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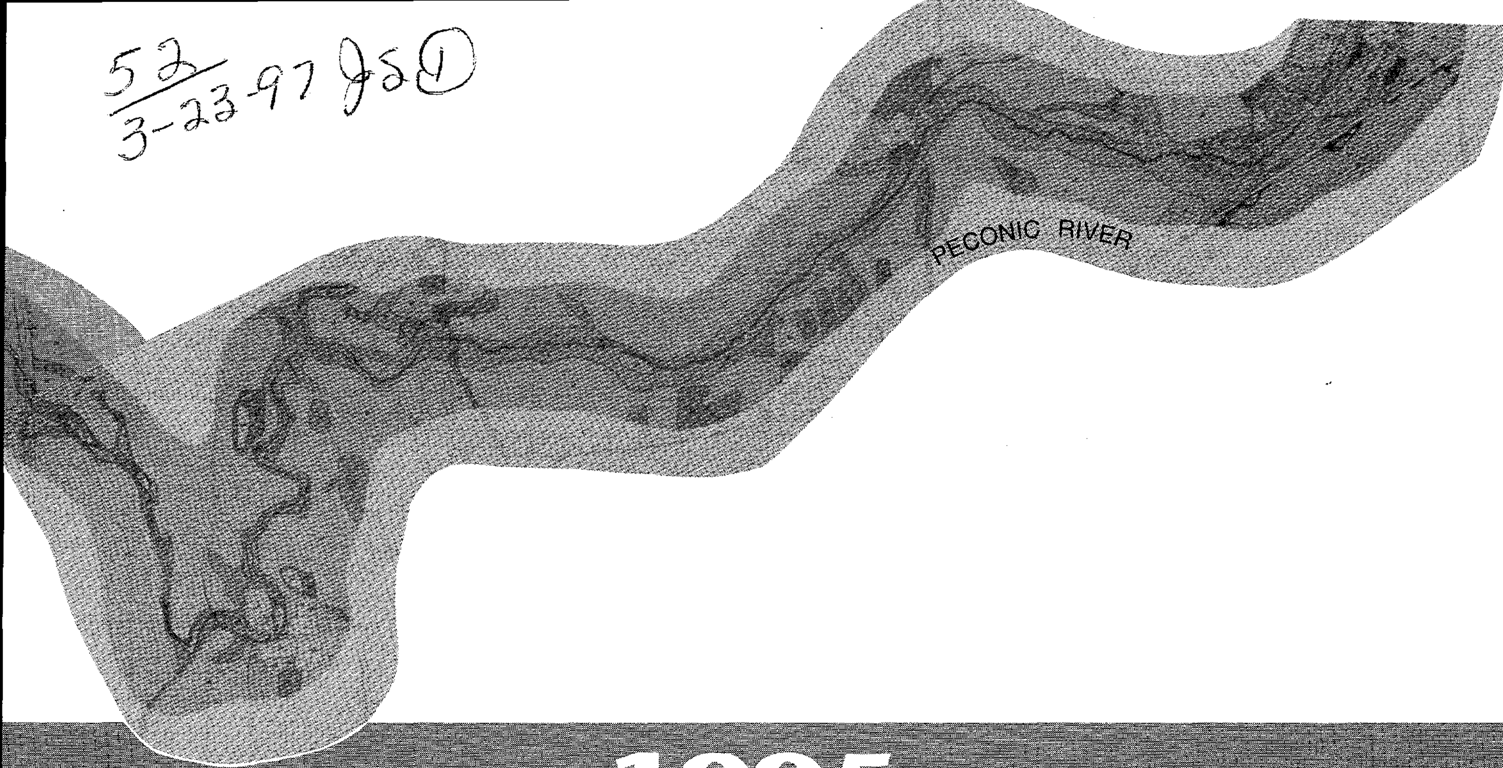
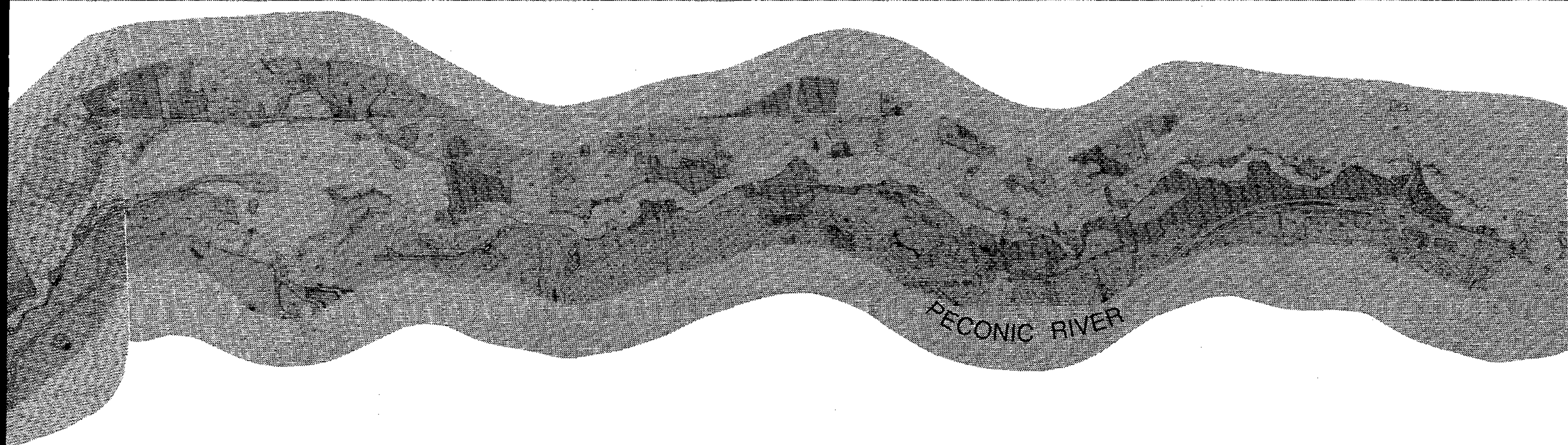


1995 Site Environmental Report



Safety and Environmental Protection Division
Brookhaven National Laboratory

On the Cover

THE PECONIC RIVER - "Peaconnuck" meaning the "the place to return" and also the word "Paumanok", or "land of tribute" was first used by the Pequot Tribe of Connecticut, who occasionally raided what is now Long Island - and hence the word ***PECONIC.***

Three groups of Algonquian Indians frequented the area, the Setaukets, the Unkechaugs, and, mostly, the Yannococks. They wandered peacefully through the region, living in rounded wigwams covered with twigs, branches and grass. They banded together to mainly ward off the Indian tribes who invaded from Connecticut and demanded food and supplies. When the white men arrived, there was little conflict as both land and food were plentiful. A few skirmishes occurred, however, the local Indians already weakened from years of Indian invasions, had little chance. Prime land and local power quickly passed to the new comers.

There were a number of Peconic River Mills and industries starting from 1695 till the early 1800s. The River Head (now called Riverhead) had a number of industries, such as; Saw mills (actually the first saw mill powered by River water in the NYS); Fulling mills - where flax and wool clothing were fulled and cleaned, and latter these mills became woolen mills, one of the most famous being the Perkin Mill; grist mills for flour and feed production from locally grown wheat and other grains; a large molding and planing mill where door work, flooring, scrolls, trims and structural members were manufactured; button factory and even a chocolate mill. All of these used the flowing River created by dams across the River to generate the needed power, however, these were supplemented by coal and oil fired engines. Mills were also constructed on the River to generate electricity, which supplied electricity to the Town of Riverhead till LILCO took over in 1922. Another big activity was the Forge Ice factory which collected and stored ice from the frozen Peconic River during winter, and even exported large quantities to New York City to be used in the very famous Reid's Ice Cream Company. The Forge Iron works was very active during the 1700s, where iron ore from swamps and bogs were used to manufacture ship anchors, and other iron products like nails, chain links, etc. All of these industries were replaced when electricity was provided for such industries by LILCO. Unfortunately, almost all these early industries along the River were destroyed by fire and there is very little evidence left for one to see, other than the remnants of some dams etc. Artesian wells were also installed in the River and served as sources of pure drinking water in the early 17th and 18th centuries. These were also submerged under sediments when these industries were shut down. These industries were replaced by the only viable industry, which was cranberries. At Calverton, the Mills pond was converted to cranberry bogs or marshes. The River provided an ideal situation where the cranberries did not freeze during winter and were covered by sand during spring - both ideal conditions for the survival and ripening of the cranberries. This industry being labor intensive was a family affair. However, with the advent of labor unions and laws against employing children, it became too expensive to maintain large bogs. Thus even this industry ceased functioning in the 1970s. The last cranberry marsh, the David marsh has now become the Swan Lake Golf Course. This demise was followed by duck farming

(cont'd on inside back cover)

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FORMAL REPORT

BROOKHAVEN NATIONAL LABORATORY
SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1995

J.R. Naidu, D.E. Paquette, G.L. Schroeder, and R.J. Lee, Editors

December 1996

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
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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 Management Section of the Division. This Section is responsible for preparing the sampling plan, collecting environmental and facility samples, analyzing the 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 1995. 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 nonradiological 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 Sampling Team and the Analytical Team (Radiological and Nonradiological). 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, and M. Surico.

The authors 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:

Safety and Environmental Protection Division

S. Chalasani	Nonradiological Analysis and Data Review
M. Clancy	Hazardous Waste Management
G. Goode	Waste Minimization and Pollution Prevention Program
K. Shurberg	Compliance - Resource Conservation Recovery Act
T. Sperry	Compliance - National Environmental Policy Act
J. Williams	Compliance - Air

Other S&EP Contributors:

G. Adams	Asbestos
H. Bowen	Data Base and Data Reports
S. Briggs	Quality Assurance
R. Thompson	Thermo Luminescent Dosimeter Assays
A. Tiganitakis	Summer Student - Groundwater data (radioactivity) analysis.

Contributors from other Departments:

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.

The authors would like to recognize the efforts made by Dr. Avril Woodhead in editing the report from a technical perspective. Her valuable suggestions and comments have definitely contributed to the readability and understanding of the observations and conclusions made in the report. We thank her for her diligence in doing this painstaking task and appreciate her time and effort spent in completing the review in an expeditious manner.

Finally, the authors would like to extend a special thanks to Rosemary Taylor, Marie DeAngelis, and Rhea Robinson for their 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 communties.

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Executive Summary

The Environmental Monitoring Program is conducted by the Environmental Management Section of the Safety & Environmental Protection (S&EP) Division. This program exists to determine whether Brookhaven National Laboratory (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 nonradiological parameters. This report summarizes the data for external radiation levels; radioactivity in air, rain, potable water, surface water, groundwater, soil, vegetation, fauna, and aquatic biota; water quality, metals content, organic compounds in groundwater, surface water, and potable water.

Analytical results are reviewed by the S&EP Division staff and, when required by permit conditions, are transmitted to the appropriate regulatory agencies through the Department of Energy (DOE). The data were evaluated using the appropriate environmental regulatory criteria. Data summaries for Calendar Year (CY) 1995 are presented in the text.

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 1995, 1,863 Ci (68.9 TBq) of argon-41 were released from the MRR; 372 Ci (13.7 TBq) of oxygen-15 were released from the BLIP Facility, and a combined total of 104 Ci (3.8 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 Building 801, Hazardous Waste Management Facility (HWMF) Incinerator and Alternating Gradient Synchroton (AGS) Facility.

Liquid Effluents

Liquid discharge limits for radiological and nonradiological 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, not specifically listed in the BNL SPDES permit, 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. In March 1995 BNL's SPDES permit was revised resulting in increased monitoring requirements for the Sewage Treatment Plant (STP) and for discharges to recharge basins. Limits for radiological releases were deferred to DOE standards.

All STP effluents met the radiological limits specified by the DOE in Order 5400.5, "Radiation Protection of the Public and the Environment". The principle radionuclide detected at the STP Peconic River Outfall was tritium. The total annual release of tritium to the Peconic was 2.7 Ci (0.1 TBq) and the annual average tritium concentration was 2,960 pCi/L (110 Bq/L), or 15% 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.

Nonradiological 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 and total coliform bacteria, and ammonia-nitrogen. Although the compliance rate exceeded 99.6%, there were eleven permit deviations; one each for removal of total suspended solids (TSS), residual chlorine, and fecal coliform, two for silver, and six 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 revised SPDES permit. In all instances the effluent concentration of BOD_5 and TSS was within SPDES limitations. The residual chlorine excursion was due to a failed check-valve in the hypochlorite dosing train which resulted in the slight over-addition of hypochlorite to the STP effluent. The cause of the exceedances of fecal coliform bacteria was found to be inadequate hypochlorite dosing. The silver exceedances 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.

In 1995, the revised BNL SPDES permit required monthly and quarterly monitoring of discharges to the BNL recharge basins. Monitoring included monthly reporting of flow, pH, and oil and grease, with quarterly reporting for organic and inorganic contaminants. Except for two pH excursions, one each at Basins HO and HTw (Outfalls 003 and 006A, respectively), all analytical results complied with the SPDES limitations. Measurements of pH at these locations 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) was used to monitor the external gamma radiation levels at 24 locations on-site and 25 locations off-site. The average annual on-site integrated dose for 1995 was 70 ± 6 mrem (0.7 ± 0.06 mSv), while the off-site integrated dose was 65 ± 6 mrem (0.65 ± 0.06 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.

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 (NYSDOH, 1993).

The maximum annual average tritium concentration was 9 pCi/m^3 (0.3 Bq/m^3), measured at the northeast site boundary. This level represents <0.01% of the DOE concentration guidelines for air. Normal trace levels of cosmogenic, terrestrial and fallout radionuclides such as beryllium-7, cesium-137 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.

Soil and 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 June 1995. All radionuclides detected in these samples were of natural origin. No nuclides attributable to Laboratory operations were detected.

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 HM, 0.8 km downstream of the STP Outfall, and Location HQ at the site boundary, adjacent to North Street. Due to persistent low-water table conditions, no flow existed at Location HQ and no samples were collected.

River samples from Location HM showed detectable levels of tritium and cesium-137 attributable to Laboratory operations. Annual average values for tritium were less than 13% of the level specified by the SDWA. Observed cesium -137 concentrations at Location HM are consistent with levels measured at the STP Outfall and are the result of continued leaching of low-level deposits from the STP sand filter beds. While measurable just above the detection limit, cesium-137 levels were small fractions (typically, < 1%) of the DOE Guide. No radionuclides attributable to Laboratory operations were observed in off-site river water samples.

Surface Water - Nonradiological 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 1995.

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 to be 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. Volatile Organic Compounds were not detected in samples of surface waters collected from the Carmans and Peconic Rivers during CY 1995.

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 1995, fish samples were collected at Donahue's Pond and Forge Pond and control samples were collected from the Carmans River and Swan Pond. 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. Results of analysis of fish collected from Forge Pond and Donahue's Pond indicate that cesium-137 is present in concentrations ranging from 1 to 30 times those of control samples. The presence of cesium-137 at these levels is indicative of a BNL contribution to the Peconic River system. This is primarily a result of releases which occurred in years past, though cesium-137 continues to be detectable in river sediment samples today due to its relatively long half-life and low environmental mobility. The maximum committed effective dose equivalent to a person ingesting 7 kilograms of fish from these locations is 0.2 mrem (2 μSv) (excluding any potential strontium-90 contribution). This is less than 1% of the dose typically received by a U.S. citizen annually from natural, internally-deposited radionuclides (NCRP, 1987).

Potable Water Supply

The Laboratory's potable water supply wells are screened from a depth of about 15m to about 26m in the Upper Glacial aquifer. During 1995, Well Nos. 4, 6, 7, 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.

Radiological Analyses

On-site potable wells were sampled for radioactive content. Gross alpha activity, gross beta activity, tritium and gamma spectroscopy analyses were performed. Gamma spectroscopy detected cesium-137 in Well #4 (FD) at 0.3 pCi/L (0.01 Bq/L), essentially at the limit of detection, and most likely a spurious result. Gross alpha and gross beta activities were approximately 1 pCi/L (0.04 Bq/L) or less, which is typical of radioactivity levels seen in environmental groundwater samples. Tritium was not detected above the Minimum Detection Limit (MDL) in any well. All analyses of on-site potable well water demonstrated that it was free from any man-made radionuclide content.

Nonradiological Analyses

Metals analyses of potable water did not reveal silver, cadmium, chromium, nor mercury in any of the samples. Low concentrations of lead, manganese, copper, and zinc were detected in well-water samples but at concentrations below their respective NYS DWS (0.015 mg/L, 0.3 mg/L, 1.3 mg/L, and 5.0 mg/L, respectively). Iron was detected in water collected at the well head from Well Nos. 4, 6 and 7. Water from these wells is treated to remove excess iron at the BNL Water Treatment Plant (WTP) before use in the domestic water distribution system. Sodium was detected in all potable wells in concentrations ranging from 8.7 to 13.5 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 (9.2 ppb) exceeded the NYSDOH standard of 5 ppb. To lower the concentration of organics in water samples collected 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 NYSDWS.

Major improvements to the BNL WTP were started in 1995. They include the construction of dual air-stripping towers, a new clear well, and wet well. Installing air stripping towers will improve the removal of POCs from the water before site distribution.

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 nonradiological levels of contamination relative to current standards.

Radiological Analyses

Two hundred and seven (207) wells were sampled for radiological analysis. For ease in identifying trends in groundwater quality, analytical results are discussed by sectors. Groundwater samples were subjected to gross alpha and gross beta, tritium, and gamma spectroscopy analysis. In certain areas, analysis for strontium-90 was also conducted. Additionally, 103 temporary vertical profile wells were installed as part of the Environmental Restoration program and were typically analyzed for tritium.

East Sector: This sector includes the Meadow Marsh-Upland Recharge Area, the Peconic River (on-site), and the area surrounding the STP sand filter beds. Gross alpha activity values were typical of ambient groundwater values seen in wells which are upgradient of Laboratory facilities; gross beta activities were somewhat elevated with a maximum recorded value of 21 pCi/L (0.8 Bq/L); and tritium was detectable at elevated levels of up to 1,340 pCi/L (50 Bq/L). Cesium-137 and strontium-90 were detected at levels above those attributable to fallout; maximum concentrations were 11 and 9 pCi/L (0.4 and 0.3 Bq/L), respectively. Elevated gross beta, tritium, cesium-137, and strontium-90 activity 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).

North Boundary: Wells near the northern boundary lie above the developed portion of the site, upgradient of known or suspected groundwater contaminant plumes; Grids 07, 17, 18, and 25 are included. Radiological results from these areas showed gross alpha and beta activities that are consistent with ambient groundwater values. No gamma-emitting radionuclides or tritium concentrations were found.

South Boundary: Wells located near the southern boundary lie below the developed portion of the site just above the William Floyd Parkway; Grids 118, 122, 126, and 130 are included. Radiological results from these areas showed gross alpha and beta activities that are consistent with ambient groundwater values. No gamma-emitting radionuclides or tritium concentrations were found.

West Sector: The western sector includes the edges of the developed portion of the site: Grids 83, 84, 94, 101, 102, and 103. As with the north and south sectors, no unusual gross activity or gamma-emitting radionuclides were found. Only one well, 94-01, showed the presence of tritium, above the minimum detection limit, at 522 pCi/L (19 Bq/L).

Central Sector: This sector covers the developed portion of the site is further broken into the following, units: the area surrounding Building 830, the Major Petroleum Facility (MPF), the Central Steam Facility (CSF), the AGS, and the WCF. Radiological results for groundwater near Building 830, the MPF, and the CSF show background radioactivity levels with no unusual radionuclides present. However, samples from wells near the AGS and WCF show the presence of radionuclides which are attributable to Laboratory operations. Elevated gross alpha and gross beta activities were detected as well as tritium, sodium-22, cobalt-60 and cesium-137. All gamma-emitting radionuclides were close to the minimum detection limits, and small fractions of DOE DCGs. The maximum observed tritium value was 3,520 pCi/L (130 Bq/L), 18% of the SDWA standard.

Groundwater around the Building 650 Sump, which once received rinse water from a radiological decontamination pad, was monitored for man-made radionuclides. Samples from wells in this area, in Grids 66 and 76, showed tritium and strontium-90 at levels attributable to past Laboratory operations. Maximum observed values for tritium and strontium-90 were 1,890 and 15 pCi/L (69 and 0.6 Bq/L), respectively. This tritium value is 9% of the SDWA standard, while the strontium-90 concentration exceeds the SDWA standard by a factor of two. The 650 Sump Outfalll is a known Area of Concern and is being addressed as part of Operable Unit (OU) IV.

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. No unusual activity was found. This is as expected since most known contaminants in this area are of a chemical nature and not radioactive.

Southeast-South Central Sector: In the southeast and south-central areas of the site, the following three contaminant source areas were monitored: the HWMF, the Current Landfill, and the Former Landfill area.

The current HWMF has been used to handle, process and store radioactive materials since the late 1940s. Soil and groundwater media 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 Area of Concern (AOC) and will be remediated under future OU I actions. Groundwater samples from wells in this area showed the presence of cesium-137, sodium-22, cobalt-60, strontium -90, and tritium. The highest tritium concentration measured in 1995 was from Well 88-26 at 42,200 pCi/L (1,560 Bq/L), approximately twice the SDWA standard. A maximum strontium -90 concentration of 91 pCi/L (3.4 Bq/L) was seen at Well 88-04, about 11 times greater than the SDWA standard of 8 pCi/L (0.3 Bq/L). The concentrations of gamma-emitting radionuclides were small fractions of the applicable DOE DCGs.

The groundwater in the areas near the "Current" (closed in 1990) and Former Landfills (closed in 1966) are also monitored for radioactive material. These burial facilities once received low-level radioactive waste generated by site operations. Precipitation over the years has caused some of this material to leach into the underlying water table. Consequently, radionuclides attributable to the Laboratory are detectable in underground plumes. Primary contaminants include tritium and strontium -90. Trace quantities (<1 pCi/L [0.04 Bq/L]) of fission-produced nuclides such as cesium-137 and cobalt-60 were detected as well. Downgradient of the Current Landfill, maximum concentrations of 9,200 and 2 pCi/L (340 and 0.07 Bq/L) were observed for tritium and strontium -90, respectively. Maximum tritium and strontium-90 values were both below SDWA standards. Downgradient of the Former Landfill, Well 97-03 was found to contain strontium -90 at 24 pCi/L (0.9 Bq/L), three times the drinking water standard.

Private Potable Wells: In addition to the on-site surveillance wells, 25 privately owned potable wells to the east of the Laboratory were sampled for radionuclides as part of a continuing cooperative program with the SCDHS. Sample collection was performed by County staff and analysis was carried out by the BNL Analytical Services Laboratory (ASL). Gross alpha and gross beta activities were typical of environmental water samples, although tritium concentrations above the analytical MDL were found in six private well samples. The annual average tritium concentrations in these wells ranged from 1,430 to 2,380 pCi/L (53 to 88 Bq/L), or 7% to 12% of the SDWA standard. The maximum concentration observed in any private well was 2,520 pCi/L (93 Bq/L), or 13% of the SDWA standard. Ingestion of water throughout the year at the maximum concentration detected would lead to a committed effective dose equivalent of 0.1 mrem (1 μSv) to the individual consuming the water. By comparison, the typical dose that a United States citizen receives annually from the ingestion of naturally-ocurring radionuclides is approximately 40 mrem (0.4 mSv)(NCRP, 1987).

Nonradiological Analyses

During 1995, 207 groundwater surveillance wells were sampled for nonradiological analyses during 366 individual sampling events . Additionally, 103 temporary vertical profile wells were installed as part of the Environmental Restoration Program; and 1,715 groundwater samples were collected from these wells. Nonradiological analyses typically consist of 1) determining water quality parameters, such as pH, conductivity, chloride, sulfate, and nitrate concentrations; 2) metals concentrations; and 3) VOC concentrations. 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; the VOCs usually are traceable to known spills or chemical-waste storage areas, and former disposal areas. In several areas of the BNL site, iron is 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. The nonradiological analyses of groundwater samples collected during 1995 are summarized below.

East Sector: In the east sector of the site, two suspected contaminant source areas were monitored: the STP/Peconic River area, and the Meadow Marsh-Upland Recharge area.

In the STP/Peconic River area, groundwater samples from 29 surveillance wells were analyzed for water quality, VOCs, and metals. Water quality data from most wells located both upgradient and downgradient of the STP show that the pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, but was consistent with values observed at upgradient locations. All other water quality parameters were within the applicable NYS AWQS. Metals analyses of groundwater samples indicate that iron concentrations exceeded the NYS AWQS of 0.3 mg/L in 16 wells, with maximum concentrations ranging from 0.38 to 53.17 mg/L. Sodium exceeded NYS AWQS of 20 mg/L in two wells, with maximum concentrations ranging from 24.81 to 28.23 mg/L. Three wells had lead concentrations above the NYS AWQS of 0.025 mg/L, with maximum concentrations ranging from 0.054 to 0.056 mg/L. The volatile organic compound trichloroethylene (TCE) was detected at 12 µg/L in one well close to the site boundary, which is above NYS AWQS of 5 µg/L. To further evaluate the extent of groundwater contamination at the BNL eastern site boundary and off-site areas, five temporary vertical profile wells were installed as part of the OU V Remedial Investigation. Volatile organic compounds were detected above or at NYS AWQS in two temporary wells. In one well, TCA, TCE and Dichloroethane (DCA) were detected at maximum concentrations of 8 µg/L, 32 µg/L, and 5 µg/L, respectively. In the second well, TCE and DCA were detected at a maximum concentrations of 8 µg/L and 6 µg/L, respectively.

In the Meadow Marsh-Upland Recharge area, groundwater samples were collected from seven Upper Glacial and one Magothy aquifer surveillance wells and analyzed for water quality, 12 wells were sampled for metals, and 28 were sampled for VOCs. Water quality data from these wells indicate that the pH was typically 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. Iron was detected above NYS AWQS in two Upper Glacial aquifer wells and one Magothy aquifer well, at maximum concentrations of 2.68, 8.13 and 5.60 mg/L, respectively. Historically, the only VOC detected above NYS DWS in the Upland Recharge/Meadow Marsh area has been 1,2-Dibromoethane (EDB). Groundwater samples collected during the April 1995 OU VI Remedial Investigation sample period, indicate that the EDB concentrations exceeded the NYS DWS of 0.05 µg/L in three southeast boundary wells at concentrations of 0.07 µg/L, 0.08 µg/L and 0.28 µg/L. Additionally, EDB was detected at a maximum concentration of 3.4 µg/L in one temporary off-site vertical profile well.

Southeast-South Central Sector: In the southeast and south-central areas of the site, the following three contaminant source areas were monitored: the HWMF, the Current Landfill, and the Former Landfill area.

In the HWMF area, 21 surveillance wells were monitored for water quality, metals, and VOCs. As in previous years, the pH of groundwater in the HWMF area was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8. All other water quality parameters were below the applicable NYS AWQS. Lead was detected at concentrations above NYS AWQS in one well, with a maximum observed concentration of 0.026 mg/L; and elevated sodium was detected in two wells. All other metals were below the NYS AWQS. Nine of the 21 HWMF surveillance wells sampled, had VOC concentrations at or above NYS AWQS. No VOCs were detected in the upgradient wells. Of the surveillance wells within and downgradient of the HWMF, in which NYS AWQS were exceeded, TCA was detected in three wells at maximum concentrations ranging from 5 µg/L to 22.7 µg/L; PCE was detected in five wells at maximum concentrations from 8.8 µg/L to 23.5 µg/L; DCA was detected in three wells at maximum concentrations ranging from 10 µg/L to 126.7 µg/L; chloroethane was detected in one well at a maximum concentration of 19.8 µg/L; and, trichlorofluoromethane was detected in one well (98-21) at 22.5 µg/L.

In the Current Landfill area, 24 groundwater surveillance wells were sampled for water quality, VOCs, and metals. Also, as part of the OU I Pre-Design Field Investigation, three temporary vertical profile wells were installed downgradient of the Current Landfill area to further assess the vertical and horizontal extent of groundwater contamination. Groundwater samples from wells located at the Current Landfill had a pH that was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median value of 6.25. Although all water quality parameters were within NYS AWQS, the wells directly downgradient of the landfill had elevated conductivity levels. The average conductivity value for the upgradient well was 117.7 µmhos/cm, whereas those for wells directly downgradient of the landfill ranged from 116 - 910 µmhos/cm. Metals analyses indicate that 12 surveillance wells located downgradient of the Current Landfill had average iron concentrations that exceeded the NYS AWQS of 0.3 mg/L. The upgradient well typically had iron concentrations below the typical minimum detection limit of 0.075 mg/L. In the downgradient wells where iron concentrations exceeded NYS AWQS, average concentrations ranged from 0.35 - 75.45 mg/L. Eight downgradient wells had sodium at concentrations above the NYS AWQS of 20 mg/L, with maximum concentrations ranging from 20.63 to 44.76 mg/L. The elevated conductivity values in the downgradient wells are probably related to these elevated iron and sodium concentrations. All other metals 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: TCA was detected in seven permanent and three temporary wells at maximum concentrations ranging from 6.5 µg/L to 28 µg/L; TCE was detected in two permanent and one temporary well at maximum concentrations ranging from 5.4 µg/L and 11 µg/L; DCA was detected in five permanent and three temporary wells at maximum concentrations ranging from 5 µg/L to 400 µg/L;

Tetrachloroethylene (PCE) was detected in one well at a maximum of 7 µg/L; Dichloroethylene (DCE) was detected in one permanent and one temporary well at maximum concentrations of 25 µg/L and 35µg/L, respectively; benzene was detected in three permanent wells at maximum concentrations ranging from 5 µg/L to 6 µg/L; carbon tetrachloride was detected at 5µg/L in one temporary well; and, chloroethane was detected in two permanent wells at maximum concentrations of 5 µg/L and 26 µg/L.

In the Former Landfill area, groundwater samples from 12 surveillance wells, were collected and analyzed for water quality, VOCs and metals. Six on-site and six off-site temporary vertical profile wells were also installed both upgradient and downgradient of the Former Landfill area during the OU I Pre-Design Field Investigation. As in previous years, the pH of most groundwater samples were typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8. All other water quality parameters were below the applicable NYS AWQS. Iron concentrations exceeded NYS AWQS in one well, with a concentration of 24.02 mg/L. Two wells had concentrations of VOCs above NYS AWQS. TCE was detected in one well at a concentration of 23.1 µg/L, and PCE was detected in a second well at a maximum concentration of 5.6 µg/L. Above NYS AWQS concentrations of VOCs were also detected in three temporary vertical profile wells installed upgradient of the Former Landfill, and in two downgradient temporary wells. The three upgradient temporary wells had VOC concentrations above NYS AWQS, with a maximum of 25 µg/L of PCE and 11 µg/L of 1,2-dichlorothane in DVPW-1, 49 µg/L of PCE in DVPW-7, and 11 µg/L of PCE detected in DVPW-9. These contaminants probably are the result of historical releases within the CSF/MPF (OU IV) area. Two of three temporary profile wells installed downgradient of the Former Landfill area had VOC concentrations that exceeded NYS AWQS with a maximum observed concentration of 96 µg/L of TCA and 35 µg/L of DCE in DVPW-2; and 94 µg/L of TCA, 8 µg/L of TCE, 74 µg/L of PCE, 34 µg/L of DCE, and 6 µg/L of 1,2-DCA in DVPW-6. Contaminants detected in DVPW-2 and DVPW-6 probably originated from the CSF/MPF (OU IV) area. However, contaminants that may have originated from the Former Landfill area were detected in off-site temporary well HP-000-13R; the maximum values of VOCs in this well were TCA at 47 µg/L, TCE at 14 µg/L, DCA at 5 µg/L, DCE at 11 µg/L, Chloroform at 580 µg/L, and 1,2-DCA at 25 µg/L.

Central Sector: In the central part of the site, nine known or suspected contaminant source areas were monitored during 1995; the CSF/MPF, AGS area, the Former Building T-111 area, the Supply and Materiel area, the WCF, Building 830, and the recharge basin near the LINAC. Those areas where contaminant concentrations exceeded NYS AWQS or water quality parameters exceeded NYS AWQS are discussed below.

Within the CSF and MPF areas, groundwater samples were analyzed for water quality, metals and VOCs from 24 surveillance wells. The five wells that monitor the MPF were also sampled for floating petroleum products in accordance with the NYSDEC license. The pH 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. Elevated iron concentrations were detected in two wells with maximum values ranging between 0.475 mg/L to 19.96 mg/L. Analyses for VOCs in groundwater samples from the five wells monitoring the MPF showed that VOCs were present at concentrations at or above NYS AWQS in two wells. TCA was detected in the upgradient well for the MPF at a maximum concentration of 13.2 µg/L, and PCE was detected in one downgradient well at a maximum observed concentration of 12.1 µg/L. In both cases, the VOCs detected are not from spills or leaks associated with MPF operations. In the case of upgradient well, the TCA is probably from releases in the Building 650 area, whereas the PCE in the downgradient well is likely to have come from a spill site located near Building 610. No benzene/ethylbenzene/toluene/xylene (BETX) 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, none were observed during 1995. Within the CSF area, 19 surveillance wells were sampled during 1995. Seven wells had VOCs at concentrations above NYS AWQS: TCA was detected in three wells at maximum concentrations ranging from 7.2 µg/L to 20.5 µg/L; TCE was present in two wells at maximum concentrations of 17 µg/L and 25 µg/L; PCE was detected in six wells at maximum concentrations ranging from 10.7 µg/L to 73.1 µg/L; cis-1,2-DCE was detected in four wells at maximum concentrations ranging from 7.9 µg/L to 79.7 µg/L; ethylbenzene was detected in two wells at maximum concentrations of 22.6 µg/L and 690 µg/L; toluene was detected in one well at a maximum concentration of 1,900 µg/L; and xylene (total) was detected in three wells at maximum concentrations ranging from 52.5 µg/L to 1,340 µg/L.

Within the Building 650 and 650 Outfall areas, groundwater samples were analyzed from five surveillance wells. The pH of most samples were either within, or slightly below, the NYS AWQS of 6.5 to 8.5. All other water quality parameters and metals concentrations were below the applicable NYS AWQS. TCA was detected in two wells located directly downgradient of Building 650 at maximum concentrations of 13.2 µg/L and 3.6 µg/L. No VOCs were detected in wells directly downgradient of the 650 Sump Outfall.

In the AGS and LINAC areas, groundwater samples were analyzed for water quality, metals, and VOCs from thirteen surveillance wells. The pH of the groundwater samples was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.2. Other water quality parameters were below the applicable NYS AWQS. In the AGS area, iron was detected above NYS AWQS in two wells. All other metals were at concentrations below the applicable NYS AWQS. Iron concentrations in the two wells (both older wells constructed of carbon-steel casings) ranged from 0.62 mg/L to 2.95 mg/L. Within the LINAC area, elevated lead concentrations were observed in the upgradient well, at a maximum concentration of 0.048 mg/L. Analyses for VOCs in groundwater samples collected from the AGS area revealed TCA at concentrations that exceeded NYS AWQS in three wells, with maximum concentrations ranging from 10.9 µg/L to 134.8 µg/L. Additionally, DCA and DCE were detected in one well at maximum concentrations of 14.7 µg/L and 7.8 µg/L, respectively. The VOCs detected in this well may have originated from cesspools associated with Buildings 914 and 919. No VOCs were detected in the LINAC area wells.

In the WCF area, groundwater samples were analyzed for water quality, metals and VOCs from five downgradient surveillance wells. The pH of the groundwater samples was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median value of 6.3. All other water quality parameters were below the applicable NYS AWQS. Metals analyses of groundwater from this area showed that all metals were below the applicable NYS AWQS. Analysis for VOCs indicated TCA at concentrations above NYS AWQS in all four downgradient wells, with maximum concentrations ranging from 12.6 µg/L to 29.5 µg/L. While groundwater samples from the upgradient well were not analyzed for VOCs during 1995, TCA has been historically detected in this well, indicating that the TCA detected in the downgradient wells may not have originated from the WCF.

In the former Building T-111 area, groundwater samples were analyzed for water quality, metals and VOCs from four surveillance wells. Water quality analyses indicate that the pH of groundwater samples collected from shallow Upper Glacial aquifer wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8, whereas the pH of the sample collected from middle Upper Glacial well 85-07 was 7.0. Other water quality parameters were below the applicable NYS AWQS. All metals concentrations in these groundwater samples were below the applicable NYS AWQS. TCA was detected above NYS AWQS in one well at a maximum concentration of 8.9 µg/L.

In the Supply and Materiel area, groundwater samples were analyzed for water quality, metals and VOCs from seven surveillance wells . 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 6.2. All other water quality parameters were below the applicable NYS AWQS. Metals analyses of groundwater samples indicated that iron concentration of 0.75 mg/L in one downgradient (an older well with carbon-steel casings). Analyses for VOCs showed that TCA was above NYS AWQS in three wells, at maximum concentrations ranging from 7 µg/L to 220 µg/L.

North Boundary, West Sector, and South Boundary: In the North Sector area, nine of the north boundary wells were sampled for water quality, metals, and VOCs. These surveillance wells monitor background (natural) water quality conditions, as well as for potential contamination originating from upgradient sources. The wells allow monitoring of groundwater quality within the shallow, intermediate, and deep portions of the Upper Glacial aquifer, and the uppermost Magothy aquifer. The pH of the groundwater samples collected 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 5.3, whereas the pH of samples from Magothy well was typically within the NYS AWQS, with a median pH of 7.4. Nitrate concentrations exceeded NYS AWQS in one deep Upper Glacial well at 10.7 mg/L. Furthermore, PCE was also detected in the same deep well at the NYS AWQS of 5 µg/L. All metals were below the applicable NYS AWQS. The nitrates and VOCs detected in the deep Upper Glacial aquifer well may signify the migration of contaminants from off-site areas onto the BNL site.

In the Western sector of BNL, seven surveillance wells were sampled during 1995. Water quality analyses indicate that 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 6.2. All other water quality parameters were below applicable NYS AWQS. Iron exceeded NYS AWQS in one well, at a maximum concentration of 8.45 mg/L. All other metals concentrations were below the applicable NYS AWQS. VOC concentrations exceeded the NYS AWQS for TCA in one well, with a maximum observed concentration of 12.3 µg/L. In addition to sampling permanent wells, 18 temporary vertical profile wells were installed in the Western and central sectors of the site as part of Phase II Groundwater Screening of the OU III Remedial Investigation /Feasibility Study (RI/FS). Analysis of Phase II groundwater samples indicates the presence of either TCA, TCE, PCE, or DCE at concentrations above NYS AWQS in most wells. The maximum observed concentrations in the Phase II vertical profile wells were TCA in 17 wells ranging from 7 µg/L to 225 µg/L; TCE in one well at a maximum concentration of 11 µg/L; PCE in two wells ranging from 6 µg/L to 50 µg/L; and, DCE in seven wells ranging from 6 µg/L to 13 µg/L. Additional VOCs such as DCA, cis-1,2-DCE, and 1,2-DCA were occasionally detected at concentrations exceeding NYS AWQS: DCA in nine wells ranging from 5 µg/L to 23 µg/L; cis-1,2-DCE in one well at a maximum concentration of 38 µg/L; and, 1,2-DCA in one well at a maximum concentration of 14 µg/L.

Along BNL's southern (downgradient) boundary, groundwater samples were collected from eight surveillance wells. The pH of the groundwater samples 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. All metals concentrations were below NYS AWQS. Analyses for VOCs indicate that TCA and TCE were detected above NYS AWQS in two deep Upper Glacial wells located near BNL's South Gate, with maximum observed concentrations of TCA ranging from 14 µg/L to 15.7 µg/L, and TCE ranging from 5.6 µg/L to 22.1 µg/L. DCE was also detected in one of the South Gate wells at a maximum concentration of 6.1 µg/L. In a third deep Upper Glacial well located along the south boundary in the south-central area of the site, TCA and DCE were detected at concentrations of 157.8 µg/L and 59.6 µg/L, respectively.

As part of the OU III RI/FS, 47 temporary vertical profile wells were installed in the south sector areas during 1995 as part of Phase I Groundwater Screening of the OU III RI/FS. Additionally, 18 temporary wells were installed in off-site areas as part of Phase III of this study. Phase I groundwater samples showed widespread VOC contamination in the southern sector of the site. The principal VOCs detected at concentrations at or above NYS AWQS were TCA, TCE, PCE, DCE, and carbon tetrachloride. The maximum observed concentrations in Phase I wells were TCA in 40 wells ranging from 5 µg/L to 1,500 µg/L; TCE in 34 wells ranging from 5 µg/L to 100 µg/L; PCE in 17 wells ranging from 5 µg/L to 2,500 µg/L; DCE in 26 wells ranging from 5 µg/L to 370 µg/L; carbon tetrachloride in 10 wells ranging from 6 µg/L to 680 µg/L. Additional VOCs such as DCA, cis-1,2-DCE, 1,2-DCA, trans-1,2-DCE, xylene, and toluene were occasionally detected at concentrations exceeding NYS AWQS. Analysis of Phase III groundwater samples indicated that VOCs originating from BNL, and possibly other off-site source areas, are present in some areas of the North Shirley residential area. The principal VOCs detected at concentrations at or above NYS AWQS were TCA, TCE, PCE, DCE, and carbon tetrachloride. The maximum observed concentrations in Phase III wells were TCA in 13 wells ranging from 5 µg/L to 32 µg/L; TCE in 13 wells ranging from 6 µg/L to 110 µg/L; PCE in one well at a maximum concentration of 24 µg/L; DCE in four wells ranging from 5 µg/L to 16 µg/L; and carbon tetrachloride in seven wells ranging from 17 µg/L to 3,200 µg/L. Cis-1,2-DCE was also detected at a concentration above NYS AWQS in one well, at a maximum concentration of 7 µg/L.

<u>Off-Site Dose Estimates</u>

The committed effective dose equivalent to the maximally exposed individual resident at the site boundary from the air pathway was calculated to be 0.06 mrem (0.6 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 was calculated to be 0.1 mrem (1 µSv). The maximum individual committed effective dose equivalent from the fish pathway was estimated using conservative assumptions to be 0.2 mrem (2 µSv), excluding any potential strontium -90 contribution. The combined maximum individual dose equivalent is 0.4 mrem (4 µSv). This dose represents 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.

The collective dose attributable to Laboratory operations, for the population up to a distance of 80 km, was calculated to be 3.4 person-rem (0.034 person-Sv). This can be compared to a collective dose equivalent to the same population of approximately 291,000 person-rem (2,910 person-Sv) due to background external radiation and 196,800 person-rem (1,968 person-Sv) from internal radioactivity in the body from natural sources.

Quality Assurance Program

Brookhaven National Laboratory has implemented DOE Order CH 5700.6C by developing policies, responsibilities, and providing generic guidance procedures for the development of Quality Assurance (QA) programs that are appropriate to ensure the achievement of Laboratory objectives. The elements of this program have been adopted and adapted, as necessary, by the S&EP Division in the development of the Division's QA program. Established protocols that document the specific activities of the Environmental Monitoring (EM) program are described in the S&EP Environmental Management Section (EMS) Standard Operating Procedure (SOP) manuals. The Division Quality Management Team has QA officers that have environmental expertise who review all activities within the EMS that are involved with the generation, collection, analysis, evaluation, and reporting of environmental data or waste management activities to ensure they comply with the S&EP Division, BNL, and DOE QA objectives.

The level of quality control and quality assurance activities depend on the nature of measurements and the intended use of the data. Checks on sample collection techniques, analysis methods, and instrument performance are incorporated into SOPs and include the use of blanks, replicates, and spikes. In addition, the respective QA officer is responsible for establishing a program of internal assessments and external audits to verify the effectiveness of sampling, analysis, and data base activities and their adherence to the QA program. The analytical laboratories participate in inter-laboratory QA programs organized by DOE, EPA, and NYSDEC. Contract laboratories used to 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.

The results of the ASL QA performance is given in Section 7.0. Overall, the S&EP Division and contractor laboratories used to analyze data presented in this report produced acceptable results in 89% of the independent inter-laboratory comparisons they participated in during 1995. The internal quality control programs 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.

1.0 <u>INTRODUCTION</u> - J. R. Naidu

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.

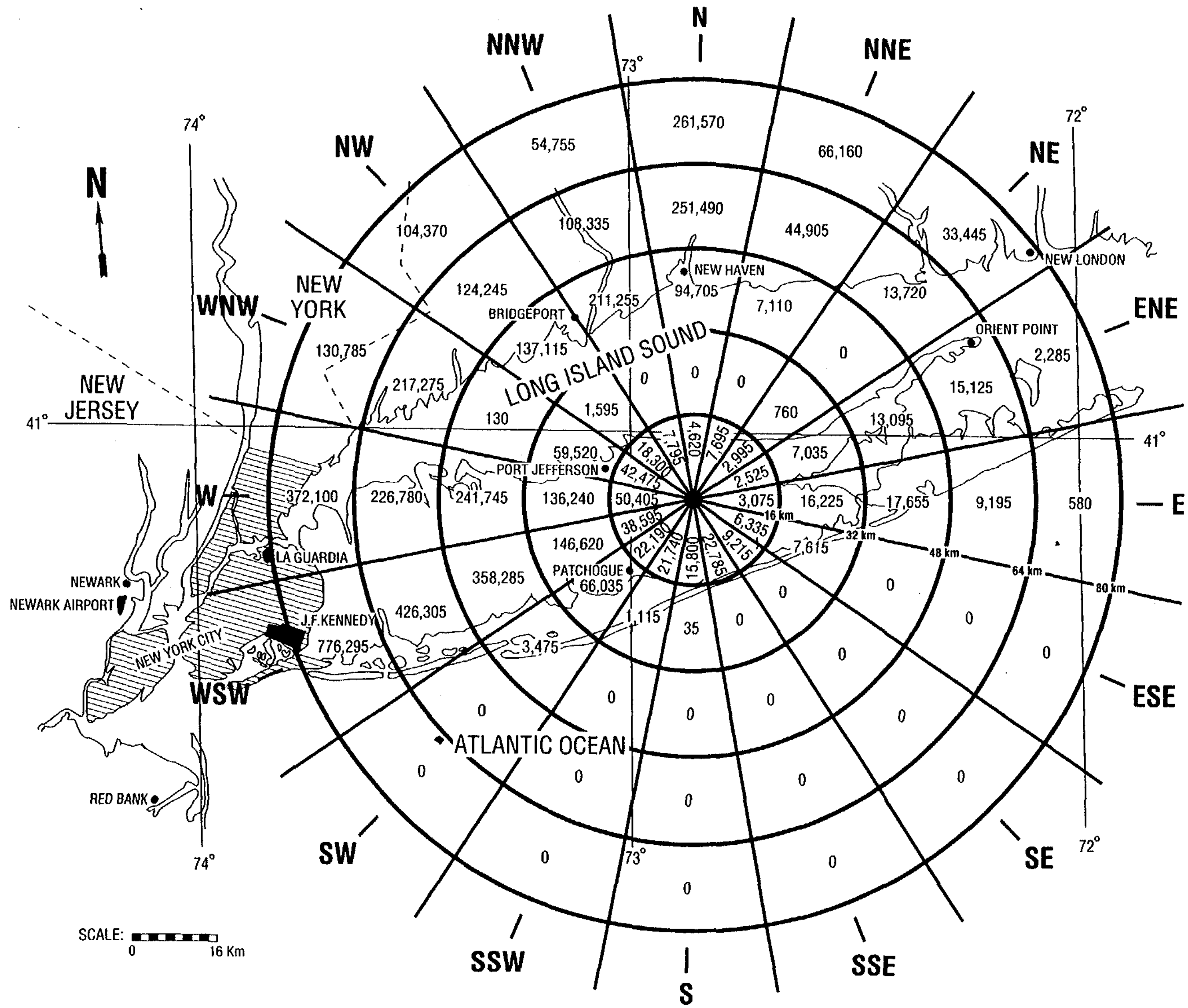
The Laboratory carries out basic and applied research in the following fields: high-energy nuclear and solid state physics; fundamental material and structural properties and the interactions of matter; nuclear medicine, biomedical and environmental sciences; and selected energy technologies. In conducting 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. Figures 1-1 and 1-2, respectively, show its location in relation to the metropolitan area and local communities. About 1.33 million persons reside in Suffolk County (LILCO, 1995) , 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 1-3 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 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



RESIDENT POPULATION 1995 WITHIN A 80 km RADIUS OF BNL

Figure 1-1

BROOKHAVEN NATIONAL LABORATORY
LOCAL (WITHIN 0.5 Km) AND ON-SITE POPULATION DISTRIBUTION

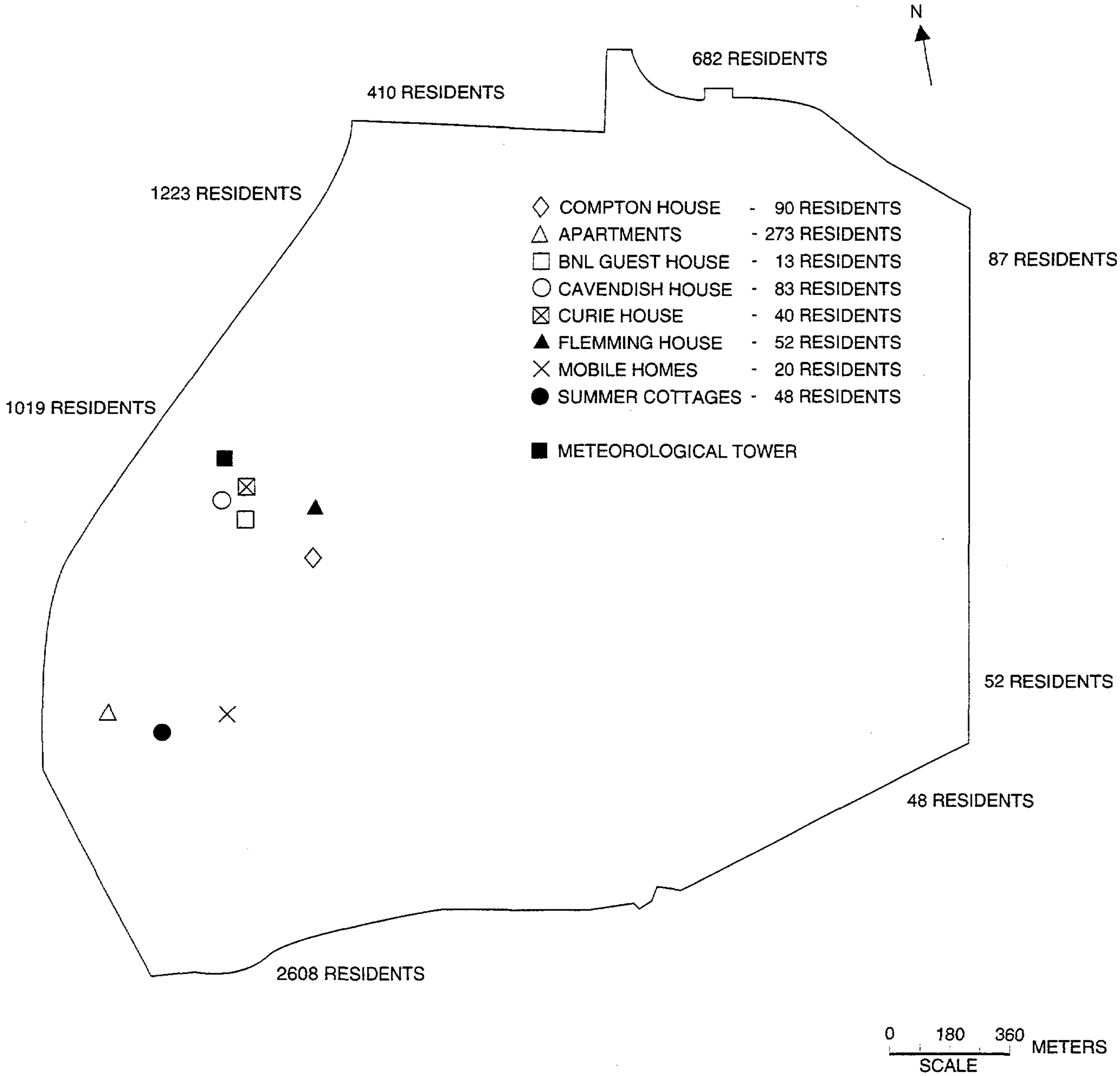
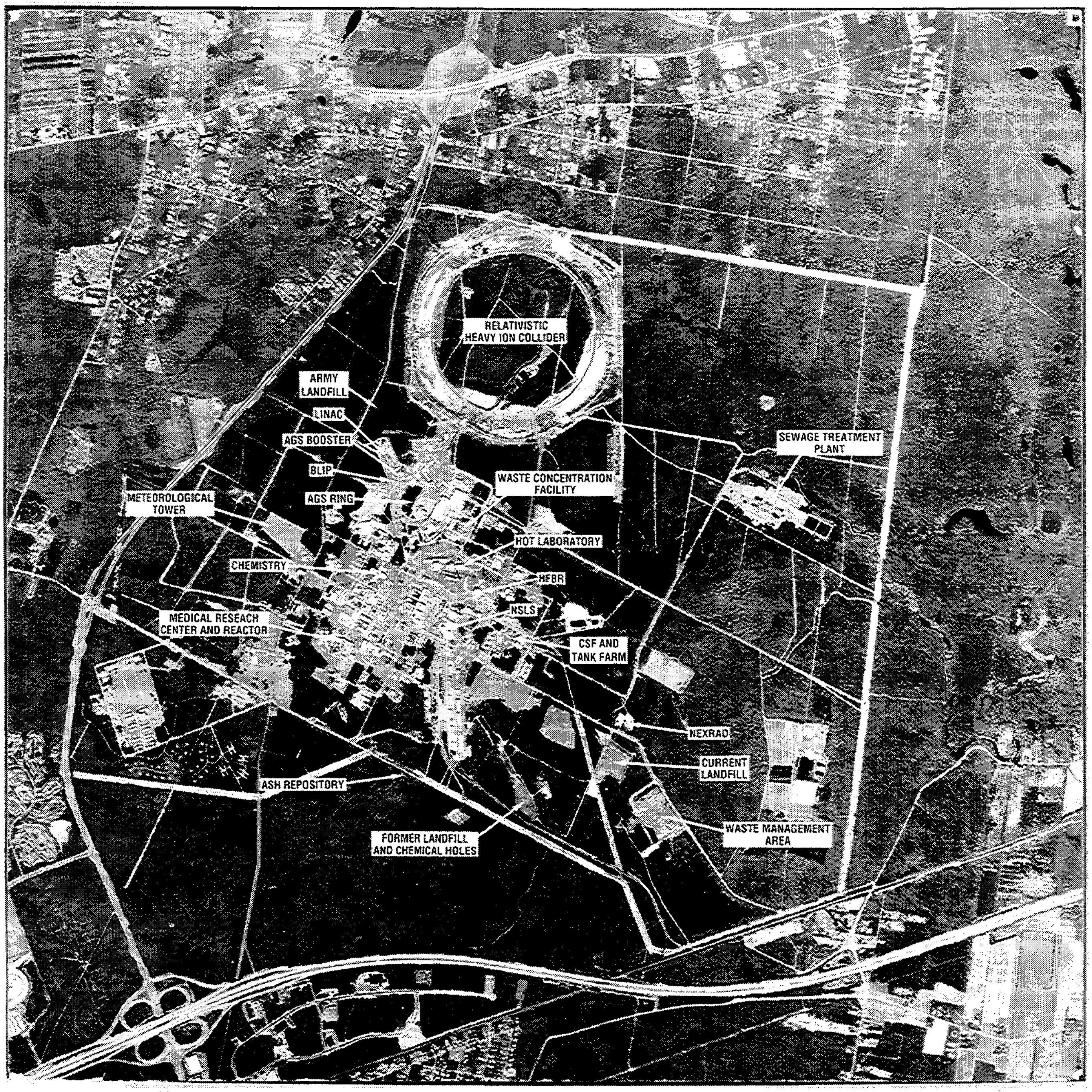


Figure 1-2

Major Facilities

Figure 1-3



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 1995, the Peconic River bed on-site was in a recharge mode, consequently, no flow left the site.

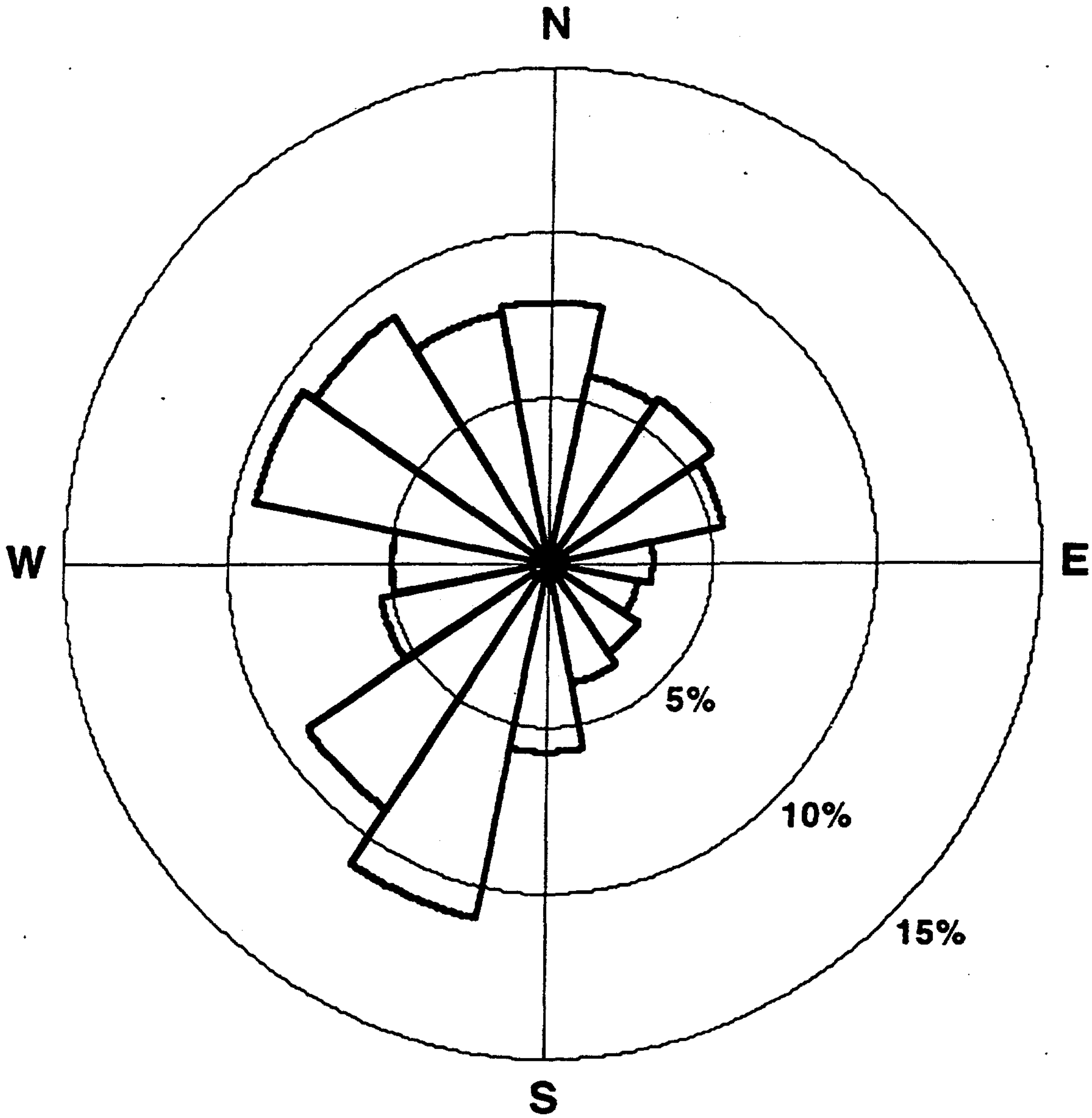
The Laboratory uses approximately 14 million liters of groundwater per day to meet potable water needs plus heating and cooling requirements. Approximately 70% of the total pumpage was returned to the aquifer through on-site recharge basins. About 15% is discharged into the Peconic River. Human consumption utilizes 4% of the total pumpage, while evaporation (cooling tower and wind losses) and cesspool plus line losses account for 9% and 2%, respectively.

