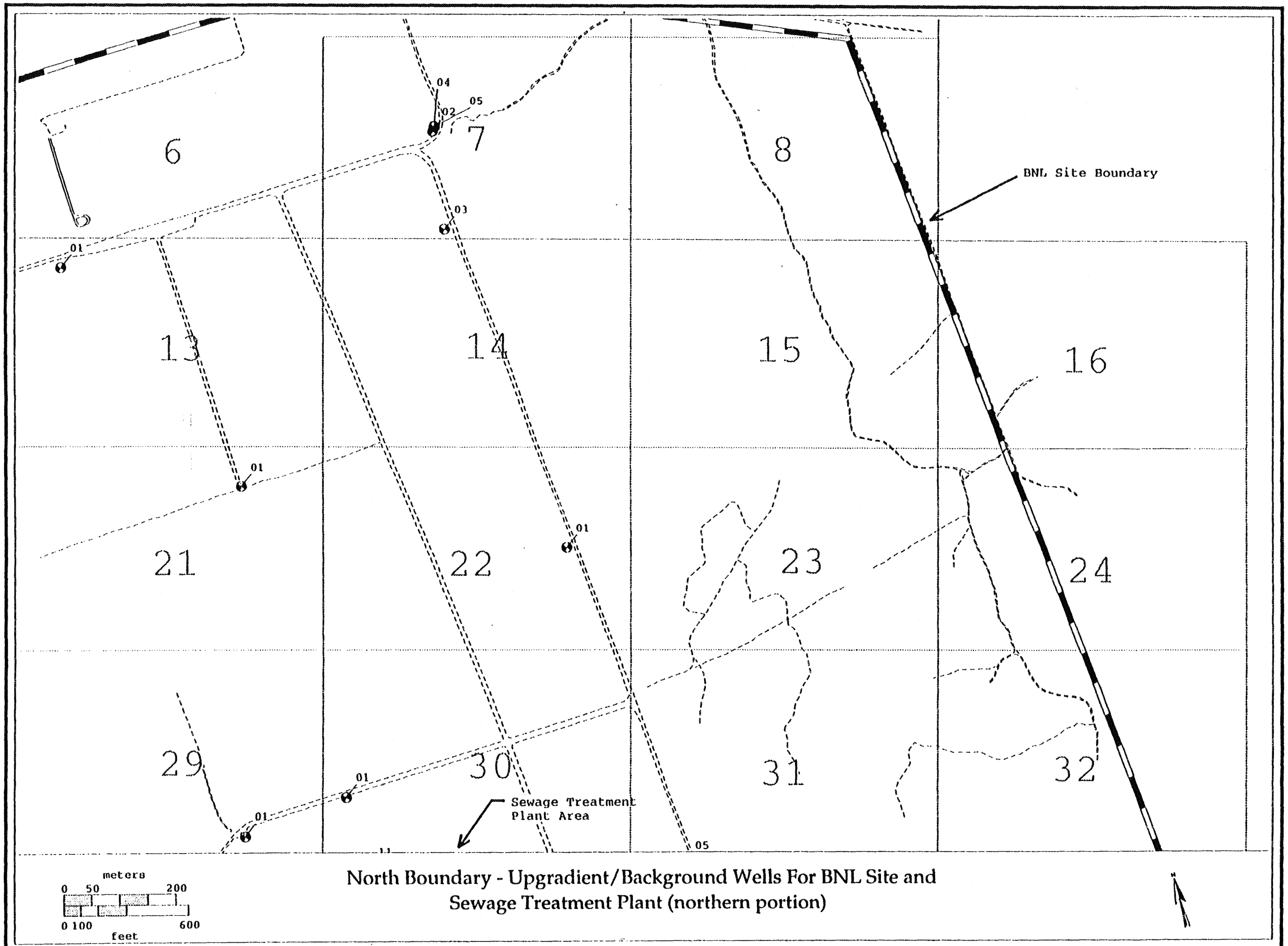


Figure 8-1 Locations of On-Site Groundwater Surveillance Wells

North Boundary - Upgradient/Background Wells For BNL Site

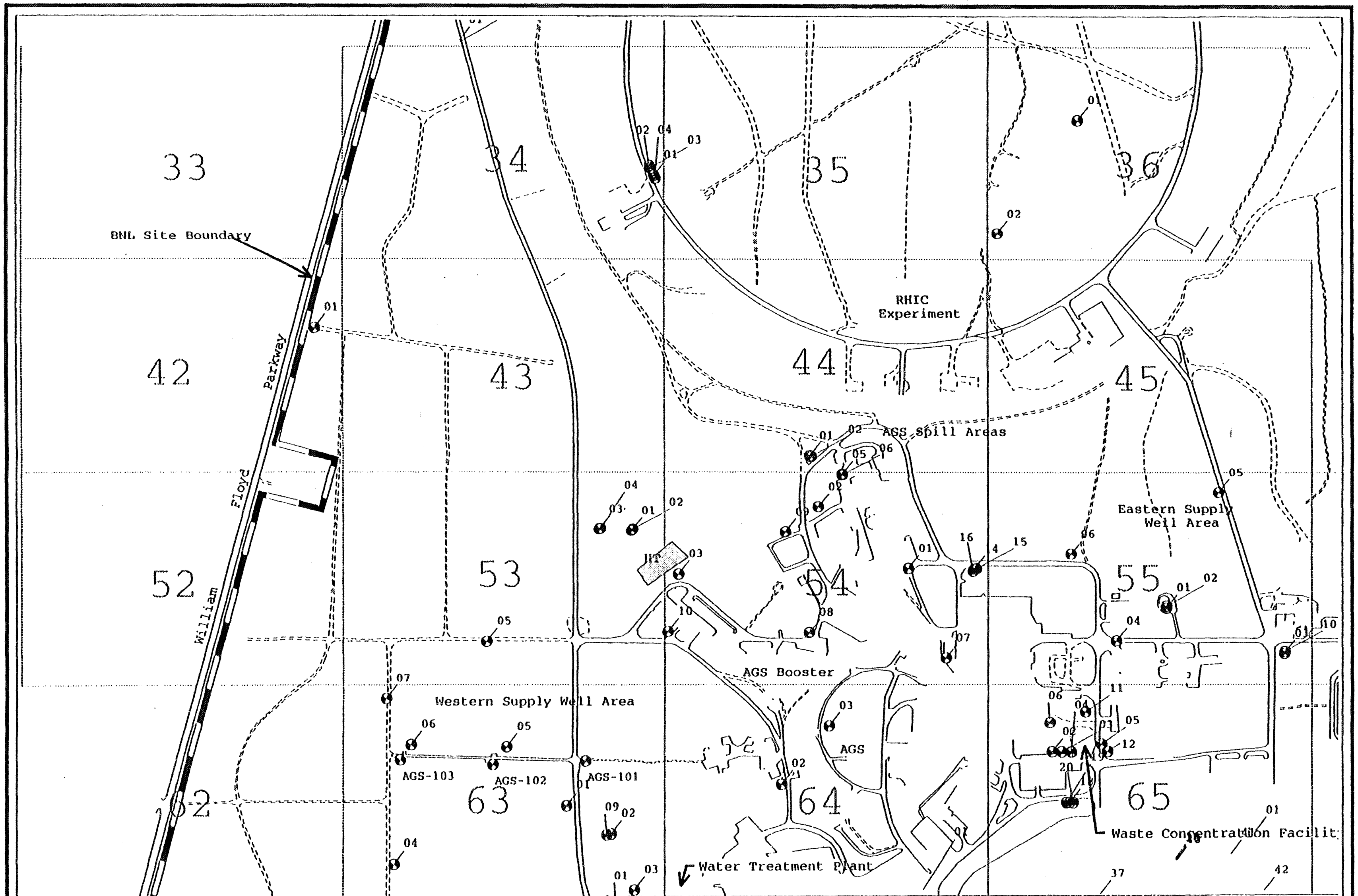
meters 0 50 200
0 100 600 feet

Figure 8–2



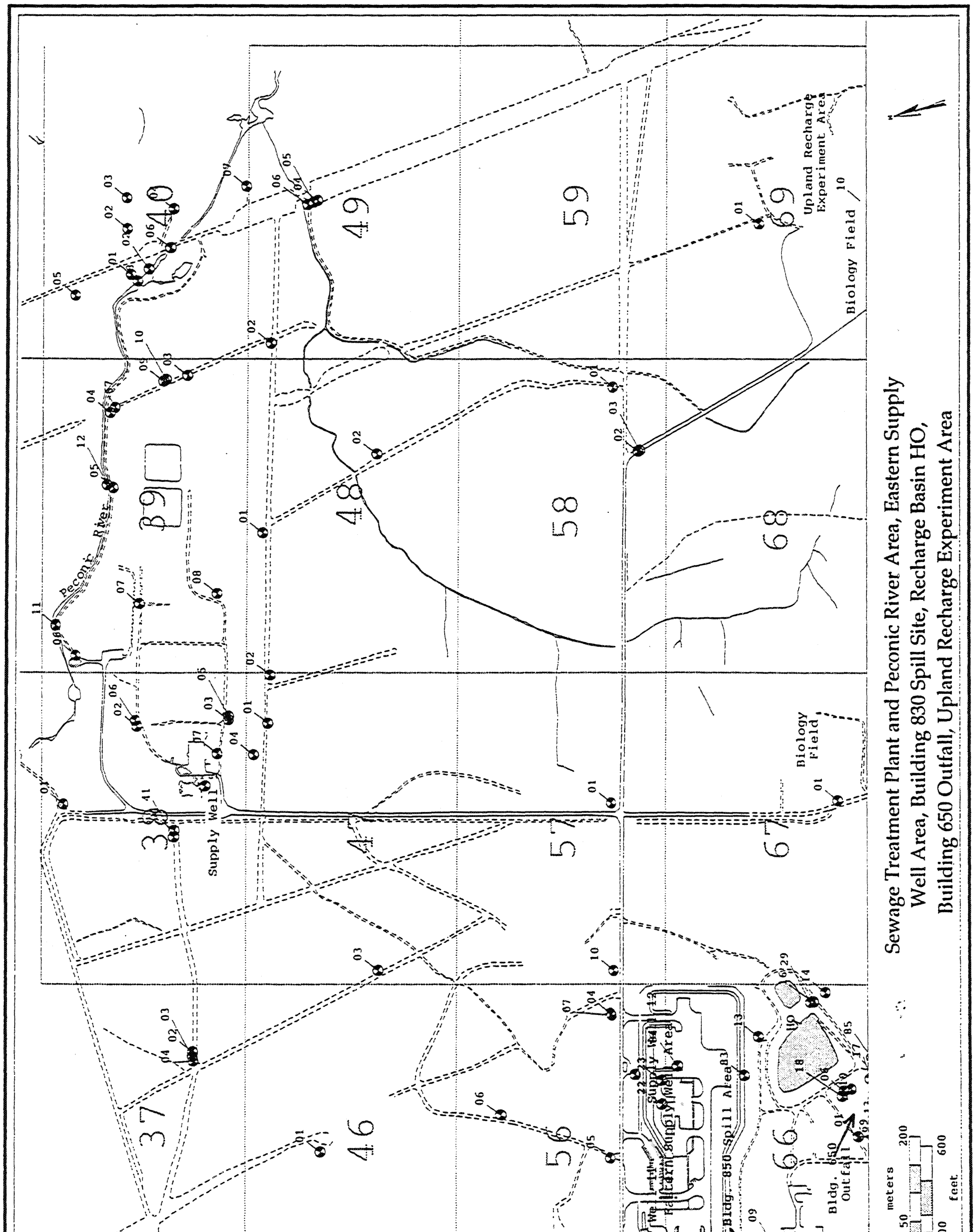
North Boundary - Upgradient/Background Wells For BNL Site and Sewage Treatment Plant (northern portion)

Figure 8-3



Western Supply Well Area (northern portion), AGS Experimental Areas, Waste Concentration Facility, Recharge Basin HT, Water Treatment Plant, Eastern Supply Well Area (western portion)

Figure 8–4



Sewage Treatment Plant and Peconic River Area, Eastern Supply Well Area, Building 830 Spill Site, Recharge Basin HO, Building 650 Outfall, Upland Recharge Experiment Area

Figure 8–5

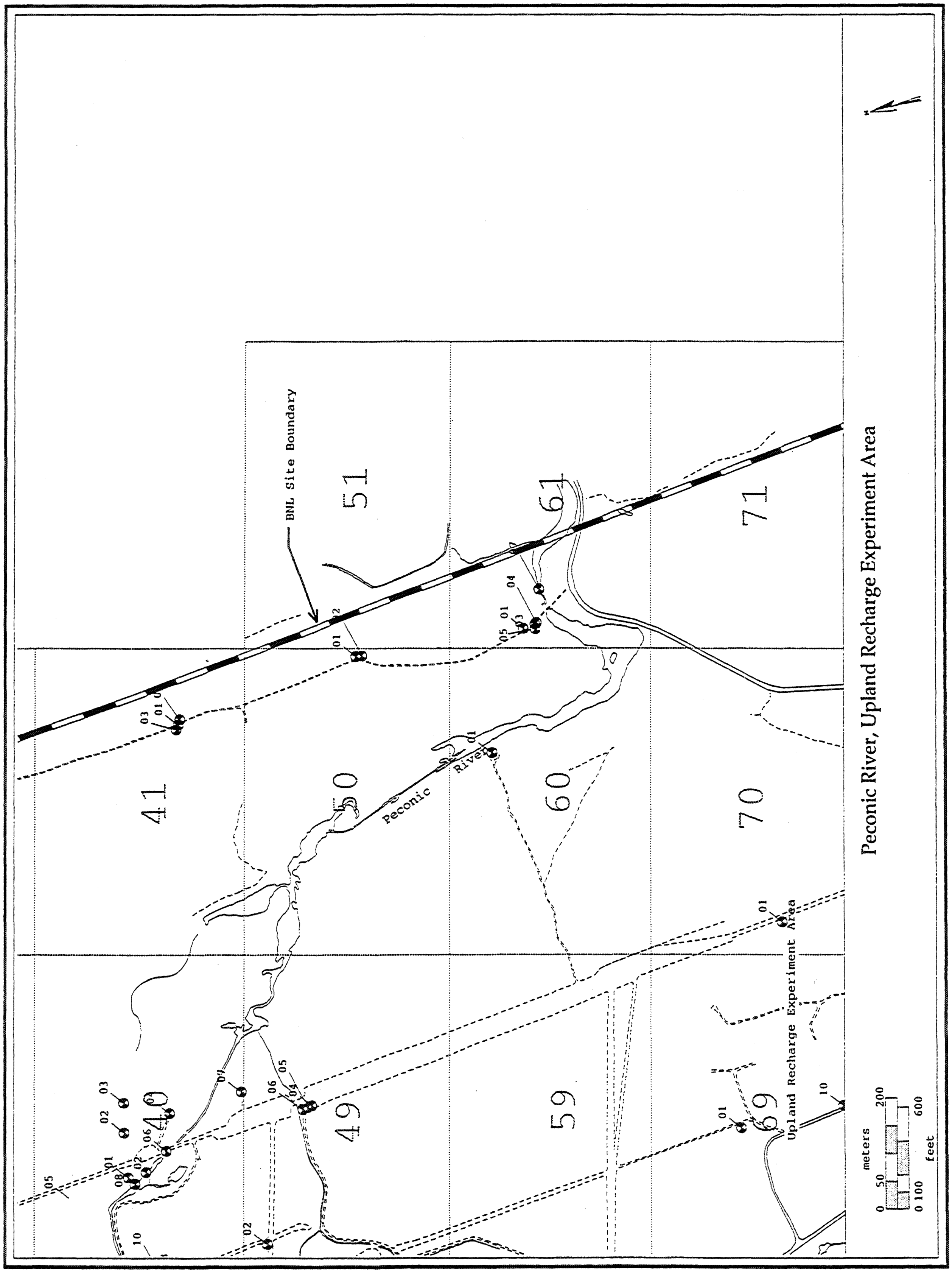
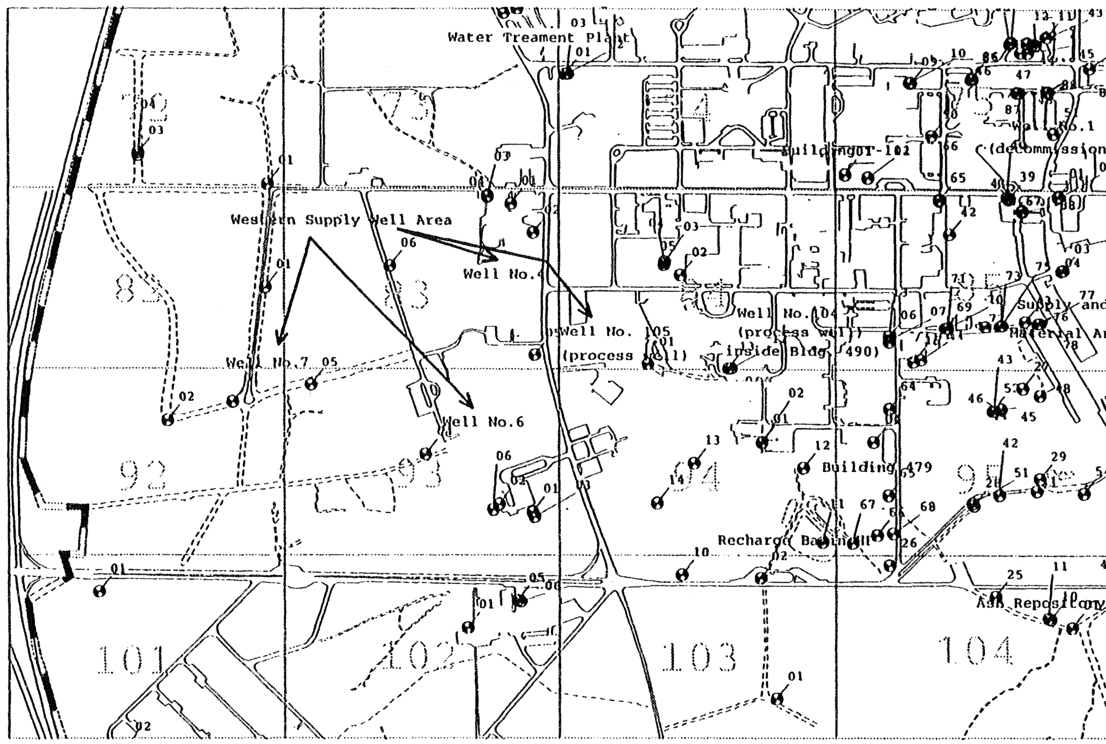
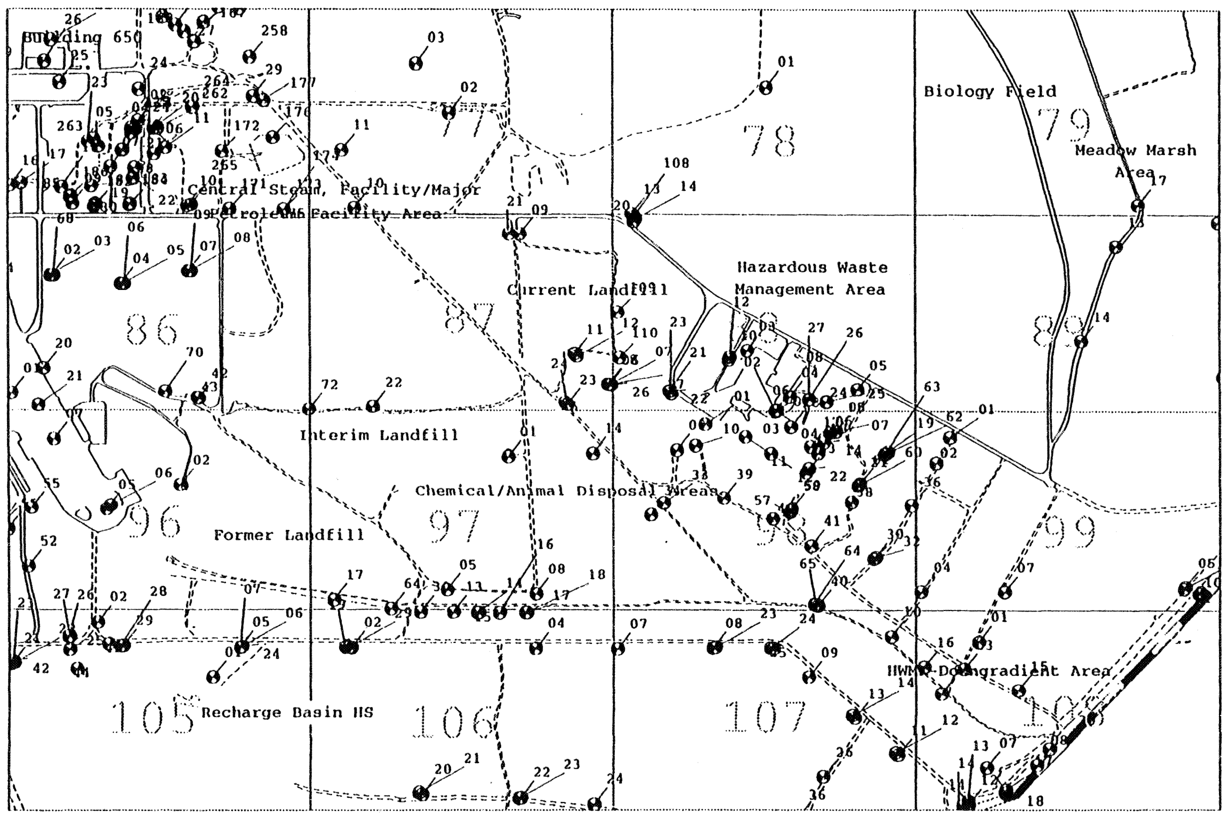

BNL Site Boundary
Peconic River
Upland Recharge Experiment Area
40
41
49
50
51
59
60
61
69
70
71
meters
0 50 200
0 100 600
feet
Peconic River, Upland Recharge Experiment Area

Figure 8–6



Western Supply Well(southern portion), Water Treatment Plant,
Building T-111, Supply and Material Area(northern portion),
Building 479, Recharge Basin HP, Ash Repository Area

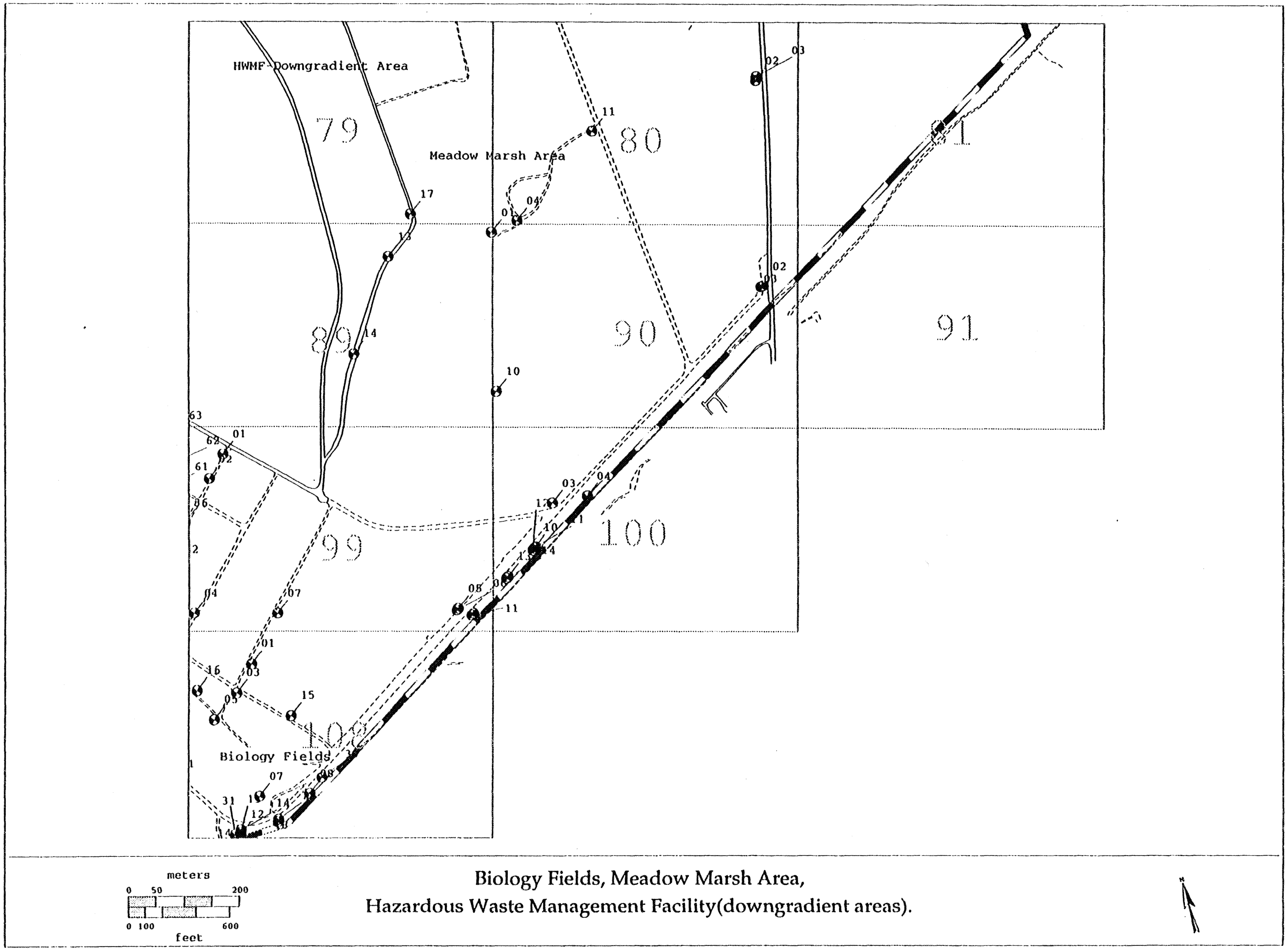
Figure 8-7



meters 0 50 200
0 100 feet 600

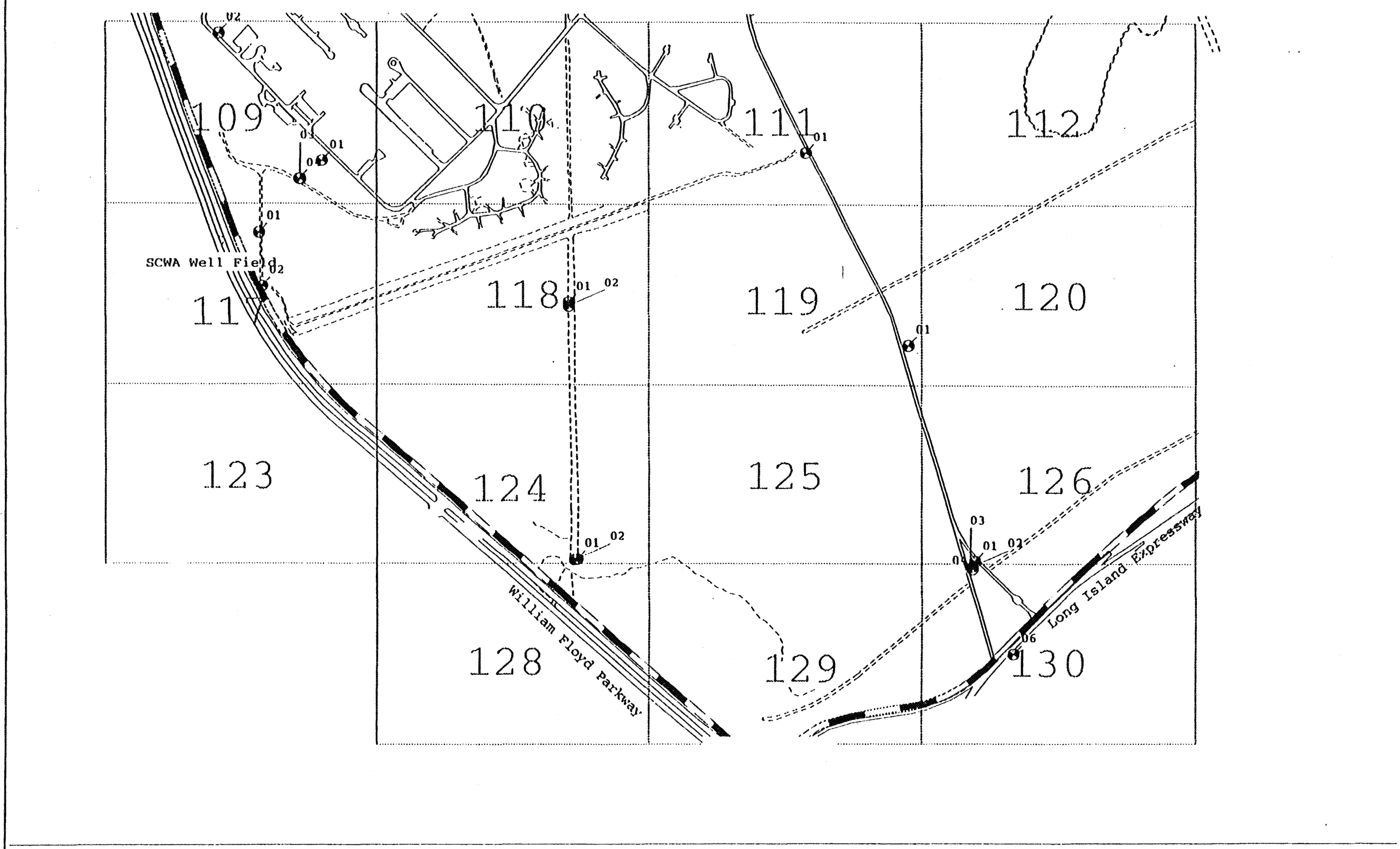
Building 650, Central Steam Facility/Major Petroleum Facility Area,
Biology Fields, Meadow Marsh Area, Hazardous Waste Management Facility,
Current Landfill, Former Landfill Area including Interim Landfill and Chemical/Animal,
Disposal Areas, Supply and Material Area(southern portion)

Figure 8-8



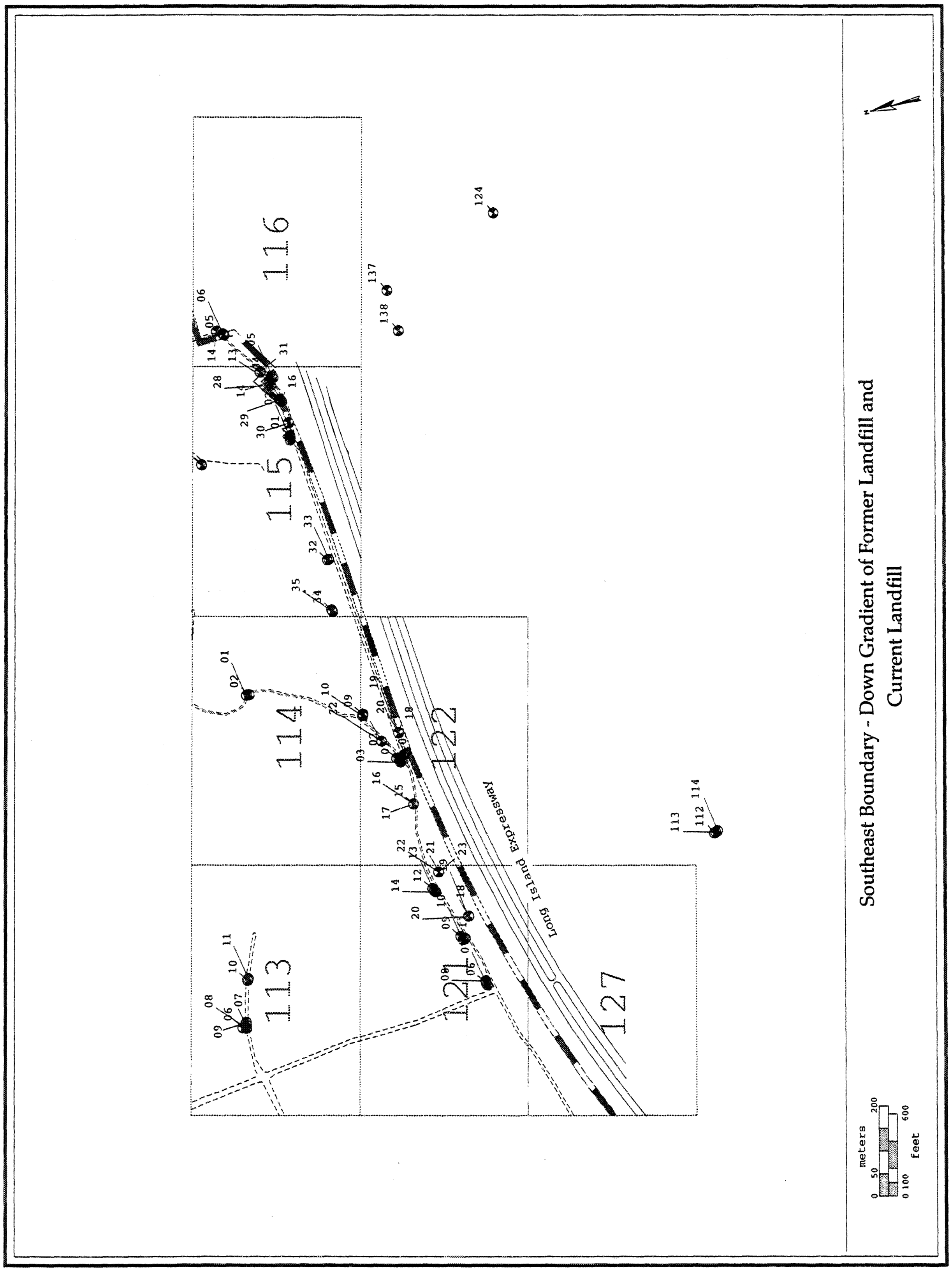
Biology Fields, Meadow Marsh Area,
Hazardous Waste Management Facility(downgradient areas).

Figure 8–9



Southwest Boundary Area

Figure 8–10



Southeast Boundary - Down Gradient of Former Landfill and Current Landfill

Figure 8-11

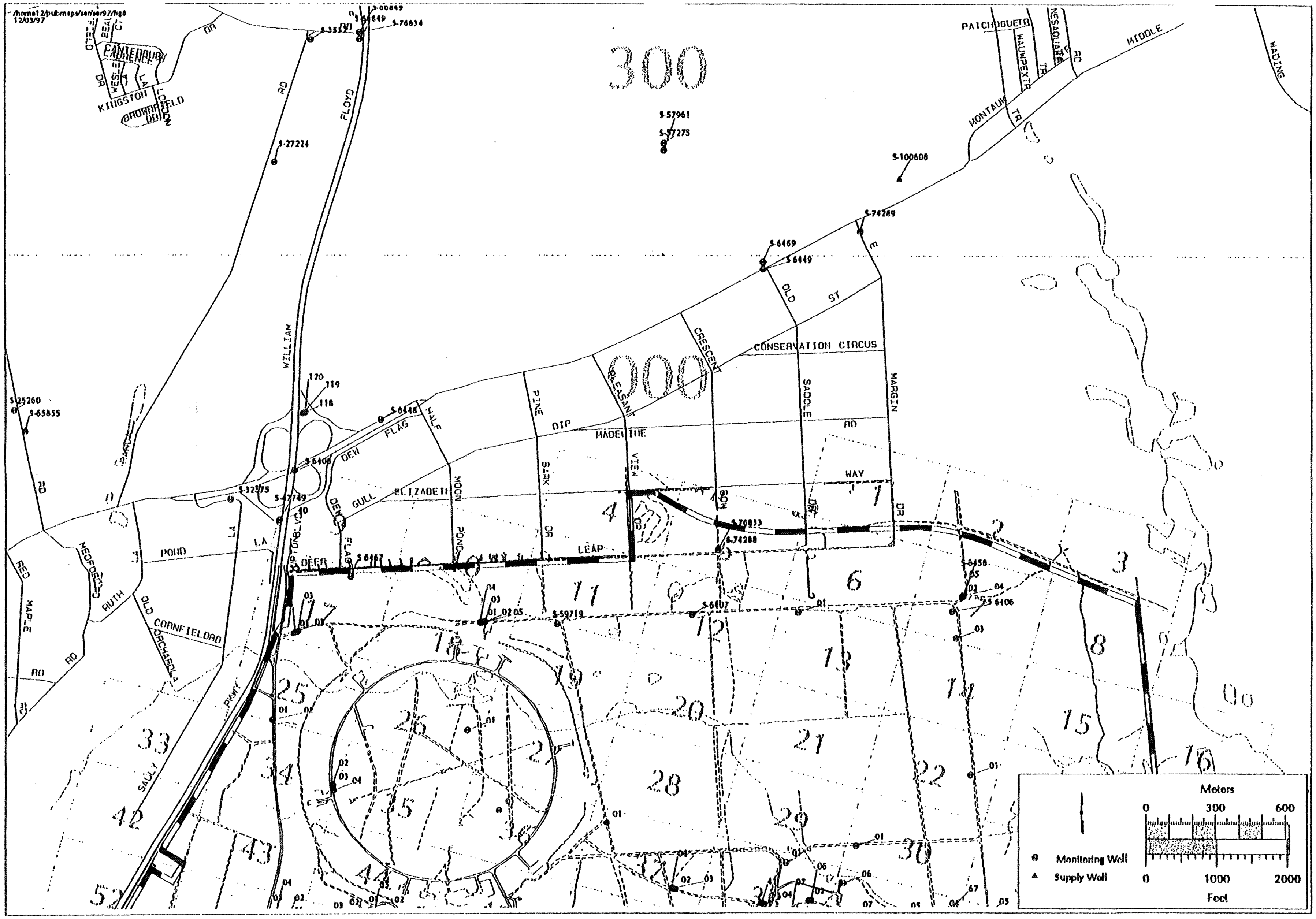


Figure 8-12 Wells Located North of Brookhaven National Laboratory

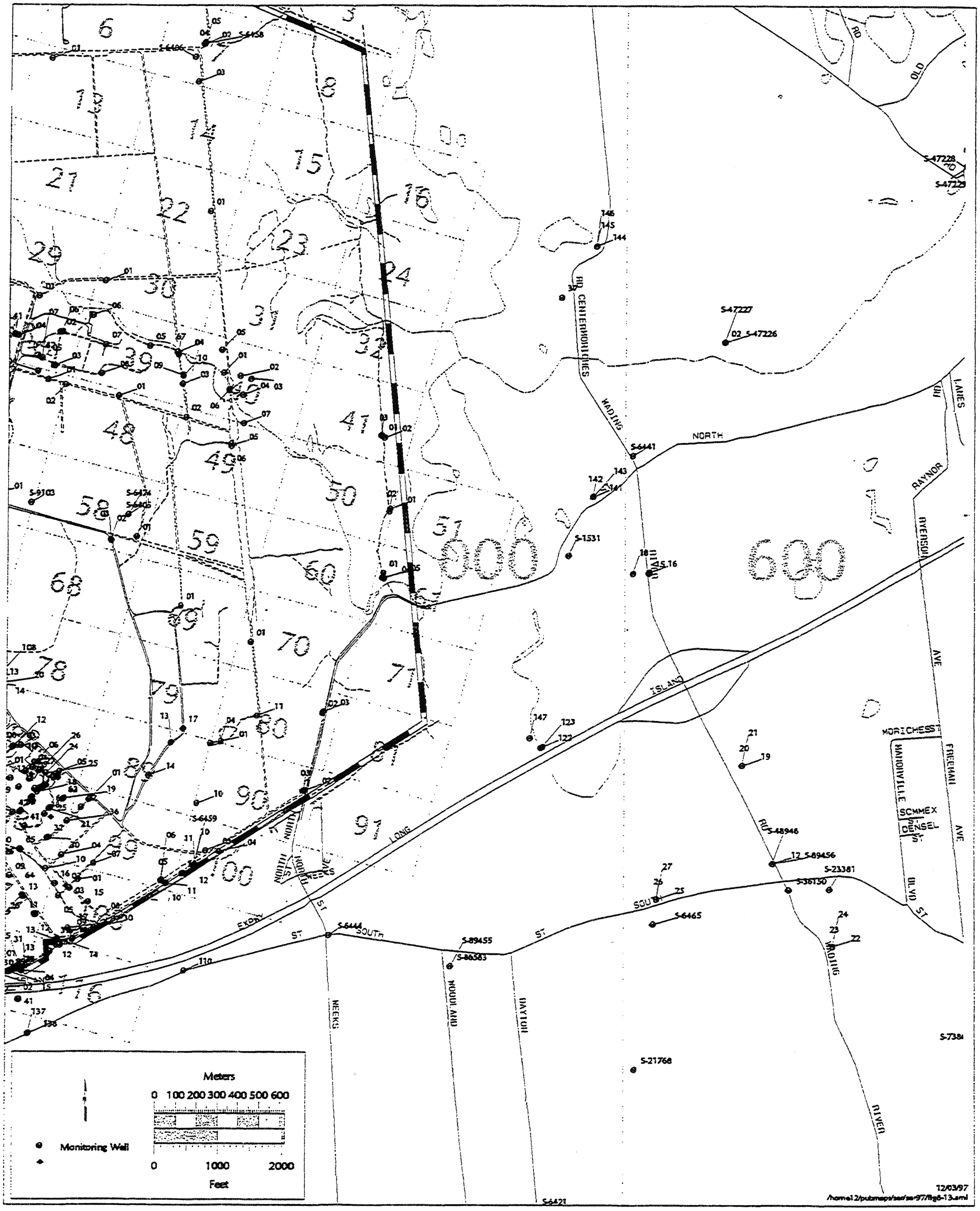


Figure 8-13 Wells Located East of Brookhaven National Laboratory

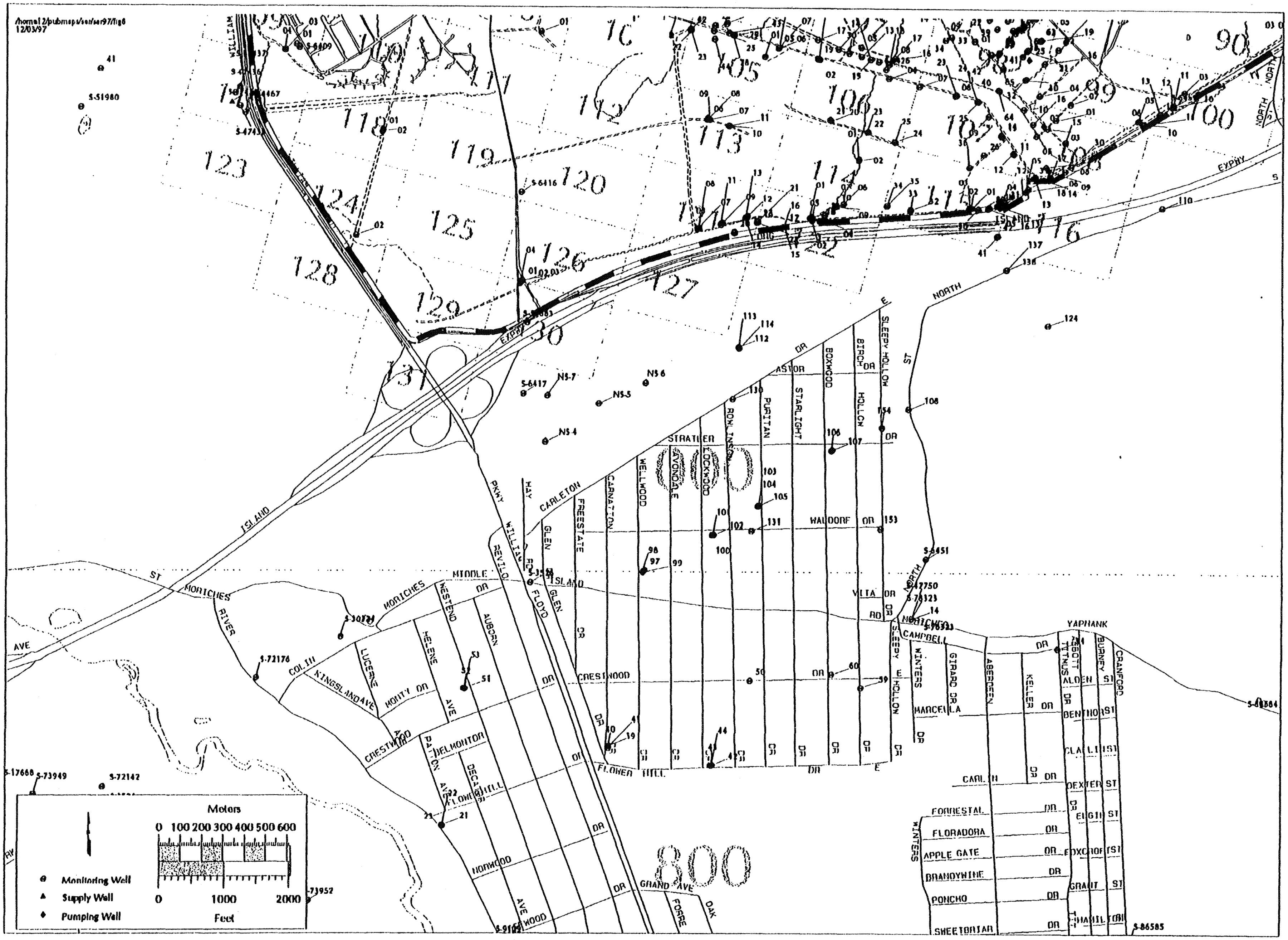


Figure 8-14 Wells Located South of Brookhaven National Laboratory

μg/L; chloroform in one well at a maximum of 7.8 μg/L and chloroethane in one well at maximum concentration of 29 μg/L. Plots for the yearly average trends in DCA concentrations in representative monitoring wells downgradient of the Current Landfill are shown in Figure 8-15.

Former Landfill: The Former Landfill area initially was used by the United States Army during World Wars I and II, then BNL used the southeast corner of the landfill from 1947 through 1966 to dispose of construction and demolition debris, sewage sludge, chemical and low-level radioactive waste, used equipment, and animal carcasses. From 1960 through 1966, Laboratory waste, glassware containing chemical and radioactive waste, and animal carcasses containing radioactive tracers were disposed of in shallow pits in an area directly east of the Former Landfill. From 1966 through 1981, the Laboratory continued to be dispose of used glassware in shallow pits located directly north of the chemical/animal pits noted above. The Former Landfill and the chemical/animal/glass disposal areas have been identified as areas contributing to soil and groundwater contamination. During 1996, a landfill cap was constructed over the Former Landfill, and remedial alternatives for source removal and/or treatment of the chemical/glass hole areas was assessed as part of the OU I FS. The extent of groundwater contamination was evaluated as part of the OU I Groundwater Removal Action (RA V).

The surveillance well network monitoring the Former Landfill area consists of 21 shallow to deep Upper Glacial aquifer wells (Figures 8-8 and 8-11). During 1996, groundwater samples were collected from 14 surveillance wells, and analyzed for water quality, VOCs, and metals (Tables 8-8 to 8-10). As with previous years, the pH of most groundwater samples typically was below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.6. All other water quality parameters were below the applicable NYS AWQS. For metals, only iron exceeded NYS AWQS, with an average concentration of 12.44 mg/L in Well 97-18. Analyses for VOCs show that in four wells contaminants were above NYS AWQS. In wells directly downgradient of the Former Landfill area, TCE was detected in Well 106-14 at 5 μg/L, and PCE and chloroform were detected in Well 97-02 at concentrations of 6.3 μg/L and 9.8 μg/L, respectively. Above NYS AWQS concentrations of VOCs were also detected in two deep wells located at the BNL site boundary. In well 122-04, TCA, TCE and DCE were detected at maximum concentrations of 200μg/L, 5 μg/L and 82 μg/L, respectively . In well 122-05, TCA and TCE were detected at maximum concentrations of 10 μg/L and 9.8 μg/L, respectively

Hazardous Waste Management Facility Area: The HWMF is the central (RCRA) receiving facility for the processing, neutralizing, and storing of hazardous and radioactive wastes before permanent off-site disposal. As the result of past handling, storage and disposal practices, soil and groundwater contamination occurred within the HWMF. Recent investigations indicated that groundwater contamination extends from this facility downgradient to an area south of the Long Island Expressway. The extent of groundwater contamination and assessment of remedial alternatives was evaluated as part of the OU I Groundwater Removal Action (RA V).

The groundwater surveillance well network at and downgradient of the HWMF consists of 45 shallow to deep Upper Glacial aquifer wells (Figure 8-8). During 1996, 19 of these wells were monitored for water quality, metals, and VOCs (Table 8-11). As in previous years, the pH of

Table 8-5
BNL Site Environmental Report for Calendar Year 1996
Current Landfill
Groundwater Surveillance Wells, Water Quality Data

Well	No. of Samples	pH (SU) Range		Conduct. (µmhos/cm)	Chlorides (mg/L)	Sulfates (mg/L) [a]	Nitrate (NO_3) (mg/L) [a]
87-09 (c)	4	5.5 - 5.8	Max.	167	27.2	15	1.4
			Avg.	146	24.2	12.1	<1
87-11	4	6.1 - 6.2	Max.	899	38.4	16.5	<1
			Avg.	796	34.4	12.0	<1
87-23	4	6	Max.	460	24.9	10.3	<1
			Avg.	445	16.9	9.6	<1
87-24	4	6.0 - 6.4	Max.	115	20.2	13.2	<1
			Avg.	113	14.8	11.9	<1
87-26	4	6.5 - 6.9	Max.	148	20.4	16.2	<1
			Avg.	146	17.2	14.3	<
87-27	4	5.9 - 6.5	Max.	363	13.9	10.9	<1
			Avg.	218	7.9	9.4	<1
88-21	4	5.6 - 6.1	Max.	494	53.5	7.5	1.35
			Avg.	290	44.2	7.2	<1
88-22	4	6.4 - 6.7	Max.	651	27.0	18	<1
			Avg.	509	25.3	16.3	<1
88-109	4	5.9 - 6.4	Max.	667	19.8	24.7	<1
			Avg.	643	17	20.1	<1
88-110	4	6.1 - 6.5	Max.	724	26.6	16.9	<1
			Avg.	667	23.7	13.8	<1
NYS AWQS		6.5 - 8.5		(b)	250	250	10
Typical MDL				10	4	4	1

(a): Holding Times for Sulfates and Nitrates were Typically Exceeded.
(b): No Standard Specified.
(c): Upgradient Well.

Table 8-6
BNL Site Environmental Report for Calendar Year 1996
Current Landfill
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
87-06(a)	4(b)	Max.	<0.025	<0.0005	0.016	<0.05	2.140	<0.0002	16.1	<0.002	<0.02
		Avg.	<0.025	<0.0005	0.005	<0.05	0.710	<0.0002	13.6	<0.002	<0.02
87-11	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	60.10	<0.0002	26.3	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	51.57	<0.0002	24.3	<0.002	<0.02
87-23	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	54.22	<0.0002	18.3	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	46.08	<0.0002	16.3	<0.002	<0.02
87-24	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	15.5	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.2	<0.002	<0.02
87-26	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	44.50	<0.0002	18.7	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	20.20	<0.0002	16.2	<0.002	<0.02
87-27	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	22.50	<0.0002	11.1	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	17.78	<0.0002	5.7	<0.002	<0.02
88-21	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	0.42	<0.0002	64.0	<0.002	<0.02
		Avg.	<0.025		<0.005	<0.05	0.17	<0.0002	30.2	<0.002	<0.02
88-22	4(b)	Max.	<0.025	<0.0005	<0.005	<0.05	62.49	<0.0002	25.6	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	41.82	<0.0002	19.9	<0.002	<0.02
88-109	3(b)	Max.	<0.025	<0.0005	<0.005	<0.05	55.40	<0.0002	14.8	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	47.52	<0.0002	12.4	<0.002	<0.02
88-110	3(b)	Max.	<0.025	<0.0005	<0.005	<0.05	63.50	<0.0002	21.1	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	47.14	<0.0002	17.2	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

(a): Upgradient Well.
(b): Three Samples Analyzed for Mercury.

Table 8-7
BNL Site Environmental Report for Calendar Year 1996
Current Landfill - Compliance Monitoring
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	DCA	Chloroethane	Chloroform	Benzene
			µg/L				
Current Landfill Compliance Monitoring							
87-09(a)	4	Max.	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
87-11	4(b)	Max.	<2.0	<2.0	24.1	<2.0	8.0
		Avg.	<2.0	<2.0	13.5	<2.0	5.4
87-23	4(b)	Max.	<2.0	<2.0	17.0	<2.0	3.3
		Avg.	<2.0	<2.0	11.7	<2.0	2.9
88-22	4(b)	Max.	<2.0	16.5	86.0	<2.0	3.1
		Avg.	<2.0	10.9	60.6	<2.0	2.1
88-109	4	Max.	<2.0	47.1	180.0	<2.0	3.4
		Avg.	<2.0	33.9	98.4	<2.0	2.7
88-110	4	Max.	<2.0	2.4	54.8	<2.0	6.1
		Avg.	<2.0	<2.0	29.3	<2.0	3.4
Other Wells (n=4)	16	Max.	<2.0	<2.0	<2.0	2.7	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5	5	5	7	0.7
Typical MDL			2(c)	2(c)	2(c)	2(c)	2(c)

(a): Upgradient Wells
(b): Other Compounds Detected
(c): MDL for 3 of 4 Sample Periods was 0.5 µg/L.

Table 8-7 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Current Landfill - RA V Remediation Area
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	DCA	Chloroethane	Chloroform	Benzene
			←		μg/L		→
RA V Remediation Area							
115-05	2	Max.	7.2	<2.0	<2.0	<2.0	<2.0
		Avg.	6.3	<2.0	<2.0	<2.0	<2.0
115-13	1(d)	Max.	3.5	68.0	29.0	<1.0	<1.0
		Avg.					
115-14	1(d)	Max.	15.5	11.7	<2.0	<2.0	<2.0
		Avg.					
115-16	1(d)	Max.	10.0	<1.0	<1.0	2.0	<1.0
		Avg.					
116-06	2(d)	Max.	14.0	15.6	<2.0	7.8	<2.0
		Avg.	10.3	13.3	<2.0	5.6	<2.0
All Other Wells (n=5)	10	Max.	3.6	<2.0	<2.0	3.8	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5	5	5	7	0.7
Typical MDL			2	2	2	2	2

(d): Other Compounds Detecated

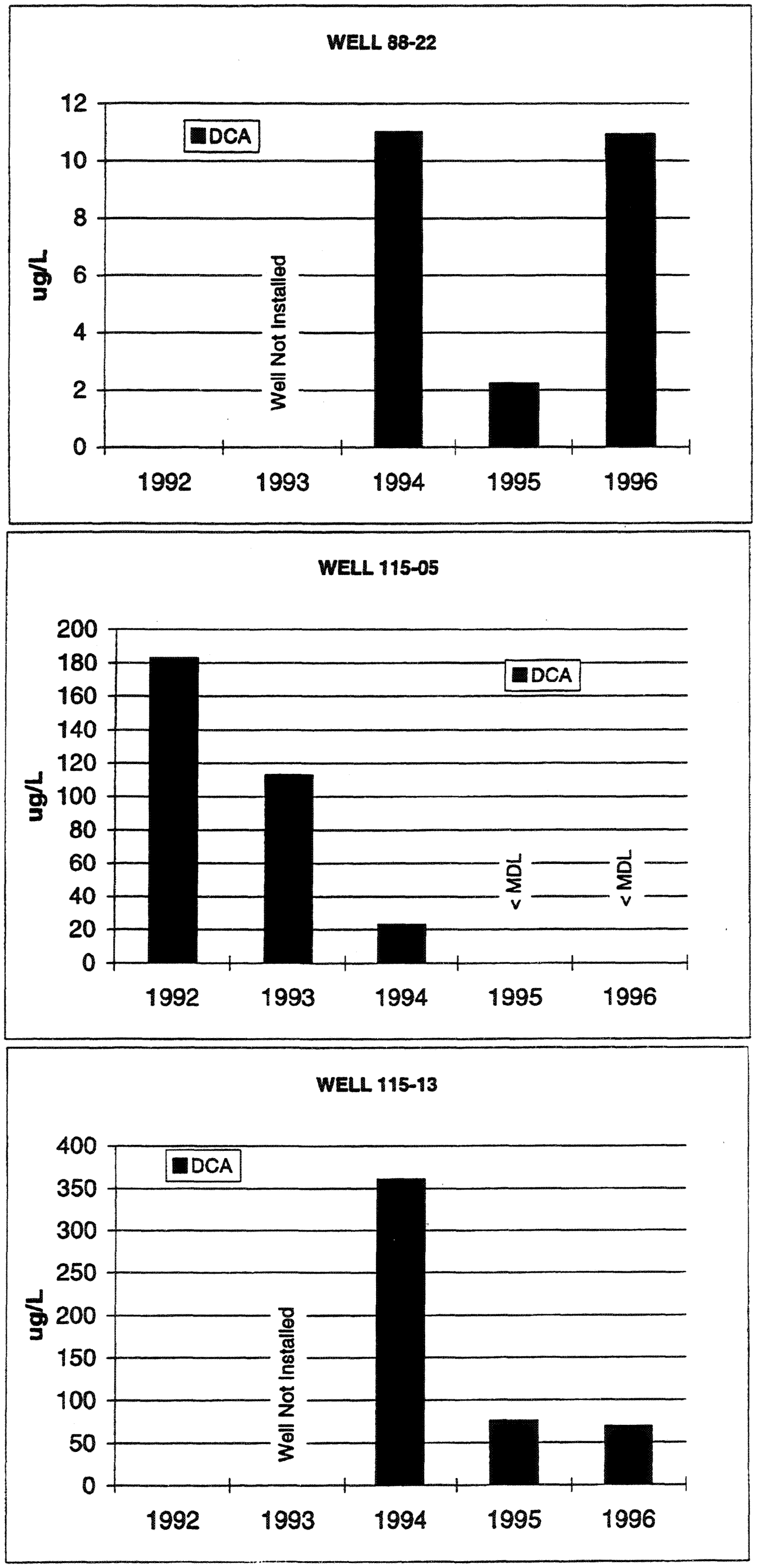


Figure 8-15. Yearly average concentration trends of 1,1 Dichloroethane (DCA) in wells downgradient of the Current Landfill: Well 88-22 located 120m downgradient of landfill; and Wells 115-05 and 115-13 located at the site boundary 1,225m downgradient of landfill.

Table 8-8
BNL Site Environmental Report for Calendar Year 1996
Former Landfill
Groundwater Surveillance Wells, Water Quality Data

Well	No. of Samples	pH (SU) Range		Conduct. (μmhos/cm)	Chlorides (mg/L)	Sulfates (mg/L) [a]	Nitrate (NO_3) (mg/L) [a]
86-42(c)	1(1)	5.85	Max.	114	15.8	13.1	<1
			Avg.				
86-43(c)	2(1)	6.2 - 6.5	Max.	138	20	16.8	<1
			Avg.	138			
97-02	2(1)	4.8 - 5.5	Max.	60	4.3	7.1	1.5
			Avg.	56			
97-03	1(1)	6.7	Max.	421	8.6	39.9	4.1
			Avg.				
97-05	2(1)	5.2 - 5.7	Max.	125	14.3	1.3	5.1
			Avg.	122			
97-18	2(1)	5.7 - 6.3	Max.	380	7	46.1	1.5
			Avg.	377			
106-14	1(0)	4.5	Max.	67	NA	NA	NA
			Avg.				
106-15	2(1)	4.7 - 5.4	Max.	77	6.9	13	<1
			Avg.	76			
106-17	2(1)	4.4 - 5.3	Max.	71	7	10.1	<1
			Avg.	67			
106-18	2(1)	5.2 - 5.9	Max.	57	6.3	8.9	<1
			Avg.	55			
NYS AWQS		6.5 - 8.5		(b)	250	250	10
Typical MDL				10	4	4	1

(a): Holding Times for Sulfates and Nitrates were Typically Exceeded.
(b): No Standard Specified.
(c): Upgradient Well.
( ): Number in the parentheses indicates number of samples analyzed for Chloride, Sulfates and Nitrates.

Table 8-9
BNL Site Environmental Report for Calendar Year 1996
Former Landfill
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
Background Wells (n=2)	4	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	17.9	<0.002	0.03
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	-	15.5	<0.002	<0.02
97-18	2	Max.	<0.025	<0.0005	<0.005	<0.05	15.05	NA	6.1	<0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	12.44	-	5.9	<0.002	<0.02
All Other Wells (n=12)	17(a)	Max.	<0.025	<0.003	0.006	0.016	<0.075	0.0003	15.7	<0.002	0.16
		Avg.	<0.025	<0.003	<0.005	<0.05	<0.075	<0.0002	7.6	<0.002	0.03
NYS AWQS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1	0.002	0.02

(a): Only three samples analyzed for Mercury.
NA: Not analyzed.

Table 8-10
BNL Site Environmental Report for Calendar Year 1996
Former Landfill
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	TCE	PCE	DCE	Chloroform
			←		µg/L		→
Upgradient Wells (n=2)	3	Max.	<2.0	<2.0	<2.0	<2.0	2.4
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
97-02	1	Max.	<2.0	<2.0	6.3	<2.0	9.8
		Avg.					
106-14	1	Max.	<2.0	5.0	<2.0	<2.0	<2.0
		Avg.					
106-17	2	Max.	3.1	<2.0	4.8	<2.0	<2.0
		Avg.	2.2	<2.0	4.4	<2.0	<2.0
122-04	2(a)	Max.	200.0	5.0	2.3	82.0	<1.0
		Avg.	141.0	3.0	1.1	54.0	<1.0
122-05	2(a)	Max.	10.0	9.8	<1.0	4.6	<1.0
		Avg.	8.0	9.4	<1.0	3.8	<1.0
All Other Wells (n=9)	13	Max.	2.9	<2.0	<2.0	<2.0	5.7
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5	5	5	5	7
Typical MDL			2	2	2	2	2

(a): Other Compounds Detected.

Table 8-11
BNL Site Environmental Report for Calendar Year 1996
Hazardous Waste Management Facility
Groundwater Surveillance Wells, Voliatile Organic Compound Data

Location	No. of Samples		TCA	PCE	DCA	Chloroform	Carbon Tetrachloride
			←		µg/L		→
HWMF							
Upgradient Wells (n=3)	6	Max.	<2.0	<2.0	<2.0	2.5	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
88-04	2(a)	Max.	3.0	16.7	<2.0	<2.0	<2.0
		Avg.	2.5	15.3	<2.0	<2.0	<2.0
88-24	2(a)	Max.	2.7	53.8	<2.0	<2.0	<2.0
		Avg.	2.0	42.3	<2.0	<2.0	<2.0
88-26	2(a)	Max.	6.0	8.2	<2.0	<2.0	<2.0
		Avg.	5.5	7.2	<2.0	<2.0	<2.0
98-59	2(a)	Max.	<2.0	<2.0	118.4	<2.0	<2.0
		Avg.	<2.0	<2.0	110.0	<2.0	<2.0
98-61	2(a)	Max.	<2.0	<2.0	6.1	<2.0	<2.0
		Avg.	<2.0	<2.0	3.0	<2.0	<2.0
108-30	1	Max.	9.2	<2.0	<2.0	6.9	11.8
		Avg.					
All Other Wells (n=9)	14	Max.	<2.0	<2.0	2.4	2.7	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5	5	5	7	5
Typical MDL			2	2	2	2	2

(a): One Sample Exceeded 14-day Holding Time.

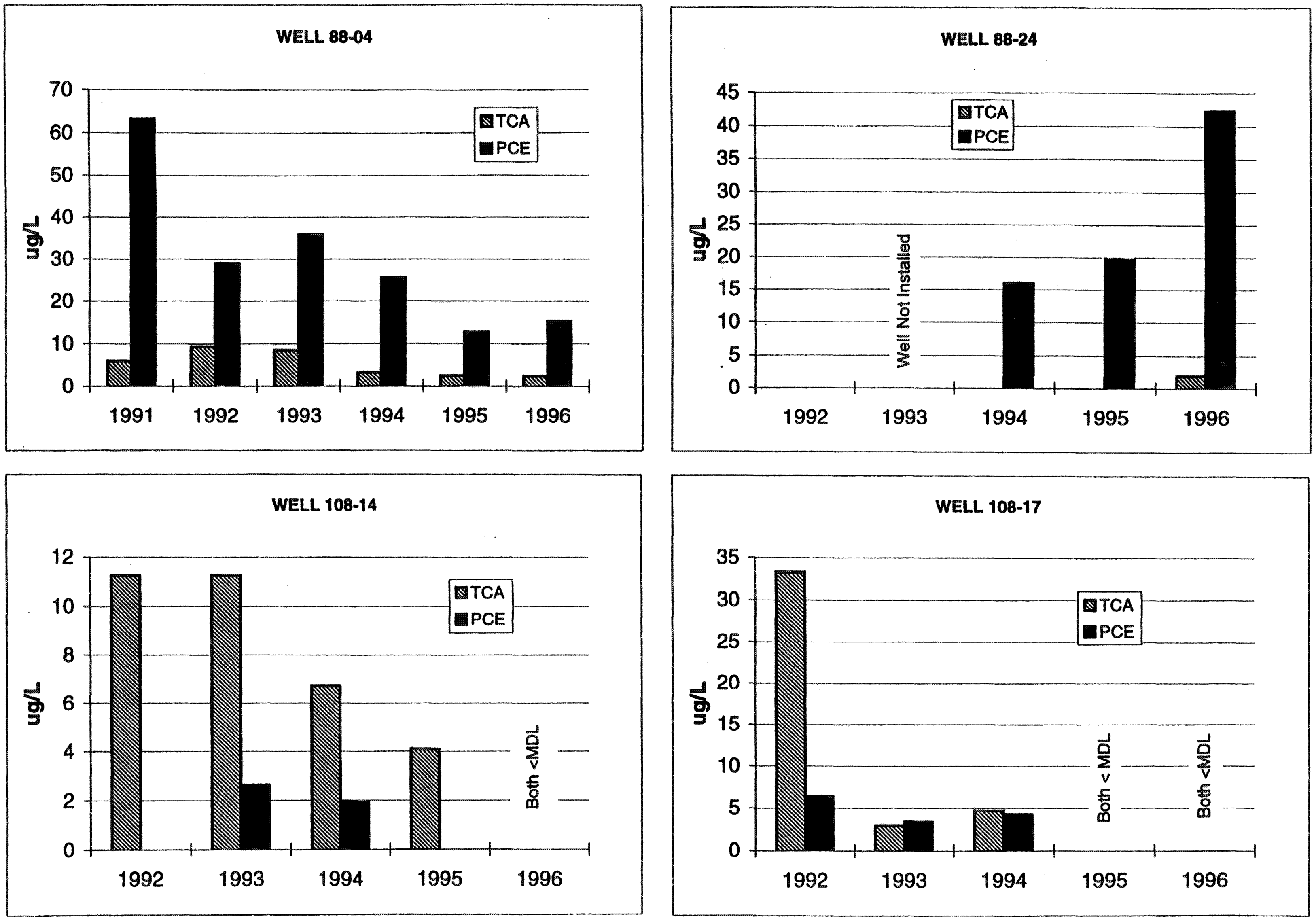


Figure 8-16. Yearly average concentration trends of 1,1,1-Trichloroethane (TCA) and Tetrachloroethylene (PCE) in wells within and downgradient of the Hazardous Waste Management Facility (HWMF): Wells 88-04 and 88-24 located within the HWMF; and Wells 108-14 and 108-17 located at the site boundary 680m downgradient of the HWMF.

groundwater in the HWMF area was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.9. All other water quality parameters were below the applicable NYS AWQS. Sodium was detected at concentrations above the NYS AWQS of 20 mg/L in Wells 88-13 and 98-59, with observed maximum concentrations of 49.1 mg/L and 26.6 mg/L, respectively. All other metals were below the NYS AWQS. Six of the 19 HWMF surveillance wells sampled had VOC concentrations above NYS AWQS. No VOCs were detected above the NYSAWQS in the upgradient Wells 88-13, 88-14, or 88-20. Of the surveillance wells within and downgradient of the HWMF in which NYS AWQS were exceeded, TCA was detected in two wells at maximum concentrations of 6 μg/L and 9.2 μg/L; PCE was detected in three wells at maximum concentrations ranging from 8.2 μg/L to 53.8 μg/L; DCA was found in two wells at maximum concentrations of 6.1 μg/L and 118.4 μg/L; chloroform was detected in one well at a maximum concentration of 6.9 μg/L; and carbon tetrachloride was detected in one well at 11.8 μg/L. Figure 8-16 shows yearly average trends for PCE and TCA based on data from representative monitoring wells within and downgradient of the HWMF.

8.2.1.2 Operable Unit III

***Alternating Gradient Synchrotron and LINAC Areas*:** In the AGS experimental areas, surface spills and discharges to cesspools and recharge basins have contaminated the soils and groundwater with VOCs. Several documented spills have occurred in the AGS Bubble Chamber area, which was used as a storage area for drums and liquid-filled scintillation counters. Groundwater contamination in the AGS experimental areas is being evaluated as part of the OU III RI/FS.

The surveillance well network for the AGS and LINAC areas consists of 19 shallow to deep Upper Glacial aquifer wells which primarily monitor groundwater near and downgradient of the AGS Bubble Chamber spill areas and the AGS and AGS Booster facilities (Figure 8-4). During 1996, groundwater samples were collected from 17 of the AGS/LINAC area surveillance wells, and analyzed for water quality, VOCs, and metals (Tables 8-12 and 8-13. The pH of the groundwater samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8. Other water quality parameters were below the applicable NYS AWQS. Samples from nine wells showed metals concentrations above NYS AWQS. Elevated levels of cadmium were detected in one well (up to 0.02 mg/L), iron in six wells (up to 124 mg/L), sodium in six well (up to 51.9 mg/L), lead in two wells (up to 0.335 mg/L), and zinc was detected in two wells (up to 40 mg/L). Elevated iron and zinc detected in two of the wells, 54-01 and 54-02, is likely due to degradation of the wells' carbon steel casings. VOC analysis of groundwater samples collected from the AGS area show TCA, TCE, and DCA at concentrations that exceeded NYS AWQS. TCA was detected in five wells at maximum concentrations ranging between 6.9 and 75 μg/L. TCE and DCA were also detected in Well 63-04, at maximum concentrations of 7.4 μg/L and 9.4 μg/L, respectively. The VOCs in Well 64-03 may have originated from cesspools associated with Buildings 914 and 919, which are located upgradient of this well. The contents of these cesspools, investigated under the IAG (Cesspools EE/CA), were found to contain VOCs at levels above NYS Soil Cleanup Guidelines. The full extent of groundwater contamination is being examined as part of the OU III RI/FS. No VOCs were detected in the LINAC area wells.

Waste Concentration Facility Area: At the WCF area, minor leaks from above ground storage tanks (D-Tanks), the storage of activated materials, and possible discharges to cesspools has contaminated the soil and groundwater. The extent of soil contamination within the WCF area was examined during the OU II RI/FS, whereas groundwater is being examined during the OU III RI/FS.

The surveillance well network monitoring the WCF consists of eight shallow to deep Upper Glacial aquifer wells (Figure 8-4). During 1996, seven downgradient surveillance wells were sampled for water quality, metals and VOCs (Table 8-14). Typically, the pH of the groundwater samples was below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.3. Although nitrate concentrations were elevated in five downgradient wells, all water quality parameters were below the applicable NYS AWQS. Iron was detected above the NYS AWQS in one well at a concentration of 6.77 mg/L and sodium was detected in another well at 28.1 mg/L. Analysis for VOCs indicated TCA exceeded NYS AWQS in four downgradient wells, 65-02, 65-03, 65-04 and 65-05; maximum observed concentrations ranged from 9 μg/L to 97 μg/L. As with previous years, TCA was also detected up to 6 μg/L in upgradient Well 65-06, which indicates that the TCA in the downgradient wells may not have originated from the WCF. Figure 8-17 plots the trends for TCA based on data from representative monitoring wells within the WCF area.

Building 830 Area: In 1986, a leak in a transfer pipe in the Building 830 liquid waste handling system released approximately 900 gallons of low-level radioactive waste. Remedial actions included removing contaminated soils and installing three shallow Upper Glacial aquifer wells to assess potential impacts to groundwater quality. Past monitoring revealed low-level radionuclide contamination, but below NYS AWQS and DOE DCGs. The full extent of and residual soil and groundwater contamination in this area is being assessed as part of the OU III RI/FS.

During 1996, groundwater samples were collected from the three Building 830 area surveillance wells (Figure 8-5), and were analyzed for metals and VOCs. The pH of groundwater samples was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.3. Metals analyses indicate that only iron exceeded NYS AWQS, being detected in Well 66-08 at a concentration of 1.72 mg/L. As with previous years, no VOCs were detected.

BNL Shotgun Range: In the north central portion of the site (north of the new Waste Management Facility), BNL maintains a shotgun range for recreational use by BNL employees. There is concern that the deposition of lead shot used at the range has or will degrade soil and groundwater quality. Also of significant importance is the fact that the shotgun range lies within the zone of contribution for BNL potable supply wells 11 and 12. Routine sampling of potable supply wells 11 and 12 has not detected elevated lead concentrations. Evaluation of groundwater quality in the shotgun range area was undertaken in late 1996 using two shallow Upper Glacial aquifer wells which had been previously only used for determining groundwater flow directions. The evaluation of soil quality is scheduled for CY 1997, and BNL will evaluate the use of less toxic shot for target practice.

During 1996, groundwater from two wells located in the shotgun range area (upgradient well 46-01 and downgradient well 56-06) were analyzed for metals and water quality. The pH of groundwater was found to be below the NYS AWQS of 6.5 - 8.5, with a pH 5.5 to 5.6. Other water

Table 8-12
BNL Site Environmental Report for Calendar Year 1996
AGS/LINAC Areas
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
Upgradient Wells	3	Max.	<0.025	<0.003	<0.005	<0.05	<0.075	<0.0002	6.1	<0.002	<0.02
(n=2)		Avg.	<0.025	<0.003	<0.005	<0.05	<0.075	<0.0002	6.0	<0.002	<0.02
54-01	2	Max.	<0.025	0.02	<0.005	0.07	8.84	<0.0002	12.3	0.335	40.0
		Avg.	<0.025	0.01	<0.005	<0.05	5.93	<0.0002	11.3	0.168	22.0
54-02	2	Max.	<0.025	<0.003	<0.005	<0.05	77.20	<0.0002	51.9	<0.002	0.62
		Avg.	<0.025	<0.003	<0.005	<0.05	39.07	<0.0002	30.5	<0.002	0.34
54-03	1	Max.	<0.005	<0.003	0.034	<0.05	10.40	<0.0001	30.3	0.352	0.05
		Avg.									
54-07	2(a)	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	24.0	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	-	20.5	<0.002	<0.02
54-09	1	Max.	<0.025	<0.003	0.089	0.230	124.0	0.0004	21.6	0.076	0.23
		Avg.									
54-14	1	Max.	<0.025	<0.003	0.006	<0.05	0.301	<0.0002	15.7	<0.002	0.04
		Avg.									
54-16	1	Max.	<0.025	<0.003	0.005	<0.05	2.6	<0.0002	7.1	<0.002	<0.02
		Avg.									
64-02	2(a)	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	21.7	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	-	20.9	<0.002	<0.02
64-03	2	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	25.0	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	-	22.0	<0.002	<0.02
Other Wells	9	Max.	<0.025	<0.003	0.034	<0.05	0.245	<0.0002	17.0	<0.002	0.03
(n=6)		Avg.	<0.025	<0.003	0.005	<0.05	<0.075	<0.0002	9.9	<0.002	<0.02
NYS AWQS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

(a): Only One Sample Analyzed for Mercury.
NA: Not analyzed.

Table 8-13
BNL Site Environmental Report for Calendar Year 1996
AGS and LINAC Areas
Groundwater Surveillance Wells, Voliatile Organic Compound Data

Location	No. of Samples		TCA	TCE	DCA	DCE
			← μg/L →			
AGS/LINAC						
Upgradient Wells (n=2)	3	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
54-07	2	Max.	10.2	<2.0	<2.0	<2.0
		Avg.	7.8	<2.0	<2.0	<2.0
64-03	2(b)	Max.	75.0	7.4	9.4	3.6
		Avg.	68.0	7.2	9.2	3.3
75-09	1	Max.	20	<1.0	<1.0	3.0
		Avg.				
75-10	1	Max.	9.0	<1.0	1.0	3.0
		Avg.				
85-07	2	Max.	13.6	2.1	4.0	8.9
		Avg.	12.3	<2.0	3.5	7.4
85-13	3	Max.	6.9	<1.0	1.1	3.0
		Avg.	5.8	<1.0	<1.0	2.3
All Other wells (n=13)	16(a)	Max.	2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

(a): Other Compounds Detected.
(b): One Sample Exceeded 14-day Holding Time.

Table 8-14
BNL Site Environmental Report for Calendar Year 1996
Waste Concentration Facility
Groundwater Surveillance Wells, Voliatile Organic Compound Data

Location	No. of Samples		TCA	DCA	Trichlorofluoromethane
			←	μg/L	→
Waste Concentration Facility					
65-06(a)	2	Max.	6.0	<1.0	<1.0
		Avg.	5.5	<1.0	
65-02	2	Max.	97.0	10.0	2.0
		Avg.	51.0	5.0	
65-03	2	Max.	14.0	<1.0	2.0
		Avg.	11.0	<1.0	
65-04	2	Max.	14.0	2.0	3.0
		Avg.	11.0	2.0	
65-05	2	Max.	9.0	<1.0	19.0
		Avg.	7.0	<1.0	
Other Wells	3	Max.	3.0	<1.0	NA
(n=3)		Avg.	1.7	<1.0	
NYS AWQS			5.0	5.0	
Typical MDL			1.0	1.0	1.0

(a): Upgradient Well.
NA: Not Analyzed.

Table 8-15
BNL Site Environmental Report for Calendar Year 1996
Supply and Materiel Area
Ground Water Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA µg/L
Supply & Material			
Upgradient Wells (n=2)	2	Max.	<1.0
		Avg.	<1.0
85-03	3(a)	Max.	<2.0
		Avg.	<2.0
86-21	2(a)	Max.	65.0
		Max.	33.0
96-06	1	Max.	27.0
		Avg.	
96-07	2(a)	Max.	25.2
		Avg.	22.1
105-02	1	Max.	<1.0
		Avg.	
NYS AWQS			5.0
Typical MDL			2.0

(a): One Sample Exceeded 14-day Holding Time.

Table 8-16
BNL Site Environmental Report for Calendar Year 1996
Former Chemistry Building Area - UST
Groundwater Surveillance Wells, Volatile Organic Compounds Data

Location	No. of Samples		Chloroform	Carbon Tetrachloride
			← μg/L →	
85-06	2	Max.	10.0	18.0
		Avg.	9.4	14.8
NYS AWQS			7.0	5.0
Typical MDL			2.0	2.0

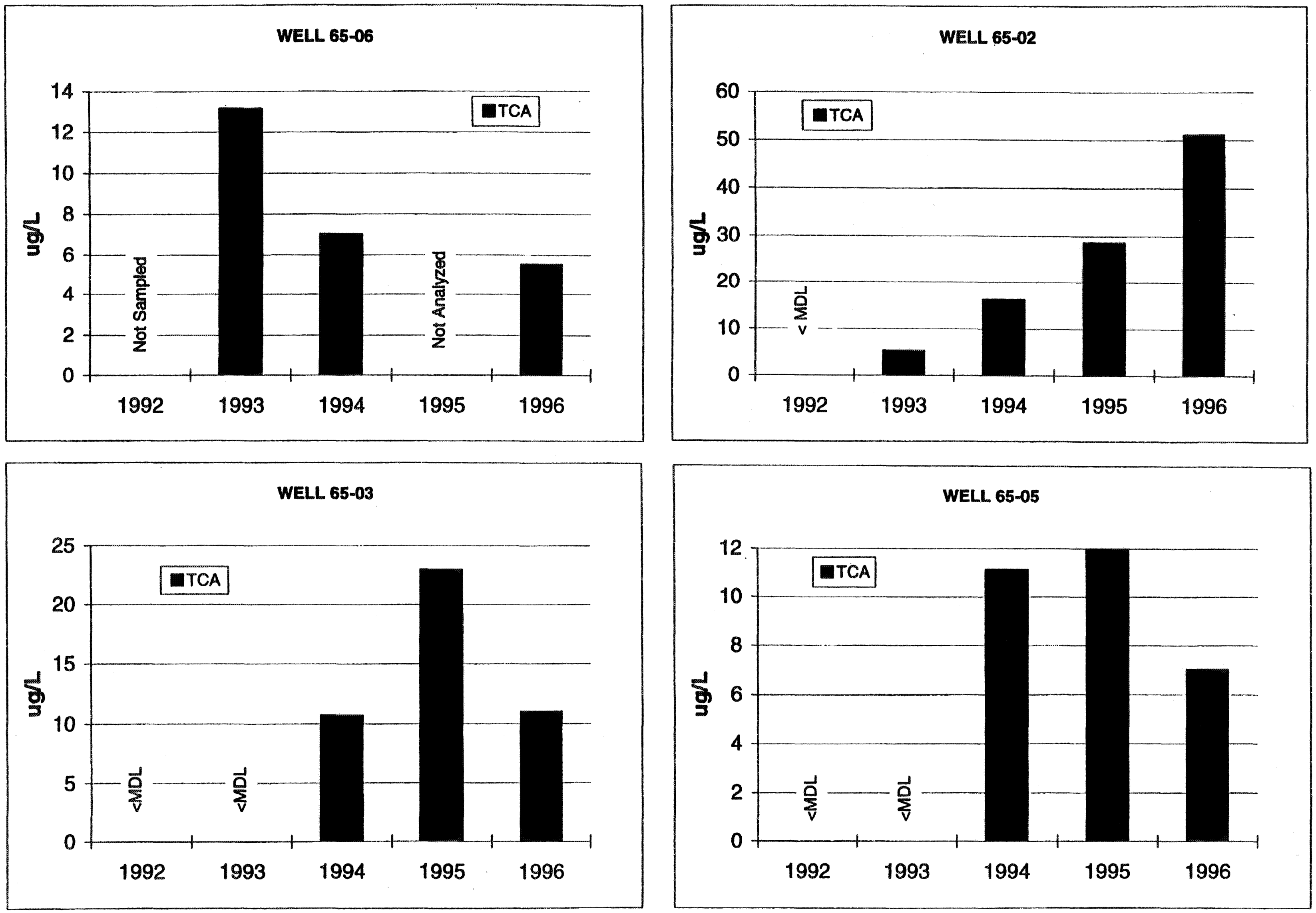


Figure 8-17. Yearly average concentration trends of 1,1,1-Trichloroethane (TCA) in wells upgradient and downgradient of the Waste Concentration Facility (WCF): Well 65-06 located directly upgradient of the WCF; Wells 65-02, 65-03, and 65-05 located directly downgradient of the WCF.