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 1-4 shows the 1995 annual wind rose for BNL. The average temperature in 1995 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 1-5.

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 1995 was 100.08 cm, which is about 22 cm below the 40-year annual average. Figures 1-6 and 1-7, respectively, present the 1995 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 southeast. Figure 1-8 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

Figure 1-4: Annual Wind Rose for Calendar Year 1995



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 1995 was towards the north-northeast.

2. Each concentric circle represents a 5 percent frequency, so wind blew towards the NNE 12% of the time in 1995.

3. Wind directions were rmeasured at a height of 88 meters.

Climatology of the BNL Site

Monthly Temperatures, 1995

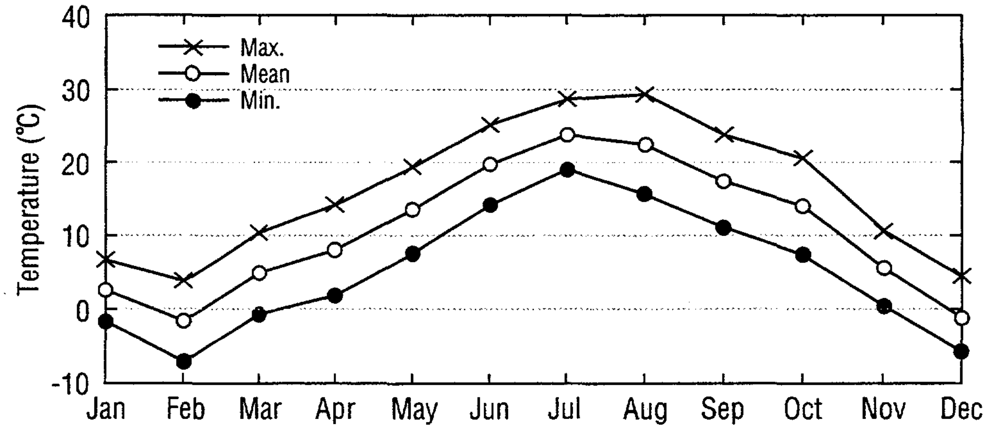


Figure 1 - 5

Climatology of the BNL Site

Monthly Precipitation, 1995

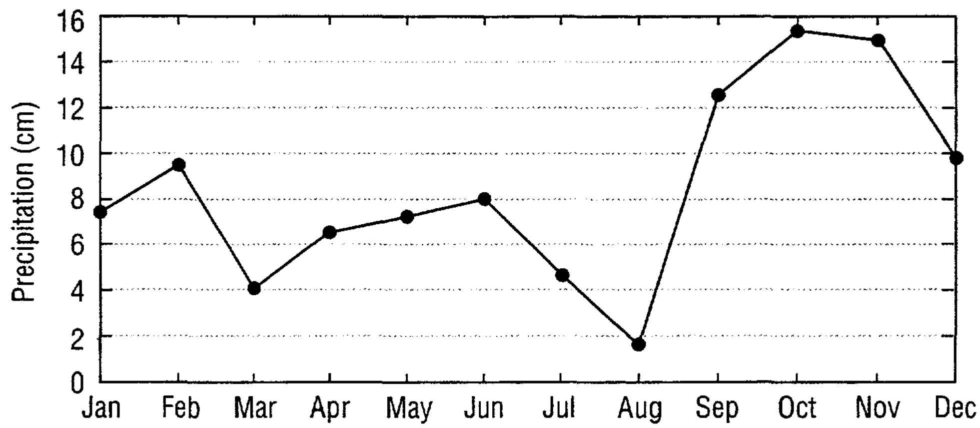


Figure 1 - 6

Climatology of the BNL Site

Precipitation Trend, 1985 - 1995

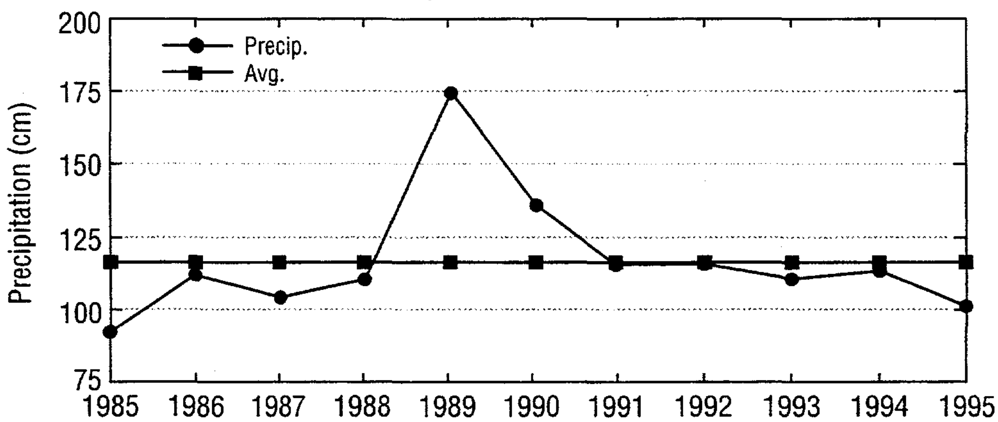


Figure 1 - 7

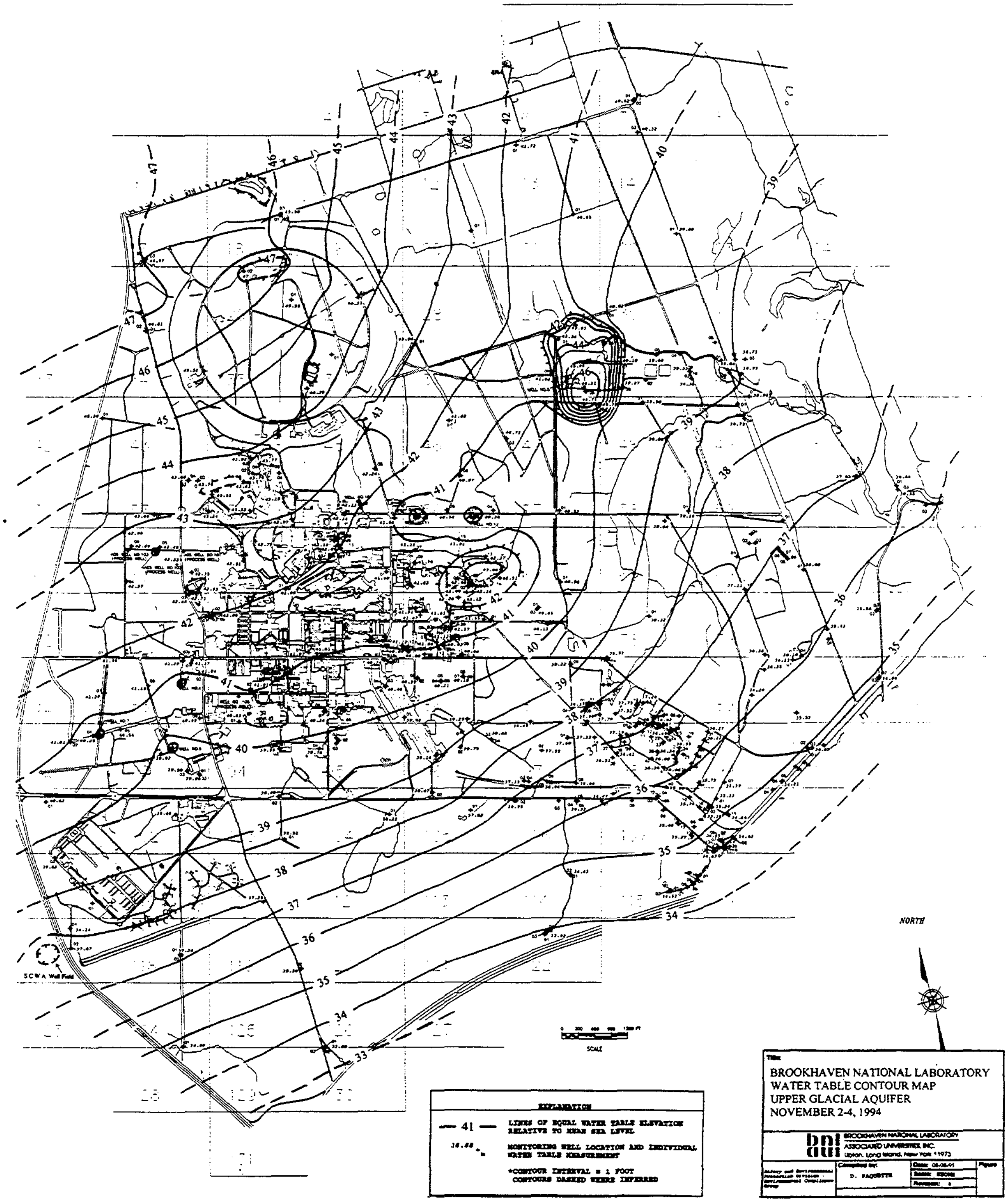


Figure 1-8
Typical Water Table Contour Map for the BNL Site

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 is being 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 New York State (NYS) endangered eastern tiger salamander (*Ambystoma tigrinum*) uses BNL's vernal ponds and some recharge basins. 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;

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 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 operated at a level of 30 MW (thermal).

2. The Medical Research Reactor, 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 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, Vertical Accelerator, and Cyclotron 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.

2.0 COMPLIANCE SUMMARY - B. A. Royce, R. J. Lee, D. E. Paquette, G. L. Schroeder, J. K. Williams, J.R. Naidu, and S. L. K . Briggs

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 1995.

2.1 Environmental Permits

A variety of processes and facilities at BNL operate under regulatory permits. These permits include one SPDES permit, a MPF license, two Resource Conservation Recovery Act (RCRA) permits (one for the existing HWMF; one for the new waste-management facility currently under construction), a certificate from the NYSDEC registering tanks storing bulk quantities of hazardous substances, eight National Emission Standards for Hazardous Air Pollutants (NESHAPS) authorizations, 61 Certificates to Operate (CO) air emission sources from NYSDEC, and 11 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, 1995.

2.2 Groundwater Compliance Monitoring

In two areas at BNL, groundwater monitoring is required by NYSDEC permits or licenses. The first is the Current Landfill which was operated until December 1990 under NYSDEC Permit No. 52-S-20. Although the Current Landfill has ceased operation in accordance with the Long Island Landfill Law, BNL has continued to monitor the groundwater under the requirements specified in the NYSDEC permit. This monitoring program has continued while BNL's Office of Environmental Restoration (OER) has conducted a remedial investigation to assess the full extent of soil and groundwater contamination associated with the landfill. The second is the MPF which currently operates under NYSDEC License No. 01-1700. The MPF is an active facility, and groundwater in the MPF area is monitored in accordance with the requirements listed in the NYSDEC License. The CY 1995 compliance monitoring results for the Current Landfill are discussed in Section 2.2.1, and those for the MPF are discussed in Section 2.3.4.

2.2.1 Current Landfill

The Current Landfill is approximately eight acres, and was operated from 1967 to 1990. As required under the Federal RCRA, as implemented by Article 27 of the NYS, Environmental Conservation Law (ECL), BNL submitted permit applications to operate the Current Landfill in 1978. An operating permit (No. 52-S-20) was issued by the NYSDEC on January 14, 1981. In compliance with the Long Island Landfill Law (1990), BNL closed the landfill on December 18, 1990 because it lacked the required landfill liner. During its operation, the

Table 2-1
BNL Site Environmental Report for Calendar Year 1995
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	11-29-96
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
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	11-29-96
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802	11-29-96
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803	11-29-96
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804	11-29-96
244	cyclone collector	NYSDEC-Air Quality	472200 3491 24401	01-28-99
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202	11-29-96
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203	11-29-96
423	stage II vapor recovery	NYSDEC-Air Quality	472200 D365 WG	09-27-95(1)
423	welding hood	NYSDEC-Air Quality	472200 3491 42305	02-01-98
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	12-31-96
457	sulfite dispensing	NYSDEC-Air Quality	472200 3491 45705	Canceled 7-95
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

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1995
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202	11-29-96
473	vapor degreaser	NYSDEC-Air Quality	472200 3491 47301	03-22-96
479	cyclone G-10	NYSDEC-Air Quality	472200 3491 47905	04-01-00
490	Inhalation Toxicology Facility	NYSDEC-NESHAPs	472200 3491 49001	06-18-00
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49002	12-7-90(2)
490	lead alloy melting	NYSDEC-Air Quality	472200 3491 49003	11-11-96
490	milling machine/block cutter	NYSDEC-Air Quality	472200 3491 49004	11-11-96
493	incinerator	NYSDEC-Air Quality	472200 3491 493AO	Cancellation(3)
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	11-29-91*
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	05-03-98
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	02-22-93*
610	combustion unit	NYSDEC-Air Quality	472200 3491 61004	Cancellation(4)
610	combustion unit - ALF	NYSDEC-Air Quality	472200 3491 61005	11-29-91*
610	combustion unit	NYSDEC-Air Quality	472200 3491 61006	03-21-93*
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)

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1995
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001	11-29-96
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002	11-29-96
703	machining exhaust	NYSDEC-Air Quality	472200 3491 70301	02-01-98
705	building ventilation	U.S. EPA - NESHAPS	BNL-288-01	None
725	blueprint machine	NYSDEC-Air Quality	472200 3491 72501	Canceled 7-95
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	05-03-98
902	sanding, cutting, drilling	NYSDEC-Air Quality	472200 3491 90203	05-03-98
902	brazing/solder exhaust	NYSDEC-Air Quality	472200 3491 90204	05-03-98
902	painting/soldering exhaust	NYSDEC-Air Quality	472200 3491 90205	05-03-98
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
905	belt sander	NYSDEC-Air Quality	472200 3491 90502	06-18-95(4)
905	machining exhaust	NYSDEC-Air Quality	472200 3491 90503	05-03-98
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	02-01-98
922	cyclone exhaust	NYSDEC-Air Quality	472200 3491 92201	04-01-00
923	electronic equip. cleaning	NYSDEC-Air Quality	submitted 3-93,	status pending

Table 2-1 (Continued)
BNL Site Environmental Report for Calendar Year 1995
BNL Environmental Permits

Bldg./Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
924	spray booth exhaust	NYSDEC-Air Quality	472200 3491 92401	09-30-98
924	magnet coil production press	NYSDEC-Air Quality	472200 3491 92402	02-01-98
924	machining exhaust	NYSDEC-Air Quality	472200 3491 92403	05-03-98
930	electroplating/acid etching	NYSDEC-Air Quality	472200 3491 93001	02-01-98
930	bead blaster	NYSDEC-Air Quality	472200 3491 93002	02-01-98
930	ultrasonic cleaner	NYSDEC-Air Quality	472200 3491 93003	02-01-98
	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	03-31-96
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 contruction).
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) Extension requested to 6-96, status pending.
(6) Cancellation requested 3-93, status pending.

landfill received six to eight tons of material per workday. Putrescible and non-putrescible wastes, including building debris and asbestos, were disposed of in the landfill until February 1981. After this date, all putrescible waste was taken to the Brookhaven Town Landfill. Although all authorized chemical waste disposal at the BNL site ended in 1966, the presence of VOCs in groundwater downgradient of the landfill indicates that disposal of low levels of chemical wastes did occur. Until the late 1970s, iron sludge residues from the BNL WTP and approximately 2,500 cubic feet of sewage sludge containing low level radioactivity, were disposed of in the landfill. From 1967 to 1978, the landfill also received low level radioactive laboratory waste, partially decontaminated equipment, contaminated clothing, and tritiated mouse litter. In past years, VOCs, metals (principally iron), and occasionally radionuclides, were detected in the Current Landfill monitoring wells at concentrations exceeding NYS AWQS.

During 1995, BNL collected groundwater samples from the one upgradient and six downgradient monitoring wells listed in the NYSDEC permit (including its subsequent modifications). However, five of the seven wells could not be monitored quarterly due to construction activities related to capping the landfill. Furthermore, the landfill cap required abandoning three downgradient wells (Wells 87-05, 87-10, and 88-02) after the first quarter sampling. Additionally, access to two wells (Wells 87-06 and 87-07) was limited to the first quarter sampling round due to construction activities. Monitoring required under the NYSDEC permit included the assessing of groundwater quality (pH, conductivity, and anions), inorganic contaminants (metals), radionuclides (gross alpha, gross beta, and tritium), and groundwater flow directions. Analysis and reporting requirements for VOCs were not specified in the NYSDEC permit; however, since 1984 BNL has collected samples for VOC analyses. All groundwater samples were collected and analyzed by the BNL S&EP Division's Sampling & Analysis Group (SAG).

Of the reportable parameters for samples collected during 1995, only iron exceeded the NYS AWQS limits of 0.3 mg/L in all six downgradient wells, with average concentrations ranging from 1.32 mg/L to 75.45 mg/L. Tritium, strontium -90, and cesium-137 were each detected in one or more of the five downgradient monitoring wells, but at fractions of their respective NYS AWQS or DCGs. Water quality analyses indicated that the pH of all groundwater samples were typically below the applicable NYS AWQS of 6.5 to 8.5 SU, with median values ranging from 5.6 for the upgradient well to 5.9 for the downgradient wells, which is typical of Long Island groundwater. The downgradeint wells also had elevated conductivity values. Average groundwater conductivity for the upgradient well was 118 µmhos/cm, whereas the conductivities in wells directly downgradient of the landfill ranged from 116 µmhos/cm to 836 µmhos/cm. Chapter 5 gives complete analytical results, including VOC analyses, from all monitoring wells at and downgradient of the Current Landfill.

The extent of groundwater contamination downgradient of the Current Landfill is presently being assessed by the OER, in fulfillment of the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) investigation requirements for Operable Unit I (see Section 2.10). The CERCLA investigations at the Current Landfill include a RI/FS, a groundwater Removal Action, and a non-time critical Removal Action for the proper closure of the landfill. Closure included constructing an impermeable cap designed in accordance with 6 New York Code of Rules and Regulations (NYCRR) Part 360 (December 1988) Solid Waste Management Facilities regulations. Construction of the landfill cap and the installation of new groundwater and methane monitoring wells began in May 1995 and was completed in November 1995.

On January 31, 1995 the NYSDEC gave BNL permission to discontinue the submittal of quarterly "BNL Landfill Monitoring Well Reports." Instead, approval was given to report the data from the landfill monitoring wells for 1995 in the annual Site Environmental Report (SER). Starting in second quarter of 1996, groundwater monitoring at the Current Landfill will be conducted as part of the post-closure monitoring program prescribed in the Inter Agency Agreement (IAG) approved Operations and Maintenance (O&M) Plan. As required under the Current Landfill O&M Plan, BNL will submit an annual Environmental Monitoring Report to the NYSDEC.

2.3 Clean Water Act

2.3.1 SPDES Permit

Sanitary and process-waste waters discharged from BNL's operations are regulated by a SPDES permit which is 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 1995 are described in the subsequent sections of this chapter.

During 1995, the Laboratory successfully negotiated with the NYSDEC to renew BNL's SPDES permit. The permit was transmitted by the NYSDEC to BNL on February 10, 1995 with an effective date of March 1, 1995. The former SPDES permit only required monitoring one discharge, whereas the new permit identifies ten outfalls, nine of which require monthly and/or quarterly monitoring. Outfall 009 which consists of numerous, miscellaneous discharges, including steam trap and air compressor blowdown, does not require monitoring. The new permit includes increases in the sampling frequency and number of analytical parameters for the STP discharge, biomonitoring of the STP effluent, monthly sampling and analysis for discharges to the recharge basins, and the preparation of several engineering evaluations.

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 revised SPDES permit requires BNL to monitor these discharges monthly for flow, pH, and oil and grease, and quarterly for numerous additional analytical parameters listed in Table 2-2. 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 SU, the Laboratory successfully negotiated an open-ended lower limitation for pH since the pH of natural groundwater and storm water are typically less than 6.5 SU. During 1995, there were two excursions of the upper pH limitation reported; one each for Outfalls 003 and 006A. In addition to cooling tower blowdown and storm water runoff, each of these Outfalls receives a high volume of non-contact cooling water which was determined to be the leading cause of these excursions. In June 1995, the Laboratory completed a study of its potable water system and undertook corrective actions to reduce the

Table 2-2
BNL Site Environmenntal Report for Calendar Year 1995
Summary of Analytical Results for Waste Water Discharges to Outfalls 002-010 (3)

Analyte		Outfall 002	Outfall 003	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	8	5		
MGD	Min.	0.044	0.24	0.036	0.045	0.046	0.035	0.00008	0.000075		
	Max.	0.0823	4.1	0.37	0.39	0.42	0.36	0.982	0.363		
pH	Min.	6.86	5.8	6.7	6.5	6.9	7.1	6.6	6.3		
SU	Max.	8.1	8.8	8.2	8.8	8.5	8.1	8	7.9	8.5	2
Oil and	N	10	10	9	10	10	NR	9	6		
Grease	Min.	< 1	<1	<1	<1	<1	NR	<1	<1		
mg/L	Max.	4	9	10	3	5	NR	14	10	15	0
	Avg.	1	2.4	2.8	1.2	2.3	NR	3.7	3.2		
Copper	N	NR	NR	3	NR	NR	NR	NR	NR		
mg/L	Min.	NR	NR	< 0.009	NR	NR	NR	NR	NR		
	Max.	NR	NR	0.044	NR	NR	NR	NR	NR	1	0
	Avg.	NR	NR	0.018	NR	NR	NR	NR	NR		
Zinc	N	NR	3	NR	NR	NR	NR	NR	NR		
mg/L	Min.	NR	< 0.01	NR	NR	NR	NR	NR	NR		
	Max	NR	0.028	NR	NR	NR	NR	NR	NR	5	0
	Avg.	NR	0.018	NR	NR	NR	NR	NR	NR		
Iron (total)	N	NR	NR	NR	NR	NR	2	NR	NR		
mg/L	Min.	NR	NR	NR	NR	NR	18	NR	NR	NA	0
	Max.	NR	NR	NR	NR	NR	92	NR	NR		
	Avg.	NR	NR	NR	NR	NR	55	NR	NR		
Iron (dissolved)	N	NR	NR	NR	NR	NR	2	NR	NR		
mg/L	Min.	NR	NR	NR	NR	NR	0.03	NR	NR		
	Max.	NR	NR	NR	NR	NR	0.08	NR	NR	NA	0
	Avg.	NR	NR	NR	NR	NR	0.06	NR	NR		

Notes

NR: Analyte is Not Required by SPDES permit condition.
ND: Analyte was Not Detected in the samples.
1. There was no discharge reported to Outfall 004 for Calendar Year 1995.
2. Since Outfalls 008 and 010 receive only storm water discharge, flow may not have been recorded during one or more months.
3. See Figure 4 -1.

Table 2-2 (Continued)
BNL Site Environmenntal Report for Calendar Year 1995
Summary of Analytical Results for Waste Water Discharges to Outfalls 002-010 (3)

Analyte		Outfall 002	Outfall 003	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	Exceedances
Chloroform	N	3	NR	NR	NR	NR	NR	NR	NR		
ug/L	Min.	ND	NR	NR	NR	NR	NR	NR	NR		
	Max.	ND	NR	NR	NR	NR	NR	NR	NR	7	0
	Avg.	ND	NR	NR	NR	NR	NR	NR	NR		
Bromo-	N	3	NR	NR	NR	NR	NR	NR	NR		
dichloromethane	Min.	ND	NR	NR	NR	NR	NR	NR	NR		
ug/L	Max.	ND	NR	NR	NR	NR	NR	NR	NR	5	0
	Avg	ND	NR	NR	NR	NR	NR	NR	NR		
1,1,1-trichloroethane	N	3	3	NR	NR	NR	NR	9	NR		
ug/L	Min.	ND	ND	NR	NR	NR	NR	ND	NR		
	Max.	ND	ND	NR	NR	NR	NR	ND	NR	5	0
	Avg.	ND	ND	NR	NR	NR	NR	ND	NR		
1,1-dicloroethylene	N	NR	NR	NR	NR	NR	NR	9	NR		
ug/L	Min.	NR	NR	NR	NR	NR	NR	ND	NR		
	Max.	NR	NR	NR	NR	NR	NR	ND	NR	5	0
	Avg.	NR	NR	NR	NR	NR	NR	ND	NR		
Dibromo-nitrilo-	N	NR	3	NR	NR	NR	NR	NR	NR		
propionimide	Min.	NR	ND	NR	NR	NR	NR	NR	NR		
mg/L	Max.	NR	ND	NR	NR	NR	NR	NR	NR	0.1	0
	Avg.	NR	ND	NR	NR	NR	NR	NR	NR		
Hydroxyethylidene-	N	3	3	3	3	3	NR	NR	NR		
diphosphonic Acid	Min.	ND	ND	ND	ND	ND	NR	NR	NR		
mg/L	Max.	0.36	0.28	0.1	0.06	0.03	NR	NR	NR	0.5	0
	Avg.	0.12	0.16	0.033	0.02	0.01	NR	NR	NR		
Tolyltriazole	N	3	3	3	3	3	NR	NR	NR		
mg/L	Min.	ND	ND	ND	ND	ND	NR	NR	NR		
	Max.	0.1	0.17	ND	ND	ND	NR	NR	NR	0.2	0
	Avg.	0.05	0.06	ND	ND	ND	NR	NR	NR		

Notes

NR: Analyte is Not Required by SPDES permit condition.
ND: Analyte was Not Detected in the samples.
1. There was no discharge reported to Outfall 004 for Calendar Year 1995.
2. Since Outfalls 008 and 010 receive only storm water discharge, flow may not have been recorded during one or more months.
3. See Figure 4 -1.

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. Fluctuations in the pH of the potable water system have been found to range as high as 9.0 SU due to variations in the performance of the caustic metering system and the objective of achieving a pH of 8.0 SU throughout the distribution system. 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. Table 2-2 provides summarizes the analytical data reported for the recharge basins for CY 1995.

Outfall 004, which receives once-through cooling water from the MRR, was out of service during CY 1995 due to TCA contamination of the process wells which previously supplied this cooling water. During 1995, all cooling water used by the MRR was supplied by the Chilled Water Plant; efforts to return this system back to a once-through well water cooled system continued. While an activated carbon adsorption system for the process well serving the MRR was constructed in 1993, the well-control system was not completed until late 1995 due to damage incurred to the variable-frequency drive system upon start-up. Tests will be conducted in 1996 and it is expected that cooling of the MRR will revert to the well water cooling system sometime in early 1996.

Outfall 007 receives water generated by the backwashing of the WTP filtration system. The start of major improvements to the WTP shut-down this facility beginning May 1, 1995; the improvements are expected to be completed during 1996. The SCDHS will be notified before the start-up of this facility.

2.3.1.2 STP Effluent, SPDES Outfall 001

In accordance with the new BNL SPDES permit, twenty-three (23) 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. Gross alpha, gross beta, and tritium are analyzed by the S&EP Division ASL. Strontium -90 was analyzed by a contractor laboratory during 1995. The remaining parameters (i.e., flow, settleable solids, residual chlorine, pH) are recorded/analyzed by the STP operators. Table 2-3 summarizes the 1995 DMR analytical data for Outfall 001. This data shows the SPDES permit discharge limits were exceeded eleven times at the STP effluent discharge point during 1995; six for BOD_5 removal, two for silver, and one each for residual chlorine, fecal coliform (max.), and TSS removal.

The issuance of the new BNL SPDES permit required major changes to the monitoring requirements for the STP discharge. The monitoring frequency and number of analytical parameters was increased in most cases, and decreased limitations were assigned to all inorganic elements. While monitoring and reporting of radiological data was deleted from the conditions of the new permit, BNL continued to monitor radiological parameters in accordance with DOE Order 5400.5. Chapter 4 contains a summary of radiological data for the STP discharge. The new permit requires that BNL document an 85% removal efficiency for the influent biologically oxidizable matter (BOD_5) and suspended solids (TSS). In addition, the average BOD_5 and TSS concentrations of the STP effluent may not exceed 10 mg/L. While compliance with the concentration

Table 2-3
BNL Site Environmental Report for Calendar Year 1995
Summary of Analytical Results for Waste Water Discharges to Outfall 001 (2)

Analyte	Min.	Max.	Avg.	Monitoring Frequency	SPDES Limit	No. of Exceedances
Temperature Degrees Farenheit	54	80.6	60.8	Daily	90	0
pH SU	5.9	7.2	NA	Cont. Recorder	Min.: 5.8 Max.: 9.0	0 0
5 day BOD mg/L	< 3	7	<3	Monthly	Max.: 20 Avg.: 10	0 0
% BOD Removal	50	91	75	Monthly	85	6
Total Suspended Solids (TSS) mg/L	<4	4	<4	Monthly	Max.: 20 Avg.:10	0 0
% TSS Removal	50	95	87	Monthly	85	1
Settleable Solids mg/L	0	0	0	Daily	0.1	0
Ammonia Nitrogen mg/L	< 0.05	1.5	0.38	Monthly	2	0
Residual Chlorine mg/L	0	0.16	0.04	Daily	< 0.1	1
Fecal Coliform MPN/100 ml	< 1	560	51	Monthly	Max.: 400 Avg. 200	1 0
Total Nitrogen mg/L	5.2	17.6	10.9	Monthly	NA	NA
Cyanide ug/L	<10	10	< 10	Twice Monthly	100	0
Copper mg/L	0.045	0.139	0.079	Monthly	0.15	0
Iron mg/L	0.095	0.28	0.19	Monthly	0.37	0
Lead mg/L	< 0.002	0.01	0.002	Monthly	0.015	0

Notes:

ND: Analyte was Not Detected in the samples.
NA: Not Applicable
1. Monitoring and reporting of data for these analytes is no longer required under the SPDES permit. Please see Section 4 for discussion of radiological releases to the environment.
2. See Figure 4 - 2.

Table 2-3 (continued)
BNL Site Environmental Report for Calendar Year 1995
Summary of Analytical Results for Waste Water Discharges to Outfall 001 (2)

Analyte	Min.	Max.	Avg.	Monitoring Frequency	SPDES Limit	No. of Exceedances
Nickel mg/L	< 0.004	0.0048	< 0.004	Monthly	0.11	0
Silver mg/L	< 0.006	0.017	0.006	Monthly	0.015	2
Zinc mg/L	0.02	0.077	0.045	Monthly	0.1	0
Toluene ug/L	<5	<10	<10	Twice Monthly	50	0
Methylene Chloride ug/L	1	44	8.2	Twice Monthly	50	0
1,1,1-Trichloroethane ug/L	<1	<10	<10	Twice Monthly	50	0
2-Butanone ug/L	<5	<10	<10	Twice Monthly	50	0
Flow MGD	NA	1.172	0.773	Cont. Recorder	Max. 2.3	0
Residual Chlorine mg/L	0.04	0.08	0.065	Daily	0.1	0
Fecal Coliform MPN/100 ml	<1	560	36	Monthly	Avg. 200 Max. 400	0 1
Total Coliform MPN/100 ml	96	232	164	Monthly	See Note 1	0
Radium-226 pCi/L	2.53	2.93	2.73	Daily	See Note 1	0
Gross Beta pCi/L	12.9	13.7	13.2	Daily	See Note 1	0
Tritium pCi/ml	ND	8.8	0.95	Daily	See Note 1	0
Strontium 90 pCi/L	0.5	0.5	0.5	Monthly	See Note 1	0

Notes

ND: Analyte was Not Detected in the samples.
NA: Not Applicable
1. Monitoring and reporting of data for these analytes is no longer required under the SPDES permit. Please see Section 4 for discussion of radiological releases to the environment.
2. See Figure 4 - 2.

limitations was achieved consistently, compliance with the removal requirements was not. This failure was attributed to the low concentration of BOD_5 and TSS in the influent to BNL's STP. While typical municipal sanitary sewage has TSS and BOD_5 concentrations of 300 mg/L each, the influent to the BNL STP has concentrations of approximately 20 mg/L. This dilute influent makes it extremely difficult to achieve the 85% removal. The Laboratory conducted an in-depth evaluation of the sanitary waste stream and identified non-contact cooling water discharges as the leading cause of the low BOD_5 and TSS. During 1996 some of the non-contact cooling water will be rerouted to the site storm water system and/or systems utilizing once-through cooling water will be replaced by either chilled recirculated water or other alternate cooling systems. By removing some of the cooling water from the STP influent, increased concentrations of BOD_5 and TSS should be realized, thereby making compliance with the removal efficiencies attainable.

Two excursions of the new silver limitation of 15 μg/L occurred during 1995; one in March (17 μg/L), and the second in November (15.2 μg/L). Due to stricter limitations imposed under the new SPDES permit, periodic exceedance of some of the metals limitations were expected. The earlier limitation for silver was 50 μg/L. While neither of these exceedances was considered significant as defined by NYSDEC guidance policies (i.e., greater than 120% of the limit), the Laboratory has sought to reduce the quantity of silver-bearing waste waters discharged to the STP. A project to replace the existing photo-developing operations in two facilities with digital photographic equipment was funded through the DOE Return On Investment (ROI) program. Procurement and installation of this equipment is expected to be complete by the end of 1996. The Laboratory has also requested that departments implement stricter controls on the discharge of silver-bearing waste waters.

The exceedance for fecal coliform is, again, due to stricter limitations imposed under the new SPDES permit; currently the effluent from the STP can contain no more than 400 MPN/100 ml, maximum, or 200 MPN/100 ml, average, fecal coliform organisms during any one-month period. The maximum concentration during March 1995 was 560 MPN/100 ml which exceeds the allowable maximum concentration. To reduce the concentration of fecal coliform in this discharge, the Laboratory changed the location where hypochlorite is added to the STP waste stream, moving the hypochlorite dosing location to a post clarification site. Subsequently, the fecal coliform concentration was significantly decreased. Since March 1995, the maximum concentration of fecal coliform present in any one sample has been 1 MPN/100 ml. There was a single excursion for residual chlorine in January 1996, due to a malfunctioning check valve in the hypochlorite-metering train. Immediate replacement of the check valve resolved the problem.

Plans to upgrade the STP during 1995 were halted due to extreme public concerns about this project. To accomplish these upgrades, dewatering of local groundwater was required to complete the excavation and installation of the modular aeration treatment system. While the Laboratory had obtained all necessary permits for constructing these improvements and for removing and discharging groundwater, BNL management , being sensitive to public concerns, halted the project. In response to these concerns, the STP upgrades will be redesigned to negate the necessity to dewater. Reallocation of funds is being requested to complete the project and include tertiary treatment for removing nitrogen and including UV disinfection. Once plans and specifications for these modifications are complete, copies will be submitted to the NYSDEC and SCDHS for review and comment.

In addition to monitoring these 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 biomonitoring program specified in the new 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. In the three quarterly toxicity tests conducted in 1995 chronic exposures did not affect survival for both the fathead minnow and waterflea. There was also no chronic effect for the waterflea reproduction. In one of the three tests conducted, a No Observable Adverse Effective Concentration (NOEC) of 50% was noted for the growth of the fathead minnow. Fish raised in the sample comprised of 100% STP effluent had an average dry weight of 0.488 mg per organism as compared to an average dry weight of 0.663 mg for the control group. All biomonitoring test data and water quality analyses were forwarded to the NYSDEC as part of routine DMR submittals. The fourth and final round of chronic toxicity testing will be conducted during the first quarter of 1996.

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 1995

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 1995, 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 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 was forwarded to the EPA designated facility on August 1, 1995. Comments regarding the results of this program were not received from the EPA until March 5, 1996. Six parameters failed to meet the acceptability criteria established by the EPA. Of particular interest, is the unacceptable results for Total Kjeldahl Nitrogen (TKN) and Total Suspended Solids (TSS). The laboratory responsible for TKN and TSS analyses has shown consistent poor performance in the past NPDES performance evaluation studies. Each of the laboratories responsible for these analyses has been requested to respond to these findings.

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, 1995, and expires on March 31, 1996. A renewal application was filed on December 27, 1995.

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 a NYSDOH certified laboratory.

Five groundwater wells, one upgradient and four downgradient, 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 5-8 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 1995 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 1995.

In addition to the MPF compliance samples, these wells were also monitored twice during CY 1995 as part of the BNL routine EM program. The analytical results are discussed in Chapter 5 of this report.

The MPF license also required that by December 31, 1995, BNL submit an in-depth integrity inspection report prepared by a NYS licensed professional engineer attesting to the integrity of the secondary containment liners. In October 1995 BNL contracted with the engineering firm of Dvirka and Bartilucci for preparing this report. Certification for seven of the eight berms was submitted to the NYSDEC on December 29, 1995. Tests of the berm serving tank 611C were inconclusive since the section of bentonite mat removed for testing was fragile and most of the bentonite was incorporated into the subsurface soils. This berm will be tested again in 1996.

On July 31, 1995 the NYSDEC performed an annual inspection of the MPF. This inspection consisted of examining all storage tanks and associated berms, testing high-level alarms and reviewing operator's logs and the SPCC plan. Deficiencies noted included rust along pipelines and tank sidewalls, the proliferation of vegetation within the secondary containment berms, and the need to upgrade the fuel off-loading area. With regard to painting the tanks and piping and constructing a fuel off-loading area, 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 includes installing epoxy coatings on the internal tank bottoms for four tanks, installing double bottoms on two tanks, upgrading above and underground piping systems and constructing a fuel off-loading facility. Copies of plans and specifications were sent to both the SCDHS and the NYSDEC for their review and comments. The NYSDEC had only minor comments regarding materials of construction for valving components. No comments were received from the SCDHS. While the 1995 MPF permit requires completion of the fuel off-loading facility by June 1996, the Laboratory has negotiated a December 31, 1996 completion date for these upgrades.

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, and 1993. 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 facility response plan 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.

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 1995, members of the S&EP Division responded to a total of 30 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. Nine 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. 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 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 1995, 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 Federal Clean Air Act(CAA). The sources reviewed and their current permit status are summarized below.

Table 2-4
BNL Site Environmental Report for Calendar Year 1995
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
½/95	No. 2 Fuel Oil	60 gal.	Yes	Ice in gasket caused leak from tank T-8 at Bldg 610. Product was collected and stained soils removed. Gasket was replaced.
1/4/95	Diesel Fuel	5 gal.	No	Hoses connected to a 550 gallon tank supporting contractor work at Bldg 811 were left in place after an emergency generator was disconnected. The contractor was expected to remove the tank but had not done so. Hoses fell from tank, discharging five gallons of fuel on to the parking lot. Diesel fuel was recovered using speedi-dry.
2/20/95	Gasoline	16.2 gals	Yes	Gasoline spill occurred during vehicle refueling sometime between 2/20 & 2/21. Speedi-dry was applied to visibly stained areas of soil. Both saturated sorbent material and contaminated soil down gradient from pumps was placed into 55-gal drums for off-site disposal. The pump nozzle overfill function was checked to see it was operating properly.
2/22/95	Sulfuric Acid	0.5 gals	No	A battery was dropped during off-loading of batteries at the roll-up door on east side of Bldg 490. The battery released 0.5 gallons of sulfuric acid to pavement. Spill area was diked. A neutralizing agent was applied to spill and swept up for off-site disposal.
2/28/95	Hydraulic Fluid	<1 qt.	No	A hydraulic line on a salt spreader developed a leak. Sorbent pads were used to recover spilled product and pigs were used to prevent migration due to storm water runoff.
3/1/95	Chloroform	1 qt.	No	Product container dropped onto floor during transfer from lab hood to secondary containment storage area. Room ventilation system was activated and personnel evacuated.
3/12/95	Diesel Fuel	3 gal	No	Spillage was inside a trailer at construction site of new MRI Bldg.; a small quantity (<1gal) leaked out. Speedi-dry was applied to spillage and put into a pail for proper disposal.
4/6/95	Hydraulic Oil	< 1 gal	No	Spillage resulted from the failure of pump seals on a contractor's drill rig. All contaminated soil was removed by the contractor and placed in 55-gallon drums for disposal.
4/26/95	Gasoline	2 gals	Yes	Spillage attributed to siphoning of product from saddle tank on contractor's drill rig. Contaminated soil was removed by contractor and placed in 55-gallon drums for disposal

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
4/26/95	Diesel Fuel	< 1 gal	No	Spillage resulted from the expansion of diesel fuel stored in a portable generator. Contaminated soil and some oil soaked asphalt was placed in a 55-gallon drum for disposal.
4/26/95	Transformer Oil	10-15 gal	No	Spill to asphalt from failure of MPS transformer at AGS. Maintenance personnel contained and subsequently removed all spilled oil and placed oil in drum for disposal. Failed transformer was pumped and oil (60 gallons) stored in drums on location until the transformer was repaired.
6/5/95	Liquid Lime (Calcium Nitrate)	1.5 gal.	No	Spill was flushed with water to the grass and nearby storm drain. This material is routinely used during the application of hydro mulch seeding as a pH amendment and fertilizer.
6/5/95	Oil	1-2 gal.	No	Spill was discovered during response to spill of calcium nitrate. Residual liquid was absorbed with oil absorbent and oil-contaminated soil was removed for off-site disposal.
7/18/95	Hydraulic Oil	2 gals.	No	Hydraulic oil spilled from contractor's backhoe the hydraulic system failed. Contractor repaired backhoe and cleaned up all oil using sand as absorbent. Stained soil was swept up and removed by contractor for disposal at an approved off-site location.
7/19/95	Ion Exchange Waste water	400 gals.	Yes	A tanker trailer being used to store ion-exchange regeneration waste-water developed a leak during the evening of 7/18. The leak was discovered at about 9:00am on 7/19. Spill absorbent socks were placed around the local storm drain, into which the tanker spillage had drained and containers were placed under the tanker to catch additional spillage. All remaining liquids were drained from the tanker into 55-gallon drums for proper disposal. Analytical results for the waste water indicated that the concentration of lead and chromium exceeded RCRA regulatory levels.
8/3/95	No. 6 Fuel Oil	55 gals.	Yes	Roughly 55 gals. of fuel oil spilled after a gasket failed in the tank farm pump-house located between tanks 1 & 2. PE personnel used speedi-dry and sorbent pads to contain and capture spilled product. Contaminated soil and other cleanup materials were placed in 55-gal drums for off-site disposal

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
8/10/95	Capacitor Oil	1-2 gals	No	Axel Capacitor assembly at Building 934 fell over while being moved outdoors across a concrete pad. The capacitor assembly was righted, placed in secondary containment tray, and wrapped in plastic. Absorbent socks, pads, and speedi-dry was used to contain and cleanup the spillage. All oil-contaminated materials were containerized. The area was cordoned off. A sample of oil was collected and analyzed for PCBs; 79 ppm of PCBs were present. Based on the estimated quantity of oil spilled and the PCB concentration, the quantity of PCBs released did not exceed the CERCLA-reportable quantity of one pound. The area was decontaminated by PE personnel. All cleanup materials were sent off-site for disposal.
8/14/95	No. 2 Fuel Oil	Unknown	Yes	Oil-contaminated soil was discovered after removing a of 1000 gallon underground tank (BNL Tank No. 405-1). Initial remediation included the removal of fourteen 55-gal drums of contaminated soil. Further site remediation was halted pending the analysis of four soil samples collected on 8/16. Follow-up soil-remediation efforts were completed on 9/20 with the removal of eight cubic yards of contaminated soil. Upon receipt of results from the analysis of a composite soil sample using EPA Methods 8021 and 8270 for volatiles and semi-volatiles, NYSDEC concluded that remediation was complete. The pit was subsequently backfilled and the drums of contaminated soil were sent off-site for disposal.
8/16/95	Oil	< 1 Qt.	No	During pick up of drums from Building 495, oil was spilled in the fenced yard north of the building. The material was quickly shoveled into a nearby garbage can, and was transferred to an appropriate waste disposal container. It is unknown if the oil was from the one of the drums or if the truck transporting the drums leaked oil.
8/18/95	Waste Water	15 - 20 gallons	No	Evaluation of 19 drums being used to store the AGS ion exchange waste-water (spilled 7/18/95) showed eight were plain, unlined steel drums. On 8/17/95, one of the drums developed a leak due to the corrosive characteristics of the waste. The drums contents were immediately transferred to a lined 55-gallon drum. On 8/18/95, BNL personnel attempted to transfer the contents of the seven remaining drums; six of them leaked when they were opened. Secondary containment pallets, onto which the drums were placed, were found to be defective and had holes in the plastic. An estimated 10 - 15 gallons of waste water was released to the asphalt paving but was absorbed with sand before it entered the local storm drain. All waste was transferred into lined 55-gallon drums for eventual disposal. All contaminated sand was swept and placed into 55-gallon drums.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
8/21/95	Hydraulic Oil	1-2 gals	No	Gauge on contractor (Delta Well Driller) drilling rig blew, spraying out 1 - 2 gallons of oil before the rig could be shut down. Plastic was placed beneath the rig. Absorbent pads were used to wipe down the rig and absorb the oil off the plastic sheet. Less than one gallon of oil reached the soil. The contractor placed all contaminated soil into drums (provided by BNL) for off-site disposal.
8/24/95	No. 6 Oil	Est 5 gal	No	Relief Valve on heater piping associated with CSF Tank 611D (No. 4) released approx 5 gallons of No. 6 oil into the secondary containment berm which is lined with Enviro-mat. The heater was drained and the valve replaced. Oil-contaminated rocks were put into drums for off-site disposal.
9/15/95	Diesel Fuel	3-5 gals	Yes	Contractor's vehicle struck a water hydrant causing extensive damage to the fuel tank and spilling from 3 to 5 gallons of diesel fuel to the ground. Fire/rescue personnel placed plastic trays under the leaking fuel tank to collect additional spillage. All contaminated soils were collected and held for off-site disposal.
9/19/95	Hydraulic Oil	1.5 gals	Yes	A LILCO truck containing a mounted boom suffered a failed hydraulic line while installing new poles adjacent (west side) to the landfill for the relocation of 69 kV service. Grounds personnel responded within one hour of the spill and removed all visibly contaminated soil. The LILCO equipment was secured and held on location pending repair by a LILCO mechanic. The drum of soil was taken to BNL's Hazardous Waste Management Facility for storage pending off-site disposal.
10/9/95	Hydraulic Oil	6 gals	Yes	Spill resulted from failed hydraulic hose on a riding lawn- mower. The equipment was in its initial 50 hours of operation so failure was unanticipated. Approximately six gallons of hydraulic fluid was dripped over approximately 18 square meters of soil North of Building 197 and immediately south and parallel to Michelson Street. A small paved area of about 6 square meters was stained at the bend in the road. All visibly contaminated soil was removed within 20 hours of the release and placed into approximately eight 55-gallon drums. Drums were transferred to BNL's Hazardous Waste Management Facility for storage pending off-site disposal.
10/10/95	Hydraulic Oil	0.5 gals	No	A Plant Engineering Riggers' forklift suffered a failed hydraulic hose on the paved area between Buildings 901 and 906. Speedi-dry was placed on the spilled material and subsequently swept up for off-site disposal. The forklift was removed from service. The spill was remediated within four hours.

Table 2-4 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
10/18/95	Hydraulic Oil	0.5 gals	No	A cement mixer delivering concrete to the Building 1006 area suffered a failed hydraulic hose operating the mixer drum. Approximately 0.5 gallons of hydraulic fluid was sprayed onto the vehicle right front tire and onto the paved RHIC-Ring Road. The driver wiped the oil from the tire. The mixer was held for repairs which were completed by the company within four hours of the incident. No additional clean up measures were warranted due to the fine mist which had been discharged.
10/19/95	No. 2 Oil	<1 pint	No	During a fuel delivery to an oil tank adjacent to Bldg. 600, a Rice Fuel Oil tanker truck began to sink in unconsolidated soil, and fuel oil began to leak from a valve beneath the vehicle. To stabilize the vehicle, the arms of a forklift were positioned beneath the undercarriage. A plastic tray was placed beneath the valve to capture leaking oil and the oil in the vehicle was off-loaded to a second Rice truck. The fuel vendor subsequently recovered the contaminated soil for off-site disposal.
10/26/95	Diesel Fuel	<1 pint	No	Soil was contaminated during the transport and refueling of paving equipment used during the construction of the perimeter service road along the south side of the current landfill. The subcontractor responsible for the paving recovered the contaminated soil for off-site disposal.
12/13/95	Hydraulic Fluid	<1 gal	No	A puddle of hydraulic fluid was observed in the parking lot between Buildings 535 and 510. Speedi-dry was applied to the spillage. Contaminated absorbent material was containerized for off-site disposal.

*Reportable to off-site agencies.

No. of Actions	Status/Comments
16	In March 1995, a request was submitted to NYSDEC to renew the COs for thirteen emission sources with permits due to expire in April. The Laboratory also asked the NYSDEC to cancel permits for three sources previously removed from service. In July, NYSDEC notified the Laboratory that they had renewed these permits.
1	In March 1995, an application to modify the exhaust system in the former Inhalation Toxicology Facility was submitted to NYSDEC. Since the modification involved installing equipment to mix chrysotile asbestos insulation and equipment to spray mixed asbestos insulation onto test panels, the application invoked requirements of 40 CFR Part 61 Subpart M. To meet the pollution control requirements of Subpart M, prefilters and HEPA filters were used in series in the exhaust system. Department of Applied Science personnel responsible for the mixing and spraying operations, monitor the equipment and exhaust systems daily for evidence of visible emissions, and regularly inspect the pollution-control equipment as required by Subpart M Section 61.144. NYSDEC approved the application and issued a permit for the operations in June.
2	In September 1995, a request to renew COs for the gasoline vapor-recovery systems at the two on-site dispensing stations was submitted to NYSDEC. Due to pending revisions in the NYS Operating Permit Program, NYSDEC subsequently informed the Laboratory that they no longer require the renewal of permits previously issued for such systems.
1	In September 1995, the Laboratory requested the deletion of the permit for the CSF Boiler 4 since the boiler was completely dismantled in March.
1	In December 1995, a request was submitted to NYSDEC and EPA Region II to waive the construction permit and emissions-testing requirements of 40 CFR 61 Subpart C for the machine cutting of beryllium crystals. A portable fume hood equipped with a HEPA filter will be used to capture potential emissions from the cutting operation. Since the expected concentrations of beryllium in the exhaust will be below the OSHA value for time-weighted average threshold limit, the exhaust will be returned to the machining room. Two area ambient monitors that will measure ambient concentrations of beryllium in the machine shop also will be used to satisfy the emissions testing requirements of Subpart C.

2.4.2 Employee Trip-Reduction Plan

In March 1995, the Laboratory learned that funding for the New York State Department of Transportation (NYSDOT) Long Island Region Improving Commute Program (LIRIC) had been reduced. As a result, NYSDOT reduced the Laboratory's grant from $132,000 to $100,000. 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. The contract approval process has caused many delays, and funds are not expected before June 1996. These delays forced the Laboratory to condense the planned pilot on-site shuttle bus service from seven to four months, and push the introduction of the service to the summer, 1996.

Some of the activities that the grant was to cover have been assumed by the Laboratory. One of these was to study the feasibility of developing a series of bicycle paths to improve site access to bicyclists. This study was completed in September 1995 by Lockwood, Kessler, Bartlett Inc.. Based on their draft report, the estimated cost to develop a comprehensive set of paths appears to be prohibitive. When the final report is received, the Employee Trip Reduction Work Group (ETRWG) and the BNL Traffic Safety Committee will review the report and make their own recommendations to management.

In June 1995, the Laboratory received written confirmation that the Suffolk County Department of Public Works approved the Employee Trip Reduction Plan, submitted in November 1994. In May 1995, the Laboratory formally initiated its Employee Trip Reduction Plan by introducing the BNL Carpool/Vanpool Program. The Commuter Assistance and Information Service was established within S&EP to distribute information about the program, and to help find suitable rideshare partners for employees using a ridematching database. Since its inception, the Commuter Assistance and Information Service has developed and distributed many pamphlets, posters, and newsletters to encourage employee participation. Furthermore, the Laboratory has subsidized the cost of a defensive driver course for participants in ridesharing partnerships.

In September 1995, an effort was made to chart the success of the program via a Traffic Count Survey at the main and north-gate entrances to the Laboratory during the peak morning travel period. Several automatic traffic recorders registered the number of vehicles entering the site, and observers tabulated the type and number of multi-passenger vehicles arriving at each gate. The survey estimated that the average passenger occupancy rate (APO) for the site rose from 1.063 to 1.091 (a 2.6 percent increase) during the first four months of the program.

In December 1995, a survey was distributed to all Department and Division heads to help identify management concerns about the potential impact of compressed work schedules on employees' productivity and efficiency. The survey also sought to identify the benefits that management believes will be derived by introducing compressed work schedules within their organizations. The survey findings will help to decide both the feasibility and form of a compressed work schedule program at the Laboratory. In December, a congressional bill was passed which makes the CAA Employee Travel Reduction Program (ETRP) a voluntary program for affected states. In effect, this bill permits states to substitute other programs for the ETRP into their State Implementation Plan for Ozone, provided the emissions reductions from these programs are equivalent to those that were projected for their ETRP. Should New York State take advantage of this bill and repeal its ETRP, the Laboratory would no longer be obligated to implement the commute option strategies identified in its Employee Trip Reduction Compliance Plan. Furthermore, the Laboratory would not be required to conduct a follow-up employee survey nor prepare a Plan Update in 1996.

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 (RACT) requirements of 6 NYCRR Subpart 227-2. The NYSDEC later approved the NOx RACT compliance plan in June 1994. During 1995, the Laboratory satisfied several milestones identified in the plan.

In January 1995, emissions were tested on Boilers 1A and 5. The results confirmed that both boilers meet the NOx RACT emission standard of 0.30 lbs/MMBTU while burning residual fuel with a sulfur content of 0.5 percent or less and a fuel-bound nitrogen content of 0.3 percent or less. The test results were transmitted to NYSDEC in March. NOx emissions testing of Boiler 7 (i.e., the replacement for Boiler 4), is scheduled for the spring of 1996.

In March 1995, copies of the CSF Operating Plan were submitted to the NYSDEC. The plan describes how the Laboratory intends to operate the CSF boilers to ensure that the NOx emissions standard is satisfied. In May 1995, the CSF began burning low sulfur and low nitrogen No. 6 oil, to meet the NOx emissions standard. Since the conversion, NOx emissions from Boiler No. 6 have averaged 0.29 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 NOx emissions limit is demonstrated by calculating the 24-hour daily arithmetic average rate of NOx emission. Outside this period, the 30-day rolling average CEM emissions rate may be 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, two AGS and one Medical Department Halon fire suppression systems were removed from service during 1995. Furthermore, inspections revealed that fourteen (14) portable Halon 1211 extinguishers were unserviceable. They were replaced with ABC dry chemical extinguishers.

2.4.5 Ozone Depleting Refrigerants

During 1995, three 300-ton R-11 centrifugal chillers in Building 725 and one 190-ton R-11 centrifugal chiller in Building 535 were taken out of service after each building was connected to the Chilled Water Facility. One of the Building 725 chillers will be used as a backup unit to ensure that industrial cooling needs for the building can be met. Meanwhile, the other two chillers in Building 725 and the single one in Building 535 have been maintained as redundant comfort cooling systems for each building. Funds requested in 1994 to replace two 80 ton Carrier R-12 reciprocating units in Building 526 are not expected to be available until after the start of the 1996 cooling season. Therefore, retrofits to both units to permit the use of R-22 have been scheduled for spring 1996.

In 1995, the Plant Engineering Maintenance Management Center (MMC) purchased a refrigerant management software program, which has improved the internal tracking of the maintenance history of all the refrigeration and air conditioning systems serviced. The program permits the MMC to better monitor refrigerant leak rates and to establish repair schedules. Plant Engineering also modified their preventative maintenance work orders to ensure that technicians record the amount of refrigerant added to a system, in accordance with record keeping requirements of 40 CFR Section 82.166.

2.4.6 National Emissions Standards for Hazardous Air Pollutants (NESHAPs)

2.4.6.1 Radioactive Airborne Effluent Emissions Governed by NESHAPs

In 1995, BNL was in full 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 0.06 mrem (0.6 μSv). All airborne effluent release data and dose calculations were transmitted to both DOE and EPA, fulfilling the June 30 annual reporting requirement.

The Building 802 Tritium Evaporator Facility began operations in May, 1995. This unit evaporates tritiated waste water which is not treatable by conventional physical or chemical separation methods. The tritiated water vapor effluent from this facility is discharged to the HFBR's 320 ft. (98 meter) stack. This facility was evaluated under the National Environmental Policy Act (NEPA) process for environmental impacts. All required notifications of facility pre- and post-start-up were made to EPA Region II on time and in accordance with NESHAPs Approval BNL-288-01.

2.4.6.2 Asbestos Emissions

Since 1993, BNL emissions have complied with 40 CFR 61 regulations on airborne fiber releases. During 1995, the EPA region II was notified on three 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 66 square feet of surface material, and 1,792 linear feet of pipe insulation.

2.5 Suffolk County Sanitary Codes

There are over 200 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 1995 is given below:

No. of Actions	Status/Comments
1	An existing 550-gallon double-walled, stainless steel, underground storage tank at Building 931 (BNL ID# 931-01; SCDHS ID# 212) needed to be relocated as part of a construction project. The tank was excavated on June 30, 1995 and inspected by

a representative from the SCDHS. The inspector found the tank to be in excellent condition and saw no evidence that the tank had leaked. The tank was equipped with a double walled fill pipe and a high level alarm upon its reinstallation.