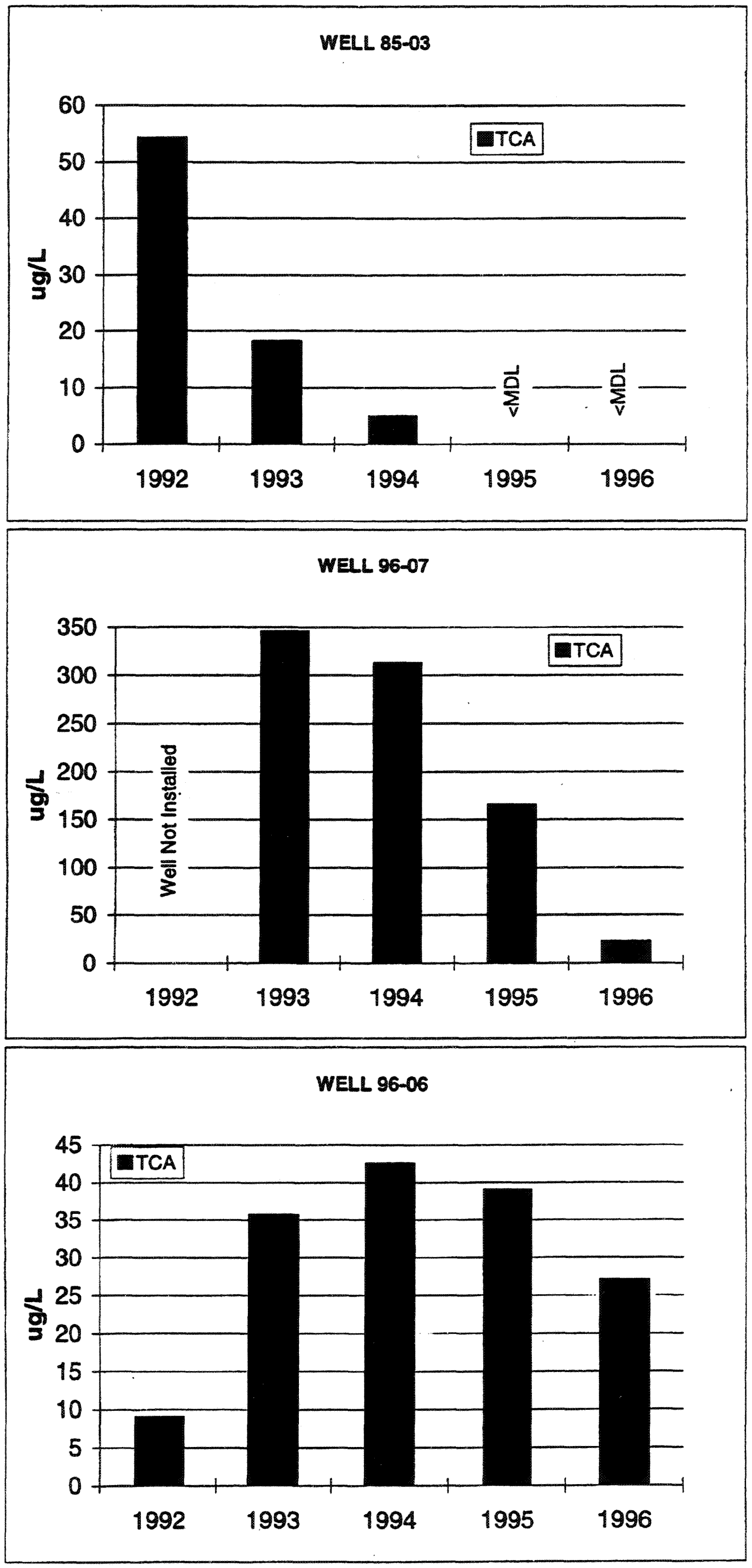


Figure 8-18. Yearly average concentration trends of 1,1,1-Trichloroethane (TCA) in wells located within the Supply and Materiel (S&M) Area: Well 85-03 located in the northern portion of the S&M Area and downgradient of Building T-86; Well 96-07 located 60m downgradient of Building 208; and Well 96-06 located in the downgradient portion of the S&M Area.

quality parameters were below the applicable NYS AWQS. All metals, including lead, were also found to be below NYS AWQS.

***Former Building T-111 Area*:** Historical accounts suggest that between 1951 and 1953 approximately five gallons of TCE was discharged to the ground every other day near former Building T-111 (presently the Building 515 complex). Groundwater monitoring downgradient of the Former Building T-111 area since 1990 has, however, revealed TCA contamination at concentrations slightly above the NYS AWQS. The extent of soil and groundwater contamination in the Former Building T-111 area is being evaluated as part of the OU III RI/FS.

The surveillance well network near and downgradient of the Building T-111 area presently consists of two shallow Upper Glacial aquifer wells (Figure 8-4 and 8-7). During 1996, groundwater samples were collected from the two surveillance wells, and analyzed for VOCs. Analyses for VOCs, however, indicate that only small amounts (2 μg/L) of TCA was detected in well 75-11.

***Water Treatment Plant Area*:** At the direction of the NYSDEC, five groundwater surveillance wells were installed at the WTP in 1993 to assess potential leaching of iron from the plant's recharge basins into the groundwater. Naturally high levels of iron in groundwater are removed at the WTP, and the precipitated iron is discharged to the recharge basins.

During 1996, one round of groundwater samples were collected from these five wells (Figures 8-4 and 8-7), and analyzed for water quality and metals. The pH of the groundwater from two upgradient wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.1, whereas it was within limits in three wells directly downgradient of the basins, with a median pH of 7.0. Other water quality parameters were below the applicable NYS AWQS. The results showed that most metals concentrations (including iron) were below the applicable NYS AWQS. However, sodium was detected slightly above the NYS AWQS of 20 mg/L in two wells, with concentrations of 20.4 and 21.4 mg/L.

***Building 423 (Motor Pool) Area*:** Building 423 serves as the site motor pool, where the BNL fleet vehicles are repaired and refueled. Gasoline is stored in two 8,000 gallon capacity underground storage tanks (USTs), and waste oil is stored in one 500 gallon capacity UST. Although the USTs and associated distribution lines meet SC Article 12 requirements for secondary containment, leak detection, and high level alarms, BNL initiated a groundwater monitoring program in 1996 to ensure that potential leakage will be detected in the event of a tank alarm system failure.

In late 1996, groundwater samples were collected from two newly installed surveillance wells and analyzed for VOCs. The wells were also checked for the presence of floating petroleum product. No floating product was detected, and VOCs were not detected in the groundwater sample from well 102-05. The VOC sample from well 102-06 exceeded its allowable analytical holding time.

***Supply and Materiel Area*:** The Supply and Materiel area is the central shipping and receiving facility for the BNL site, and is also the location of several small machine shops and storage areas. There have been several documented spill events within the Supply and Materiel area, including a release of TCA to the sanitary system and soils near a vapor degreaser located in

Building 208, and a leaking underground fuel oil tank near Building 457. The full extent of soil and groundwater contamination in the Supply and Materiel area is being examined as part of the OU III RI/FS.

The surveillance well network near the Supply and Materiel area consists of eight shallow and two middle Upper Glacial aquifer wells (Figures 8-7 and 8-8). During 1996, seven of the wells were sampled for VOCs (Tables 8-15). The pH of the groundwater samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.1. For VOCs, TCA was detected above NYS AWQS in Wells 86-21, 96-06, and 96-07 at maximum concentrations of 65 µg/L, 27 µg/L, and 25.2 µg/L, respectively. Figure 8-18 plots the yearly average trends for TCA from representative monitoring wells within and downgradient of the Supply and Materiel area.

Former Chemistry Department Area: The Former Chemistry Department complex was located on Rochester Street and Bell Avenue. In the 1950s, the Chemistry Department conducted a long-term solar nuetrino study utilizing a 1,000 gallon-capacity tank installed in an underground location south of Bell Avenue. When in use, this tank was filled with 1,000 gallons of carbon tetrachloride. Available records indicate that the carbon tetrachloride was removed from the tank, and that air was blown through the tank to remove residual traces of the solvent. During CY 1998, BNL will attempt to locate and abandon the tank, and install additional wells to further evaluate groundwater quality downgradient of the tank.

Groundwater quality downgradient of the Former Chemistry Department complex is presently monitored by a single shallow Upper Glacial aquifer well (Figure 8-7). During 1996, the well (85-06) was sampled for VOCs (Table 8-16). Carbon tetrachloride and chloroform were detected above NYS AWQS at maximum concentrations of 18 µg/L and 10 µg/L, respectively.

North Sector: Background water quality for the BNL site is monitored with over 20 surveillance wells which are located north of the BNL site and along BNL's northern boundary. These wells monitor (natural) water quality, as well as potential contamination originating from upgradient sources. These wells consist of shallow, intermediate, and deep Upper Glacial aquifer wells, and several upper Magothy aquifer wells (Figures 8-2, 8-3, and 8-12).

During 1996, 19 of the north sector wells were sampled for water quality, VOCs, and metals (Tables 8-17 and 8-18). The pH of the groundwater samples from the shallow to deep Upper Glacial aquifer wells were typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8, whereas those from Magothy well 17-04 were typically within the NYS AWQS, with a median pH of 7.4. Nitrate concentrations exceeded NYS AWQS in deep Upper Glacial well 17-03 at 10.8 mg/L. Furthermore, PCE was also detected at 4 µg/L in well 17-03, slightly below the NYS AWQS of 5 µg/L. In seven wells, either Iron or sodium concentrations were above NYS AWQS. Iron was detected in three wells at concentrations ranging between 0.315 mg/L and 12 mg/L. Sodium was detected in different three wells, with concentrations ranging between 22.7 and 37.1 mg/L. The nitrates and VOCs detected in Well 17-03 signify the migration of contaminants from off-site areas onto the BNL site.

Western and Central Sectors: Potable and process supply wells located in the west and central sectors of the developed area of the BNL site have been contaminated by low levels of VOCs (principally TCA). The VOCs are likely to have originated from a number of source areas located

Table 8-17
BNL Site Environmental Report for Calendar Year 1996
North Sector
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
17-02	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	22.7	<0.002	<0.02
		Avg.									
17-03	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	27.3	<0.002	<0.02
		Avg.									
17-04	1	Max.	<0.025	<0.0005	<0.005	<0.05	0.315	<0.0002	4.7	<0.002	<0.02
		Avg.									
34-02	1	Max.	<0.005	<0.004	<0.005	0.016	5.630	<0.0001	10.6	<0.002	0.04
		Avg.									
72-03	1	Max.	<0.005	<0.004	<0.005	<0.05	0.230	<0.0001	37.1	<0.002	0.01
		Avg.									
72-04	1	Max.	<0.005	0.005	0.005	0.008	12.00	<0.0001	6.9	<0.002	0.02
		Avg.									
All Other Wells	6	Max.	<0.025	<0.0005	0.005	<0.05	<0.075	<0.0002	18	<0.002	0.07
(n=6)		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.9	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

Table 8-18
BNL Site Environmental Report for Calendar Year 1996
North and West Sectors
Groundwater Surveillance Wells, Voliatile Organic Compound Data

Location	No. of Samples		TCA (µg/L)	PCE (µg/L)	DCA (µg/L)	Chloroform (µg/L)
North Sector						
17-03	2	Max.	<2.0	4.0	<2.0	<2.0
		Avg.	<2.0	2.0	<2.0	<2.0
All Other wells (n=16)	32	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
West Sector						
83-01	2	Max.	<2.0	<2.0	<2.0	16.0
		Avg.	<2.0	<2.0	<2.0	15.5
83-02	2	Max.	7.3	<2.0	<2.0	20.7
		Avg.	5.6	<2.0	<2.0	17.3
83-04	1	Max.	5.0	<2.0	3.0	<1.0
		Avg.				
All Other wells (n=4)	4	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0

Table 8-19
BNL Site Environmental Report for Calendar Year 1996
Southern Sector - North Shirley
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
			←			ug/L		→
South Sector								
104-10	2	Max.	25.0	<1.0	12	<1.0	<1.0	<1.0
		Avg.	14.0	<1.0	6.5	<1.0	<1.0	<1.0
104-11	2	Max.	14.0	2.0	<1.0	2.2	<1.0	<1.0
		Avg.	9.0	1.9	<1.0	1.3	<1.0	<1.0
105-22	2	Max.	13.0	<1.0	69.0	2.0	<1.0	<1.0
		Avg.	6.5	<1.0	35.0	1.0	<1.0	<1.0
105-23	2(a)	Max.	6.4	32.0	1,500.0	1.6	<1.0	<1.0
		Avg.	6.2	20.0	1,205.0	1.3	<1.0	<1.0
113-07	2	Max.	120.0	<1.0	2,200.0	16.0	<1.0	<1.0
		Avg.	78.0	<1.0	1,595.0	13.0	<1.0	<1.0
113-08	2(a)	Max.	3.0	1.0	1,500.0	<1.0	<1.0	<1.0
		Avg.	1.5	<1.0	1,350.0	<1.0	<1.0	<1.0
113-09	2	Max.	1.2	<1.0	6.7	<1.0	<1.0	5.2
		Avg.	1.1	<1.0	4.3	<1.0	<1.0	4.6
113-10	2	Max.	4.3	<1.0	21	<1.0	<1.0	1.5
		Avg.	2.4	<1.0	15.5	<1.0	<1.0	1.3
NYS AWQS		5.0	5.0	5.0	5.0	5.0	7.0	5.0
Typical MDL		1.0	1.0	1.0	1.0	1.0	1.0	1.0

(a): Other Compounds Detected.
(J): Estimated Concentration.

Table 8-19 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Southern Sector - North Shirley
Groundwater Surveillance Wells, Volatile Organic Compound Data

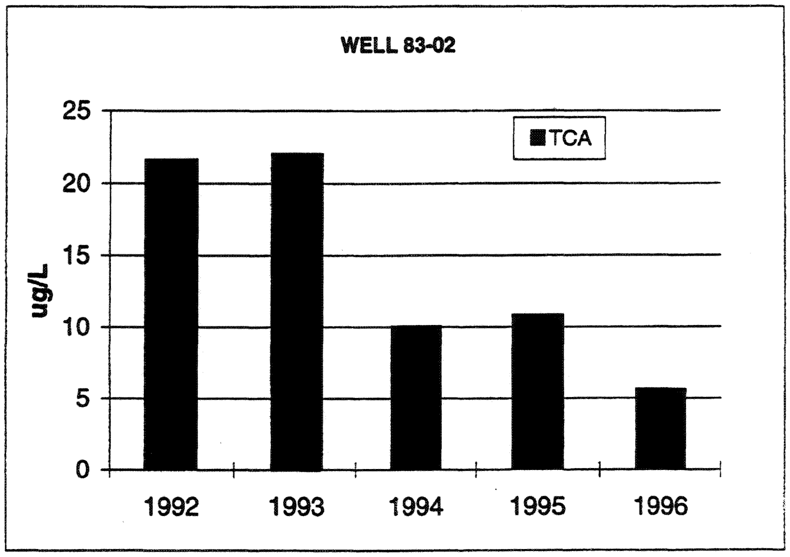
Location	No. of Samples		TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
			←			ug/L		→
South Sector								
113-11	2(a)	Max.	1.4	1.0	<1.0	<1.0	11.0	520.0
		Avg.	1.0	<1.0	<1.0	<1.0	10.5	440.0
121-10	2(a)	Max.	5.9	17.0	3,900.0	2.0	3.0	200.0
		Avg.	5.4	15.5	2,600.0	1.9	2.7	137.0
121-11	2	Max.	34.0	3J	<5.0	10.0	5.6	<5.0
		Avg.	30.5	2.5J	<5.0	8.9	<5.0	<5.0
121-13	2	Max.	78.0	9.2	13.0	24.0	2.1	10.0
		Avg.	39.0	4.6	11.5	12.0	2.0	8.0
121-14	2(a)	Max.	920.0	27.0	<1.0	280.0	2.0	5.0
		Avg.	715.0	27.0	<1.0	225.0	1.6	4.9
103-02	3	Max.	9.8	6.3	<2.0	2.0	2.0	<2.0
		Avg.	7.8	5.2	<2.0	<2.0	<2.0	<2.0
130-03	2	Max.	8.0	10.0	<2.0	3.3	3.5	<2.0
		Avg.	7.0	9.0	<2.0	3.1	3.3	<2.0
Other Wells	19	Max.	1.4	<1.0	<1.0	<1.0	1.6	1.6
(n=15)		Avg.	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NYS AWQS		5.0	5.0	5.0	5.0	5.0	7.0	5.0
Typical MDL		1.0	1.0	1.0	1.0	1.0	1.0	1.0

(a): Other Compounds Detected.
(J): Estimated Concentration.

Table 8-19 (Continued)
BNL Site Environmental Report for Calendar Year 1996
Southern Sector - North Shirley
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
			ug/L					
North Shirley								
000-104	1	Max.	<1.0	16.0	<1.0	<1.0	1.0	13.0
		Avg.						
000-112	1	Max.	<100.0	<100.0	<100.0	<100.0	40J	5,100.0
		Avg.						
000-130	1	Max.	1.0	19.0	<1.0	<1.0	15.0	970.0
		Avg.						
000-131	1	Max.	3.0	17.0	<1.0	1.0	2.0	100.0
		Avg.						
Other Wells	25	Max.	<1.0	<1.0	<1.0	<1.0	2.0	<1.0
(n=21)		Avg.	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NYS AWQS		5.0	5.0	5.0	5.0	5.0	7.0	5.0
Typical MDL		1.0	1.0	1.0	1.0	1.0	1.0	1.0

(a): Other Compounds Detected.
(J): Estimated Concentration.



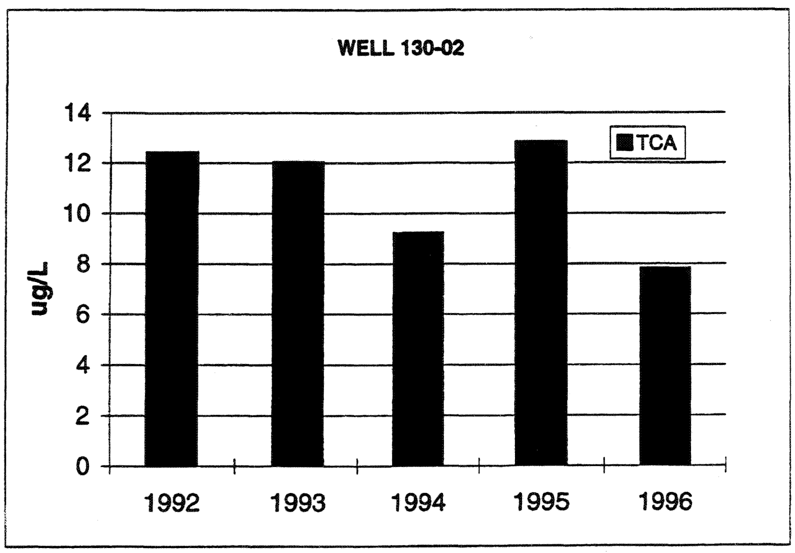


Figure 8-19. Yearly average concentration trends of 1,1,1-Trichloroethane (TCA) in wells within the West Sector and southwest boundary of the BNL site: Well 83-02 located in the Paint Shop and Potable Well 4 area; and Well 130-02 located near BNL's South Gate.

in the (upgradient) AGS experimental areas, operations at the Paint Shop, and possibly from sewer-line leaks. Moreover, the combined pumpage from the supply wells have resulted in considerable deviations in the direction of groundwater flow (horizontally and vertically) and the commingling of contaminant plumes. Source area characterization and groundwater contamination is being assessed in the west and central sector areas (specifically, in the vicinity of the Paint Shop, Potable Well 4, decommissioned Potable Well 2, and Process Supply Wells 9, 104, and 105), as part of the OU III RI/FS.

The western and central sector of BNL is currently monitored by ten shallow to middle Upper Glacial aquifer surveillance wells (Figure 8-7). During 1996, seven of the wells were sampled for VOCs and four were also sampled for water quality and metals (Table 8-18). The pH of the samples was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.7. All other water quality parameters were below applicable NYS AWQS. Metals analyses indicate that iron and sodium exceeded NYS AWQS. Iron and sodium were detected in well 84-03, at concentrations of 0.417 mg/L and 34.9 mg/L, respectively. Also, iron was detected in well 84-05 at 6.21 mg/L and sodium was detected in well 84-01 at 20.5 mg/L. Groundwater from Well 83-01 exceeded the NYS AWQS for chloroform at a maximum concentration of 16 µg/L. TCA and chloroform were detected in well 83-02, with maximum observed concentrations of 7.3 µg/L and 20.7 µg/L, respectively. TCA was also detected in well 84-04 at the AWQS of 5 µg/L. Figure 8-19 plots the concentration trends for TCA for Well 83-02.

***South Sector and Off-site Areas*:** Due to the direction of groundwater flow, groundwater contamination resulting from chemical releases in the central developed area of the site (e.g., the AGS experimental areas, WCF, Former Building T-111, Paint Shop, and the Supply and Materiel Warehouse area) would ultimately migrate to BNL's southern boundary before moving off-site. Groundwater surveillance using recently installed off-site wells has shown that VOCs have migrated beyond BNL's southern boundary and into the North Shirley area.

The surveillance well network monitoring BNL's southern sector (south of Princeton Avenue) consists of nearly forty wells which monitor the shallow, intermediate, and deep portions of the Upper Glacial aquifer and two Magothy aquifer wells (Figures 8-7, 8-10, 8-11, and 8-14). Twenty-five wells are located south of BNL in North Shirley. (Please note that South Boundary surveillance wells monitoring the Current Landfill and HWMF are not included in this summary.) Furthermore, two new Upper Glacial aquifer wells were installed between the BNL apartment area (southwest corner of BNL) and the SCWA William Floyd Well Field. During 1996, 32 on-site and 25 off-site Upper Glacial wells were sampled for metals and VOCs (Table 8-19). Samples from six on-site wells were also analyzed for water quality. The pH of the groundwater was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.9. All other water quality parameters were below applicable NYS AWQS. Metals analyses indicated that iron and sodium exceeded NYS AWQS in numerous wells. Iron was detected above NYSAWQS in 14 on-site and 18 off-site wells. In samples from on-site wells, iron concentrations ranged from 0.321 mg/L to 11.3 mg/L, whereas iron concentrations in off-site wells ranged from 0.323 mg/L to 5.29 mg/L. Sodium was detected above NYSAWQS in five on-site and two off-site wells. In samples from on-site wells, sodium concentrations ranged from 21.1 mg/L to 44.8 mg/L, whereas iron concentrations in off-site wells ranged from 25.6 mg/L to 27.1 mg/L. Analysis of groundwater samples indicates widespread VOC contamination in the southern sector of the site. Principal

VOCs detected at concentrations at or above NYS AWQS were TCA, TCE, PCE, DCE, chloroform and carbon tetrachloride. Figure 8-19 plots the concentration trends for TCA in southern boundary well 130-02.

Maximum observed concentrations in on-site wells were: TCA in 11 wells ranging from 5.9 μg/L to 920 μg/L; TCE in six wells ranging from 6.3 μg/L to 32 μg/L; PCE in nine wells ranging from 6.7 μg/L to 3,900 μg/L; DCE in four wells ranging from 10 μg/L to 280 μg/L; chloroform in one well at 11 μg/L; and carbon tetrachloride in five wells ranging from 5 μg/L to 520 μg/L. Additionally, compounds such as methylene chloride (up to 67 μg/L) and toluene (up to 5 μg/L) were occasionally detected at concentrations exceeding NYS AWQS (see the OU III RI Report for a complete listing of detected compounds). No VOCs were detected in samples collected from wells installed between BNL and the SCWA William Floyd Well Field (e.g., BNL monitoring wells 109-03 and 109-04). Analysis of groundwater samples from off-site middle to deep Upper Glacial aquifer wells indicates that VOCs originating from BNL, and possibly other off-site source areas, is present in some areas of North Shirley (Table 8-19). The principal VOCs detected at concentrations at or above NYS AWQS were TCE, chloroform, and carbon tetrachloride. The maximum observed concentrations in off-site wells were: TCE in three wells ranging from 16 μg/L to 19 μg/L; chloroform in two wells at maximum concentrations of 15g/L and 40 μg/L; and carbon tetrachloride in four wells ranging from 13 μg/L to 5,100 μg/L. For detailed information on the distribution of VOCs in BNL's southern sector and in North Shirley, the reader is referred to the OU III Remedial Investigation Report.

8.2.1.3 Operable Unit IV

Central Steam Facility/Major Petroleum Facility Area: The CSF supplies steam for heating to all major facilities of the Laboratory through an underground distribution system. The MPF is the holding area for most fuels used at the CSF. Five shallow wells monitoring the MPF were installed as part of the licensing requirements for this facility, and are screened across the water table so that free products (i.e., oil floating on top of the groundwater) can be detected. The surveillance wells at the CSF were installed primarily to monitor ground-water contamination resulting from a 1977 leak of approximately 23,000 gallons of Alternative Liquid Fuel (a fuel oil/spent solvent mixture). The CSF/MPF area has been the subject of an RI/FS (OU IV), and will undergo active soil and groundwater remediation starting in the winter of 1997.

The surveillance well network at the CSF and MPF area consists of 30 shallow to deep Upper Glacial aquifer wells (Figures 8-5 through 8-8). During 1996, 23 wells were monitored for water quality, metals, and VOCs (Table 8-20). The five MPF wells were also sampled monthly for floating petroleum products, and two times per year for polynuclear aromatics and base-neutral extractable compounds (EPA Method 625), in accordance with the NYSDEC license (see Section 2.3.4). The pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.0. Other water quality parameters were below the applicable NYS AWQS. Most metals concentrations were below the applicable NYS AWQS, except iron concentrations were elevated in three wells with maximum values ranging between 2.02 mg/L and 32.49 mg/L), and sodium exceeded the standard in one well at a concentration of 23.7 mg/L. In the five wells monitoring the MPF, VOCs were present at concentrations above NYS AWQS in upgradient Well 76-25 with TCA at a maximum concentration of 17.4 μg/L. The TCA detected in well 76-25 is likely to have originated from releases in the Building 650 area. No BETX, or other hydrocarbon-related compounds were detected in the MPF wells. The five surveillance wells at the MPF were examined monthly for floating petroleum products; as in previous years, no floating petroleum products were observed during 1996.

Of the 18 CSF surveillance wells sampled during 1996, eight wells had VOCs at concentrations above NYS AWQS: TCA was detected in one well at maximum concentration of 14.3 μg/L; TCE was detected in one well at maximum concentration of 10 μg/L; PCE was detected in seven wells at maximum concentrations ranging from 10.7 μg/L to 40 μg/L; DCE was detected in one well at 19.9 μg/L. Numerous other VOCs were detected in wells 76-04 and 76-08, which are located within and directly downgradient of the 1977 spill site: cis-1,2-DCE (up to 107.5 μg/L); ethylbenzene (up to 520 μg/L); 1,2,3-trimethylbenzene (up to 45.2 μg/L); 1,2,4-trimethylbenzene in well 76-04 (up to 31.7 μg/L); 1,3,5-trimethylbenzene (up to 125.2 μg/L); 1-ethyl-2-methylbenzene (up to 91.5 μg/L); 1-ethyl-4-methylbenzene in well 76-04 (up to 73.5 μg/L); n-butyl ether in well 76-04 (up to 180 μg/L); Toluene (up to 850 μg/L); and xylene (total) (up to 950 μg/L). Plots for ethylbenzene, toluene, and xylene (total) based on data from representative monitoring wells downgradient of the 1977 fuel oil/solvent spill area are given in Figure 8-20.

Building 650**:** Building 650 was used as a decontamination facility for the removal of radioactivity from clothing and heavy equipment. Drainage from an exterior heavy-equipment decontamination pad led to a natural depression approximately 800 feet to the northeast of the building (known as the Building 650 Sump Outfall), near AGS Recharge Basin HO. The surveillance well network at Building 650 and the 650 Outfall area consists of 11 shallow Upper Glacial aquifer wells (Figure 8-8). Ten wells were installed in 1993 as part of the OU IV RI/FS; during which the extent of groundwater contamination resulting from operations at Building 650 was evaluated. Remedial alternatives for radiologically contaminated soils are being evaluated as part of the OU I FS.

During 1996, groundwater samples were collected for metals and VOC analysis from Building 650 wells 76-25, 76-26, and 76-28 (Table 8-21). The pH of the groundwater was typically below the NYS AWQS of 6.5 to 8.5, with a median pH of 6.1. All metals concentrations were below the applicable NYS AWQS. However, TCA was detected in Well 76-25 and Well 76-26 at maximum concentrations of 17.4 μg/L and 5.0 μg/L, respectively. In the 650 sump outfall area, six wells were sampled for water quality, metals and radionuclides (radionuclide data presented in Section 8.2.2). The pH of the groundwater in the 650 sump outfall area was typically slightly below the NYS AWQS of 6.5 to 8.5, with a median pH of 6.2. All other water quality parameters were below the applicable NYS AWQS. Sodium was detected above the NYS AWQS of 20 mg/L in three wells, with concentrations of 21.6 mg/L, 23.8 mg/L, and 30 mg/L.

8.2.1.4 Operable Unit V

***Sewage Treatment Plant / Peconic River Area*:** The Sewage Treatment Plant processes sanitary sewage for BNL facilities. The STP consists of a clarifier (for primary treatment) and sand filter beds (for secondary or effluent polishing). Approximately 15% of the water released to the filter beds is either lost to evaporation or to direct groundwater recharge; the remaining water is discharged to the Peconic River. This discharge is regulated under a NYSDEC SPDES permit. Past radiological and chemical releases to the sanitary system resulted in contamination of soils,

Table 8-20
BNL Site Environmental Report for Calendar Year 1996
Central Steam Facility
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	No. of Samples		TCA	TCE	PCE	DCE	Ethylbenzene	Toluene	Xylene (tot.)
			←			µg/L			→
Upgradient Wells	3	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
(n=2)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
76-04	1(a)	Max.	3.3	3.2	24.5	<2.0	520.0	850.0	950.0
		Avg.							
76-08	3(a)	Max.	2.1	<2.0	34.2	<2.0	10.6	<2.0	174.0
		Avg.	<2.0	<2.0	25.3	<2.0	4.5	<2.0	58.7
76-09	2	Max.	14.3	<2.0	11.2	<2.0	<2.0	<2.0	<2.0
		Avg.	7.7	<2.0	6.2	<2.0	<2.0	<2.0	<2.0
76-21	2	Max.	<2.0	<2.0	10.7	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	9.9	<2.0	<2.0	<2.0	<2.0
76-22	2	Max.	<2.0	<2.0	24.7	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	12.3	<2.0	<2.0	<2.0	<2.0
76-23	2	Max.	<2.0	<2.0	13.8	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	13.5	<2.0	<2.0	<2.0	<2.0
105-06	3(a)	Max.	4.0	10.0	40.0	19.9	<2.0	<2.0	<2.0
		Avg.	2.3	7.6	26.0	6.9	<2.0	<2.0	<2.0
105-07	3(a)	Max.	3.1	4.3	4.6	<2.0	<2.0	<2.0	<2.0
		Avg.	2.4	3.8	4.0	<2.0	<2.0	<2.0	<2.0
106-19	2	Max.	<2.0	<2.0	7.5	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	3.7	<2.0	<2.0	<2.0	<2.0
All Other Wells	17	Max.	<2.0	<2.0	2.3	<2.0	<2.0	<2.0	<2.0
(n=8)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0	2.0

(a): Other Compounds Detected.

Table 8-21
BNL Site Environmental Report for Calendar Year 1996
Building 650
Groundwater Surveillance Wells, Volatile Organic Compounds Data

Location	No. of Samples		TCA	PCE	DCA
			←	µg/L	→
76-28(a)	2	Max.	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0
76-25	2	Max.	17.4	<2.0	<2.0
		Avg.	12.5	<2.0	<2.0
76-26	2	Max.	5.0	2.4	2.4
		Avg.	4.3	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0

(a): Upgradient Well.

Table 8-22
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant/Peconic River Area
Groundwater Surveillance Wells, Water Quality Data

Well	No. of Samples	pH (SU) Range		Conduct. (µhos/cm)	Chlorides (mg/L)	Sulfates [(a)] (mg/L)	Nitrate (NO_3) [(a)] (mg/L)
38-01	3	4.6 - 5.2	Max.	73	9.8	14	<1
			Avg.	69	9.0	11.8	<1
38-02	3	5.3 - 6.1	Max.	137	14.6	12	4.1
			Avg.	98	9.9	10.7	2.9
38-03	3	5.7 - 6.3	Max.	88	7.2	13.6	2.3
			Avg.	79	5.9	10.7	<1
38-05	3	5.6 - 5.9	Max.	102	10.9	11.7	2.6
			Avg.	97	10.1	10.6	1.6
38-06	2	4.9 - 5.9	Max.	67	6.1	13	1.6
			Avg.	63	5.4	11.1	<1
39-05	3	5.2 - 5.6	Max.	92	13.6	7	<1
			Avg.	72	10.4	5.8	<1
39-06	3	5.4 - 6.2	Max.	366	45.8	9.8	<1
			Avg.	267	27.2	9.1	<1
39-07	3	5.5 - 6.8	Max.	212	32	15.0	<1
			Avg.	170	23.7	14.2	<1
39-08	3	5.7 - 6.1	Max.	213	31.4	18.5	4.2
			Avg.	204	29.7	17	3.5
39-09	2	5.1 - 5.7	Max.	63	11.6	10.1	6.5
			Avg.	57	8.4	8.6	5.2
39-10	2	6.6	Max.	70	6.4	7	<1
			Avg.	69	6.3	6.5	<1
60-01	2	5.4 - 6.0	Max.	71	10.4	12.4	<1
			Avg.	68	8.7	10.2	<
61-03	2	4.9	Max.	75	9.9	15.0	<1
			Avg.	74	9.2	13.4	<1
NYS AWQS		6.5 - 8.5		(b)	250	250	10
Typical MDL				10	4	4	1

(a): Holding Times for Sulfates and Nitrates were Typically Exceeded.
(b): No Standard Specified.

Table 8-23
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant/Peconic River Area
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
39-05	3(a)	Max.	<0.025	<0.0005	<0.005	<0.05	0.367	<0.0002	9.5	<0.002	0.07
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.221	-	7.5	<0.002	0.02
39-06	4(a)	Max.	<0.025	<0.0005	<0.005	<0.05	1.324	0.0004	27.6	<0.002	0.05
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.895	-	17.4	<0.002	<0.02
39-07	3(a)	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	35.4	<0.002	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	-	25.5	<0.002	0.02
39-08	3(a)	Max.	<0.025	<0.0005	<0.005	<0.05	1.430	<0.0002	31.8	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.477	-	30.5	<0.002	<0.02
60-01	2(a)	Max.	<0.025	<0.0005	0.006	<0.05	3.897	<0.0002	10.2	0.003	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	2.020	-	8.6	<0.002	0.02
61-03	2(a)	Max.	<0.025	<0.0005	0.006	<0.05	8.870	<0.0002	8.1	0.009	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	4.435	-	7.5	0.005	0.02
All Other Wells	18(b)	Max.	<0.025	0.0009	<0.005	<0.05	<0.075	<0.0002	16.4	<0.002	0.07
(n=7)		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.4	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	0.2	0.3	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

(a): Only One Sample Analyzed for Mercury.
(b): Only Seven Samples Analyzed for Mercury.

Table 8-24
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant/Peconic River Area
Groundwater Surveillance Wells, Volatile Organic Compound Data

Location	**No. of Samples**		**TCE µg/L**
50-01	2	Max.	18.0
		Avg.	17.0
61-05	2	Max.	20.0
		Avg.	16.0
000-122	2	Max.	6.6
		Avg.	6.0
All Other Wells (n=22)	39	Max.	<2.0
		Avg.	<2.0
NYS AWQS			5
Typical MDL			2

Table 8-25
BNL Site Environmental Report for Calendar Year 1996
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, EDB Data

Location	No. of Samples		1,2-Dibromoethane (EDB) µg/L
Upgradient Wells (n=2)	4	Max.	<0.02
		Avg.	<0.02
89-14	2	Max.	0.02
		Avg.	<0.02
99-06	2	Max.	0.04
		Avg.	0.03
99-10	2	Max.	0.02
		Avg.	<0.02
99-11	2	Max.	0.03
		Avg.	<0.02
100-13	2	Max.	0.1
		Avg.	0.05
100-14	2	Max.	0.1
		Avg.	0.09
Other Wells (n=10)	20	Max.	<0.02
		Avg.	<0.02
NYS DWS			0.05
Typical MDL			0.02

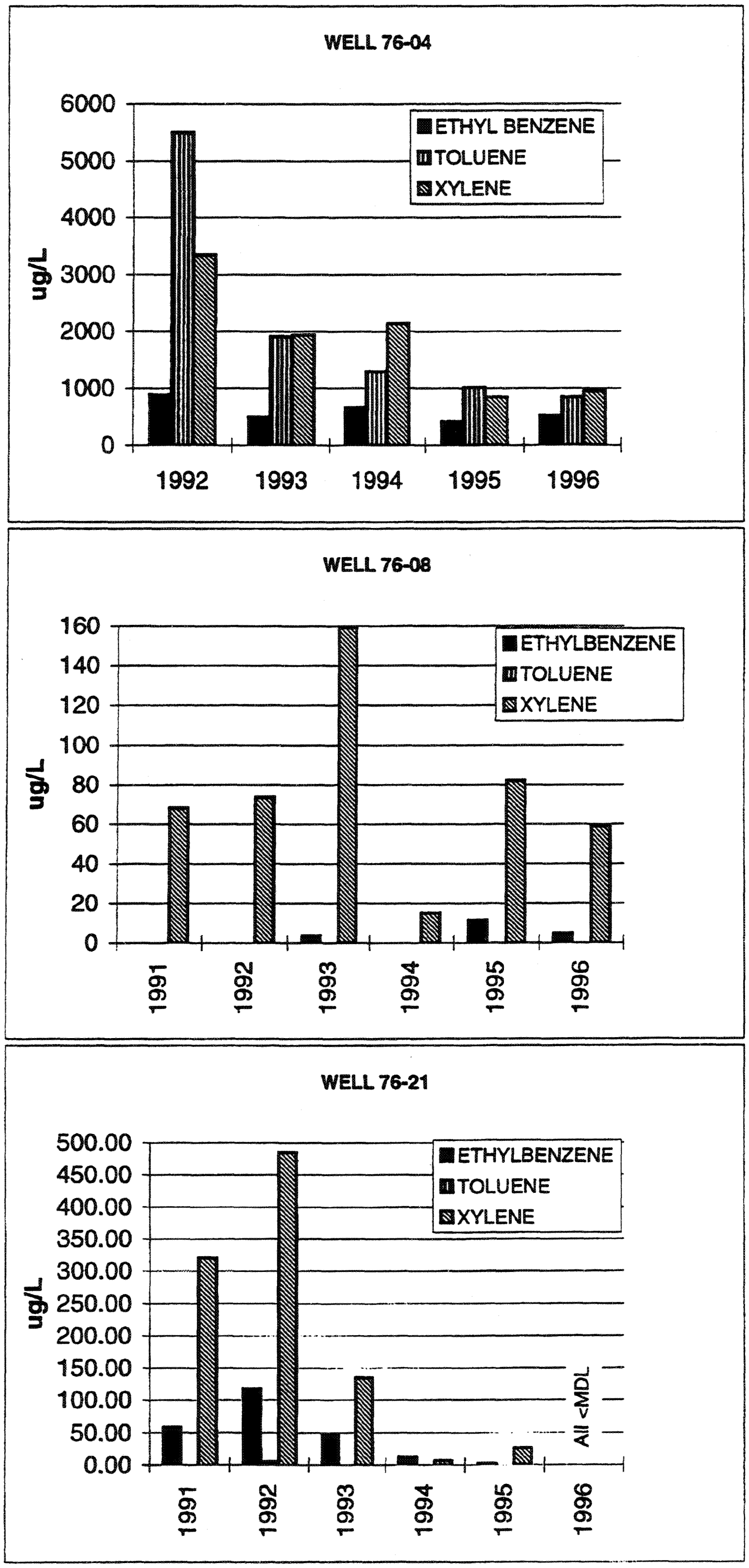


Figure 8-20. Yearly average concentration trends of ethylbenzene, toluene, and xylene (tot.) in wells within and downgradient of the 1977 fuel oil/ solvent spill area; Well 76-04 located within the spill area; Well 76-21 located 60m downgradient of the spill site; and Well 76-08 located 90m downgradient of the spill site.

sediments and groundwater in the STP and Peconic River areas. As a result, the STP and Peconic River areas were the subject of a RI/FS (Operable Unit V), which was conducted under the IAG between DOE, EPA, and NYSDEC.