1 An existing 1000-gallon, outdoor, underground tank at Building 405 (BNL ID# 405-01; SCDHS ID# 31) used to store fuel oil was removed in August 1995. A representative from the SCDHS witnessed the removal. There was evidence of contaminated soil near the fill pipe during excavation. The incident was reported to the NYSDEC and EPA. Additional soil was excavated and placed in drums for off-site disposal. Table 2-4 gives additional details of this incident.

1 Repairs were made to the high level alarm on a 550-gallon underground storage tank at Building 754.

12 A project was initiated to bring twelve indoor tanks used to store water-treatment chemicals into compliance with SCDHS requirements. The work includes 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 (490-11, 490-12, 635-01, & 637-01). The plans and specifications for this project were submitted to the SCDHS for their review in 1995. Construction began in 1995 with an anticipated completion date in 1996.

In addition to these activities, several plans and associated specifications for upgrading tanks and piping were submitted to the SCDHS for their review. These projects included upgrades to the MPF and construction of the new Waste Management Facility. A package of information (including piping specifications, as well as manufacturer's product specifications for the leak detection system) was also sent to the SCDHS in response to their comments about an upgrade to underground piping from Building 801 to Building 811.

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 six wells during 1995. 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 system. The content of the BNL monitoring program 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 1995 included; monthly bacteriological analyses, quarterly analyses for POCs, an annual analysis for SOCs and Pesticides, semi-annual inorganic chemicals analyses and annual micro-extractables and asbestos analyses. Monitoring requirements for CY 1994 and 1995 were similar. Potable water samples were collected by BNL personnel and analyzed by a 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.

All reported bacteriological, SOCs, pesticides, micro-extractables, and asbestos data collected during CY 1995 was within the NYS DWS. Water from Wells 4, 6 and 7 contains elevated levels of iron and color, and consequently, is treated to remove iron at the WTP. The WTP uses a calcium hydroxide water softening process for precipitating iron oxide from the water received from these wells. This process also reduces the color of the water. The potable water effluent from the WTP met all NYS DWS in CY 1995. While the effluent quality of the WTP met all NYS DWS, further improvements to the treatment process were begun in 1995. This project includes the installing air stripping towers to abate of POCs, such as TCA, building a new clearwell, and improving the WTP control system. Construction commenced on May 1, 1995 and continued throughout of 1995. Consequently, no water was pumped from wells 4, 6 and 7 during this period.

Table 2-6 shows that the water from 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. In 1992 and 1993, Potable Wells 10 and 11 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 ranging from a minimum of 6.0 to a maximum of 9.2 µg/L. However, concentrations of TCA in treated water samples showed they were less than the NYS DWS. Nevertheless, activated carbon for well 11 was changed when the treated effluent reached a maximum TCA concentration of 4.9 µg/L. Although the analytical data for Well 12 has shown all POCs to be less than the NYS DWS, activated carbon was installed during 1995 as a preventative measure.

Monitoring of the BNL potable water system for lead and copper continued during CY 1995. In response to the 1994 reported contravention of the Federal Action Level for lead, monitoring was increased with forty locations sampled semi-annually. Compliance with the Federal Action Levels for both metals was demonstrated during both testing periods. Therefore, monitoring for CY 1996 will be reduced back to 20 locations analyzed annually. 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

Table 2 - 5
BNL Site Environmental Report for Calendar Year 1995
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	NA	NA	NA	<5	<5	<5	<5	15	Units
Odor	NA	NA	NA	0	0	0	0	3	Units
Cyanide	NA	NA	NA	<10	<10	<10	<10	NS	ug/L
Conductivity	NA	NA	NA	94	118	110	146	NS	umhos
Chlorides	NA	NA	NA	11	16	15	19	250	mg/L
Sulfates	NA	NA	NA	7.4	7.4	8.3	6.8	250	mg/L
Nitrates	NA	NA	NA	0.6	0.5	0.3	0.5	10	mg/L
Ammonia	NA	NA	NA	<0.02	<0.02	<0.02	<0.02	NS	mg/L
pH	NA	NA	NA	5.8	5.5	6.3	6.7	NS	SU
Methylene Blue Active Substances	NA	NA	NA	<0.04	<0.04	<0.04	<0.04	NS	mg/L
Antimny	NA	NA	NA	<5.9	<5.9	<5.9	<5.9	6.0	ug/L
Arsenic	NA	NA	NA	<3.0	<3.0	<3.0	<3.0	50	ug/L
Barium	NA	NA	NA	<0.2	<0.2	<0.2	<0.2	2.0	mg/L
Beryllium	NA	NA	NA	<3.0	<3.0	<3.0	<3.0	4.0	mg/L
Cadmium	NA	NA	NA	<5.0	<5.0	<5.0	<5.0	5.0	ug/L
Chromium	NA	NA	NA	<0.01	<0.01	<0.01	<0.01	0.1	mg/L
Fluoride	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	2.2	mg/L
Iron	NA	NA	NA	<0.02	<0.02	<0.02	0.07	0.3	mg/L
Lead	NA	NA	NA	<1.0	<1.0	<1.0	2.3	15	ug/L
Manganese	NA	NA	NA	<0.01	<0.01	<0.01	0.03	0.3	mg/L
Mercury	NA	NA	NA	<0.2	<0.2	<0.2	<0.2	2.0	ug/L
Nickel	NA	NA	NA	<0.04	<0.04	<0.04	<0.04	0.1	mg/L
Selenium	NA	NA	NA	<5.0	<5.0	<5.0	<5.0	10.0	ug/L
Sodium	NA	NA	NA	7.8	9.6	10.8	14.4	NS	mg/L
Thallium	NA	NA	NA	<1.9	<1.9	<1.9	<1.9	2.0	ug/L
Zinc	NR	NR	NR	<0.02	0.02	0.03	<0.02	5.0	mg/L
Gross α Activity	NR	NR	NR	NR	NR	NR	NR	15	pCi/L
Asbestos	NA	NA	NA	NR	NR	NR	<0.02	7	M.Fibers/L
Calcium	NA	NA	NA	6.1	6.2	5.3	8.1	NS	mg/L
Alkalinity	NA	NA	NA	12.5	50	30.3	47.6	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 from May through December 1995; consequently, Inorganics were not analyzed.
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 1995
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds, Pesticides and Micro-Extractables [1]

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	0.9	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	1.0	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	3.4	1.5	2.3	ND	1.4	9.2	0.8	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	4.5	6.2	0.5	0.7	ND	0.6	0.6	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 1995
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds, Peticides and Micro-Extractables [1]

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-chlorotolueneND	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 1995
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds, Peticides and Micro-Extractables [1]

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,-D	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	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 1995
Potable Water Wells, Analytical Data for Principal Organic Compounds, Synthetic Organic Compounds, Peticides and Micro-Extractables [1]

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
Methomyl	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.

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 1, 1995. Recommendations for adding more lime at the WTP will be implemented upon restart of this facility.

The SCDHS inspected the BNL potable water supply system on September 13, 1995 with walk-through inspections 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 cross connection control program since 1985. This program includes the installing of both primary and secondary cross-connection control 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 1995, annual test reports were submitted for 115 CCC devices.

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 1994, 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.

2.7.2 PCB Consent Order

During the Alternate Liquid Fuel Program, the Laboratory received a one-time off-specification military jet fuel which contained PCBs in excess of 50 ppm in October 1984. This material then was blended with other fuel, resulting in 286,000 gallons of material with a PCB concentration above the maximum allowed. On January 21, 1986, the EPA Region II formally approved BNL's plan to incinerate this material at a 10% firing rate (concentration of 8 ppm) in BNL's high-efficiency Boilers 4 and 5 (Daggett, 1986). The material was stored at BNL while negotiations continued with the NYSDEC, who issued a final Order on Consent on May 15, 1992. This Order on Consent required DOE to ensure that BNL burn the PCB-contaminated fuel in high-efficiency Boiler 5. Under the conditions of this order, no permits were required.

Burning of the PCB contaminated fuel started on July 7, 1992 and was completed on April 4, 1993. As required by the conditions of the Order on Consent, the Laboratory prepared a plan for decontaminating CSF Tank No. 5. Notice of approval of the plan was received from NYSDEC in January 1994 and from the EPA in February 1994. Decontamination of the CSF Tank No. 5 was completed on November 16, 1994.

In December 1994, the Laboratory contracted with a Professional Engineer to conduct an internal tank inspection and, and to certify that CSF Tank No. 5 was cleaned in accordance with the approved plan. This document was submitted to the EPA and NYSDEC in January, 1995. Both agencies accepted the report, and the consent order is considered complete. The CSF Tank No.5 will remain empty until it is upgraded under the Fuel Transfer Facility Upgrade Project.

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 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; eleven tanks are included in this Certificate.

2.9 Resource Conservation and Recovery Act

2.9.1 Facility Upgrades

BNL held the ground-breaking ceremony for building a new Waste Management Facility on May 30, 1995. BNL's Plant Engineering Division, which is managing the construction, awarded the construction contract to J. Kokolakis Contracting Inc., Rocky Point, NY. Construction is scheduled for completion in the fall of 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). Numerous safety and environmental protection features were incorporated into the facility design, including large-capacity secondary containment, 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)

BNL received two Part 373 Permits during 1995. Based upon a major modification of the permit for the existing HWMF, the NYSDEC issued a final Part 373 Permit for BNL's current facility. The permit, NYSDEC Permit #1-4722-00032/00021-0 became effective on April 5, 1995 and expires on August 31, 1998.

BNL also received the Part 373 Permit for the new Waste Management Facility. Construction involving the RCRA and Mixed Waste Buildings could not proceed until the permit was issued. The permit, NYSDEC Permit #1-4722-00032/00102-0 became effective July 13, 1995 and expires on July 12, 2005.

2.9.3 90-Day Accumulation Areas and Satellite Areas

Hazardous waste generator training programs have played an important role in emphasizing regulatory compliance, and the importance of preventing pollution and minimizing waste generation. In 1995, hazardous waste generator training was given on a site-specific basis with individual generator training being provided at the Departments or Divisions. The training includes modules on identifying hazardous waste, accumulation of waste at satellite areas, preventing pollution, and minimizing waste. This training was well-received, and will continue to be offered annually. Additionally, a computer-based training module was developed for the RCRA generator training course. The 90-Day Accumulation Area training was given at each accumulation area for each respective 90-Day Area manager and designee; this training will be offered annually.

BNL issued ES&H Standard 6.2.1, "Accumulating RCRA Hazardous Waste", on March 27, 1995. The Standard clearly communicates both the Federal and State (NYSDEC) regulations governing storage of hazardous waste at points of generation (satellite areas) and at 90-Day accumulation areas.

2.9.4 Facility Audits

In March 1995, a Tier III Assessment of BNL's Environmental Restoration and Waste Management programs was conducted by the Radian Corporation, under contract with Associated Universities, Inc.. The appraisal recommended that BNL include industrial waste handlers and recyclers in an audit program similar to that conducted for hazardous-waste treatment, storage, and disposal facilities. This issue has yet to be resolved. The assessment also identified several issues on waste characterization for compliance with Phase II Land Disposal Restrictions and documentation of any regulatory exemptions. These two issues were addressed in BNL's response to the assessment and are considered closed.

The NYSDEC conducted an inspection of BNL's hazardous waste management program in June 1995. The NYSDEC observed that certain hazardous wastes were stored beyond the one year limit dictated by the Land Disposal Restrictions. The wastes in question were stored beyond the limit due to uncertainty about their radioactive content. Radioactive content determinations must be made in accordance with the DOE Waste Moratorium criterion of "No Radioactivity Added". BNL demonstrated to the NYSDEC that work was progressing steadily toward a final resolution, and so this was not raised to the level of a formal compliance order. The majority of the wastes in question were subsequently shipped as nonradioactive hazardous waste in August, 1995.

BNL Environmental Compliance staff periodically participate in the Departmental/Divisional self-inspection programs (Tier I Inspections). Participation allows the compliance staff to interact with Departmental staff and guide them on specific issues. Internal audits and inspections of 90-Day Accumulation Areas revealed an increased awareness of requirements, and increased level of compliance. Minor problems are still being identified at Satellite Areas. The results of internal inspections were summarized and provided to BNL management on a quarterly basis during 1995.

2.9.5 RCRA/TSCA Waste Moratorium

The Process Knowledge Program enabled the Hazardous Waste Management Engineering and Operations Group to identify those wastes which meet the criteria of the EM document "Performance Objective for the Certification of Nonradioactive Hazardous Wastes" and to send those wastes off-site. Wastes which are determined to have potential for added radioactivity are held by Hazardous Waste Management and are managed as mixed wastes, pending the approval of the final stage of BNL's response to the Moratorium.

The development of a process (termed 'Phase III') to assess the radioactive content of wastes suspected of containing added radioactivity in volume or bulk is proceeding. An internal working group was formed in September 1995 and developed a program which was submitted for DOE review in December 1995. BNL intends to utilize both in-house analytical laboratory and survey capability and the commercial laboratories for the required analysis.

Pending approval of the program, BNL has submitted 'case-by-case' exemption requests to DOE seeking permission to ship hazardous wastes. The most recent request was submitted in January 1995 and approved by DOE in August 1995.

2.9.6 Pollution Prevention Program

BNL has begun to implement 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 Program Plan.

The program is structured to evaluate and reduce waste generation, including radioactive, mixed, hazardous, and solid waste on a Department-by-Department basis. The effort, and the investment in pollution prevention is showing successes. Efforts in vehicle maintenance operations reduced hazardous waste generation to zero in 1995, mainly through product substitution and planning. In July 1995, BNL submitted a proposal entitled 'Conversion to Digital Photography' to the DOE High Return on Investment funding *competition. The project was funded and is scheduled for implementation the first half of 1996.* When implemented this project has the potential to reduce the photographic waste stream by nearly 70%. BNL also totally redesigned a process used for cleaning ultra-high vacuum parts at the NSLS. The new process, which achieved the desired cleanliness specification, eliminates the use of harsh acids and will probably eliminate hazardous waste generation from this operation. The process will be incorporated into a newly designed Centralized Degreasing Facility in early 1996.

Pollution-prevention training was incorporated into the RCRA waste-generator training program to continue to raise awareness and identify opportunities to reduce waste generation.

2.9.7 Waste Disposal

During 1995, 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 1995, BNL continued to develop a Mixed Waste Site Treatment Plan with DOE's Brookhaven Group and Chicago Operations Office, and the NYSDEC. BNL has progressed from a Draft Site Treatment Plan (DSTP) to a Proposed Site Treatment Plan (PSTP) with input from these agencies and then submitted the PSTP to the NYSDEC for final approval.

The NYSDEC accepted the treatment technologies and facilities identified in the PSTP, and is working with BNL and the DOE towards developing a consent order that is amenable to all parties. BNL expects to gain written approval of the plan in 1996. As a show of good faith, BNL met the first two milestones identified in the plan and will continue to work with the treatment facilities identified in the PSTP to facilitate the compliant treatment and disposal of mixed waste.

2.9.9 Mixed Waste Inventory Report

In 1995, BNL responded to a request from DOE for updated data for the 1994 Mixed Waste Inventory Report (MWIR). This report initially collected data across the DOE complex on the quantity, and physical, chemical, and radiological properties of mixed wastes held in storage. The update provided DOE with information on current inventory and any changes in proposed treatment options. This information gives DOE some insight on the types and quantities of mixed waste at its facilities, and any problems in providing/arranging for adequate treatment.

2.10 Comprehensive Environmental Response, Compensation and Liability Act

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

In 1991, BNL established the OER to oversee the Laboratory's Superfund activities. This office's responsibility is to remediate areas of known contamination, and to identify, mitigate, and eliminate other areas of potential contamination.

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, NEPA, as well as corresponding NYS 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.

There are currently twenty-eight AOCs at the BNL site. They consist of both active facilities, such as the STP, the HWMF, potable wells; and inactive facilities, such as the former landfills, cesspools, and radioactive waste storage tanks. The AOCs have been grouped and prioritized into OUs and Removal Actions (RAs); this prioritization is documented in BNL's Response Strategy Document (RSD).

During the last quarter of 1995, community involvement in the Environmental Restoration program increased significantly. The December public meeting for OU IV's Feasibility Study and Proposed Remedial Action Plan drew about 120 community members and resulted in a substantial Responsiveness Summary document. Also, public interest and involvement in the cleanup program increased as the Operable Unit I Groundwater Removal Action was formulated, and a January 16, 1996 public meeting on the issue was announced.

In accordance with the IAG milestone's, during 1995, the following field activities were conducted and reports have been submitted to the EPA and the NYSDEC for review:

January 1995

Removal Action II: Draft Closeout Report for the Building 650 Underground Storage Tanks was submitted to EPA/NYSDEC.

Operable Unit I/VI: Remedial Investigation field work was completed.

Operable Unit V: Installation of all Remedial Investigation monitoring well were completed.

Operable Unit IV: Public comment period for the Remedial Investigation/Risk Assessment Reports was begun.

February 1995

Operable Unit V: Phase I Remedial Investigation field work was completed.

Sitewide Biological Survey: Geographic surveying of delineated wetlands was completed.

March 1995

Removal Action I: The containment structure was dismantled and shipped off-site. Field work portion of the project was completed.

Removal Action II: Mixed waste drums were shipped to Hanford, WA.

Operable Unit III: Phase I Groundwater screening survey field work was initiated.

Sitewide Biological Survey: Draft report was submitted to EPA/NYSDEC.

April 1995

Removal Action V: Draft Engineering Evaluation and Cost Analysis for the Groundwater Removal Action was submitted to EPA and NYSDEC.

Operable Unit I/VI: Non-intrusive geophysical characterization of the Glass Holes and Chemical/ Animal Hole areas conducted.

May 1995

Operable Unit I/VI: Capping of Current Landfill was initiated.

Operable Unit III: Fieldwork related to lithology and groundwater screening survey continued.

June 1995

Operable Unit I/VI: Rough grading of the Current Landfill site was completed and gas vents were installed. Laying of geotextile and sand for the gas venting layer was started.

Operable Unit IV: Draft Record of Decision was submitted to EPA and NYSDEC.

July 1995

Removal Action V: Off-site groundwater investigations were begun for Groundwater Removal Action project.

Operable Unit I/VI: Laying of geotextile and sand for the Current Landfill gas venting layer was completed. Liner installation was initiated. Geophysical characterization of Glass Holes and Chemical/ Animal Holes was completed.

Operable Unit III: Groundwater screening survey continued on site and along BNL's south boundary road.

Operable Unit V: Phase II of the Unit V field investigation was initiated.

Sitewide Hydrogeological Characterization: Phase III well installation program was started.

August 1995

Removal Action I: Closeout Report for the "D" Tanks Removal Action Project was submitted to EPA and NYSDEC.

Removal Action III: Excavation work on the Cesspool Removal Action was initiated.

Removal Action V: Draft Action Memorandum for Groundwater Removal Action was submitted to EPA/NYSDEC.

Operable Unit III: Phase I of the groundwater screening survey was completed.

September 1995

Removal Action I and II: Three shipments of "D" Tanks and Underground Storage Tanks metal waste were shipped for storage to the DOE's facility in Hanford, Washington.

Operable Unit I/VI: The Remedial Investigation/Risk Assessment and Initial screening of alternatives reports were submitted to the EPA and NYSDEC. The preliminary cap design for the Former Landfill was submitted to DOE/EPA/NYSDEC.

Operable Unit III: Phase II (on-site) and Phase III (off-site) drilling for the groundwater survey was initiated. Off-site residential private well sampling and analysis was started.

Operable Unit V: Sludge from the Imhoff Tanks was pumped out and stored on-site.

October 1995

Removal Action V: The Groundwater Removal Action remedial design work plan was sent to DOE/EPA/NYSDEC.

Operable Unit I/VI: The 30% design for capping of the Former Landfill was submitted to DOE, EPA, and NYSDEC.

Operable Unit III: Remedial investigation field work was begun.

November 1995

Operable Unit I/VI: The physical capping of the Current Landfill was completed. A draft Supplemental Characterization Report for the Glass Holes and Chemical/Animal Holes was submitted to EPA and NYSDEC.

Operable Unit IV: The Feasibility Study Report and the Proposed Remedial Action Plan were finalized.

December 1995

Operable Unit II: Remedial investigation fieldwork was initiated.

Operable Unit III: Phase II groundwater investigation was completed. All permanent on-site remedial investigation monitoring wells were installed.

Operable Unit IV: A public meeting was held to receive comments on the Feasibility Study and the Proposed Remedial Action Plan.

Sitewide Hydrogeological Characterization: Phase IV well installation was initiated.

2.11 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 1994 was sent in February 1995 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 June 27, 1995, Brookhaven National Laboratory submitted Form R for Reporting Year 1994 to the EPCRA Reporting Center and to the New York State Emergency Response Commission. Four chemicals were included: acetone, chlorine, methanol, and sulfuric acid. On June 16, 1995 EPA issued a final rule deleting acetone from EPCRA reporting. BNL's submission of acetone was automatically deleted from the TRI database.

On June 26, 1995, EPA promulgated a final rule deleting non-aerosol forms of sulfuric acid from EPCRA reporting. On August 17, 1995, BNL withdrew its Form R for sulfuric Acid.

2.12 National Environmental Policy Act

During 1995, environmental evaluations were completed for 216 proposed projects in accordance with 10 CFR 1021, and DOE Order 451.1, which outlines DOE's rules for implementing NEPA. One hundred and thirty-five were considered minor actions requiring no additional documentation, and 81 projects required submission of Environmental Evaluation Notification Forms to DOE. No environmental assessments were started during 1995. With the issuance of a Finding of No Significant Impact on the environmental assessments for a proposed new Radiation Calibration Facility, the addition of an underground vault to Chemistry to conduct radiation chemistry, the construction of a new HWMF, and programmed improvements to the AGS during 1994, *no ongoing documents remained. The Laboratory continued to provide input on the DOE Waste Management* Programmatic Environmental Impact Statement (WMPEIS) and the DOE Spent Nuclear Fuel Programmatic Environmental Impact Statement (SNF EIS) managed by the DOE-EH Office of NEPA Program Policy and Assistance. A Record of Decision on the SNF EIS was issued in June 1995. In December 1995, a public hearing on the WMPEIS was held at BNL, one of several DOE facilities discussed in the document. This *document was being revised at the end of 1995.*

2.13 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.

2.14 Endangered Species Act

Brookhaven National Laboratory was notified by the U. S. Fish and Wildlife Service and the NYSDEC on December 13, 1993 and December 7, 1993, respectively, that no Federal or NYS endangered or threatened species occur within the Laboratory's impact area. However, an ecological inventory was completed in 1995 under the IAG to evaluate the potential impact of BNL's environmental remediation efforts. This inventory of habitats and species is documented in a report issued on September 25, 1995 (CDM/ LMS, 1995). No federally threatened or endangered species were identified at BNL during this survey, except for occasional transient individuals of several bird species. The survey identified 12 locations within BNL boundaries where breeding by the New York State Endangered eastern tiger salamander (*Ambystoma tigrinum*) was confirmed. Several other NYS species of special concern were also noted at BNL. This information will be considered during future planning operations that may alter habitats. This is illustrated in a Future Land Use Plan issued on August 31, 1995 (BNL, 1995).

2.15 National Historic Preservation Act

The Deputy Commissioner for Historic Preservation of the New York State Office of Parks, Recreation, and Historic Preservation issued a determination on April 2, 1991 that only activities which would impact the Graphite Reactor Building (Building 701), the Old Cyclotron Enclosure (Building 902), and on-site World War I era trenches require additional consultation. All other activities would have no effect upon cultural resources in, or eligible for, inclusion in the National Register of Historic Places. The Department of the Interior Questionnaire on Fiscal Year 1994 Federal Archaeological Activities was submitted to DOE-BHO on March 28, 1995. There were no activities affecting cultural or historic resources were conducted during CY 1995.

2.16 Floodplain Management

During 1995, one construction action was contemplated near or within the 100-year floodplain, involving planned upgrades to the BNL Sewage Treatment Plant where below-grade aeration tanks were to be installed. Although the construction site was outside the 100-year flood plain, part of this work included dewatering, and discharging some of the pumped groundwater to the Peconic River. A request for authorization to do this was made to the NYSDEC in February 1995, and approval was received on September 26, 1995. Proposed discharges of up to 1,000,000 gallons per day to the Peconic River were evaluated, and found to have no impact on the delineation of the floodplain, provided that pumping was limited to periods of low flow in the river. Due to public reaction about the discharge of slightly contaminated groundwater to the Peconic River, this project was postponed to allow re-engineering (see Section 5 for information on groundwater quality in the STP area). Before the NYSDEC authorization, this work was evaluated and found consistent with Executive Order 11988 (Floodplain Management), and all aspects of Executive Order 11990 (Protection of Wetlands).

2.16.1 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 1994, authorization was received from the NYSDEC to complete the upgrades to BNL's STP, which would involve temporary discharges of groundwater to the river from dewatering during construction, and moderate ground disturbance associated with construction. The activities to be conducted under this permit application were subsequently re-evaluated in response to public reaction. Activities not associated with dewatering were continued during 1995. The revised STP upgrades project, which does not include dewatering and discharge to the Peconic River, is expected to continue in 1996.

2.17 Protection of Wetlands

Other than the permitting actions described in Sections 2.16 and 2.16.1 above, no activities conducted during CY 1995 impacted the wetlands nor their buffer zones. As part of the settlement of a Notice of Violation received by BNL from EPA for RCRA and TSCA violations, the Laboratory proposed to survey wetland habitats and develop protection, preservation, and possibly enhancement actions. A biological inventory of wetlands at BNL began in November 1993 to establish up-to-date knowledge on site resources and to analyze the impact of BNL's environmental remediation efforts. Detailed delineation of wetland boundaries was completed during 1995 (CDM/LMS, 1995).

2.18 Environmental Compliance Audits

2.18.1 Tiger Team Issues

In March and April of 1990, the DOE conducted a comprehensive ES&H and waste operations assessment at BNL. This effort, known as the Tiger Team Assessment (TTA), was conducted in response to Secretary of Energy Admiral James D. Watkins, Ret., 10-Point Initiative to strengthen ES&H programs and waste management operations in the DOE community. The TTA's purpose was to develop concise information about the site's status on ES&H compliance issues, root causes for noncompliance, and the adequacy of response actions needed to address identified problems. In addition, the assessment included an evaluation of the adequacy and effectiveness of the DOE and site's contractor (AUI), in the management, organization, and administration of the ES&H programs (DOE, 1990). The BNL Action Plan for the Tiger Team Assessment was completed and published in October 1990 (BNL, 1990).

In the area of compliance with environmental and waste management concerns, there were 37 findings dealing with the lack of conformance to applicable Federal and State laws and regulations, County codes, DOE Orders, and 27 findings in which best management practices were not in place. By the end of 1994, 33 of the 37 environmental compliance issues were addressed. One unresolved compliance issue was closed during 1995. The remaining three compliance issues require substantial resources and are being dealt with on a schedule determined by a risk-based prioritization system.

2.18.2 EPA NESHAPs Audit 1995

In September 1995, BNL received a facility compliance inspection by a representative of the USEPA Region II, Radiation and Indoor Air Branch. The site was toured, and radioactive emission sources were visited. Special attention was paid to air effluent monitoring equipment at the HFBR and MRR, as well as the Laboratory's ambient air sampling network. No deficiencies were reported.

2.18.3 DOE Chicago ES&H Assessment

The DOE Chicago Operations Office assessed BNL's air quality protection program from October 30 through November 3, 1995. The purpose was to evaluate the Clean Air Act program for compliance with the requirements of EPA, NYSDEC, SCDHS, and DOE. The functional areas of the program that were assessed included (1) the Title V permit program; (2) the radionuclide and asbestos control and monitoring programs; (3) the ozone depleting substances program; and (4) the chemical accident prevention program. The assessment included review of documents for compliance with applicable regulations; interviews with BNL personnel; and field observations of operations of facilities, programs, equipment and instrumentation. The overall conclusion was that BNL has a very good air quality protection program. Four recommendations were made, which, when implemented, will strengthen the overall air quality program.

3.0 ENVIRONMENTAL PROGRAM INFORMATION - J. R. Naidu

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 ;
- 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 CY1995 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;
- to ensure that discharges comply with authorized limits and regulatory requirements;
- to verify the adequacy of effluent controls in facilities;
- to notify proper officials of unusual or unforeseen conditions and, where appropriate, to activate a special environmental monitoring program;
- to communicate accurate, effective environmental monitoring and surveillance results to DOE, other government agencies, and the general public;
- to maintain an accurate continuous record of the impact of the BNL operations on the environment;
- to determine radioactive concentrations and nonradioactive contaminants in environmental media to assess the immediate and long-term consequences of normal and accidental releases;
- to distinguish between environmental contaminants and effects from BNL operations and those from other sources;

- to evaluate and revise the environmental monitoring program in response to changing conditions dictated by facility operations and/or environmental analysis results;
- to provide site-specific data for risk assessments for human populations near BNL;
- to determine the long-term buildup of site-released contaminants and predict their environmental trends;
- to establish a baseline of environmental quality so that trends in the physical, chemical, and biological condition of environmental media can be characterized;
- to identify and quantify new or existing environmental quality problems and to evaluate the need for remedial actions or mitigating measures; and
- to 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 two organizations involved in carrying out the tasks outlined above. These are:

a. The Office of Environmental Restoration:

This office was established 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 onsidered 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 insure 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 remedial investigation/feasibility studies, conducting characterization studies, identifying preferred treatment process, and preparing and finalizing a Record of Decision 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 Management Section (EMS):

This Section was restructured from the former Environmental Protection Section (EPS) and the Hazardous Waste Management Section in 1994, and is organized into three groups and one team: the Engineering and Operations Group, the Environmental Compliance Group, the SAG, and the Training and Procedures Team. The principal groups responsible for environmental monitoring are the SAG and the Environmental Compliance group (ECG).

The combination of the above three sub-groups provides the basis for writing the Annual SER, and the DMRs as required by the various environmental permits issued by the Regulatory Agencies which oversee the Laboratory's operations.

The purpose and mission of the EMS is to support the Departments/Divisions in implementing and complying with environmental and waste management program standards, properly managing the Laboratory's hazardous wastes, performing environmental surveillance, and providing analytical services. The section fulfills its mission in the following ways:

- Developing environmental and waste management ES&H SEAPPMs;
- Assisting the Departments/Divisions in complying with laws and regulations and the permit processes;
- Preparing permit applications and renewals;
- Operating an efficient waste-management facility;
- *Conducting the BNL Environmental Monitoring program and operating the Analytical Services* Laboratory for radiological and non-radiological analyses;
- 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 the local regulatory community, and commenting on proposed regulations.

3.2.1 Environmental Compliance Group

The Environmental Compliance Group assists and guides the Laboratory in all areas of regulatory compliance, and submits compliance reports and permit applications to the regulatory agencies. This Group also provides technical oversight and assistance in conducting environmental monitoring and reviewing data for determining the impact on the environment from Laboratory operations. The Group 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. Because most radionuclides are released in such small quantities that any resultant doses are unmeasurable, mathematical models are used to calcuate the transport and dispersion of radionuclides in the environment. The Group 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 90 such reviews were performed during CY 1995. Several members of the ECG are emergency responders, and are on 24-hour call in the event of an oil/chemical spill at BNL.

3.2.2 Sampling and Analysis Group

The Sampling and Analysis Group is responsible for implementing the EMP. This Group has developed the EMP and updates it regularly in collaboration with the ECG and the QA Office (S&EP Division). The Field Sampling Team collect the samples, and the analyses is performed by the ASL. In addition, the Group also responds to emergency spills when required, conducts pre-operational investigations, and performs special sampling and/or analytical requests from other BNL organizations. Reports based on review and assessment of data are also prepared and submitted to requesting Departments and Divisions.

3.2.3 Engineering and Operations Group

Hazardous Waste Management activities are directed by the Engineering and 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 EMS 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.

3.2.4 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 Section in terms of the directives on QA pertaining to environmental sampling, analytical processes, and documentation, which include review of data.

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 analyzed by these agencies and the data is published in their departmental annual reports.

3.4 Environmental Programmatic Changes in 1995

In 1995, the Laboratory initiated the following new programs in support of the Site Environmental Monitoring Program, and the Environmental Restoration Program:

A) Brookhaven National Laboratory completed upgrades of the permanent air- and water-monitoring stations. The new air-monitoring stations have been operational since the second quarter of 1994. These stations replaced 30-year-old structures, and the particulate and charcoal filter sampling systems also were improved. The new surface water flow rate and proportional sampling systems, along the Peconic River, have been operational since the first quarter of 1995. Flow monitoring and proportional sampling devices also were installed at each of the liquid-effluent recharge basins. New SPDES permit requirements became effective in March 1995.

B) Brookhaven National Laboratory, in conjunction with the NYSDEC, expanded its Peconic River surveillance program. Samples now are collected twice a year to examine the potential impact of BNL releases and the intermittent Peconic River's off-site flow on the Peconic River's fish population and extent of fish contamination, if any.

C) As part of the ongoing remedial investigations, 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.

D) In accordance with the BNL Employee Trip Reduction Plan, submitted as required pursuant to Title 17, Part 38 of the NYS Code of Rules and Regulations, the Laboratory initiated its Carpool/Vanpool Program in May 1995. A key element to the success of this program was the establishment of a Commuter Assistance and Information Service within the S&EP Division. Through this new service, S&EP Division uses a geocoding ridesharing database to find suitable partners for employees seeking ridesharing arrangements. Since the service was initiated, S&EP Division disseminated numerous pamphlets, posters, and a newsletter to promote and encourage employee participation in the program. To measure the program's progress, S&EP Division surveyed the vehicles entering the site from 7 - 9 a.m. for one week in September. The survey revealed a modest increase in the average vehicle occupancy for the site; up from 1.063 to 1.091 persons per vehicle.

E) Brookhaven National Laboratory made its first shipments of Mixed Waste (consisting both radioactive and hazardous materials) during 1995. Approximately 1,200 gallons of mixed waste was shipped to the DOE's Hanford facility in Washington State.

3.5 Environmental Restoration

As indicated in Sections 2.10 and 3.2.a, the OER has full responsibility for conducting environmental restoration activities as required under the IAG. Chapter 2 (Compliance Summary), Section 2.10 summarizes the OER's work.

3.6 Waste Minimization and Pollution Prevention Programs

The BNL Waste Minimization and Pollution Prevention (Wmin/P2) Program 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 implementing of a formal waste minimization and pollution prevention program at BNL, and contains information on Wmin 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 1995, the following pollution prevention projects were implemented:

1. The vehicle maintenance facility at BNL reduced RCRA Hazardous waste generation to zero by switching to a petroleum naptha parts washer with a flash point of 150 provided by Safety Kleen. The vehicle maintenance facility also rescheduled oil changes for non-emergency fleet vehicles, reducing waste oil by 640 gallons/year and saving $2,790 annually in avoided new oil and labor costs.
2. In a cooperative agreement between BNL, Lawrence Berkeley Laboratory, and DOE over 15,000 tons of slightly radioactive concrete shield-block from the BEVELAC Accelerator at LBL were transferred for reuse at the Relativistic Heavy Ion Collider (RHIC) accelerator, saving approximately $40 million in potential disposal costs.
3. By implementing a program identified by the AGS Waste Minimization Working Group, the AGS reduced mixed waste by 77%, generating only 400 lbs of activated heavy metals in 1995, compared to 755 lbs in 1994.
4. A PPOA of the ion-xchange regeneration wastes from AGS (a system that generates approximately 15,000 gallons of low level radioactive wastewater annually) was initiated by Hazardous Waste Management Group.
5. The Solid Waste Recycling Program, managed by PE, expanded to begin recycling topsoil and asphalt in 1995.
6. BNL reduced waste generation of TCA to less than 300 lbs, a 86% reduction from 1992.
7. A PPOA of the #197 H Acid Cleaning Facility was initiated. A contract was established with DOW Advanced Cleaning Systems to develop a new process to clean ultra-high vacuum components used at the NSLS, and thus eliminate the use of hydrofluoric and nitric acids.

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. 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

An independent technical review of the Brookhaven Environmental Restoration Project was conducted between March 20 and March 24, 1995. The assessment team evaluated the project activities to determine if they were "necessary and sufficient", and if they were efficiently implemented. Four overall recommendations were made and are being addressed by the OER.

3.8.2 Other Assessments

A number of other assessments of the environmental functions were conducted in 1995. They include the following:

- DOE-Chicago Assessment of Clean Air Act Program, October 30 - November 3, 1995;
- NYS Department of Health Environmental Laboratory Approval Program, May 8, 1995; and
- 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.

4.0 ENVIRONMENTAL PROGRAM DESCRIPTION- J. R. Naidu, R. J. Lee, G. L. Schroeder, and J. Williams

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:

1. ***Effluent monitoring*** , the collection and analysis of samples or measurements of liquid and gaseous effluents for the purpose of characterizing and quantifying contaminants, assessing radiation exposure to members of the public, and demonstrating compliance with applicable standards, and

2. ***Environmental Surveillance***, 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.

A detailed description of the rationale and design criteria for the environmental surveillance and the effluent monitoring program is described in the BNL Environmental Monitoring Plan. This plan also discusses the extent and frequency of monitoring and measurements, procedures for laboratory analyses, QA requirements, and program implementation procedures. Complete details regarding individual monitoring activities can be found in subsections grouped according to environmental media. Groundwater protection and surveillance activities are summarized in Chapter 5.

4.1 Primer on Environmental Radiation

4.1.1 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 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.

Sievert The alternate unit of measuring human radiation exposure used internationally and with increasing frequency in the United States, 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.

4.1.2 Brief Overview of 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 below.

4.1.3 Types of Radiation

Alpha 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 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 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.

4.1.4 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.

4.1.5 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.

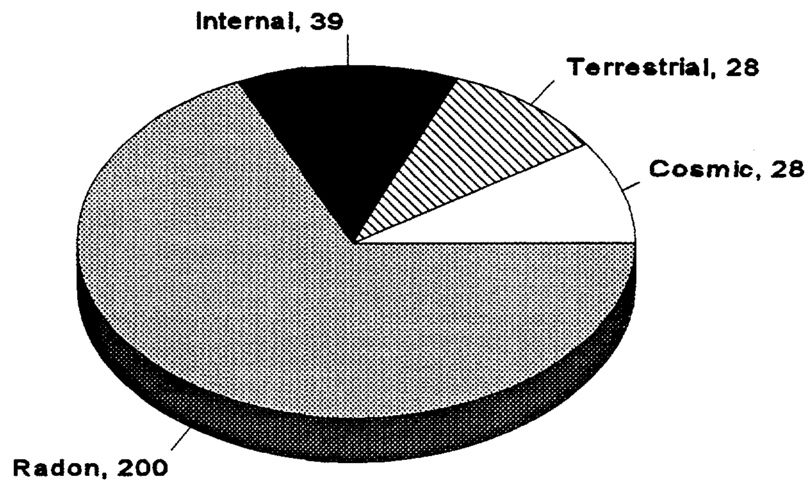
Radon Radon is a naturally-occurring radionuclide that is generated by the decay of uranium ores in the soil. It is by far the greatest contributor to an individual's radiation dose. Exposure occurs through the inhalation of radon decay products in the atmosphere. The level of exposure varies greatly 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.

4.1.6 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.



Annual Radiation Dose Due to Natural Background (mrem).
Source: NCRP Report No. 93.

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.

4.1.7 Meaning of Radiological Parameters

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 in Section 4.1.11 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.

4.1.8 Scientific notation

Because 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.

4.1.9 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 *milli*gram is equal to one thousandth of a gram. Other common prefixes used in this report are shown below.

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 (p)	1×10^{-12}	1E-12	tera (T)	1×10^{12}	1E12

4.1.10 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 and cannot, therefore, 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 (typically, 1 pCi/L or less), 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.

4.1.11 Tritium

Among the radioactive materials that are used or produced at Brookhaven National Laboratory, tritium has received the greatest amount of public attention. Tritium is the common name for the isotope hydrogen-3, a radionuclide with a half-life of about 12 years which decays by emitting a beta particle to form stable helium. Although its physical half-life is measured in years, tritium has a *biological half-life* of about 10 days, meaning that 50 percent of any tritium in the body is eliminated in approximately 10 days. It occurs 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. Tritium has many uses in medical and biological research as a labeling agent in chemical compounds and is frequently used in university settings.

Tritium is constantly formed by natural means when cosmic radiation from space interacts with the gaseous elements of the earth's upper atmosphere. Other sources of tritium in the environment have included nuclear power reactor operations, nuclear weapons testing, and commercial products such as self-illuminating exit signs and wrist watches. 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.

4.2 Effluent Emissions and Environmental Surveillance

The primary purpose of the BNL effluent monitoring program is to determine whether:

1. Facility operations, waste treatment, and control systems are functioning as designed to contain environmental pollutants;
2. The applicable environmental standards and effluent control requirements are met.

The primary purpose of the BNL environmental surveillance program is to:

1. Quantify the presence of potential contaminants in the environment resulting from BNL operations; and

2. Assess environmental and human health impacts from BNL operations.

This annual report for CY 1995 follows the recommendations given in DOE Order 5400.1, "General Environmental Protection Program."

4.2.1 Airborne Effluent Emissions - Radioactive

The following Sections describe the primary radioactive effluents released to the atmosphere in 1995 and the facilities which produced them. Facility locations within the BNL site are shown in Figure 4-1 and effluent types and quantities are listed in Table 4-1.

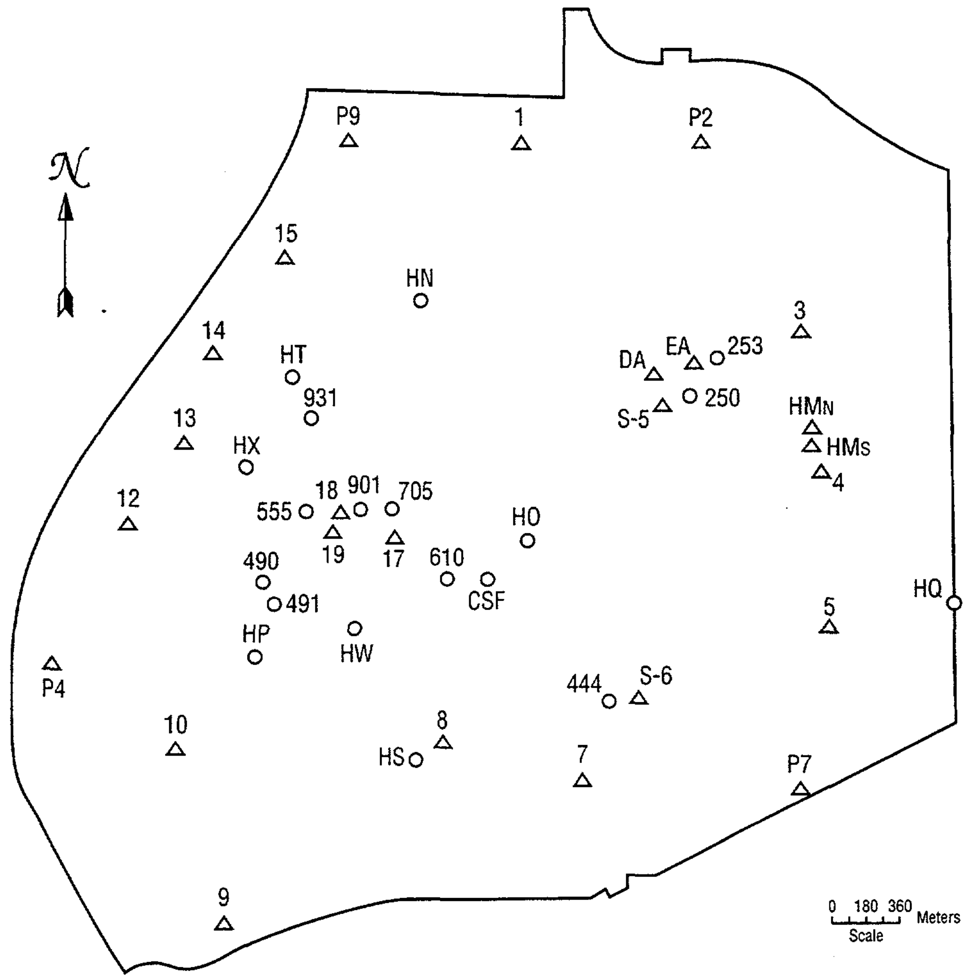
4.2.1.1 BMRR

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 1995, the BMRR released 1,863 Ci (69 TBq) of argon-41 as an airborne effluent. 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, it results in a maximum annual 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).

Figure 4 - 1

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

○ **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

Table 4-1
BNL Site Environmental Report for Calendar Year 1995
Summary of Airborne Radionuclide Releases by Facility

Facility	Nuclide	Ci released
HFBR	Ba-128	9.76E-06
	Be-7	9.80E-07
	Br-77	2.29E-06
	Br-82	2.13E-03
	Co-60	1.80E-07
	Cs-137	3.00E-08
	H-3	9.76E+01
	I-126	4.82E-06
	I-131	1.44E-06
	K-40	6.50E-05
	Mn-56	1.47E-06
	Xe-133	8.33E-06
	Xe-133m	5.60E-07
	Xe-135	5.19E-06
BLIP	Be-7	5.07E-05
	Cs-137	6.70E-07
	H-3	3.78E-01
	Mn-54	2.50E-07
	O-15	3.72E+02
BMRR	Ar-41	1.86E+03
Evaporator Facility	H-3	6.84E+00
	Co-56	6.54E-06
	Co-57	2.25E-05
	Co-58	3.01E-05
	Co-60	7.86E-06
	Cs-137	5.66E-03
	Mn-54	5.69E-06
	Mn-56	4.27E-06
	Na-22	5.16E-07
	Rb-83	5.31E-06
	Rb-84	3.31E-06
	Zn-65	2.39E-05

Facility	Nuclide	Ci released
Bldg. 801	As-74	6.42E-06
	Be-7	1.01E-04
	Br-77	4.24E-04
	Co-57	1.73E-06
	Cs-132	1.13E-04
	Cs-137	1.50E-05
	Ga-68	1.85E-02
	Ge-69	4.18E-02
	I-124	3.46E-04
	I-126	1.56E-03
	K-40	4.86E-03
	Rb-84	4.50E-06
	Rb-86	6.57E-03
	Sb-124	5.89E-05
	Se-75	4.25E-05
	Xe-127	5.64E-06
Incinerator	Co-57	3.20E-06
	H-3	1.29E-03
	I-125	4.00E-05
	Sr-85	2.00E-06

Note: 1 Ci = 3.7E+10 Bq

See Figure 4-1 for facility locations.

4.2.1.2 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. In 1995, the BLIP Facility released 372 Ci (14 TBq) of oxygen-15 as an airborne effluent.

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

In 1995, 98 Ci (3.6 TBq) of airborne HTO was released from the HFBR. 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.

4.2.1.4 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 Waste Concentration Facility. 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. 1995 was the first year during which the Evaporator was used; 6.8 Ci (252 GBq) of HTO was released as an airborne effluent.

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 4-1 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.

4.2.1.5 Other Facilities

Airborne radionuclides are also released from Building 801 and the Waste Management Incinerator (see Table 4-1 for isotopes and quantities). However, the quantities are quite 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.

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 several orders of magnitude less than this value. Due to the extremely low potential doses from this facility, continuous on-line monitoring is not required.

4.2.2 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 produce the majority of nonradioactive air emissions at the laboratory. The CSF lies 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 MM Btu/hr. Boiler 5 is a Combustion Engineering VU-60 unit installed in 1965 that has a heat input of 75 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 [This boiler replaces Boiler No. 4 (a combustion engineering unit with a heat imput of 225 MMBTU/hr), which was dismantled in 1995]. After a shakedown period and completion of stack testing as required by special conditions of the construction permit issued by the NYSDEC, Boiler No. 7 is expected to be fully operational in the summer of 1996. 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. All four boilers are monitored for opacity, O_2, and CO_2. Emissions from these boilers are reported quarterly to the NYSDEC.

In January 1995, emissions tests were conducted on Boilers 1A and 5 while burning residual fuel with a fuel bound nitrogen content of 0.3 percent or less. Test results confirmed that both boilers meet the Nox RACT emission standard of 0.3 lbs/MMBTU. The tests were required as a condition of BNL's NOx RACT Compliance Plan that the NYSDEC approved in June 1994.

The former Inhalation Toxicology Facility in Building 490 is another significant source that is subject to federal emissions control and monitoring requirements. In June 1995, the NYSDEC issued a permit to the Laboratory, which allowed the DAS to use the facility to fabricate GVF-12.7 fireproofing test panels as part of a Cooperative Research and Development Agreement. The panels are fabricated in a three-step process. In the first step, GVF-12.7 fireproofing is made by dry blending gypsum, vermiculite, dodecyl sodium sulfate and chrysotile asbestos fibers. During the second step, water is added to the dry mix in a mixing hopper. The wet mixture is then fed to a pump system where it is spray atomized onto flat steel test panels of various dimensions. Because the fabrication process involves the mixing and spray application of an asbestos material, exhaust systems for each process hood were designed to exceed pollution control requirements established by NESHAPs 40 CFR 61 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 meet Subpart M requirements, each process hood exhaust is visually monitored daily 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 work commenced on August 1, 1995, no visible emissions of asbestos have been observed.

4.2.3 Liquid Effluents

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.

4.2.4 Liquid Waste Management

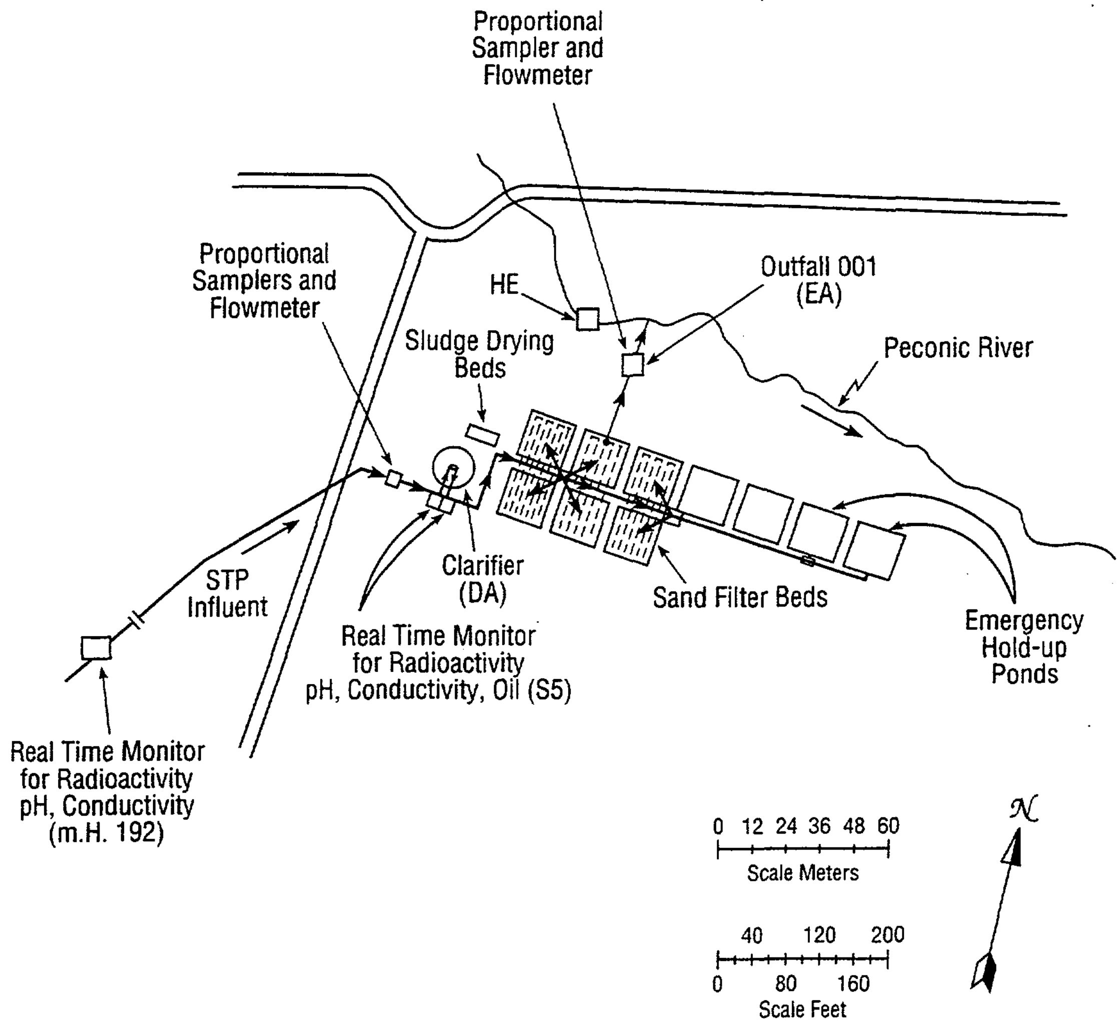
Liquid chemical wastes are collected by the Hazardous Waste Management Engineering and Operations Group (E&OG). These wastes are packaged in accordance with Department of Transportation (DOT), EPA, NYSDEC and DOE regulations for licensed off-site disposal.

The E&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 "active" (D-waste) and "inactive" (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 1995, authorized releases of F-waste to the sanitary system totaled 106,015 gallons (401,572 liters). Total activity released was 5.3 mCi (0.2 GBq), 95% of which was due to tritium and 5% due to various beta/gamma-emitting radionuclides.

4.2.4.1 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 and approximately 85% of the water is recovered by an underlying tile field, where it is 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, no flow was recorded at the BNL boundary during 1995.

The effluent not collected by the tile fields, approximately 15%, recharges directly to groundwater under the filter beds and/or evaporates. Figure 4-2 is a schematic of the STP and its related 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. At the clarifier, an oil monitor examines the STP influent for the presence of oil. 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.



Sewage Treatment Plant - Sampling Stations.

Figure 4 - 2

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.

4.2.4.2 Sanitary System Effluent- Radiological

The STP is sampled at the input to the clarifier and at the Peconic River Outfall. 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 alpha activity in STP effluent remained low in 1995. The measured values were generally less than the MDL, indicating that the observed activity was at background levels (see Table 4-2 and Figure 4-4). Gross activity measurements are used as a screening tool for detecting the presence of radioactivity without identifying the specific radionuclide causing the activity. The Safe Drinking Water Act 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). Proposed amendments to the SDWA would include a 50 pCi/L (2 Bq/L) screening level for gross beta activity, above which individual radionuclide analysis (gamma spectroscopy) would be required (EPA, 1991). Due to instrumentation error, gross beta activity measurements for the STP were voided for samples collected from January through November (see Chapter 7 for discussion). However, average beta activity in this effluent stream has remained consistent with background levels for many years. Gamma spectroscopy results indicated that this continued to be the case in 1995. Gross beta values at EA and DA in December were below the 8 pCi/L (0.3 Bq/L) detection limit.

Gamma spectroscopy, a more sensetive analysis, detected beta/gamma-emitting radionuclides in the STP's influent and effluent sporadically throughout the year, although at levels that were close to or below the minimum detection limits of the analysis system (see Table 4-3). The presence of cesium-137 in the STP effluent is due to the continued leaching of very small amounts of cesium-137 from the sand filter beds which were deposited during an unplanned sanitary release in June, 1988 (Miltenberger *et al.*, 1989). The SDWA does not yet specify standards for radionuclides other then radium-226, radium-228, tritium and strontium -90, though it does establish an annual dose limit of 4 mrem (0.04 mSv) via the drinking water pathway from beta and gamma-emitting radionuclides. For radionuclides which are not specified, 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 4-3 under "SDWA Limit". The average cesium-137 concentration in the STP effluent was found to be less than 1% of the drinking water standard.

Iodine-131 (half-life = 8 days) was detected in STP effluent on three occasions in 1995, always at levels close to the detection limit of the analytical method. This radionuclide does not appear to have been in common use at either the Biology or Medical Departments during this time. Iodine-131 is commonly used in the treatment of hyperthyroidism and may have entered the sanitary waste system via individuals who received therapeutic administrations. Radionuclides employed in the nuclear medicine industry are considered non-regulated when released to sanitary systems via patient excreta. Measured levels were found to be thousands of times less than the applicable DCGs.

Table 4-2
BNL Site Environmental Report for Calendar Year 1995
Radiological Analysis Results of Sewage Treatment Plant Influent and Effluent

	Flow (liters)	Gross Alpha Avg. (pCi/L)	Gross Alpha Max. (pCi/L)	Tritium Avg. (pCi/L)	Tritium Max. (pCi/L)
Station DA - STP Influent					
January	8.99E+07	0.76	2.91	806	2,440
February	7.68E+07	0.25	1.09	442	1,040
March	9.14E+07	1.21	5.08	2,131	8,000
April	7.33E+07	1.26	5.33	1,715	7,130
May	1.04E+08	0.74	4.17	2,203	10,600
June	1.02E+08	0.63	2.61	3,047	5,150
July	9.87E+07	0.45	2.16	2,889	7,100
August	1.01E+08	0.44	1.83	1,094	1,570
September	8.13E+07	0.39	1.52	1,099	1,840
October	9.80E+07	0.74	2.87	1,237	2,820
November	7.75E+07	1.15	14.60	926	1,480
December	6.66E+07	0.46	1.49	1,073	1,920
Annual Avg.		0.59		1,298	
Total Rel. (L or mCi)	1.06E+09	0.63		1,376	
Station EA - Peconic River Outfall					
January	7.11E+07	0.64	2.53	1,516	8,810
February	5.62E+07	0.69	2.93	556	1,100
March	8.16E+07	1.37	5.92	1,994	6,750
April	7.40E+07	1.36	6.74	1,598	5,080
May	8.41E+07	0.56	2.54	1,830	6,060
June	7.92E+07	1.09	11.10	3,005	4,430
July	7.43E+07	0.47	2.18	7,116	23,400
August	9.57E+07	0.87	2.85	10,193	17,100
September	7.59E+07	0.85	3.80	1,236	2,620
October	8.02E+07	0.58	1.79	1,254	2,470
November	7.48E+07	2.21	33.80	904	1,390
December	6.95E+07	1.13	2.53	997	1,600
Annual Avg.		0.99		2,960	
Total Release (L or mCi)	9.17E+08	0.91		2,713	
SDWA Limit (Annual Avg.)		15		20,000	
Typical MDL		3.7		380	

Note: Gross beta data for January through November, 1995 voided for these locations due to instrument error. See "Quality Assurance", Chapter 7 for complete discussion. Average gross beta concentrations for December, 1995 = 1.7 and 2.2 pCi/L for DA and EA, respectively. Both of these values are below the MDL of 8 pCi/L.

Table 4-3
Radiological Analysis Results of Sewage Treatment Plant Influent and Effluent
Gamma Emitting Radionuclides and Strontium-90

	Flow (liters)	Be-7	Co-57	Co-58	Co-60	Cs-137	I-131	Mn-54	Na-22	Sr-90
		←				(pCi/L)				→
Station DA - STP Influent										
January	8.99E+07	ND	ND	ND	ND	0.10	ND	ND	ND	0.11
February	7.68E+07	0.44	ND	ND	ND	0.09	4.15	ND	ND	0.00
March	9.14E+07	ND	ND	ND	ND	ND	0.90	ND	ND	0.25
April	7.33E+07	0.46	ND	ND	ND	0.08	ND	ND	ND	0.02
May	1.04E+08	ND	ND	ND	ND	0.03	ND	ND	ND	0.04
June	1.02E+08	2.12	ND	ND	0.03	ND	ND	ND	ND	0.22
July	9.87E+07	0.41	ND	ND	ND	ND	ND	ND	ND	0.10
August [1]	1.01E+08									0.07
September	8.13E+07	ND	ND	ND	ND	ND	0.63	ND	ND	0.08
October	9.80E+07	ND	ND	ND	ND	0.18	ND	ND	ND	0.05
November	7.75E+07	ND	ND	ND	ND	ND	ND	ND	ND	0.10
December	6.66E+07	16.00	2.55	1.89	1.17	ND	ND	3.07	1.34	0.06
Annual Avg.		1.62	0.21	0.16	0.10	0.04	0.47	0.26	0.11	0.09
Total Release (L or mCi)	1.06E+09	1.39	0.17	0.13	0.08	0.04	0.45	0.20	0.09	0.10
Station EA - Peconic River Outfall										
January	7.11E+07	ND	ND	ND	ND	0.82	ND	ND	ND	0.07
February	5.62E+07	ND	ND	ND	0.06	0.53	1.58	ND	ND	0.13
March	8.16E+07	ND	ND	ND	ND	0.50	ND	ND	ND	0.57
April	7.40E+07	ND	ND	ND	ND	0.64	ND	ND	ND	0.24
May	8.41E+07	ND	ND	ND	ND	0.52	ND	ND	ND	0.11
June	7.92E+07	ND	ND	ND	0.05	0.89	ND	ND	ND	0.19
July	7.43E+07	ND	ND	ND	0.04	0.69	ND	ND	0.16	0.14
August [1]	9.57E+07									0.00
September	7.59E+07	ND	ND	ND	ND	0.80	0.30	ND	ND	0.10
October	8.02E+07	ND	ND	ND	ND	0.18	ND	ND	ND	0.09
November	7.48E+07	ND	ND	ND	ND	0.96	0.37	ND	ND	-0.08
December	6.95E+07	4.55	0.81	0.40	0.31	5.33	ND	ND	1.45	0.10
Annual Avg.		0.41	0.07	0.04	0.04	1.08	0.20	0.00	0.15	0.15
Total Release (L or mCi)	9.17E+08	0.32	0.06	0.03	0.03	0.86	0.14	0.00	0.11	0.13
DOE Order 5400.5 DCGs[2] (pCi/L)		1,000,000	100,000	40,000	5,000	3,000	3,000	50,000	10,000	1,000
SDWA Limit (pCi/L)[3]		40,000	4,000	1,600	200	120	120	2,000	400	8
Typical MDL (pCi/L)		1.60	0.14	0.18	0.23	0.20	0.21	0.18	0.20	0.12

[1] No sample was composited for gamma analysis during August. ND: Not Detected.

[2] DCG = Derived Concentration guide. The DCG value represents the concentration of a radionuclide in water that would cause a committed effective dose equivalent (CEDE) of 100 mrem if 2 liters a day were ingested for one year.

[3] Concentration required to produce the Safe Drinking Water Act annual dose limit of 4 mrem.

Samples of the STP effluent 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 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 STP influent and effluent 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 4.2.4), and (3) the release of tritiated distillate generated by the on-site liquid waste concentration process.

In addition to the airborne releases discussed in Section 4.2.1.3, 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 1995 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 1995, the annual average tritium concentration as measured at the Peconic River Outfall was 2,960 pCi/L (110 Bq/L), or 15% 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 combined total of 2.7 Ci (100 GBq) of tritium was released during the year. This continues the trend of annual tritium releases below 4 Ci (148 GBq) per year that has existed since 1985 (see Figures 4-3 and 4-5).

4.2.4.3 Sanitary System Nonradiological Analyses

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. Chapter 2 discusses BNL's SPDES compliance program.

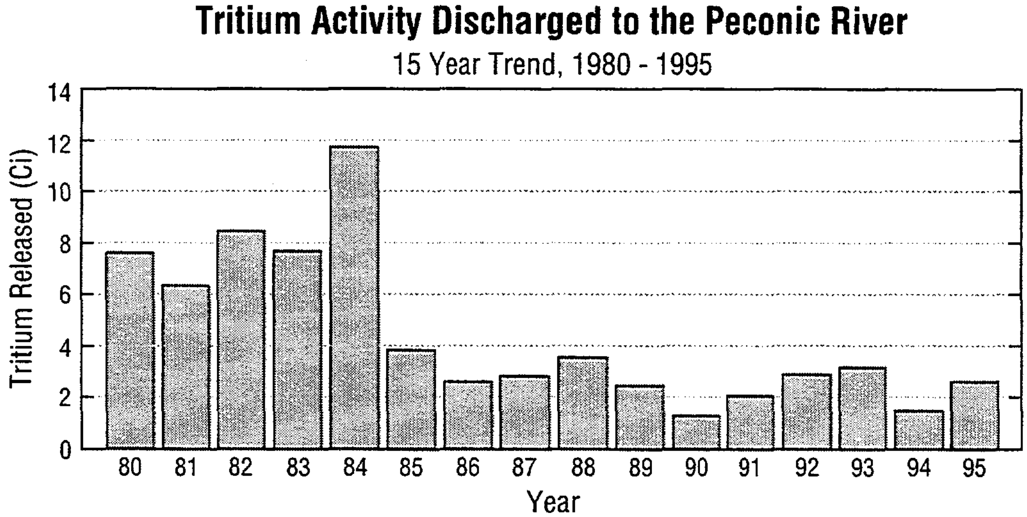


Figure 4 - 3

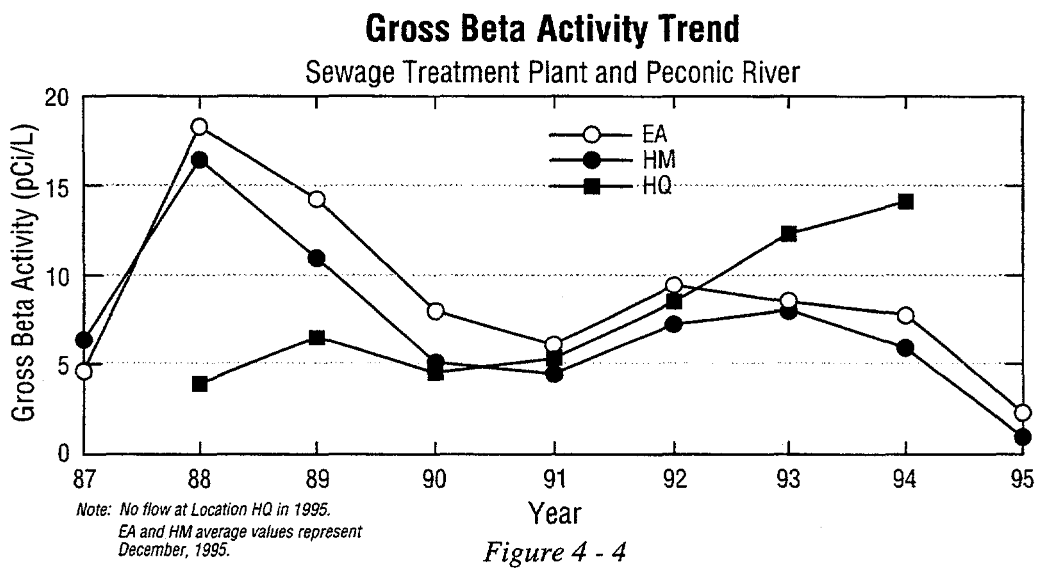


Figure 4 - 4

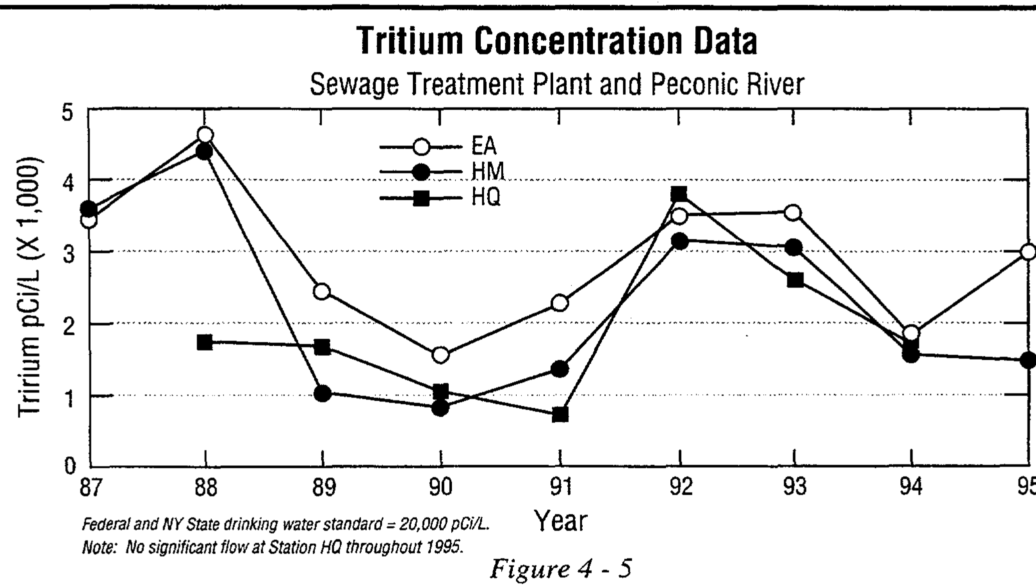


Figure 4 - 5

In addition to collecting and analyzing the STP effluent samples for SPDES compliance purposes, the S&EP Division monitored the STP influent and effluent routinely during 1995. Daily influent and effluent 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, the effluent 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 4-4 summarizes the water quality and metals analytical results for these samples. Comparison of the effluent data to the SPDES effluent limitations shows that only zinc exceeded the revised SPDES effluent release limits. Nine of the monthly composite samples were within SPDES permit limits for zinc and only samples prepared in January and February 1995 exceeded the limitation. The average zinc concentration recorded for the year was well within the limit. In contrast to the routine compliance results, there were no silver exceedances in any of the monthly composite samples prepared and analyzed by BNL. All other data corresponds with the compliance data reported in Chapter 2 (Table 2-2).

Figures 4-6 through 4-10 plot five year trends for the maximum monthly concentrations of copper, iron, lead, silver, and zinc in the effluent of the STP as reported in the DMRs; the new SPDES permit limits are also shown. The plots show that the majority of the discharges comply with the new permit conditions; however, as anticipated, the lower effluent limitations established under the proposed permit will require stricter source controls to ensure compliance.

4.2.4.4 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 are held, characterized, and authorized by S&EP Division before disposal.

The new 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. The data for these process discharges showed that silver from Building 197B exceeded BNL's SPDES permit limitation established for the STP discharge. Silver concentrations in the photographic developing operations ranged from non-detectable to 140 µg/L. Installing digital photographic equipment in this facility in CY 1996 should reduce the silver contributions from this facility.

To further characterize the effluents discharged into the head works of the STP, the waste-water sampling and characterization project started in 1993 was continued in 1995. In 1995, samples were collected by BNL personnel from ten locations and analyzed by a NYSDOH certified contractor laboratory for contaminants expected to be present. The list of analytes for each discharge was based upon departmental surveys distributed in 1992 and subsequent tours and inspections of facilities. No contaminants were identified

Table 4 - 4
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant (STP) [a]
Average Water Quality and Metals Data

	STP Influent				STP Effluent			
	N	Min.	Max.	Avg.	N	Min.	Max.	Avg.
pH (SU) (b)	NA	5.5	9.3	NA	NA	5.9	7.2	NA
Conductivity (umhos/cm)				(c)	251	176.5	380	263.6
Temperature (C)	260	14	25	21	251	3.6	26.9	16.2
Results in mg/L								
Dissolved Oxygen	NA	NA	NA	NA	251	5.8	13.5	9
Chlorides	NA	NA	NA	NA	44	23	53.2	35.4
Nitrate (as N)	NA	NA	NA	NA	44	1.1	8.3	5
Sulfates	NA	NA	NA	NA	44	6.7	18.8	15
Chlorine Residual	NA	NA	NA	NA	251	0	0.16	0.03
Silver	11	<0.025	<0.025	<0.025	11	<0.025	<0.025	<0.025
Cadmium	11	<0.0005	<0.0005	<0.0005	11	<0.0005	<0.0005	<0.0005
Chromium	11	<0.005	<0.005	<0.005	11	<0.005	<0.005	<0.005
Copper	11	<0.05	0.17	0.074	11	0.055	0.1	0.071
Iron	11	0.25	0.54	0.34	11	0.11	0.2	0.15
Manganese	11	<0.05	<0.05	<0.05	11	<0.05	<0.05	<0.05
Mercury	10	<0.0002	0.00021	<0.0002	10	<0.0002	0.0006	<0.0002
Sodium	11	27.9	37.9	33.8	11	28	40.4	34.9
Lead	11	0.003	0.008	0.005	11	<0.002	0.0053	<0.002
Zinc	11	0.034	0.094	0.049	11	<0.02	0.19	0.048

N: No. of samples.
NA: Not Applicable.
(a): The locations of the monitoring stations are shown on Figure 4 -2.
(b): The pH values are those recorded by the STP operators and are continuously monitored.
(c): Continuously monitored.

Maximum Effluent Concentration of Copper

Discharged from BNL's STP, 1991 - 1995

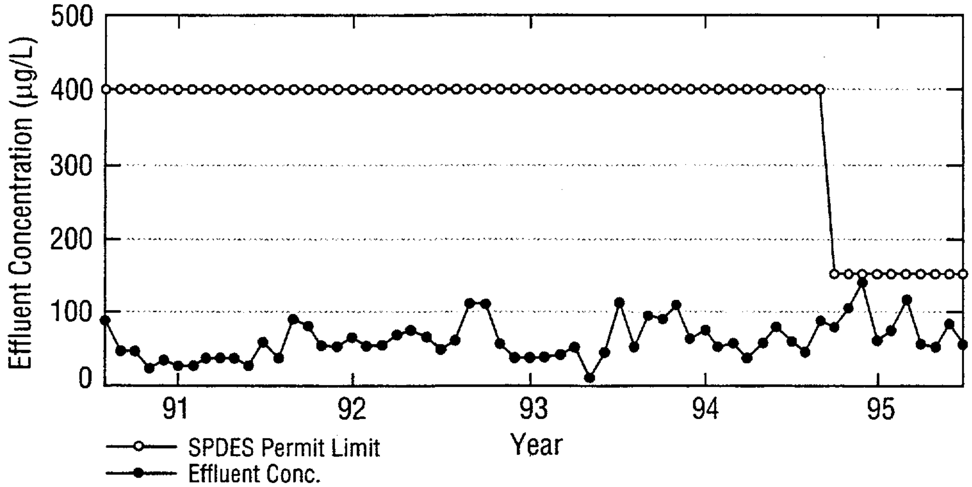


Figure 4 - 6

Maximum Effluent Concentration of Lead

Discharged from BNL's STP, 1991 - 1995

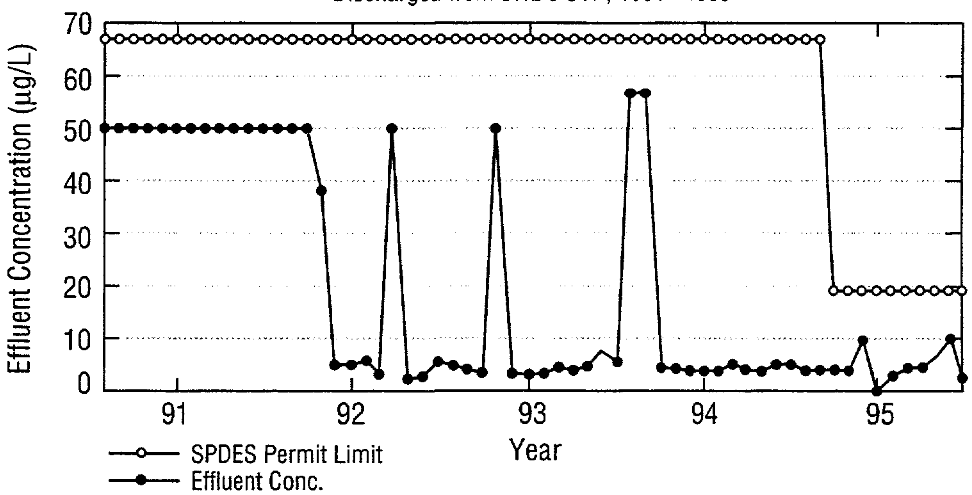


Figure 4 - 7

Maximum Effluent Concentration of Silver

Discharged from BNL's STP, 1991 - 1995

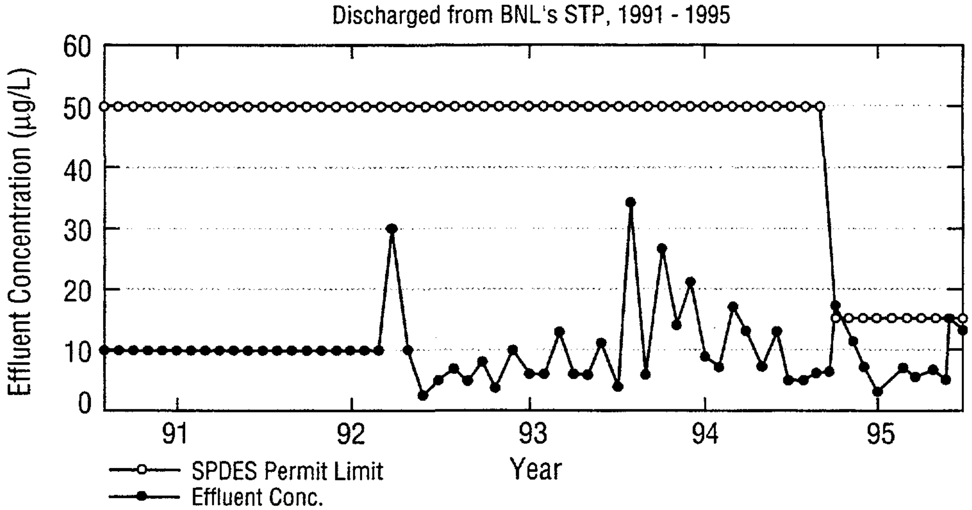


Figure 4 - 8

Maximum Effluent Concentration of Zinc

Discharged from BNL's STP, 1991 - 1995

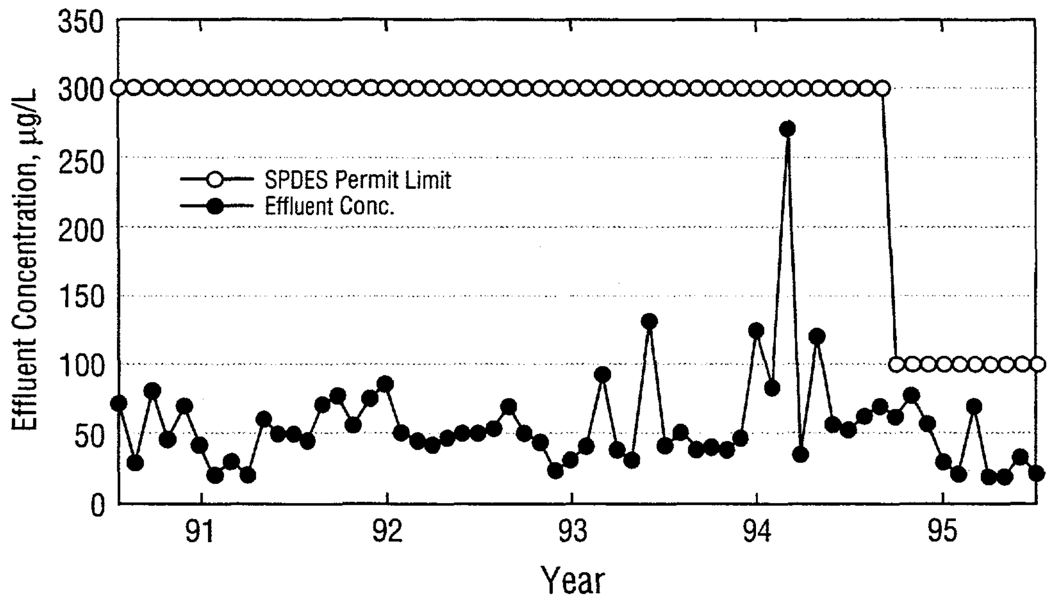


Figure 4 - 9

Maximum Effluent Concentration of Iron

Discharged from BNL's STP, 1991 - 1995

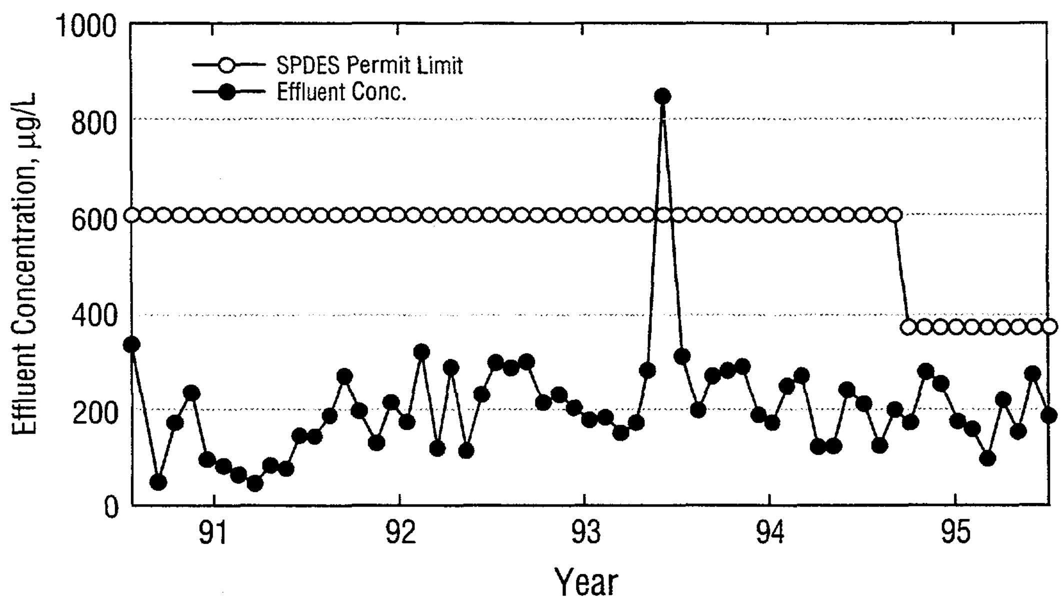


Figure 4 -10

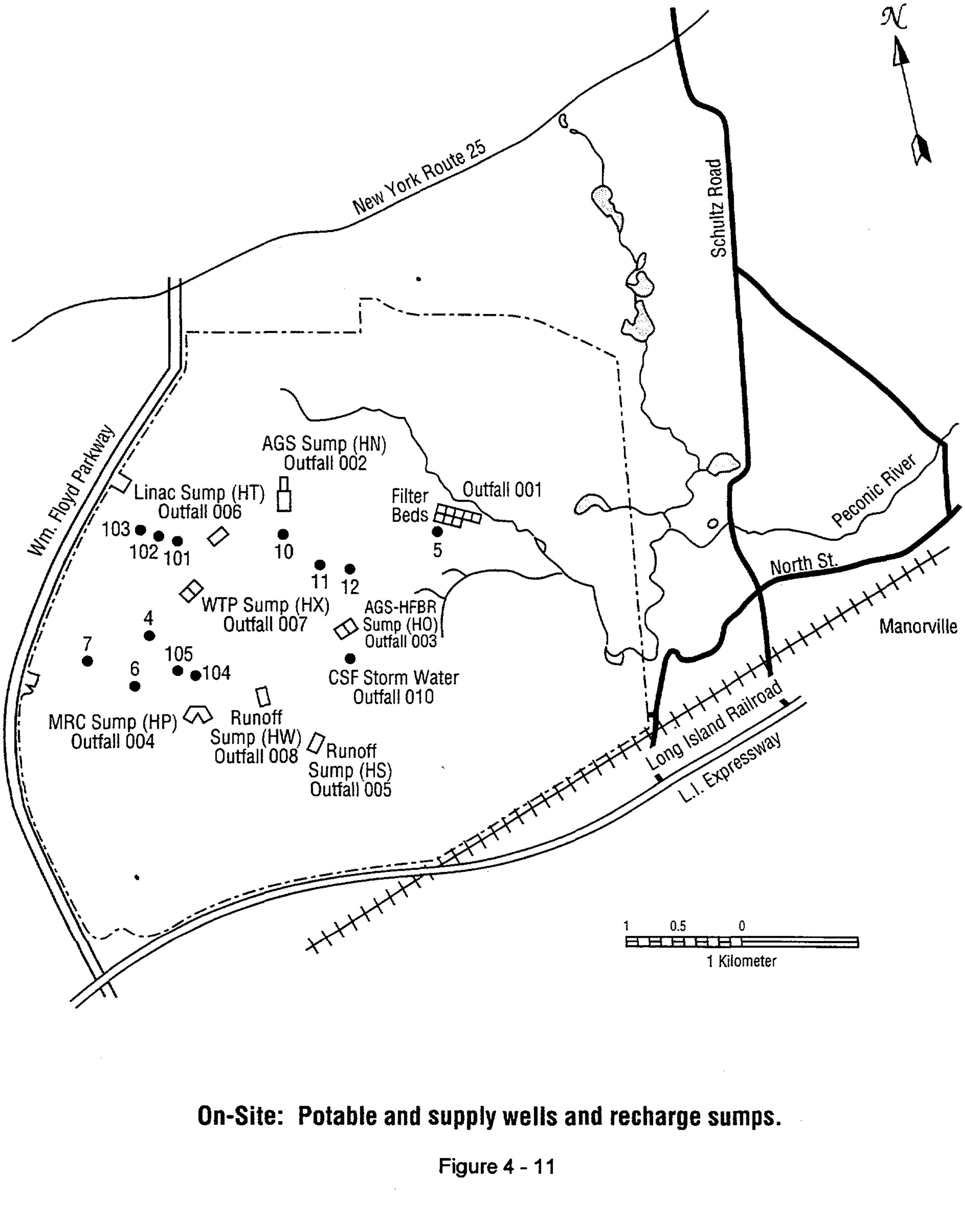
during this project outside those already permitted for discharge under the new SPDES permit. Copper was common in many of the discharges and ranged in concentration from 40 µg/L to approximately 3.0 mg/L; its sources include corrosion products from the potable water system and cooling water systems. Completion of this project, in conjunction with the waste water analyses conducted in 1993, has aided in characterizing the waste waters discharged from major contributors to the BNL STP head works.

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 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 E&OG for disposal guidance.

4.2.4.5 Recharge Basins

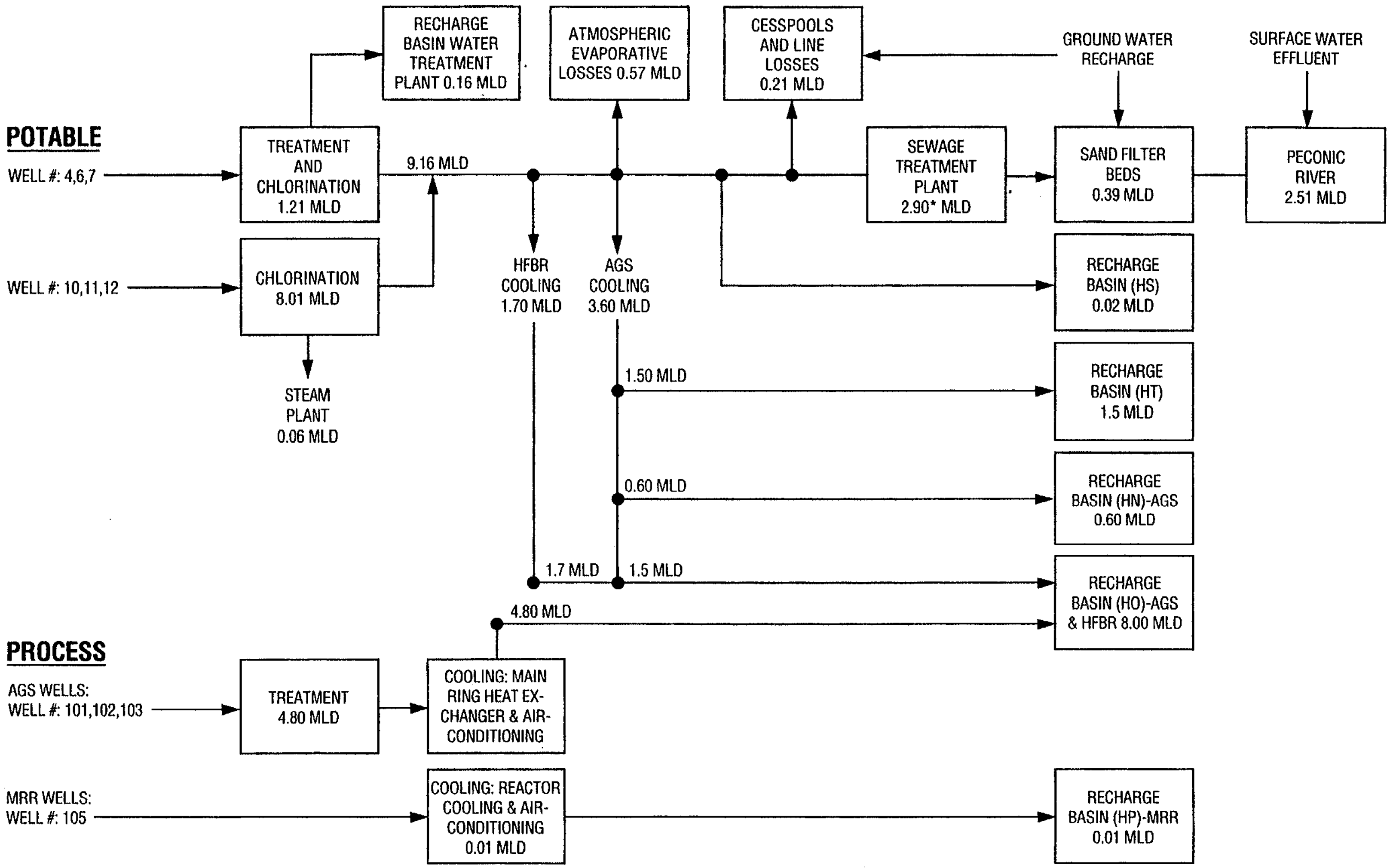
Figure 4-11 depicts the locations of BNL's recharge basins. An overall schematic of water use at the Laboratory is shown in Figure 4-12. After use in "once through" heat exchangers and process cooling, approximately 10.5 MLD of water was returned to the aquifer through on-site recharge basins or cess pools; 0.6 MLD to Basin HN (Outfall 002); 8.0 MLD to Basin HO (Outfall 003); 0.02 MLD to Basin HS (Outfall 005); 1.5 MLD to Basin HT (Outfall 006); 0.16 MLD to Basin HX; and, 0.01 MLD to Basin HP (Outfall 004) which receives discharges from the MRR. Only nominal pumping of Well 105 was conducted during 1995 in anticipation of the restart of this well in 1996; consequently, this discharge was not sampled . All other cooling water for the MRR was supplied by the Chilled Water Facility. 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.

In the spring of 1995, the PE Division constructed and started the operation of monitoring stations at four of the eight recharge structures. These devices include a flow-metering device (i.e., a parshall flume or weir) and a monitoring shed which houses flow-recording devices and a sample collection system. The flow recording devices consists of a flow measuring system (i.e., ultrasonic sensor or area-velocity meter) and a chart recorder. 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 4.8 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



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

Figure 4 - 11



NOTE: WELL #104 WAS NOT OPERATING.

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

BROOKHAVEN NATIONAL LABORATORY SCHEMATIC OF WATER USE AND FLOW FOR 1995.

Figure 4- 12

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. The combined discharge from both the AGS and HFBR averaged 8.0. MLD.

During 1995, water samples were collected from Basins HN, HO, HS, HT, HW, HX and the CSF storm water outfall. No samples were collected at Basin HP due to a lack of significant flow at this location. As required by the BNL SPDES permit, each recharge basin was sampled monthly and quarterly for SPDES-specified parameters. Chapter 2 discusses the SPDES compliance data.

In addition to the analysis of regulatory compliance samples, the S&EP Division also monitored the recharge basins for radiological, water quality, volatile organics, and metallic constituents in 1995. A description of this monitoring program follows.

4.2.4.6 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 chromium-51, vanadium-48 and zinc-65. Full results of the analyses for such gamma-emitting nuclides are presented in Table 4-5. Because of their extremely low concentrations, several of the radionuclides detected at Basin HN were below the MDL for the analysis. Also, while cobalt-58 and -60 are indicated in the results for Basin HW, the observed values are at or below the detection limit; the identification of these nuclides is most likely spurious. In the case of other measured radionuclides, all were far below applicable DCGs.

4.2.4.7 Recharge Basins - Nonradiological 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 from the recharge basins were analyzed for water quality parameters, metals and volatile organic compounds (VOCs). The water quality and metals data are summarized in Tables 4-6 and 4-7, respectively. For VOCs, only trace concentrations (i.e., 2 μg/L or less) of chloroform were detected in the samples collected from Basins HN, HO, and HT. Chloroform probably is present in these samples as a potable-water chlorination by-product. Concentrations of TCA were also detected at trace levels (i.e., < 1 μg/L) in two samples collected at Basin HT.

The analytical data in Tables 4-6 and 4-7 shows all parameters, except for iron at Basins HO, HW and HS, and pH at Basin HO, to comply with the respective groundwater discharge standards. Effluents to Basin HO contain elevated levels of iron due to the discharge of groundwater used in once-through cooling-water systems. Groundwater used for cooling at the AGS contains elevated concentrations of naturally occurring iron which is sequestered in solution to prevent fouling of the heat exchangers. Elevated concentrations of iron in

Table 4-5
BNL Site Environmental Report for Calendar Year 1995
Radiological Analysis of Recharge Basin Water
Gamma Emitting Radionuclides

Basin	Collection Date	Be-7	Co-56	Co-57	Co-58	Co-60	Cr-51	Cs-137	Mn-54	Na-22	V-48	Zn-65
		◄					(pCi/L)					►
HN	8-Mar-95	32.40	ND	0.84	3.45	17.30	ND	ND	ND	ND	ND	ND
HN	8-Jun-95	47.60	0.45	0.80	2.89	0.17	50.10	0.17	0.63	2.47	10.50	3.85
HN	20-Jul-95	289.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HO	8-Mar-95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	8-Jun-95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HT	7-Jun-95	ND	ND	ND	ND	ND	ND	0.25	ND	ND	ND	ND
HS	9-Mar-95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	7-Jun-95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HP	*No samples collected at this basin due to lack of flow in 1995.*											
HW	9-Mar-95	ND	ND	ND	0.24	ND	ND	ND	ND	ND	ND	ND
	7-Jun-95	ND	ND	ND	ND	0.71	ND	ND	ND	ND	ND	ND
Typical MDL		18.3	1.4	0.4	1.6	0.7	58.9	0.7	0.7	0.8	56.2	1.6
DOE Order 5400.5 DCG[1]		1,000,000	10,000	100,000	40,000	5,000	1,000,000	3,000	50,000	10,000	20,000	9,000
SDWA Limit[2]		40,000	400	4,000	1,600	200	40,000	120	2,000	400	800	360

[1] DCG = Derived Concentration guide. The DCG value represents the concentration of a radionuclide in water that would cause a committed effective dose equivalent (CEDE) of 100 mrem if 2 liters a day were ingested for one year.
[2] Concentration required to produce the Safe Drinking Water Act annual dose limit of 4 mrem.
ND: Not Detected
MDL: Minimum Detection Limit

Locations of recharge basins is shown in Figure 4-1.

Table 4 - 6
BNL Site Environmental Report for Calendar Year 1995
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	11	10	6	2	2	2
(RHIC Recharge)	Min.	6.9	11.2	146	21.8	12.6	<1.0
	Max.	7.7	22.9	233	21.9	15.8	<1.0
	Avg.	NA	18.4	190	21.85	13.9	<1.0
HO	N	11	10	5	2	2	2
(HFBR-AGS)	Min.	5.8	6.8	111	17.8	9.5	<1.0
	Max.	8.9	21.9	240	21.6	12.1	<1.0
	Avg.	NA	15.9	160	19.7	10.8	<1.0
HS	N	12	9	4	2	2	2
(Storm Water)	Min.	6.6	4	82	7	5	<1.0
	Max.	8.2	26.7	92	9	8.4	<1.0
	Avg.	NA	14.7	86.6	8	6.7	<1.0
HT (c)	N	22	20	12	4	6	6
(LINAC)	Min.	6.5	9.7	121	15.3	10.3	<1.0
	Max.	8.5	24.6	200	26.6	17.7	1.3
	Avg.	NA	18.3	143	20.6	13	<1.0
HW	N	9	8	3	3	3	3
(Weaver Rd.)	Min.	6.6	6.8	65	<4.0	<4.0	<1.0
	Max.	7.8	26.7	131	14.2	9.6	1.2
	Avg.	NA	16.3	97.8	7	<4.0	<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 shown in Figure 4-1.
(b): The holding times specified by the USEPA were exceeded for all nitrate analyses.
(c): Recharge Basin HT is comprised of two discharge structures; consequently, twice as many samples were collected.
(d): No effluent standard specified.

Table 4 - 7
BNL Site Environmental Report for Calendar Year 1995
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	3	Min.	<0.025	<0.0005	<0.005	0.052	<0.075	<0.0002	<0.05	17.9	<0.002	0.032
(RHIC)		Max.	<0.025	<0.0005	<0.005	0.077	0.147	<0.0002	<0.05	18	<0.002	0.096
		Avg.	<0.025	<0.0005	<0.005	0.067	0.092	<0.0002	<0.05	18	<0.002	0.058
HO	2	Min.	<0.025	<0.0005	<0.005	<0.05	1.5	<0.0002	0.19	13.6	<0.002	<0.02
(AGS/HFBR)		Max.	<0.025	<0.0005	<0.005	<0.05	2	<0.002	0.3	15.9	<0.002	0.024
		Avg.	<0.025	<0.0005	<0.005	<0.05	1.8	<0.0002	0.25	14.8	<0.002	<0.02
HS	2	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	4	<0.002	0.077
(Storm Water)		Max.	<0.025	<0.0005	<0.005	<0.05	1.14	<0.0002	<0.05	8.6	0.017	0.101
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.55	<0.0002	<0.05	6.3	0.009	0.09
HT (b)	4	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.5	<0.002	0.022
(LINAC)		Max.	<0.025	<0.0005	<0.005	0.136	0.21	<0.0002	<0.05	22.4	0.005	0.144
		Avg.	<0.025	<0.0005	<0.005	0.08	0.09	<0.0002	<0.05	16	0.002	0.066
HW	4	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	2.1	<0.002	0.036
(Weaver Rd.)		Max.	<0.025	0.0017	0.008	<0.05	0.74	<0.0002	<0.05	10.8	0.048	0.098
		Avg.	<0.025	0.0008	0.005	<0.05	0.3	<0.0002	<0.05	4.9	0.025	0.058
NYSDEC Effluent 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 4-1.
(b): Recharge Basin HT is comprised of two discharge structures.
(c): No effluent standard specified.

the discharges to Basins HS and HW may be attributed to the presence of sediment in storm water run-off, and the high concentration of iron (6,000 - 10,000 mg/Kg) in native soils. The elevated pH reading recorded at Basin HO was attributed to the pH of the potable-water system which, in 1995, was raised to a minimum of 8.0 to reduce its corrosivity. A description of this program is given in Chapter 5.

No water samples were collected from Basin HX and the CSF storm water outfall in 1995 other than those reported in Chapter 2. All basins will be monitored at least quarterly in CY 1996.

4.2.5 Environmental Measurements and Analyses

4.2.5.1 External Radiation Monitoring

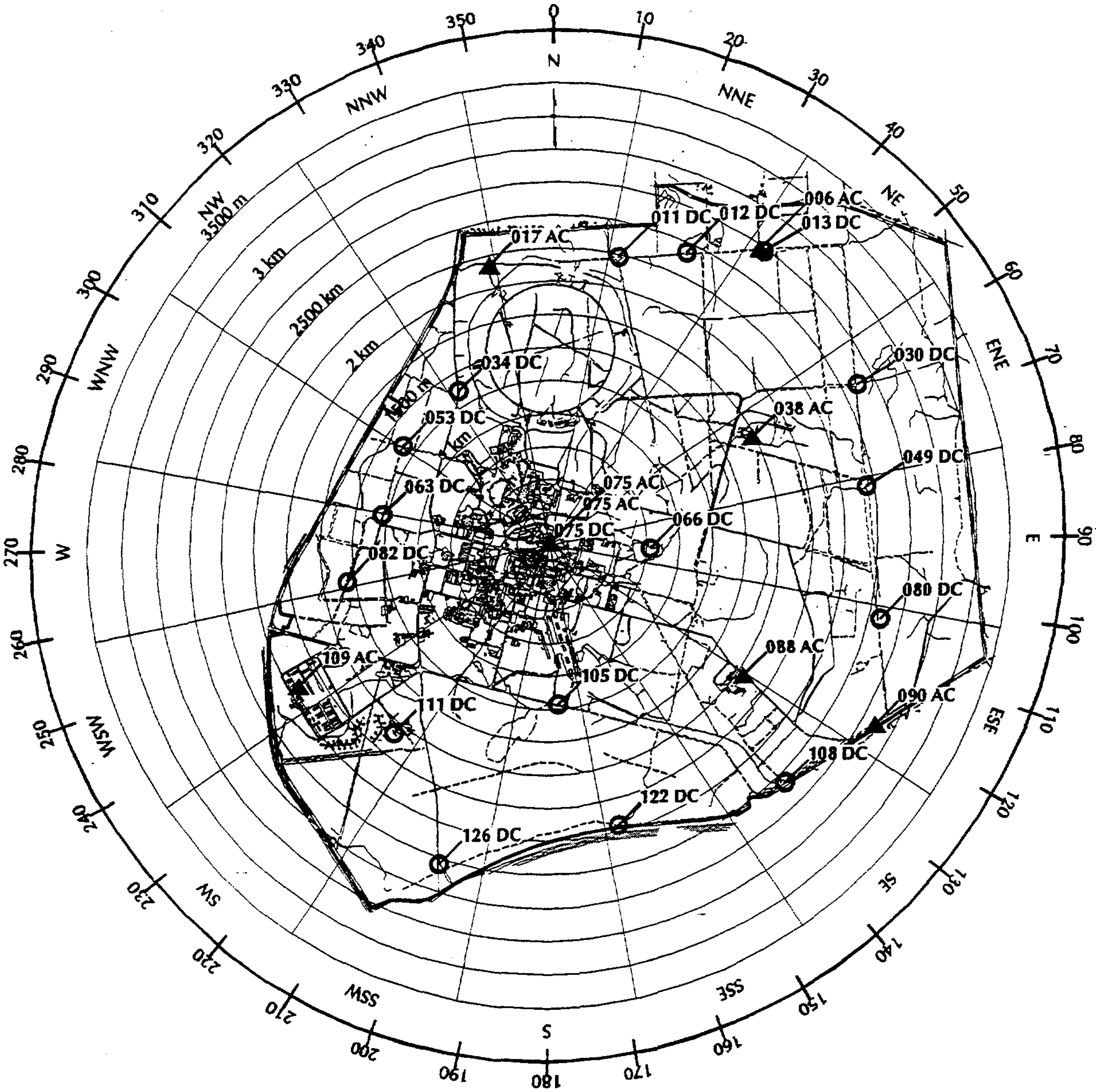
BNL conducts measurements of environmental background radiation through a network of dosimeter units placed at the site boundary. These units, called thermoluminescent dosimeters, or *TLDs*, measure gamma radiation which originates from cosmic and terrestrial sources (see Section 4.1 for discussion) 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 4-13). In addition to the dosimeters located on Laboratory property, 25 off-site locations are also monitored (see Figure 4-14). 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 1995 TLD data are summarized in Table 4-8.

The average off-site external radiation dose value was 65 ± 6 mrem/yr (0.65 ± 0.06 mSv/yr). (The "±" value represents the standard deviation for the group of measurements.) This is consistent with the value of 69 ± 6 mrem/yr (0.69 ± 0.06 mSv/yr) measured in 1994. These levels are typical of those measured throughout the northeastern part of the United States (NCRP, 1987). The average on-site external radiation dose rate was 70 ± 6 mrem/yr (0.07 ± 0.06 mSv/yr). This is also well within the normal background exposure range. These measurements do not include exposure due to internally deposited radionuclides or radon.

4.2.5.2 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 4-1). HTO is collected by using a pump to draw 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.



Brookhaven National Laboratory
Location of On-site TLDs

Figure 4 - 13

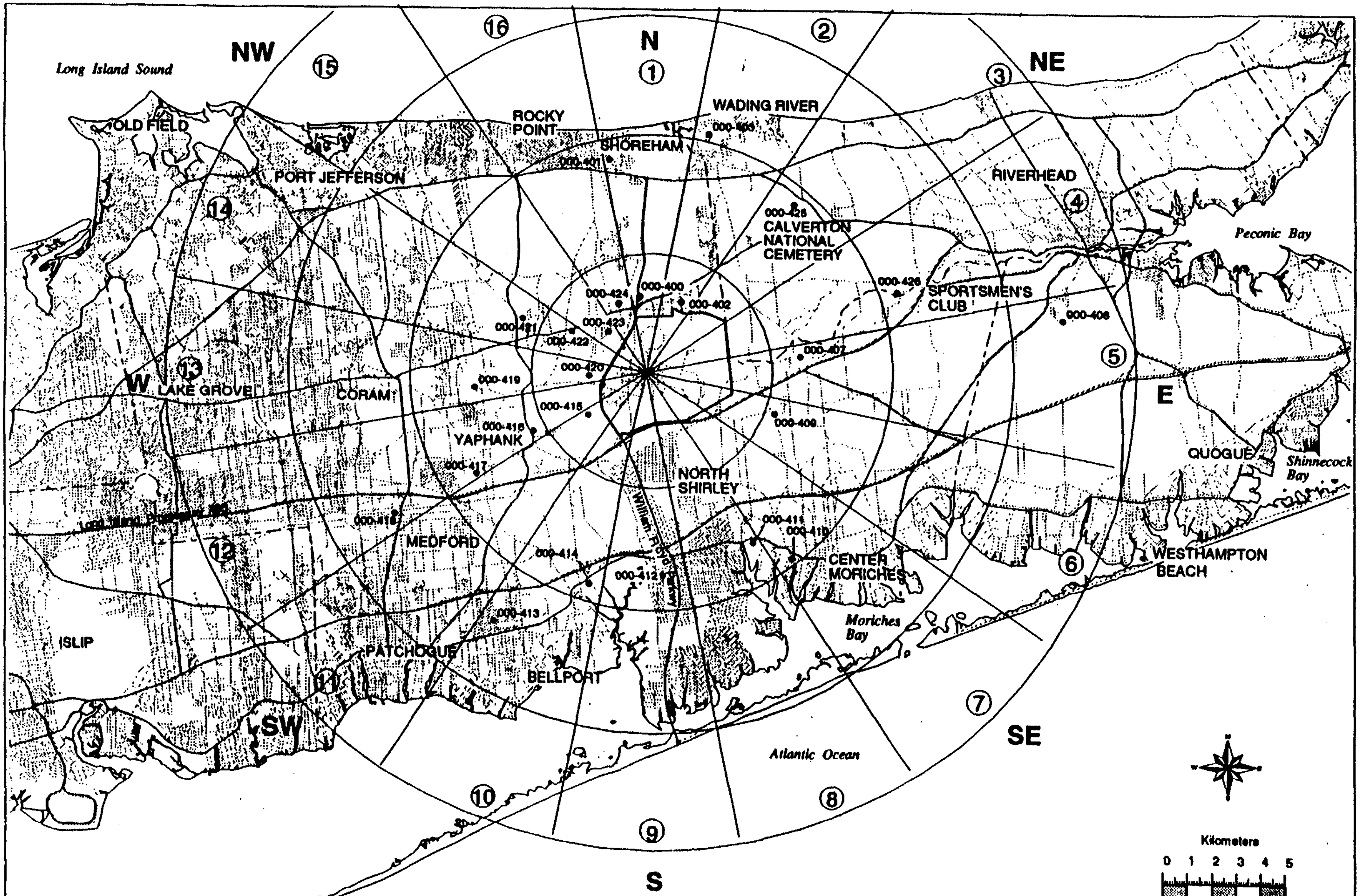


Figure 4 - 14

Location of Off-Site TLDs

Table 4-8
BNL Site Environmental Report for Calendar Year 1995
External Dose Equivalent Rates for All TLD Locations

Location	Old ID	No. of Samples	Exposure Period (days)	Annual Dose (mrem/yr)
000-400	1T3.0	4	381	58
000-401	1T8.8	4	354	58
000-402	2T3.2	3	275	71
000-403	2T10.5	4	368	73
000-404	3T8.8	4	372	59
000-405	4T7.5	4	372	62
000-406	5T4.2	3	258	57
000-407	5T6.5	3	272	58
000-408	5T17.1	4	375	64
000-409	6T5.1	4	370	63
000-410	7T9.7	4	370	61
000-411	8T8.0	4	362	68
000-412	9T8.3	4	360	72
000-413	10T12.0	4	362	70
000-414	10T9.3	4	369	70
000-415	11T3.7	4	358	61
000-416	12T5.0	4	365	62
000-417	12T7.2	4	363	64
000-418	12T12.5	2	177	76
000-419	12T2.8	4	365	65
000-420	13T2.6	4	369	69
000-421	14T5.6	4	370	74
000-422	14T3.1	4	369	68
000-423	15T3.0	3	297	62
000-424	16T3.4	1	92	58
011-400	1T	3	272	60
013-400	2T	4	364	62
017-400	16T2.1	4	364	62
030-400	3T	4	364	64
034-400	15T	4	364	71
034-401	15T1.4	3	275	77
037-400	S13	3	272	78
038-450	S6	4	364	66
049-400	4T	4	364	61
053-400	14T	4	364	76
063-400	13T	4	364	75
066-400	N/A	2	181	64
073-400	13T1.4	4	364	76
074-451	Bldg 907	3	275	65
080-400	5T	4	364	72
082-400	12T	4	364	79
090-400	6T2.8	4	364	69
105-400	N/A	4	364	77
108-450	N/A	4	364	74
109-400	10T1.8	4	364	71
111-400	10T	4	364	73
122-400	N/A	4	364	68
123-400	8T2.3	2	183	60
126-400	9T	4	364	73
Annual Average, all locations:		67	+/- 6 mrem	
Annual Average, on-site locations:		70	+/- 6 mrem	
Annual Average, off-site locations:		65	+/- 6 mrem	

See Figure 4-14.

Table 4-9 lists the number of samples collected at each location, the minimum value observed, the maximum value observed, and the annual average concentration. Negative values in the "minimum" column indicate results that were actually below the background value for the analysis; this is equivalent to non-detection. 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 122, the Laboratory's southern boundary. The calculated airborne concentration was 78 pCi/m^3 (2.9 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 seven out of 45 samples collected at the Grid 122 station showed results above the MDL throughout 1995.

4.2.5.3 Airborne Radionuclide Monitoring

As part of the environmental air monitoring program, six stations are in place around the BNL site which sample the air for radioactive content. Glass fiber filter paper is used to capture airborne particulate matter and triethylene-diamine (TEDA) 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 and analyzed for gamma-emitting radionuclides (see Table 4-11).

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".

Particulate filter analysis results are reported in Table 4-10. Annual average gross alpha activity measurements ranged from <0.01 to 0.03 pCi/m^3 (<0.3 to 1.0 mBq/m^3), while gross beta results ranged from 0.02 to 0.07 pCi/m^3 (0.7 to 2.6 mBq/m^3). 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 state and national background levels.

Table 4-9
BNL Site Environmental Report for Calendar Year 1995
Ambient Tritium Concentrations at Site Perimeter

BNL Grid Location	Wind Sector	Samples Collected	Min. (pCi/m^3)	Max. (pCi/m^3)	Avg. (pCi/m^3)
011	NNE	41	-9.4	6.4	0.4
012	NNE	43	-9.8	32.7	1.6
006	NE	23	0.6	36.7	8.9
013	NE	42	-3.3	12.8	1.1
030	ENE	43	-7.3	13.7	-0.1
049	E	43	-6.8	7.3	0.5
066	E	27	-7.0	16.7	3.2
080	ESE	44	-8.9	7.1	0.1
090	ESE	47	-3.8	6.7	0.9
108	SE	43	-6.8	5.0	0.4
122	SSE	45	-7.9	77.9	2.5
105	S	32	-4.9	9.8	1.0
126	SSW	44	-5.5	8.9	0.4
111	SW	45	-5.3	42.0	2.5
109	WSW	45	-6.3	8.5	1.1
063	W	49	-9.6	13.0	0.5
082	W	48	-3.8	5.1	0.4
053	WNW	43	-6.7	14.4	0.6
017	NNW	47	-2.3	10.8	1.1
034	NNW	48	-7.5	21.6	1.0

Note: typical MDL = 4.0 pCi/m^3.
See Figure 4 - 13

Table 4-10
BNL Site Environmental Report for Calendar Year 1995
Gross Alpha, Gross Beta and Gamma-Emitting Radionuclide Activity for Environmental Air Monitoring Stations

Station (Grid)		Alpha	Beta	Bi-211	Be-7	Cs-137	Co-58	I-131	K-40	Pb-214	Ra-224	Ra-226
		←					(pCi/m^3)					→
P9 (006)	Min.	ND	ND	ND	0.073	ND	ND	0.005	0.015	ND	ND	ND
	Max.	0.015	0.114	ND	0.143	ND	ND	0.036	0.021	ND	ND	ND
	Avg.	0.001	0.018	ND	0.096	ND	ND	0.020	0.018	ND	ND	ND
	N	29	29	29	29	29	29	29	29	29	29	29
P2 (017)	Min.	ND	ND	ND	0.089	0.006	ND	ND	0.046	ND	ND	ND
	Max.	0.142	0.106	ND	0.268	0.006	ND	ND	0.046	ND	ND	ND
	Avg.	0.004	0.017	ND	0.169	0.006	ND	ND	0.046	ND	ND	ND
	N	51	50	51	51	51	51	51	51	51	51	51
S6 (088)	Min.	ND	ND	ND	0.090	ND	0.015	0.048	0.026	ND	0.105	0.100
	Max.	0.999	0.150	ND	1.040	ND	0.015	0.048	0.079	ND	0.105	0.100
	Avg.	0.022	0.027	ND	0.276	ND	0.015	0.048	0.057	ND	0.105	0.100
	N	52	50	52	52	52	52	52	52	52	52	52
P7 (090)	Min.	ND	0.004	0.049	0.125	ND	ND	0.067	ND	0.022	ND	ND
	Max.	1.040	0.345	0.049	0.982	ND	ND	0.067	ND	0.022	ND	ND
	Avg.	0.027	0.066	0.049	0.597	ND	ND	0.067	ND	0.022	ND	ND
	N	52	51	53	53	53	53	53	53	53	53	53
P4 (109)	Min.	ND	ND	0.047	0.108	ND	0.007	0.044	0.075	ND	0.215	ND
	Max.	0.123	0.202	0.047	0.557	ND	0.007	0.044	0.075	ND	0.215	ND
	Avg.	0.004	0.023	0.047	0.242	ND	0.007	0.044	0.075	ND	0.215	ND
	N	51	51	52	52	52	52	52	52	52	52	52
S5 (038)	Min.	ND	ND	ND	0.097	ND	ND	ND	0.042	ND	ND	ND
	Max..	0.290	0.110	ND	0.249	ND	ND	ND	0.076	ND	ND	ND
	Avg.	0.008	0.017	ND	0.184	ND	ND	ND	0.064	ND	ND	ND
	N	49	50	50	50	50	50	50	50	50	50	50
Typical MDL		0.005	0.020	0.020	0.043	0.006	0.006	0.020	0.110	0.009	0.008	0.069
DOE Order 5400.5 DCG		NS	NS	NS	40,000	400	2,000	400	900	2,000	4	1

N= Number of samples collected.
MDL = Minimum Detection Limit.
DCG = Derived Concentration Guide.
NS = Not Specified.

Note: The average value quoted represents the average of all instances of the detection of the particular parameter. It does not represent the annual average airborne concentration.

Table 4-11
BNL Site Environmental Report for Calendar year 1995
Gamma-Emitting Radionuclide Activity Detected on Charcoal Filters

Station (Grid)		Be-7	Bi-211	Cs-137	K-40	Pb-212	Pb-214	Ra-224
		◄			(pCi/m^3)			►
P9 (006)	Min.	ND	0.004	ND	0.024	0.001	0.001	ND
	Max.	ND	0.010	ND	0.062	0.001	0.001	ND
	Avg.	ND	0.007	ND	0.043	0.001	0.001	ND
	N	6	6	6	6	6	6	6
P2 (017)	Min.	0.044	ND	0.009	0.314	0.007	0.007	0.069
	Max.	0.476	ND	0.009	1.670	0.011	0.007	0.197
	Avg.	0.260	ND	0.009	0.626	0.009	0.007	0.133
	N	11	11	11	11	11	11	11
S6 (088)	Min.	ND	0.029	0.006	0.090	0.007	0.008	0.017
	Max.	ND	0.029	0.006	1.710	0.007	0.017	0.017
	Avg.	ND	0.029	0.006	0.668	0.007	0.013	0.017
	N	12	12	12	12	12	12	12
P7 (090)	Min.	0.031	ND	0.005	0.277	ND	0.011	0.232
	Max.	0.031	ND	0.007	8.140	ND	0.011	0.232
	Avg.	0.031	ND	0.006	1.075	ND	0.011	0.232
	N	12	12	12	12	12	12	12
P4 (109)	Min.	ND	ND	0.011	0.198	0.014	0.013	ND
	Max.	ND	ND	0.011	0.533	0.015	0.017	ND
	Avg.	ND	ND	0.011	0.368	0.015	0.015	ND
	N	11	11	11	11	11	11	11
S5 (038)	Min.	0.028	0.033	ND	0.152	ND	0.022	ND
	Max.	0.043	0.033	ND	0.426	ND	0.022	ND
	Avg.	0.036	0.033	ND	0.322	ND	0.022	ND
	N	12	12	12	12	12	12	12
Typical MDL		0.048	0.033	0.005	0.033	0.007	0.009	0.073
DOE Order 5400.5 DCG		40,000	NS	400	900	2,000	2,000	4

N= Number of samples collected. DCG = Derived Concentration Guide. NS = Not Specified.
MDL = Minimum Detection Limit. ND = Not Detected.