The surveillance well network at the STP and Peconic River areas consists of over 50 shallow to deep Upper Glacial aquifer wells (Figures 8-5, 8-6 and 8-13). Four of these wells are located of-site. During 1996, groundwater samples from 25 of these wells were analyzed for water quality, VOCs, and metals (Tables 8-22 to 8-24). In most wells, the pH of groundwater was typically below the NYS AWQS of 6.5 - 8.5, with a median pH of 5.7. All other water quality parameters were within the applicable NYS AWQS. Although elevated levels of nitrates (NO_3) were detected in five shallow wells located near the STP filter beds, the concentrations were below NYS AWQS. Iron concentrations exceeded NYS AWQS of 0.3 mg/L in five wells, with maximum concentrations ranging from 0.367 mg/L to 8.87 mg/L. Three wells had sodium concentrations above the NYS AWQS of 20 mg/L, with maximum concentrations ranging from 27.6 mg/L to 35.4 mg/L. The volatile organic compound TCE was detected in two deep Upper Glacial aquifer wells located at the BNL site boundary and one deep off-site well. Maximum detected TCE concentrations in wells 50-01, 61-05, and 000-122 were 18 μg/L, 20 μg/L and 6.6 μg/L, respectively.

8.2.1.5 Operable Unit VI

Meadow Marsh-Upland Recharge Area: The Meadow Marsh-Upland Recharge area was used by BNL in the mid 1970s as an experimental sewage treatment area. Consequently, the soils and groundwater in this area are suspected of being contaminated with a variety of radionuclides, metals, and VOCs. Biological agricultural fields are also located in this area. Evaluation of the extent of possible soil and groundwater contamination in the Meadow Marsh-Upland Recharge area was conducted as part of the OU I/VI RI/F conducted under the IAG.

The surveillance well network at the Meadow Marsh-Upland Recharge area consists of 27 shallow to deep Upper Glacial aquifer wells and one upper Magothy aquifer well (Figures 8-5, 8-8 and 8-9). Twelve of the monitoring wells were installed in 1994 as part of the OU I/VI RI/FS. During 1996, groundwater samples from 19 Upper Glacial and one Magothy aquifer surveillance wells were analyzed for water quality, 17 wells were sampled for metals, and 25 were sampled for VOCs (Table 8-25). The pH of groundwater was typically below the lower limit of the NYS AWQS of 6.5 -8.5, with a median pH of 5.8. Nitrates (NO_3) were detected above the NYS AWQS of 10 mg/L in well 79-17, at a concentration of 15 mg/L. Well 79-17 is a shallow Upper Glacial aquifer well located directly downgradient of the agricultural fields. All other water quality parameters were below the applicable NYS AWQS. Iron was detected above NYS AWQS in Upper Glacial aquifer well 90-03 and Magothy aquifer well 100-04, at maximum concentrations of 2.7 mg/L and 3.88 mg/L, respectively. Zinc was detected above NYS AWQS in Well 100-04, with a concentration of 0.90 mg/L. Historically, the only VOC detected above NYS DWS (or NYS AWQS) in the Upland Recharge/Meadow Marsh area was EDB. During 1996, EDB was detected in southeast boundary wells 100-13 and 100-14 at maximum concentrations of 0.10 μg/L in each well. (Note: the NYS DWS for EDB is used since it is more restrictive than the NYS AWQS of 5 μg/L.). Historical records indicate that the EDB was applied to several areas of the agricultural fields as a fumigant.

8.2.2 Radiological Analyses

8.2.2.1 Operable Unit I

Current Landfill: Table 8-26 shows the radiological analysis results of groundwater samples collected in the vicinity of the Current Landfill (closed in 1990)(see Figure 8-X). This landfill once received waste such as animal carcasses and protective clothing contaminated with low specific-activity radioactive material (CDM, 1996). Groundwater wells are positioned in Grids 087, 115, and 116 to monitor the movement of contaminant plumes originating at this landfill. Downgradient wells closest to the landfill in Grid 087 have consistently shown elevated gross beta activity concentrations; a maximum value of 27 pCi/L (1.0 Bq/L) was observed in 1996. Strontium-90 was also detectable in Grid 087 at levels above those attributable to fallout; the maximum observed concentration was 21 pCi/L (0.8 Bq/L). A plot of groundwater gross beta and strontium-90 activity trends are shown in Figures 8-22 and -23.

Of the Current Landfill monitoring wells sampled in 1996, tritium was detected at a maximum concentration of 2,240 pCi/L (83 Bq/L) at Well 87-11. A maximum tritium concentration of 12,900 pCi/L (477 Bq/L) was recorded at Well 87-07 in 1995, though this well was not sampled for radiological parameters in 1996. Tritium continues to be detectable further south in Grids 115 and 116; the maximum concentration observed in this area was 2,470 pCi/L (91 Bq/L). Tritium concentrations for wells in this area have historically been highest in Wells 87-05, -06, and -07. However, these wells were not sampled in 1996. Tritium concentrations in downgradient well 115-05 have remained fairly consistent since its installation in 1992 (see Figure 8-21).

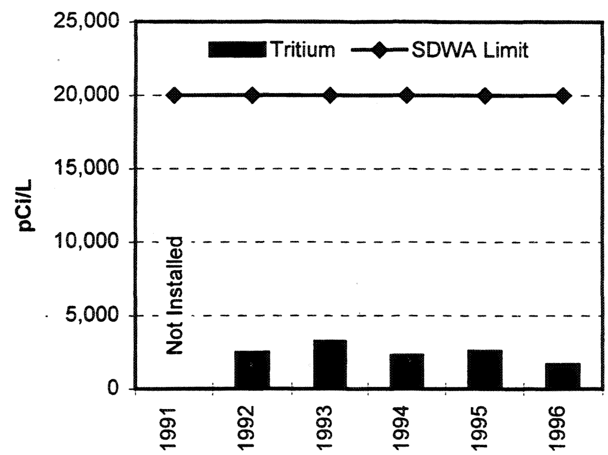


Figure 8-21 Annual average tritium concentrations, Well 115-05.

Gamma-emitting radionuclides such as beryllium-7, cesium-137 and cobalt-60 were detected sporadically in Current Landfill monitoring wells. All were at concentrations equal to small fractions of drinking water standards. The extent of groundwater contamination in this area has been evaluated as part of the Groundwater Removal Action (RA V).

Table 8-26
BNL Site Environmental Report for Calendar Year 1996
Current Landfill Groundwater Radioactivity Data

Well	Collect Date	Alpha	Beta	Tritium	Sr-90	Be-7	Cs-134	Cs-137	Co-58	Co-60	Mn-54	Na-22	Zn-65
		(pCi/L)											
087-09 *	12-Feb-96	0.8 ± 0.4	< 1.6	< 390	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	1.1	4.2	200	1.30	ND	ND	1.50	ND	3.80	ND	ND	ND
	1-Sep-96	ND	2.4	ND	1.67	ND	ND	ND	ND	ND	ND	ND	ND
	1-Nov-96	1.4	4.8	ND	20.70	ND	ND	ND	ND	0.67	ND	ND	ND
087-11	8-Feb-96	< 3.5	< 8.8	968 ± 291	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	ND	17.5	2,020	1.18	ND	ND	ND	ND	ND	0.82	ND	ND
	1-Sep-96	ND	16.5	1,710	1.19	16.60	ND	ND	ND	2.00	ND	ND	ND
	1-Nov-96	12.3	26.9	2,240	5.75	7.17	ND	ND	ND	ND	ND	ND	ND
088-21	12-Feb-96	2.6 ± 1.6	< 9.3	< 390	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	0.1	11.1	868	6.80	ND	ND	ND	ND	ND	ND	ND	ND
	1-Sep-96	ND	10.1	828	3.05	ND	ND	ND	ND	ND	ND	ND	ND
	1-Nov-96	4.1	11.9	1,560	3.57	ND	ND	ND	ND	1.50	ND	0.99	ND
088-22	12-Feb-96	2.2 ± 1.4	< 9.3	749 ± 273	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	0.0	7.6	485									
	1-Sep-96	ND	7.4	212	1.83	ND	ND	ND	ND	ND	ND	ND	3.30
	1-Nov-96	6.4	20.2	1,690	2.08	ND	ND	ND	0.56	ND	ND	1.53	ND
087-23	12-Feb-96	< 2.1	< 9.3	1,060 ± 288	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	0.4	5.6	743	2.50	ND	ND	ND	ND	ND	ND	ND	ND
	1-Sep-96	ND	5.0	ND	1.59	ND	ND	ND	ND	1.91	ND	ND	ND
	1-Nov-96	ND	3.3	621	0.86	ND	ND	ND	ND	0.70	ND	ND	3.52
DOE Order 5400.5 DCG		NS	NS	20,000 (b)	8 (b)	1,000,000	2,000	3,000	40,000	5,000	50,000	10,000	9,000

Notes:
1. All first quarter data supplied by S&EP Division. Results from second, third and fourth quarters from 1996 Current Landfill Environmental Monitoring Report, CDM Federal.
2. 1996 Current Landfill Report does not provide confidence intervals or MDLs for values below the detection limit.

(a) Well not sampled for this analyte during first quarter round. ND = Not Detected. NS = Not specified. * This well is upgradient of the facility.
(b) 40 CFR 141 SDWA limit shown.

Table 8-26 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Current Landfill Groundwater Radioactivity Data

Well	Collect Date	Alpha	Beta	Tritium	Sr-90	Be-7	Cs-134	Cs-137	Co-58	Co-60	Mn-54	Na-22	Zn-65
		(pCi/L)											
087-24	12-Feb-96	< 0.5	< 1.6	< 390	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	1.4	2.7	ND	ND	ND	ND	0.67	ND	ND	ND	ND	ND
	1-Sep-96	ND	ND	ND	ND	ND	ND	ND	ND	1.95	ND	ND	ND
	1-Nov-96	1.4	1.5	ND	0.69	ND	ND	ND	ND	1.59	ND	ND	ND
087-26	8-Feb-96	ND	ND	< 424	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	ND	2.0	ND	ND	ND	ND	ND	ND	2.40	ND	ND	ND
	1-Sep-96	ND	1.3	172	ND	ND	ND	ND	2.00	ND	ND	ND	ND
	1-Nov-96	3.6	7.1	2,010	ND	ND	ND	ND	ND	ND	ND	ND	ND
087-27	8-Feb-96	< 3.5	< 8.8	1,910 ± 335	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	1.3	6.6	267	1.30	ND	ND	ND	0.77	ND	ND	ND	ND
	1-Sep-96	ND	3.3	668	1.05	ND	1.00	ND	ND	ND	ND	ND	ND
	1-Nov-96	2.2	6.4	ND	ND	11.70	ND	ND	ND	ND	ND	ND	2.29
088-109	26-Feb-96	< 2.1	< 8.3	1,840 ± 334	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	1.1	7.9	1,100	1.30	ND	ND	ND	1.40	ND	ND	ND	ND
	1-Sep-96	ND	8.7	1,190	0.90	ND	ND	4.00	ND	ND	ND	ND	ND
	1-Nov-96	9.6	21.1	754	10.50	ND	ND	ND	ND	2.78	ND	ND	3.56
088-110	14-Feb-96	< 4.1	< 9.8	1,330 ± 301	(a)	ND	ND	ND	ND	ND	ND	ND	ND
	1-Jul-96	1.7	12.2	2,010	1.20	ND	ND	ND	0.80	ND	ND	ND	ND
	1-Sep-96	ND	11.4	763	2.20	24.00	3.78	ND	2.79	3.10	ND	ND	ND
	1-Nov-96	6.9	25.9	1,470	2.67	ND	ND	ND	ND	ND	ND	ND	ND
DOE Order 5400.5 DCG		NS	NS	20,000(b)	8(b)	1,000,000	2,000	3,000	40,000	5,000	50,000	10,000	9,000

Notes:
1. All first quarter data supplied by S&EP Division. Results from second, third and fourth quarters from 1996 Current Landfill Environmental Monitoring Report, CDM Federal.
2. 1996 Current Landfill Report does not provide confidence intervals or MDLs for values below the detection limit.
(a) Well not sampled for this analyte during first quarter round. ND = Not Detected. NS = Not specified.
(b) 40 CFR 141 SDWA limit shown.

Table 8-26 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Current Landfill Groundwater Radioactivity Data

Well	N		Alpha	Beta (pCi/L)	Tritium
Current Landfill					
115-01	2	Max.	< 0.6	< 1.6	< 439
		Avg.	< 0.1	0.4 ± 0.1	-256 ± 338
115-02	2	Max.	< 0.6	< 1.6	<439
		Avg.	0.1 ± 0.0	0.6 ± 0.4	-290 ± 257
115-03	2	Max.	< 0.6	< 1.4	< 439
		Avg.	0.2 ± 0.1	0.6 ± 0.5	-273 ± 282
115-04	2	Max.	< 0.5	< 1.5	850 ± 269
		Avg.	0.2 ± 0.1	0.9 ± 0.4	715 ± 270
115-05	2	Max.	< 0.6	< 1.5	2,280 ± 328
		Avg.	0.1 ± 0.2	0.9 ± 0.4	1,665 ± 1,230
115-13	2	Max.	< 0.5	< 1.5	1,650 ± 303
		Avg.	0.1 ± 0.1	1.1 ± 0.6	1,198 ± 905
115-14	2	Max.	< 0.5	8.3 ± 1.4	< 445
		Avg.	0.3 ± 0.4	5.3 ± 6.1	415 ± 36
115-16	2	Max.	< 0.5	< 1.5	2,470 ± 342
		Avg.	0.2 ± 0.0	0.8 ± 0.4	1,885 ± 1,170
116-05	2	Max.	< 0.5	1.9 ± 0.9	1,180 ± 294
		Avg.	0.2 ± 0.3	1.3 ± 1.1	1,054 ± 253
116-06	2	Max.	0.4 ± 0.2	< 1.4	2,130 ± 346
		Avg.	0.3 ± 0.2	1.0 ± 0.6	1,870 ± 520
DOE Order 5400.5 DCG			NS	NS	20,000 (a)

Notes:
1. No non-primordial gamma-emitting radionuclides detected in these wells.
2. Strontium-90 analysis was not performed on samples from these wells
N = No. of samples collected.
(a) 40 CFR 141 SDWA limit shown. NS = Not specified.

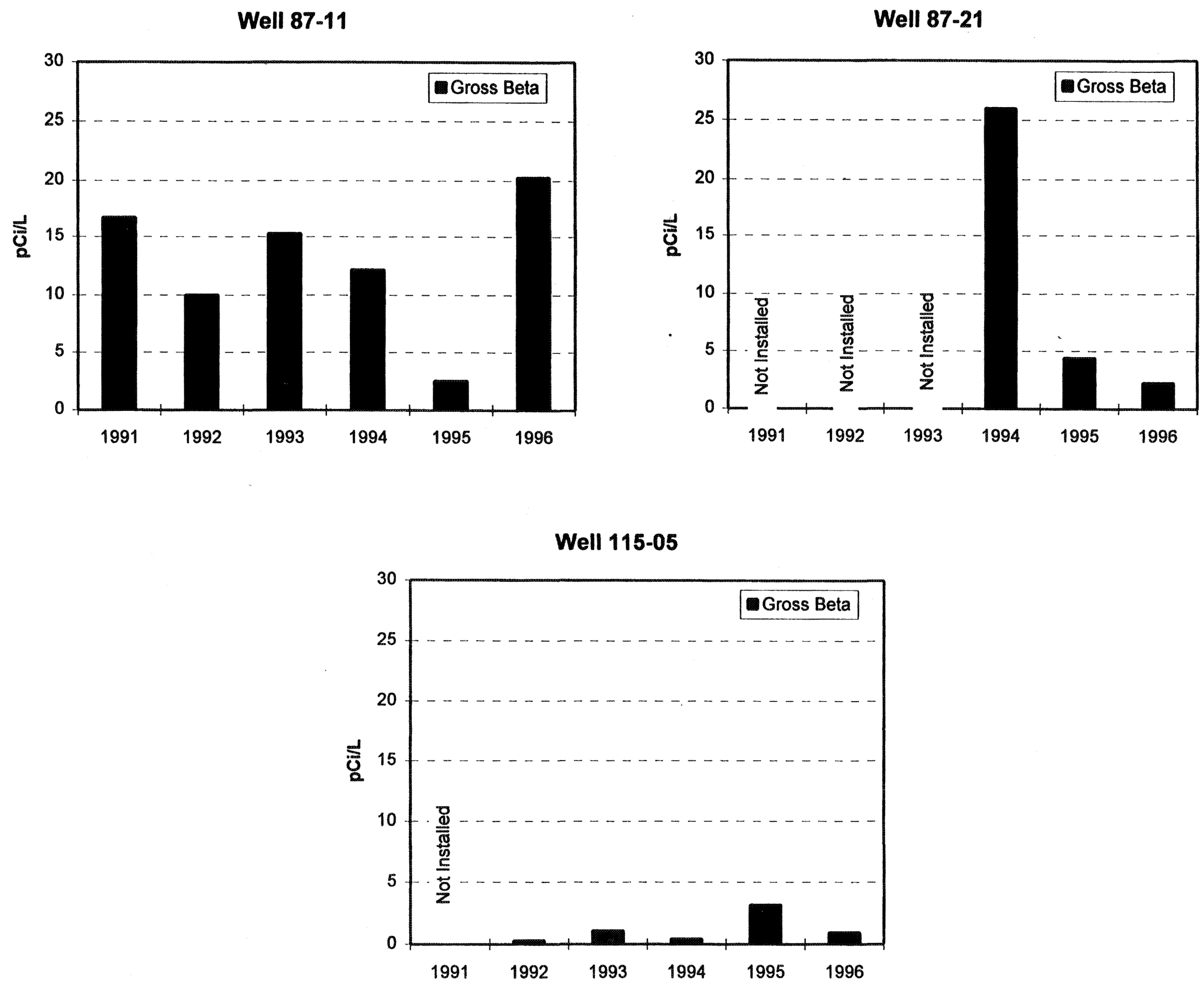
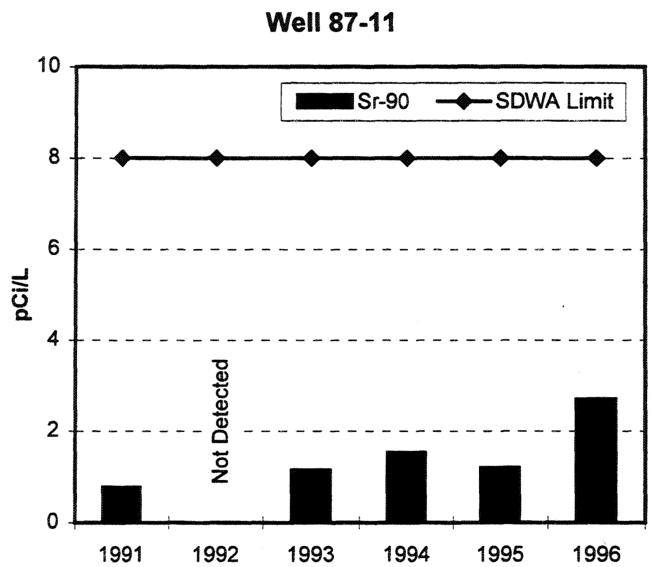


Figure 8-22 Annual average gross beta activity concentrations in the Current Landfill area. Wells 87-11 and 87-21 are located directly downgradient of the Landfiill; Well 115-05 is located at the site boundary 1,225 meters downgradient of the Landfill.



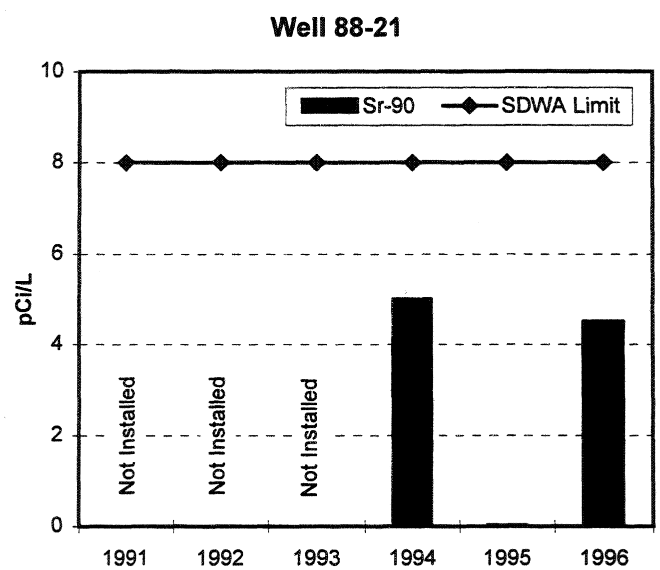


Figure 8-23 Annual average strontium-90 concentrations in wells directly downgradient of the Current Landfill Area.

Former Landfill Area: Like the Current Landfill, the Former Landfill (in operation from 1947 to 1966) also received low-level radioactive wastes when it was in use. Consequently, radionuclides generated by past Laboratory operations are detectable in downgradient wells. Geographic information is shown in Figure 8-8. Gross alpha and beta activity, tritium and gamma-emitting radionuclides were generally at ambient environmental levels, with the exception of Well 97-03, where a strontium-90 concentration of 42 pCi/L (1.6 Bq/L) was observed. This is five times greater than the SDWA limit and is consistent with past results for this well. Trends of strontium-90 activity at Well 97-03 (plotted in Figure 8-24) indicate increasing activity concentrations since 1992.

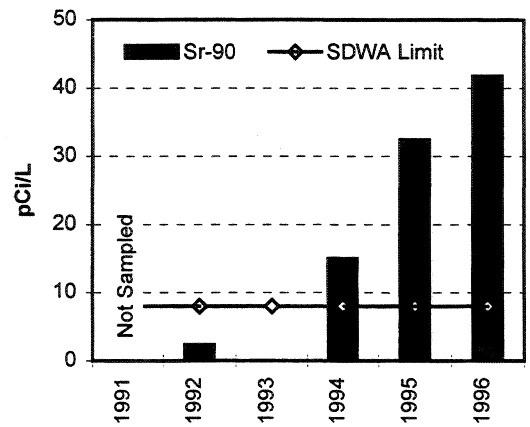


Figure 8-24 Annual average strontium-90 concentrations, Well 97-03.

Hazardous Waste Management Facility: The current HWMF has been used to handle, process, and store radioactive materials since the late 1940s. Soils and groundwater in the area are known to be contaminated with a number of radionuclides produced by BNL. As a result, the HWMF has been identified as an AOC and will be remediated under future OU I actions. The groundwater monitoring well network at the HWMF (see Figure 8-8 & Figure 8-9) consists of a shallow well network located near the facility and a set of deeper wells extending outwards in the direction of groundwater flow. Groundwater samples from this area indicate the presence of fission products cesium-137, strontium-90, and cobalt-60, as well as tritium and the activation product sodium-22. Radiological analysis results for samples from these wells are presented in Table 8-28.

Annual average gross beta concentrations were elevated in several instances, ranging from approximately 10 pCi/L (0.4 Bq/L) to a maximum value of 94 pCi/L (3.5 Bq/L) at Well 88-04. Trend data for beta activity in several wells is presented in Figure 8-25. There is no general trend apparent, with the exception of Well 88-04, which has shown a decrease in overall beta activity in the last four years. In some cases, the additional beta activity in these wells appears to be due to the presence of strontium/yttritum-90. Strontium-90 was detected at levels above background in seven out of fourteen wells sampled in this area. A maximum value of 36 pCi/L (1.3 Bq/L) was recorded at Well 88-04, which is on the immediate grounds of the HWMF. This concentration is 4.5 times greater than the SDWA limit of 8 pCi/L (0.3 Bq/L). Groundwater modeling indicates that strontium-90 released near the HWMF will attenuate to concentrations below drinking water standards before reaching the site boundary (CDM, 1996). Strontium-90 concentration trends for two wells from this area are plotted in Figure 8-26.

Tritium values downgradient of the HWMF ranged from just above the detection limit to 24,800 pCi/L (918 Bq/L) at Well 88-26. This is a factor of two lower than the maximum value seen at Well 88-26 in 1995. Samples from wells further south, at the Laboratory's boundary, showed reduced

Table 8-27
BNL Site Environmental Report for Calendar Year 1996
Former Landfill Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium (pCi/L)	Cs-137	Sr-90
Former Landfill							
086-42	2	Max.	< 0.5	5.1 ± 1.2	< 449	ND	< 0.13
		Avg.	0.2 ± 0.1	3.0 ± 4.2	-170 ± 23		(b)
086-43	3	Max.	< 0.7	6.4 ± 1.3	< 405	ND	< 0.15
		Avg.	0.0 ± 0.2	2.7 ± 5.1	-99 ± 108		(b)
097-02	2	Max.	0.7 ± 0.4	3.3 ± 1.1	< 405	ND	0.42 ± 0.17
		Avg.	0.2 ± 0.9	2.7 ± 1.3	-175 ± 198		0.29 ± 0.27
097-03	1	Max.	0.5 ± 0.3	97.0 ± 4.1	< 405	ND	41.79 ± 1.5
097-05	2	Max.	< 0.5	2.7 ± 1.1	< 405	ND	0.22 ± 0.13
		Avg.	0.2 ± 0.1	2.5 ± 0.5	-275 ± 231		0.20 ± 0.05
097-18	2	Max.	< 2.7	< 8.2	< 405	0.78 ± 0.47	0.80 ± 0.25
		Avg.	1.8 ± 0.1	3.5 ± 2.9	-101 ± 244		0.53 ± 0.55
106-14	1	Max.	< 0.4	3.3 ± 1.1	< 423	ND	(a)
106-15	2	Max.	< 0.4	< 1.4	< 423	ND	< 0.13
		Avg.	0.0 ± 0.3	1.0 ± 0.8	256 ± 264		(b)
106-17	2	Max.	0.5 ± 0.3	7.0 ± 1.3	866 ± 283	ND	1.62 ± 0.31
		Avg.	0.3 ± 0.4	6.3 ± 1.4	430 ± 873		(b)
106-18	2	Max.	< 0.4	< 1.6	< 449	ND	< 0.12
		Avg.	0.3 ± 0.1	1.1 ± 0.6	-104 ± 207		-0.03 ± 0.01
106-29	1	Max.	< 1.2	1.9 ± 1.1	< 245	ND	< 0.63
114-02	2	Max.	1.1 ± 0.4	< 1.6	< 405	ND	(a)
		Avg.	0.6 ± 1.0	0.9 ± 1.0	-312 ± 651		
122-01	2	Max.	< 0.4	< 1.6	< 372	ND	< 0.66
		Avg.	0.2 ± 0.3	0.1 ± 0.2	-164 ± 266		(b)
122-02	2	Max.	< 0.5	5.7 ± 1.3	464 ± 187	ND	< 0.86
		Avg.	0.3 ± 0.4	3.8 ± 3.8	172 ± 544		(b)
122-04	3	Max.	4.2 ± 0.7	4.1 ± 1.2	< 465	ND	< 0.48
		Avg.	2.2 ± 4.0	2.6 ± 3.0	-137 ± 446		0.17 ± 0.12
122-05	1	Max.	1.7 ± (c)	2.2 ± (c)	< 257	ND	< 0.70

Notes:
(a) Location was not sampled for this analyte.
(b) Location sampled for this analyte only once.
(c) 95% confidence interval not available for this data point.

ND = Not Detected.
N = No. of samples collected.

Table 8-28
BNL Site Environmental Report for Calendar Year 1996
Hazardous Waste Management Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Cs-137	Co-60	Na-22	Sr-90
			(pCi/L)						
Hazardous Waste Management Facility									
088-03	2	Max.	2.5 ± 0.6	43.2 ± 2.8	524 ± 273	0.41 ± 0.18	0.33 ± 0.11	ND	15.61 ± 0.91
		Avg.	1.3 ± 2.4	29.8 ± 26.8	482 ± 84	(a)	0.30 ± 0.08		(c)
088-04	2	Max.	4.08 ± 0.7	93.6 ± 3.9	939 ± 271	ND	ND	1.05 ± 0.26	35.87 ± 1.40
		Avg.	2.5 ± 3.1	82.6 ± 22.0	787 ± 305			(a)	(c)
088-13*	2	Max.	< 2.7	< 8.6	< 389	ND	ND	ND	1.42 ± 0.52
		Avg.	0.0 ± 1.8	5.6 ± 3.3	-196 ± 79				(c)
088-14*	2	Max.	< 0.6	< 1.4	< 439	ND	ND	ND	< 0.14
		Avg.	0.4 ± 0.1	0.6 ± 0.2	-180 ± 144				(c)
088-20*	2	Max.	< 0.6	2.4 ± 1.1	< 336	ND	ND	ND	0.97 ± 0.20
		Avg.	0.4 ± 0.2	1.9 ± 1.1	41 ± 307				0.64 ± 0.95
088-24	2	Max.	< 0.6	17.7 ± 1.9	3,190 ± 355	ND	ND	ND	4.32 ± 0.50
		Avg.	0.4 ± 0.1	15.3 ± 4.9	2,490 ± 1,400				(c)
088-26	2	Max.	< 0.6	13.9 ± 1.7	24,800 ± 793	ND	ND	1.70 ± 0.79	4.61 ± 0.51
		Avg.	0.2 ± 0.1	13.2 ± 1.5	14,920 ± 19,760			1.26 ± 1.26	(c)
098-07	1	Max.	< 0.5	1.7 ± 1.0	< 405	ND	ND	ND	(b)
098-57	2	Max.	0.4 ± 0.2	10.5 ± 1.6	1,550 ± 321	ND	ND	ND	2.64 ± 0.38
		Avg.	0.3 ± 0.3	6.3 ± 8.4	1,530 ± 40				(c)
098-58	2	Max.	1.1 ± 0.4	17.3 ± 1.8	< 389	ND	ND	ND	4.84 ± 0.54
		Avg.	0.7 ± 0.8	14.9 ± 4.8	-66 ± 28				(c)
DOE Order 5400.5 DCG			NS	NS	20,000 d)	3,000	5,000	10,000	8(d)

ND = Not Detected.
N = No. of samples collected.
NS = Not specified.

(a) This analyte was detected only once.
(b) This location not sampled for this analyte.
(c) Location sampled for this analyte once only.
(d) 40 CFR 141 SDWA limit shown.

* Well is upgradient of the facility.

Table 8-28 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Hazardous Waste Management Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Cs-137	Co-60	Na-22	Sr-90
			(pCi/L)						
Hazardous Waste Management Facility (cont.)									
098-59	2	Max.	0.9 ±	< 7.4	1,240 ± 285	ND	ND	ND	< 0.20
		Avg.	0.7 ± 0.5	1.2 ± 3.6	1,175 ± 130				-0.17 ± 0.20
098-60	2	Max.	0.6 ± 0.3	2.4 ± 0.9	< 336	ND	ND	ND	< 0.21
		Avg.	0.2 ± 0.8	2.0 ± 0.7	89 ± 58				0.05 ± 0.16
098-61	2	Max.	< 0.6	< 1.6	< 439	ND	ND	ND	< 0.12
		Avg.	0.0 ± 0.1	1.2 ± 0.2	26 ± 18				(c)
108-13	2	Max.	< 0.5	3.1 ± 1.1	< 439	ND	ND	ND	(b)
		Avg.	0.2 ± 0.2	3.0 ± 0.3	-72 ± 270				
108-14	2	Max.	0.6 ± 0.4	< 1.4	877 ± 301	ND	ND	ND	(b)
		Avg.	0.2 ± 0.6	1.0 ± 0.2	815 ± 125				
108-17	2	Max.	0.6 ± 0.4	4.6 ± 1.2	939 ± 267	ND	0.18 ± 0.10	ND	< 0.13
		Avg.	0.4 ± 0.4	4.2 ± 0.7	855 ± 169		(a)		(c)
108-18	2	Max.	< 0.5	< 0.9	979 ± 269	ND	ND	ND	(b)
		Avg.	0.3 ± 0.3	1.4 ± 0.5	847 ± 265				
108-30	2	Max.	< 0.5	1.38 ± 0.9	2,330 ± 302	ND	0.89 ± 0.42	ND	(b)
		Avg.	0.2 ± 0.2	1.2 ± 0.3	2,225 ± 210		(a)		
108-31	2	Max.	< 0.5	15.4 ± 1.7	1,720 ± 277	ND	ND	ND	< 0.14
		Avg.	0.3 ± 0.4	8.2 ± 14.3	1,390 ± 660				(c)
DOE Order 5400.5 DCG			NS	NS	20,000 d)	3,000	5,000	10,000	8(d)

* Well is upgradient of the facility.
ND = Not Detected.
N = No. of samples collected.

(a) This analyte was detected only once.
(b) This location not sampled for this analyte.
(c) Location sampled for this analyte once only.
(d) 40 CFR 141 SDWA limit shown.

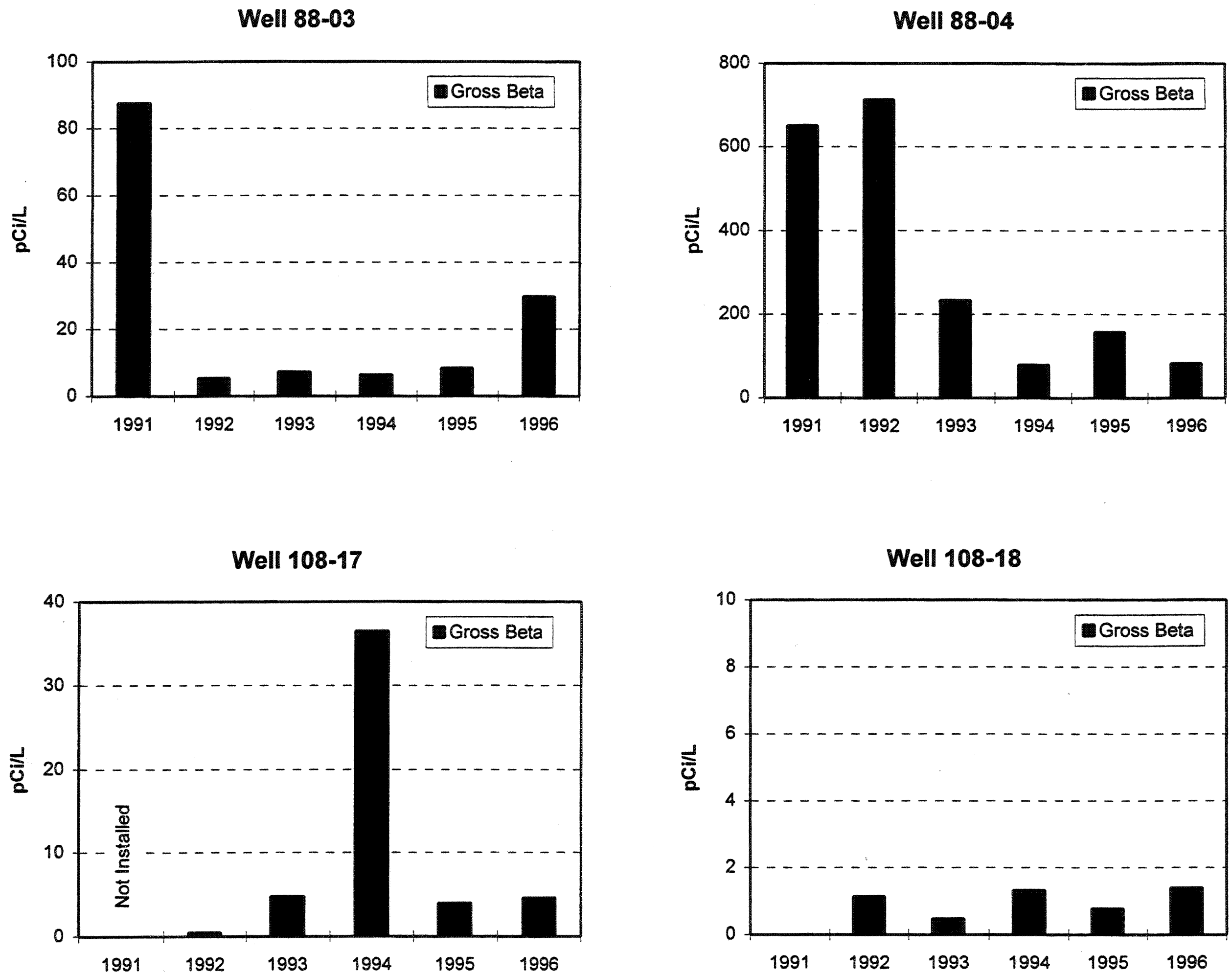
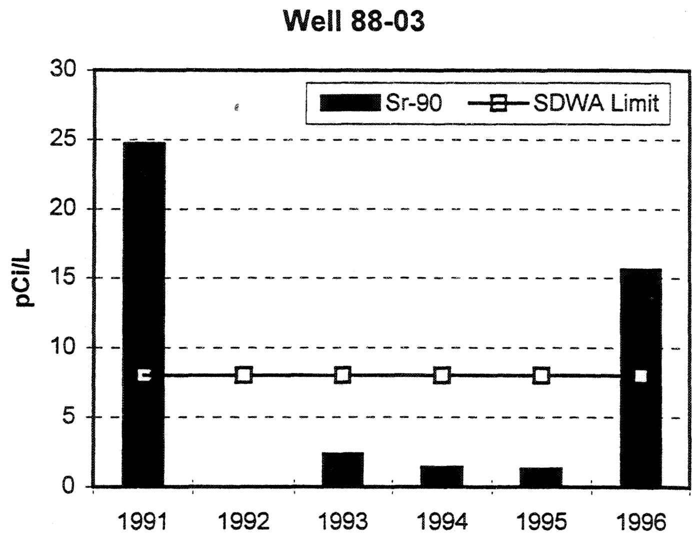


Figure 8-25 Annual average grosss beta activity concentrations within and downgradient of the Hazardous Waste Management Facility. Wells 88-03 and 88-04 arelocated within the HWMF; Wells 108-17 amd 108-18 are located at the site boundary 680 meters downgradient of the HWMF.



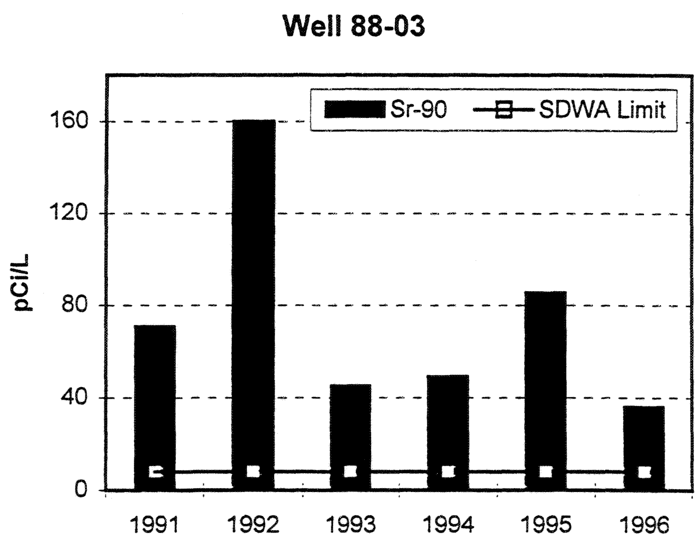


Figure 8-26 Annual average strontium-90 concentrations in Hazardous Waste Management Area.