Note: The average value quoted represents the average of all instances of the detection of the particular parameter. It does not represent the annual average airborne concentration.

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, lead-214, radium-224 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 cesium-137, cobalt-58 and iodine-131, all at levels far below the airborne DCGs and close to the detection limits of the system. Results from the gamma analysis of the charcoal filters showed similar results: cosmogenic and naturally-occurring radionuclides only.

The detection of iodine-131 (half-life = 8 days) is questionable since (1) no corresponding emissions were observed from any on-site facilities during the time period in question, and (2) it was detected on the particulate filters, and not on the charcoal filter as would be expected. One possibility is that the iodine was in a water vapor form, allowing it to be retained on the particulate filter, and preventing its capture in the corresponding charcoal sample. It is also possible that the filters were cross-contaminated with another sample in the analytical lab during handling or processing, providing spurious results.

4.2.5.4 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 4-12 and Figure 4-1). 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.

4.2.5.5 Terrestrial and Ecological Radioactivity Studies

BNL maintains a soil and vegetation sampling plan for the site. A fauna sampling program was implemented in 1992 and the results were reported in the 1992 Site Environmental Report (Naidu, *et al.*, 1993). Since the program calls for sampling to be conducted once every five years, no collections were made in 1995. Similarly, a soil and vegetation collection program was initiated in 1993. This plan calls for sampling every three years, so sampling was not required in 1995. 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 were collected in June, 1995. These samples were analyzed by the BNL ASL for gamma-emitting radionuclides. Results are shown in Table 4-13. No radionuclides attributable to Laboratory operations were detected. Cesium-137 detected in soil and grass samples is typical of levels due to fallout observed in the United States (Golchert and Kolzow 1994).

Table 4-12
BNL Site Environmental Report for Calendar Year 1995
Analysis of Precipitation for Radioactivity

Station (Grid)	Compass Sector	Samples Collected		**Alpha**	**Beta** (pCi/L)	**Tritium**
P4 (017)	WSW	12	Min.	-1.5	-2.8	-338
			Max.	28.8	23.1	408
			Avg.	2.9	6.3	-6
S5 (038)	ENE	12	Min.	-1.5	-3.5	-193
			Max.	57.6	26.6	254
			Avg.	5.7	6.4	48
Typical MDL				7.4	2.2	360

MDL: Minimum Detection Limit.

Table 4 - 13
BNL Site Environmental Report for Calendar Year 1995
Radionuclide Concentrations in Vegetation and Soil Around BNL

Location	Matrix	Sample Date	Be-7 pCi/Kg	K-40 pCi/Kg	Cs-137 pCi/Kg	Ra-226 pCi/Kg	Th-232 pCi/Kg
Yaphank Honor Farm	Soil	6/23/95	477	ND	161	1290	568
NYS Game Farm (Ridge)	Soil	6/23/95	155	4760	97	878	121
Berenzy's Orchard (Northville)	Soil	6/23/95	ND	6510	328	2750	372
Yaphank Honor Farm	Grass	6/23/95	372	5370	ND	ND	ND
NYS Game Farm (Ridge)	Grass	6/23/95	754	3110	22	ND	ND
Berenzy's Orchard (Northville)	Grass	6/23/95	492	4800	ND	ND	ND
Berenzy's Orchard (Northville)	Strawberries	6/23/95	ND	1520	ND	ND	ND
Typical MDL			0.07	0.18	0.01	0.03	0.23

ND: Not Detected; Radionuclide concentration less than the system Minimum Detection Limit (MDL)

4.2.5.6 Peconic River Aquatic Surveillance - Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at six locations: Station HM, the location of the former site boundary, 790 meters downstream of the STP discharge point; Station HQ, 2.1 km downstream from the discharge point; Location HA and HB, 5 km downstream from the discharge point; Location HC, 7 km downstream of the discharge point; and Location HR, 21 km downstream from the discharge point. A control site (Location HH) on the Carmans River in North Shirley, was also sampled. This location does not have the potential to be influenced by BNL liquid effluents. Sampling points along the Peconic River are identified in Figure 4-15. From January through October 1995, routine grab samples at Location HM were collected three times per week. In February 1995, these locations were equipped with Parshall flumes allowing flow proportional sampling and volume measurements to be made by an automated system.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Table 4-14. Average gross beta activity at Station HM was close to the minimum detection limit, and consistent with levels observed at the Carmans River control location. Cesium-137 levels at Station HM were slightly greater than ambient levels, although also close to the limit of detection. Cesium-137 levels observed at Station HM are consistent with those measured at the STP Outfall (see Section 4.2.4). These levels are small fractions of the applicable DCGs. Although a single-day spike in tritium activity (27,400 pCi/L) was observed at HM in July, values throughout the year were consistently between 2,000 and 5,000 pCi/L, i.e., less than 25% of the SDWA limit. Due to continued on-site recharge of the Peconic, no radioactivity attributable to BNL was observed beyond this station.

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 4-16 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 1995, water levels at Station HQ have been below the conduit which transports water from the BNL site to the weir at Station HQ. In the absence of significant flow, no samples could be collected from this location in 1995. Samples from Locations HA, HB, and HC were collected during the second quarter of 1995, where as at HR and HH samples were collected monthly.

4.2.5.7 Peconic River Aquatic Surveillance - Nonradiological Analyses

The Peconic River was sampled at five locations during 1995; one on-site (Sampling Locations HM 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 1995. Location HQ, which is situated along the Peconic River at the BNL site boundary, was not sampled during 1995 due to the low precipitation and the absence of flow.

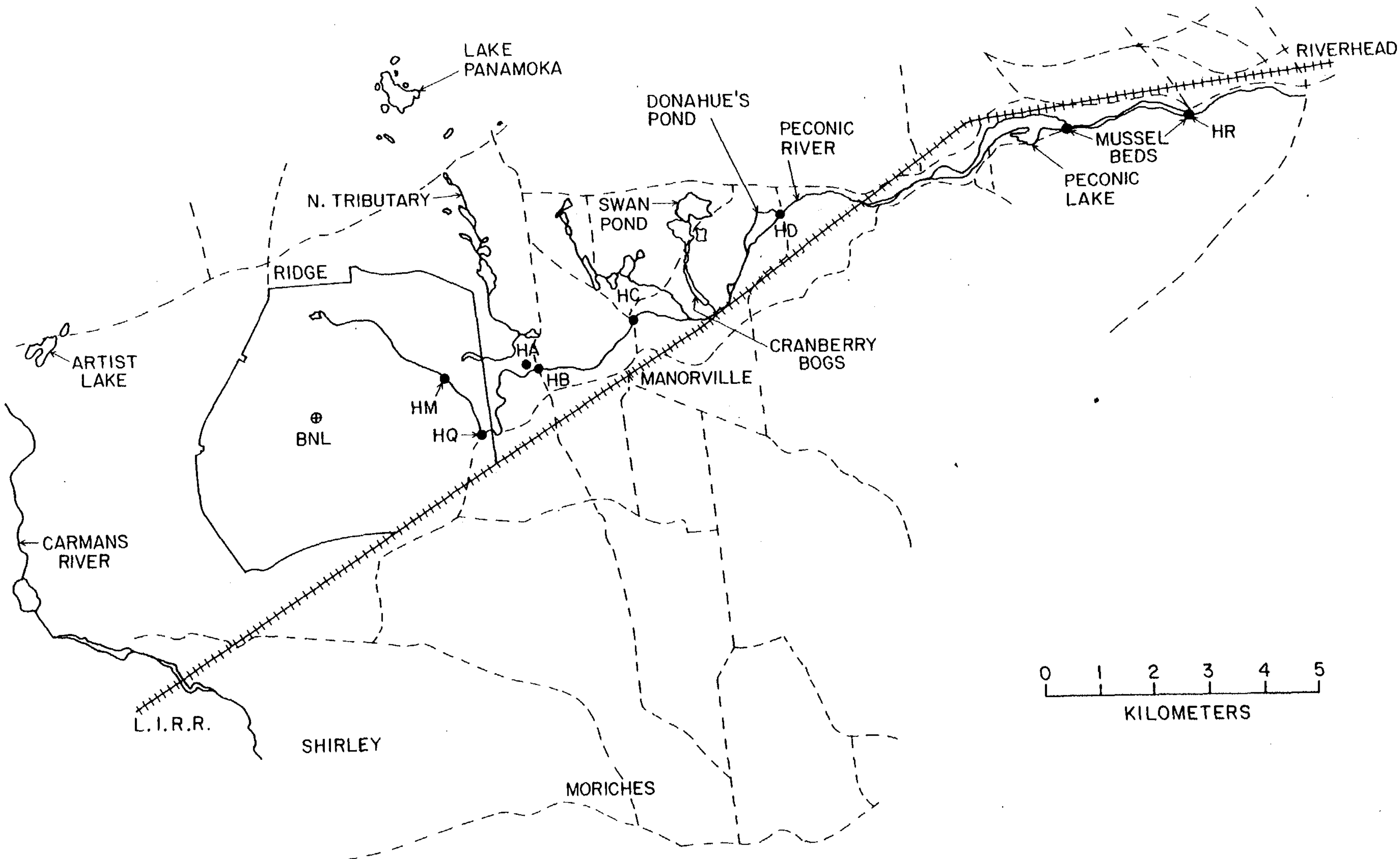


Figure 4 - 15 Peconic River Sampling Stations.

Table 4-14
Annual Gross Alpha, Gross Beta, Tritium, Gamma and Strontium-90 Concentrations in Peconic River and Carmans River

Location		Gross Alpha	Gross Beta	Tritium	Be-7 (pCi/L)	Na-22	K-40	Cs-137	Sr-90
HM	N	150	12	150	4	4	4	4	4
Peconic On-Site	Max.	9.01	7.70(a)	27,400	ND	0.20	4.85	1.18	2.19
	Avg	0.55	1.03	2,541	ND	0.20	3.61	0.87	0.64
HA	N	1	1	1	1	1	1	1	(d)
Peconic Off-Site	Max.	0.55	1.03	-128	ND	ND	ND	0.22	
HB	N	1	1	1	(d)	(d)	(d)	(d)	(d)
Peconic Off-Site	Max.	(b)	(b)	-151					
HC	N	1	1	1	1	1	1	1	(d)
Peconic Off-Site	Max.	(b)	(b)	-160	2.8	ND	2.99	0.14	
HR	N	12	12	12	1	1	1	1	(d)
Riverhead	Max.	45.30	11.40	334	ND	ND	3.64	ND	
	Avg	4.14	1.43	-62	ND	ND	3.64	ND	
HH (Control)	N	12	12	12	1	1	1	1	(d)
Carmans River	Max.	2.00	6.36	228	ND	ND	ND	ND	
	Avg	0.53	1.53	-106	ND	ND	ND	ND	
DOE Order 5400.5 DCG		NS	NS	20000(c)	1000000	10000	7000	3000	8(c)
Typical MDL		0.9	2.5	380	1.6	0.2	3.0	0.2	0.1

(a) Gross beta measurements for HM from January through November were voided following QA review. Data from December shown. See Chapter 7 for discussion.
(b) Data voided based on QA review.
(c) NYS Drinking Water Standard shown.
(d) Location not sampled for this analyte.

NS: Not Specified.
MDL: Minimum Detection Limit.
N: Number of samples collected for particular analyte.

Notes:
1. There was no signiifcant flow at Location **HQ** (site boundary). No samples were collected.
2. Location **HH** is a control location used to indicate typical background values.

STP Liquid Flow Data

Ten Year Trend, 1985 - 1995

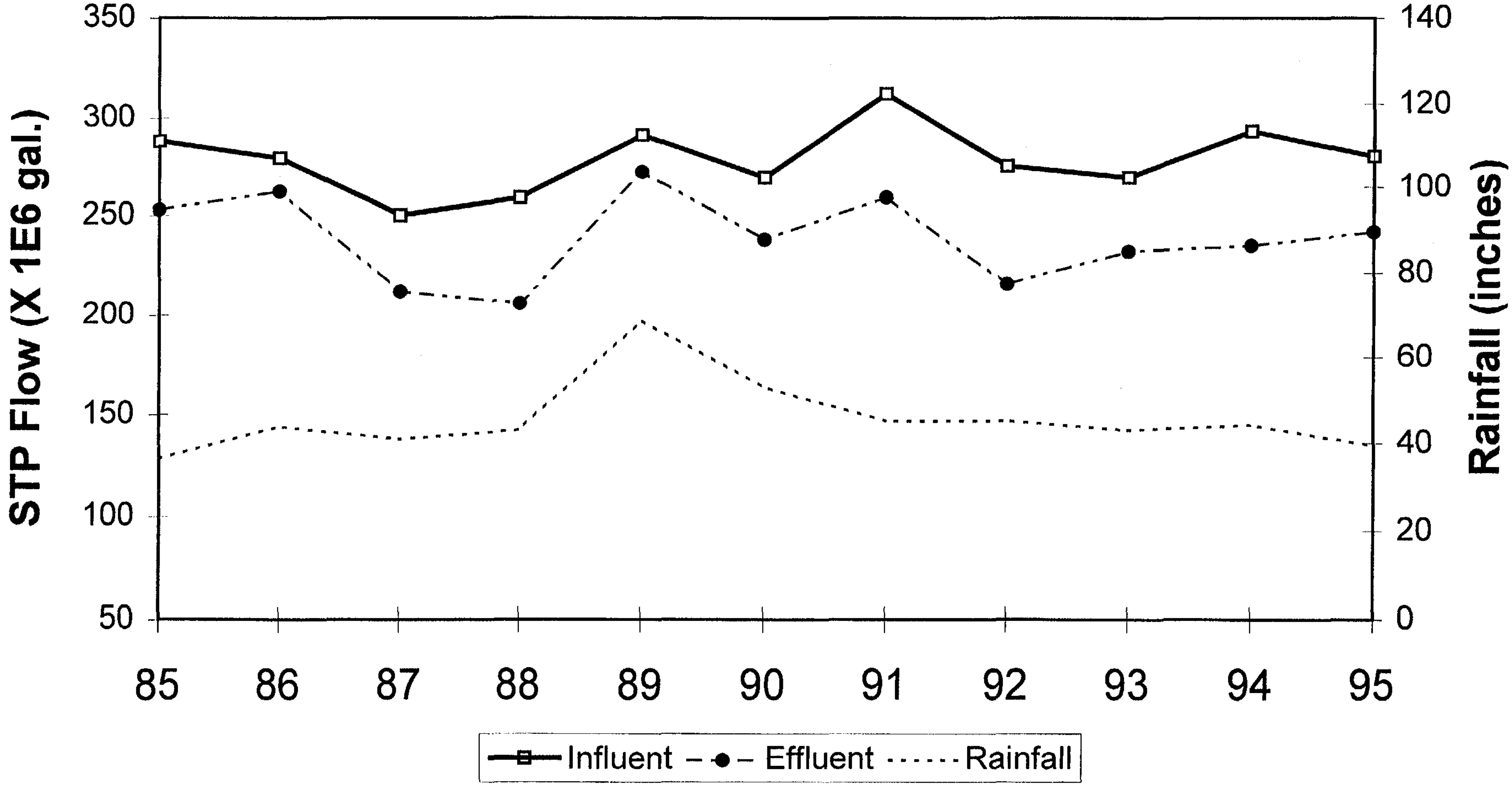


Figure 4-16

A summary of water quality and metals analytical data for these surface waters is given in Tables 4-15 and 4-16, respectively. Location HM which is located down stream of the BNL STP has characteristics very similar to the STP discharge. All water quality parameters, except pH, were well within the BNL SPDES effluent standards and/or NYS AWQS for a Class C water system. Locations HA, HB, HC, and HR are at various points along the Peconic River, off-site and downstream 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 metals concentrations except iron, are well below the revised SPDES effluent limitations established by the NYSDEC for discharges to the Peconic River and/or NYS AWQS. Iron was above the SPDES limits at several locations, most probably due to the naturally high concentrations of iron in groundwater and native sediments.

During 1995, all surface waters were analyzed for VOC contamination by the S&EP Division analytical laboratory. With the exception of a single chloroform concentration of 2.3 µg/L detected at location HM, no VOCs were detected above the laboratory detection limit of 2 µg/L in samples from the Peconic or Carmans River stations. Trace (i.e., < 1 µg/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.

4.2.5.8 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 1995, fish samples were collected at Donahue's Pond and Forge Pond (see Figure 4-15). Control samples were collected from the Carmans River and Swan Pond. Specific information regarding the sampling point, distance from the BNL effluent release point, species of fish collected and analytical results are presented in Table 4-17. 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. Only gamma spectroscopy analysis was performed on these samples.

Cesium-137 (half-life = 30 years) and other fission-produced radionuclides are detectable throughout the environment of the northern hemisphere as a result of global fallout. This must be taken into account when attempting to distinguish BNL-related radionuclide levels from existing environmental levels. Therefore, the results of all aquatic biota analyses are background-subtracted, that is, the radionuclide concentrations seen in fish taken at control locations are subtracted from those of samples collected from the study area, yielding a net result.

Fish collected from Forge Pond and Donahue's Pond indicate that cesium-137 is present in concentrations ranging from 1 to 30 times those of control samples. Net cesium-137 concentrations ranged from near background levels at Forge Pond of 13 to 303 pCi/kg (0.5 to 11.2 Bq/kg) wet, to 615 pCi/kg (23 Bq/kg)wet, at Donahue's Pond. The presence of cesium-137 at these levels is indicative of a BNL contribution

Table 4-15
BNL Site Environmental Report for Calendar Year 1995
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	HM	N	144	144	144	139	43	43	43
		Minimum	5.2	112.4	0.8	4.2	25.9	13	2.3
		Maximum	6.9	349	27.2	12.2	59	16.7	6.4
		Average	NA	243	13.7	8.2	36	15	4.2
	HQ	N	0	0	0	0	0	0	0
		Concentration	NA	NA	NA	NA	NA	NA	NA
	HA	N	1	1	1	1	1	1	1
		Concentration	4.6	46.4	7.4	9	5.5	5.6	<1.0
	HB	N	1	1	1	1	1	1	1
		Concentration	4.8	48.8	6.2	9	6.4	5.8	<1.0
	HC	N	1	1	1	1	1	1	1
		Concentration	5.8	63.2	9.3	9.2	8	7.2	<1.0
	HR	N	11	7	9	7	1	1	1
		Minimum	6	102	1	8.8	13.2	7.2	<1.0
		Maximum	7.6	118	25.4	12.2	13.2	7.2	<1.0
		Average	NA	112	12.9	10.4	13.2	7.2	<1.0
Carmans	HH	N	10	6	8	5	1	1	1
		Minimum	6	135	2.1	8.1	23.7	9.6	<1.0
		Maximum	7.5	158	22.1	11.5	25	10.3	1.6
		Average	NA	147	12	9.2	24.4	10	<1.0
NYS AWQS (b)			6.5 - 8.5	(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 4 -15.
(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 4 - 16
BNL Site Environmental Report for Calendar Year 1995
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	HM	N	11	11	11	12	12	11	11	11	12	11
		Min.	< 0.025	<0.0005	<0.005	<0.05	< 0.075	<0.0002	<0.05	27.7	<0.002	<0.02
		Max.	<0.025	<0.0005	<0.005	0.07	0.19	<0.0002	< 0.05	39.6	0.0028	0.083
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.13	<0.0002	<0.05	34.4	<0.002	0.036
	HA	N	1	1	1	1	1	1	1	1	1	1
		Result	< 0.025	<0.0005	<0.005	<0.05	0.38	<0.0002	<0.05	3.89	<0.002	0.026
	HB	N	1	1	1	1	1	1	1	1	1	1
		Result	< 0.025	<0.0005	<0.005	<0.05	0.7	<0.0002	0.066	4.3	<0.002	0.029
	HC	N	1	1	1	1	1	1	1	1	1	1
		Result	< 0.025	<0.0005	<0.005	<0.05	0.37	<0.0002	0.05	5.55	<0.002	0.027
	HR	N	1	1	1	1	1	1	1	1	1	1
		Result	< 0.025	<0.0005	<0.005	<0.05	0.24	<0.0002	< 0.05	14.5	<0.002	0.037
Carmans	HH	N	1	1	1	1	1	1	1	1	1	1
		Result	< 0.025	<0.0005	<0.005	<0.05	0.44	<0.0002	0.31	8.7	<0.002	0.091
NYSDEC SPDES Limit or AWQS			0.015	0.0005	0.00	0.1	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 locations of the Peconic and Carmans River samples are shown on Figure 4 - 15.
(b): There are no SPDES limits or AWQS specified for these compounds.

Table 4 - 17
BNL Site Environmental Report for Calendar Year 1995
Radionuclide Concentrations in Fish

Sample Location	Distance from BNL Disharge (Km)	Remarks	Sample Date	Species	K-40 Concentration pCi/Kg.wet	Cs-137 Total Concentration pCi/Kg.wet	Cs-137 Net Concentration pCi/Kg.wet
BNL - Onsite (STP Discharge Point)	0	Peconic River Headwaters (STP)	9/25/95	Brown Bullhead	2314	588	567
	0.8	Peconic River St. HM	9/25/95	Chain Pickerel	3257	509	488
Peconic River (Off-Site)	10	Donahue's Pond	9/28/95	Blue Gill	1690	273	252
			4/26/95	Golden Shiner	1629	83	62
			9/25/95	Golden Shiner	1440	66	45
				Golden Shiner	4185	331	310
				Golden Shiner	2313	178	157
			4/26/95	Brown Bullhead	2509	402	381
				Brown Bullhead	1699	431	410
				Brown Bullhead	1843	304	283
				Brown Bullhead	3973	627	606
			9/28/95	Brown Bullhead	1944	314	293
				Brown Bullhead	3975	570	549
				Brown Bullhead	2540	440	419
				Brown Bullhead	1490	272	251
			4/26/95	Carp	1972	204	183
			4/27/95	Chain Pickerel	2137	615	594
			9/28/95	Chain Pickerel	2987	303	282
				Chain Pickerel	2463	519	498
				Chain Pickerel	3096	636	615
	20	Forge Pond	4/27/95	Golden Shiner	1877	34	13
				Golden Shiner	2272	43	22
				Golden Shiner	4384	93	72
				Golden Shiner	2639	71	50
				Golden Shiner	1883	35	14
			9/27/95	Golden Shiner	1792	56	35

NA: Not Applicable to Control Location.

Table 4 - 17 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Radionuclide Concentrations in Fish

Sample Location	Distance from BNL Disharge (Km)	Remarks	Sample Date	Species	K-40 Concentration pCi/Kg.wet	Cs-137 Total Concentration pCi/Kg.wet	Cs-137 Net Concentration pCi/Kg.wet
	20	Forge Pond	4/27/95	Large Mouth Bass	1814	143	122
			4/27/95	Large Mouth Bass	2009	147	126
				Chain Pickerel	1853	129	108
				Chain Pickerel	2296	287	266
			9/27/95	Chain Pickerel	4280	324	303
				Chain Pickerel	2916	123	102
Swan Pond		Control-Adjacent to Peconic River	9/25/95	Golden Shiner	2213	52	NA
				Large Mouth Bass	1366	56	NA
				Yellow Perch	1752	108	NA
				Brown Bullhead	4548	72	NA
				Brown Bullhead	2530	51	NA
Carmans River		Control	4/27/95	Golden Shiner	2149	6	NA
				Blue Gill	2236	17	NA
				Blue Gill	1890	12	NA
				Blue Gill	1744	13	NA
				Blue Gill	1694	16	NA
			9/26/95	Blue Gill	2033	21	NA
				Blue Gill	1950	12	NA
			4/25/95	Brown Bullhead	2339	18	NA
			4/27/95	Brown Bullhead	1984	11	NA
				Brown Bullhead	1784	15	NA
				Brown Bullhead	4320	52	NA
				Brown Bullhead	3219	26	NA
			9/26/95	Brown Bullhead	2492	27	NA
				Brown Bullhead	2128	17	NA
				Brown Bullhead	3845	49	NA
				Brown Bullhead	2461	24	NA
				Eel	1531	32	NA
				Eel	1726	37	NA
				Eel	1813	48	NA

NA: Not Applicable to Control Location.

to the Peconic River system. This is primarily a result of releases which occurred in years past, though cesium-137 continues to be detectable in river samples today due to its relatively long half-life. Once deposited in aquatic systems, cesium-137 is well-retained in sediments (Eisenbud, 1987). Sediments can serve as a repository for radioactive materials which enter the aquatic food chain through bottom-feeding biota (Eisenbud, 1987). Dose projections based on fish consumption are contained in Chapter 6.

Figure 4-17 shows a plot of cesium-137 concentrations in fish caught in Donahue's Pond, 10 km downstream. Results for the Brown Bullhead species have been used in each case to maintain a consistent comparison. 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 radioactive decay (NYSDOH, 1996). Figure 4-18 shows a five year trend of cesium-137 measured in the influent to and effluent from the STP. As evidenced by the extremely low cesium-137 activity in the infuent (typically less than 50 µCi [1.6 MBq]) compared to the effluent, continued low-level emissions from the STP are a result of leachate from the 1988 deposit to the sand filter beds (Miltenberger *et al.*, 1989). It is clear that the primary source of cesium-137 observed in fish taken from the Peconic near BNL continues to be radionuclide deposits in river sediment, present as a result of historic emissions, and not current operations.

4.2.5.9 Biomonitoring: Chronic Toxicity Tests

The Chronic Toxicity Testing program begun in 1993 for the STP effluent was continued in 1995 with the collection and bioassay analysis of three effluent samples. As required by BNL's revised SPDES permit, this program consisted of seven-day Tier II Chronic Toxicity Tests of the BNL STP effluent conducted quarterly, beginning with the second quarter of 1995. 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.

As with previous years, there were no appreciable toxic effects exhibited by the fathead minnow nor water flea in the 100% STP effluent. Testing conducted in April and July showed no chronic toxicity for either the *Ceriodaphnia* or the fathead minnow. Testing in November showed only a minor growth decrease for the fathead minnow kept in the pure STP effluent compared with the control group; consequently a No Observable Adverse Effect Level of 50% was reported for this test. The average dry weight for the fish in the pure STP effluent was 0.49 mg, whereas the control value was recorded as 0.66 mg. The effluent was not toxic for the waterflea in the November test. Toxicity testing of the STP effluent will be continued into the first quarter of 1996, at which time the NYSDEC will evaluate the results to determine the need for additional monitoring.

Cesium-137 Measured in Fish Taken from Donahue's Pond

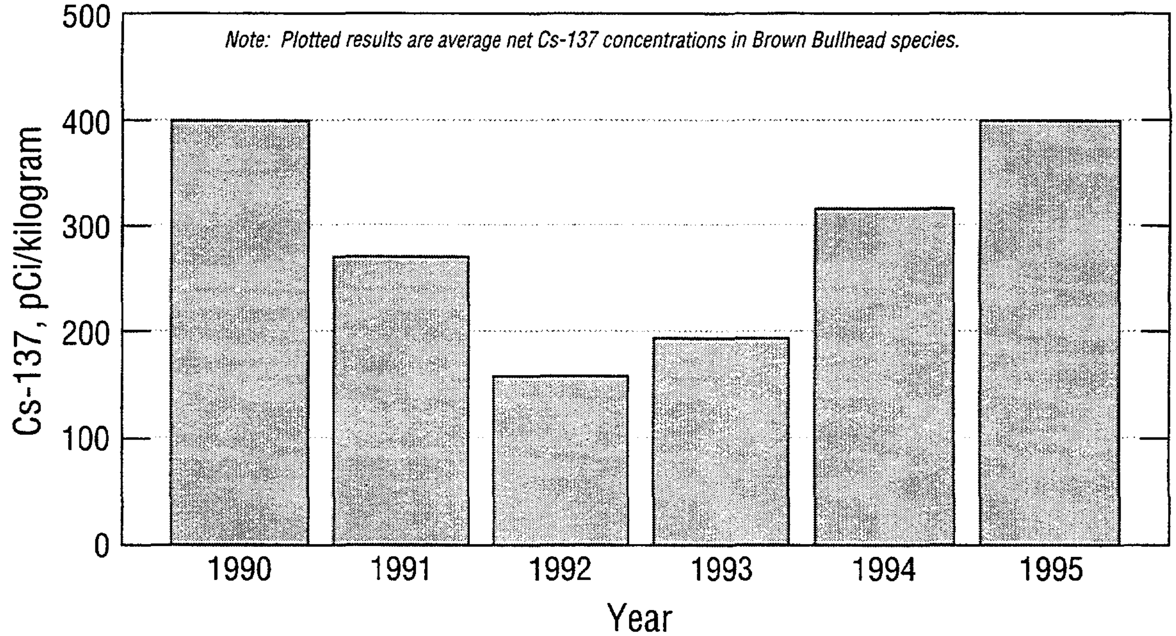


Figure 4 - 17

Cesium-137 in STP Effluent Trend Data, 1990 - 1995

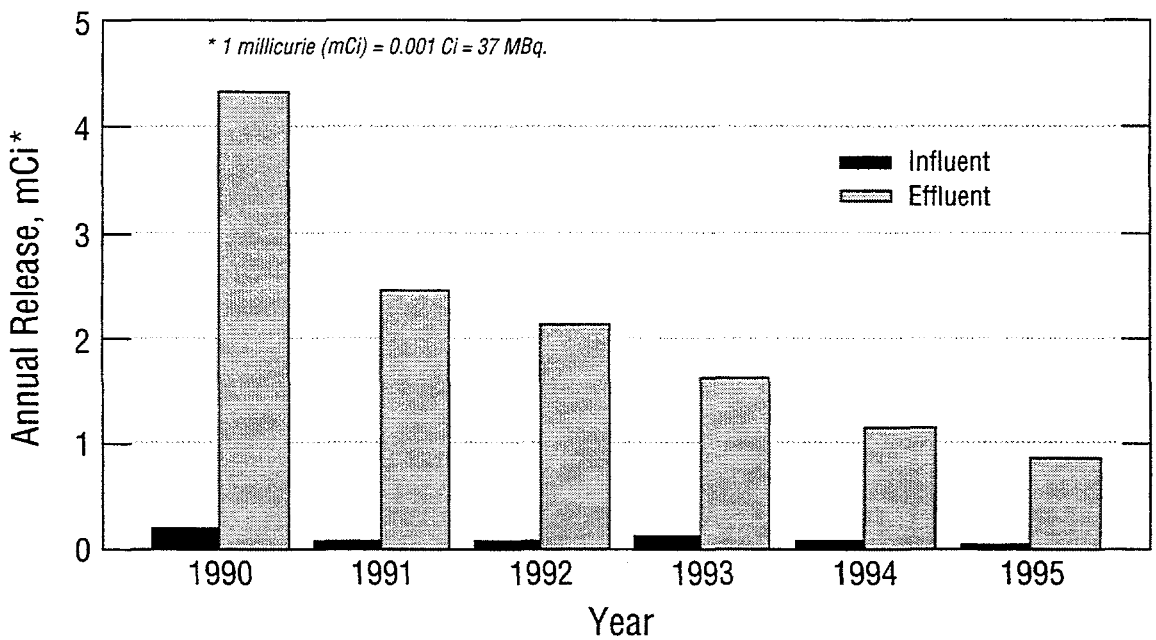


Figure 4 - 18

5.0 GROUNDWATER PROTECTION - D. E. Paquette, G. L. Schroeder J. R. Naidu, and R. J. Lee

Groundwater quality at BNL is being protected through programs designed to minimize future releases of environmental pollutants, and through site remediation carried out under the IAG between the DOE, EPA, and NYSDEC. The IAG provides a framework for remediating contaminated soils and groundwater at BNL.

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 a groundwater and surface water monitoring program so contaminant releases are detected quickly;

5. 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;

6. 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; and,

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

5.1 Groundwater Surveillance

Groundwater quality and flow directions at BNL are routinely monitored through a network of approximately 500 on-site surveillance wells. The surveillance wells generally monitor specific facilities where degradation of the groundwater is known or suspected, to fulfill permit requirements, and at BNL site boundary areas to assess the quality of groundwater entering or leaving the site. The specific facilities include the following: the STP/Peconic River Area; Meadow Marsh-Upland Recharge Area; HWMF area; Current Landfill; Former Landfill; Ash Repository; CSF/MPF; AGS; WCF; Supply and Materiel; and several smaller facilities.

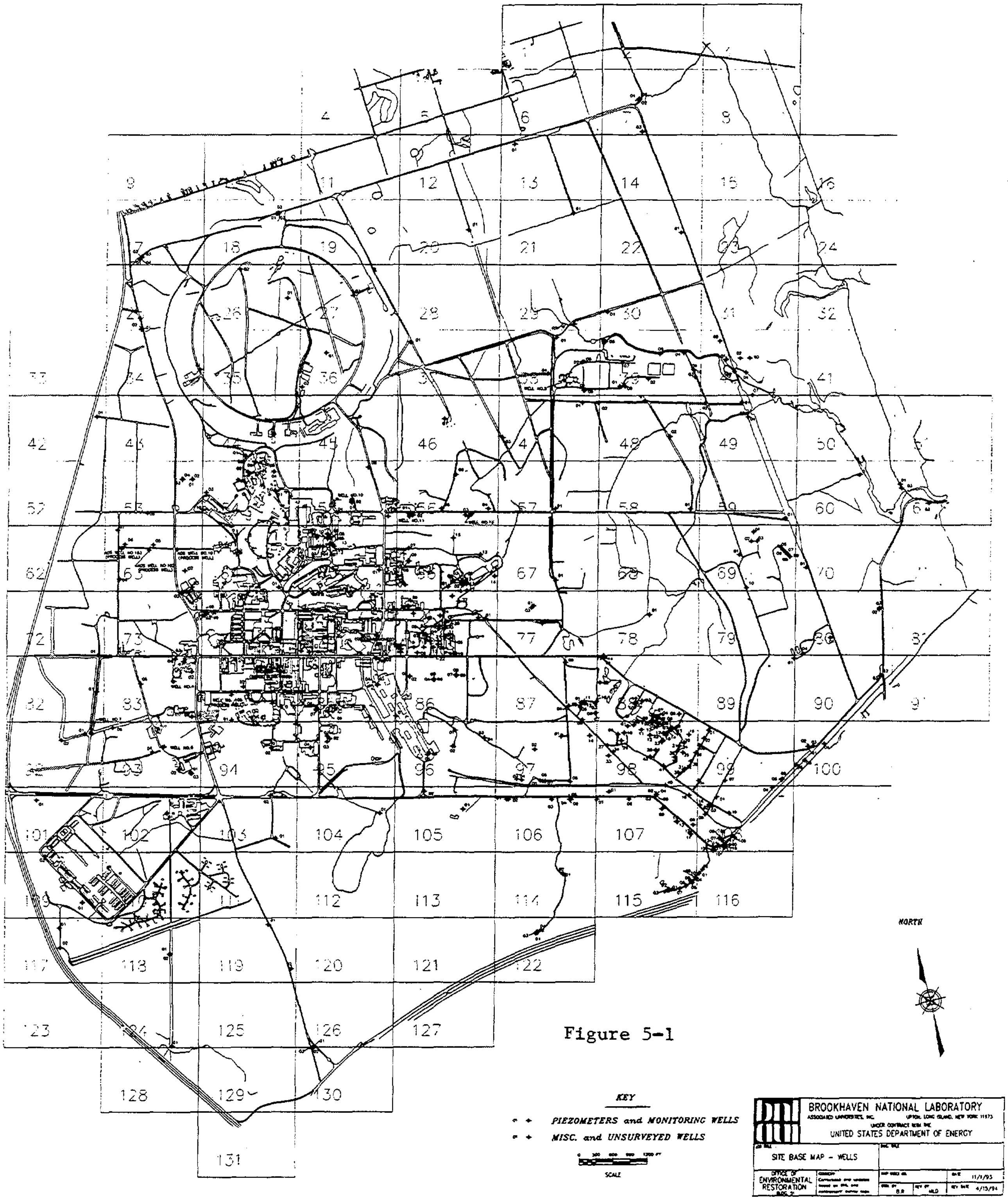
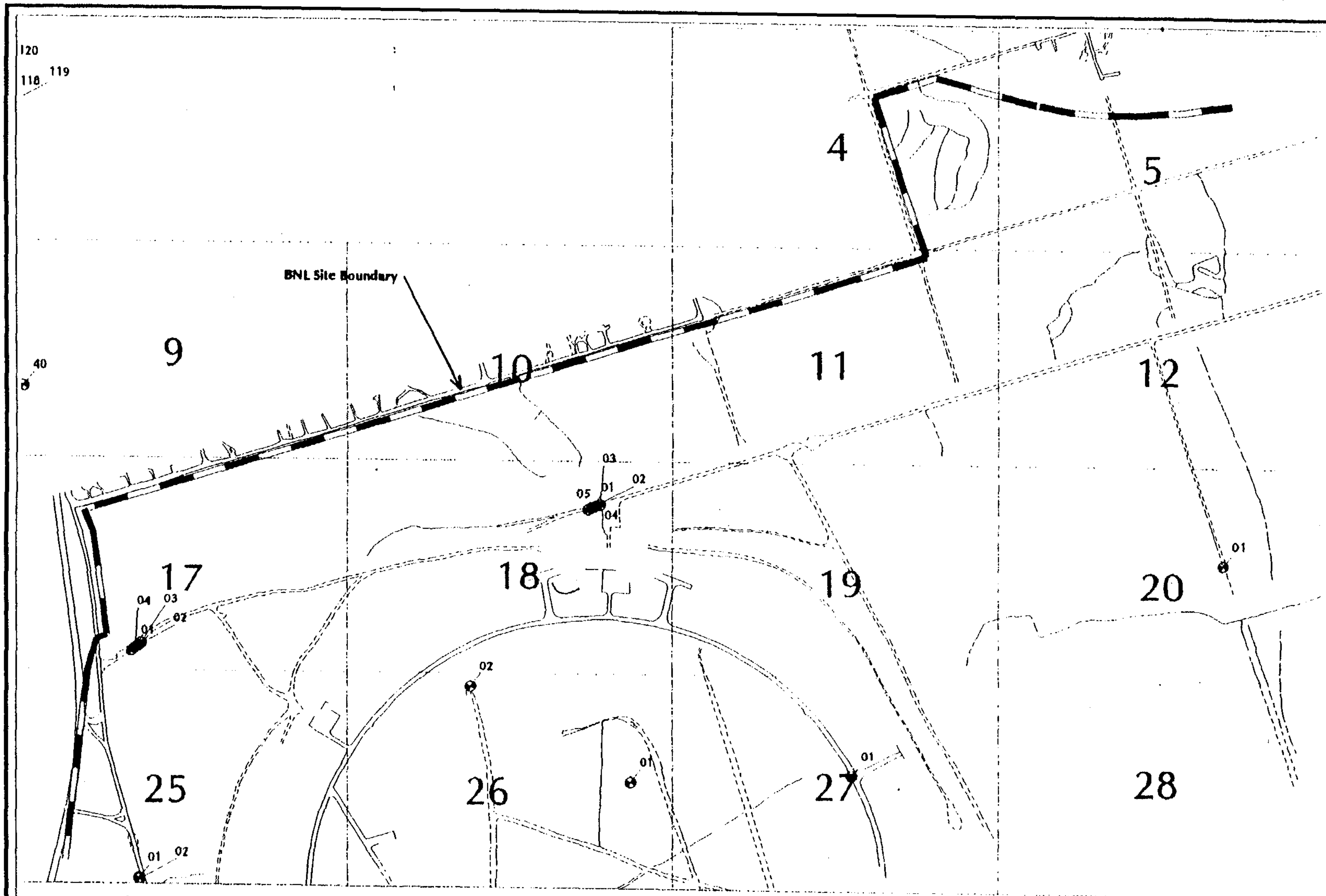
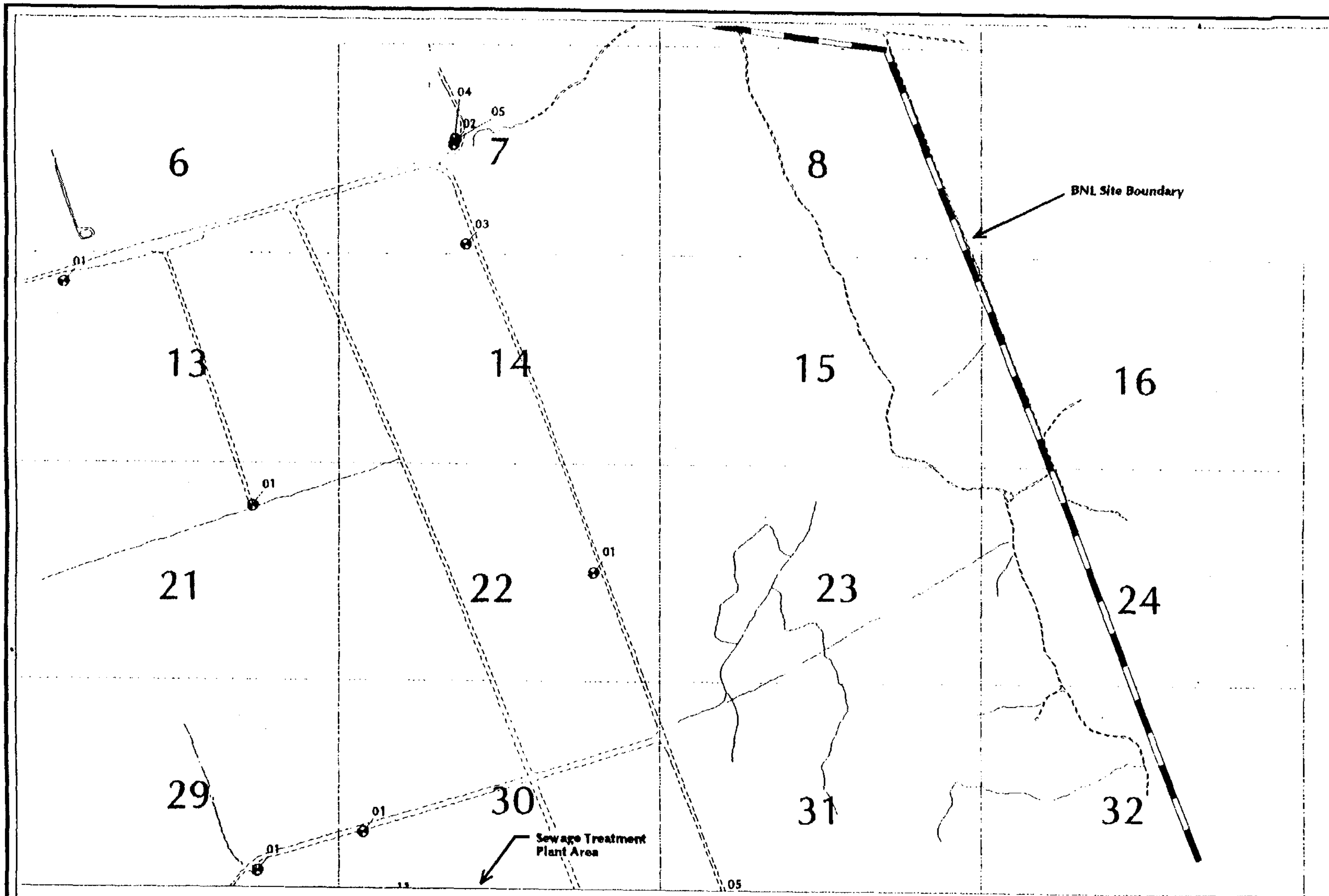

NORTH
KEY
PIEZOMETERS and MONITORING WELLS
MISC. and UNSURVEYED WELLS
SCALE
BROOKHAVEN NATIONAL LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
SITE BASE MAP - WELLS
OFFICE OF ENVIRONMENTAL RESTORATION
11/1/93
4/15/94

Figure 5-1

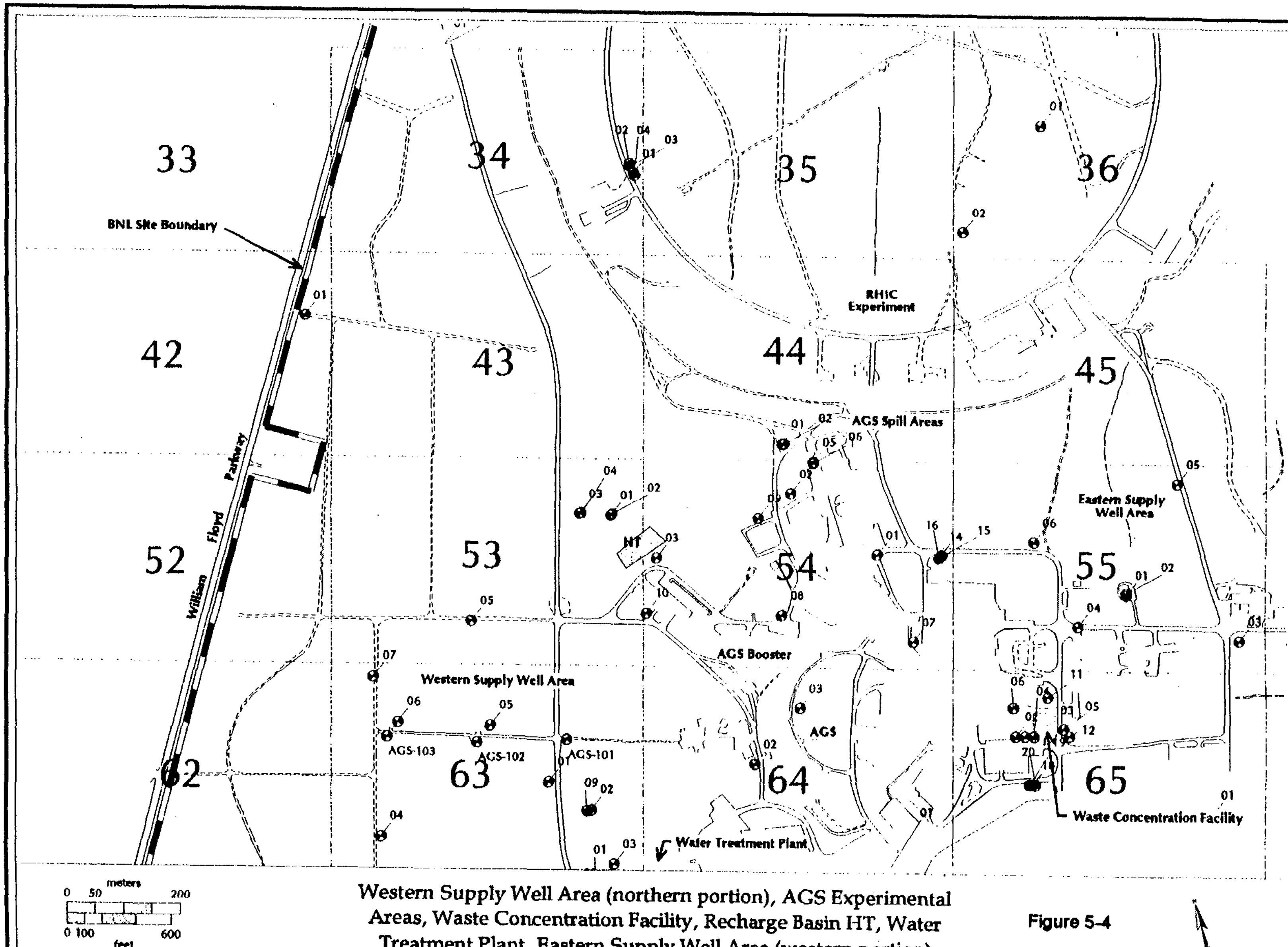


North Boundary - Upgradient/Background Wells For BNL Site

Figure 5-2

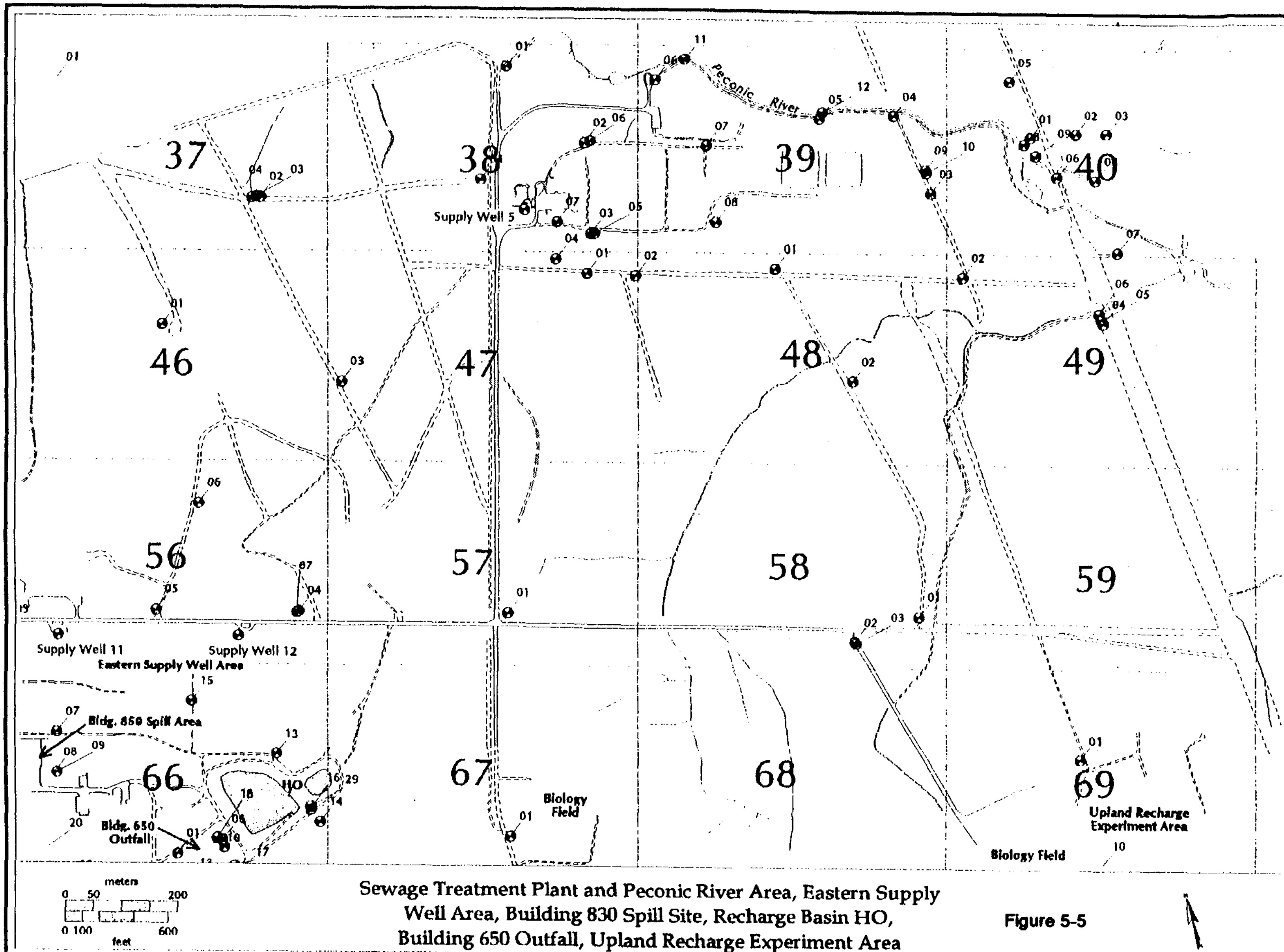


North Boundary - Upgradient/Background Wells For BNL Site and Sewage Treatment Plant (northern portion)
Figure 5-3



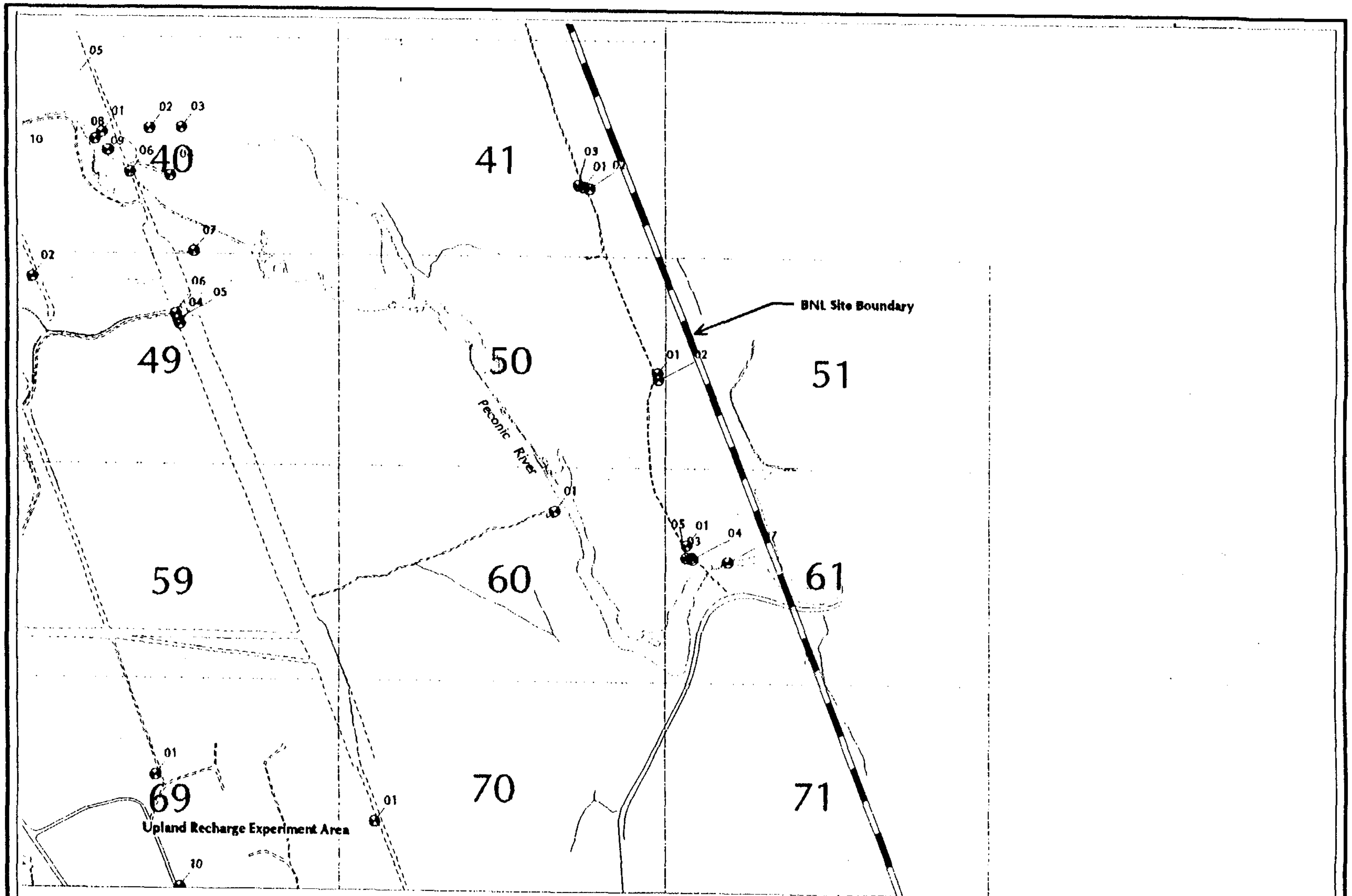
Western Supply Well Area (northern portion), AGS Experimental Areas, Waste Concentration Facility, Recharge Basin HT, Water Treatment Plant, Eastern Supply Well Area (western portion)

Figure 5-4



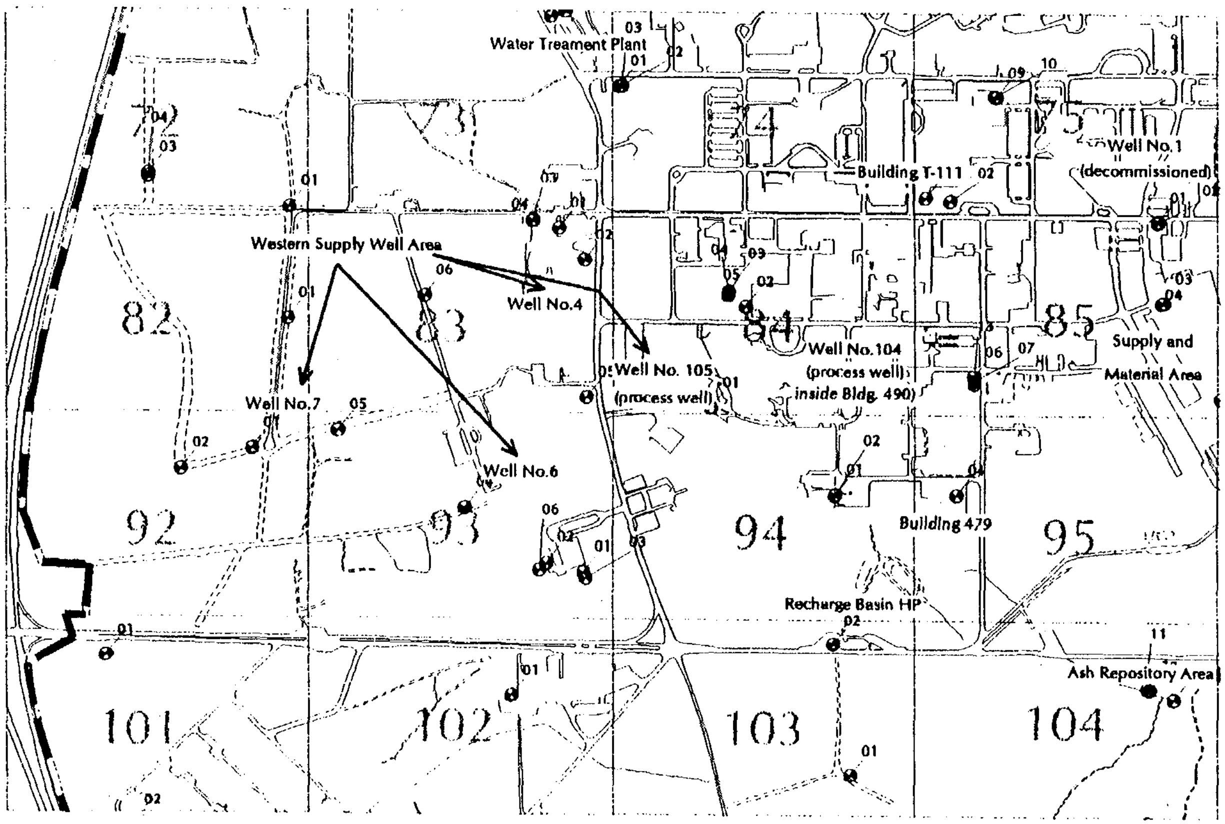
Sewage Treatment Plant and Peconic River Area, Eastern Supply Well Area, Building 830 Spill Site, Recharge Basin HO, Building 650 Outfall, Upland Recharge Experiment Area