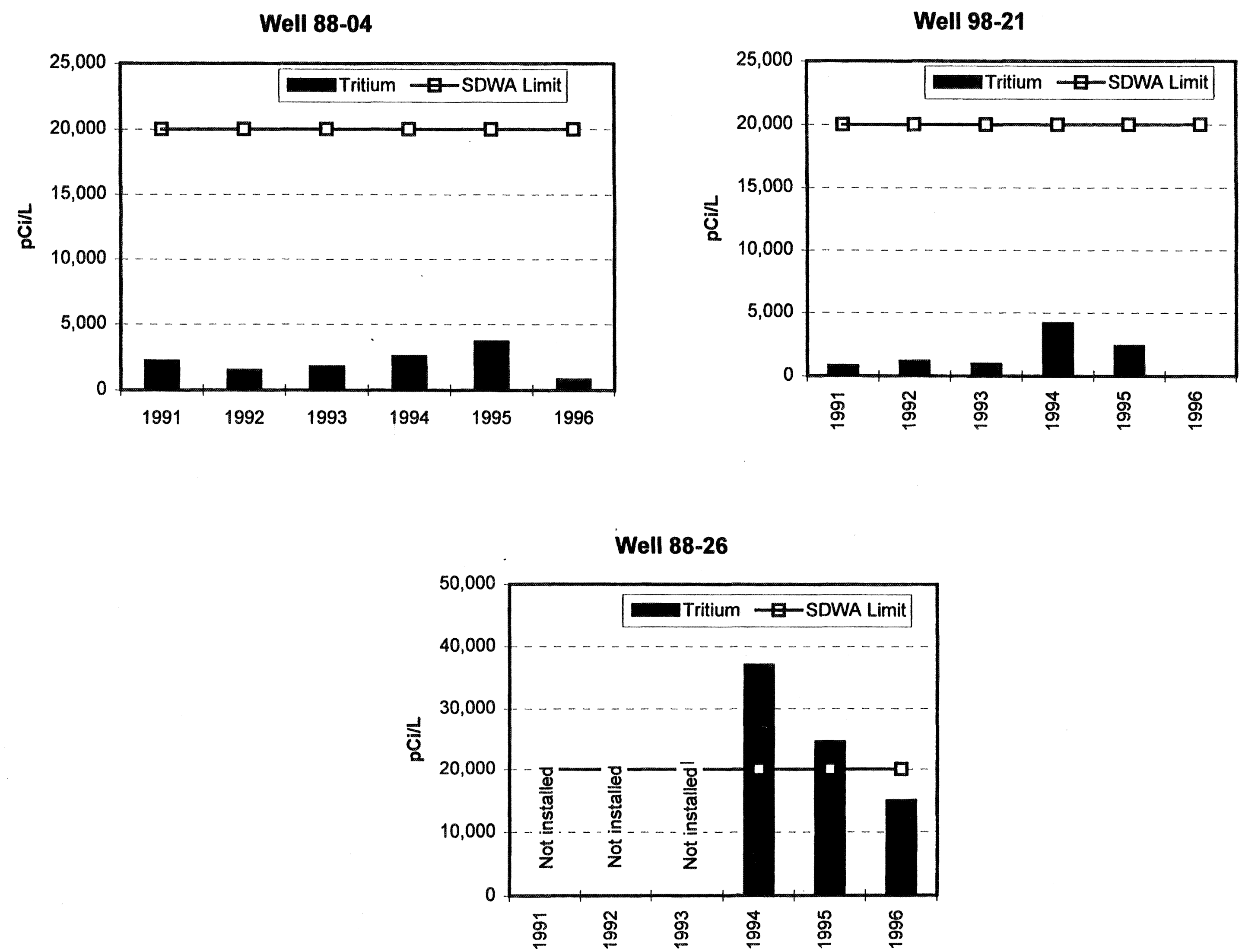


Figure 8-27 Annual average tritium concentrations in wells within and immediately downgradient of the Hazardous Waste Management Facility.

tritium concentrations of 1,000 to 2,000 pCi/L (37 to 74 Bq/L), indicating that maximum concentrations are located to the north, within BNL property. Trend plots of tritium activity in selected wells are shown in Figure 8-27.

Cesium-137, cobalt-60, beryllium-7, and sodium-22 were detected in several downgradient wells. Maximum recorded values were 0.4 pCi/L (0.01 Bq/L), 3.8 pCi/L (0.14 Bq/L), 16.6 pCi/L (0.6 Bq/L), and 1.5 pCi/L (0.06 Bq/L), respectively. All average and maximum concentrations of these nuclides were small fractions of the DOE DCGs and Federal drinking water standards.

8.2.2.2 Operable Unit III

North Sector: This sector is north of the developed portion of the site, upgradient of known or suspected groundwater contaminant plumes related to BNL operations. Groundwater in this sector is monitored by wells in Grids 07, 17, 18, and 25 (see Figures 8-2). Because of its location, data from the north sector can be used to establish ambient groundwater conditions in the area. Radiological results from this sector show gross alpha and beta activities that are consistent with expected background values (see Table 8-29). As expected, no unusual gamma-emitting radionuclides or significant tritium concentrations were found.

South Sector and Off-site Areas: The South Sector includes the area between Princeton Avenue and the southern site boundary. In support of Operable Unit III, wells were installed in the North Shirley area to monitor the migration of chemical contaminants from the south sector (see Section 8.2.1.2 for details and Figure 8-14 for geographic location). The radiological sampling results for on-site wells showed typical ambient gross activity levels. Neither tritium nor man-made gamma-emitting radionuclides were detected in any well. Strontium-90 results were either less than the detection limit or were "J" qualified (result is uncertain or biased) or "UJ" qualified (result represents non-detection) by the analytical laboratory. This data is shown in Table 8-30.

Twenty four wells installed in North Shirley were sampled for radiological parameters as well. Gross alpha and beta activity concentrations were found to be normal and representative of expected ambient levels. Twenty three wells showed no tritium above the detection limit of approximately 200 pCi/L (7.4 Bq/L); one sample was reported at 188 $\pm$ 107 pCi/L (7 $\pm$ 4 Bq/L), a value that is statistically indistinguishable from background. All strontium-90 analyses were either below the detection limit or were qualified "J" or "UJ" (see definitions above). Data is presented in Table 8-31.

Supply and Materiel: Samples collected from groundwater wells surrounding the Supply and Materiel buildings (Grids 85, 86, 96, and 105), south of Brookhaven Avenue, showed typical background levels for gross alpha and beta activity, gamma-emitting radionuclides and tritium (see Table 8-32). No unusual activity was found. This is as expected since the known contaminants in this area are of a chemical nature and not radioactive.

Table 8-29
BNL Site Environmental Report for Calendar Year 1996
North Boundary and Magothy Well Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Sr-90
			←	(pCi/L)		→
Upper Glacial & Magothy Aquifer Wells, North Boundary						
007-04	2	Max.	0.6 ± 0.4	2.0 ± 1.1	< 379	(b)
		Avg.	0.6 ± 0.1	1.9 ± 0.1	101 ± 55	
007-05	2	Max.	0.8 ± 0.4	< 1.6	348 ± 237	(b)
		Avg.	0.6 ± 0.3	1.1 ± 0.7	163 ± 371	
017-01	2	Max.	< 0.8	< 1.6	< 379	(b)
		Avg.	-0.1 ± 0.2	0.4 ± 0.9	282 ± 183	
017-02	2	Max.	1.0 ± 0.5	< 1.6	< 306	(b)
		Avg.	0.5 ± 1.0	1.0 ± 0.4	201 ± 1	
017-03	2	Max.	< 0.8	< 1.7	582 ± 252	(b)
		Avg.	0.0 ± 0.0	0.2 ± 1.1	407 ± 351	
017-04	2	Max.	0.9 ± 0.3	< 1.6	< 379	(b)
		Avg.	0.4 ± 0.9	0.8 ± 0.9	43 ± 86	
018-01	2	Max.	< 0.8	3.7 ± 1.2	414 ± 242	(b)
		Avg.	0.2 ± 0.2	3.1 ± 1.2	342 ± 144	
018-02	2	Max.	< 0.8	< 1.6	< 379	(b)
		Avg.	-0.01 ± 0.3	0.6 ± 0.6	239 ± 251	
018-04 (a)	1	Max.	< 0.6	2.0	< 374	(b)
018-05 (a)	2	Max.	< 0.6	< 1.7	< 374	(b)
072-03	1	Max.	2.1 ± 0.6	2.2 ± 0.6	< 166	0.6 ± 0.6
072-04	1	Max.	2.4 ± 0.7	2.8 ± 1.0	< 207	2.8 ± 0.7
Magothy Wells, Interior of Site						
063-09 (a)	2	Max.	0.7 ± (c)	< 1.7	< 362	(b)
085-13 (a)	3	Max.	< 0.6	2.1 ± (c)	711 ± (c)	4.89 ± (c)
106-19 (a)	2	Max.	< 0.6	< 1.5	< 374	(b)
DOE Order 5400.5 DCG			NS	NS	20,000 (d)	8 (d)

Notes:
(a) Data from OER 1996 Sitewide Groundwater Monitoring Report, values < MDL not reported.
(b) Well not sampled for this analyte.
(c) Confidence interval not avilable for this value.
(d) 40 CFR 141 SDWA limit shown.

= No. of samples collected.
NS = Not Specified.

Table 8-30
BNL Site Environmental Report for Calendar Year 1996
Operable Unit 3 Groundwater Radioactivity Data (On-Site, South Sector)

Well	N		Alpha	Beta	Tritium	Sr-90
			(pCi/L)			
Operable Unit 3 Wells (On-Site)						
103-01	2	Max.	0.1 ± 0.4	2.6 ± 1.1	< 380	(a)
		Avg.	0.1 ± 0.1	2.2 ± 0.8	-239 ± 465	
103-02	1	Max.	< 3.2	< 9.3	< 372	(a)
104-10	2	Max.	16.1 ± 3.8	10.7 ± 1.8	< 245	< 0.78
		Avg.	8.6 ± 15.0	6.3 ± 8.7	100 ± 128	0.54 ± 0.29
104-11	2	Max.	(a)	(a)	< 274	(a)
		Avg.			(b)	
105-21	1	Max.	< 1.6	3.3 ± 1.6	< 277	< 0.78
105-22	1	Max.	< 1.7	< 2.6	< 266	3.13 ± 0.84 (e)
105-23	1	Max.	2.3 ± 1.7	< 2.8	< 266	< 0.67
105-24	2	Max.	< 0.6	6.4 ± (d)	< 254	(a)
		Avg.	(b)	4.4 ± 4.2	(b)	
105-25	1	Max.	< 1.3	2.3 ± 1.4	< 254	< 0.71
105-29	1	Max.	8.6 ± 1.2	3.8 ± 1.3	< 194	< 0.96
113-06	1	Max.	< 1.1	< 1.9	< 254	< 0.38
113-07	3	Max.	3.5 ± (d)	2.9 ± (d)	< 208	8.89 ± 1.60 (e)
		Avg.	2.3 ± 2.4	2.3 ± 1.0	(b)	(c)
113-08	3	Max.	1.6 ± 1.1	2.2 ± 1.1	< 212	1.0 ± 0.47 (e)
		Avg.	(b)	(b)	(b)	(c)
113-09	2	Max.	2.4 ± (d)	4.6 ± 1.3	< 252	< 0.72
		Avg.	(b)	(b)	(b)	(c)
113-10	3	Max.	2.4 ± 1.3	2.8 ± 1.1	< 212	< 0.66
		Avg.	1.8 ± 1.1	2.3 ± 0.7	(b)	(c)
113-11	2	Max.	< 2.4	1.9 ± 1.1	< 257	< 0.62
		Avg.	(b)	(b)	(b)	(c)
DOE Order 5400.5 DCG			NS	NS	20,000 (f)	8 (f)

Notes:
(a) Well not sampled for this analyte. NS = Not Specified.
(b) Insufficient data available to calculate average value.
(Data includes values not specifically reported if below detection limit; see 1996 OER Sitewide Groupndwater Report.)
(c) Location sampled only once for this analyte.
(d) Confidence interval unavailable, see 1996 OER Sitewide Groundwater Report.
(e) Data qualified as "J" by the analytical laboratory, indicating an unusually uncertain or biased, detected result.
(f) 40 CFR 141 SDWA limit shown.

Table 8-30 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Operable Unit 3 Groundwater Radioactivity Data (On-Site, South Sector)

Well	N		Alpha	Beta	Tritium	Sr-90
			←	(pCi/L)		→
Operable Unit 3 Wells (On-Site)						
118-01	2	Max.	< 0.5	1.4 ± 0.9	< 357	(a)
		Avg.	0.1 ± 0.0	1.1 ± 0.5	-99 ± 369	
118-02	2	Max.	< 0.5	2.5 ± 1.0	< 396	(a)
		Avg.	0.1 ± 0.3	1.4 ± 2.3	-7 ± 119	
121-06	1	Max.	1.3 ± 0.9	<1.7	< 257	< 0.58
121-07	2	Max.	< 1.7	< 2.3	< 256	1.3 ± 0.46 (f)
		Avg.	(b)	(b)	(b)	(c)
121-08	2	Max.	4.2 ± (d)	2.3 ± (d)	< 243	< 0.68
		Avg.	3.9 ± 0.5	1.9 ± 0.8	(b)	(c)
121-09	1	Max.	< 1.5	< 2.0	< 257	< 0.63
121-10	2	Max.	< 1.8	1.6 ± (d)	< 266	< 0.62
		Avg.	(b)	1.3 ± 0.6	(b)	(c)
121-11	2	Max.	7.4 ± 2.3	2.3 ± 1.1	< 257	< 0.70
		Avg.	(b)	(b)	(b)	(c)
121-12	1	Max.	< 1.1	< 1.7	< 257	< 0.64
121-13	2	Max.	2.8 ± 1.4	2.6 ± 1.0	< 257	< 0.77
		Avg.	(b)	(b)	(b)	(c)
121-14	2	Max.	< 1.3	2.4 ± 1.2	< 257	< 0.76
		Avg.	(b)	(b)	(b)	(c)
124-02	1	Max.	< 0.7	< 1.1	< 255	< 0.88
126-01	3	Max.	< 0.6	< 1.5	< 255	< 0.91
		Avg.	0.2 ± 0.4	1.0 ± 0.3	-99 ± 484	(c)
130-02	4	Max.	< 0.7	13.3 ± 1.7	< 370	< 0.84
		Avg.	0.2 ± 0.5	4.0 ± 10.8	185 ± 283	(c)
130-03	1	Max.	< 0.8	< 1.1	< 255	2.38 ± 0.82 (e)
130-04	1	Max.	< 1.4	< 1.8	< 327	< 0.75
DOE Order 5400.5 DCG			NS	NS	20,000 (g)	8 (g)

Notes:
(a) Well not sampled for this analyte. NS = Not Specified.
(b) Insufficient data available to calculate average value.
(Data includes values not specifically reported if below detection limit; see 1996 OER Sitewide Groupndwater Report.)
(c) Location sampled only once for this analyte.
(d) Confidence interval unavailable, see 1996 OER Sitewide Groundwater Report.
(e) Data qualified as "J" by the analytical laboratory, indicating an unusually uncertain or biased, detected result.
(f) Data qualified as "UJ" by the analytical laboratory, indicating a non-detected result with unexpectedly high uncertainty and high or low bias, respectively.
(g) 40 CFR 141 SDWA limit shown.

Table 8-31
BNL Site Environmental Report for Calendar Year 1996
Operable Unit 3 Groundwater Radioactivity Data (Off-Site)

Well	N	Alpha	Beta	Tritium	Sr-90	
		←	(pCi/L)		→	
North Shirley Area						
000-97	1	2.6 ± 0.9	6.4 ± 1.4	< 212	< 0.83	
000-98	1	3.6 ± 1.3	4.7 ± 1.3	< 213	< 1.06	
000-98	1	< 1.1	< 1.7	< 203	< 0.79	
000-100	1	< 1.5	2.5 ± 1.2	< 210	< 0.86	
000-101	1	3.5 ± 1.1	2.9 ± 1.1	< 208	< 1.98	
000-102	1	< 1.1	< 1.8	< 212	3.47 ± 0.97	(a)
000-103	1	2.0 ± 1.2	2.5 ± 1.1	< 214	< 0.82	
000-104	1	2.9 ± 1.4	2.4 ± 1.1	< 211	< 0.84	
000-105	1	< 0.9	< 1.7	< 214	< 0.93	
000-106	1	< 1.2	< 1.8	< 209	< 0.87	
000-107	1	1.3 ± 0.7	2.1 ± 1.0	< 212	< 0.69	
000-112	1	< 1.4	2.8 ± 1.1	< 211	< 0.85	
000-113	1	0.7 ± 0.6	< 1.8	< 211	< 0.83	
000-114	1	< 1.3	2.9 ± 1.2	< 218	0.87 ± 0.55	(a)
000-131	1	1.8 ± 0.9	< 1.4	< 171	0.47 ± 0.29	(b)
800-21	1	2.7 ± 1.7	6.5 ± 1.4	< 218	< 0.77	
800-22	1	< 1.2	2.3 ± 1.1	< 213	< 0.84	
800-23	1	< 1.1	< 1.8	< 216	< 0.72	
800-39	1	3.3 ± 1.0	4.9 ± 1.1	< 181	1.60 ± 0.47	(b)
800-40	1	8.8 ± 1.7	3.7 ± 0.9	< 181	1.29 ± 0.56	(b)
800-41	1	7.1 ± 1.5	3.1 ± 0.9	< 173	< 1.09	
800-42	1	1.1 ± 0.7	3.1 ± 0.9	< 168	1.03 ± 0.35	(b)
800-43	1	1.8 ± 0.8	< 1.4	188 ± 107	0.87 ± 0.40	(b)
800-44	1	2.6 ± 0.9	< 1.4	< 171	< 0.59	
DOE Order 5400.5 DCG		NS	NS	20,000 (c)	8 (c)	

Notes:
1. Source for all data in this table is the OU III Remedial Investigation Report.
2. N = No. of samples collected.
3. NS = Not Specified.

(a) Result was qualified "J" by the analytical laboratory, indicating an uncertain or biased result.
(b) Result was qualified "UJ" by the analytical laboratory, indicating a non-detected result with unexpectedly high uncertainty and high or low bias, respectively.
(c) 40 CFR 141 SDWA limit shown.

Table 8-32. Supply and Material Area Groundwater Radioactivity Data

Well	N	Alpha	Beta	Tritium	Sr-90
		(pCi/L)			
085-03	1	< 0.7	< 1.4	< 412	(a)
086-21	1	< 0.7	2.2 ± 1.0	< 412	(a)
096-07	1	< 0.6	3.6 ± 1.1	< 396	(a)
105-02	1	< 1.0	< 1.5	254 ± 155	0.91 ± 0.44

Notes: (a) This location not sampled for this analyte. ND = Not Detected. N = No. of samples collected.

AGS and LINAC Area: Wells in the vicinity of these facilities are positioned in Grids 54, 64, and 65 (Figure 8-4). Low-level radionuclides also have been detected in area groundwater, which may be the result of the outside storage of activated scrap metal or soil and/or soil moisture activation due to beam-target interaction. Radiological data is presented in Table 8-33. All gross alpha activity concentrations in these wells were typical of environmental levels, though Wells 64-02 and 54-06 showed elevated gross beta activity. Water samples from Wells 54-07 and 64-02 showed tritium concentrations just above the limit of detection. Well 64-02 also showed sodium-22 (half-life = 2.6 years), which was measured at a concentration of 4.7 pCi/L (0.17 Bq/L). Strontium-90 was also detected in three of the 11 wells near the AGS; the maximum concentration observed was 1.6 pCi/L (0.06 Bq/L) in Well 54-02. This is equal to 20% of the drinking water standard. This is not a radionuclide which could be generated by AGS operations. Therefore, the detection of strontium-90, in this area raises some questions about the results. It is possible this data indicates historic contamination present from some past operation, not associated with the AGS.

HFBR Area: Two wells were installed downgradient of the HFBR in 1996. Samples collected in December 1996 indicated the presence of tritium at concentrations up to 44,700 pCi/L (1,654 Bq/L) (see Table 8-33). Tritium concentrations at two times the drinking water standard resulted in an intensive 60-day campaign to identify the source of the tritium, characterize the extent of the contamination, and install a groundwater pumping system at the leading edge of the plume. Delineation of the tritium plume was accomplished through the installation of over 120 temporary groundwater characterization wells, 70 permanent monitoring wells, and two horizontal wells below the HFBR structure. Nearly 1,900 groundwater samples were collected during the investigation.

The plume was found to extend from the HFBR to an area near Princeton Avenue, a distance of approximately 1,280 meters (4,200 ft.). The leading edge of the plume was determined to be approximately 1,463 meters (4,800 ft.) north of BNL's southern boundary. Groundwater analysis indicated that tritium concentrations within the plume range from 660,000 pCi/L (2,440 Bq/L)

Table 8-33
BNL Site Environmental Report for Calendar Year 1996
AGS and HFBR Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Na-22	Sr-90
			←		(pCi/L)		→
Alternating Gradient Synchrotron Area							
044-01*	1	Max.	< 0.5	2.6 ± 1.1	< 449	ND	(b)
044-02*	1	Max.	0.7 ± 0.4	< 1.5	< 449	ND	(b)
054-01	1	Max.	< 2.7	< 7.3	< 503	ND	1.16 ± 0.34
054-02	1	Max.	< 2.1	< 8.2	< 503	ND	1.57 ± 0.28
054-05	1	Max.	< 0.5	< 1.5	< 449	ND	(b)
054-06	1	Max.	< 2.1	24.2 ± 6.3	< 449	ND	< 0.35
054-07	2	Max.	2.2 ± 0.5	8.8 ± 1.5	685 ± 270	0.44 ± 0.15	0.76 ± 0.30
		Avg.	1.2 ± 2.0	7.7 ± 2.2	371 ± 628	(a)	(a)
054-08	2	Max.	0.8 ± 0.3	2.1 ± 1.0	< 412	ND	(b)
		Avg.	0.2 ± 1.1	1.7 ± 0.9	-294 ± 731		
064-01	1	Max.	< 0.4	4.6 ± 1.2	< 449	ND	< 0.33
064-02	2	Max.	< 2.1	16.5 ± 1.9	439 ± 248	4.66 ± 0.96	< 0.42
		Avg.	0.3 ± 1.0	8.8 ± 15.4		(a)	(a)
064-03	2	Max.	0.7 ± 0.3	3.0 ± 1.1	< 396	ND	(b)
		Avg.	0.3 ± 0.7	3.0 ± 0.01	-134 ± 164		
HFBR Area							
065-01*	1	Max.	1.1 ± 0.4	3.1 ± 1.3	< 377	ND	(b)
075-11	2	Max.	< 0.4	21.3 ± 6.0	2,110 ± 343	ND	(b)
		Avg.	0.1 ± 0.1	12.2 ± 18.2	1,282 ± 1,656		
075-12	2	Max.	0.8 ± 0.4	3.8 ± 4.5	44,700 ± 1,140	ND	(b)
		Avg.	0.1 ± 1.4	2.3 ± 4.6	23,610 ± 42,180		
DOE Order 5400.5 DCG			NS	NS	20,000 (c)	10,000	8 (c)

Notes:
(a) This analyte was sampled for or detected only once.
(b) This location not sampled for this analyte.
(c) 40 CFR 141 SDWA limit shown.

* Well is upgradient of this facility.
ND = Not Detected.
N = No. of samples collected.
NS = Not Specified.

immediately south of the HFBR, to approximately 6,000 pCi/L (222 Bq/L) at the plume's leading edge, near Princeton Avenue. Following a detailed evaluation of the HFBR's piping and water storage systems, the Spent Fuel Pool was found to leaking at a rate of 6 to 9 gallons per day. It was determined that this was the primary source of the detected tritium. This tritium plume was designated AOC 29, and possible remedial responses will be evaluated as part of the OU III RI/FS.

Waste Concentration Facility: The WCF (Building 811) is used to reduce the volume of liquid radioactive wastes by removing suspended solids. Past leakage from above-ground waste storage tanks and the storage of activated materials have led to radiological groundwater contamination in the immediate area. Radiological data is presented in Table 8-34. Wells surrounding the WCF showed elevated gross beta activity; maximum concentrations observed was 72 pCi/L (2.7 Bq/L). Four of the eight sampled wells showed the presence of strontium-90; maximum concentration occurred in Well 65-18 at 25 pCi/L (0.9 Bq/L). This is a factor of three above the drinking water standard. Sodium-22 was consistently detected in each of the five wells sampled near the WCF; concentrations ranged between 2 and 19 pCi/L (0.1 to 0.7 Bq/L), less than 1% of the DCG value. Because of its mechanism of production and half-life, the observed sodium-22 is more likely associated with the AGS and not with the WCF (WCF is downgradient of the AGS.) This is also supported by the fact that sodium-22 has been detected in upgradient well 65-06. No significant tritium was detected in this area.

Western and Central Sectors: This area contains monitoring wells in the vicinity of Potable Well 4 and Process Supply Wells 9, 104 and 105. Wells 84-03, 84-04, 84-05, and 94-01 showed no detectable activity. Well 84-02 showed elevated gross alpha and beta activity, but no corresponding gamma-emitting radionuclides were detected. Samples from Wells 83-01 and 83-02 indicated the presence of strontium-90, though at levels which were very near the analytical detection limit.

Building 830: In 1986, it was discovered that a waste transfer line between Building 830 and an underground storage tank had leaked. Approximately 900 gallons of liquid radioactive waste were lost (Miltenberger et al., 1989). Soil contaminated by the leak was excavated and removed in 1988 and monitoring wells were installed the following year to allow for the characterization of groundwater quality. Samples collected from Wells 66-08, and 66-09 showed ambient levels of gross alpha and beta activity. Neither tritium nor any other radionuclides attributable to BNL were observed. Well 66-07 showed elevated gross beta activity at 20 pCi/L (0.7 Bq/L), but no corresponding gamma or strontium-90 activity was detected.

8.2.2.3 Operable Unit IV

Building 650: This building was used as a decontamination facility for the removal of radioactive material from clothing and heavy equipment. Drainage from outdoor decontamination of heavy equipment was routed to a drain system which emptied out into a natural depression (known as the Building 650 Sump Outfall) 800 feet to the northeast (see Figure 8-5). Table 8-37 shows the groundwater radionuclide concentrations in the Building 650/Sump Outfall areas. Elevated gross beta activity was observed in Wells 76-24 and 76-13; the maximum value seen was 62 pCi/L (2.3

Table 8-34
BNL Site Environmental Report for Calendar Year 1996
WCF Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium (pCi/L)	Na-22	Sr-90
Waste Concentration Facility							
65-02	3	Max.	< 3.1	8.4 ± 4.8	< 214	2.08 ± 0.51	1.04 ± 0.43 (b)
		Avg.	0.0 ± 0.6	5.4 ± 5.0	-233 ± 482	1.81 ± 0.55	(a)
65-03	3	Max.	< 3.1 ± 1.6	14.5 ± 5.3	< 214	4.37 ± 0.78	1.06 ± 0.45 (b)
		Avg.	0.3 ± 1.0	10.1 ± 6.6	-12 ± 140	3.42 ± 1.90	(a)
65-04	2	Max.	0.7 ± 0.3	10.3 ± 1.6	< 578	7.16 ± 1.20	1.37 ± 0.58 (b)
		Avg.	0.2 ± 1.1	9.6 ± 1.5	-13 ± 448	6.26 ± 1.80	(a)
65-05	3	Max.	4.0 ± 1.8	72.0 ± 8.7	< 578	19.40 ± 3.85	< 0.67
		Avg.	1.3 ± 4.1	37.6 ± 49.7	165 ± 394	15.20 ± 8.40	(a)
65-06*	3	Max.	2.2 ± 1.6	57.0 ± 7.9	439 ± 151	16.90 ± 3.30	< 0.59
		Avg.	1.3 ± 1.9	24.9 ± 45.5	6 ± 674	10.53 ± 12.70	(a)
65-18	1	Max.	< 2.0	57.3 ± 6.7	< 215	ND	24.5 ± 2.60
65-19	1	Max.	< 1.8	< 2.6	589 ± 162	ND	< 0.59
65-20	1	Max.	< 1.9	< 3.2	< 229	ND	0.64 ± 0.37 (b)
DOE Order 5400.5 DCG			NS	NS	20,000 (c)	10,000	8 (c)

Notes:

* Well is upgradient of this facility.

(a) Well sampled only once for this analyte.

(b) Sample result 'UJ' qualified by the analytical laboratory, indicating a non-detected result with an unexpectedly high uncertainty and high or low bias, respectively.

(c) 40 CFR 141 SDWA Limit shown.

NS = Not Specified.

Table 8-35
BNL Site Environmental Report for Calendar Year 1996
Western Supply Well Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Sr-90
			← (pCi/L) →			
83-01	2	Max.	< 0.5	3.1 ± 1.1	< 247	0.91 ± 0.45
		Avg.	0.1 ± 0.01	2.0 ± 2.2	-161 ± 309	(a)
83-02	2	Max.	< 0.5	1.6 ± 0.9	< 256	0.76 ± 0.42
		Avg.	0.2 ± 0.4	1.2 ± 0.7	-119 ± 432	(a)
84-02	1	Max.	15.1 ± 5.3	14.0 ± 2.5	< 254	< 0.68
84-03	1	Max.	< 2.3	< 3.2	< 254	< 0.62
84-04	1	Max.	< 2.1	< 2.4	< 245	< 0.82
84-05	1	Max.	< 2.2	< 2.8	< 274	< 0.70
94-01	1	Max.	< 0.5	< 1.4	< 449	(b)

Notes: (a) This analyte was sampled for only once.
(b) This location not sampled for this analyte.

N = No. of samples collected.

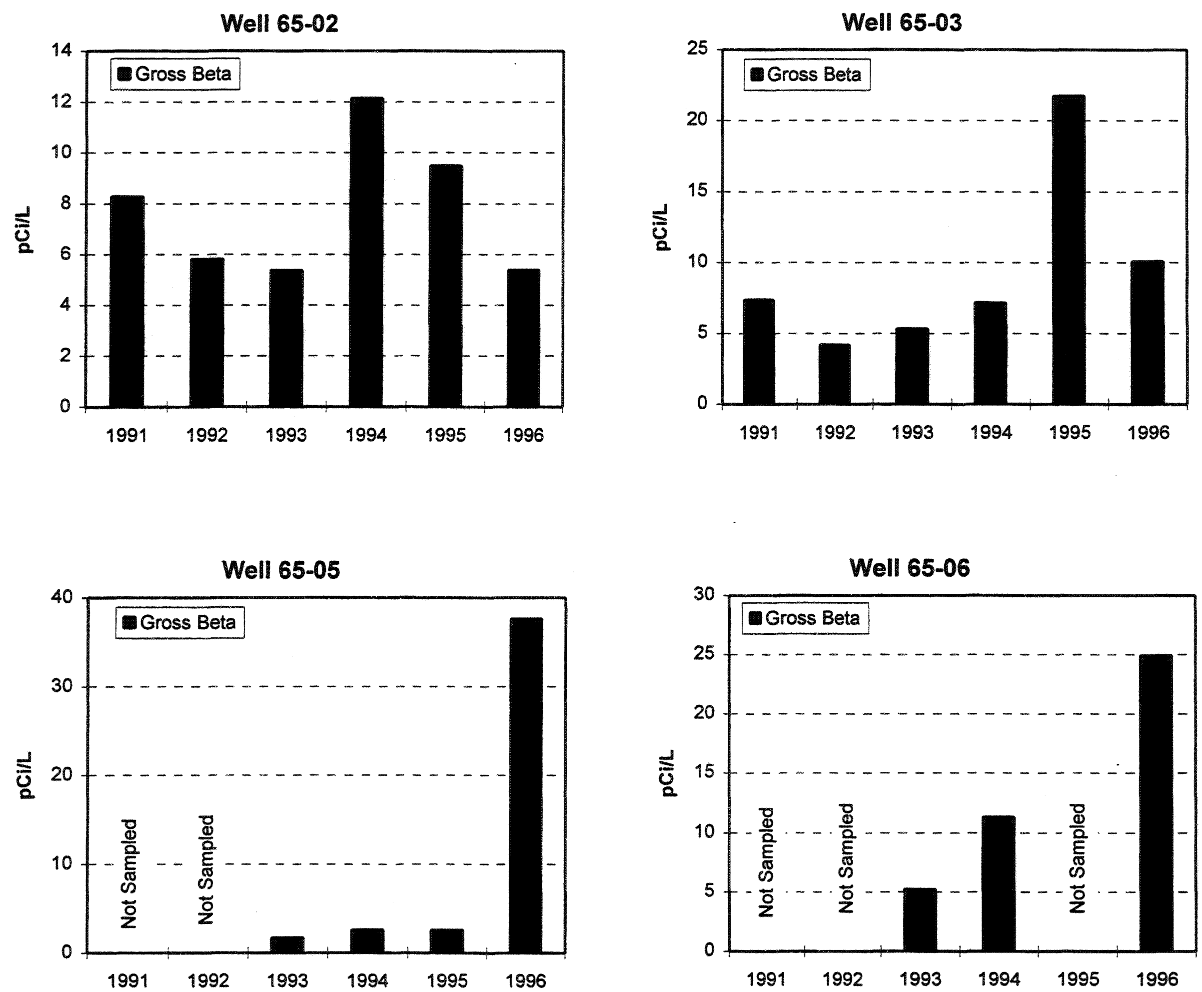


Figure 8-28 Annual average gross beta activity trends at the Waste Concentration Facility. Well 65-06 is located directly upgradient of the WCF; Wells 65-02, 65-03, and 65-05 located directly downgradient of the WCF.

Table 8-36. Building 830 Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Sr-90
			←	(pCi/L)		→
066-07	1	Max.	< 0.5	20.0 ± 2.0	< 401	< 0.12
066-08	1	Max.	< 0.5	2.3 ± 1.5	< 401	(a)
066-09	1	Max.	< 0.5	< 1.5	< 401	(a)

Notes: N = No. of samples collected.

(a) This location not sampled for this analyte based on low gross beta activity results.

(b) No non-primordial gamma-emitting radionuclides detected in these wells.

Bq/L) in Well 76-13. No significant gamma-emitting radionuclides were found. Maximum tritium concentrations were just above the detection limit in three of the nine wells sampled.

Central Steam Facility/Major Petroleum Facility: Radiological results for groundwater near the CSF and the MPF show background radioactivity levels with no unusual radionuclides present. Data are presented in Tables 8-37 and 8-38.

8.2.2.4 Operable Unit V

Sewage Treatment Plant and Peconic River : In the areas surrounding the STP and Peconic River, gross alpha activity values were typical of ambient groundwater values while gross beta activities were somewhat elevated in Wells 38-03, 39-08 and 60-01 with a maximum recorded value of 17 pCi/L (0.6 Bq/L). Tritium was detectable at elevated levels of up to 1,620 pCi/L (60 Bq/L). Cesium-137 and strontium-90 are typically seen in these wells. However, no cesium was observed in any of the samples collected in 1996 and strontium-90 concentrations were down significantly from those recorded in 1995. Elevated gross beta, tritium, cesium-137, and strontium-90 activity near the STP are primarily due to liquid effluents which the STP currently processes (in the case of tritium) and has processed in the past (in the case of cesium-137 and strontium-90). Data are presented in Table 8-39. The general trend in both cases is a decrease in activity over the last five years.

Private Supply Wells - East of BNL: In addition to the on-site surveillance wells maintained by BNL, 40 privately owned potable wells to the east of the Laboratory were sampled for radionuclides as part of a continuing cooperative program with SCDHS. Sample collection was performed by County Staff and analyses was carried out by the BNL Analytical Services Laboratory. Additional analyses were also performed by laboratories not associated with BNL (only those samples analyzed by BNL are included in this report.) Tritium concentrations above the minimum detection limit were found in several private well samples (see Table 8-41). Five

Table 8-37
BNL Site Environmental Report for Calendar Year 1996
Operable Unit 4 Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Cs-137	Sr-90
			←		(pCi/L)		→
Major Petroleum Facility							
076-25*	2	Max.	< 3.1	< 8.4	< 454	ND	(b)
		Avg.	0.3 ± 1.2	-14.0 ± 23.0	-116 ± 6		
076-16	2	Max.	< 0.6	< 8.4	< 454	ND	(b)
		Avg.	-0.2 ± 0.9	-12.3 ± 25.0	-124 ± 119		
076-17	2	Max.	< 3.1	< 8.4	< 454	ND	(b)
		Avg.	0.6 ± 0.2	-13.1 ± 24.6	-177 ± 137		
076-18	2	Max.	< 0.6	< 8.4	< 454	0.67 ± 0.37	(b)
		Avg.	0.3 ± 0.01	-11.1 ± 27.6	-182 ± 93	(a)	
076-19	2	Max.	< 0.5	< 8.4	< 454	0.17 ± 0.14	(b)
		Avg.	0.3 ± 0.02	-13.1 ± 25.4	-127 ± 82	(a)	
Building 650							
076-25	2	Max.	< 3.1	< 8.4	< 454	ND	(b)
		Avg.	0.3 ± 1.2	-14.0 ± 23.0	-116 ± 6		
076-26	2	Max.	< 0.7	2.5 ± 1.1	516 ± 229	ND	(b)
		Avg.	0.0 ± 0.0	2.4 ± 0.1	293 ± 446		
076-28	2	Max.	< 0.6	< 1.6	375 ± 221	ND	(b)
		Avg.	0.1 ± 0.2	1.2 ± 0.1	228 ± 295		
Buidling 650 Outfall							
066-17	2	Max.	< 0.6	2.1 ± 1.1	< 454	ND	(b)
		Avg.	0.05 ± 0.6	1.5 ± 1.1	-102 ± 288		
066-18	2	Max.	< 0.6	2.3 ± 1.1	< 454	ND	(b)
		Avg.	0.2 ± 0.1	2.1 ± 0.4	-114 ± 269		
076-13	2	Max.	1.2 ± 0.5	62.0 ± 3.2	< 454	ND	< 0.13
		Avg.	0.8 ± 0.8	54.2 ± 15.6	-121 ± 298		(c)
076-20	2	Max.	< 0.5	3.1 ± 1.1	719 ± 264	ND	0.52 ± 0.20
		Avg.	-0.2 ± 1.5	3.0 ± 0.2	396 ± 646		(c)
076-24	2	Max.	< 0.4	10.6 ± 1.6	< 454	ND	(b)
		Avg.	-0.1 ± 0.4	9.7 ± 1.9	-8 ± 31		
076-27	2	Max.	< 0.6	2.9 ± 1.1	< 363	0.18 ± 0.13	(b)
		Avg.	0.2 ± 0.1	2.4 ± 1.1	4 ± 63	(a)	
DOIE Order 5400.5 DCG			NS	NS	20,000 (d)	3,000	8 (d)

Notes:
(a) Radionuclide detected only once at this location.
(b) Well not sampled for this analyte.
(c) Location sampled only once for this analyte.
(d) 40 CFR 141 SDWA Limit shown.

* Well is upgradient of the facility.
N = No. of samples collected.
ND = Not Detected.
NS = Not Specified.

Table 8-38
BNL Site Environmental Report for Calendar Year 1996
CSF / Supply and Materiel Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Sr-90
			←	(pCi/L)		→
Central Steam Facility						
076-02*	2	Max.	< 0.8	1.7 ± 1.0	< 362	(a)
		Avg.	-0.3 ± 0.1	0.6 ± 2.2	-75 ± 173	
076-04	2	Max.	< 0.5	2.8 ± 1.1	< 401	(a)
		Avg.	0.2 ± 0.03	2.7 ± 0.2	-108 ± 3	
076-08	2	Max.	< 0.8	2.2 ± 1.1	< 362	(a)
		Avg.	-0.5 ± 0.1	0.6 ± 3.1	-31 ± 38	
076-09	2	Max.	< 0.5	2.3 ± 1.1	< 454	(a)
		Avg.	0.2 ± 0.3	1.7 ± 1.2	-244 ± 637	
076-21	2	Max.	< 0.5	2.6 ± 1.1	< 362	(a)
		Avg.	-0.2 ± 0.3	0.6 ± 4.1	-35 ± 128	
076-22	2	Max.	< 0.5	1.8 ± 1.0	< 454	(a)
		Avg.	0.1 ± 0.001	1.2 ± 1.1	-352 ± 605	
076-23	2	Max.	< 0.6	2.4 ± 1.1	< 363	(a)
		Avg.	-0.3 ± 0.2	0.0 ± 4.7	-109 ± 15	
076-24*	2	Max.	< 0.4	10.6 ± 1.6	< 454	2.95 ± 0.49
		Avg.	-0.1 ± 0.4	9.7 ± 1.9	-8 ± 31	(b)
086-04	2	Max.	< 0.8	< 1.6	< 362	(a)
		Avg.	-0.4 ± 0.1	-0.6 ± 2.3	-132 ± 90	
086-05	2	Max.	< 0.8	< 1.6	< 362	(a)
		Avg.	0.1 ± 0.7	-1.0 ± 4.9	-160 ± 15	
086-06	2	Max.	< 0.8	1.7 ± 1.0	< 454	< 0.13
		Avg.	0.4 ± 0.1	1.1 ± 1.3	-93 ± 382	(b)
086-07	2	Max.	< 3.1	10.5 ± 5.2	< 362	(a)
		Avg.	0.4 ± 1.4	4.8 ± 11.5	-164 ± 5	
086-08	2	Max.	0.7 ± 0.4	1.5 ± 1.0	< 362	(a)
		Avg.	0.4 ± 0.5	-0.1 ± 3.1	-261 ± 35	
086-09	2	Max.	< 0.6	< 1.6	< 454	(a)
		Avg.	-0.1 ± 0.2	1.1 ± 0.1	-145 ± 140	
Supply and Materiel						
105-05	3	Max.	< 0.4	< 1.6	< 256	0.77 ± 0.46
		Avg.	0.0 ± 0.9	1.1 ± 0.7	35 ± 210	(b)
105-06	3	Max.	0.8 ± 0.4	3.0 ± 1.5	< 256	< 0.71
		Avg.	0.4 ± 0.6	2.2 ± 1.4	30 ± 123	(b)
105-07	3	Max.	< 1.4	< 2.4	< 247	< 0.63
		Avg.	0.3 ± 1.1	0.9 ± 0.8	96 ± 133	(b)
DOE Order 5400. DCG			NS	NS	20,000 (c)	8 (c)

Notes:
(a) Well not sampled for this analyte.
(b) Location sampled only once for this analyte.
(c) 40 CFR 141 SDWA Limit shown.

N = No. of samples collected.
NS = Not Specified.

* Well is upgradient of the 1977 oil / solvent spill site.

Table 8-39
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant/Peconic River Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium	Sr-90
			(pCi/L)			
Sewage Treatment Plant and Peconic River						
038-01	3	Max.	0.8 ± 0.5	3.5 ± 1.1	< 352	(c)
		Avg.	0.6 ± 0.3	2.4 ± 2.1	-355 ± 407	
038-02	3	Max.	< 0.7	3.8 ± 1.1	1,620 ± 250	(c)
		Avg.	0.1 ± 0.5	3.3 ± 0.7	569 ± 1,607	
038-03	3	Max.	< 0.8	12.2 ± 1.6	1,180 ± 226	1.71 ± 0.32
		Avg.	0.4 ± 0.5	9.8 ± 4.3	137 ± 1,480	(a)
038-05	3	Max.	4.0 ± 2.5	8.4 ± 5.4	569 ± 197	(b)
		Avg.	1.8 ± 3.2	3.7 ± 6.6	329 ± 459	(a)
038-06	2	Max.	1.3 ± 0.5	2.8 ± 1.1	< 297	(c)
		Avg.	0.8 ± 1.0	2.0 ± 1.7	-110 ± 46	
039-05	3	Max.	1.7 ± 0.6	3.0 ± 1.0	949 ± 294	(c)
		Avg.	0.7 ± 1.4	2.8 ± 0.3	372 ± 1,021	
039-06	4	Max.	< 3.1	9.6 ± 5.0	852 ± 224	1.77 ± 0.17
		Avg.	1.1 ± 1.7	5.0 ± 5.8	79 ± 893	(a)
039-07	3	Max.	< 0.7	4.3 ± 1.2	733 ± 211	0.98 ± 0.24
		Avg.	0.4 ± 0.3	3.6 ± 1.0	180 ± 782	
039-08	3	Max.	8.8 ± 2.3	14.5 ± 5.0	515 ± 199	(c)
		Avg.	5.1 ± 7.5	6.9 ± 13.6	333 ± 432	
039-09	2	Max.	1.1 ± 0.6	2.5 ± 1.0	< 297	(c)
		Avg.	0.8 ± 0.6	2.4 ± 0.3	-428 ± 720	
039-10	2	Max.	< 0.5	< 1.6	< 250	(c)
		Avg.	0.4 ± 0.1	0.6 ± 1.0	-176 ± 56	
060-01	2	Max.	9.1 ± 2.8	17.4 ± 6.4	333 ± 197	0.47 ± 0.29
		Avg.	5.1 ± 7.9	10.4 ± 13.9	-144 ± 954	(a)
061-03	2	Max.	0.8 ± 0.4	3.2 ± 1.0	< 305	0.99 ± 0.14
		Avg.	0.7 ± 0.2	0.8 ± 4.8	-234 ± 868	(a)
DOE Order 5400.5 DCG			NS	NS	20,000 (d)	8 (d)

Notes:
1. All data in this table from samples analyzed by S&EP.
2. No non-primordial gamma-emitting radionuclides were detected in these samples.
3. Average value error equal to 2 standard errors of the mean.

(a) Well sampled for this analyte only once.
(b) Data voided based on QA review.
(c) Well not sampled for this analyte.
(d) 40 CFR 141 SDWA Limit shown.

N = No. of samples collected.
NS= Not Specified.

Table 8-39 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Sewage Treatment Plant/Peconic River Area Groundwater Radioactivity Data

Well	Collect Date	Alpha	Beta	Tritium
		←	(pCi/L)	→
Sewage Treatment Plant and Peconic River				
041-02	18-Mar-96	<0.75	<1.78	<389
	4-Sep-96	<0.62	<1.71	<380
041-03	18-Mar-96	<0.75	<1.78	<389
	4-Sep-96	<0.62	<1.71	<380
049-05	19-Mar-96	<0.75	<1.78	663
	4-Sep-96	1.04	2.86	<380
049-06	19-Mar-96	<0.75	<1.78	1069
	4-Sep-96	<0.62	<1.71	<380
061-04	18-Mar-96	<0.75	<1.78	<389
	5-Sep-96	<0.62	<1.71	<380
061-05	18-Mar-96	<0.75	<1.78	848
	5-Sep-96	<0.62	2.0	985
000-122	27-Mar-96	0.64	<1.37	<411
	13-Sep-96	<0.62	1.7	<465
000-123	27-Mar-96	<0.53	2.36	<412
	13-Sep-96	<0.5	1.74	<465
600-15	26-Mar-96	<0.53	<1.37	<392
	11-Sep-96	<0.62	<1.71	<362
600-15	25-Mar-96	8.58	<8.08	<392
	11-Sep-96	3.86	<9.38	<362
DOE Order 5400.5 DCG		NS	NS	20,000 (a)

Notes:
1. All data in this table from OER 1996 Sitewide Groundwater Monitoring Report.
2. Confidence intervals not included in SWGM report.

(a) 40 CFR 141 SDWA Limit shown.

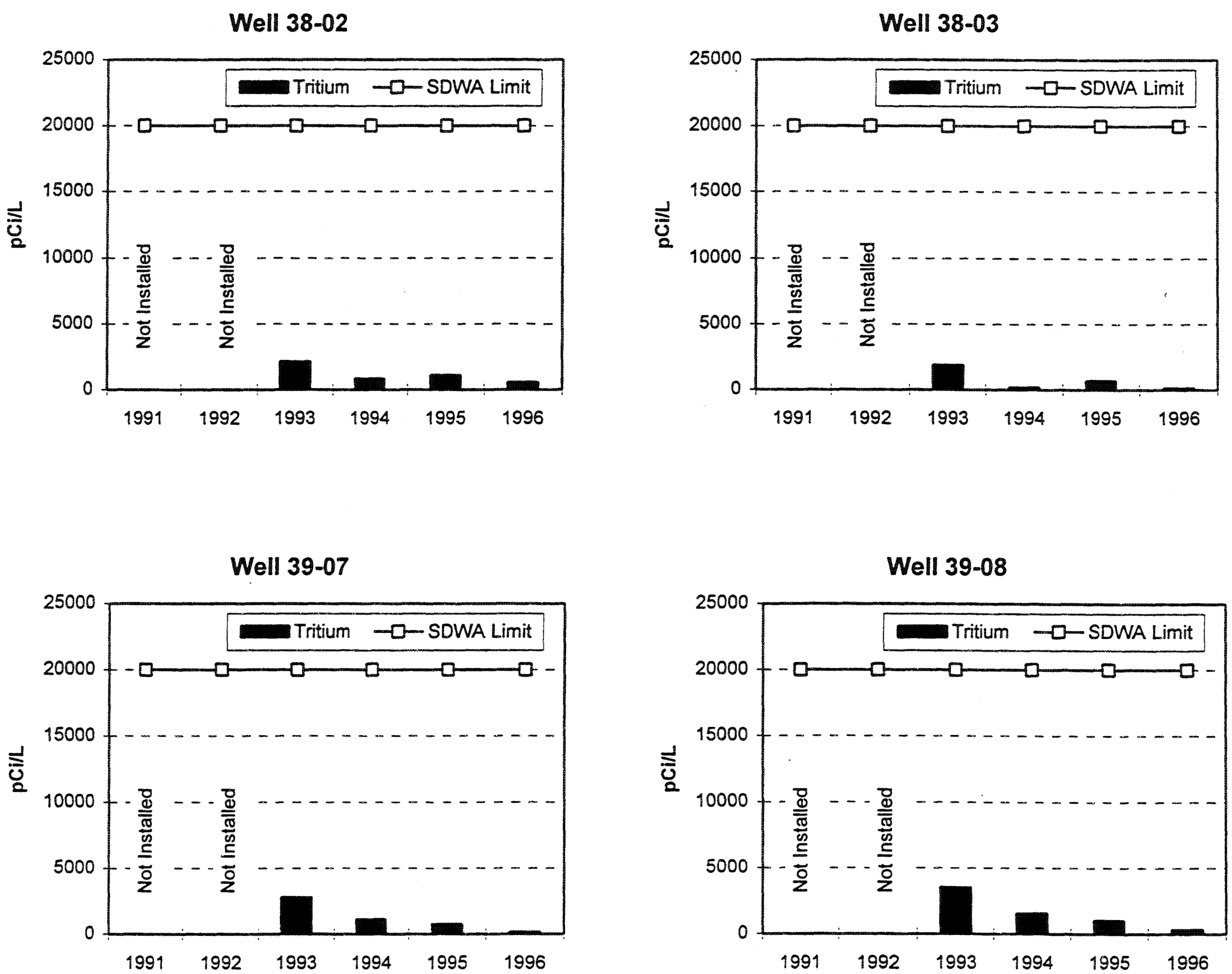


Figure 8-29 Annual average tritium activity trends at the Sewage Treatment Plant.

locations consistently showed levels which were unambiguously positive. The maximum concentrations in these wells ranged from 1,140 to 3,930 pCi/L (42 to 145 Bq/L), or 6% to 20% of the drinking water standard. Ingestion of water throughout the year at the maximum concentration detected would lead to a committed effective dose equivalent 0.2 mrem/yr (2 μSv/yr) to the individual consuming the water. By comparison, the typical dose that a U. S. citizen receives annually from the ingestion of naturally-occurring radionuclides is approximately 40 mrem (0.4 mSv) (NCRP, 1987).

Table 8-41 shows the tritium levels in potable off-site wells north of the Laboratory and in the North Shirley area. All tritium concentrations observed in these wells were below the minimum detection limit for the analytical method. Figure 8-30, below, shows a 10 year trend of maximum recorded tritium concentrations in off-site potable wells. No private well has shown tritium concentrations which exceed or approach the drinking water standard.

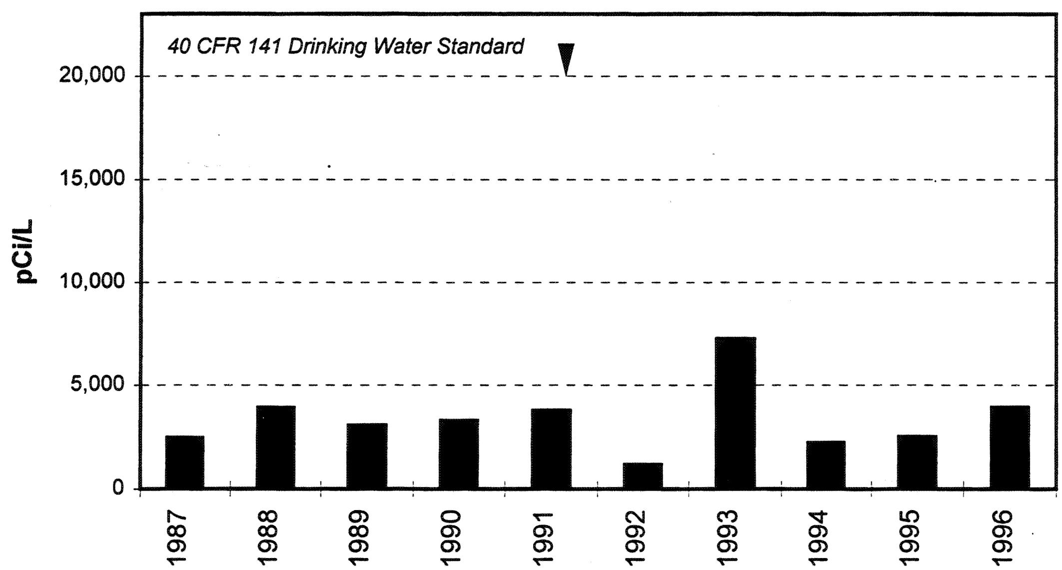


Figure 8-30 Maximum tritium values in off-site potable wells, 10 yr. trend.

8.2.2.5 Operable Unit VI

Meadow Marsh: Wells downgradient of the former Upland Recharge experiment showed no radioactivity above background levels in 1996. Data is presented in Table 8-40.

Table 8-40
BNL Site Environmental Report for Calendar Year 1996
Upland Recharge Area Groundwater Radioactivity Data

Well	N		Alpha	Beta	Tritium
			←	(pCi/L)	→
Upland Recharge Area					
058-02	2	Max.	< 0.6 ±	1.6 ± 1.0	398 ± 244
		Avg.	0.1 ± 0.1	1.2 ± 0.8	196 ± 404
058-03	2	Max.	< 0.4	< 1.6	< 341
		Avg.	0.0 ± 0.6	0.6 ± 0.3	-357 ± 648
079-17	2	Max.	< 0.4	< 1.6	< 350
		Avg.	0.0 ± 0.5	0.9 ± 0.6	-277 ± 653
080-02	2	Max.	< 0.6	2.4 ± 1.0	< 379
		Avg.	0.0 ± 0.1	2.3 ± 0.2	17 ± 573
080-03	2	Max.	< 0.4	2.1 ± 1.0	< 379
		Avg.	0.1 ± 0.1	1.0 ± 2.2	37 ± 196
089-13	2	Max.	0.7 ± 0.4	3.1 ± 1.1	< 379
		Avg.	0.5 ± 0.3	2.3 ± 1.5	-238 ± 763
089-14	2	Max.	< 0.7	< 1.4	< 379
		Avg.	0.0 ± 0.1	0.8 ± 0.2	163 ± 292
090-02	2	Max.	< 0.4	2.1 1.0	< 346
		Avg.	0.2 ± 0.3	1.3 ± 1.5	-316 ± 720
090-03	2	Max.	< 0.8	< 1.6	< 379
		Avg.	-0.1 ± 0.1	0.5 ± 0.3	104 ± 143
DOE Order 5400.5 DCG			NS	NS	20,000 (a)

Notes:
1. No non-primordial gamma-emitting radionuclides were detected in these samples.
(a) 40 CFR 141 SDWA Limit shown.
N = No. of samples collected.
NS = Not Specified.

Table 8-40 (cont.)
BNL Site Environmental Report for Calendar Year 1996
Upland Recharge Area Groundwater Radioactivity Data

Well	N		Alpha	Beta (pCi/L)	Tritium
Upland Recharge Area (cont.)					
099-05	2	Max.	< 0.7	< 1.4	< 379
		Avg.	0.0 ± 0.5	1.1 ± 0.9	-19 ± 314
099-06	2	Max.	< 0.7	2.3 ± 1.0	437 ± 240
		Avg.	0.0 ± 0.5	1.6 ± 1.3	254 ± 365
099-10	2	Max.	< 0.6	1.7 ± 1.0	< 379
		Avg.	0.0 ± 0.2	1.3 ± 0.7	131 ± 251
099-11	2	Max.	< 0.6	1.6 ± 0.9	< 379
		Avg.	0.2 ± 0.1	1.5 ± 0.2	48 ± 117
100-04	2	Max.	9.2 ± 2.7	< 8.9	< 379
		Avg.	6.1 ± 6.3	5.7 ± 5.4	157 ± 281
100-11	2	Max.	< 0.8	< 1.4	< 379
		Avg.	0.0 ± 0.4	0.8 ± 1.2	21 ± 382
100-12	2	Max.	8.2 ± 0.2	< 1.6	< 379
		Avg.	4.0 ± 8.4	0.4 ± 0.3	-60 ± 309
100-13	2	Max.	0.8 ± 0.4	< 1.5	< 379
		Avg.	0.3 ± 1.0	0.5 ± 0.2	108 ± 193
100-14	2	Max.	< 0.5	< 1.5	< 379
		Avg.	0.2 ± 0.1	0.1 ± 0.04	34 ± 46
800-24 (a)	2	Max.	<0.53	1.47	<411
800-25 (a)	2	Max.	<0.62	<1.71	<362
DOE Order 5400.5 DCG			NS	NS	20,000 (b)

Notes:
1. No non-primordial gamma-emitting radionuclides were detected in these samples.
(a) Data from OER 1996 Sitewide Groundwater Monitoring Report, values <MDL not reported.
(b) 40 CFR 141 SDWA Limit shown.
N = No. of samples collected.
NS = Not Specified.

Table 8-41
BNL Site Environmental Report for Calendar Year 1996
Off-Site Potable Well Tritium Analysis Data

Location	1st Qtr. (pCi/L)	2nd Qtr. (pCi/L)	3rd Qtr. (pCi/L)	4th Qtr. (pCi/L)
1	< 405	NS	NS	NS
2	NS	NS	< 362	NS
3	< 405	NS	NS	831 ± 293
4	NS	< 330	< 423	NS
5	NS	NS	NS	NS
6	< 405	NS	< 423	611 ± 281
7	NS	NS	< 362	NS
8	NS	< 330	NS	NS
9	NS	NS	NS	528 ± 278
10	NS	< 330	NS	NS
11	NS	< 330	< 362	669 ± 285
12	NS	2,180 ± 291	NS	2,520 ± 366
13	1,460 ± 308	1,320 ± 257	1,560 ± 284	NS
14	1,140 ± 294	1,290 ± 253	1,450 ± 310	1,330 ± 316
15	557 ± 262	363 ± 211	< 438	NS
16	NS	929 ± 240	NS	1,850 ± 343
17	NS	3,930 ± 352	2,870 ± 377	2,170 ± 346
18	NS	NS	NS	524 ± 286
19	< 405	< 378	< 438	NS
20	NS	< 378	NS	NS
21	< 405	NS	NS	NS
22	< 405	< 378	< 362	NS
23	NS	NS	< 438	NS
24	< 405	< 378	< 362	NS
25	NS	NS	< 438	NS
26	< 405	< 378	NS	NS
27	NS	< 378	NS	NS
28	NS	< 378	< 362	NS
29	NS	NS	NS	594 ± 289
30	< 405	NS	< 362	494 ± 288
31	NS	NS	NS	< 469
32	< 405	NS	NS	NS
33	< 405	NS	NS	NS
34	NS	NS	< 423	691 ± 286
35	NS	NS	< 423	660 ± 284
36	NS	NS	NS	< 469
37	< 405	NS	NS	NS
38	< 405	NS	NS	NS
39*	NS	1,330 ± 256	NS	1,250 ± 319
40	< 405	< 378	< 362	853 ± 294
41	< 405	NS	NS	NS

Federal Drinking Water Standard for tritium: 20,000 pCi/L
Maximum value observed: 3,930 pCi/L (20% of the Standard).

* Peconic River sample along North Street, Manorville.
NS = Not Sampled during the quarter.

Note: This data includes the results of analyses performed by the BNL Safety & Environmental Protection Division only.

9. RADIOLOGICAL DOSE ASSESSMENT

9.1 Effective Dose Equivalent Calculations - Airborne Pathway

Brookhaven National Laboratory is subject to the requirements of Title 40 CFR Part 61, Subpart H, (NESHAPs). This EPA Rule establishes national policy regarding the airborne emission of radionuclides. It specifies the monitoring and reporting requirements for various types of radionuclides and establishes the public dose limit for the airborne pathway as 10 mrem (0.1 mSv) per year.

The NESHAPs regulations require the use of the CAP88-PC (Clean Air Act Assessment Package-1988) computer model in demonstrating site compliance. The CAP88-PC model uses a Gaussian plume equation to estimate the average dispersion of radionuclides released from elevated stacks or area sources (EPA, 1992). The program computes radionuclide concentrations in air, rates of deposition on ground surfaces and concentrations in food (where applicable) to arrive at a final value for projected effective dose equivalent (EDE) at the specified distance from the release point to the location of interest. The program supplies both the calculated EDE to the maximally exposed individual, and the collective population dose within an 80 km radius of the emission source(s). This model provides very conservative dose estimates in most cases.

Input parameters used in the model include radionuclide type, emission rate in curies per year, and stack parameters such as height, diameter and exhaust velocity of the effluent. Site-specific weather data supplied by measurements from BNL's meteorological tower are used in the model. Data includes wind speed, direction, frequency and temperature. A 10-year average data set for these meteorological parameters is used. Population data for the surrounding area is based on customer records of the Long Island Lighting Company.

For purposes of modeling the dose to the maximally exposed individual (MEI), all emission points are co-located at the center of the developed portion of the site (approximately, at the location of the HFBR stack). Due to the wind frequency distribution on-site, the maximum dose is consistently projected in the NNE sector. The distance from the HFBR stack to the nearest residences adjacent to the site boundary in the NNE direction is approximately 3,000 meters. The placement of the MEI at 3,000 meters NNE was initiated with the 1995 Site Environmental Report. Prior to this, the MEI was assumed to be at the geographically closest boundary (to the west), only 1,500 meters away. However, due to the consistent wind patterns in the area, it is more accurate to locate the MEI in the NNE sector. This has the effect of somewhat reducing the total dose from the airborne pathway as compared to years prior to 1995.

In addition to stack sources, 'area' or 'diffuse' sources must also be evaluated for airborne emissions potential. The only diffuse source on the BNL site is the water contained in the STP holding ponds. The only radionuclide with the potential to become airborne from this source is tritium, via evaporation. The total tritium inventory in the ponds varied throughout the year, but a constant source term has been assumed for purposes of dose evaluation. The conservative assumption was made that the maximum source inventory measured in the pond in 1996 represented the inventory throughout the year. The tritium inventory of Pond No. 1 was the greater of the two ponds at approximately 0.43 Ci (16 GBq). This value is based on tritium analyses of pond water and measurements of total water volume. It is assumed that no more than 10% of this inventory resulted in an airborne release via evaporative processes. The resulting dose to the maximally exposed individual from this source as calculated by the CAP88 model is 0.000001 mrem/yr (1E-8 mSv/yr).

In 1996, the effective dose equivalent to the MEI adjacent to the NNE boundary of the site was 0.07 mrem (0.7 μSv). Argon-41 released from the BMRR contributed 80% of this dose. By comparison, this is 143 times less than the EPA airborne dose limit of 10 mrem (0.1 mSv) and 4,286 times smaller than the EDE received annually from natural background radiation. This dose is also too small to distinguish from background using the most sensitive environmental TLDs.

9.2 Effective Dose Equivalent Calculations - Water Pathway

Since the Peconic River is not used as a drinking water supply, nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactive material (NYSDOH, 1993). However, water in the Peconic River does recharge to the underground aquifer which is used as a drinking water supply for residential homes. For purposes of evaluating the potential maximum EDE to an individual from water ingestion, the results from the radiological analysis of private wells adjacent to the Laboratory were used. These samples are provided to and analyzed by BNL via the cooperative environmental surveillance program with the SCDHS.

Tritium was the only BNL-related radionuclide detected in any of the private wells that were sampled. The maximum tritium concentration observed in a residential well throughout 1996 was 3,930 pCi/L (93 Bq/L). This is five times less than the 20,000 pCi/L (740 Bq/L) limit established by the EPA National Primary Drinking Water Regulations under the SDWA (40 CFR 141). In calculating the potential dose to an individual via the drinking water pathway, it is conservatively assumed that this maximum concentration is consumed at a rate of 2 liters per day for 365 days a year. Under these assumptions, the dose to the maximally exposed individual via this pathway is 0.18 mrem (2 μSv). (See Appendix B for a description of the calculational methods.) This represents 4.5% of the 4 mrem (40 μSv) dose limit specified for this pathway by the SDWA. This data is summarized in Table 9-1.

9.3 Effective Dose Equivalent Calculations - Fish Consumption

Calculations were also made to determine the potential dose to an individual consuming fish taken from Donahue's Pond, a water body fed by the Peconic River. The maximum concentration of strontium-90 found in fish taken from Donahue's Pond was of the *pumpkinseed* species: 0.93 pCi/g (34 mBq/g) in the viscera and bones and 0.32 pCi/g (12 mBq/g) in the flesh and skin. The concentration of cesium-137 in the flesh and skin of the same pumpkinseed fish was 0.47 pCi/g (17 mBq/g). As noted in Section 7.8.1, higher concentrations of both cesium and strontium were observed in fish collected from Fresh Pond in Montauk, a distant water body used as a control location. This indicates that the radiological dose resulting from the consumption of fish from Donahue's Pond would not differ in any significant way than that received from eating fish from other Long Island water bodies. However, for the sake of evaluation, individual dose estimates are provided here.

For the evaluation, an individual is assumed to eat 7 kg of fish during the course of the year. Since it is realistic to assume that the flesh and skin is the part of the fish most often eaten by anglers, this is what is used in the dose calculation. Consumption at the rates and concentrations discussed above would result in a maximum committed EDE of 0.46 mrem (5 µSv). By comparison, the average individual EDE caused by the ingestion of naturally-occurring radionuclides in the U.S. is about 40 mrem (0.4 mSv) per year (NCRP, 1987).

9.4 Effective Dose Equivalent Calculations - Meat Consumption

As part of the environmental surveillance program, measurements were made of flesh samples collected from deer taken on BNL property (see Section 7.5.1) as well as from off-site locations. Cesium-137 was detected in meat samples from on-site deer at concentrations higher than those found in comparable off-site deer. Analysis for strontium-90 indicated no difference in flesh concentration levels between on-site and off-site samples. While on-site sport hunting is not permitted, there are no physical barriers preventing deer from migrating beyond the site boundary. An estimate of the dose resulting from consumption of deer meat based on samples collected in 1996 is presented here.

The NYSDEC Wildlife Branch estimates that deer meat consumption ranges between 2 to 9 kg (4 to 20 lbs.) per person per year. The calculation of the maximum individual committed EDE is based on the assumption that an individual consumes deer meat at the upper estimate of 9 kg/yr, and that the meat contains cesium-137 at the highest observed concentration of 11.7 pCi/g (0.4 Bq/g). Under the stated assumptions, the committed EDE would be equal to 5.27 mrem (53 µSv).

9.5 Collective Dose Equivalent

While the EDE is the parameter used to measure the radiation dose to an individual, the collective effective dose equivalent is a value used to estimate health risks for an exposed population. For the air exposure pathway, the CAP88-PC model provides collective EDE estimates using population data for the area within an 80 kilometer radius of the BNL site. The population data is broken into the number of people living within each of the 16 compass sectors at 16 km radial intervals. Again, argon-41 emitted from the MRR was the largest contributor to the total collective dose at 2,900 person-mrem (29 person-mSv). This constitutes 99% of the total collective dose projected for the population within an 80 km radius of the Laboratory.

The collective EDE to the community using the private water source described in Section 8.2.2.4 (assumed to be not more than 500 persons) would be 90 person-mrem (0.9 person-mSv). This assumes that each member of the 500 person community consumes water which contains tritium at the highest concentration observed in samples collected by the SCDHS in all of 1996. Finally, the total number of individuals who routinely consume fish taken from Donahue's Pond was estimated to be no greater than 625 (LILCO, 1996), leading to a calculated collective EDE of 288 person-mrem (2.9 person-mSv).

By comparison, the collective dose due to external radiation from natural background to the population within an 80 km radius of the Laboratory amounts to approximately 291,000 person-rem (2,910 person-Sv), and about 196,800 person-rem (1,968 person-Sv) from internal radioactivity in the body from natural sources (excluding potential radon contributions).

9.6 Summary and Conclusion

Calculations of effective dose equivalents from all BNL facilities which have the potential to release radionuclides to the atmosphere indicate that radiological doses attributable to Laboratory operations were far below the limits established by Federal regulations. Direct measurement of external radiation levels by TLD confirms that exposure rates at the site boundary are consistent with background levels observed throughout New York State (NYSDOH, 1993).

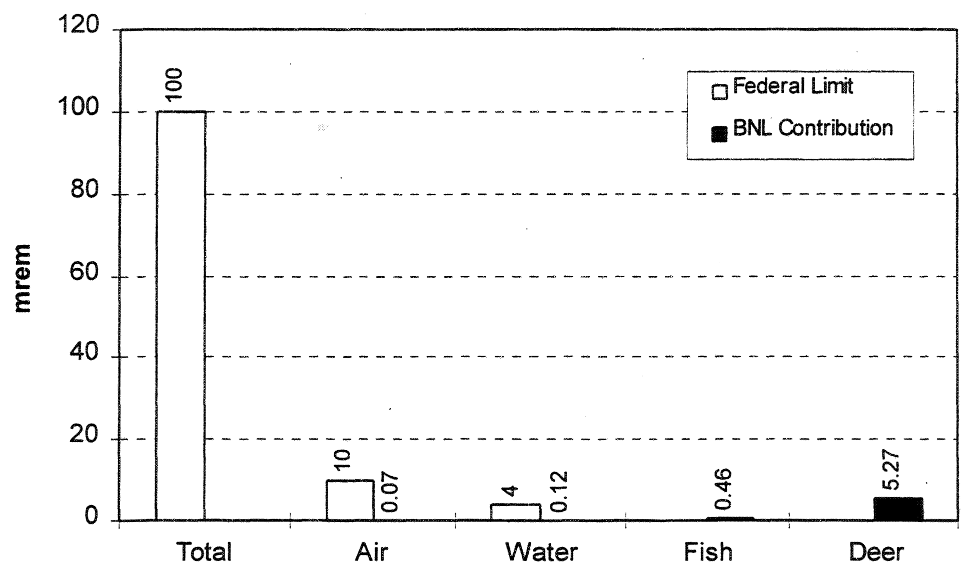


Figure 9-1 Dose summary, max. BNL contribution and Federal limits.

The EDEs presented in this Chapter are based on the maximally exposed individual for each scenario using the stated assumptions. Given this, it is not plausible that any single person could receive a radiological dose equal to the sum of these individual pathways. For this to occur, an individual would be required to consume water, fish and deer at the highest concentrations of radionuclides observed in all samples collected in 1996. However, even if these pathways were to be summed, the total dose from all pathways would equal 6% of the 100 mrem/yr (1 mSv) DOE limit established for the protection of the public. This total represents approximately 0.6% of the average individual dose received annually from natural background sources, including radon

(NCRP, 1987). These maximum credible doses demonstrate that in 1996, radioactive material associated with BNL operations had no impact on the health of the public or environment in the surrounding area.

Table 9-1. Summary of Dose From All Environmental Pathways

Pathway	Primary Contributing Radionuclide(s)	Maximum Individual EDE (mrem)	Regulatory Pathway Limit (mrem)	Collective EDE (person-mrem)
Air	Ar-41	0.07	10	2900
Water	H-3	0.18	4	90
Fish*	Cs-137 Sr-90	0.16 0.29	NS	288
Deer Meat**	Cs-137	5.27	NS	NA

Notes:
1. 1 mrem = 0.01 mSv.
2. EDE = Effective Dose Equivalent.
3. NS = None Currently Specified
4. NA = Not Applicable

Because all doses shown in Table 9-1 are calculated rather than measured, they represent potential rather than actual doses.

** Based on maximum concentrations observed in fish collected from Donahue's Pond. Note that these concentrations were less than those observed in fish from some control locations. This indicates that radionuclide levels in Peconic River fish are in a range which is normal for fish in waters which have not received discharges from BNL.*

*** Based on maximum cesium concentrations observed in on-site deer. On-site sport hunting is not currently permitted.*

10. QUALITY ASSURANCE PROGRAM

Responsibility for quality at BNL starts with the Laboratory Director and permeates down through the entire organization, with individuals at each level assuming their appropriate share. The BNL Quality Management (QM) Office, headed by the QM Manager, coordinates and evaluates QA implementation at the Laboratory, and provides professional assistance and guidance to the Departments and Divisions. The S&EP Division appointed a Quality Representative and Quality Management Team (QMT) to assist, assess, advise, and improve implementation of the Division-wide QA program.

The QA Program developed by BNL to achieve Laboratory objectives provides policies, responsibilities, and guidance procedures for the Divisions and Departments based on DOE Order 5700.6C. The S&EP Division has adopted or adapted these program elements into the S&EP Division Management System Manual (BNL, 1994) and has established responsibilities, methods, and controls for conducting its operations. The Environmental Protection Office and Analytical Services Laboratory (ASL) integrated both these elements and the additional environmental QA requirements of DOE Order 5400.1 into their sampling, analysis, and data handling activities. The implementing procedures on Environmental Monitoring, Radiation Measurements, Analytical Chemistry, and Regulatory Programs, in conjunction with the S&EP Division Management System Manual (BNL, 1994) and the S&EP QA Procedures, comprise the QA Program for the environmental surveillance and effluent monitoring programs.

The objectives of the Environmental Protection QA Program are to ensure that management provides planning, organization, direction, control, and support to achieve the objectives of the environmental program; line managers achieve quality in their product or services; and overall performance is reviewed and evaluated using a rigorous assessment process. This program was developed to ensure compliance with QA requirements established by DOE in Orders 5700.6C, Quality Assurance, and 5400.1, General Environmental Protection Program.

The S&EP Division QMT is responsible for establishing a program of internal assessments and external audits to verify the effectiveness of the environmental sampling, analysis, and database activities and their adherence to the QA program. Annual self-assessments of activities by the respective managers identify areas needing attention. Furthermore, the ASL participates in inter-laboratory performance evaluation programs organized by DOE, EPA, and NYSDOH. Contract laboratories that augment the capabilities of the in-house Laboratory are required to maintain a comprehensive QA program and are subject to audits by S&EP Division personnel to ensure its implementation. In addition, the BNL QM Office, DOE-CH, regulatory agencies, and other independent groups periodically audit the environmental programs.

A major activity for the Environmental Protection Office and the ASL is ensuring that environmental media are sampled and analyzed in a way that provides representative, defensible data. The QA program supports this activity by incorporating QA elements, such as field sampling designs, documented procedures, chain of custody, a calibration/standardization program, acceptance criteria, statistical data analyses, software QA, and data processing systems, in the environmental surveillance and effluent monitoring programs. Standard Operating Procedures are established to calibrate instruments, analyze samples, and check quality control. Depending on the analytical method, quality control checks include analysis of blanks or background concentrations, use of Amersham or National Institute for Standards and Technology (NIST) traceable standards, and analysis of reference standards, spiked samples, and duplicate samples. The Laboratory supervisors review all analytical and quality control results before the data is reported and incorporated into the database. The ASL is certified by the NYSDOH, Environmental Laboratory Approval Program (ELAP) for specific analytes identified below. The offsite contractor laboratories that perform radiological and chemical analyses to augment the onsite analytical capabilities also are required to incorporate these QA elements into their operation.

10.1 Radiological Analyses

The S&EP Division ASL performs radiological analysis of both environmental and facility samples for gross alpha, gross beta, gamma, tritium, and strontium-90. The Laboratory participates in the DOE Environmental Measurements Laboratory (EML) QA Program and the EPA National Exposure Research Laboratory, Characterization Research Division, Las Vegas (NERL-LV) Performance Evaluation Study. In 1996, the Laboratory was certified by NYSDOH ELAP for potable and non-potable analysis of gross alpha and beta and photon emitters (gamma). In addition it was certified to perform potable analysis for tritium. During 1996, the ASL analyzed samples using an alternative analytical method for determining strontium-90 that was not approved by NYSDOH (see appendix C). The ASL analyzes proficiency samples as part of the ELAP certification program. The results of these three intercomparison programs are presented in Tables 10-1 through 10-3, respectively.

Overall, the ASL performance in the EML intercomparison study was acceptable in 94% of the analyses. Thirty-four of fifty-one EML analyses were within established acceptance limits showing excellent agreement with the known value; eleven of fifty-one were within upper and lower warning limits demonstrating satisfactory agreement; three analyses fell outside the acceptance limits; and the remaining five were not analyzed. Many of the September air filter test results were reported in the warning and unacceptable range, but a review of the QC data for the unacceptable cobalt-57 and manganese-54 analyses on the air filter matrix showed no problem associated with the sample preparation, analytical process, or data calculations. However, the EML test filter is not the same geometry used to calibrate the gamma spectrometer or used in the BNL EM air monitoring program, which would account for a positive bias. These results imply that the environmental air sampling data presented in this report may be overestimated. Lastly, review of the unacceptable tritium analysis revealed a dilution factor error during this sample's data processing; Table 10-1 presents the corrected results.

Overall, the ASL performance in the NERL intercomparison study was acceptable in 91% of the analyses. The NERL-LV comparisons resulted in excellent agreement for fourteen of the thirty-two analyses (within 1σ of the known value), and good agreement for ten analyses (within 2σ of the known). Five of the thirty-two analyses were within the warning limit, between 2 and 3σ, and the remaining three sample analyses were unacceptable because the results were outside the ± 3 σ control limit.

Table 10-1
BNL Site Environmental Report for Calendar Year 1996
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Matrix	Units	Isotope	Date	EML	BNL	Ratio	Comments
Air Filter	pCi/Filter	Alpha	Mar-96	43.74	52.38	1.20	
			Sep-96	31.05	32.67	1.05	
		Am241	Sep-96	5.99	11.88	1.98	Warning
		Beta	Mar-96	47.79	61.83	1.29	
			Sep-96	13.50	21.33	1.58	Warning
		Ce144	Mar-96	899.10	864.00	0.96	
		Co57	Mar-96	240.30	246.24	1.02	
			Sep-96	399.60	556.2	1.39	Not Acceptable
		Co60	Mar-96	796.50	704.7	0.88	
			Sep-96	233.28	270.00	1.16	Warning
		Cs134	Mar-96	396.90	351.00	0.88	
			Sep-96	291.60	310.50	1.06	
		Cs137	Mar-96	179.28	214.38	1.20	Warning
			Sep-96	230.04	299.70	1.30	Warning
		Mn54	Mar-96	92.88	104.22	1.12	
			Sep-96	171.45	231.12	1.35	Not Acceptable
		Ru106	Mar-96	313.20	324.00	0.97	
			Sep-96	291.60	324.00	1.11	Warning
		Sb125	Mar-96	264.06	334.80	1.27	Warning
			Sep-96	291.60	394.20	1.35	Warning
		Sr90	Mar-96	1.06	NA		
Soil	pCi/g	Am241	Sep-96	364.50	756.00	2.07	Warning
		Co60	Sep-96	78.84	73.17	0.93	
		Cs137	Mar-96	9693.00	9558.00	0.99	
			Sep-96	41850.00	44820.00	1.07	
		K40	Mar-96	12555.00	11178.00	0.89	
			Sep-96	8100.00	7263.00	0.90	
		Sr90	Mar-96	1340.00	NA		
			Sep-96	69.90	NA		
Vegetation	pCi/g	Co60	Mar-96	1611.90	1255.50	0.78	Warning
			Sep-96	294.30	245.97	0.84	
		Cs137	Mar-96	25488.00	25623.00	1.01	
			Sep-96	5130.00	4995.00	0.97	
		K40	Mar-96	27810.00	23895.00	0.86	
			Sep-96	26784.00	23490.00	0.88	Warning
		Sr90	Mar-96	1300.00	NA		
			Sep-96	1390.00	NA		

NA = Not Analyzed
ND = Not Detected
Note: Comment column provides EML evaluation of analytical performance which is based on control limits established from percentiles of historic data distributions. No comment indicates performance within acceptable limits.

Table 10-1 (Continued)
BNL Site Environmental Report for Calendar Year 1996
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Matrix	Units	Isotope	Date	EML	BNL	Ratio	Comments
Water	pCi/L	Alpha	Mar-96	49950.0	55350.0	1.11	
			Sep-96	32670.0	31320.0	0.96	
		Beta	Mar-96	20088.0	24948.0	1.24	
			Sep-96	14580.0	18360.0	1.26	
		Co60	Mar-96	885.6	882.9	1.00	
			Sep-96	1649.7	1714.5	1.04	
		Cs137	Mar-96	1034.1	1147.5	1.11	
			Sep-96	2416.5	2700.0	1.12	
		H3	Mar-96	6777.0	5751.0	0.85	
			Sep-96	15849.0	11934.0	0.75	[(a)] Warning
		Mn54	Mar-96	1036.8	1161.0	1.12	
			Sep-96	1633.5	1814.4	1.11	
		Sr90	Mar-96	39.2	35.6	0.91	
			Sep-96	73.2	64.8	0.89	

NA = Not Analyzed
ND = Not Detected
Note: Comment column provides EML evaluation of analytical performance which is based on control limits established from percentiles of historic data distributions. No comment indicates performance within acceptable limits.
[(a)] = Dilution factor not applied on original data submission. Corrected data is presented.