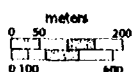
Figure 5-5



Peconic River, Upland Recharge Experiment Area

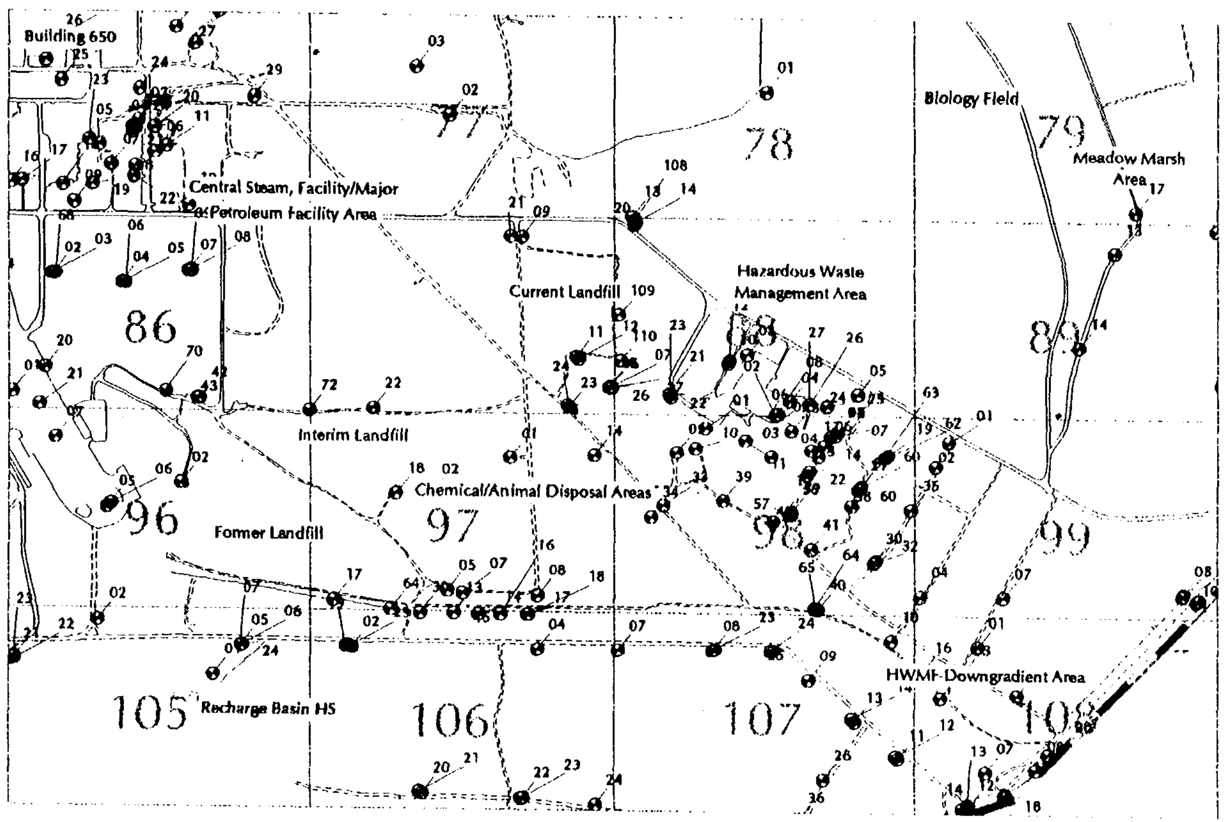
Figure 5-6





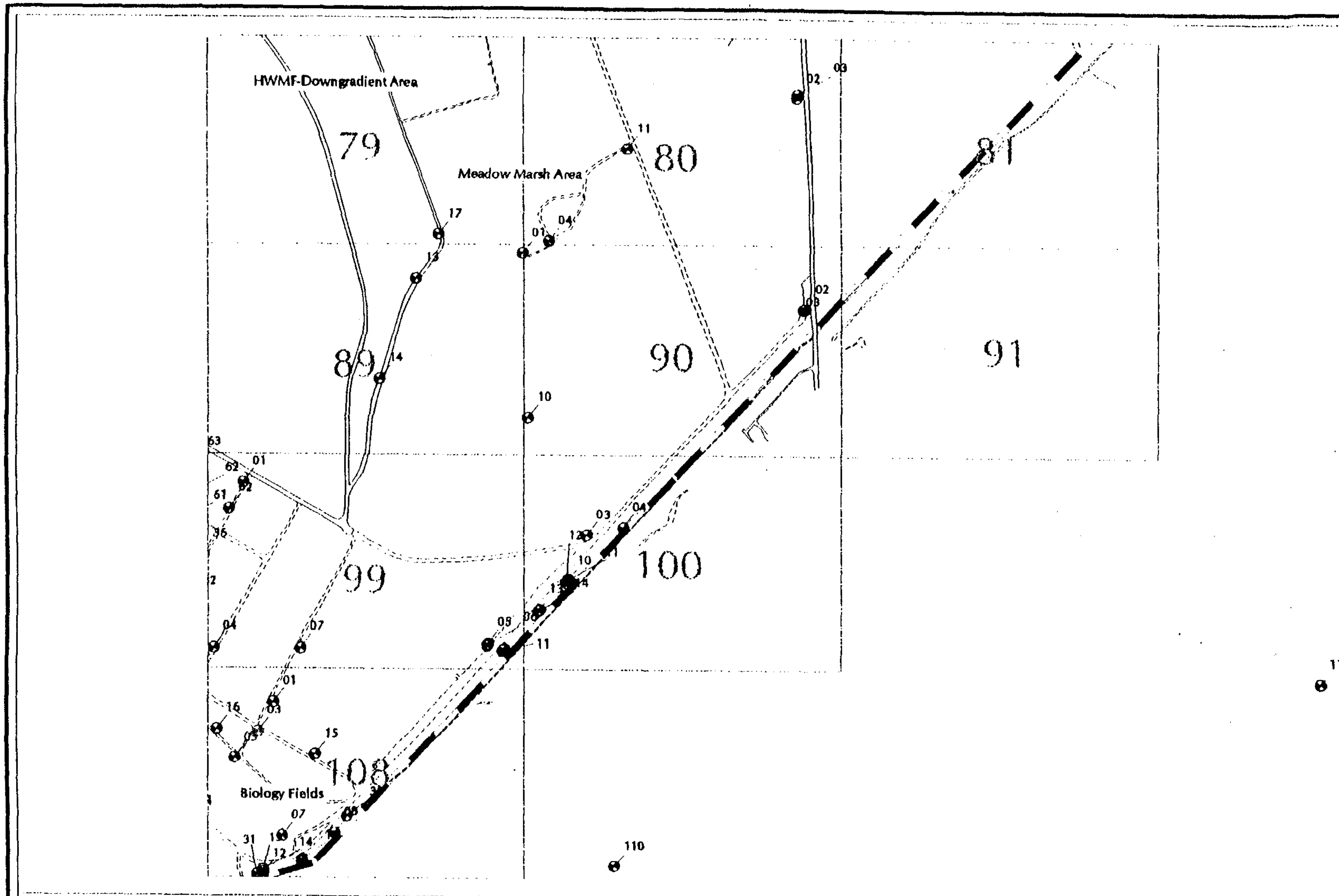
Western Supply Well(southern portion), Water Treatment Plant,
Building T-111, Supply and Material Area(northern portion),
Building 479, Recharge Basin HP, Ash Repository Area

Figure 5-7



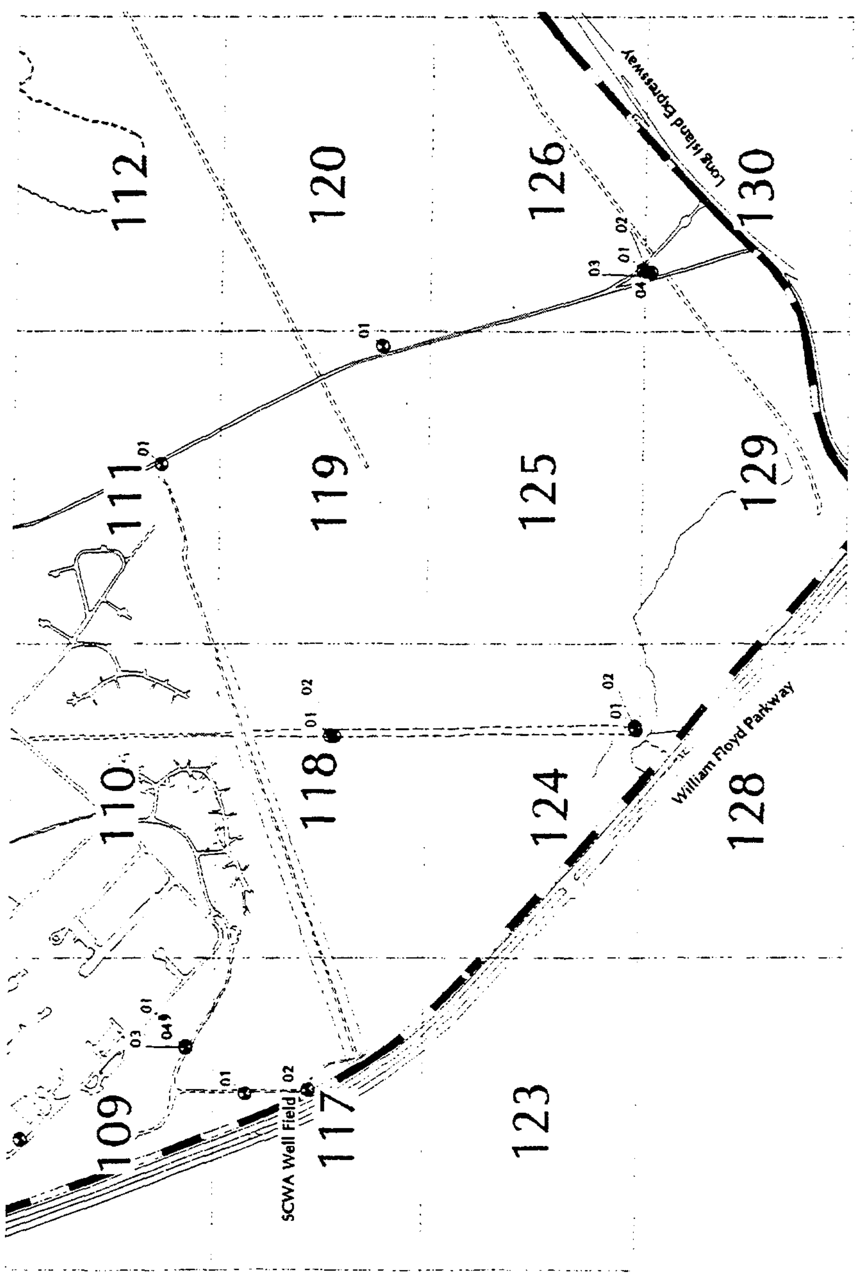
Building 650, Central Steam Facility/Major Petroleum Facility Area,
Biology Fields, Meadow Marsh Area, Hazardous Waste Management Facility,
Current Landfill, Former Landfill Area including Interim Landfill and Chemical/Animal,
Disposal Areas, Supply and Material Area(southern portion)

Figure 5-8



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

Figure 5-9

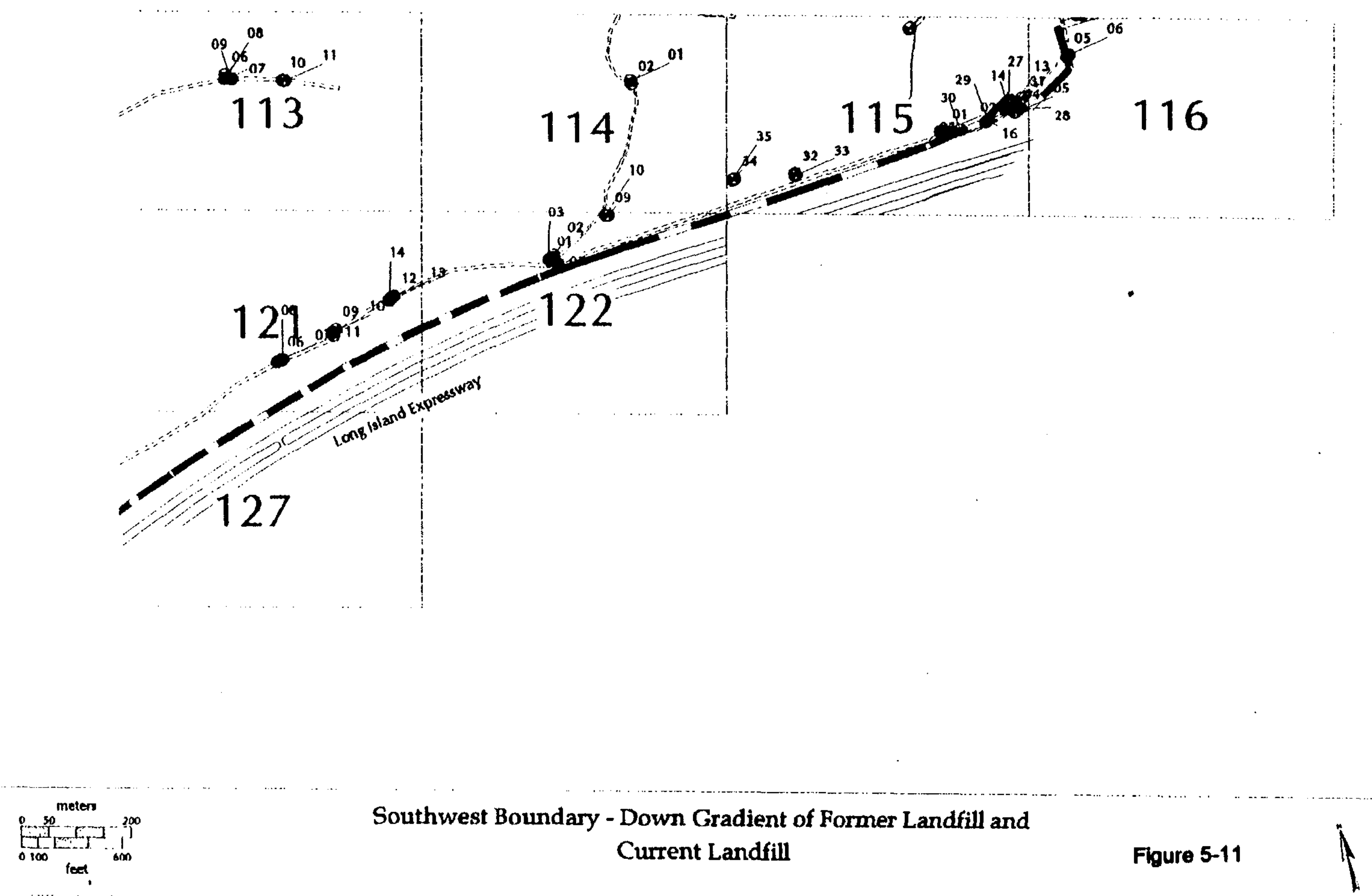


meters 0 50 200

feet 0 100 600

Southwest Boundary Area

Figure 5-10



Southwest Boundary - Down Gradient of Former Landfill and Current Landfill

Figure 5-11

Groundwater quality is also routinely monitored at six active potable supply wells and five process supply wells. Figures 5-1 through 5-11 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.

5.1.1 Potable Water and Process Supply Wells

During 1995, approximately 14.1 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. Wells 4, 6, 7, 10, 11, and 12 supplied drinking water, Wells 101, 102 and 103 were 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, supplied minimal secondary-cooling water to the Medical Department Research Reactor during 1995. Well 104 was permanently decommissioned due to the continued elevation of TCA above the NYS DWS (5µg/L). Well 5 was formerly used to supply non-potable water to the STP area. A new water main was installed in 1995 which rendered this well obsolete. This well will be abandoned in 1996.

The data discussed in the subsequent text and tables are compared to DCGs to determine compliance with operational limits and, because the Upper Glacial aquifer underlying Nassau and Suffolk Counties has been designated a "Sole Source" aquifer, the data are also compared to the EPA and NYS DWS.

Grab samples were obtained quarterly from Potable Wells 4, 6, 7, 10, 11 and 12 and analyzed for radioactivity, water quality indices, metals, and VOCs. Regulatory compliance samples were collected quarterly, the results of these analyses are discussed in Chapter 2.

Process Supply Well Nos. 9, 101, 102, and 103 were used periodically during 1995 and were analyzed for water quality, inorganic and organic contaminants routinely in 1995. Water chemistry analyses (i.e., pH and conductivity) were also performed for Wells 101, 102, and 103 by the AGS facility operators, as needed, to meet their operational requirements. As discussed above, Process Supply Well 105, which is used to provide secondary cooling water to the MRR was not sampled in 1995.

5.1.1.1 Radiological Analyses

Potable and process well water was sampled and analyzed for gross alpha and gross beta activity, tritium, and gamma-emitting radionuclides; results are listed in Table 5-1. Gross activity levels were consistent with those of typical environmental water samples. Tritium was not observed above the MDL in any of the wells sampled. All wells were free from gamma-emitting radionuclides with the exception of Well No.4 (Old ID "FD") where beryllium-7 and cesium-137 were detected. The concentrations of these nuclides were very low and at or close to their respective MDLs, making their identification inconclusive. The detected concentrations were small fractions of the DOE DCGs. Any potential radiological dose received from the consumption of water from Well No. 4 would be far below the State and Federal drinking water dose limit of 4 mrem (40 µSv) per year.

Table 5-1
BNL Site Environmental Report for Calendar Year 1995
On-Site Potable and Process Well Radiological Data

Well No.	Grid-ID	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Be-7	Cs-137
				←		(pCi/L)			→
WTP-Inf	073-400	1	Max.	0.89	1.19	-44	ND	ND	ND
WTP-Eff	073-401	1	Max.	-0.20	0.98	49	ND	ND	ND
Potable Wells									
4	083-400	1	Max.	0.00	0.90	-49	ND	3.07	0.31
6	093-400	1	Max.	0.44	0.98	20	ND	ND	ND
10	055-400	3	Max.	0.47	1.34	377	ND	ND	ND
			Avg.	0.31	0.60	-116			
11	056-400	3	Max.	1.10	0.99	167	1.91	ND	ND
			Avg.	0.37	0.74	-157			
12	056-401	4	Max.	0.19	2.12	235	3.15	ND	ND
			Avg.	0.07	1.23	-96	2.68	ND	ND
Process Wells									
9	084-302	4	Max.	NA	NA	350	2.61	ND	ND
			Avg.	NA	NA	-113	2.61	ND	ND
7	092-400	1	Max.	-0.33	0.94	-89	ND	ND	ND
102	063-301	2	Max.	1.09	2.25	207	2.97	ND	ND
			Avg.	0.66	1.45	53	2.95	ND	ND
SDWA Limit(a)				15(b)	NS	20,000	280	80,000	120
Typical MDL				0.9	2.5	380	3.9	1.6	0.2

(a) Safe Drinking Water Act Limits for gamma-emitting radionuclides based on 4% of the DOE DCG value.
(b) Excluding radon and uranium.
NS: Not Specified.
MDL: Minimum Detection Limit.

5.1.1.2 Nonradiological Analyses

Six wells were used to supply potable water at BNL during CY 1995. 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 1995 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 bacteriological and inorganic analytical data and POC and SOC analytical data collected during CY 1995 has been summarized on Tables 2-5 and 2-6, respectively. Review of the data contained in Tables 2-5 and 2-6 show the BNL potable supply to meet the all NYS DWS in CY 1995.

Several operational modifications were made to BNL's Potable Water supply system in 1995 including a Desk Top Corrosion Control Study prepared by a contract engineering firm to the Plant Engineering Division, and construction modifications to the WTP. In response to the 1994 contravention of the lead action level, BNL was required to conduct a Desk Top Study to evaluate the corrosion potential of the water supply and to implement corrective actions to reduce its potential for dissolving lead and copper from plumbing fixtures. The report recommended raising the pH of the distribution system to a minimum of 8.0. Re-evaluation of the lead and copper concentrations within the potable water distribution system has shown they now meet the Federal Action Levels. To further reduce the concentration of volatile organics in the potable water, construction of air-stripping towers at the WTP started in May 1995. This project includes 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 and a new clearwell and wetwell. Construction continued throughout 1995; consequently, Wells 4, 6, and 7 were not pumped after May 1, 1995.

In addition to the requirements of NYSDOH compliance monitoring, the S&EP Division maintains a comprehensive sampling and analysis program for the BNL potable water supply. During 1995, the S&EP Division monitored the potable wells for metals, water quality parameters, and VOCs. All analyses were conducted by the S&EP Division ASL using EPA-approved methods. Tables 5-2, 5-3, and 5-4 summarize all the data collected during 1995.

The water-quality data shows 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 5.8 - 6.6 and are typical of Long Island. Well Nos. 10, 11, and 12 are equipped with metering pumps which add sodium hydroxide to maintain the pH of the effluent at approximately 8.0, and reduce the corrosivity of the groundwater.

The majority of metals including silver, cadmium, chromium, and mercury were not detected in the Laboratory's potable supply wells. Manganese, copper, lead, and zinc were detected at levels below their respective NYS DWS. Iron was not detected in water samples collected at the well head of Potable Well Nos. 10, 11, and 12 nor in the treated effluent from the BNL WTP. Iron was detected at ambient levels in Potable Well Nos. 4, 6, and 7. The water from these latter wells is treated at the WTP which has an iron removal efficiency in excess of 90% and distributes water (WTP-EFF) with concentrations below the 0.3 mg/L NYS DWS. Sodium was detected in all wells at ambient concentrations.

Table 5 - 2
BNL Site Environmental Report for Calendar Year 1995
Potable Water and Process Supply Wells
Water Quality Data

Well Id. (a)		pH SU	Conductivity umhos/cm	Chlorides mg/L	Sulfates[C] mg/L	Nitrate as N [C] mg/L
WTP - In	N	1	1	1	1	1
(F1)	Result	6	111	17.2	10.4	<1.0
WTP - Eff	N	1	1	1	1	1
(F2)	Result	6.6	116	18.6	10.9	<1.0
4 (FD)	N	1	1	1	1	1
	Result	5.9	116	16.9	10.2	<1.0
6 (FF)	N	1	1	1	1	1
	Result	5.8	119	14.2	10.6	<1.0
7 (FG)	N	1	1	1	1	1
	Result	6.5	117	16.1	10.3	<1.0
10 (FO)	N	3	3	3	3	3
	Min.	5.9	106	11.7	9.1	<1.0
	Max.	6.3	111	30.4	15.2	1.3
	Avg.	NA	108	19.2	11.7	<1.0
11 (FP)	N	3	3	2	2	2
	Min.	5.8	126	14.7	13.1	<1.0
	Max.	5.8	137	14.9	15.8	<1.0
	Avg.	NA	130	14.8	14.5	<1.0
12 (FQ)	N	4	4	3	3	3
	Min.	6.3	114	14	10.2	<1.0
	Max.	6.6	123	15.8	11.8	<1.0
	Avg.	NA	119	15	11.1	<1.0
102 (FI)	N	2	2	2	2	2
	Min.	5.8	132	21.8	8.2	<1.0
	Max.	6.4	142	24	9	<1.0
	Avg.	NA	137	22.9	8.6	<1.0
9 (FM)	N	4	4	4	4	4
	Min.	6.1	116	14.7	6.6	<1.0
	Max.	6.6	121	16.4	13.1	<1.0
	Avg.	NA	118	15.7	10.1	<1.0
NYSDWS		(b)	(b)	250	250	10
Typical MDL		NA	10	4	4	1

N: No. of samples.
NA: Not Applicable
WTP-In: Water Treatment Plant Influent
WTP-Eff: Water Treatment Plant Effluent
NYSDWS: New York State Drinking Water Standard
MDL: Minimum Detection Limit
(a): The location of potable and process wells is shown on Figure 4 - 16.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 3
BNL Site Environmental Report for Calendar Year 1995
Potable and Process Supply Wells
Metals Data

Well Id. (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**
WTP-In	N	1	1	1	1	1	1	1	1	1	1
(F1)	Result	<0.025	<0.0005	<0.005	<0.05	1.16	<0.0002	0.054	9.7	<0.002	<0.02
WTP-Eff	N	1	1	1	1	1	1	1	1	1	1
(F2)	Result	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	10.3	<0.002	<0.02
4 (FD)	N	1	1	1	1	1	1	1	1	1	1
	Result	<0.025	<0.0005	<0.005	0.075	0.099	<0.0002	0.153	9.6	0.0029	< 0.02
6 (FF)	N	1	1	1	1	1	1	1	1	1	1
	Result	<0.025	<0.0005	<0.005	<0.05	3.23	<0.0002	0.078	9	<0.002	0.025
7 (FG)	N	1	1	1	1	1	1	1	1	1	1
	Result	<0.025	<0.0005	<0.005	<0.05	1.67	<0.0002	< 0.05	10.1	<0.002	<0.02
10 (FO)	N	3	3	3	3	3	3	3	3	3	3
	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	8.7	<0.002	<0.02
	Max.	<0.025	< 0.0005	<0.005	0.054	<0.075	<0.0002	<0.05	10.5	<0.002	0.024
	Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.5	<0.002	< 0.02
11 (FP)	N	3	3	3	3	3	3	3	3	3	3
	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	10.6	<0.002	<0.02
	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.6	< 0.002	0.028
	Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.1	<0.002	< 0.02
12 (FQ)	N	4	4	4	4	4	4	4	4	4	4
	Min.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.9	<0.002	<0.02
	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13.5	<0.002	0.04
	Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13	<0.002	<0.02
9 (FM)	N	4	4	4	4	4	4	4	4	4	4
	Min.	<0.025	<0.0005	<0.005	<0.05	0.31	<0.0002	<0.05	11.2	<0.002	<0.02
	Max.	<0.025	<0.0005	<0.005	<0.05	0.72	<0.0002	<0.05	11.9	<0.002	< 0.02
	Avg.	<0.025	<0.0005	<0.005	<0.05	0.51	<0.0002	<0.05	11.5	<0.002	<0.02
102 (FI)	N	2	2	2	2	2	2	2	2	2	2
	Min.	<0.025	<0.0005	<0.005	<0.05	2.1	<0.0002	0.38	13.3	<0.002	<0.02
	Max.	<0.025	<0.0005	<0.005	0.06	4.5	<0.0002	0.4	17.5	0.009	0.043
	Avg.	<0.025	<0.0005	<0.005	<0.05	3.3	<0.0002	0.39	15.4	0.0045	0.022
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.
WTP-In: Water Treatment Plant Influent.
WTP-Eff: Water Treatment Plant Effluent.
NYSDWS: New York State Drinking Water Standard.
MDL: Minimum Detection Limit.
(a): The location of potable and process wells is shown on Figure 4 - 11.
(b): No standard specified.

Table 5 - 4
BNL Site Environmental Report for Calendar Year 1995
Potable Water and Process Supply Wells
Volatile Organic Compound Data

Well Id. (a)		Chloroform ug/L	DCE ug/L	TCA ug/L	TCE ug/L
WTP-In	N	1	1	1	1
(F1)	Result	<2.0	<2.0	<2.0	<2.0
WTP-Eff	N	1	1	1	1
(F2)	Result	4.9	<2.0	<2.0	<2.0
4 (FD)	N	1	1	1	1
	Result	5.1	<2.0	<2.0	<2.0
6 (FF)	N	1	1	1	1
	Result	<2.0	<2.0	<2.0	<2.0
7 (FG)	N	1	1	1	1
	Result	<2.0	<2.0	<2.0	<2.0
10 (FO)	N	9	9	9	9
	Min.	<2.0	<2.0	<2.0	<2.0
	Max.	<2.0	<2.0	2.6	<2.0
	Avg.	<2.0	<2.0	<2.0	<2.0
11 (FP)	N	4	4	4	4
	Min.	<2.0	<2.0	7.2	<2.0
	Max.	<2.0	<2.0	9	<2.0
	Avg.	<2.0	<2.0	8.2	<2.0
12 (FQ)	N	4	4	4	4
	Min.	<2.0	<2.0	<2.0	<2.0
	Max.	<2.0	<2.0	<2.0	<2.0
	Avg.	<2.0	<2.0	<2.0	<2.0
9 (FM)	N	4	4	4	4
	Min.	<2.0	<2.0	9.7	<2.0
	Max.	3.1	4.2	17.4	2.1
	Avg.	<2.0	2.8	16.3	<2.0
102 (FI)	N	4	4	4	4
	Min.	<2.0	<2.0	<2.0	<2.0
	Max.	<2.0	<2.0	<2.0	<2.0
	Avg.	<2.0	<2.0	<2.0	<2.0
NYSDWS		100	5	5	5
Typical MDL		2	2	2	2

N: No. of samples.
WTP-In: Water Treatment Plant Influent.
WTP-Eff: Water Treatment Plant Effluent.
NYSDWS: New York State Drinking Water Standard.
MDL: Minimum Detection Limit.
(a): The location of potable and process wells is shown on Figure 4 - 11.

During the second or third month of each quarter, BNL collects samples which are analyzed on site by S&EP 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 chloroform and TCA were detected in the potable wells. The concentration of TCA in Well 11 appears to exceed the NYS DWS; however, this well was fitted with a carbon-adsorption treatment system during CY 1992 which effectively reduces the concentration of TCA below the NYS DWS. All remaining eight organic compounds were not detected in water samples collected during CY 1995.

Process Wells 9, and 102 were also sampled and analyzed during CY 1995. 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. Tables 5-2 and 5-3 show the concentrations of water-quality and inorganic elements are within ambient levels. Iron is present in all wells at concentrations which are consistent with native groundwater. Concentrations of organic compounds in Well 9 which is located within a known Area of Concern, contained concentrations of TCA which exceed the NYS DWS. This well's water is not used for drinking and the concentrations present do not interfere with the fish experiments conducted in Building 463.

5.1.2 Groundwater Monitoring

Groundwater monitoring is an integral part of BNL's Environmental Monitoring Program (in fulfilment of DOE Orders and NYS permits) and the BNL's 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 1995, 207 surveillance wells were monitored during 366 individual sampling events. Additionally, 103 temporary vertical profile wells were installed as part of the Restoration Program, from which 1,715 groundwater samples were collected.

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. In the STP/Peconic River areas, a small number of older, small diameter (1.25") wells constructed of carbon steel casings and brass screens are still used to collect radiological samples and measure water levels. Following the completion of the OU V RI/FS project, these older wells will either be abandoned or used exclusively for water level measurements. 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 (Schroeder and Miltenberger, 1991). 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 nonradiological levels of contamination. The groundwaters underlying the BNL site are designated as Class GA fresh groundwater by NYS. Nonradiological 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 5-1). Radiological data are compared to both NYS AWQS (for tritium) and DOE DCGs for beta/gamma emitting radionuclides.

5.1.2.1 Nonradiological Analyses

Operable Unit I Areas

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 spring, 1995. The full extent of groundwater contamination and assessment of remedial alternatives are being evaluated as part of the OU I Groundwater Removal Action. .

The surveillance well network at the Current Landfill consists of 41 shallow to deep Upper Glacial aquifer wells (Figure 5-8). During 1995, 24 of the groundwater surveillance wells were sampled for water quality, VOCs, and metals (Tables 5-5 to 5-8). Also, as part of the OU I Pre-Design Field Investigation, three temporary vertical profile wells were installed downgradient of the Current Landfill area to further assess the vertical and horizontal extent of groundwater contamination (Figure 5-12, Table 5-9) (Geraghty & Miller, 1996). Water quality data from wells located at the Current Landfill indicate that the pH typically was slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.25. 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 117.7 µmhos/cm, whereas the average conductivities for wells directly downgradient ranged from 116 to 910 µmhos/cm. Twelve surveillance wells downgradient of the Current Landfill had average iron concentrations ranging from 0.35 to 75.45 mg/L that exceeded the NYS AWQS of 0.3 mg/L; whereas upgradient Well 87-09 typically had an average concentration below the typical MDL of 0.075 mg/L. The elevated conductivity values in downgradient wells probably were related to these high iron concentrations. 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; they were not detected in upgradient Well 87-09. The following data were obtained from downgradient wells where NYS AWQS were exceeded: TCA was detected in seven permanent and three temporary wells (DVPW-4, DVPW-5, and DVPW-9) at maximum concentrations ranging from 6.5 µg/L to 28 µg/L; TCE was detected in two permanent and one temporary well (DVPW-05) at maximum concentrations ranging from 5.4 µg/L to 11 µg/L; DCA was detected in five permanent and three temporary wells (DVPW-4, DVPW-5, and DVPW-9) at maximum concentrations ranging from 5 µg/L to 400 µg/L; PCE was detected in one well at a maximum of 7 µg/L; DCE was detected in one permanent and one temporary well (DVPW-5) at maximum concentrations of 25 µg/L and 35 µg/L, respectively; benzene was detected in three permanent wells at maximum concentrations ranging from 5 µg/L to 6 µg/L; carbon tetrachloride was detected at 5 µg/L in one temporary well (DVPW-9); chloroform was detected in two temporary wells at maximum concentrations of 9 µg/L and 13 µg/L; and chloroethane was detected in two permanent wells at maximum concentrations of 5 µg/L and 26 µg/L. Plots for the yearly average trends in DCA concentrations in representative monitoring wells downgradient of the Current Landfill are shown in Figure 5-13. The iron trend data are shown in Figure 5-14.

Table 5 - 5
BNL Site Environmental Report for Calendar Year 1995
Current Landfill and Former Landfill Areas
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates (c) mg/L	Nitrate as N (c) mg/L
Current Landfill							
87-09(a)	4	5.4 - 5.9	Max.	166.0	30.2	10.0	<1.0
			Avg.	117.7	19.2	9.2	<1.0
87-05	1	6.1	Max.	755.0	32.7	<4.0	<1.0
			Avg.				
87-06	1	5.8	Max.	662.0	17.6	8.9	<1.0
			Avg.				
87-07	1	6.2	Max.	836.0	35.0	6.9	<1.0
			Avg.				
87-10	1	6.3	Max.	910.0	44.7	10.3	<1.0
			Avg.				
87-11	4	5.9 - 6.2	Max.	905.0	38.7	14.7	<1.0
			Avg.	827.0	35.0	12.8	<1.0
87-23	4	6.0 - 6.4	Max.	533.0	21.9	8.1	<1.0
			Avg.	498.1	18.6	7.3	<1.0
87-24	4	5.4 - 6.2	Max.	251.9	18.4	16.6	<1.0
			Avg.	152.5	17.5	15.5	<1.0
87-26	4	5.9 - 7.1	Max.	635.0	24.8	15.0	<1.0
			Avg.	299.9	19.4	13.3	<1.0
87-27	4	6.3 - 6.5	Max.	710.0	21.2	13.1	<1.0
			Avg.	515.7	19.4	10.6	<1.0
88-02	1	5.4	Max.	116.0	6.4	32.9	<1.0
			Avg.				
88-21	2	6.1 - 6.6	Max.	199.0	36.2	16.7	<1.0
			Avg.	190.0	27.0	13.9	<1.0
88-22	2	6.6 - 7.0	Max.	274.0	22.0	17.2	<1.0
			Avg.	227.0	19.2	16.8	<1.0
115-01	3	5.6 - 6.2	Max.	53.0	5.5	8.3	<1.0
			Avg.	40.1	4.9	7.8	<1.0
115-02	3	5.5 - 5.7	Max.	53.0	6.8	6.6	<1.0
			Avg.	48.1	6.0	6.6	<1.0
115-03	3	5.4 - 5.9	Max.	54.0	6.5	8.2	<1.0
			Avg.	50.3	5.8	7.5	<1.0
115-04	3	5.5 - 6.0	Max.	80.0	10.7	12.7	<1.0
			Avg.	74.7	9.9	12.2	<1.0
115-05	3	6.0 - 6.1	Max.	85.0	11.5	13.6	<1.0
			Avg.	79.7	10.2	12.9	<1.0
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 5 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Current Landfill and Former Landfill Areas
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Current Landfill							
115-13	2	5.8 - 6.3	Max.	309.9	19.3	10.3	<1.0
			Avg.	251.4	19.2	9.6	<1.0
115-14	2	5.2 - 5.7	Max.	166.0	21.4	25.4	<1.0
			Avg.	159.0	19.2	19.9	<1.0
115-15	2	5.4 - 5.8	Max.	125.0	12.9	19.5	<1.0
			Avg.	120.0	12.6	17.9	
115-16	3	5.5 - 6.0	Max.	90.0	12.7	13.9	<1.0
			Avg.	60.1	12.1	12.5	<1.0
116-05	3	5.8 - 6.4	Max.	84.0	12.6	13.1	<1.0
			Avg.	81.6	11.8	12.7	<1.0
116-06	2	6.1 - 6.5	Max.	104.0	12.2	7.2	<1.0
			Avg.	102.0	11.9	5.6	<1.0
Former Landfill							
86-42(a)	2	5.8 - 6.2	Max.	122.0	17.2	15.3	<1.0
			Avg.	116.5	14.9	14.8	<1.0
86-43(a)	2	5.9 - 6.2	Max.	146.0	18.3	17.2	<1.0
			Avg.	128.5	17.2	16.9	<1.0
97-02	1	5.1	Max.	56.0	6.3	7.4	<1.0
			Avg.				
97-03	2	6.0 - 6.8	Max.	461.0	6.8	49.9	4.6
			Avg.	358.5	6.4	47.5	2.3
97-05	2	5.1 - 5.7	Max.	109.0	5.6	18.2	1.4
			Avg.	104.5	5.1	15.6	1.2
97-17	1	5.6	Max.	49.0	5.4	6.6	<1.0
			Avg.				
97-18	1	5.9	Max.	445.0	9.3	41.9	4.3
			Avg.				
106-14	1	5.0	Max.	63.0	7.7	8.6	<1.0
			Avg.				
106-15	2	5.2 - 5.6	Max.	78.0	5.0	13.0	<1.0
			Avg.	76.0	4.0	12.5	<1.0
106-17	2	4.8 - 5.4	Max.	63.0	6.6	10.3	<1.0
			Avg.	62.5	6.6	10.0	<1.0
106-18	2	5.1 - 5.8	Max.	54.0	5.3	9.3	<1.0
			Avg.	53.0	4.8	9.0	<1.0
114-02	2	5.1 - 5.8	Max.	45.0	6.7	4.7	<1.0
			Avg.	42.0	6.4	4.6	<1.0
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 6
BNL Site Environmental Report for Calendar Year 1995
Current Landfill & Former Landfill
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
Current Landfill											
87-09(a)	4	Max.	<0.025	<0.0005	0.005	<0.05	0.202	<0.0002	13.23	<0.002	0.03
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.03	<0.002	<0.02
87-05	1	Max.	<0.025	<0.0005	<0.005	<0.05	75.45	<0.0002	30.48	<0.002	0.17
		Avg.									
86-06	1	Max.	<0.025	<0.0005	<0.005	<0.05	40.30	<0.0002	19.33	<0.002	0.17
		Avg.									
87-07	1	Max.	<0.025	<0.0005	<0.005	<0.05	47.08	<0.0002	26.81	<0.002	0.03
		Avg.									
87-10	1	Max.	<0.025	<0.0005	<0.005	<0.05	72.75	<0.0002	44.76	<0.002	<0.02
		Avg.									
87-11	4	Max.	<0.025	<0.0005	<0.005	<0.05	62.82	<0.0002	27.69	<0.002	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	56.85	<0.0002	26.32	<0.002	<0.02
87-23	4	Max.	<0.025	<0.0005	<0.005	<0.05	63.99	<0.0002	17.38	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	51.32	<0.0002	15.34	<0.002	0.03
87-26	4	Max.	<0.025	<0.0005	<0.005	<0.05	52.73	<0.0002	23.25	<0.002	0.03
		Avg.	<0.025	<0.0005	<0.005	<0.05	21.53	<0.0002	19.19	<0.002	<0.02
87-27	4	Max.	<0.025	<0.0005	<0.005	<0.05	54.31	<0.0002	20.63	<0.002	0.08
		Avg.	<0.025	<0.0005	<0.005	<0.05	21.72	<0.0002	18.91	<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	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 6 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Current Landfill & Former Landfill
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
Current Landfill											
88-02	1	Max.	<0.025	<0.0005	<0.005	<0.05	1.316	<0.0002	11.75	<0.002	0.95
		Avg.									
88-21	2	Max.	<0.025	<0.0005	<0.005	<0.05	8.63	<0.0002	22.24	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	5.98	<0.0002	18.36	<0.002	<0.02
88-22	2	Max.	<0.025	<0.0005	<0.005	<0.05	16.66	<0.0002	20.94	<0.002	0.20
		Avg.	<0.025	<0.0005	<0.005	<0.05	12.14	<0.0002	17.77	<0.002	0.10
115-14	1	Max.	<0.025	<0.0005	<0.005	<0.05	0.355	<0.0002	17.92	<0.002	<0.02
		Avg.									
All Other Wells (n=11)	29	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	16.01	<0.002	0.08
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.38	<0.002	<0.02
Former Landfill											
86-42(a)	2	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	15.33	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.52	<0.002	<0.02
86-43(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	19.13	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	18.58	<0.002	<0.02
97-18	1	Maximum	<0.025	<0.0005	<0.005	<0.05	24.02	<0.0002	5.49	<0.002	<0.02
		Average									
All other Wells (n=9)	15	Maximum	<0.025	0.0008	<0.005	<0.05	<0.075	0.0007	9.97	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.68	<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	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 7
BNL Site Environmental Report for Calendar Year 1995
Current Landfill and Former Landfill Areas
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			←			ug/L		→
Current Landfill								
87-09(a)	4	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
87-07	1	Max.	<2.0	<2.0	<2.0	4.0	<2.0	<2.0
		Avg.						
87-11	3	Max.	<2.0	<2.0	<2.0	5.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
115-04	3	Max.	12.9	5.4	4.0	<2.0	2.3	<2.0
		Avg.	8.1	4.1	2.4	<2.0	<2.0	<2.0
115-05	3	Max.	23.0	4.7	7.0	<2.0	3.0	3.0
		Avg.	18.3	2.9	5.0	<2.0	<2.0	2.6
115-13	2	Max.	27.7	7.2	<2.0	150.0	25.0	<2.0
		Avg.	26.4	7.1	<2.0	75.0	23.2	<2.0
115-14	2	Max.	8.0	<2.0	<2.0	60.1	4.2	<2.0
		Avg.	5.2	<2.0	<2.0	50.1	2.1	<2.0
115-15	2	Max.	6.5	<2.0	<2.0	20.4	2.5	<2.0
		Avg.	3.8	<2.0	<2.0	11.1	<2.0	<2.0
115-16	3(b)	Max.	22.5	4.7	<2.0	<2.0	3.3	4.5
		Avg.	8.6	<2.0	<2.0	<2.0	<2.0	<2.0
116-05	2	Max.	9.5	2.8	3.1	<2.0	<2.0	2.6
		Avg.	9.2	2.4	<2.0	<2.0	<2.0	2.4
116-06	2(b)	Max.	4.6	<2.0	<2.0	25.3	<2.0	<2.0
		Avg.	3.9	<2.0	<2.0	23.1	<2.0	<2.0
All Other Wells	32	Max.	<2.0	<2.0	<2.0	3.3	<2.0	5.0
(n=12)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Former Landfill								
Upgradient Wells	4	Max.	<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
97-02	1	Max.	<2.0	<2.0	2.7	<2.0	<2.0	9.1
		Avg.						
106-14	1	Max.	<2.0	23.1	<2.0	<2.0	<2.0	2.1
		Avg.						
106-17	2	Max.	2.3	<2.0	5.6	<2.0	<2.0	<2.0
		Avg.	1.9	<2.0	4.5	<2.0	<2.0	<2.0
All Other Wells	12	Max.	2.3	<2.0	<2.0	<2.0	<2.0	7.0
(n=7)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

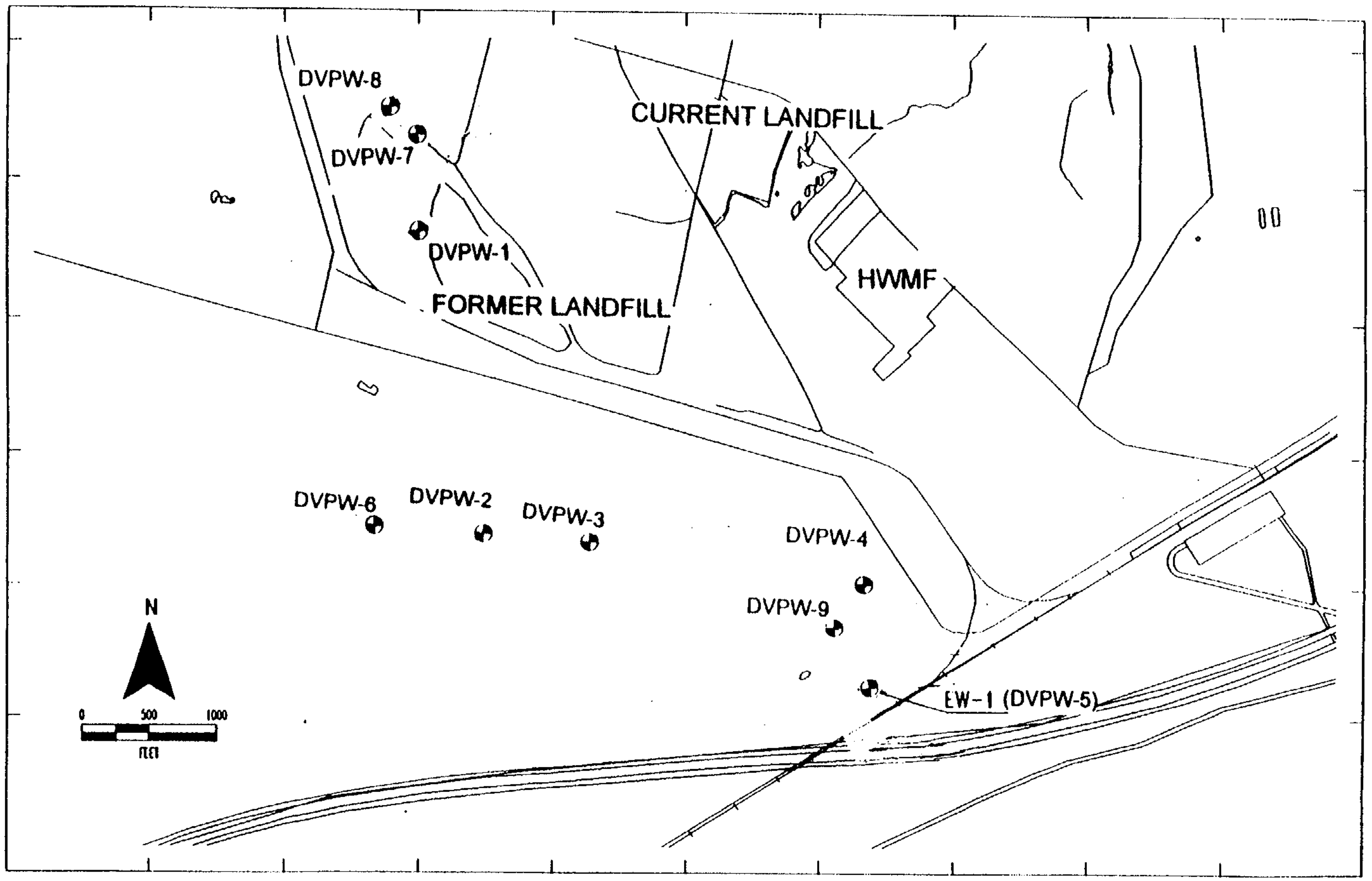
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time exceeded on one sample.

Table 5 - 8
BNL Site Environmental Report for Calendar Year 1995
Current Landfill and Former Landfill Areas
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylene (ug/L)
Current Landfill						
87-09(a)	4	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
87-05	1	Max.	5.0	<2.0	<2.0	2.6
		Avg.				
87-06(b)	1	Max.	3.0	<2.0	<2.0	<2.0
		Avg.				
87-07	1	Max.	6.0	<2.0	<2.0	<2.0
		Avg.				
87-11	3(b)	Max.	5.3	<2.0	<2.0	<2.0
		Avg.	4.3	<2.0	<2.0	<2.0
87-23	4(b)	Max.	3.3	<2.0	<2.0	<2.0
		Avg.	2.5	<2.0	<2.0	<2.0
87-27	4(b)	Max.	3.0	<2.0	<2.0	<2.0
		Avg.	1.4	<2.0	<2.0	<2.0
88-22	2	Max.	1.1 J	<2.0	<2.0	<2.0
		Avg.	0.6	<2.0	<2.0	<2.0
115-13	2	Max.	1.9 J	<2.0	<2.0	<2.0
		Avg.	1.8	<2.0	<2.0	<2.0
115-14	2	Max.	1.8 J	<2.0	<2.0	<2.0
		Avg.	1.6	<2.0	<2.0	<2.0
115-15	2	Max.	0.7 J	<2.0	<2.0	<2.0
		Avg.	0.4	<2.0	<2.0	<2.0
116-06	2(c)	Max.	0.7 J	<2.0	<2.0	<2.0
		Avg.	0.4	<2.0	<2.0	<2.0
All Other Wells	35(b)(c)	Max.	0.6 J	<2.0	<2.0	<2.0
(n=13)		Avg.	<2.0	<2.0	<2.0	<2.0
Former Landfill						
All Wells	20	Max.	<2.0	<2.0	<2.0	<2.0
(n=12)		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Other compounds detected.
(c): Holding time exceeded for one sample.
(J): Estimated value; Compound detected, but below method detection limit.

Figure 5 - 12



Brookhaven National Laboratory
Operable Unit I
Location of Pre-Design Investigation Vertical Profile Wells

Table 5 - 9
BNL Site Environmental Report for Calendar Year 1995
OU I Pre-Design Field Investigation
***Vertical Profile Wells* - Current Landfill and Former Landfill Areas**
Highest Observed Concentrations Volatile Organic Compounds [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCA	DCE	Chloroform	Carbon Tetrachloride	Chloroethane
		←			ug/L				→
DVPW-1*	18	2	3	25	<1	<1	6	3	<1
DVPW-2*	17	96	2	1	2	35	13	<1	<1
DVPW-3	18	3	2	<1	<1	<1	2	<1	<1
DVPW-4*	19	12	3	1	46	2	4	2	42
DVPW-5*	9	28	11	<1	400	35	<1	<1	260
DVPW-6*	17	94	8	74	4	34	5	<1	<1
DVPW-7	8	2	2	49	<1	<1	2	<1	<1
DVPW-8	8	<1	<1	11	<1	<1	2	<1	<1
DVPW-9*	18	9	2	<1	43	2	9	5	56
NYS AWQS		5	5	5	5	5	7	5	5
Typical MDL		1	1	1	1	1	1	1	1

* = Other Compounds Detected
(a): For detailed information on the vertical distribution of contaminants see: Summary Report - Phase II Field Investigations October 18 - December 29, 1995, Geraghty and Miller, Inc.

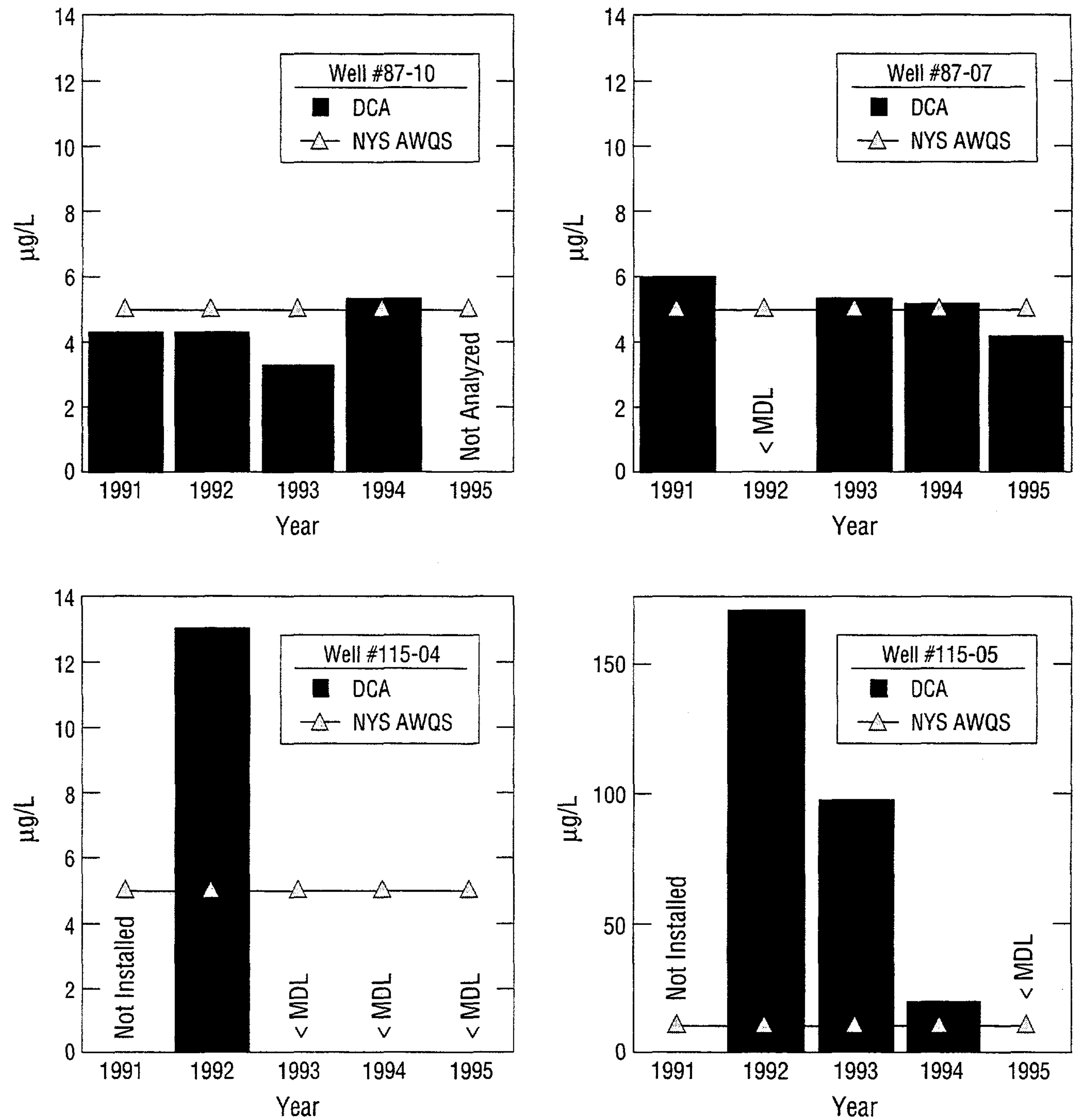


Figure 5-13 Yearly average concentration trends of 1,1-Dichloroethane (DCA) in wells downgradient of the Current Landfill: Well 87-10 located at downgradient margin of landfill; Well 87-07 located 75m downgradient of landfill; and Wells 115-04 and 115-05 located at the site boundary 1,225m downgradient of the landfill.