Table 10-2
BNL Site Environmental Report for Calendar Year 1996
BNL Quality Assessment Program Results
National Exposure Research Laboratory (NERL-LV)

Matrix	Units	Isotope	Date	NERL	BNL	Ratio	Comments
Water	pCi/L	Alpha	Apr-96	74.80	69.70	0.93	(a)
			Jul-96	24.40	19.73	0.81	(a)
			Oct-96	59.10	48.30	0.82	
			Oct-96	10.30	8.33	0.81	
		Ba133	Jun-96	745.00	705.20	0.95	
			Nov-96	64.00	73.20	1.14	
		Beta	Apr-96	166.90	179.30	1.07	(a)
			Jul-96	44.80	51.23	1.14	(a)
			Oct-96	111.80	124.90	1.12	
			Oct-96	34.60	43.33	1.25	>3 sigma
		Co60	Jun-96	99.00	99.90	1.01	
			Apr-96	31.00	31.30	1.01	
			Oct-96	15.00	17.30	1.15	
			Nov-96	44.00	47.90	1.09	
		Cs134	Apr-96	46.00	41.30	0.90	
			Jun-96	79.00	70.70	0.89	(b)
			Oct-96	20.00	21.70	1.09	
			Nov-96	11.00	14.30	1.30	
			Apr-96	50.00	54.70	1.09	
		Cs137	Jun-96	197.00	204.80	1.04	
			Oct-96	30.00	37.70	1.26	
			Nov-96	19.00	27.70	1.46	
		H3	Mar-96	22002.00	20966.70	0.95	
			Aug-96	10879.00	10266.70	0.94	
		Sr89	Apr-96	43.00	33.67	0.78	>3 sigma
			Jul-96	25.00	21.00	0.84	
			Oct-96	10.00	7.70	0.77	
		Sr90	Apr-96	16.00	17.30	1.08	
			Jul-96	12.00	12.70	1.06	
			Oct-96	25.00	22.30	0.89	
		Zn65	Jun-96	300.00	324.90	1.08	
			Nov-96	35.00	45.30	1.29	>3 sigma

(a) = Results not formally reported to NERL-LV.

(b) = Probable error in NERL-LV known value. Comparision to "grand average" shows good agreement, within 1 sigma.

NA = Not Analyzed.

ND = Not Detected.

Note: Comment column provides NERL evaluation of analytical performance which is based on 2 and 3 on 2 and 3 normalized standard deviations about the known value. Results outside these control limits are deemed not acceptable or a statistical outlier. No comment indicates performance within acceptable limits.

Review of the QC data for the unacceptable results showed no problem associated with the sample preparation, analytical process, or data calculations. Although the gross alpha and beta results of April and July were not formally reported to NERL-LV, the samples were treated as blind samples in the Laboratory and manually compared to the NERL-LV reported values.

Lastly, the radiological results from the ELAP proficiency test for gross alpha and beta showed acceptable agreement for six of the eight analyses. However, the two remaining analyses were unacceptable due to a transcription error on the original submission (the alpha and beta results were transposed). The corrected data is presented in Table 10-3 and shows the gross beta result exceeded the acceptance limit at this low activity level.

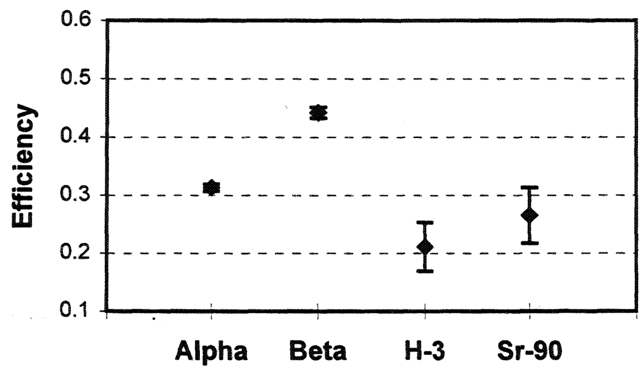


Figure 10- 1 Instrument Efficiency Summary for 1996

Figures 10-1 through 10-3 summarize the internal quality control program for the radiological instruments. Figure 10-1 shows the annual mean and 99% confidence interval for the efficiency of the alpha, beta, tritium, and strontium-90 analyzers, as determined by a daily calibration standard. All analyzers showed stable results. Figure 10-2 summarizes the daily variation in background counts experienced by each of these instruments in 1996. An investigation into the wide range of the 99% confidence interval indicated for H-3 revealed that the liquid scintillator experienced increased variability in the last quarter of 1996 and required preventative maintenance. Figure 10-3 compares the mean and 99% confidence intervals of the cesium-137 energy calibration for each gamma detector, as measured by a daily calibration standard. The actual 661.65 keV cesium-137 gamma energy line is illustrated on the

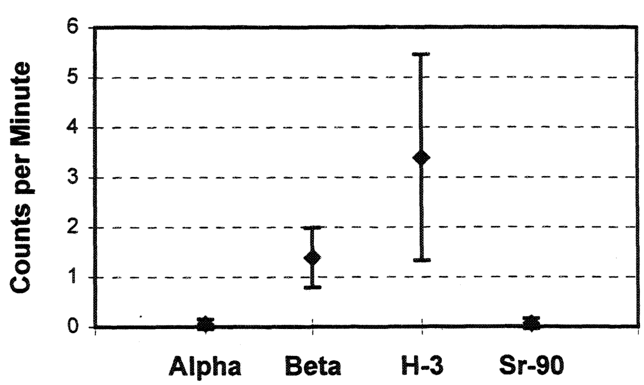


Figure 10- 2 Instrument Background Summary for 1996

Table 10-3
BNL Site Environmental Report for Calendar Year 1996
BNL Potable Water Radiochemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (pCi/L)	BNL (pCi/L)	Ratio	Comment
Alpha	Apr-96	16	20.0	1.25	
	Apr-96	69	76.5	1.11	
	Oct-96	14	11.7	0.84	
	Oct-96	59	62.4	1.06	(a)
Beta	Apr-96	12	13.7	1.14	
	Apr-96	86	97.9	1.14	
	Oct-96	10	13.7	1.37	(a) Not acceptable
	Oct-96	76	89.6	1.18	

(a) = Transcription error on orignial data submission. Corrected data is presented.

Note: Comment column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value. No comment indicates performance within acceptable limits.

graph as the center dashed line and the acceptance band of ± 1 keV is shown as the upper and lower dashed lines. As can be seen, all gamma detectors operated within the acceptance limit during 1996.

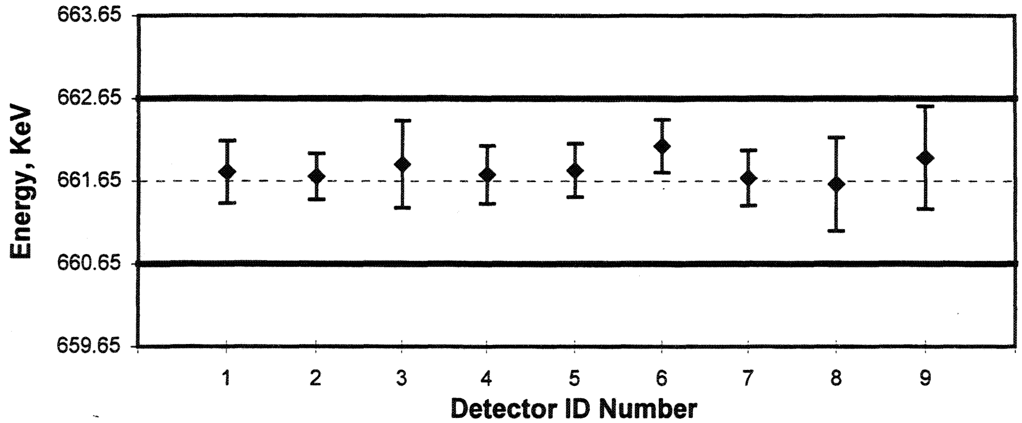


Figure 10- 3 Cesium-137 Energy Calibration Summary for 1996

The ASL performed an alternative strontium-90 method developed at the DOE Argonne National Laboratory (described in Appendix C). Figure 10-4 compares the mean and 99% confidence interval of the deviation of each detector's response from the calibration value. The plot shows that the mean percent deviation from the calibration standards was within ± 2%. Each of the daily efficiency checks performed on all detectors was within the ± 5% acceptance band, except one measurement on detector 10, however excess variability in the daily responses of detectors 3, 5, and 10 caused the 99% confidence interval to exceed the acceptance band even though the daily checks did not. Quality control samples spiked with strontium-90 yielded mean recoveries of 96% ± 7%, showing an improvement from the previous year.

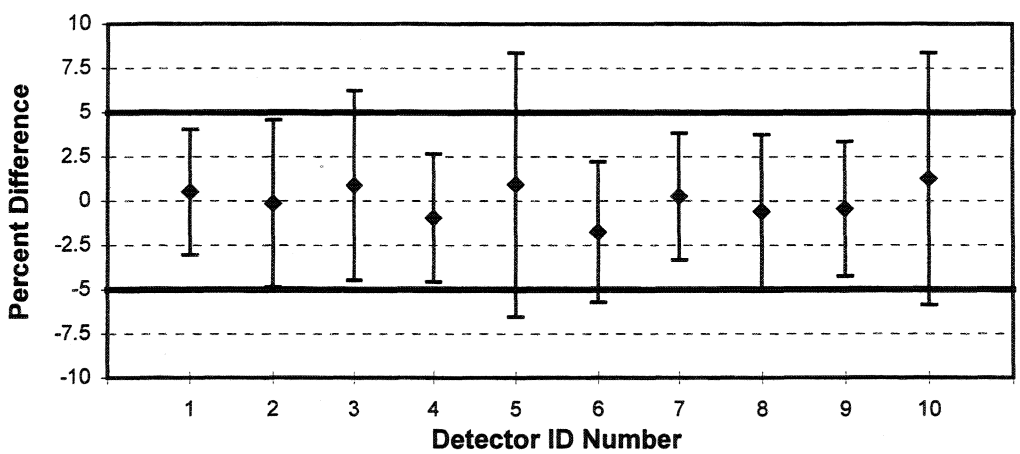


Figure 10-4 Strontium-90 Instrument Efficiency Summary for 1996.

During the July 1996, there was an onsite audit of the radiological analytical processes conducted by NYSDOH ELAP. In addition, an appraisal of the ASL was conducted by an independent organization as part of the BNL Tier III Assessment Program. In both cases, corrective action plans for the findings and recommendations were developed and implementation is ongoing.

10.2 Analytical Chemistry

The S&EP ASL is certified by NYSDOH ELAP for metals and anions under the environmental analyses of potable water category, and specific purgeable organic compounds under the environmental analyses of non-potable water category. The analytes for which the ASL holds potable water certification are silver, cadmium, chromium, copper, iron, mercury, manganese, sodium, lead, zinc, chloride, nitrate (as nitrogen), and sulfate. The compounds which the lab holds certification in nonpotable water are benzene, toluene, xylene, ethylbenzene, chloroform, 1,1-Dichloroethylene (DCE), 1,1-Dichloroethane (DCA), 1,1,1-Trichloroethane (TCA), Trichloroethylene (TCE), and Tetrachloroethylene (PCE).

Table 10-4 presents the results of organic and inorganic proficiency samples analyzed for this certification program. The results show that 100% of all organic analyses of proficiency samples performed for NYSDOH in 1996 were within acceptance limits. There was excellent agreement, within ± 10%, in twenty-two of twenty-eight organic analyses. The remaining six tests were within ± 27% of the known value, showing good agreement. These results confirm the accuracy of the data presented in this report.

Similarly, the inorganic proficiency test results were acceptable in 94% of the analyses as shown in Table 10-5. Test results showed excellent agreement, within ± 10%, in forty-six of the fifty-two analyses, with thirty-four analyses being within ± 5% of the known value, again confirming the accuracy of the data presented in this report. Good agreement, within ± 17%, was found in three, and the remaining three were unacceptable. An investigation of the unacceptable results revealed that the dilution factor was not correctly applied to the mercury result and that incorrect units were reported for the sodium data on the original submission of the April 1996 proficiency test data. Table 10-5 presents the corrected results in the cases of data processing errors.

The ASL also participated in the EPA Environmental Monitoring Systems Laboratory (EMSL-CI) water pollution and water supply performance evaluation studies. Tables 10-6 and 10-7, respectively, give the results of these studies. Overall, the ASL performance in the EMSL-CI water pollution intercomparison study (WP035) was acceptable in 89% of the analyses. The performance was excellent for thirteen of the fourteen organic analyses and one chloroform analysis was acceptable, but in the warning limit. However, the total residual chlorine results were unacceptable. An investigation into the analysis revealed that the analytical data was transcribed incorrectly onto the report form. Table 10-7 shows the results from using the WS037 EMSL-CI water supply samples for an internal blind QC study. The Laboratory was in the process of relocating during the WS037 reporting period and therefore could not submit the results formally to EMSL-CI. Excellent performance was measured in sixteen of nineteen comparisons. An investigation into the three unacceptable results revealed an error in the total xylene algorithm, an error in Pb concentration due to an incorrect dilution factor, and an GC/MS chromatogram setting

Table 10-4
BNL Site Environmental Report for Calendar Year 1996
BNL Non-Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comment
1,1-Dichloroethane	Jan-96	25.80	30.10	1.17	
	Jan-96	57.10	61.70	1.08	
	Jul-96	36.40	38.00	1.04	
	Jul-96	71.10	72.70	1.02	
Benzene	Jan-96	15.00	16.10	1.07	
	Jan-96	36.80	38.90	1.06	
	Jul-96	25.50	25.00	0.98	
	Jul-96	67.50	69.40	1.03	
Ethyl benzene	Jan-96	15.40	15.10	0.98	
	Jan-96	36.70	35.10	0.96	
	Jul-96	21.10	21.20	1.00	
	Jul-96	52.50	57.90	1.10	
Tetrachloroethene	Jan-96	19.30	20.50	1.06	
	Jan-96	52.90	50.90	0.96	
	Jul-96	30.20	33.20	1.10	
	Jul-96	45.50	57.80	1.27	
Toluene	Jan-96	16.60	16.70	1.01	
	Jan-96	42.60	42.80	1.00	
	Jul-96	27.00	26.90	1.00	
	Jul-96	35.70	40.70	1.14	
Total Xylene	Jan-96	24.00	23.00	0.96	
	Jan-96	46.70	45.20	0.97	
	Jul-96	17.00	18.20	1.07	
	Jul-96	40.10	45.00	1.12	
Trichloroethene	Jan-96	25.90	29.50	1.14	
	Jan-96	68.80	68.30	0.99	
	Jul-96	20.30	22.00	1.08	
	Jul-96	40.60	46.50	1.15	

Note: Comment column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value. No comment indicates performance within acceptable limits.

Table 10-5
BNL Environmental Report for Calendar Year 1996
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comment
Cadmium	Apr-96	3.33	3.60	1.08	
	Apr-96	8.33	8.80	1.06	
	Oct-96	6.25	6.70	1.07	
	Oct-96	12.50	12.60	1.01	
Chloride	Apr-96	8.20	7.74	0.94	
	Apr-96	113.00	108.00	0.96	
	Oct-96	11.90	12.00	1.01	
	Oct-96	122.00	114.00	0.93	
Chromium	Apr-96	20.80	20.60	0.99	
	Apr-96	117.00	103.00	0.88	
	Oct-96	37.50	40.60	1.08	
	Oct-96	100.00	105.00	1.05	
Copper	Apr-96	83.30	86.00	1.03	
	Apr-96	667.00	682.00	1.02	
	Oct-96	150.00	155.00	1.03	
	Oct-96	500.00	508.00	1.02	
Iron	Apr-96	135.00	142.00	1.05	
	Apr-96	499.00	522.00	1.05	
	Oct-96	127.00	117.00	0.92	
	Oct-96	375.00	365.00	0.97	
Lead	Apr-96	13.30	15.60	1.17	
	Apr-96	26.70	30.90	1.16	
	Oct-96	18.80	20.60	1.10	
	Oct-96	37.50	39.50	1.05	
Manganese	Apr-96	125.00	129.00	1.03	
	Apr-96	233.00	242.00	1.04	
	Oct-96	75.10	69.00	0.92	within marginal limits
	Oct-96	187.00	180.00	0.96	
Mercury	Apr-96	1.55	1.12	0.72	[a]
	Apr-96	6.39	6.33	0.99	
	Oct-96	3.06	3.28	1.07	
	Oct-96	7.51	8.03	1.07	
Nitrate (as N)	Apr-96	1.55	1.48	0.95	
	Apr-96	6.12	5.57	0.91	
	Oct-96	0.90	0.91	1.01	
	Oct-96	8.10	8.00	0.99	

[a] = dilution factor not applied on original data submission; corrected data is presented.
[b] = units were in error on original data submission; corrected data is presented.
Note: Comment column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value. No comment indicates performance within acceptable limits.

Table 10-5 (Continued)
BNL Environmental Report for Calendar Year 1996
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comment
Silver	Apr-96	18.40	18.20	0.99	
	Apr-96	50.00	50.00	1.00	
	Oct-96	12.60	12.60	1.00	
	Oct-96	37.50	36.00	0.96	
Sodium	Apr-96	9910.00	10300.00	1.04	(b)
	Apr-96	24800.00	25700.00	1.04	(b)
	Oct-96	14900.00	15000.00	1.01	
	Oct-96	33300.00	33500.00	1.01	
Sulfate (as SO4)	Apr-96	25.80	25.40	0.98	
	Apr-96	127.00	126.00	0.99	
	Oct-96	67.40	67.30	1.00	
	Oct-96	190.00	187.00	0.98	
Zinc	Apr-96	127.00	125.00	0.98	
	Apr-96	1170.00	1180.00	1.01	
	Oct-96	127.00	128.00	1.01	
	Oct-96	1880.00	1800.00	0.96	

(b) = Units were in error on original data submission. Corrected data is presented.

Note: Comment column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value. No comment indicates performance within acceptable limits.

Table 10-6
BNL Site Environmental Report for Calendar Year 1996
BNL Water Pollution Performance Evaluation Studies - WP035
USEPA Environmental Monitoring Systems Laboratory - Cincinnati

Analyte	Units	Date	BNL	EMSL-CI	Ratio	Comments
Chloroform	ug/l	Apr-96	74.10	64.80	1.14	
	ug/l	Apr-96	18.00	14.20	1.27	Warning
1,1,1 Trichloroethane	ug/l	Apr-96	79.00	63.70	1.24	
	ug/l	Apr-96	18.20	16.20	1.12	
Trichloroethene	ug/l	Apr-96	77.40	72.30	1.07	
	ug/l	Apr-96	18.20	16.10	1.13	
Tetrachloroethene	ug/l	Apr-96	71.60	73.60	0.97	
	ug/l	Apr-96	11.10	10.40	1.07	
Benzene	ug/l	Apr-96	55.40	55.90	0.99	
	ug/l	Apr-96	10.30	9.30	1.11	
Ethylbenzene	ug/l	Apr-96	50.00	56.40	0.89	
	ug/l	Apr-96	10.50	10.40	1.01	
Toluene	ug/l	Apr-96	43.20	44.70	0.97	
	ug/l	Apr-96	7.83	7.60	1.03	
TSS	mg/l	Apr-96	79.60	88.00	0.90	
	mg/l	Apr-96	48.20	56.00	0.86	
Total Residual Cl	mg/l	Apr-96	0.41	0.41	1.00	(a)
	mg/l	Apr-96	3.18	2.80	1.32	(a)

(a) = Transcription error on original data submissin. Corrected data is presented.

Note: Comment column provides EMSL-CI evaluation of analytical performance which is based on 95 and 99% prediction interval calculated from samples analyzed by EPA and State Laboratories. No comment indicates performance within acceptable limits.

Table 10-7
BNL Site Environmental Report for Calendar Year 1996
BNL Water Supply Performance Evaluation Studies - WS037
USEPA Environmental Monitoring Systems Laboratory - Cincinnati

Analyte	Units	Date	BNL	EMSL-CI	Ratio	Comments
Cd	ug/l	Sep-96	10.00	10.20	0.98	(a)
Cr	ug/l	Sep-96	79.70	72.90	1.09	(a)
Cu	ug/l	Sep-96	56.00	55.70	1.01	(a)
Pb	ug/l	Sep-96	12.75	13.80	0.92	(a, b)
Hg	ug/l	Sep-96	7.07	8.16	0.87	(a)
Cu	ug/l	Sep-96	56.00	55.70	1.01	(a)
Mn	ug/l	Sep-96	43.10	48.10	0.90	(a)
Zn	ug/l	Sep-96	589.00	600.00	0.98	(a)
NO3 - N	mg/l	Sep-96	8.18	8.30	0.99	(a)
SO4	mg/l	Sep-96	287.00	280.00	1.03	(a)
Chloroform	ug/l	Sep-96	23.60	22.30	1.06	(a)
DCE	ug/l	Sep-96	20.90	16.50	1.27	(a) Not Acceptable
TCA	ug/l	Sep-96	11.00	10.30	1.07	(a)
TCE	ug/l	Sep-96	8.64	8.70	0.99	(a)
Benzene	ug/l	Sep-96	13.60	12.50	1.09	(a)
PCE	ug/l	Sep-96	9.27	9.60	0.97	(a)
Toluene	ug/l	Sep-96	5.32	5.70	0.93	(a)
Ethylbenzene	ug/l	Sep-96	8.53	9.19	0.93	(a)
Total Xylenes	ug/l	Sep-96	11.94	12.90	0.93	(c)

(a) = Results not formally reported to EMSL-CI.

(b) = Dilution factor not applied on original data submission. Corrected data is presented.

(c) = Error in algorithm used in original data submission. Corrected data is presented.

Note: Comment column provides EMSL-CI evaluation of analytical performance which is based on 40CFR141 analyte-specific acceptance limits. No comment indicates performance within acceptable limits.

causing an overestimated DCE result. Corrective actions included reprocessing all xylene data,requesting funding to automate data processing, and requesting the manufacturer to adjust GC/MS settings. The corrected xylene and Pb data is presented in Table 10-7.

Figures 10-5 and 10-6 summarize the internal quality control program for the ion chromatography and atomic absorption methods used for inorganic analyses. Figure 10-5 presents the annual mean and 99% confidence interval for reference check and calibration check sample recoveries analyzed in each metal or anion sample batch. The anions were ± 11% and metals ± 14% of the target value, except mercury, which was ± 22%. The plot shows that all results fell within their respective acceptance bands (± 15% for all analytes except mercury, which is ± 30%). Figure 10-6 gives the mean and 99% confidence interval of spike recoveries performed for all analyses. Each daily spike sample measured its recovery within the ± 25% acceptance limit, however, excess variability in the Pb response caused its 99% confidence interval to exceed the acceptance band. These data attest to the accuracy of the data presented in this report.

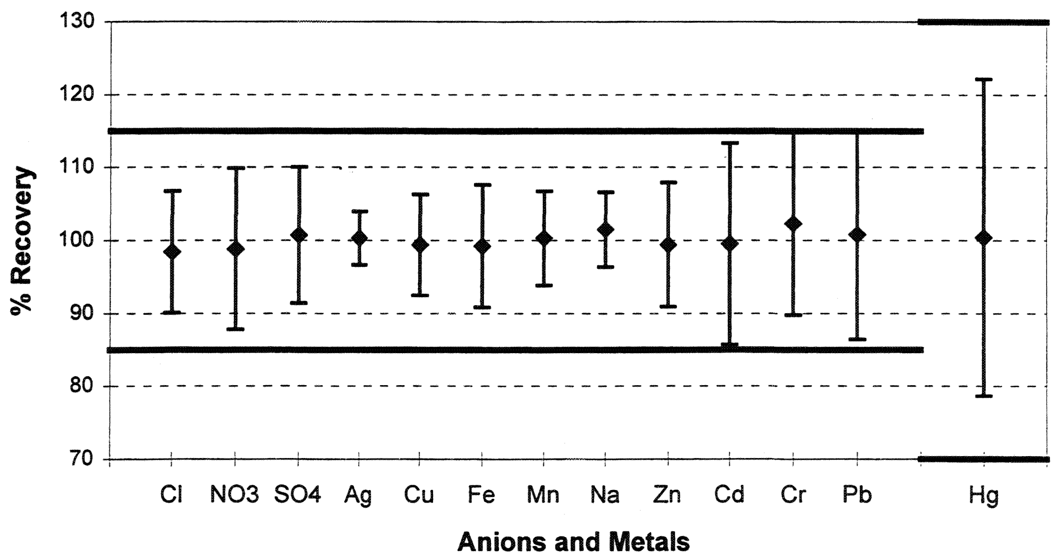


Figure 10- 5 Reference Check Summary for 1996 Inorganic Analyses

Figures 10-7 through 10-9 show the results of the internal quality control program for the gas chromatography/mass spectroscopy method used in the organic analyses. Several factors contributed to exceedances of the QC criteria established for this analysis and are described in the applicable section below. The laboratory moved its operation and installed a new instrument. This state of the art instrument expanded the analytical capability of the ASL, however encountered numerous breakdowns before operating reliably. In addition, these malfunctions and resultant downtime contributed to sample holding time exceedances. During this period, samples were flagged as "J" if analysis was completed between 14 and 28 days after collection (for positive and non-detect results), and "R" if analysis was completed between 28 and 42 days after collection (for non-detect results). If analysis was performed between 28 and 42 days after

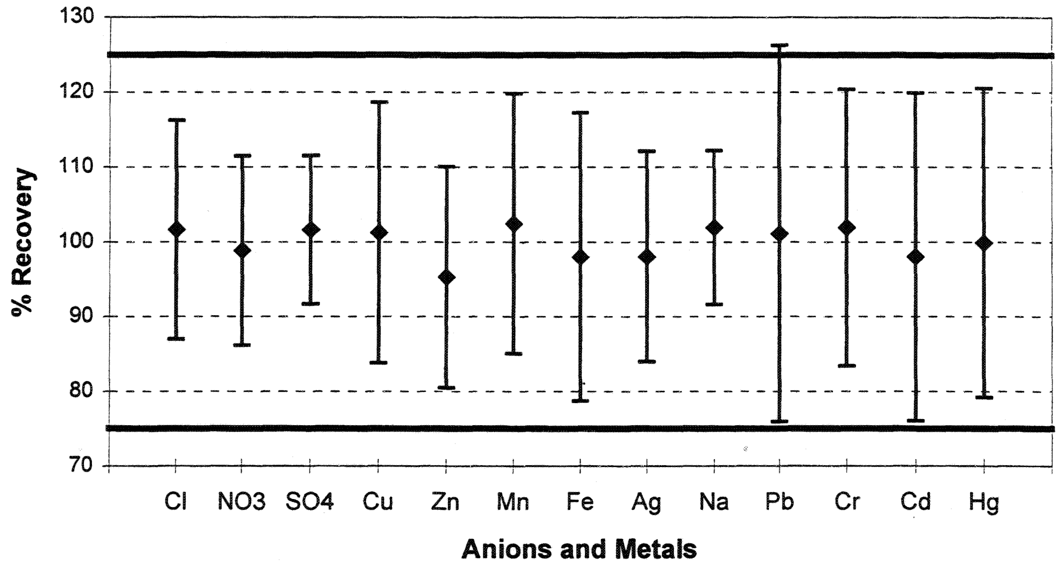


Figure 10- 6 Summary of Spike Recoveries for 1996 Inorganic Analyses.

collection, positive results were flagged "J". After 42 days, all values were rejected. Corrective actions by the manufacturer, which were extended to all of their customers, resulted in instrument upgrades and extension of the warranty period.

Figure 10-7 summarizes the recoveries of the organic reference check samples by presenting the mean and 99% confidence interval for each of the primary volatile organic compounds. Variability was within the internally established control limit, ± 20% of the known concentration, for each analyte except DCE (± 42%) and toluene (± 24%). The acceptance limit established by the EPA National Functional Guideline for this type of QC sample is ± 40%. Increased variability of the DCE response was due to poor resolution of this chromatographic peak, which elutes in the

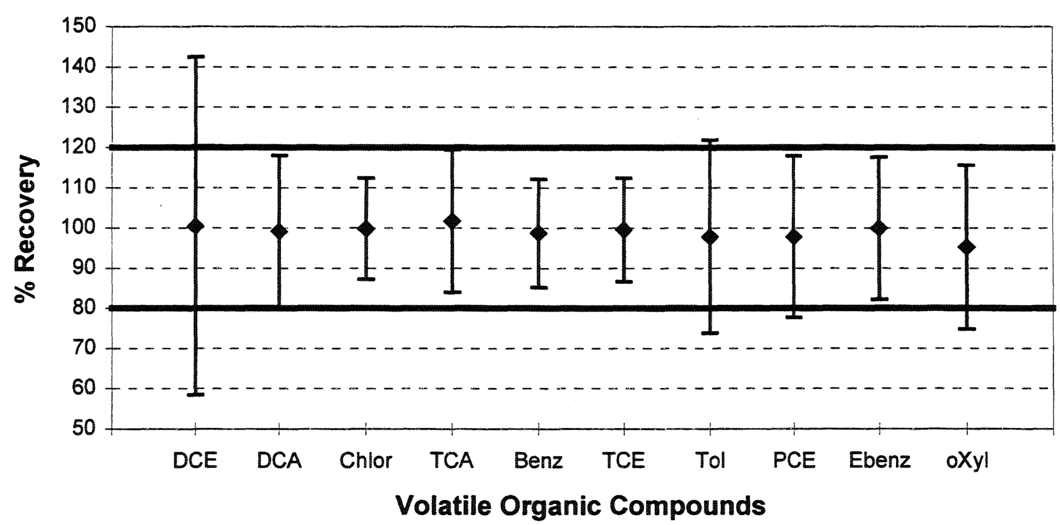


Figure 10-7 Reference Check Summary for Organic Analyses in 1996.

region of the chromatogram immediately following the solvent peak. The manufacturer was contacted to make the appropriate adjustments to prevent recurrence of the problem.

Figure 10-8 presents the 99% confidence intervals of surrogate and spike recoveries for the organic analyses. The method's performance for each of the two surrogate analyses was ± 11% and ± 20% of the target value (fluorobenzene [Flbenz] and 4-Bromofluorobenzene [BFB], respectively) exceeding the acceptance limit of ± 15% in the BFB case. The matrix spike recoveries ranged between ± 20 - 26%, all within the acceptance band of ± 25% except for TCA. This variability was indicative of the instrument problems occurring during this period including malfunctions in the autosampler valve and leaks in the concentrator. Data review and validation resulted in samples being "J" qualified, indicating estimates due to exceedances of surrogate recoveries beyond EPA limits.

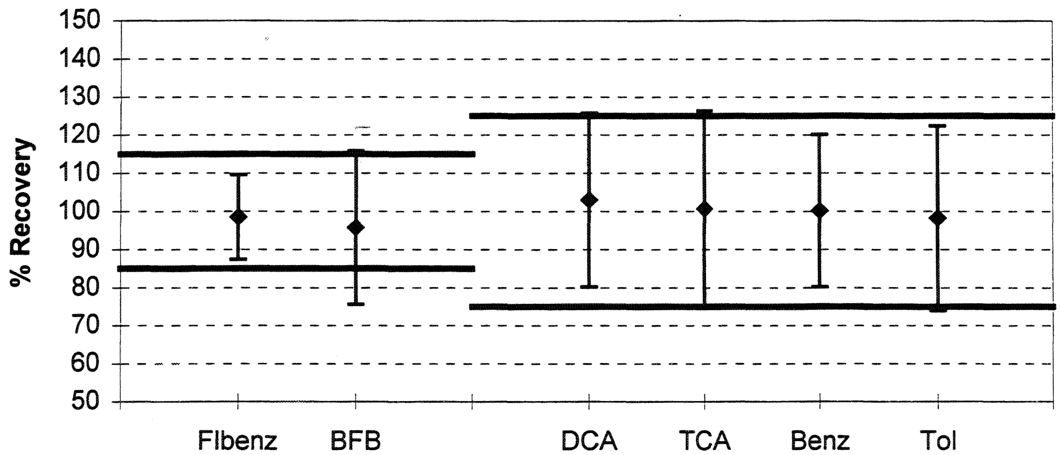


Figure 10-8 Surrogate and Spike Recovery Summaries for Organic Analyses in 1996

Lastly, the precision of the method was measured by analyzing duplicate samples; Figure 10-9 presents the results as relative percent difference. All duplicate analyses showed agreement within the EPA acceptance limit of ± 25%, however exceeded the internal control limits of ± 10%. Irregularities in the injection of internal standards were noted during the data review. The percent variation in the internal standards corresponded with the change in spike recoveries, indicating that the variation resulted from inconsistencies in the autosampler mechanical injections.

During August 1996, there was an onsite audit of the analytical chemistry processes conducted by NYSDOH ELAP. In addition, an appraisal of the Analytical Services Laboratory was conducted by an independent organization as part of the BNL Tier III Assessment Program. In both cases, corrective action plans for the findings and recommendations were developed and implementation is ongoing.

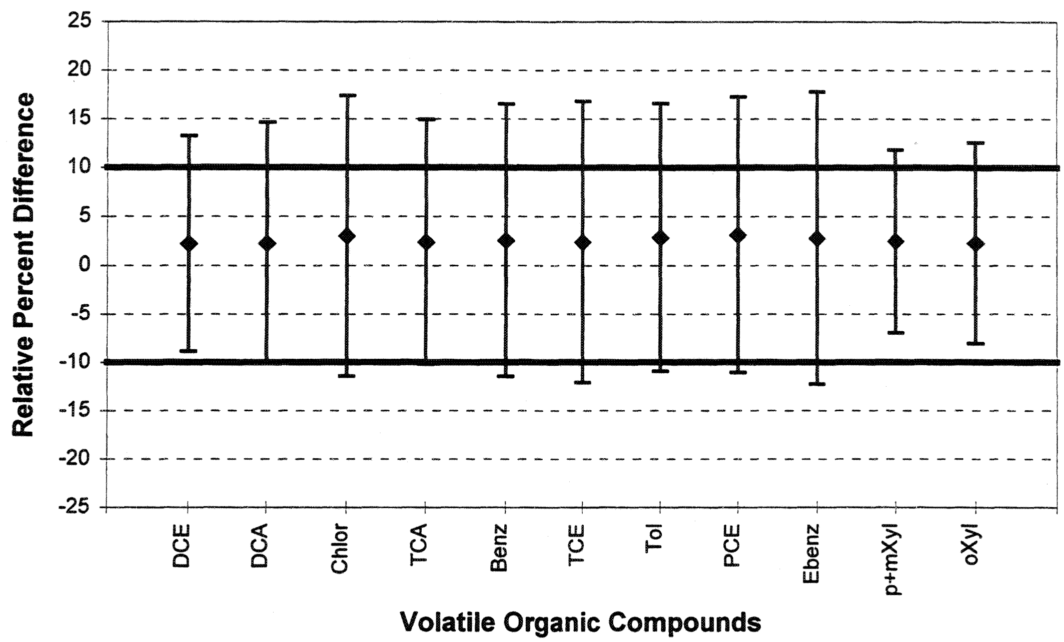


Figure 10-9 Matrix Spike Duplicate Summary for Organic Analyses in 1996.

10.3 Contractor Laboratories

Samples collected for regulatory compliance purposes, such as SPDES discharge monitoring reports, WTP monthly reports, and CSF semiannual reports are analyzed by offsite contractor laboratories. Contractors also augment the capabilities of the onsite laboratory, for example, strontium-90 and Toxicity Characteristic Leachate Procedure (TCLP), when demand on the S&EP Division ASL exceeds its capacity. The laboratory has a person dedicated to specifying contract and technical requirements, including applicable certifications for each analytical method, and evaluating contractor performance. The incoming data packages are reviewed to ensure that they comply with the contract specification before the data is reported. The commercial laboratories are audited periodically by the supervisor and QA Officer to verify competence in analytical methodology and implementation of a comprehensive QA program. As a result of poor agreement on proficiency tests in 1995 for several key compliance parameters, BNL terminated a contract with one of their analytical services contractors in 1996. Audits were performed of two potential contractors and a new contract established by the end of 1996. Results presented in this section reflect both contractors used during 1996 to analyze compliance samples.

The contract laboratories responsible for analyzing the BNL SPDES samples are required to participate in the NPDES Performance Evaluation Study; these results are presented in Table 10-8. Twenty of the twenty-one analyses showed acceptable agreement, with fifteen analyses being within 10% of the known value, however one sample, 5-day BOD, was unacceptable. A dilution error was determined to be the cause of this error and corrective action was implemented to prevent its recurrence.

Table 10-8
BNL Site Environmental Report for Calendar Year 1996
BNL Contractor Laboratory Performance Evaluation Study
BNL National Pollution Discharge Elimination System (NPDES) - DMR QA 16

Analyte	Units	Date	Reported	NPDES	Ratio	Comments
Cu	µg/L	Apr-96	579.000	552.000	1.05	
Fe	µg/L	Apr-96	816.000	790.000	1.03	
Pb	µg/L	Apr-96	1960.000	1812.000	1.08	
Ni	µg/L	Apr-96	416.000	375.000	1.11	
Zn	µg/L	Apr-96	1310.000	1203.000	1.09	
pH		Apr-96	8.880	8.730	1.02	
TSS	mg/L	Apr-96	21.200	30.000	0.71	Warning
Oil and Grease	mg/L	Apr-96	16.400	19.500	0.84	
Ammonia - N	mg/L	Apr-96	11.000	10.000	1.10	
NO3 - N	mg/L	Apr-96	1.940	2.100	0.92	
Kjeldahl - N	mg/L	Apr-96	9.420	8.900	1.06	
	mg/L					
5 Day BOD	mg/L	Apr-96	6.700	13.000	0.52	Not acceptable
Total Cyanide	mg/L	Apr-96	0.821	0.921	0.89	
Total Phenolics	mg/L	Apr-96	0.487	0.483	1.01	
Total Residual Cl	mg/L	Apr-96	0.690	0.690	1.00	
Fathead Minnow Chronic Data -						
Survival, NOEC	%	Apr-96	25.000	25.000	1.00	
Growth, IC25	%	Apr-96	30.800	31.300	0.98	
Growth, NOEC	%	Apr-96	25.000	25.000	1.00	
Cerlodaphnia Chronic Data						
Survival, NOEC	%	Apr-96	25.000	25.000	1.00	
Growth, IC25	%	Apr-96	19.100	28.200	0.68	
Growth, NOEC	%	Apr-96	25.000	25.000	1.00	

Note: Comment column provides evaluation of analytical performance which is based on 95 and 99% prediction interval calculated from samples analyzed by EPA and State laboratories No comment indicates performance within acceptable limits.

This same contractor participated in the EMSL-CI Water Pollution Performance Evaluation Study (WP035 in April 1996). The results given in Table 10-9 for the same SPDES parameters show acceptable agreement for twenty-five of thirty analyses. However, five samples were outside their acceptance limits. Overall, this contractor Laboratory performed acceptably in 80% of the comparisons. This table also includes the EMSL-CI WP036 (November 1996) results reported by the new contractor used at the end of 1996. This contractor performed acceptably in thirteen of fifteen analyses, and unacceptably in two. A review of the data showed low recovery in the total residual chlorine analysis, but no attributable cause for the oil and grease data. Further investigation showed excellent agreement in other proficiency samples and blind QC samples analyzed in the same batch, thus indicating a possible mix up in the ampul sent by EMSL-CI.

The Office of Environmental Restoration contracts several analytical laboratories for services required by that office. The office follows the QA guidance of the BNL QM Office and EPA CERCLA guidance for remedial investigation/feasibility studies and removal activities. Each operable unit and/or area of concern has its own Sampling and Analysis Plan and QA Project Plan. The respective project managers at Office of Environmental Restoration are responsible for ensuring that the data quality meets the specific needs of the project.

Table 10-9
BNL Site Environmental Report for Calendar Year 1996
BNL Contractor Laboratory Water Pollution Performance Evaluation Studies
USEPA Environmental Monitoring Systems Laboratory - Cincinnati

Analyte	Units	Date	Contractor	EMSL-CI	Ratio	Comments
Cu	ug/l	Apr-96	89.700	86.700	1.03	
	ug/l	Apr-96	379.000	370.000	1.02	
	ug/l	Nov-96	569.000	552.000	1.03	
Fe	ug/l	Apr-96	47.400	30.400	1.56	Not Acceptable
	ug/l	Apr-96	562.000	464.000	1.21	Not Acceptable
	ug/l	Nov-96	822.000	790.000	1.04	
Pb	ug/l	Apr-96	300.000	297.000	1.01	
	ug/l	Apr-96	434.000	399.000	1.09	
	ug/l	Nov-96	396.000	375.000	1.06	
Ni	ug/l	Apr-96	527.000	496.000	1.06	
	ug/l	Apr-96	654.000	611.000	1.07	
	ug/l	Nov-96	1890.000	1812.000	1.04	
Zn	ug/l	Apr-96	81.200	71.900	1.13	
	ug/l	Apr-96	1880.000	1800.000	1.04	
	ug/l	Nov-96	1240.000	1203.000	1.03	
pH		Apr-96	4.330	4.300	1.01	
		Apr-96	5.400	5.500	0.98	
		Nov-96	8.860	8.730	1.01	
TSS	mg/l	Apr-96	84.000	88.000	0.95	
	mg/l	Apr-96	54.000	56.000	0.96	
	mg/l	Nov-96	26.600	30.000	0.89	
Oil and Grease	mg/l	Apr-96	35.900	46.000	0.78	
	mg/l	Apr-96	13.400	18.900	0.71	
	mg/l	Nov-96	6.600	19.500	0.34	Not Acceptable
Ammonia - N	mg/l	Apr-96	19.700	19.000	1.04	
	mg/l	Apr-96	1.730	1.400	1.24	
	mg/l	Nov-96	10.000	10.000	1.00	
NO3 - N	mg/l	Apr-96	6.540	8.310	0.79	Not Acceptable
	mg/l	Apr-96	0.340	0.390	0.87	
	mg/l	Nov-96	2.000	2.100	0.95	
Kjeldahl - N	mg/l	Apr-96	0.875	0.540	1.62	
	mg/l	Apr-96	8.510	7.800	1.09	
	mg/l	Nov-96	9.100	8.900	1.02	
5 Day BOD	mg/l	Apr-96	160.000	141.000	1.13	
	mg/l	Apr-96	67.300	62.500	1.08	
	mg/l	Nov-96	13.000	13.000	1.00	
Total Cyanide	mg/l	Apr-96	0.360	0.030	11.96	
	mg/l	Apr-96	0.539	0.410	1.31	Not Acceptable
	mg/l	Nov-96	0.782	0.822	0.95	
Total Phenolics	mg/l	Apr-96	1.070	2.710	0.39	Not Acceptable
	mg/l	Apr-96	0.566	1.190	0.48	Warning
	mg/l	Nov-96	0.530	0.483	1.10	
Total Residual Chlorine	mg/l	Apr-96	3.050	2.800	1.09	
	mg/l	Apr-96	0.500	0.410	1.22	
	mg/l	Nov-96	0.520	0.690	0.75	Not Acceptable

Note: Comment column provides evaluation of analytical performance which is based on 95 and 99% prediction interval calculated from samples analyzed by EPA and State laboratories. No comment indicates performance within acceptable limits.

Appendix A - Glossary of Terms

AGS	- Alternating Gradient Synchrotron
AOC	- Area of Concern
ASL	- Analytical Services Laboratory
AUI	- Associated Universities Inc.
BHO	- Brookhaven Area Office
BLIP	- Brookhaven LINAC Isotope Production Facility
BNL	- Brookhaven National Laboratory
BETX	- Benzene Ethylbenzene Toluene Xylene
BOD_5	- Biochemical Oxygen Demand
CAA	- Clean Air Act
CBS	- Chemical Bulk Storage
CERCLA	- Comprehensive Environmental Response, Compensation & Liability Act
CH	- Chicago
CO	- Certificates to Operate
CSF	- Central Steam Facility
CY	- Calendar Year
CWA	- Clean Water Act
DAS	- Department of Applied Science
DAT	- Department of Applied Technology
DCA	- Dichloroethane
DCE	- Dichloroethylene
DCG	- Derived Concentration Guide
DMR	- Discharge Monitoring Report
DOE	- Department of Energy
DOT	- Department of Transportation
ECL	- Environmental Conservation Law
EDB	- Ethylene Dibromide
EM	- Environmental Monitoring
EMG	- Environmental Monitoring Group
EML	- Environment Measurements Laboratory
EMS	- Environmental Management Section
EMSL-LV	- Environmental Measurements Systems Laboratory - Las Vegas
EP	- Environmental Protection
EPA	- Environmental Protection Agency
EPO	- Environmental Protection Office
ES&H	- Environmental, Safety, and Health
HFBR	- High Flux Beam Reactor
HWMA	- Hazardous Waste Management Area
HWMF	- Hazardous Waste Management Facility

HWMG	- Hazardous Waste Management Group
IAG	- Interagency Agreement
LEPC	- Local Emergency Planning Committee
LINAC	- Linear Accelerator
MDL	- Minimum Detection Limit
MLD	- Million Liters per Day
MPF	- Major Petroleum Facility
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NA	- Not Analyzed
NPDES	- National Pollutant Discharge Elimination System
ND	- Not Detected
NEPA	- National Environmental Policy Act
NESHAPs	- National Emission Standards for Hazardous Air Pollutants
NIST	- National Institute for Standards and Technology
NPL	- National Priority List
NR	- Not Reported
NS	- Not Sampled
NSLS	- National Synchrotron Light Source
NYCRR	- New York Code of Rules and Regulations
NYS	- New York State
NYS AWQS	- New York State Ambient Water Quality Standard
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
NYSDOT	- New York State Department of Transportation
NYS DWS	- New York State Drinking Water Standard
OER	- Office of Environmental Restoration
OU	- Operable Unit
PCB	- Polychlorinated biphenyls
PCE	- Tetrachloroethylene
PC	- Permit to Construct
P&GA	- Photography and Graphic Arts
PE	- Plant Engineering
POC	- Principal Organic Compound
PVC	- Polyvinyl Chloride
QA	- Quality Assurance
RACT	- Reasonable Available Control Technology
RCRA	- Resource Conservation and Recovery Act
RI/FS	- Remedial Investigation/Feasibility Study
RHIC	- Relativistic Heavy Ion Collider
RSD	- Response Strategy Document

SAG	- Sampling and Analysis Group
SARA	- Superfund Amendments and Reauthorization Act
SCDHS	- Suffolk County Department of Health Services
SDWA	- Safe Drinking Water Act
SEAPPM	- Safety and Environmental Administrative Policy and Procedures Manual
S&EP	- Safety and Environmental Protection
SER	- Site Environmental Report
SERC	- (New York) State Emergency Response Committee
S&M	- Supply and Materiel
SOC	- Synthetic Organic Compound
SOP	- Standard Operating Procedures
SPCC	- Spill Prevention Control and Counter Measures
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
TCA	- 1,1,1-Trichloroethane
TCE	- Trichloroethylene
TCLP	- Toxic Characteristic Leachate Procedure
TLD	- Thermoluminescent Dosimeters
TSCA	- Toxic Substance Control Act
TSS	- Total Suspended Solids
TTA	- Tiger Team Assessment
VOC	- Volatile Organic Compound
WCF	- Waste Concentration Facility
WSRRSA	- Wild, Scenic, and Recreational River Systems Act
WTP	- Water Treatment Plant

Glossary of Units

Bq	- Becquerel
Bq/L	- Becquerel per liter
Bq/M^3	- Becquerel per cubic meter
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
$CiMW^{-1}h^{-1}$	- Curie per megawatt hour
cm	- Centimeter
cm^3	- Cubicmeter
cm/d	- Centimeters per day
m^3/min	- cubic meters per minute
d	- Day
gal	- Gallon

GBq	- Giga Becquerel
GeV	- Giga electron volt
GeV/amu	- Giga electron volt per atomic mass unit
gph	- Gallon per hour
ha	- Hectare
kg/yr	- Kilogram per year
km	- Kilometer
L/d	- Liters per day
m	- Meter
mCi	- Millicurie
MeV	- Mega electron volt
mg/L	- Milligram per liter
ml	- Milliliter
MLD	- Million liters per day
mrem	- Millirem
mrem/yr	- Millirem per year
mSv	- milli seivert
mSv/yr	- milli seivert/year
MW	- Megawatts
nCi/L	- Nanocuries per liter
pCi/kg	- Picocuries per kilogram
pCi/L	- Picocuries per liter
pCi/m^3	- Picocuries per cubic meter
pH	- Hydrogen ion concentration
rem	- Unit of radiation dose equivalent
Sv	- Seivert
TBq	- Tera Becquerel
µCi	- Microcuries
µCi/L	- Microcuries per liter
µg/L	- Micrograms per liter

Appendix B - Methodologies

1. Dose Calculation - Atmospheric Release Pathway

Dispersion of airborne radioactive material was calculated for each of the 16 compass sectors using the CAP88 dose model. CY 1996 site meteorology and 10 year wind averages were used to calculate annual dispersions for the midpoint of a given sector and distance. Facility-specific radionuclide release rates (in Ci per year) were also used. All annual site boundary and collective dose values were generated using the CAP88 computer code, which calculates the total dose due to contributions from the immersion, inhalation, and ingestion pathways.

2. Tritium Dose Calculation - Potable Water Pathway

The method used to calculate the maximum individual committed effective dose equivalent and the collective dose equivalent are shown along with the basic assumptions used in the calculation. For the maximum individual, the highest annual average tritium concentration, measured from a single potable well was used to calculate the total quantity of tritium ingested via the drinking-water pathway. For calculating the collective dose equivalent, the annual average tritium concentration was obtained by averaging all positive results from potable wells which were in the demographic region adjacent to the Laboratory. The annual intake of tritium via the drinking water pathway was calculated from the following equation:

$$AI = 1 \times 10^{-6}\, C \cdot IR \cdot T$$

Where: AI = Activity Intake, μCi

C = annual average water concentration, pCi/L

IR = Ingestion Rate (2) L/d

T = Time, 365 d

The committed effective-dose equivalent was calculated from the following equation:

$$H = AI \times DCF \times P$$

where:

H = committed effective dose-equivalent, rem

AI = Activity Intake, μCi

DCF = Dose Conversion Factor, rem/μCi (6.3E-5 rem/μCi)

P = Exposed population

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the exposed population was assumed to be approximately 500.

3. Dose Calculation - Fish Ingestion Pathway

To estimate the collective-dose equivalent from the fish consumption pathway, the following procedure was used:

a. Radionuclide data for fish samples were all converted to pCi/g wet weight; this is the form in which the fish is caught and consumed.

b. The average fish consumption for an individual engaged in recreational fishing in the Peconic River was based on a study done by the NYSDEC which suggests that the consumption rate is approximately 7 kg/yr (NYSDEC, 1985).

c. DOE Order 5400.5 50-year Committed Dose Equivalent factors (in rem per μCi intake) based on the ICRP 26 model were applied. They are as follows:

Tritum:	6.3E-05 rem/μCi
Strontium-90:	1.3E-01 rem/μCi
Cesium-137:	5.0E-02 rem/μCi

d. Calculation: Intake (7 kg/yr) x Activity in flesh μCi/kg x Factor rem/μCi = rem

4. Dose Calculation - Deer Meat Consumption

This calculation is performed in exactly the same way as shown in the previous section. The same DOE Order 5400.5 dose conversion factors are used. The only change is the estimate of total kilograms ingested in the course of a year. For deer meat, the consumption rate of 9 kg/yr is based on the upper range of venison consumption estimates supplied by the NYSDEC Wildlife Branch.

5. Radiological Data Processing

Radiation events occur in a random fashion such that if a radioactive sample is counted multiple times a distribution of results will be obtained. This spread, known as a poisson distribution, will be centered about a mean value. If counted multiple times, the background activity of the instrument (the number of radiation events observed when no sample is present) will also be seen to have a distribution of values centered about a mean. The goal of a radiological analysis is to determine whether the sample in question contains activity in excess of the instrument or environmental background. Since the activity of the sample and the background are both poisson distributed, subtraction of background activity from the measured sample activity results in a value which may vary slightly from one analysis to the next. Therefore, the concept of a minimum detection limit (MDL) is established to determine the statistical likelihood that the sample contains activity that is truly greater than the instrument background.

Identifying a sample as containing activity greater than background when it actually is not is known as a Type I error. As with most laboratories, the BNL Analytical Laboratory sets its acceptance of a Type I error at 5% when calculating the minimum detection limit for a given analysis. That is, for any value which is greater than or equal to the MDL there is 95% confidence that it represents the detection of true activity. Values which are less than the MDL may be valid, but they have a reduced confidence associated with them. Therefore, all data is reported regardless of its value.

At very low sample activity levels, close to the instrument background, it is possible to obtain a sample result which is less than the background. When the sample activity is subtracted from the background to obtain a net value, a negative value results. In such a situation, a single radiation event observed during a counting period can have a significant effect on the result. Subsequent analysis may produce a net result that is positive. Therefore, all negative values are retained for reporting as well. This data handling practice is consistent with the guidance provided in NCRP Report No. 58, *Handbook of Radioactivity Measurements Procedures* and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. Typical MDLs for the various analyses performed on environmental and effluent samples are shown in Tables B-1, B-2 and B-3.

Table B-1. Typical Detection Limits for Gross Activity and Tritium Analyses

Analysis	Matrix	Aliquot (mL)	MDL (pCi/L)
Gross alpha	water	100	4
		500	1
Gross beta	water	100	9
		500	3
Tritium	water	1	3,900
		7	380

Table B-2. Typical Minimum Detection Limits for Gamma Spectroscopy Analysis

Nuclide	300 g, soil (uCi/g)	300 ml, water (uCi/mL)	12000 ml, water (uCi/ml)
^{7}Be	7E-8	1E-7	2E-9
^{22}Na	9E-9	1E-8	2E-10
^{40}K	2E-7	2E-7	4E-9
^{48}Sc	1E-8	1E-8	2E-10
^{51}Cr	8E-8	1E-7	2E-9
^{54}Mn	8E-9	1E-8	2E-10
^{56}Mn	2E-7	3E-7	5E-9
^{57}Co	7E-9	9E-9	1E-10
^{60}Co	1E-8	1E-8	2E-10
^{65}Zn	2E-8	2E-8	5E-10
^{134}Cs	1E-8	1E-8	2E-10
^{137}Cs	9E-9	1E-8	2E-10
^{226}Ra	3E-8	3E-8	5E-10
^{228}Th	2E-8	3E-8	4E-10
^{82}Br	1E-8	2E-8	3E-10
^{131}I	9E-9	1E-8	2E-10
^{133}I	1E-8	2E-8	3E-10

Note: All MDLs shown above are approximate. For gamma spectroscopy, the MDL of the analysis is dependent upon several variables, such as the efficiency of the particular detector, the activity of the sample, etc. These factors will vary between analyses and instrumentation.

Table B-3. Typical Detection Limits for Chemical Analyses.

Constituent*	BNL	OFF-SITE
Ag	0.025	0.010
Cd	0.0005	0.005
Cr	0.005	0.010
Cu	0.050	0.025
Fe	0.075	0.100
Hg	0.0002	0.0002
Mn	0.050	0.015
Na	1.0	5.0
Pb	0.005	0.003
Zn	0.02	0.020
Ammonia-N	NA	0.02
Nitrite-N	NA	0.01
Nitrate-N	1.0	NA
Specific Conductance	10 μmhos/cm	NA
Chlorides	4.0	NA
Sulfates	4.0	NA
1,1,1-trichloroethane	0.002	0.005
trichloroethylene	0.002	0.005
tetrachloroethylene	0.002	0.005
chloroform	0.002	0.005
chlorodibromomethane	0.002	0.005
bromodichloromethane	0.002	0.005
bromoform	0.002	0.005
benzene	0.002	0.005
toluene	0.002	0.005
xylene	0.002	0.005

* All concentrations in mg/L except where noted.

Appendix C - Instrumentation and Analytical Methods

The analytical laboratory of S&EP Division is divided into 1) radiological, and 2) nonradiological sections to facilitate analysis of specific parameters in each category. The following analytes are analyzed in each category.

- **Radiological:** Gross alpha, gross beta, gamma, tritium, and strontium-90.
- **Non-radiological:** Purgeable aromatics, Purgeble halocarbons, PCBs, anions, and metals.

The methods and instrumentation for each category are briefly described below. Only validate and regulatory referenced methods were used during the analysis. All samples were collected and preserved by trained technicians according to appropriate referenced methods. Well-qualified, and trained analysts performed different analyses. The analytical laboratory is certified by NYSDOH for the radiological and nonradiological parameters (except for PCBs) performed. The radiological laboratory participates in the following:

Gross Alpha and Gross Beta Analysis - Water Matrix

Water samples are collected in one liter polyethylene containers, and preserved at the time of collection by acidification to pH 2 using nitric acid. If the samples are effluent or surface stream samples from locations DA, EA, HM or HQ, or Building 535B daily process samples, then 100 ml are extracted for analysis. Groundwater samples are typically analyzed using a 500 ml aliquot. Due to high iron content, a 100 ml aliquot of ground water from the landfill areas may be used. The aliquot is evaporated to near-dryness in a glass beaker, which is rinsed to remove the solids and the combined solids and rinsate are transferred to a 5-cm diameter stainless-steel planchet which is then evaporated to dryness. The planchettes are placed in a drying oven at 105°C for a minimum of 2 hours; removed to a desiccator and allowed to cool; weighed and counted in a gas-flow proportional counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background which is subtracted from the raw data before computing net concentration. System performance is checked daily with NIST-traceable standards: Americium-241 for alpha, and Strontium-90 for beta.

Gross Alpha and Gross Beta Analysis - Air Particulate Matrix

Air particulate samples are collected on 50-mm glass fiber filters at a nominal flow rate of 15 liters per minute. At the end of the collection, the filters are returned to the analytical laboratory for assay. Filters are counted twice in a gas flow proportional counter for 50 minutes. The first count occurs immediately upon receipt in the analytical laboratory, and is used to screen the samples for unusual levels of air particulate activity. The filters are then recounted approximately one week later. This delay permits the short-lived radon/thoron daughters to decay. The second analysis is used for environmental assessments. The first sample of each batch is a blank filter whose count rate is subtracted from the raw data before calculating net concentration. The system's performance is checked daily with NIST-traceable standards: Americium-241 for alpha, and Strontium-90 for beta.

Tritium Analysis - Water Matrix

Water samples are collected in polyethylene containers. No preservatives are added before collecting the sample. Effluent and surface stream samples from locations DA, EA, HM, or HQ, or Building 535B daily- process samples as well as groundwater samples were analyzed using a 7 ml aliquot. Potable-water samples were distilled following the method outlined in EPA 1980, 906.0 and a 7 ml aliquot analyzed. Liquid scintillation cocktail then is added to the aliquot so that the final volume in the liquid-scintillation counting vial is 7 ml of sample plus 10 ml of cocktail. Samples then are counted in a low-background liquid-scintillation counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data before calculating the net concentration. The second sample in each batch is a NIST-traceable tritium standard which is used to verify the system's performance and efficiency. Each sample is also monitored for quenching. Corrections for background, quenching, and efficiency for the sample matrix are factored into the final net concentrations for each sample.

Tritium Analysis - Air Matrix

Concentration of tritium in ambient and facility air are measured by drawing the air at a rate of approximately 200 cc/min through a desiccant. At the end of each collection period, typically one week, the desiccant is brought to the analytical laboratory for processing. It is heated in a glass manifold system. Effluent samples have dedicated glassware, as do environmental samples. The off-gas, containing moisture from the sampled air, is collected by a water-cooled glass condenser. A 7 ml aliquot of this water is then assayed for tritium content. Liquid scintillation cocktail is then added to the aliquot so that the final volume in the counting vial is 17 ml. Samples are then counted in a low-background liquid scintillation counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data before computing net concentration. The second sample in each batch is a NIST-traceable tritium standard which is used to verify the system's performance and efficiency. Each sample is also monitored for quenching. Corrections for background, water recovery, air sample volume, quenching and efficiency for the sample matrix are factored into the final net concentrations for each sample.

Strontium-90 Analysis

Strontium-90 analyses are currently performed on water, soil and aquatic biota samples. Ground water samples are processed in house using DOE Method RP500, which utilizes a crown ether to selectively separate strontium from the acidified sample matrix. The strontium is then eluted using dilute nitric acid. The resulting eluent is then evaporated on a 2.5 cm stainless steel planchet and the sample counted in a gas-flow proportional counter. Samples are prepared in batches, including a standard and a blank in each batch. Chemical recovery is determined for each sample by the recovery of strontium carbonate. NIST-traceable strontium-90 standards are used to calibrate and verify the performance of the counting instrument. Samples are counted twice to verify strontium-90 and yttrium-90 ingrowth.

Potable water samples as well as samples of solids are shipped to a contractor laboratory which is certified to perform the EPA 1980, 905.0 method for strontium-90 in drinking water. This method employes time-consuming and costly wet-chemistry techniques to isolate strontium from the sample. Samples are counted twice to verify strontium-90 and yttrium-90 ingrowth. Samples are typically processed in a batch. Backgrounds and system performance are verified with each batch. Chemical recoveries are determined by a combination of gravimetric and strontium-85 standard addition techniques.

Gamma Spectroscopy Analysis

Surface, potable, and groundwater surveillance samples are typically of 12 liters and are placed in polyethylene bottles without preservatives. Samples are then passed through a mixed-bed ion-exchange column at a rate of 20 cc/min. The column is then removed, the resin placed in a Teflon-lined aluminum can and counted on a calibrated gamma spectroscopy detector for 50,000 seconds. Where effluent is sampled in a flow-proportional manner, a 10 ml aliquot is passed through the mixed bed column on an as needed basis. Typically, the sizes for such samples approach 50 to 100 liters. Air-particulate filters and air-charcoal canisters are counted directly on the calibrated gamma spectroscopy detector for 10,000 seconds. Soil, vegetation, and aquatic biota are all processed following collection. Typically, a 50, 100, or 300 g aliquot is taken, placed in a Teflon-lined aluminum can and directly counted. For gamma spectroscopy analyses, overnight backgrounds are counted once per week, with calibration check and background checked daily. Analytical results reflect net activity that has been corrected for background and efficiency for each counting geometry used.

Purgeable Aromatics and Purgeable Halocarbons

Water samples are collected in 40 ml glass vials with removable teflon-lined caps without any headspace, and preserved with 1:1 HCl to pH <2.0. Samples are stored at 4° C and analyzed within 14 days.

Ten (10) purgeable compounds (benzene, toluene, ethyl benzene, total xylenes, chloroform, 1,1-dichloroethane, 1,1-dichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene) are analyzed under this category following EPA Method 624 protocols using GC/MS. These ten compounds were chosen as the target compounds since they are known or suspected to be present in the monitoring wells based on DOE's survey of the site in 1988 (USDOE, 1988) and a comprehensive analysis of 51 new monitoring wells installed in 1989 using EPA's Contract Laboratory Program (CLP) (EPA, 1987, 1988). There are currently two Hewlett-Packard GC/MS instruments. One instrument is exclusively used to analyze of purgeable compounds and the other for screening extractables and other extraneous compounds in non-routine samples. Since the groundwater under BNL is classified as a sole source aquifer under the Safe Drinking Water Act and Class GA groundwater by the NYSDEC, the detection limits reported for the compounds are close to drinking NYS DWS and AWQS. Even though the QC generated for the purgeable analysis meets the EPA drinking water method 524.2 requirements, however, to facilitate certification from NYSDOH for limited number of analytes required by BNL, EPA method 624 is used under "non-potable" water category.

The method involves purging a 25-ml-aliquot of the sample with ultra pure helium in a specially designed sparger using the Purge and Trap technique. Each sample is spiked with known concentration of internal standards and surrogates before purging to facilitate identifying, quantifying, and determining the extraction efficiency of analytes from the matrix. The purged analytes are trapped on to a specially designed trap and thermally desorbed on to the DB-624 megabore capillary-chromatographic column by back flushing the trap with helium. Individual compounds are separated with a temperature program of the GC and enter the mass spectrometer where they undergo fragmentation to give characteristic mass spectra. The unknown compounds are identified by comparing their mass spectra and retention times with reference compounds, and quantitated by internal standard method. The quantitation data is supported by extensive QA/QC, such as tuning the mass spectrometer to meet bromofluoro-benzene criteria, initial and continuing calibrations verifying daily response factors, method blanks, surrogate recoveries, duplicate analysis, matrix spike and matrix spike duplicate analysis, and reference standard analysis to verify the daily working standard.

PCB Analysis

Samples are collected in 50-100 ml glass containers with teflon-lined lid and stored at 4° C and analyzed within 30 days.

Transformer oil, mineral oil, hydraulic fluid, waste oil, and spill wipe-samples are analyzed for PCBs using gas chromatography-electron capture detector (GC-ECD) method. This method is similar to EPA SW-846 method 8080 and is targeted to identify and quantitate seven different mixtures of PCB congeners in the samples.

The method consists of diluting a known weight of the sample with isooctane and removing the interfering compounds with one or more aliquots of concentrated sulfuric acid till the acid layer is almost colorless. All the oil matrix, along with other interfering polar compounds, are selectively removed from the sample, leaving the PCBs in isooctane solvent.

There are two GC-ECD instruments for analyzing PCBs. Each GC-ECD instrument is calibrated with different concentrations of each PCB mixture to establish linearity. The PCBs found in the samples are identified and quantitated by comparing the retention times and chromatographic patterns with the standards. Methods blanks, duplicates, spikes, and reference standards are run as part of QA/QC.

Anions

Chloride, nitrate-N, and sulfate are analyzed using Dionex Ion-chromatography (IC) with ion suppression and conductivity detection technique.

Samples from monitoring wells are collected in 500 - 1000 ml polypropylene bottles, cooled to 4° C, and analyzed within 28 days. For nitrate analysis in drinking water analysis, samples are supposed to be analyzed within 48 hrs. However, even though holding times were exceeded for nitrate analysis of monitoring well samples, the depletion of nitrate is expected to be negligible.

The anions are passed through an anion-exchange polymer column and eluted with carbonate/bicarbonate solution. Then the eluent passes through a ion-suppressing column where the background contribution from the eluent is suppressed, leaving the target anions to be detected by conductivity meter.

Initially, the IC system is calibrated with standards to define its working range. The target anions in the samples are identified and quantitated by comparing the retention times and areas with the standards. Method blanks, duplicates, replicates, spikes, and reference standards are routinely analyzed as part of QA/QC.

Metals

Samples are collected in 1000 ml polypropylene bottles and stabilized with ultra-pure nitric acid to a pH of <2. The samples are analyzed within 6 months, except for mercury which is analyzed within 26 days.

Cadmium, chromium, lead (furnace), copper, iron, manganese, silver, sodium, zinc (flame), and mercury (manual cold vapor) are analyzed with Perkin-Elmer atomic absorption spectrometer. Using the flame technique, the sample containing the target element is nebulized and atomized in an oxy-acetylene flame. At the same time, a beam of light from a element-specific hollow cathode lamp corresponding to the absorption frequency of target element is passed through the flame. The atomized element absorbs the energy specific to that element from the cathode lamp and the intensity of absorption is proportional to the concentration of the element in the sample. Calibration curves establish the linearity of the system and samples are quantitated by comparing with standards.

Using the furnace technique, chemical interference is eliminated in two stages: first, by heating the sample at 105 - 110° C to remove moisture, and second, at 600 - 900° C to burn out any organic matrix. Final atomization is achieved by heating the furnace to 2400 - 2700° C. The rest of the technique is similar to the flame method, above. Using this furnace technique, sub-ppb detection limits are possible for water samples.

Using a cold-vapor technique for mercury, a 100 ml aliquot of the sample is digested with potassium permanganate/persulfate oxidizing solution at 95° C for 2 hours to oxidize any organically bound and/or monovalent mercury to mercury (II) ion state. Excess oxidizing agent is destroyed with hydroxylamine hydrochloride. The mercuric ion later is reduced to elemental mercury with excess stannous chloride which is purged with helium into the absorption cell. The absorption is directly proportional to the concentration of mercury in the sample.

All these atomic absorption techniques involve initial calibrations to define the calibration range, continuing calibrations, method blanks, duplicates, replicates, matrix spikes, and reference standard analysis as a part of QA/QC.

APPENDIX D - CY 1996 SER - Groundwater Monitoring Wells List

Wells Sampled by Safety and Environmental Protection Division (SEP) and Office of Environmental Restoration (OER)

Operable Unit I

Hazardous Waste Management Facility

88-13*	SEP
88-14*	SEP
88-20*	SEP
88-108*	NS
88-03	SEP
88-04	SEP
88-24	SEP
88-26	SEP
98-07	NS
98-21	NS
98-22	NS
98-57	SEP
98-58	SEP
98-59	SEP
98-60	SEP
98-61	SEP
108-13	SEP
108-14	SEP
108-17	SEP
108-18	SEP
108-30	SEP
108-31	SEP

Current Landfill - Compliance

87-09*	SEP/ESE
87-11	SEP/ESE
87-23	SEP/ESE
87-24	SEP/ESE
87-26	SEP/ESE
87-27	SEP/ESE
88-21	SEP/ESE
88-22	SEP/ESE
88-109	SEP/ESE
88-110	SEP/ESE

Current Landfill - RA V Area

107-26	NS
115-01	SEP
115-02	SEP
115-03	SEP
115-04	SEP
115-05	SEP
115-13	NS
115-14	SEP
115-15	NS
115-16	NS
115-28	NS
115-29	NS
115-30	NS
115-36	NS
116-05	SEP
116-06	SEP
000-124	NS
000-137	NS
000-138	NS

Former Landfill

86-42*	SEP
86-43*	SEP
86-70*	NS
97-02	SEP
97-03	SEP
97-05	SEP
97-18	SEP
106-14	SEP
106-15	SEP
106-17	SEP
106-18	SEP
106-19	NS
106-20	NS
106-21	NS
106-22	NS
106-23	NS
106-24	NS
106-29	OER
106-30	NS
113-32	NS
113-33	NS
113-34	NS
113-35	NS
114-01	NS
114-02	SEP
122-01	OER/SEP
122-02	OER/SEP
122-03	NS
122-04	OER/SEP
122-05	OER
122-09	NS
122-10	NS
122-18	NS
122-19	NS
122-20	NS
122-21	NS
122-22	NS
000-108	NS
000-109	NS

Operable Unit III

Waste Concentration Facility

65-06*	OER/SEP
65-02	OER/SEP
65-03	OER/SEP
65-04	OER/SEP
65-05	OER/SEP
65-18	OER
65-19	OER
65-20	OER

AGS/LINAC Areas

44-01*	OER/SEP
44-02*	SEP
53-01*	OER
54-01	OER
54-02	OER
54-03	OER
54-05	OER/SEP
54-06	OER
54-07	SEP
54-08	SEP
54-09	OER
54-10	NS
54-14	OER
54-15	OER
54-16	OER
55-06	OER
64-01	OER
64-02	NS
64-03	OER
85-07	OER
85-13	OER

Building 830

66-07	OER/SEP
66-08	OER/SEP
66-09	OER/SEP

HFBR

65-01*	SEP
75-11	SEP
75-12	SEP

Former T-111 Area

75-01	OER/SEP
75-02	OER/SEP

Former Chemistry Department Area

85-06	OER/SEP

Shotgun Range

46-01	SEP
56-06	SEP

Supply and Material Area

85-01*	OER/SEP
85-02*	OER/SEP
85-03	NS
86-01	NS
86-21	SEP
96-06	OER
96-07	OER/SEP
105-02	OER

Water Treatment Plant Area

63-01	SEP
63-02	SEP
63-03	SEP
73-01	SEP
73-02	SEP

Western Supply Well Area

83-01	OER/SEP
83-02	OER/ SEP
84-01	SEP
84-02	OER
84-03	OER
84-04	OER
84-05	OER
94-01	SEP

BNL Gasoline Station

85-16	SEP
85-17	SEP

BNL Motor Pool

102-01	SEP
102-05	SEP
102-06	SEP

Southern Sector - OU III Plumes On- and Off-site Areas

103-01	SEP
103-02	SEP
103-10	NS
104-10	OER
104-11	OER
105-21	OER
105-22	OER
105-23	OER
105-24	OER
105-25	NS
105-26	NS
105-27	NS
105-28	NS
105-29	OER
113-06	OER
113-07	OER
113-08	OER
113-09	OER
113-10	OER
113-11	OER
118-01	SEP
118-02	SEP
121-06	OER
121-07	OER
121-08	OER
121-09	OER
121-10	OER
121-11	OER
121-12	OER
121-13	OER
121-14	OER
121-22	NS
121-23	NS
122-15	NS
122-16	NS

NS = Well Not Sampled During CY 1996   * = Upgradient Well for Area

APPENDIX D - CY 1996 SER - Groundwater Monitoring Wells List

Wells Sampled by Safety and Environmental Protection Division (SEP) and Office of Environmental Restoration (OER)

122-17	NS
124-02	OER
126-01	OER
130-02	OER
130-03	OER
130-04	OER
000-97	OER
000-98	OER
000-99	OER
000-100	OER
000-101	OER
000-102	OER
000-103	OER
000-104	OER
000-105	OER
000-106	OER
000-107	OER
000-112	OER
000-113	OER
000-114	OER
000-130	OER
000-131	OER
800-21	OER
800-22	OER
800-23	OER
800-39	OER
800-40	OER
800-41	OER
800-42	OER
800-43	OER
800-44	OER

SCWA On-Site Sentinel Wells - Wm. Floyd Well Field

109-03	OER
109-04	OER

Operable Unit IV

Central Steam Facility - 1977 Spill Site

76-02*	SEP
76-24*	SEP
76-04	SEP
76-08	SEP
76-09	SEP
76-21	SEP
76-22	SEP
76-23	SEP
86-04	SEP
86-05	SEP
86-06	SEP
86-07	SEP
86-08	SEP
86-09	SEP
105-05	OER
105-06	OER
105-07	OER
106-19	OER

Major Petroleum Facility

76-25*	SEP
76-16	SEP
76-17	SEP
76-18	SEP
76-19	SEP

Building 650

66-20*	NS
76-25	SEP
76-26	SEP
76-28	SEP

Building 650 Outfall

66-17	SEP
66-18	SEP
76-13	SEP
76-20	SEP
76-24	SEP
76-27	SEP

Operable Unit V

Sewage Treatment Plant - Peconic River

37-02*	NS
37-03*	NS
37-04*	NS
47-03	NS
29-01	NS
38-01	SEP
38-02	SEP
38-03	SEP
38-04	SEP
38-05	SEP
38-06	SEP
39-05	SEP
39-06	SEP
39-07	SEP
39-08	SEP
39-09	SEP
39-10	SEP
41-01	NS
41-02	OER
41-03	OER
48-02	NS
49-04	NS
49-05	OER
49-06	OER
50-01	OER
50-02	OER
60-01	SEP
61-03	SEP
61-04	OER
61-05	OER
000-122	OER
000-123	OER
600-15	OER
600-16	OER

Operable Unit VI

Upland Recharge - Meadow Marsh

58-02*	SEP
58-03*	SEP
79-17	SEP
80-02	SEP
80-03	SEP
89-13	SEP
89-14	SEP
90-02	SEP
90-03	SEP
99-05	SEP
99-06	SEP
99-10	SEP
99-11	SEP
100-03	NS
100-04	SEP
100-11	SEP
100-12	SEP
100-13	SEP
100-14	SEP
000-25	OER
000-110	OER
800-24	OER
800-25	OER

North Boundary - Background Wells

000-118	OER
000-119	OER
000-120	OER
07-04	SEP
07-05	SEP
17-01	SEP
17-02	SEP
17-03	SEP
17-04	SEP
18-01	SEP
18-02	SEP
18-04	OER
18-05	OER
34-01	NS
34-02	OER
34-03	OER
34-04	NS
63-09	OER
72-03	OER
72-04	OER

NS = Well Not Sampled During CY 1996   * = Upgradient Well for Area

Appendix - References

Brookhaven National Laboratory, 1989a, "Quality Assurance Manual (March 1989)."

Brookhaven National Laboratory, 1989b, "Safety and Environmental Protection Quality Assurance Program Document (May 1989)."

Brookhaven National Laboratory, 1990, "Action Plan for the Tiger Team Assessment Report, Revision 3 (October 15, 1990)." BNL-52258.

Brookhaven National Laboratory, 1995, "Future Land Use Plan (August 31, 1995)." BNL-62130.

CDM Federal Programs/Lawler Matusky and Skelly Engineers, 1995, "Site Wide Biological Inventory Report (September 25, 1995)."

CDM Federal Programs, 1996, "Brookhaven National Laboratory, Draft Final, Remedial Investigation/Risk Assessment Report, Operable Unit I/VI (February 29, 1996)."

Corin, L.P., 1990, "Review of Federally Threatened or Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory", Letter to Gerald C. Kinne, September 25, 1990.

Daggett, C.J., 1986, Letter from C. J. Daggett (USEPA Region II) to D. Schweller (USDOE Brookhaven Area Office), Reference: PCB-Contaminated Fuel; Subject: U. S. Environmental Protection Agency Final Approval, January 21, 1986.

Eisenbud, M., "Environmental Radioactivity from Natural, Industrial, and Military Sources, Third Ed.," Academic Press, Inc., Orlando, 1987.

Energy Research and Development Administration, 1977, Brookhaven National Laboratory, "Final Environmental Impact Statement (July 1977)."

Geragthy and Miller, Inc., 1996b, "Regional Groundwater Model, Brookhaven National Laboratory, Upton, New York" (November 1996).

Golchert, N.W., and Kolzow, R.G., 1994, "Argonne National Laboratory - East Site Environmental Report for Calendar Year 1993, (May 1994)." ANL-94/10.

Koppelman, L., 1978, "Long Island Waste Treatment Management Plan," Vol. I and II, July 1978.

Long Island Lighting Company, 1995, "Long Island Lighting Company Population Estimates."

Miltenberger, R.P., Royce, B.A., Naidu, J.R. (eds.), "Brookhaven National Laboratory Site Environmental Report for Calendar Year 1988 (June, 1989)." BNL-52207.

Nagle, C. M.,1975, Climatology of Brookhaven National Laboratory: 1949-1973, BNL Report No. 50466, November 1975.

Nagle, C. M., 1978, "Climatology of Brookhaven National Laboratory: 1974 through 1977." BNL-50857, May, 1978.

Naidu, J.R., Royce, B.A., and Miltenberger, R.P. (eds.), 1993, "Brookhaven National Laboratory Site Environmental Report for Calendar Year 1992 (May 1993)." BNL-52411.

National Council on Radiation Protection and Measurements, 1979, "Tritium in the Environment." Report No. 62.

National Council on Radiation Protection and Measurements, 1987a, "Recommendations on Limits for

Exposure to Ionizing Radiation", NCRP Report No. 91.

National Council on Radiation Protection and Measurements, 1987b, "Exposure of the Population of the United States and Canada from Natural Background Radiation," Report No. 94.

New York State Department of Health, 1993, "Environmental Radiation in New York State 1993," Albany, NY.

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

Panek, F., 1985, New York State Department of Environmental Conservation, Personal Communication with J.R. Naidu, 1985.

Scheibel, M.S., 1990, "Review of New York State Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory", Letter to Gerald C. Kinne, September 24, 1990.

J.R. Naidu, et. al, 1996, "Brookhaven National Laboratory Environmental Monitoring Plan."

U.S. Department of Energy, 1988a, "Internal Dose Conversion Factors for Calculation of Dose to the Public (July 1988)." DOE/EH-0071.

U.S. Department of Energy, 1988b, "Environmental Survey, Brookhaven National Laboratory, June 1988." DOE/EH/OEV-14-P

U.S. Department of Energy, 1990, "Tiger Team Assessment of the Brookhaven National Laboratory (June 1990)", DOE/EH-0140.

U.S. Department of Energy, 1987, "Compendium of Superfund Field Operations Methods (December 1987)." U. S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency, 1992, "User's Guide for CAP88-PC, Version 1.0 (March 1992)." US EPA 402-B-92-001.

U.S. Environmental Protection Agency, 1996, "Environmental Radiation Data Report 76 (January 1996)." EPA-402-R-96-004.

Warren, M. A., de Laguna, W., and Lusczynski, N.J., 1968, "Hydrology of Brookhaven National Laboratory and Vicinity," U.S. Geological Survey Bulletin 1156-C.

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FRESHWATER FISHES OF LONG ISLAND (Continued)

other structure. Perch anglers will have success using live bait such as minnows or earthworms and artificial baits such as small curly-tail or tube jigs and spinners. Anglers should beware of the sharp fin rays when handling yellow perch.

Brook Trout: The region's native trout and New York state's fish, anglers once flocked to the spring-fed creeks of Long Island to fish for sea-run populations of this attractive trout. Although sea-run populations have for the most part disappeared, wild populations continue to flourish in many of our streams. Brook trout are traditionally taken with colorful flies, but can be caught on small spinners and spoons, as well as small garden and wax worms.

Rainbow Trout: Named after the pink stripe along its side, this western native has been stocked widely around the world. These fish are famous for their fighting ability, often making impressive leaps out of the water when hooked. Rainbow trout are stocked each spring into a number of lakes, ponds and streams. Fish over 20" are possible in some of our better trout waters. Earthworms, wax worms, as well as small spinners and spoons are effective.

Brown Trout: A native of Europe, brown trout are know as the wariest of the trout species. Brown trout are stocked each spring in many Long Island waters and can reach trophy sizes in some of our waters. Look for the largest brown trout in the tidal sections of our trout streams, where fish over 8 lbs., are not uncommon. The same bait used for other trout species are also effective for brown trout, but they must be presented carefully to fool this crafty fish.

Brown Bullhead: Long Island's native catfish, brown bullhead are common in most warmwater lakes, ponds and streams. Bullheads use their whiskers or barbels to search for food along the bottom and are commonly caught during low light periods on various natural baits such as worms, chicken livers and special processed catfish baits. Watch out for the serrated "horns" on the pectoral and dorsal fins when handling these scaleless fish.

Common Carp: Often labeled as a "trash" fish by U.S. anglers, carp are the largest freshwater fish found in our waters. Carp are tolerant of poor water quality and are now found in a large number of region's lakes, ponds and rivers. Carp are a very challenging fish to catch even for the best of the anglers. Anglers typically use delicate presentations with scented doughballs or corn to fool this crafty fish. Carp are considered a delicacy in many parts of the world.

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