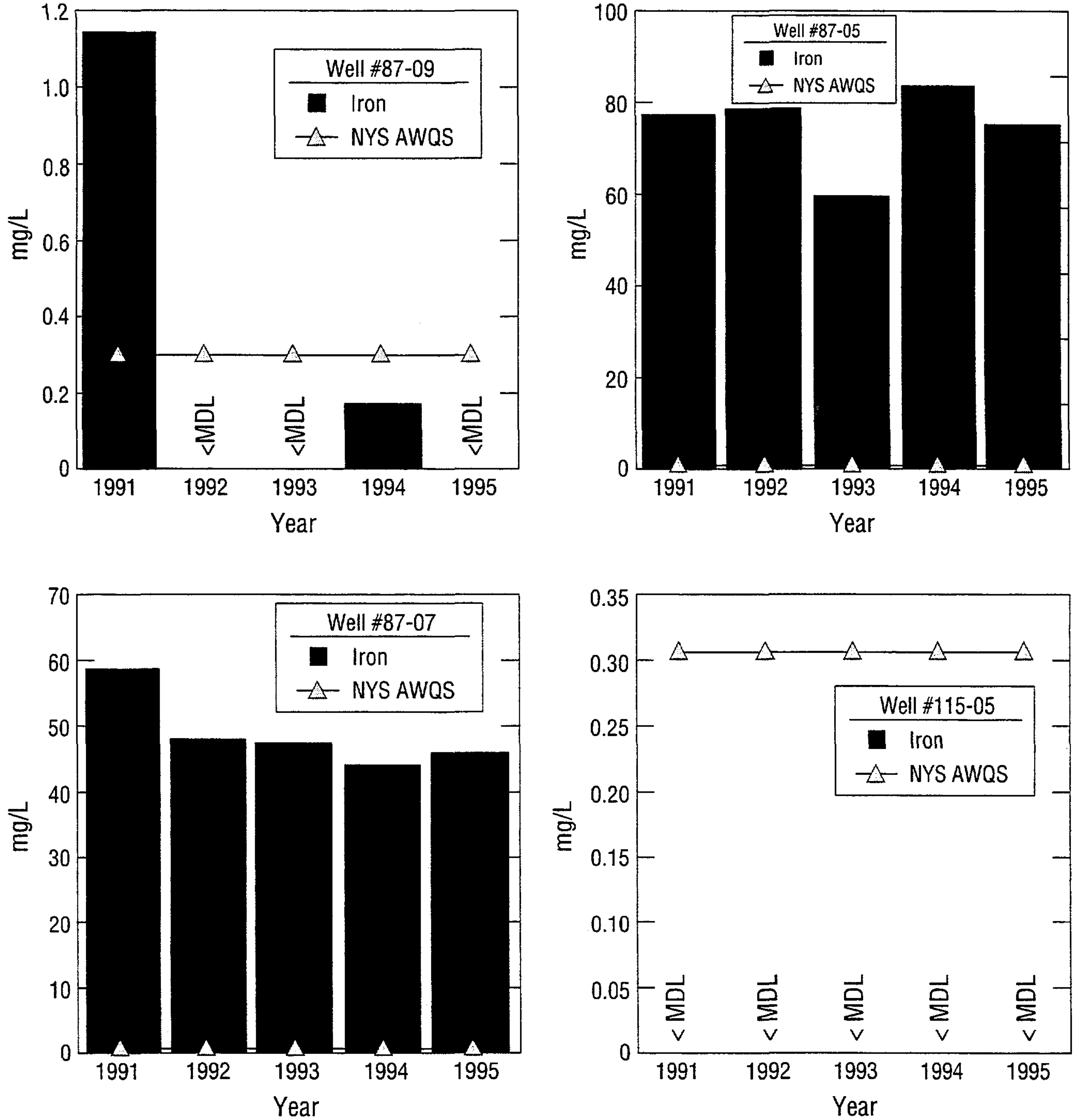


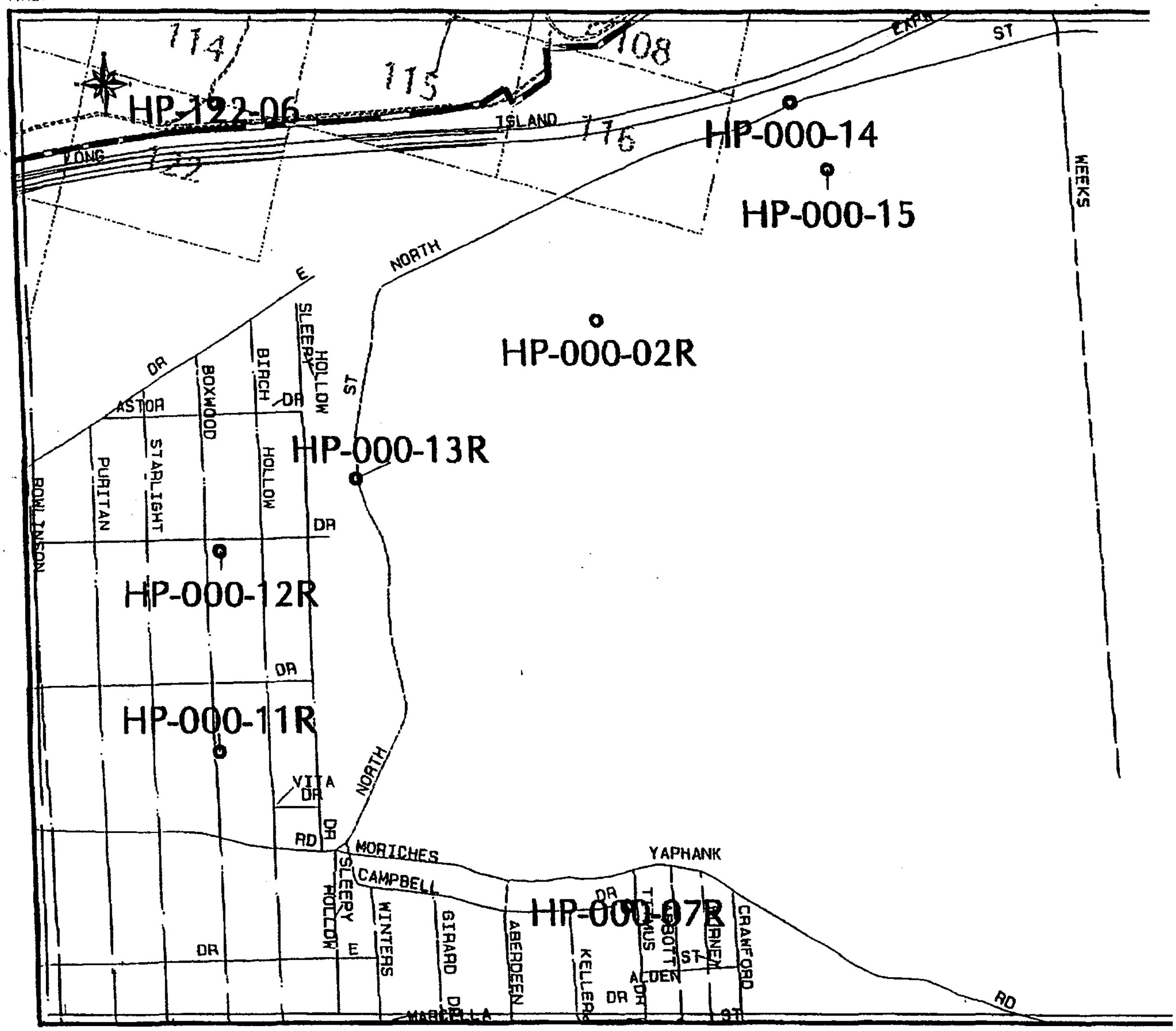
Figure 5-14 Yearly average concentration trends of Iron in wells upgradient and downgradient of the Current Landfill: Well 87-09 located at upgradient margin of landfill; Well 87-05 located at downgradient margin of landfill; Well 87-07 located 75m downgradient of landfill; and Well 115-05 located at the site boundary 1,225m downgradient of the landfill.

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. The Former Landfill and these chemical disposal areas have been identified as areas contributing to soil and groundwater contamination. During 1996, a landfill cap will be constructed over the Former Landfill, and remedial alternatives for source removal and/or treatment of the chemical/glass hole areas will be assessed as part of the OU I FS.

The surveillance well network monitoring the Former Landfill area consists of 21 shallow Upper Glacial aquifer wells (Figure 5-8). During 1995, groundwater samples were collected from 12 surveillance wells, and analyzed for water quality, VOCs, and metals (Tables 5-5 to 5-8). Six on-site temporary vertical profile wells were also installed both upgradient and downgradient of the Former Landfill area during the OU I Pre-Design Field Investigation (Figure 5-12, Table 5-9) (Geraghty & Miller, 1996a). These six wells were used to further assess the vertical and horizontal extent of groundwater contamination originating from the Former Landfill, and the OU IV area which is located directly upgradient of the Former Landfill area. Additionally, to further evaluate the off-site extent of contaminants from the Former Landfill area, six vertical profile wells were installed off-site during 1995 (Figure 5-15, Table 5-10) (Geraghty & Miller, 1995).

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 5.8. All other water quality parameters were below the applicable NYS AWQS. For metals, only iron exceeded NYS AWQS, with a concentration of 24.02 mg/L in Well 97-18. Analyses for VOCs show that in two wells organic contaminants were above NYS AWQS. TCE was detected in Well 106-14 at 23.1 µg/L, and PCE was detected in Well 106-17 at a maximum concentration of 5.6 µg/L. Above NYS AWQS concentrations of VOCs were also detected in five temporary vertical profile wells installed upgradient and downgradient of the Former Landfill. All three upgradient wells had VOC concentrations above NYS AWQS, with a maximum of 25 µg/L of PCE and 11 µg/L of 1,2-dichlorothane in DVPW-1, 49 µg/L of PCE in DVPW-7, and 11 µg/L of PCE detected in DVPW-9. These contaminants probably are the result of historical releases within the CSF/MPF (OU IV) area. Two of three temporary profile wells installed downgradient of the Former Landfill area had also had VOC concentrations that exceeded NYS AWQS, with a maximum observed concentration of 96 µg/L of TCA and 35 µg/L of DCE in DVPW-2; and 94 µg/L of TCA, 8 µg/L of TCE, 74 µg/L of PCE, 34 µg/L of DCE, and 6 µg/L of 1,2-DCA in DVPW-6. Contaminants detected in DVPW-2 and DVPW-6 probably originated from the Central Steam/Major Petroleum Facility (OU IV) area. However, contaminants that may have originated from the Former Landfill area were detected in off-site temporary well HP-000-13R; the maximum values were TCA at 47 µg/L, TCE at 14 µg/L, DCA at 5 µg/L, DCE at 11 µg/L, chloroform at 580 µg/L, and 1,2-DCA at 25 µg/L.

Figure 5 - 15



Brookhaven National Laboratory
Operable Unit I
Off-Site Vertical Profile Wells

Table 5 - 10
BNL Site Environmental Report for Calendar Year 1995
Operable Unit I/VI - Offsite Vertical Profile Wells
Maximum Observed Concentrations Volatile Organic Compounds [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCA	DCE	Chloroform	Carbon Tetrachloride	1,2-DCA	EDB
		ug/L								
HP-122-06	27	1	0.7	2.7	<0.5	<0.5	2.4	<0.5	<0.5	<0.01
HP-000-12R	15	<0.5	<0.5	0.6	<0.5	<0.5	2.3	<0.5	<0.5	<0.01
HP-000-13R	9	47	14	1.4	5	11	580	3.9	25.0	<0.01
HP-000-14R	22	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	3.4
HP-800-7R	20	<0.5	<0.5	<0.5	<0.5	<0.5	1.6	<0.5	<0.5	<0.01
HP-800-11R	21	<0.5	<0.5	<0.5	<0.5	<0.5	2.0	<0.5	<0.5	<0.01
NYS AWQS		5.0	5.0	5.0	5.0	5.0	7.0	5.0	5.0	0.05*
Typical MDL		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.01

(a): See Interim Report for Operable Unit I Offsite Vertical Profile Borings & Monitoring Well Installation at Brookhaven National Laboratory for detailed information on vertical distribution of contamination.
***:** More restrictive NYS DWS is used.

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 ground-water 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 full extent of groundwater contamination and assessment of remedial alternatives are being evaluated as part of the OU I Groundwater Removal Action.

The groundwater surveillance well network at and downgradient of the HWMF consists of 45 shallow to deep Upper Glacial aquifer wells (Figures 5-8 and 5-9). During 1995, 21 of these wells were monitored for water quality, metals, and VOCs (Tables 5-11 to 5-14). As in previous years, the pH of groundwater in the HWMF area typically was slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8. All other water quality parameters were below the applicable NYS AWQS. Lead was detected at concentrations above NYS AWQS in Well 108-30, with an observed maximum observed concentration of 0.026 mg/L. All other metals were below the NYS AWQS. Nine of the 21 HWMF surveillance wells sampled had VOC concentrations at or above NYS AWQS. No VOCs were detected 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 three wells at maximum concentrations ranging from 5 µg/L to 22.7 µg/L; PCE was detected in five wells at maximum concentrations ranging from 8.8 µg/L to 23.5 µg/L; DCA was found in three wells at maximum concentrations ranging from 10 µg/L to 126.7 µg/L; chloroethane was detected in one well at a maximum concentration of 19.8 µg/L; and trichlorofuoromethane was detected in one well (98-21) at 22.5 µg/L. Figure 5-16 shows yearly average trends for PCE and TCA based on data from representative monitoring wells within and downgradient of the HWMF.

Operable Unit III Areas

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. Low-level radionuclides also have been detected in groundwater, which may be the result of the outside storage of activated scrap metal or soil/soil moisture activation due to beam-target interaction. 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 16 shallow 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 5-4). During 1995, groundwater samples were collected from ten of the AGS area surveillance wells and three LINAC area wells, and analyzed for water quality, VOCs, and metals (Tables 5-15 to 5-18). 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 6.2. Other water quality parameters were below the applicable NYS AWQS. For the AGS area wells, except for elevated iron concentrations in samples collected from Wells 54-01 and 54-02, all other metals were below the applicable NYS AWQS. Metals analyses from

Table 5 - 11
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Facility
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [(c)] mg/L	Nitrate as N [(c)] mg/L
Hazardous Waste Management <u>Facility</u>							
88-13(a)	3	5.4 - 6.2	Max.	534.0	113.7	17.1	<1.0
			Avg.	363.7	73.1	12.9	<1.0
88-14(a)	3	5.2 - 6.0	Max.	62.0	6.9	13.1	<1.0
			Avg.	58.7	5.7	12.5	<1.0
88-20(a)	2	6.0 - 6.5	Max.	148.0	22.4	13.6	<1.0
			Avg.	138.5	19.0	13.4	<1.0
88-03	3	5.0 - 5.7	Max.	130.0	24.1	7.8	1.2
			Avg.	95.6	17.7	6.5	<1.0
88-04	3	5.5 - 6.1	Max.	300.5	28.5	28.6	2.1
			Avg.	228.5	26.2	23.9	1.7
88-24	3	5.9 - 6.2	Max.	104.1	7.3	13.3	1.1
			Avg.	101.6	6.1	12.6	<1.0
88-26	3	5.8 - 6.3	Max.	111.0	5.2	18.1	<1.0
			Avg.	102.6	4.6	17.3	<1.0
98-07	2	5.4 - 5.9	Max.	85.5	13.0	10.1	<1.0
			Avg.	85.2	12.0	9.7	<1.0
98-21	3	5.4 - 5.8	Max.	129.0	5.9	30.6	1.8
			Avg.	111.8	4.9	28.4	1.4
98-22	2	5.7 - 6.2	Max.	121.0	18.0	12.3	<1.0
			Avg.	116.4	16.4	12.0	<1.0
98-57	3	5.7 - 6.2	Max.	256.9	16.7	12.2	<1.0
			Avg.	180.6	15.3	11.6	<1.0
98-58	3	6.2 - 6.5	Max.	304.9	22.7	13.6	<1.0
			Avg.	220.9	21.0	12.4	<1.0
98-59	2	6.5 - 6.6	Max.	438.0	29.5	11.7	<1.0
			Avg.	426.0	29.2	11.6	<1.0
98-60	3	6.0 - 6.4	Max.	114.0	17.8	12.0	<1.0
			Avg.	106.1	17.0	11.8	<1.0
98-61	2	6.1 - 6.5	Max.	120.0	17.1	11.5	<1.0
			Avg.	116.5	16.2	11.0	<1.0
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 11 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Facility
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Hazardous Waste Management Facility							
108-13	3	5.2 - 5.7	Max.	71.3	9.0	13.5	<1.0
			Avg.	66.8	8.3	13.1	<1.0
108-14	3	5.6 - 6.1	Max.	84.8	10.8	12.0	<1.0
			Avg.	80.6	10.6	11.9	<1.0
108-17	3	5.5 - 5.9	Max.	82.0	10.2	13.8	<1.0
			Avg.	77.1	10.2	13.5	<1.0
108-18	3	5.8 - 6.7	Max.	88.0	12.2	13.1	<1.0
			Avg.	81.5	11.6	12.3	<1.0
108-30	3	5.7 - 6.3	Max.	86.0	11.9	13.6	<1.0
			Avg.	83.4	11.4	12.3	<1.0
108-31	2(1)	6.2 - 6.7	Max.	95.0	11.1	6.9	<1.0
			Avg.	94.0			
NYS AWQS Quality Standard		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 12
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Area
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
88-13(a)	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	57.06	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	39.67	<0.002	<0.02
88-14(a)	3	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.30	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.15	<0.002	<0.02
108-30	2	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.23	0.026	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.16	0.013	<0.02
All Other Wells (n=18)	48	Max.	<0.025	<0.0005	0.013	<0.05	0.256	<0.0002	26.04	0.003	0.11
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.79	<0.002	<0.02
NYS AWQS			0.05	0.01	0.05	0.2	0.30	0.002	20	0.025	0.3
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.00	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 13
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Facility
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			ug/L					
HWMF								
Upgradient Wells	7	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
(n=3)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
88-04	3	Max.	2.7	<2.0	19.6	<2.0	<2.0	<2.0
		Avg.	2.5	<2.0	11.6	<2.0	<2.0	<2.0
88-24	3	Max.	<2.0	<2.0	23.5	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	19.7	<2.0	<2.0	<2.0
88-26	3(a)	Max.	11.3	<2.0	14.5	<2.0	<2.0	<2.0
		Avg.	6.1	<2.0	10.1	<2.0	<2.0	<2.0
98-21	3(a)	Max.	22.7	<2.0	12.7	<2.0	<2.0	2.3
		Avg.	19.8	<2.0	11.4	<2.0	<2.0	<2.0
98-58	2	Max.	<2.0	<2.0	<2.0	41.2	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	39.1	<2.0	<2.0
98-59	2(b)	Max.	<2.0	<2.0	<2.0	126.7	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	101.8	<2.0	<2.0
98-61	2	Max.	<2.0	<2.0	<2.0	10.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	5.0	<2.0	<2.0
108-14	3	Max.	5.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	4.0	<2.0	<2.0	<2.0	<2.0	<2.0
108-18	3	Max.	5.0	<2.0	<2.0	<2.0	<2.0	6.0
		Avg.	3.5	<2.0	<2.0	<2.0	<2.0	3.5
108-30	3	Max.	2.0	<2.0	8.8	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	6.8	<2.0	<2.0	<2.0
108-31	2	Max.	4.8	<2.0	<2.0	2.9	<2.0	3.4
		Avg.	4.0	<2.0	<2.0	2.8	<2.0	2.6
All Other Wells	19	Max.	2.0	<2.0	<2.0	4.4	<2.0	<2.0
(n=7)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Other compounds detected.
(b): Holding time exceeded on one sample.

Table 5 - 14
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Facility
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			← ug/L →			
Haradous Waste Management Facility						
All Wells (n=21)	55	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

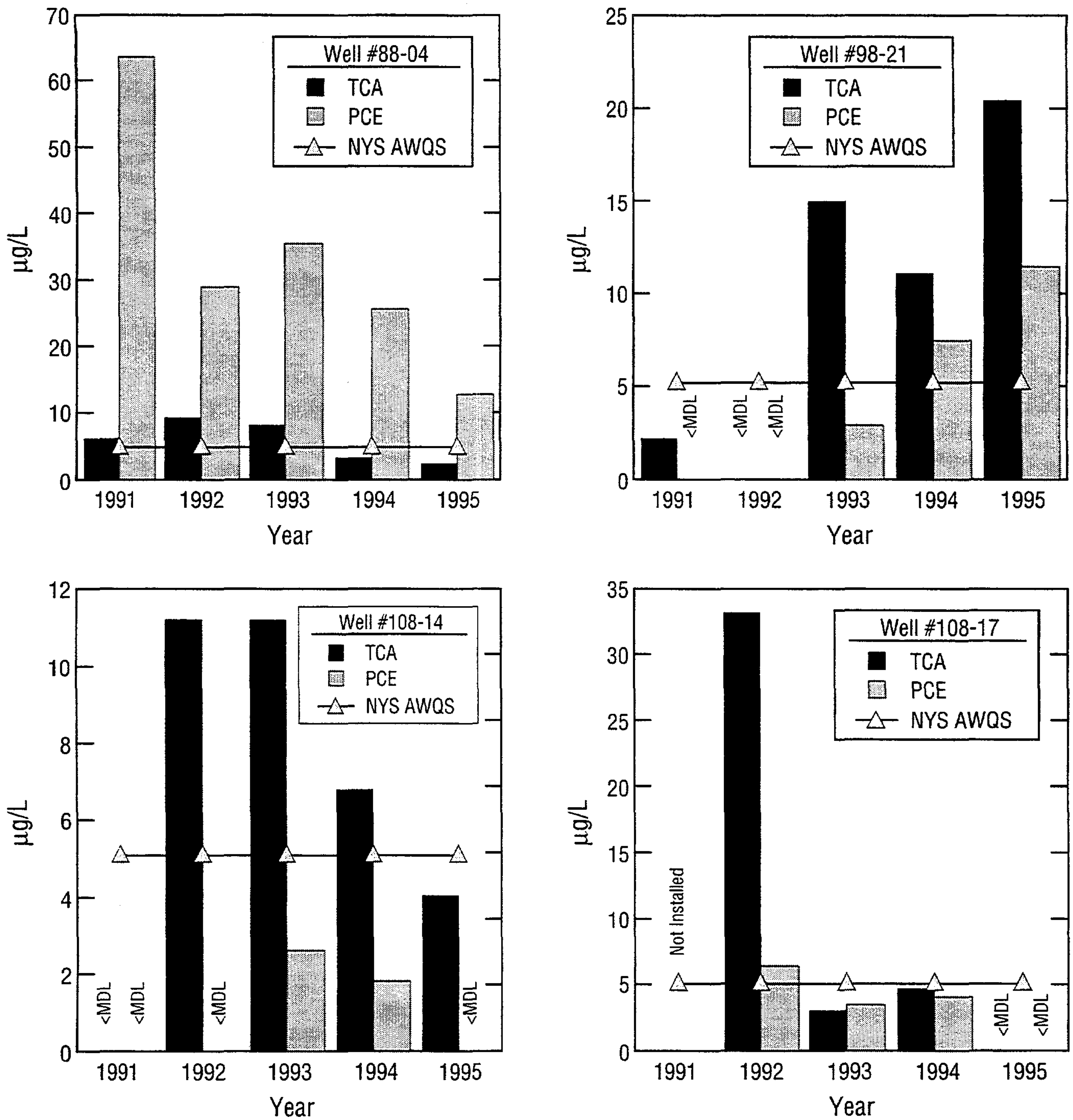


Figure 5-16 Yearly average concentration trends of 1,1,1-Trichloroethane (TCA) and Tetrachloroethylene (PCE) in wells upgradient and downgradient of the Hazardous Waste Management Facility (HWMF): Well 88-04 located within the HWMF; Well 98-21 located 110m downgradient of the HWMF; Well 108-14 located at the site boundary 675m downgradient of the HWMF; and Well 108-17 located at site boundary 680m downgradient of HWMF.

Table 5 - 15
BNL Site Environmental Report for Calendar Year 1995
AGS & LINAC Areas
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [(c)] mg/L	Nitrate as N [(c)] mg/L
AGS							
44-02(a)	1	5.4	Max. Avg.	50.2	<4.0	6.5	<1.0
54-01	1	6.6	Max. Avg.	153.5	17.1	12.1	<1.0
54-02	1	6.2	Max. Avg.	171.4	32.6	10.1	<1.0
54-05	1	6.5	Max. Avg.	66.2	<4.0	10.6	<1.0
54-06	1	6.6	Max. Avg.	208.5	8.7	21.3	<1.0
54-07	1	6.9	Max. Avg.	232.9	12.6	19.9	3.2
54-08	1	6.8	Max. Avg.	234.6	31.7	11.4	1.5
64-01	1	6.2	Max. Avg.	350.4	62.8	17.3	4.8
64-02	1	7.0	Max. Avg.	466.1	75.6	22.1	3.0
64-03	1	5.8	Max. Avg.	176.3	17.0	15.0	2.4
LINAC							
53-01(a)	2	5.2 - 6.1	Max. Avg.	43.0 43.0	4.5 4.2	9.3 8.8	<1.0 <1.0
53-04(a)	1	5.7	Max. Avg.	155.0	32.6	6.5	1.4
54-03	1	6.2	Max. Avg.	186.0	23.5	15.8	5.8
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 16
BNL Site Environmental Report for Calendar Year 1995
AGS & LINAC Areas
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			◄				mg/L				►
AGS Area											
44-02(a)	1	Max. Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	2.20	<0.002	0.03
54-01	1	Max. Avg.	<0.025	0.0007	<0.005	<0.05	2.95	<0.0002	9.30	<0.002	1.98
54-02	1	Max. Avg.	<0.025	<0.0005	<0.005	<0.05	0.62	<0.0002	18.68	<0.002	0.04
All other Wells (n=7)	7	Max. Avg.	<0.025 <0.025	<0.0005 <0.0005	<0.005 <0.005	<0.05 <0.05	<0.075 <0.075	<0.0002 <0.0002	38.84 18.84	<0.002 <0.002	0.03 <0.02
LINAC											
53-01(a)	2	Max. Avg.	<0.025 <0.025	<0.0005 <0.0005	<0.005 <0.005	<0.05 <0.05	<0.075 <0.075	<0.0002 <0.0002	3.85 3.63	0.048 0.024	0.04 0.02
53-04(a)	1	Max. Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	17.18	<0.002	<0.02
54-03	1	Max. Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	23.49	0.004	0.07
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

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 17
BNL Site Environmental Report for Calendar Year 1995
AGS and LINAC
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			←		ug/L			→
AGS								
Upgradient Wells (n=2)	3	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
54-07	2	Max.	11.1	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	9.1	<2.0	<2.0	<2.0	<2.0	<2.0
64-03	2	Max.	134.8	10.9	<2.0	14.7	7.8	<2.0
		Avg.	74.9	5.9	<2.0	8.6	4.2	<2.0
All Other wells (n=7)	13	Max.	2.1	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
LINAC								
All Wells (n=2)	2	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Table 5 - 18
BNL Site Environmental Report for Calendar Year 1995
AGS and LINAC
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			← ug/L →			
AGS						
All Wells (n=11)	20	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
LINAC						
All Wells (n=2)	2	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Wells 54-01 and 54-02 (both older wells constructed of carbon steel casings) show iron concentrations of 2.95 mg/L and 0.62 mg/L, respectively. Within the LINAC area, elevated lead concentrations were observed in upgradient well 53-01, at a maximum of 0.048 mg/L. VOCs in groundwater samples collected from the AGS area show TCA at concentrations that exceeded NYS AWQS in Wells 54-07 and 64-03, at maximum concentrations of 11.1 and 134.8 µg/L, respectively. Additionally, TCE, DCA, and DCE were detected in Well 63-04, at maximum concentrations of 10.9 µg/L, 14.7 µg/L and 7.8 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 six shallow Upper Glacial aquifer wells (Figure 5-4). During 1995, five downgradient surveillance wells were sampled for water quality, metals and VOCs (Tables 5-19 to 5-22). 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 all five wells, all water quality parameters were below the applicable NYS AWQS. Metals analyses of groundwater from this area indicated that all metals were below the applicable NYS AWQS. 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 12.6 µg/L to 29.5 µg/L. While groundwater samples from upgradient Well 65-06 were not analyzed for VOCs during 1995, TCA has been historically detected in this well, indicating that the TCA in the downgradient wells may not have originated from the WCF. Figure 5-17 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 will be assessed as part of the OU III RI/FS.

During 1995, groundwater samples were collected from the three Building 830 area surveillance wells (Figure 5-5), and were analyzed for water quality, VOCs, and metals (Tables 5-19 to 5-22). The pH of the samples was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.1. Other water quality parameters were below the applicable NYS AWQS. Metals and VOC analyses indicate that only lead exceeded NYS AWQS, being detected in Well 66-07 at a concentration of 0.019 mg/L.

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 three shallow and one middle Upper Glacial aquifer wells (Figure 5-7). During 1995, groundwater samples were collected from the four surveillance wells, and analyzed for water quality, VOCs, and metals (Tables 5-19 to 5-22). The pH of groundwater samples from shallow Upper Glacial aquifer wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.8, whereas the pH of the sample collected from middle Upper Glacial well 85-07 was 7.0. Other water quality parameters were below the applicable NYS AWQS. Metals analyses of the groundwater samples showed that all concentrations were below the applicable NYS AWQS. Analyses for VOCs, however, indicate that TCA was detected above NYS AWQS in middle Upper Glacial aquifer well 85-07, at a maximum concentration of 8.9 μg/L. DCA was also detected in Well 85-07 at 4.5 μg/L, slightly below NYS AWQS.

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 1995, groundwater samples were collected from these five wells (Figures 5-4 and 5-7), and analyzed for water quality, VOCs, and metals (Tables 5-19 to 5-22). The pH of the groundwater from upgradient wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.9, whereas it was within limits in wells directly downgradient of the basins. Other water quality parameters were below the applicable NYS AWQS. The results showed that most metals and all VOC concentrations were below the applicable NYS AWQS.

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 5-7 and 5-8). During 1995, seven of the wells were sampled for water quality, VOCs, and metals (Tables 5-23 to 5-26). 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 6.2. Although nitrate concentrations were elevated in five wells, all water quality parameters were below the applicable NYS AWQS. Metals analyses showed that iron concentrations were above NYS AWQS in one downgradient Well 105-02 (an older well constructed of carbon steel casings) at a concentration of 0.75 mg/L. For VOCs, TCA was detected above NYS AWQS in Wells 86-21, 96-06, and 96-07 at maximum concentrations of 7 μg/L, 60.9 μg/L, and 220 µg/L, respectively. Figure 5-18 plots the yearly average trends for TCA from representative monitoring wells within and downgradient of the Supply &Materiel area.

North Sector: Along the north boundary of BNL, eleven surveillance wells monitor background (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 two upper Magothy aquifer wells (Figures 5-2 and 5-3).

During 1995, nine of the north boundary wells were sampled for water quality, VOCs, and metals (Tables 5-27 to 5-30). 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 5.3, 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 10.7 mg/L. Furthermore, PCE was also detected in well 17-03 at the NYS AWQS of 5 µg/L. All metals were below the applicable NYS AWQS. 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). Contamination originated from source areas 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 (Figures 5-4 and 5-7). During 1995, seven of the wells were sampled for water quality, metals, and VOCs (Tables 5-27 to 5-30). The pH of the samples was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.2. All other water quality parameters were below applicable NYS AWQS. Metals analyses indicate that iron exceeded NYS AWQS in Well 103-01, at a maximum concentration of 8.45 mg/L; all other metals concentrations were below the applicable NYS AWQS. Groundwater from Well 83-02 exceeded the NYS AWQS for TCA, with a maximum observed concentration of 12.3 µg/L. Figure 5-19 plots the yearly average concentration trends for TCA for Well 83-02. In addition to permanent wells, 18 temporary vertical profile wells were installed during 1995 as part of Phase II Groundwater Screening of the OU III RI/FS (Figure 5-21), to characterize the vertical and horizontal extent of contamination close to the OU III source areas. Analysis of Phase II groundwater samples indicates the presence in most wells of either TCA, TCE, PCE, DCE, or chloroform at concentrations above NYS AWQS (Table 5-32). Maximum observed concentrations in Phase II vertical profile wells were: TCA in 17 wells ranging from 7 µg/L to 225 µg/L; TCE in one well at a maximum concentration of 11 µg/L; PCE in two wells ranging from 6 µg/L to 50 µg/L; DCE in seven wells ranging from 6 µg/L to 13 µg/L; and chloroform in two wells at maximum concentrations of 14 µg/L and 30 µg/L. Additional VOCs such as DCA, cis-1,2-DCE, and 1,2-DCA were occasionally detected at concentrations exceeding NYS AWQS: DCA in nine wells ranging from 5 µg/L to 23 µg/L; cis-1,2-DCE in one well at a maximum concentration of 38 µg/L; and 1,2-DCA in one well at a maximum concentration of 14 µg/L. For detailed information on the vertical distribution of VOCs, the reader is referred to ERM Northeast Groundwater Screening Report for OU III (1996b).

Table 5 - 19
BNL Site Environmental Report for Calendar Year 1995
Waste Concentration Facility, Building 830 & T-111 and Water Treatment Plant
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Waste Concentration Facility							
65-06(a)	1	6.6	Max.	280.0	41.4	19.2	3.3
			Avg.				
65-02	2	6.2 - 6.8	Max.	270.0	20.0	21.2	3.6
			Avg.	246.5	17.6	20.8	2.9
65-03	2	6.0 - 6.6	Max.	243.0	15.1	25.8	3.3
			Avg.	242.0	13.2	23.1	2.9
65-04	2	6.0 - 6.6	Max.	249.0	16.0	23.9	3.6
			Avg.	240.0	12.4	22.5	3.4
65-05	2	5.8 - 6.2	Max.	221.0	13.9	22.4	2.9
			Avg.	214.0	12.9	21.6	2.6
Building 830							
66-07(a)	1	5.7	Max.	119.0	17.3	10.9	<1.0
			Avg.				
66-08	1	6.0	Max.	190.0	NA	NA	NA
			Avg.				
66-09	1	6.5	Max.	127.0	18.3	9.7	<1.0
			Avg.				
Building T-111							
75-01	1	6.0	Max.	381.0	74.4	17.3	2.4
			Avg.				
75-02	1	6.1	Max.	454.0	82.3	29.7	2.7
			Avg.				
85-06	1	5.6	Max.	253.0	35.2	20.6	2.5
			Avg.				
85-07	1	7.0	Max.	139.0	11.6	5.1	<1.0
			Avg.				
Water Treatment Plant							
63-01(a)	1	5.7	Max.	110.0	15.4	10.2	<1.0
			Avg.				
63-02(a)	1	6.1	Max.	125.0	16.4	10.5	<1.0
			Avg.				
63-03	1	7.0	Max.	144.0	18.9	10.6	<1.0
			Avg.				
73-01	1	7.0	Max.	151.0	19.3	9.8	<1.0
			Avg.				
73-02	1	6.8	Max.	169.0	19.5	9.7	<1.0
			Avg.				
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

NA: Not Analyzed.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 20
BNL Site Environmental Report for Calendar Year 1995
Waste Construction Facility, Building 830, Former Building T-111, Water Treatment Plant
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
Waste Concentration Facility											
All Wells (n=5)	9	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	16.96	<0.002	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	12.96	<0.002	<0.02
Building 830											
66-07(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	15.22	0.019	<0.02
		Avg.									
All Other Wells (n=2)	2	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	17.80	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	16.74	<0.002	<0.02
Former Building T-111											
All Wells (n=4)	4	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	41.07	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	27.89	<0.002	<0.02
Water Treatment Plant											
63-01(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.87	<0.002	<0.02
		Avg.									
63-02(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.27	<0.002	<0.02
		Avg.									
73-01	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	12.02	0.018	0.02
		Avg.									
All Other Wells (n=2)	2	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.84	0.004	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.62	0.002	0.02
NYS AWQS			0.05	0.01	0.05	0.2	0.30	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

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 5 - 21
BNL Site Environmental Report for Calendar Year 1995
Waste Concentration Facility - Building 830 (Former Building T-111, Water Treatment Plant)
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			ug/L					
Waste Concentration Facility								
65-02	2	Max.	29.5	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	28.2	<2.0	<2.0	<2.0	<2.0	<2.0
65-03	2	Max.	25.8	<2.0	<2.0	2.1	<2.0	2.2
		Avg.	22.3	<2.0	<2.0	<2.0	<2.0	<2.0
65-04	2	Max.	24.6	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	20.9	<2.0	<2.0	<2.0	<2.0	<2.0
65-05	2	Max.	12.6	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	12.1	<2.0	<2.0	<2.0	<2.0	<2.0
Building 830								
All Wells (n=3)	3	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	2.7
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Former Building T-111								
85-07	1	Max.	8.9	<2.0	<2.0	4.5	<2.0	<2.0
		Avg.						
All Other wells (n=3)	5(a)	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	6.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Water Treatment Plant								
All Wells (n=5)	5	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	15.7
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	10.2
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Other compounds detected.

Table 5 - 22
BNL Site Environmental Report for Calendar Year 1995
Waste Concentration Facility, Building 830 Former Building T-111, Water Treatment Plant
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			← ug/L →			
Waste Concentration Facility						
All Wells (n=4)	8	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
Building 830						
All Wells (n=3)	3	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
Former Building T-111						
All Wells (n=4)	6	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
Water Treatment Plant						
All Wells (n=5)	5	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

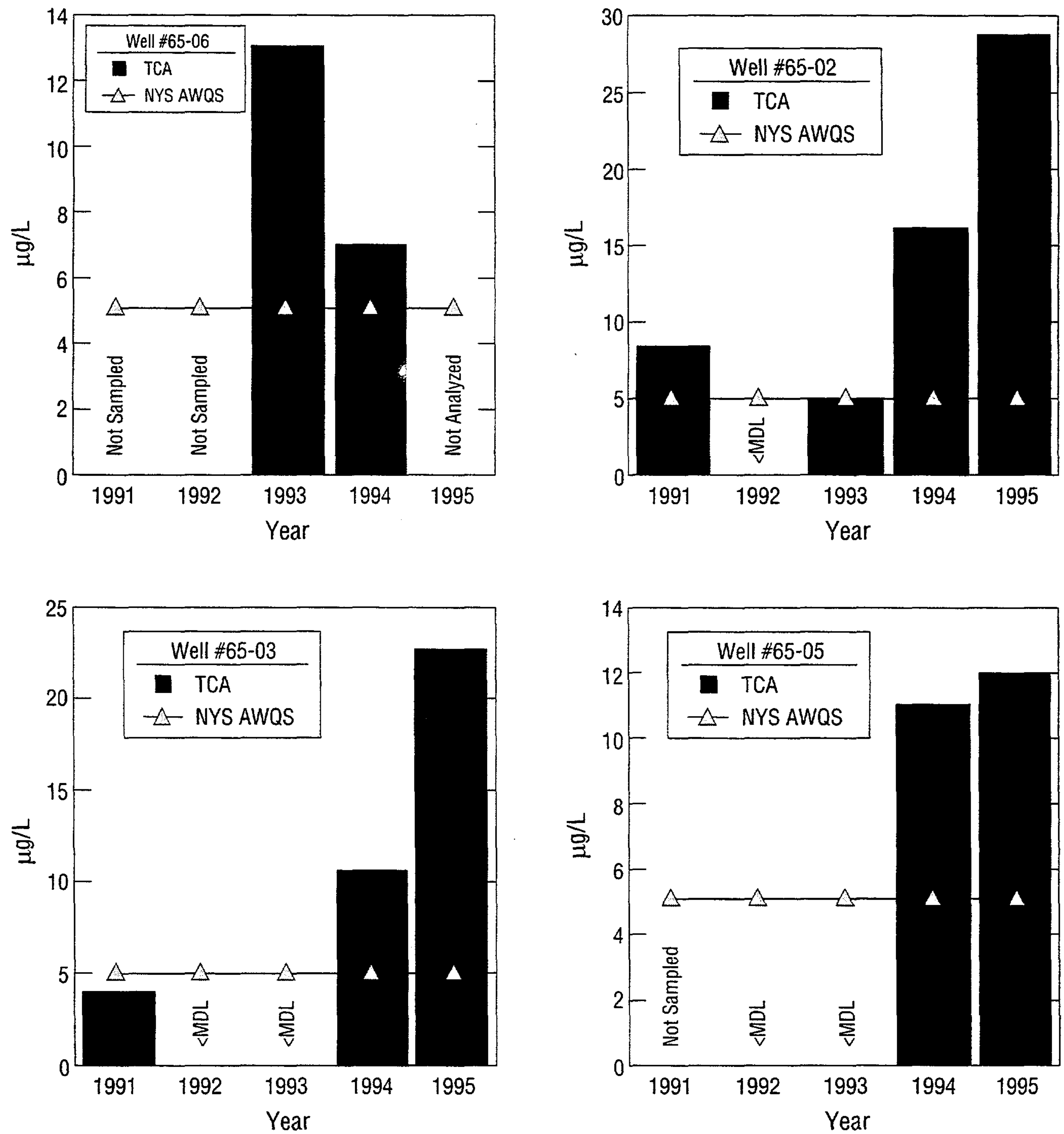


Figure 5- 17 Yearly average concentration trends of 1,1,1-Trichloroethane in wells upgradient and downgradient of the Waste Concentration Facility (WCF): Well 65-06 located directly upgradient of the WCF; Wells 65-02, 65-03 and 65-05 are located directly downgradient of the WCF.

Table 5 - 23
BNL Site Environmental Report for Calendar Year 1995
Supply & Materiel Area
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Supply & Materiel							
85-02(a)	1	6.2	Max.	123.3	16.2	8.3	<1.0
			Avg.				
85-03	1	6.6	Max.	177.4	8.4	15.3	1.8
			Avg.				
86-21	1	5.9	Max.	225.2	25.6	17.3	5.8
			Avg.				
96-06	2	6.0 - 6.4	Max.	289.0	46.6	17.6	3.7
			Avg.	114.9	40.4	17.6	3.2
96-07	2	5.9 - 6.0	Max.	327.2	35.1	24.6	3.8
			Avg.	295.6	29.8	22.3	3.4
105-02	1	5.9	Max.	134.0	15.1	24.0	<1.0
			Avg.				
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 24
BNL Site Environmental Report for Calendar Year 1995
Supply & Materiel
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
85-01(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	26.45	<0.002	<0.02
		Avg.									
85-02(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.65	<0.002	0.03
		Avg.									
105-02	1	Max.	<0.025	<0.0005	<0.005	<0.05	0.750	<0.0002	21.69	<0.002	<0.02
		Avg.									
All Other Wells	6	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	29.21	<0.002	0.06
(n=4)		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	19.70	<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

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 25
BNL Site Environmental Report for Calendar Year 1995
Supply and Materiel Area
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			←		ug/L			→
Supply & Material								
Upgradient Wells (n=2)	4	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
86-21	2	Max.	7.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Max.	3.5	<2.0	<2.0	<2.0	<2.0	<2.0
96-06	3(a)	Max.	60.9	<2.0	<2.0	<2.0	2.8	<2.0
		Avg.	38.9	<2.0	<2.0	<2.0	<2.0	<2.0
96-07	3(a)	Max.	220.0	3.0	<2.0	<2.0	4.0	<2.0
		Avg.	160.5	<2.0	<2.0	<2.0	<2.0	<2.0
All Other wells (n=2)	3	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Holding times exceeded on one sample.

Table 5 - 26
BNL Site Environmental Report for Calendar Year 1995
Supply and Materiel Area
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			ug/L			
Supply & Material						
All Wells (n=7)	15(a)	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Holding time exceeded for two samples.

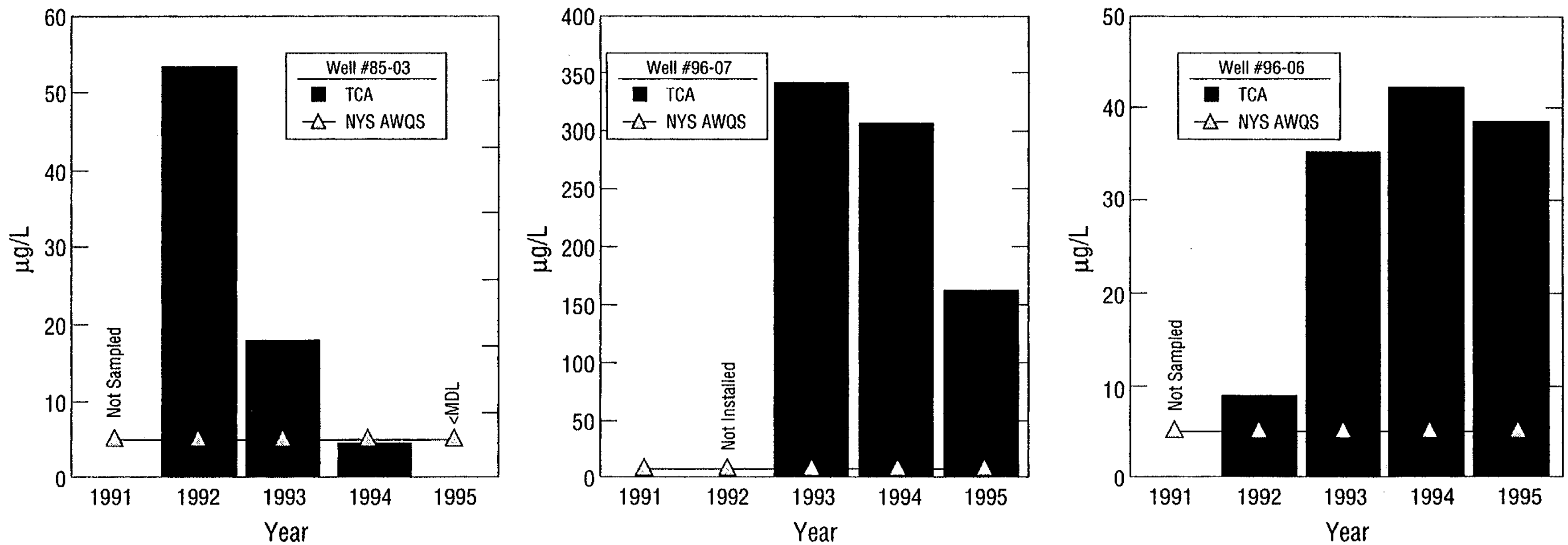


Figure 5-18 Yearly average concentration trends of 1,1,1-Trichloroethane in wells located within and downgradient of the Supply and Materiel Area (S&M): Well 85-03 located in the northern portion of the S&M Area and downgradient of Building T-86; Well 96-07 located 60m downgradient of the Building 208; and Well 96-06 is located in the downgradient portion of the S&M Area.

Table 5 - 27
BNL Site Environmental Report for Calendar Year 1995
North, West and South Sectors
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
North Sector							
07-04	2	5.5	Max.	69.0	9.1	8.6	<1.0
			Avg.	68.8	8.4	8.5	<1.0
17-01	2	5.2 - 5.3	Max.	73.0	11.8	9.3	<1.0
			Avg.	71.3	9.2	9.2	<1.0
17-02	2	5.7 - 5.8	Max.	245.0	40.5	24.5	4.6
			Avg.	241.1	39.9	22.8	4.5
17-03	2	5.7 - 5.8	Max.	330.0	40.3	29.6	10.7
			Avg.	325.0	40.1	29.4	10.6
17-04	2	7.3 - 7.6	Max.	135.0	5.9	<4.0	<1.0
			Avg.	132.1	5.5	<4.0	<1.0
18-01	2	5.1	Max.	56.1	5.0	7.5	<1.0
			Avg.	50.0	<4.0	7.2	<1.0
18-02	2	5.7 - 5.8	Max.	74.6	10.1	7.9	<1.0
			Avg.	71.3	9.75	7.6	<1.0
18-03	2	5.7	Max.	115.3	18.8	11.1	<1.0
			Avg.	111.2	17.1	9.4	<1.0
25-02	1	4.8	Max.	144.0	29.5	16.3	<1.0
			Avg.				
West Sector							
83-01	2	6.2 - 6.4	Max.	120.8	20.0	10.9	<1.0
			Avg.	118.4	19.2	10.4	<1.0
83-02	2	6.2 - 6.5	Max.	141.0	21.4	11.2	<1.0
			Avg.	134.2	18.5	11.1	<1.0
84-01	2	5.9 - 6.2	Max.	202.1	41.7	17.6	<1.0
			Avg.	194.5	38.1	16.9	<1.0
94-01	2	5.7 - 6.0	Max.	150.0	20.2	20.6	2.4
			Avg.	148.0	15.2	18.2	1.9
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 27 (Continued)
BNL Site Environmental Report for Calendar Year 1995
North, West and South Sectors
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
West Sector							
102-01	2	5.3 - 5.5	Max.	242.0	59.3	11.5	<1.0
			Avg.	199.5	44.0	11.2	<1.0
103-01	2	6.9 - 8.9	Max.	129.0	20.7	10.2	<1.0
			Avg.	126.0	19.4	9.4	<1.0
103-02	1	7.1	Max.	89.0	6.9	7.9	<1.0
			Avg.				
South Sector							
118-01	2	6.0 - 6.1	Max.	72.6	7.6	10.4	<1.0
			Avg.	66.3	7.2	9.8	<1.0
118-02	2	6.1 - 6.3	Max.	135.5	24.2	12.0	<1.0
			Avg.	119.2	23.8	10.8	<1.0
122-01	1	5.2	Max.	41.0	5.2	6.3	<1.0
			Avg.				
122-02	1	5.3	Max.	120.0	17.2	14.3	<1.0
			Avg.				
122-04	1	5.4	Max.	136.0	25.1	11.1	<1.0
			Avg.				
126-01	2	5.8 - 6.1	Max.	59.3	5.8	10.0	<1.0
			Avg.	57.6	5.1	9.9	<1.0
130-02	2	6.1 - 6.2	Max.	160.0	26.9	19.5	1.2
			Avg.	158.2	25.1	19.0	1.2
130-03	2	6.5 - 6.7	Max.	175.0	29.4	14.9	1.5
			Avg.	170.6	26.9	14.6	1.5
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for sulfates and nitrates were typically exceeded.

Table 5 - 28
BNL Site Environmental Report for Calendar Year 1995
North Sector, West Sector, South Sector
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
North Sector											
All Wells (n=9)	17	Max.	<0.025	<0.0005	<0.005	<0.05	0.229	<0.0002	27.21	0.003	0.10
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.68	<0.002	<0.05
West Sector											
103-01	2	Max.	<0.025	<0.0005	<0.005	<0.05	8.45	<0.0002	14.42	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	4.22	<0.0002	14.01	<0.002	<0.02
All Other Wells (n=6)	6	Max.	<0.025	<0.0005	<0.005	<0.05	0.130	<0.0002	19.24	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.07	<0.002	0.02
South Sector											
All Wells (n=8)	10	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	17.8	<0.002	0.03
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.45	<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

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 29
BNL Site Environmental Report for Calendar Year 1995
North, West and South Sector
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			ug/L					
North Sector								
17-03	2	Max.	<2.0	<2.0	5.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	2.5	<2.0	<2.0	<2.0
All Other wells (n=9)	14	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
West Sector								
83-01	2	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	26.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	23.9
83-02	2	Max.	12.3	<2.0	<2.0	<2.0	<2.0	14.0
		Avg.	11.9	<2.0	<2.0	<2.0	<2.0	13.4
All Other wells (n=6)	10	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
South Sector								
130-02	2	Max.	15.7	5.6	<2.0	2.7	2.7	3.6
		Avg.	12.7	5.4	<2.0	2.0	<2.0	3.2
130-03	2	Max.	14.0	22.1	<2.0	<2.0	6.1	7.9
		Avg.	10.9	17.1	<2.0	<2.0	4.8	7.0
122-04	1	Max.	157.8	<2.0	<2.0	<2.0	59.6	<2.0
All Other wells (n=5)	8	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	2.6
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Table 5 - 30
BNL Site Environmental Report for Calendar Year 1995
North, West and South Sector
Ground Water Surveillance Wells, BETX Data

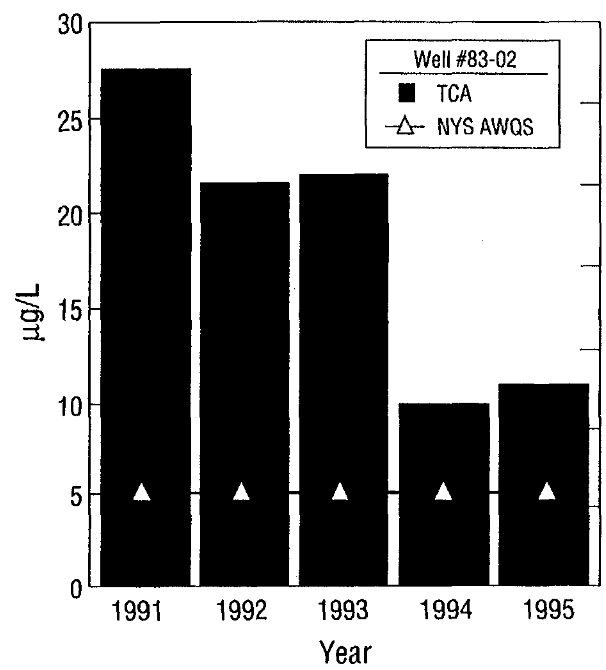
Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			← ug/L →			
North Sector						
All Wells (n=9)	16	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
West Sector						
All Wells (n=8)	14	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
South Sector						
All Wells (n=8)	13	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

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 permanent on-site wells, and temporary on-site and off-site wells show that VOCs have migrated beyond BNL's boundary.

The permanent surveillance well network along BNL's southern (downgradient) boundary currently consists of eight wells which monitor the shallow, intermediate, and deep portions of the Upper Glacial aquifer and two Magothy aquifer wells (Figures 5-10 and 5-11). (Please note that South Boundary surveillance wells monitoring the Current Landfill and HWMF are not included in this summary.) During 1995, the eight Upper Glacial wells were sampled for water quality, metals, and VOCs (Tables 5-27 to 5-30). 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. All metals concentrations were below NYS AWQS. Analyses for VOCs indicate that TCA and TCE were above NYS AWQS in Well 130-02, with maximum observed concentrations of 15.7 µg/L and 5.6 µg/L, respectively. Three compounds, TCA, TCE and DCE were observed in Well 130-03 at maximum concentrations of 14 µg/L, 22.1 µg/L, and 6.1 µg/L, respectively. In deep Upper Glacial Well 122-04, TCA and DCE were detected at concentrations of 157.8 µg/L and 59.6 µg/L, respectively. Figure 5-19 plots the yearly average concentration trends for TCA in Well 130-02.

As part of the OU III RI/FS, 47 temporary vertical profile wells were installed in the south sector areas during 1995 as part of Phase I Groundwater Screening (Figure 5-20). Additionally, 18 temporary wells were installed in off-site areas as part of Phase III of the OU III study (Figure 5-22). The temporary profile wells were installed to characterize the vertical and horizontal extent of contamination downgradient of the OU III source areas. Analysis of Phase I groundwater samples indicates widespread VOC contamination in the southern sector of the site (Table 5-31). Principal VOCs detected at concentrations at or above NYS AWQS were TCA, TCE, PCE, DCE, and carbon tetrachloride. Maximum observed concentrations in Phase I wells were: TCA in 40 wells ranging from 5 µg/L to 1,500 µg/L; TCE in 34 wells ranging from 5 µg/L to 100 µg/L; PCE in 17 wells ranging from 5 µg/L to 2,500 µg/L; DCE in 26 wells ranging from 5 µg/L to 370 µg/L; carbon tetrachloride in 10 wells ranging from 6 µg/L to 700 µg/L; and chloroform in 25 wells ranging from 7 µg/L to 38 µg/L. Additionally, DCA, cis-1,2-DCE, 1,2-DCA, trans-1,2-DCE, xylene and toluene were occasionally detected at concentrations exceeding NYS AWQS. Analysis of Phase III groundwater samples indicates that VOCs originating from BNL, and possibly other off-site source areas, is present in some areas of the North Shirley residential area (Table 5-33). The principal VOCs detected at concentrations at or above NYS AWQS were TCA, TCE, PCE, DCE, and carbon tetrachloride. The maximum observed concentrations in Phase III wells were: TCA in 13 wells ranging from 5 µg/L to 32 µg/l; TCE in 13 wells ranging from 6 µg/L to 110 µg/L; PCE in one well at a maximum concentration of 24 µg/L; DCE in four wells ranging from 5 µg/L to 16 µg/L; chloroform in two wells at maximum concentrations of 8 µg/L and 33 µg/L; and carbon tetrachloride in seven wells ranging from 17 µg/L to 3,200 µg/L. Cis-1,2-DCE was also detected at a concentration above NYS AWQS in one well, at a maximum of 7 µg/L. For detailed information on the vertical distribution of VOCs, the reader is referred to ERM Northeast, Groundwater Screening Report for OU III (1996b).



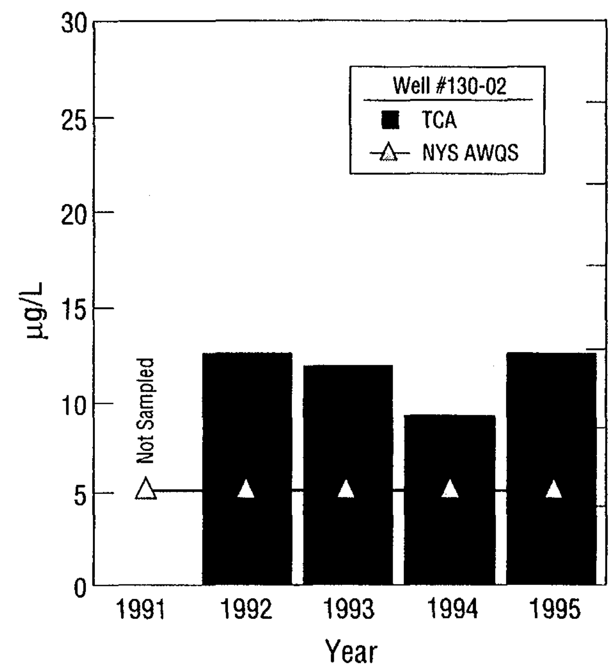


Figure 5-19 Yearly average concentration trends of 1,1,1-Trichloroethane in wells within the West Sector and southwestern boundary of the BNL site; Well 83-02 is located in the Paint Shop and Potable Well 4 area; and Well 130-02 located near BNL's South Gate.

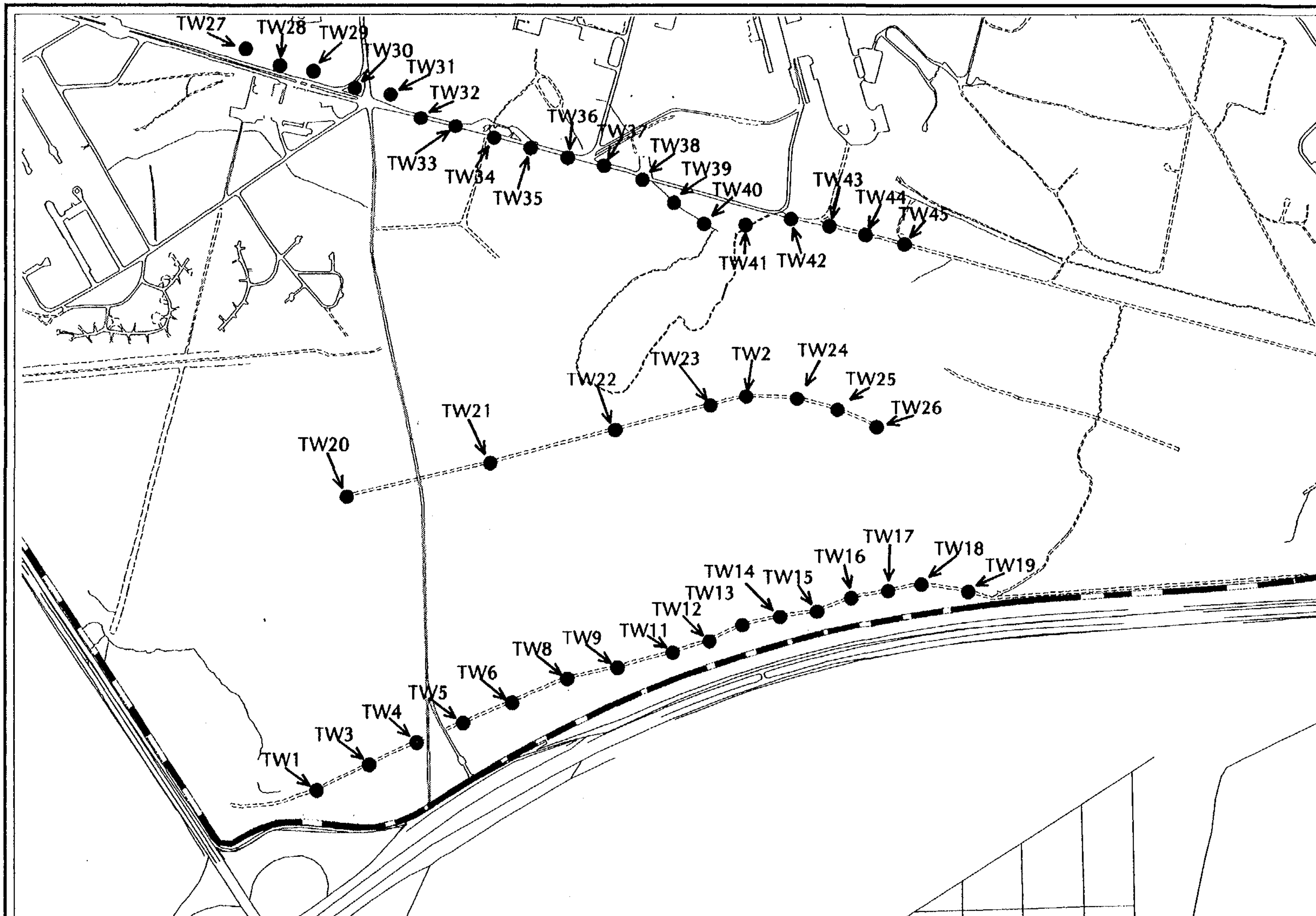


Figure 5 - 20

Brookhaven National Laboratory
Operable Unit III
Location of Phase 1 Temporary Wells

Table 5 - 31
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase I
Vertical Profile Wells - Southern Sector
Highest Observed Concentrations Volatile Organic Compounds [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
		◄—		ug/L			—►
TW-1	17	8	16	<1	<1	9	<1
TW-2	24	2	<1	1	<1	1	<1
TW-3*	17	19	21	<1	<1	8	<1
TW-4*	13	14	19	<1	6	17	<1
TW-5*	15	13	10	1	5	5	<1
TW-6*	17	21	14	<1	7	8	<1
TW-8*	15	19	14	<1	6	7	<1
TW-9	18	21	11	<1	7	9	<1
TW-11*	17	19	9	1	6	7	<1
TW-12*	22	16	14	<1	6	7	<1
TW-13*	19	11	8	5	3	3	<1
TW-14*	20	3	<1	2	<1	9	<1
TW-15*	20	235	20	2500	60	5	200
TW-16	21	1500	46	77	370	4	12
TW-17*	20	960	100	<1	210	4	49
TW-18*	20	310	47	<1	110	2	6
TW-19*	20	115	90	<1	<1	6	9
TW-20*	19	16	9	2	5	6	<1
TW-21*	16	18	7	2	6	11	<1
TW-22*	18	13	8	<1	5	9	<1
TW-23*	22	17	6	<1	6	6	<1
TW-24*	23	120	4	1300	21	7	2
TW-25	23	15	6	200	3	38	700
NYS AWQS		5	5	5	5	7	5
Typical MDL		1	1	1	1	1	1

* = Other Compounds Detected.
Note: Wells TW-7 and TW-10 were not installed.
(a): For detailed information on Vertical distribution of contaminants see: Ground Water Screening Report Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.
MDL: Minimum Detection Limit.

Table 5 - 31 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase I
Vertical Profile Wells - Southern Sector
Highest Observed Concentrations Volatile Organic Compounds [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
		◄		ug/L			►
TW-26*	21	64	9	36	19	9	2
TW-27	15	4	<1	<1	<1	<1	<1
TW-28*	15	11	8	<1	5	3	<1
TW-29*	14	2	8	3	3	<1	9
TW-30*	16	17	6	1	6	9	<1
TW-31*	14	14	5	<1	5	10	<1
TW-32*	10	9	4	<1	3	14	<1
TW-33*	11	15	3	<1	3	9	<1
TW-34	11	10	1	<1	3	7	<1
TW-35*	12	11	1	<1	2	5	<1
TW-36*	12	10	1	<1	2	8	<1
TW-37*	14	13	5	2	4	11	<1
TW-38*	14	19	8	10	5	9	2
TW-38 RD*	15	31	11	11	5	12	4
TW-39	14	28	6	5	8	9	<1.0
TW-40*	18	16	6	7	2	2	<1
TW-41	17	21	38	2100	7	10	<1
TW-42*	17	44	22	1000	13	1	6
TW-43*	15	5	5	28	2	3	10
TW-43RD*	14	4	7	80	<1	4	11
TW-44*	15	74	9	74	17	7	3
TW-45*	15	19	2	9	2	2	<1
NYS AWQS		5	5	5	5	7	5
Typical MDL		1	1	1	1	1	1

* = Other Compounds Detected.
Note: Wells TW-7 and TW-10 were not installed.
(a): For detailed information on Vertical distribution of contaminants see: Ground Water Screening Report Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.
MDL: Minimum Detection Limit.

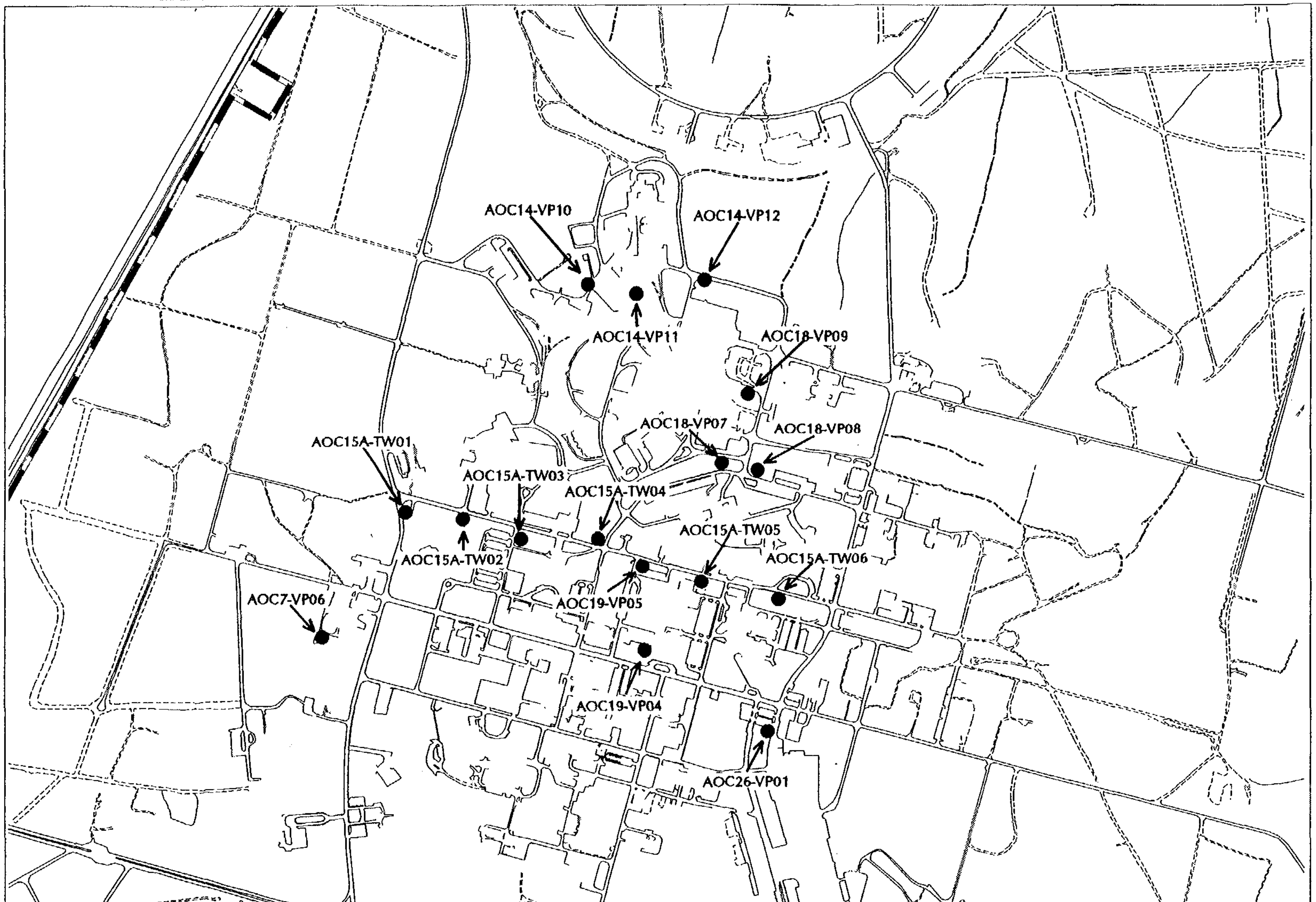


Figure 5 - 21

Brookhaven National Laboratory
Operable Unit III
Location of Phase 2 Temporary Wells

/home15/jen/ou/ou3ph2.aml

Table 5 -32
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase II
Vertical Profile Wells - Central and Western Areas
Highest Observed Concentrations Volatile Organic Compounds [(a)]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
		ug/L					
AOC 7 VP6	14	20	<1	<1	3	14	<1
AOC 14 VP10*	13	7	<1	<1	<1	2	<1
AOC 14 VP11*	14	20	<1	<1	2	1	<1
AOC 14 VP12*	14	7	<1	<1	<1	2	<1
AOC 15A TW01*	16	4	<1	<1	1	30	<1
AOC 15A TW02*	14	10	1	<1	4	3	<1
AOC 15A TW03*	14	11	<1	<1	<1	4	<1
AOC 15A TW04*	15	20	<1	<1	6	5	<1
AOC 15A TW05*	17	28	2	<1	8	6	<1
AOC 15A TW06*	15	27	2	<1	4	5	<1
AOC 18 VP07*	15	32	1	<1	4	5	<1
AOC 18 VP08*	15	10	1	<1	2	5	<1
AOC 18 VP09*	10	20	<1	<1	1	2	<1
AOC 19 VP04*	14	66	3	<1	13	6	<1
AOC 19 VP05*	16	26	1	<1	7	5	<1
AOC 26 VP01*	22	31	1	<1	10	2	1
AOC 26 VP02*	18	225	3	6	7	1	<1
AOC 26 VP03*	18	87	11	50	8	2	4
NYS AWQS		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

* = Other Compounds Detected
(a): For detailed information on vertical distribution of contaminants see: Groundwater Screening Report Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.
MDL: Minimum Detection Limit.

Figure 5 - 22

Brookhaven National Laboratory
Operable Unit III
Location of Phase 3 Temporary Wells

Table 5 - 33
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase III
Vertical Profile Wells - Offsite
Highest Observed Concentrations Volatile Organic Compounds [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCE	Chloroform	Carbon Tetrachloride
		◄		ug/L			►
OS-1*	20	32	86	<1	16	3	68
OS-2*	16	31	63	<1	<1	3	17
OS-3	18	5	7	<1	1	3	<1
OS-4	19	6	2	<1	1	4	<1
OS-5*	22	32	1	<1	3	3	<1
OS-6*	19	<1	<1	<1	3	2	<1
OS-7*	26	<1	2	<1	<1	2	<1
OS-8*	26	12	65	<1	4	33	3200
OS-9	22	4	7	<1	<1	2	<1
OS-10*	17	12	25	<1	3	3	26
OS-11	16	8	6	<1	3	2	<1
OS-12	12	8	19	<1	3	8	<1
OS-13*	18	24	6	<1	3	2	<1
OS-14*	15	16	10	<1	6	5	<1
OS-15*	17	16	6	<1	5	3	<1
SC-95A	13	4	70	<0.5	2	<0.5	300
SC-95B*	17	30	110	24	16	4	60
SC-95C	5	2	<0.5	<0.5	<0.5	<0.5	710
NYS AWQS		5	5	5	5	7	5
Typical MDL		1	1	1	1	1	1

* = Other Compounds Detected.

(a): For detailed information on vertical distribution of contaminants see: Groundwater Screening Report Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.

MDL: Minimum Detection Limit.

Operable Unit IV Areas

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 spring of 1997.

The surveillance well networks at the CSF and MPF has 30 shallow to deep Upper Glacial aquifer wells (Figures 5-5 and 5-8). During 1995, 25 wells were monitored for water quality, metals, and VOCs (Tables 5-34 to 5-37). The five MPF wells were also sampled for floating petroleum products in accordance with the NYSDEC license. The pH 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. Most metals concentrations were below the applicable NYS AWQS, except iron concentrations were elevated in Wells 76-04 (maximum value of 19.96 mg/L), 76-08 (0.475 mg/L), and 76-21 (2.457 mg/L). In the five wells monitoring the MPF, VOCs were present at concentrations at or above NYS AWQS in two, upgradient Well 76-25 with TCA at a maximum concentration of 13.2 µg/L and downgradient Well 76-19 with PCE at a maximum of 12.1 µg/L. In both cases, these VOCs are not the result of spills or leaks associated with MPF operations. In the case of upgradient Well 76-25, the TCA is likely to have originated from releases in the Building 650 area, whereas the PCE in Well 76-19 is likely to have originated from a spill site near Building 610. No BETX 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 1995.

Of the 19 CSF surveillance wells sampled during 1995, seven wells had VOCs at concentrations above NYS AWQS: TCA was detected in three wells at maximum concentrations ranging from 7.2 µg/L to 20.5 µg/L; TCE was detected in two wells at maximum concentrations of 17 µg/L and 25 µg/L; PCE was detected in six wells at maximum concentrations ranging from 10.7 µg/L to 73.1 µg/L; cis-1,2-DCE was detected in four wells (76-08, 76-09, 76-21 and 76-23) at maximum concentrations ranging from 7.9 µg/L to 79.7 µg/L; ethylbenzene was detected in two wells at maximum concentrations of 22.6 µg/L and 690 µg/L; Toluene was detected in one well at a maximum concentration of 1,900 µg/L; and xylene (total) was detected in three wells at maximum concentrations ranging from 52.5 µg/L to 1,340 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 5-23.

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 (Figures 5-5 and 5-8). Ten wells were installed in 1993 as part of the OU IV RI/FS; the full extent of groundwater contamination resulting from operations at Building 650

Table 5 - 34
BNL Site Environmental Report for Calendar Year 1995
Major Petroleum Facility, Central Steam Facility and Building 650/650 Outfall
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Major Petroleum Facility							
75-25(a)	2	5.7 -6.1	Max.	196.0	33.0	18.1	1.2
			Avg.	181.0	25.2	16.8	1.2
76-16	2	5.0 - 5.5	Max.	175.0	6.9	34.3	7.3
			Avg.	157.0	6.0	30.4	6.1
76-17	2	5.2 - 5.6	Max.	161.0	6.8	24.6	6.7
			Avg.	139.5	5.6	21.5	5.2
76-18	2	5.5 - 5.8	Max.	142.0	<4.0	30.4	3.1
			Avg.	119.0	<4.0	22.2	3.0
76-19	2	5.8 - 6.3	Max.	158.0	8.9	32.7	<1.0
			Avg.	136.5	8.6	24.2	<1.0
Central Steam Facility							
76-24(a)	1(0)	5.6	Max.	155.0	NA	NA	NA
			Avg.				
76-02	2	6.6 - 6.7	Max.	144.0	18.4	13.8	<1.0
			Avg.	142.0	18.2	12.9	<1.0
76-04	2	6.2	Max.	188.2	15.2	17.2	1.8
			Avg.	186.1	15.0	12.0	<1.0
76-05	1	5.9	Max.	189.4	12.0	28.1	2.2
			Avg.				
76-07	1	6.0	Max.	120.0	17.0	12.2	<1.0
			Avg.				
76-08	2	6.0 - 6.1	Max.	145.6	14.5	14.5	<1.0
			Avg.	140.8	14.4	13.8	<1.0
76-09	2	5.5 - 6.1	Max.	186.0	19.3	20.0	1.5
			Avg.	160.2	17.8	15.8	<1.0
76-20	1(0)	5.6	Max.	359.0	NA	NA	NA
			Avg.				
76-21	2	5.1 - 6.0	Max.	118.0	14.9	13.2	<1.0
			Avg.	117.1	12.6	13.2	<1.0
76-22	2	5.7 - 6.2	Max.	145.0	17.8	12.7	1.7
			Avg.	139.5	17.2	11.2	<1.0
76-23	2	6.0 - 6.1	Max.	377.1	41.6	56.6	5.2
			Avg.	326.6	40.7	40.9	3.8
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

NA: Not Analyzed.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): *No standard specified.*
(c): Holding times for Sulfates and Nitrates were typically exceeded.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.

Table 5 - 34 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Major Petroleum Facility, Central Steam Facility and Building 650/650 Outfall
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Central Steam Facility							
86-04	2(1)	5.6 - 6.1	Max.	115.0	10.8	15.6	1.6
			Avg.	112.0			
86-05	2(1)	5.9 - 6.0	Max.	114.0	15.7	10.4	<1.0
			Avg.	112.0			
86-06	2(1)	5.8 - 6.8	Max.	136.0	18.8	14.7	<1.0
			Avg.	134.0			
86-07	2(1)	5.5 - 5.8	Max.	176.0	13.9	18.5	1.4
			Avg.	165.0			
86-08	2	5.9 - 6.4	Max.	126.0	17.2	10.9	<1.0
			Avg.	125.4	16.1	10.3	<1.0
86-09	2(1)	5.8 - 6.2	Max.	126.0	17.7	12.8	<1.0
			Avg.	125.0			
105-05	1	5.7	Max.	64.0	5.8	9.2	<1.0
			Avg.				
105-06	1	5.6	Max.	140.6	11.3	25.9	<1.0
			Avg.				
105-07	1	6.2	Max.	131.4	15.8	21.1	<1.0
			Avg.				
Building 650/650 Outfall							
66-17	1	6.7	Max.	136.7	17.2	11.5	<1.0
			Avg.				
66-18	1	6.7	Max.	138.7	17.5	12.6	<1.0
			Avg.				
76-13	1(0)	6.1	Max.	104.0	NA	NA	NA
			Avg.				
76-25	2	5.7 - 6.1	Max.	196.0	33.0	18.1	1.2
			Avg.	181.0	25.2	16.8	1.2
76-26	2(1)	5.8 - 6.6	Max.	192.7	38.0	10.6	<1.0
			Avg.	176.3			
76-27	1(0)	6.5	Max.	170.0	NA	NA	NA
			Avg.				
76-28	2(1)	5.9 - 7.2	Max.	90.4	9.3	14.2	<1.0
			Avg.	84.7			
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

NA: Not Analyzed.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
~~**(b):** No standard specified.~~
(c): Holding times for Sulfates and Nitrates were typically exceeded.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.

Table 5 - 35
BNL Site Environmental Report for Calendar Year 1995
Major Petroleum Facility, Central Steam Facility and Building 650
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
Major Petroleum Facility											
All Wells (n=5)	5	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	13.68	<0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.98	<0.002	<0.02
Central Steam Facility											
76-24(a)	1	Max.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.96	<0.002	<0.02
		Avg.									
76-04	2	Max.	<0.025	<0.0005	<0.005	<0.05	19.96	<0.0002	12.78	0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	14.39	<0.0002	12.28	<0.002	<0.02
76-08	2	Max.	<0.025	<0.0005	<0.005	<0.05	0.475	<0.0002	9.51	<0.002	<0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.452	<0.0002	9.18	<0.002	<0.02
76-21	2	Max.	<0.025	0.0005	<0.005	<0.05	2.457	<0.0002	7.84	<0.002	0.02
		Avg.	<0.025	<0.0005	<0.005	<0.05	(b)	<0.0002	6.61	<0.002	<0.02
All Other Wells (n=16)	26	Max.	<0.025	<0.0005	<0.005	<0.05	0.082	<0.0002	35.79	<0.002	0.1
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.87	<0.002	<0.02
Building 650 & Outfall											
All Wells (n=7)	11	Max.	<0.025	<0.0005	<0.005	<0.05	0.140	<0.0002	17.50	<0.002	0.06
		Avg.	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.39	<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	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Only one Fe Sample Analyzed.

Table 5 - 36
BNL Site Environmental Report for Calendar Year 1995
Major Petroleum Facility, Central Steam Facility and Building 650/650 Outfall
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			←			ug/L		→
Major Petroleum Facility								
76-25(a)	2	Max.	13.2	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	8.2	<2.0	<2.0	<2.0	<2.0	<2.0
76-19	2	Max.	<2.0	<2.0	12.1	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	6.0	<2.0	<2.0	<2.0
All Other Wells	6	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
(n=3)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Central Steam Facility								
76-24(a)	1	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.						
76-04	2(b)	Max.	20.5 J	17.0 J	<50	<50	<50	<50
		Avg.	10.0	8.5	<50	<50	<50	<50
76-05	1	Max.	<2.0	<2.0	10.7	<2.0	<2.0	<2.0
		Avg.						
76-08	2	Max.	3.2	2.7	41.3	<2.0	<2.0	2.4
		Avg.	2.8	2.4	20.6	<2.0	<2.0	<2.0
76-09	2(d)	Max.	7.2	<2.0	7.2	<2.0	<2.0	<2.0
		Avg.	3.6	<2.0	3.6	<2.0	<2.0	<2.0
76-21	2	Max.	<2.0	2.1	73.1	<2.0	<2.0	<2.0
		Avg.	<2.0	2.0	52.6	<2.0	<2.0	<2.0
76-23	2(d)	Max.	3.3	<2.0	15.0	<2.0	<2.0	<2.0
		Avg.	2.5	<2.0	12.4	<2.0	<2.0	<2.0
105-06	2	Max.	12.1	25.0	57.9	2.4	<2.0	2.4
		Avg.	9.6	20.6	48.6	<2.0	<2.0	2.2
105-07	2	Max.	<2.0	3.9	3.1	<2.0	<2.0	4.8
		Avg.	<2.0	3.6	2.6	<2.0	<2.0	3.4
All Other Wells	19	Max.	<2.0	<2.0	2.7	<2.0	<2.0	2.5
(n=10)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Building 650 & 650 Outfall								<2.0
								<2.0
76-25(c)	2	Max.	13.2	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	8.2	<2.0	<2.0	<2.0	<2.0	<2.0
76-26(c)	1	Max.	3.6	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.						
All Other Wells	3	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
(n=3)		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Sample analyzed @ 1:50 dilution J = estimated value.
(c): Wells 76-25 and 76-26 are downgradient of building 650.
(d): Other compounds detected.

Table 5 - 37
BNL Site Environmental Report for Calendar Year 1995
Major Petroleum Facility, Central Steam Facility and Building 650/650 Outfall
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene (ug/L)	Ethylbenzene (ug/L)	Toluene (ug/L)	Xylene (ug/L)
Major Petroleum Facility						
All Wells (n=5)	10	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
Central Steam Facility						
76-24(a)	1	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.				
76-04	2(b)	Max.	<50.0	690.0	1,900.0	1340.0
		Avg.	<50.0	410.0	1,015.0	850.0
76-08	2(c)	Max.	<2.0	22.6	<2.0	163.6
		Avg.	<2.0	11.3	<2.0	81.8
76-21	2(c)	Max.	<2.0	4.2	<2.0	52.5
		Avg.	<2.0	2.5	<2.0	26.2
All Other Wells (n=15)	28	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
Building 650 and 650 Outfall						
All Wells (n=5)	6	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Sample analyzed @ 1:50 Dilution.
(c): Other compounds detected.

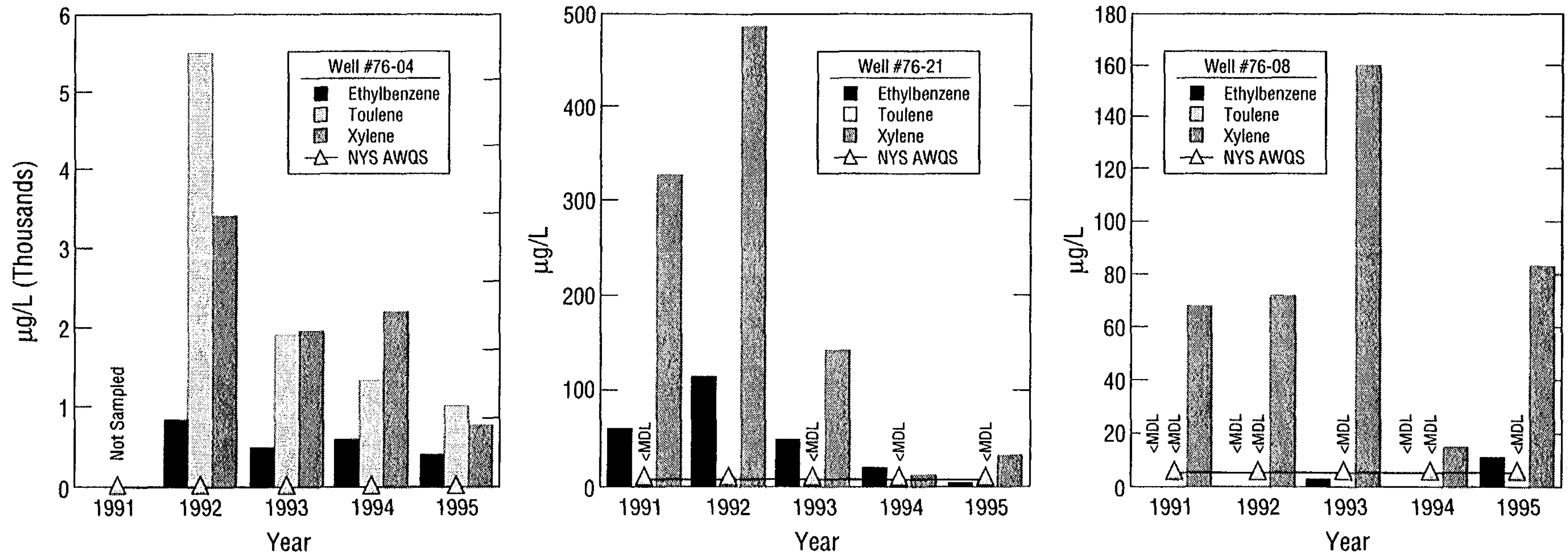


Figure 5-23 Yearly average concentration trends of ethylbenzene, toluene, and xylene in wells located within and downgradient of the 1977 fuel oil/solvent spill area: Well 76-04 located with the spill area; Well 76-21 is 60m downgradient of the spill site; and Well 76-08 is 90m downgradient.

is presently being evaluated. Remedial alternatives for radiologically contaminated soils are being evaluated as part of the OU I FS.

During 1995, groundwater samples were collected from Wells 76-25 and 76-26 which are located directly downgradient of Building 650 (Tables 5-34 to 5-37). The pH of most groundwater samples were either within or slightly below the NYS AWQS of 6.5 to 8.5. All other water quality parameters and metals concentrations were below the applicable NYS AWQS. However, TCA was detected in Well 76-25 and Well 76-26 at maximum concentrations of 13.2 and 3.6 μg/L, respectively. No VOCs were detected in wells directly downgradient of the 650 Sump Outfall.

Operable Unit V Area

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. Because of past radiological and chemical releases to the soils and groundwater in the BNL STP and the nearby Peconic River areas (both on-site and off-site), the STP and Peconic River areas are currently the subject of a RI/FS (Operable Unit V), which is being conducted under the IAG between DOE, EPA, and NYSDEC.

The surveillance well network at the STP and Peconic River areas consists of 29 shallow to deep Upper Glacial aquifer wells (Figure 5-3, 5-5, and 5-6). During 1995, groundwater samples from these wells were analyzed for water quality, VOCs, and metals (Tables 5-38 to 5-41). In most wells located both upgradient and downgradient of the STP the pH was typically below the NYS AWQS of 6.5 - 8.5, with a median pH of 5.5. All other water quality parameters were within the applicable NYS AWQS. Four shallow wells located near the STP filter beds, however, exhibited elevated levels of nitrate-nitrogen, but below NYS AWQS. Iron concentrations exceeded NYS AWQS of 0.3 mg/L in 16 wells, with maximum concentrations ranging from 0.38 mg/L to 53.17 mg/L. Six wells had lead concentrations above the NYS AWQS of 0.015 mg/L, with maximum concentrations ranging from 0.019 mg/L to 0.056 mg/L. The volatile organic compound TCE was detected in deep Upper Glacial aquifer well 61-05 at concentrations of 12 μg/L. To further evaluate the extent of groundwater contamination at the BNL eastern site boundary and off-site areas, five temporary vertical profile wells were installed as part of the OU V Remedial Investigation (Figure 5-24; ERM Northeast, 1996a). Volatile organic compounds were detected above or at NYS AWQS in two temporary wells (Table 5-42). In temporary well 53-03, TCA, TCE, DCA, and chloroform were detected at a maximum concentrations of 8 μg/L, 32 μg/L, 5 μg/L, and 10 μg/L, respectively. In temporary well 00-88, TCE and DCA were detected at maximum concentrations of 8 μg/L and 6 μg/L, respectively.

Operable Unit VI Areas

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

Table 5 - 38
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant/Peconic River
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Sewage Treatment Plant/ Peconic River							
37-02(a)	1(0)	5.7	Max.	50.0	NA	NA	NA
			Avg.				
37-03(a)	1(0)	5.4	Max.	55.0	NA	NA	NA
			Avg.				
37-04(a)	1(0)	6.1	Max.	50.0	NA	NA	NA
			Avg.				
47-03(a)	1(0)	5.1	Max.	35.0	NA	NA	NA
			Avg.				
29-01	1(0)	6.39	Max.	145.0	NA	NA	NA
			Avg.				
37-01	1(0)	4.9	Max.	60.0	NA	NA	NA
			Avg.				
38-01	3(2)	4.5 - 5.4	Max.	66.6	5.5	11.7	1.0
			Avg.	55.2	5.3	10.8	<1.0
38-02	3(2)	5.5 - 5.7	Max.	115.5	12.7	9.5	5.1
			Avg.	103.8	11.4	9.4	4.2
38-03	3(2)	5.0 - 5.4	Max.	147.0	18.0	14.2	4.3
			Avg.	104.9	11.4	12.8	3.9
38-04	1(0)	6.6	Max.	230.0	NA	NA	NA
			Avg.				
38-05	3(2)	5.4 - 5.6	Max.	88.5	8.9	9.7	<1.0
			Avg.	73.2	8.8	9.6	<1.0
38-06	4(3)	5.2 - 5.6	Max.	290.0	37.1	16.4	<1.0
			Avg.	107.9	15.5	11.1	<1.0
39-05	2(1)	5.2 - 5.5	Max.	72.9	7.2	6.9	<1.0
			Avg.	61.4	-	-	-
39-06	2(1)	6.0 - 6.1	Max.	308.6	28.9	10.1	<1.0
			Avg.	251.8	-	-	-
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

NA: Not Analyzed.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for Sulfates and Nitrates were typically exceeded.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.
Note: Table includes water quality data presented in the Operable Unit V Remedical Investigation Report.

Table 5 - 38 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant/Peconic River
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [(c)] mg/L	Nitrate as N [(c)] mg/L
Sewage Treatment Plant/ Peconic River							
39-07	3(2)	5.7 - 6.0	Max.	238.0	34.2	18.6	5.5
			Avg.	168.7	24.7	16.8	5.1
39-08	3(2)	4.6 - 5.7	Max.	150.0	25.9	17.1	6.0
			Avg.	94.4	24.4	15.4	5.8
39-09	3(2)	4.6 - 5.3	Max.	69.3	9.5	9.5	<1.0
			Avg.	57.8	9.1	8.9	<1.0
39-10	1(0)	6.5	Max.	60.0	NA	NA	NA
			Avg.				
48-02	1(0)	4.7	Max.	30.0	NA	NA	NA
			Avg.				
49-04	1(0)	5.5	Max.	35.0	NA	NA	NA
			Avg.				
60-01	1(0)	5.4	Max.	40.0	NA	NA	NA
			Avg.				
61-03	1(0)	4.6	Max.	45.0	NA	NA	NA
			Avg.				
49-05	1(0)	5.8	Max.	30.0	NA	NA	NA
			Avg.				
49-06	1(0)	6.4	Max.	40.0	NA	NA	NA
			Avg.				
61-04	1(0)	5.5	Max.	40.0	NA	NA	NA
			Avg.				
61-05	1(0)	6.5	Max.	95.0	NA	NA	NA
			Avg.				
41-01	1(0)	5.2	Max.	40.0	NA	NA	NA
			Avg.				
41-02	1(0)	5.8	Max.	30.0	NA	NA	NA
			Avg.				
41-03	1(0)	6.4	Max.	60.0	NA	NA	NA
			Avg.				
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

NA: Not Analyzed.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for Sulfates and Nitrates were typically exceeded.
( ): Number in parenthesis indicates samples analyzed for Chlorides, Sulfates, and Nitrates.
Note: Table includes water quality data presented in the Operable Unit V Remedical Investigation Report.

Table 5 - 39
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant & Peconic River Areas
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe (mg/L)	Hg	Na	Pb	Zn
37-02(a)	1	Max.	<0.025	<0.0038	<0.005	<0.05	<0.075	<0.0002	9.02	<0.002	<0.02
		Avg.									
37-03(a)	1	Max.	<0.025	<0.0038	<0.005	<0.05	<0.075	<0.0002	8.86	<0.002	<0.02
		Avg.									
37-04(a)	1	Max.	<0.025	<0.0038	<0.005	<0.05	0.381	<0.0002	5.58	<0.002	<0.02
		Avg.									
47-03(a)	1	Max.	<0.025	<0.0038	<0.005	<0.05	0.282	<0.0002	4.06	<0.002	(R)
		Avg.									
29-01	1	Max.	<0.025	<0.0038	0.014	<0.05	14.4	<0.0002	7.53	0.008	0.04
		Avg.									
38-02	3	Max.	<0.025	<0.0038	0.009	<0.05	13.4	<0.0002	10.70	0.006	0.04
		Avg.	<0.025	<0.0038	<0.005	<0.05	4.47	<0.0002	9.73	0.002	<0.02
38-03	3	Max.	<0.025	<0.0038	0.019	<0.05	14.6	<0.0002	10.96	0.021	0.27
		Avg.	<0.025	<0.0038	<0.005	<0.05	4.87	<0.0002	7.32	0.007	0.19
38-04	1	Max.	<0.025	<0.0038	0.022	<0.05	26.4	<0.0002	7.17	0.013	0.07
		Avg.									
39-05	3	Max.	<0.025	<0.0038	<0.005	<0.05	1.0	<0.0002	11.19	<0.002	0.05
		Avg.	<0.025	<0.0038	<0.005	<0.05	0.849	<0.0002	7.88	<0.002	0.03
39-06	2	Max.	<0.025	<0.0038	0.013	<0.05	10.4	<0.0002	11.3	0.006	0.04
		Avg.	<0.025	<0.0038	0.006	<0.05	5.937	<0.0002	11.1	0.003	0.03
39-07	3	Max.	<0.025	<0.0038	0.038	<0.05	42.10	<0.0002	28.23	0.054	0.14
		Avg.	<0.025	<0.0038	0.012	<0.05	14.077	<0.0002	22.02	0.018	0.05
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

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Only one Zn Sample Analyzed.
R: Data Rejected.

Table 5 - 39 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant & Peconic River Areas
Groundwater Surveillance Wells, Metals Data

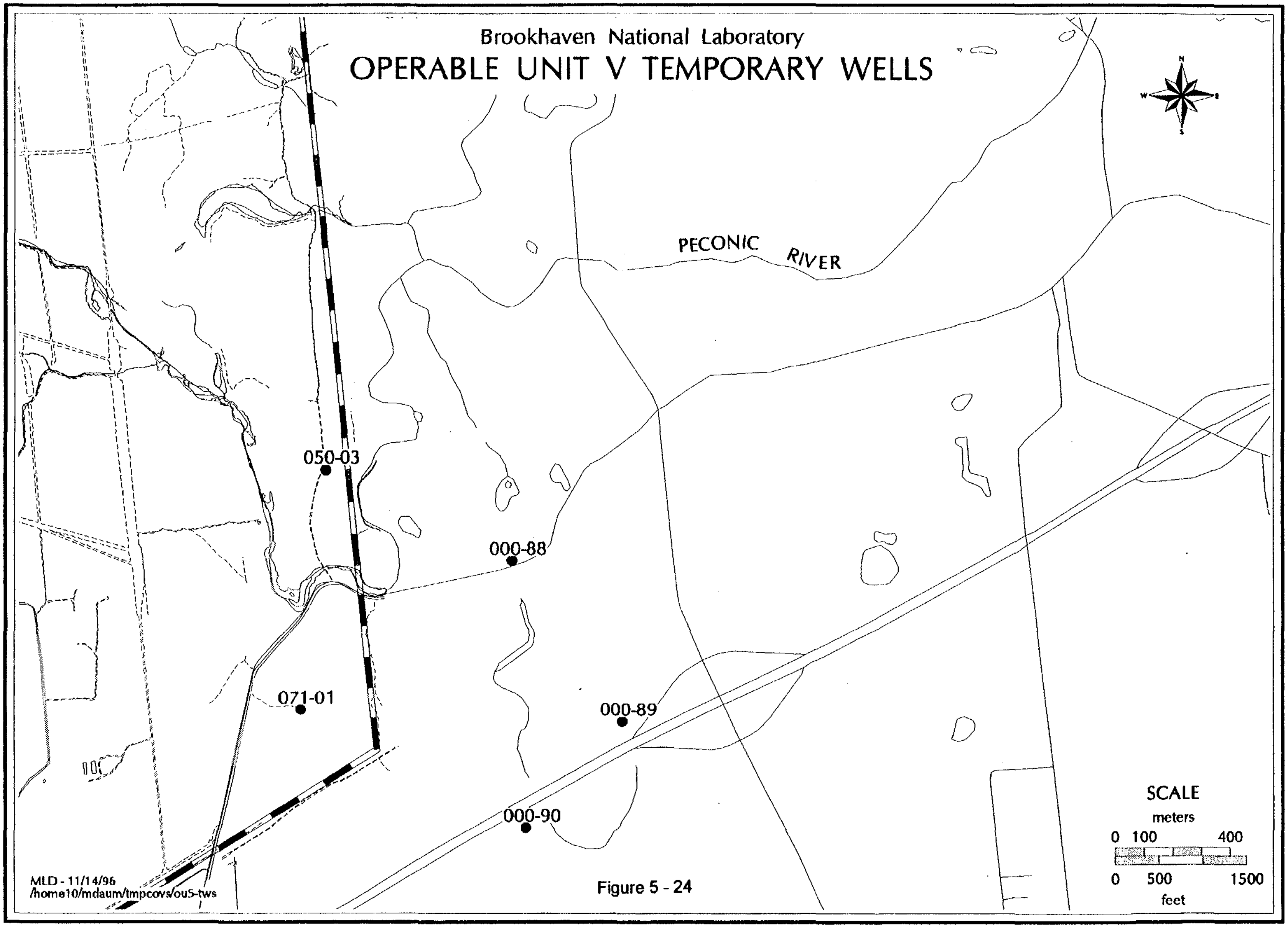
Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			←				mg/L				→
39-08	3	Max.	<0.025	<0.0038	<0.005	<0.05	0.515	<0.0002	24.81	<0.002	0.02
		Avg.	<0.025	<0.0038	<0.005	<0.05	0.172	<0.0002	23.27	<0.002	<0.02
39-09	3	Max.	<0.025	<0.0038	0.05	0.07	34.6	0.0004	6.44	0.056	0.14
		Avg.	<0.025	<0.0038	0.017	<0.05	11.533	<0.0002	5.96	0.018	0.05
41-03	1	Max.	<0.025	<0.0038	<0.005	<0.05	0.437	<0.0002	6.27	<0.002	0.04
		Avg.									
48-02	1	Max.	<0.025	<0.0038	0.029	<0.05	30.10	<0.0002	4.21	0.024	(R)
		Avg.									
49-04	1	Max.	<0.025	<0.0038	0.006	<0.05	8.40	<0.0002	3.26	0.004	(R)
		Avg.									
49-05	1	Max.	<0.025	<0.0038	<0.005	<0.05	0.318	<0.0002	4.63	<0.002	(R)
		Avg.									
60-01	2	Max.	<0.025	<0.0038	0.030	<0.05	23.40	<0.0002	8.32	0.019	<0.02 (b)
		Avg.	<0.025	<0.0038	0.015	<0.05	11.70	<0.0002	7.16	0.009	
61-03	2	Max.	<0.025	<0.0038	0.0300	0.08	53.170	<0.0002	5.76	0.054	0.2 (b)
		Avg.	<0.025	<0.0038	0.0238	0.07	40.635	<0.0002	5.32	0.035	
All other Wells (n=10)	16	Max.	<0.025	<0.0038	<0.005	<0.05	0.238	<0.0002	8.23	<0.002	0.02
		Avg.	<0.025	<0.0038	<0.005	<0.05	<0.075	<0.0002	5.80	<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	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Only one Zn Sample Analyzed.
R: Data Rejected.

Table 5 - 40
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant /Peconic River Area
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			ug/L					
Sewage Treatment Plant/Peconic River								
Upgradient Wells (n=4)	4	Max.	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0
		Avg.	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
61-05	1	Max.	3.0	12.0	<1.0	2.0	<1.0	<1.0
		Avg.						
41-03	1	Max.	<1.0	1.0	<1.0	2.0	<1.0	1.0
		Avg.						
All Other Wells (n=23)	44	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	3.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	7.0
Typical MDL (a)			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): MDL for samples analyzed during the OU V RI was 1.0 ug/L.


Brookhaven National Laboratory
OPERABLE UNIT V TEMPORARY WELLS
PECONIC RIVER
N
W
E
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000-88
071-01
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000-90
SCALE
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Figure 5 - 24

Table 5 - 41
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant /Peconic River Area
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			ug/L			
Sewage Treatment Plant/Peconic River						
All Other Wells (n=29)	50	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL (a)			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): MDL for samples analyzed during the OU V RI was 1.0 ug/L.

Table 5 - 42
BNL Site Environmental Report for Calendar Year 1995
Operable Unit V
Vertical Profile Wells - East Boundary and Offsite Areas
Maximum Observed Concentrations Voliate Organic Compounds and Tritium [a]

Well Number	No. of Sample Intervals	TCA	TCE	PCE	DCA ug/L	DCE	Chloroform	Cis 1,2 DCE	Tritium pCi/L
071-01	25	1	<1	<1	<1	<1	1	<1	676
050-03	22	8	32	<1	5	4	10	<1	1040
000-88	26	1	8	<1	6	<1	<1	4	1710
000-89	24	2	<1	<1	<1	<1	<1	<1	488
000-90	25	<1	4	<1	2	<1	<1	3	1790
NYS AWQS		5	5	5	5	5	7	5	20000
Typical MDL		1	1	1	1	1	1	1	380

(a): For detailed information on the vertical distribution of contaminants see: Ground Water Screening Survey Report, Operable Unit V, Brookhaven National Laboratory, January 1996, ERM Northeast.

agricultural fields are also located in this area, and analysis of groundwater samples indicate that the pesticide EDB was applied to these fields.

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 5-6, 5-8 and 5-9). Twelve of the monitoring wells were installed in 1994 as part of the OU I/VI RI/FS. During 1995, groundwater samples from seven Upper Glacial and one Magothy aquifer surveillance wells were analyzed for water quality (Table 5-43), 12 wells were sampled for metals (Table 44) and 28 were sampled for VOCs (Tables 5-45 and 5-46). The pH was typically 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. Iron was detected above NYS AWQS in Upper Glacial aquifer Wells 90-03 and 100-14 and in Magothy aquifer well 100-04, at maximum concentrations of 2.68, 8.13, and 5.60 mg/L, respectively. Lead was above NYS AWQS in Well 100-04, with a maximum concentration of 0.016 mg/L. Historically, the only VOC detected above NYS DWS (or NYS AWQS) in the Upland Recharge/Meadow Marsh area was EDB. Groundwater samples collected during the April 1995 OU VI RI sample period, showed that EDB concentrations exceeded the NYS DWS of 0.05 µg/L in three wells (Table 5-47). (Note: the NYS DWS for EDB is used since it is more restrictive than the NYS AWQS of 5 µg/L.) EDB was detected in three southeast boundary wells at concentrations of 0.07 µg/L, 0.08 µg/L and 0.28 µg/L; additionally, EDB was detected at a maximum concentration of 3.4 µg/L in off-site temporary vertical profile well HP-000-14R -10).

5.1.2.2 Radiological Analyses

Operable Unit I Areas

Current Landfill: Table 5-48 shows the radiological analysis results of groundwater samples collected in the vicinity of the Current Landfill (closed in 1990)(see Figure 5-8). 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 consistently show elevated gross beta activity concentrations; a maximum value of 26 pCi/L (1.0 Bq/L) was observed. Strontium -90 was also detectable at levels above those attributable to fallout near the Current Landfill in Grid 087. The maximum observed strontium-90 concentration was 2 pCi/L (0.1 Bq/L), or 25% of the limit specified in the SDWA. No significant strontium-90 was detected in southern Grids. This is as expected since the capacity of soils permeated with groundwater to store fission products has been shown to be substantial. The lateral travel rate of strontium-90 is quite low and has been shown to be as little as 5 meters per year (Eisenbud, 1987). A plot of groundwater gross beta and strontium-90 activity trends are shown in Figures 5-25 and 5-26. No distinct trends are evident in the data for this area.

Tritium is also detectable at elevated levels ranging from 1,000 to near 10,000 pCi/L (37 to 370 Bq/L). A maximum tritium concentration of 12,900 pCi/L (477 Bq/L), or 65% of the SDWA standard, was recorded at Well 87-07. Tritium continues to be detectable further south in Grids 115 and 116, though at reduced levels; the maximum concentration observed in this area was 5,360 pCi/L (198 Bq/L). Tritium concentration trends

Table 5 - 43
BNL Site Environmental Report for Calendar Year 1995
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, Water Quality Data

Well Number	No. of Samples	pH Su		Conductivity umhos/cm	Chlorides mg/L	Sulfates [c] mg/L	Nitrate as N [c] mg/L
Upland Recharge/Meadow Marsh Area							
80-02	2	5.2 - 6.9	Max.	45.0	5.2	8.4	<1.0
			Avg.	44.5	5.1	7.8	<1.0
88-03	2	5.6 - 5.9	Max.	52.0	7.7	10.0	<1.0
			Avg.	51.5	7.2	9.9	<1.0
90-02	2	5.2 - 5.7	Max.	53.0	5.9	8.4	<1.0
			Avg.	50.5	5.8	8.2	<1.0
90-03	1	5.2	Max.	78.0	8.6	7.9	<1.0
			Avg.				
99-05	2	5.4 - 5.9	Max.	88.0	13.4	11.1	<1.0
			Avg.	87.0	11.6	10.5	<1.0
99-06	2	5.4 - 5.9	Max.	100.0	14.1	12.8	1.2
			Avg.	98.0	13.2	12.6	<1.0
100-03	1	5.2	Max.	45.0	6.3	6.3	<1.0
			Avg.				
100-04	1	5.7	Max.	74.0	8.8	10.1	<1.0
			Avg.				
NYS AWQS		6.5 - 8.5		(b)	250.0	250.0	10.0
Typical MDL				10.0	4.0	4.0	1.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No standard specified.
(c): Holding times for Sulfates and Nitrates were typically exceeded.

Table 5 - 44
BNL Site Environmental Report for Calendar Year 1995
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, Metals Data

Location	No. of Samples		Ag	Cd	Cr	Cu	Fe	Hg	Na	Pb	Zn
			mg/L								
90-03	1	Max.	<0.025	<0.0005	<0.005	<0.05	2.69	<0.0002	6.61	<0.002	<0.02
		Avg.									
100-04	2	Max.	<0.025	<0.005	0.027	<0.05	8.98	<0.0002	5.83	0.016	0.80
		Avg.	<0.025	<0.005	0.018	<0.05	6.04	<0.0002	5.80	0.013	0.72
		Max.									
100-14	1	Avg.	<0.004	<0.005	0.028	0.012	8.13	0.0001	5.56	0.013	0.74
All Other Wells	14	Max.	<0.025	<0.005	<0.007	<0.05	<0.075	<0.0002	9.78	<0.002	0.04
(n=9)		Avg.	<0.025	<0.005	<0.007	<0.05	<0.075	<0.0002	5.84	<0.002	<0.02
NYS AWQS			0.05	0.01	0.05	0.2	0.30	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

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 5 - 45
BNL Site Environmental Report for Calendar Year 1995
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA	TCE	PCE	DCA	DCE	Chloroform
			ug/L					
All Wells (n=28)	40(a)	Max.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
NYS AWQS			5.0	5.0	5.0	5.0	5.0	## 7.0
Typical MDL (b)			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Holding time exceeded for four samples.
(b): MDL for samples analyzed for the OU VI RI was 1.0 ug/L.

Table 5 - 46
BNL Site Environmental Report for Calendar Year 1995
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, BETX Data

Location	No. of Samples		Benzene	Ethylbenzene	Toluene	Xylene
			← ug/L →			
All Wells (n=28)	40(a)	Max.	<2.0	<2.0	<2.0	<2.0
		Avg.	<2.0	<2.0	<2.0	<2.0
NYS AWQS			0.7	5.0	5.0	5.0
Typical MDL (b)			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Holding time exceeded for four samples.
(b): MDL for samples analyzed for the OU VI RI was 1.0 ug/L.

Table 5 - 47
BNL Site Environmental Report for Calendar Year 1995
Upland Recharge/Meadow Marsh Area
Groundwater Surveillance Wells, 1, 2 - Dibromoethane Data

Location	No. of Samples		1, 2 - Dibromoethane (EDB) ug/L
Upgradient Wells (n=4)	4	Max.	<0.03
		Avg.	
99-11	1	Max.	0.07
		Avg.	
100-13	1	Max.	0.08
		Avg.	
100-14	1	Max.	0.78
		Avg.	
All Other Wells (n=18)	18	Max.	<0.03
		Avg.	
NYS DWS			0.05
Typical MDL			0.03

Table 5-48
BNL Site Environmental Report for Calendar Year 1995
Current Landfill Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Cs-137	Co-60	Sr-90
			←			(pCi/L)			→
Current Landfill									
87-09(a)	4	Max.	1.86	3.47	159	5.17	0.26	ND	0.39
		Avg.	0.33	1.86	10	5.17	0.26	ND	0.19
87-05	1	Max.	2.23	13.30	2870	ND	ND	ND	2.16
87-06	1	Max.	-4.99	2.87	7520	10.30	ND	ND	1.43
87-07	1	Max.	-1.45	14.80	12900	16.70	ND	ND	2.00
87-10	1	Max.	2.15	26.80	1060	3.65	0.31	0.16	NA
87-11	4	Max.	13.60	22.20	3680	15.20	0.78	0.84	1.52
		Avg.	3.04	20.60	2553	11.81	0.51	0.75	1.31
87-23	4	Max.	2.73	10.70	752	ND	ND	0.80	1.52
		Avg.	1.45	7.30	431	ND	ND	0.80	1.03
87-24	4	Max.	1.07	2.06	58	ND	ND	ND	0.04
		Avg.	0.32	1.12	-115	ND	ND	ND	0.02
87-26	4	Max.	2.98	2.09	8570	8.46	0.19	ND	1.34
		Avg.	0.78	0.99	1939	5.70	0.19	ND	0.71
87-27	4	Max.	1.68	12.40	9200	6.60	ND	ND	1.12
		Avg.	0.04	5.56	5527	6.60	ND	ND	0.71
88-02	1	Max.	0.32	1.27	-73	ND	ND	ND	NA
88-21	2	Max.	1.52	5.94	223	ND	ND	ND	1.38
		Avg.	0.97	4.44	190	ND	ND	ND	0.71
88-22	2	Max.	0.50	5.00	278	5.15	ND	ND	0.19
		Avg.	0.25	4.19	173	5.15	ND	ND	0.17
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	3000	5000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed

Table 5-48 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Current Landfill Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40 (pCi/L)	Cs-137	Co-60	Sr-90
Current Landfill									
115-01	3	Max.	0.43	1.50	0	2.25	ND	ND	-0.02
		Avg.	0.11	0.68	-130	2.25	ND	ND	(c)
115-02	3	Max.	0.08	0.85	52	3.52	ND	ND	-0.03
		Avg.	0.03	0.28	-75	3.23	ND	ND	(c)
115-03	3	Max.	0.22	1.54	-23	ND	ND	0.54	-0.01
		Avg.	-0.06	0.78	-113	ND	ND	0.54	(c)
115-04	3	Max.	0.44	5.93	1120	2.47	ND	ND	0.05
		Avg.	0.31	2.37	982	2.47	ND	ND	(c)
115-05	2	Max.	0.36	8.35	2990	2.71	ND	ND	0.14
		Avg.	0.20	3.14	2557	2.71	ND	ND	(c)
115-13	2	Max.	0.73	1.10	5360	9.28	ND	ND	0.11
		Avg.	-0.59	(c)	5170	6.41	ND	ND	(c)
115-14	2	Max.	0.64	1.94	2420	ND	ND	ND	ND
		Avg.	0.20	0.95	1550	ND	ND	ND	ND
115-15	3	Max.	0.66	3.12	709	2.47	ND	ND	-0.05
		Avg.	0.33	2.42	598	2.47	ND	ND	(c)
115-16	3	Max.	0.27	0.62	3780	ND	0.27	ND	ND
		Avg.	0.15	0.52	2190	ND	0.27	ND	ND
116-05	2	Max.	0.16	1.26	2190	ND	ND	ND	0.27
		Avg.	-0.21	0.26	1935	ND	ND	ND	(c)
116-06	2	Max.	-0.29	0.04	1050	3.43	ND	ND	0.04
		Avg.	-0.30	-0.16	886	3.43	ND	ND	(c)
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	3000	5000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed

Table 5-48 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Former Landfill Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40 (pCi/L)	Cs-137	Co-60	Sr-90
Former Landfill									
86-42(a)	2	Max.	0.18	0.52	132	2.60	ND	ND	0.07
		Avg.	0.09	0.26	63	2.60	ND	ND	(c)
86-43(a)	2	Max.	0.75	1.20	440	5.20	ND	0.44	0.03
		Avg.	0.42	0.90	323	3.85	ND	0.30	(c)
97-01	1	Max.	0.23	4.66	-22	2440.00	ND	ND	0.16
97-02	2.	Max.	0.86	2.48	132	ND	0.29	ND	0.17
		Avg.	0.58	2.42	21	ND	0.29	ND	(c)
97-03	2	Max.	3.35	108.00	-38	ND	ND	ND	40.47
		Avg.	1.84	79.85	-101	ND	ND	ND	32.41
97-05	3	Max.	0.64	3.18	120	ND	ND	ND	0.28
		Avg.	0.40	1.69	26	ND	ND	ND	0.14
97-08	1	Max.	0.65	(d)	-12	ND	ND	ND	0.18
97-17	1	Max.	0.00	0.45	0	ND	ND	ND	NA
97-18	2	Max.	0.90	(d)	122	42.57	ND	ND	0.54
		Avg.	0.45	(d)	-33	42.57	ND	ND	(c)
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	3000	5000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.
(d) Data point voided based on QA review.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed

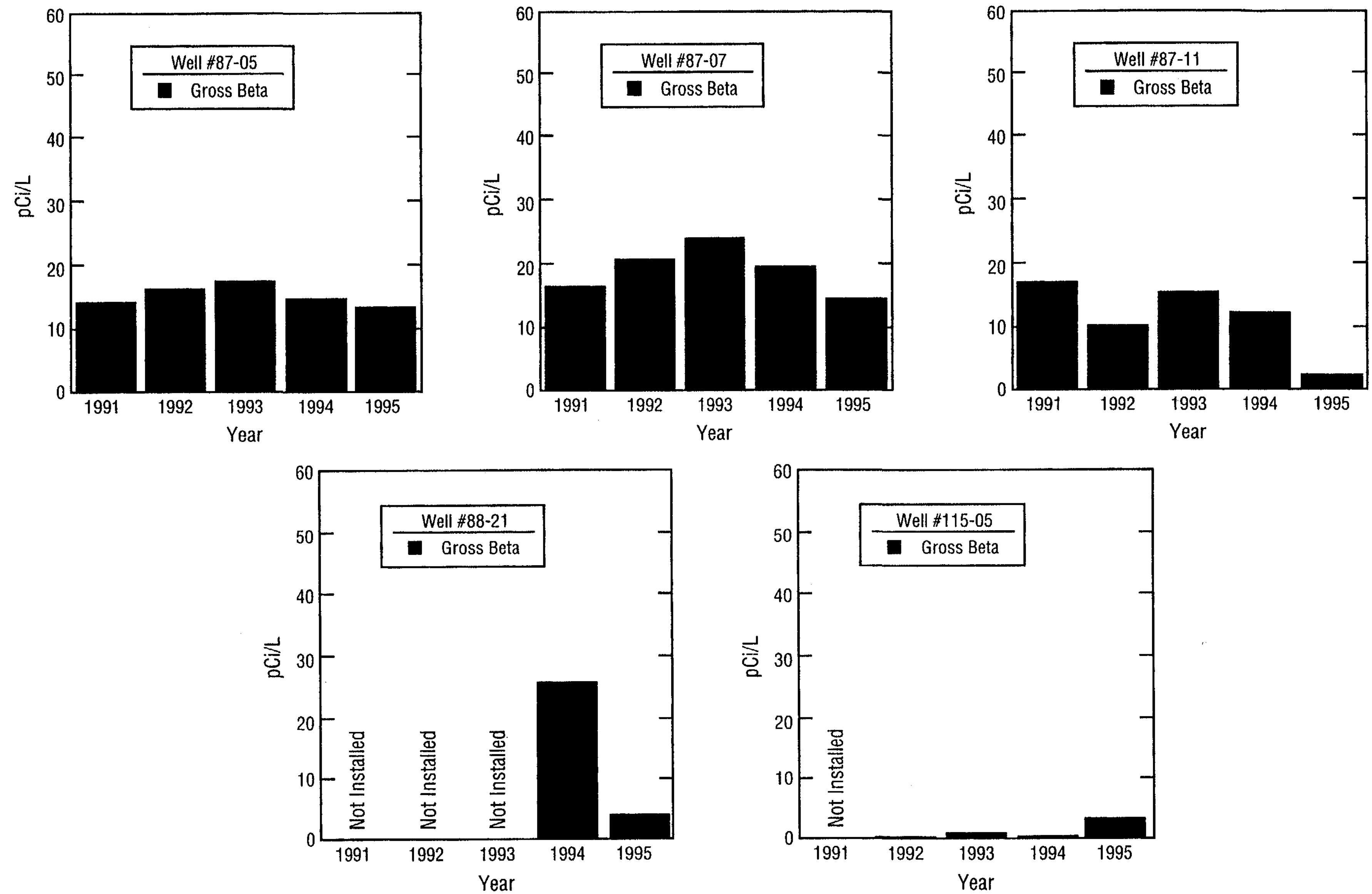


Figure 5-25 Yearly average Gross Beta concentration in wells located in the Current Landfill area: Wells 87-05 and 87-11 are located at the downgradient margin of the landfill; Well 87-07 and 88-21 are located 75 m and 125 m downgradient of the landfill respectively; and, Well 115-05 is located at the site boundary, 1,225 m downgradient of the landfill.

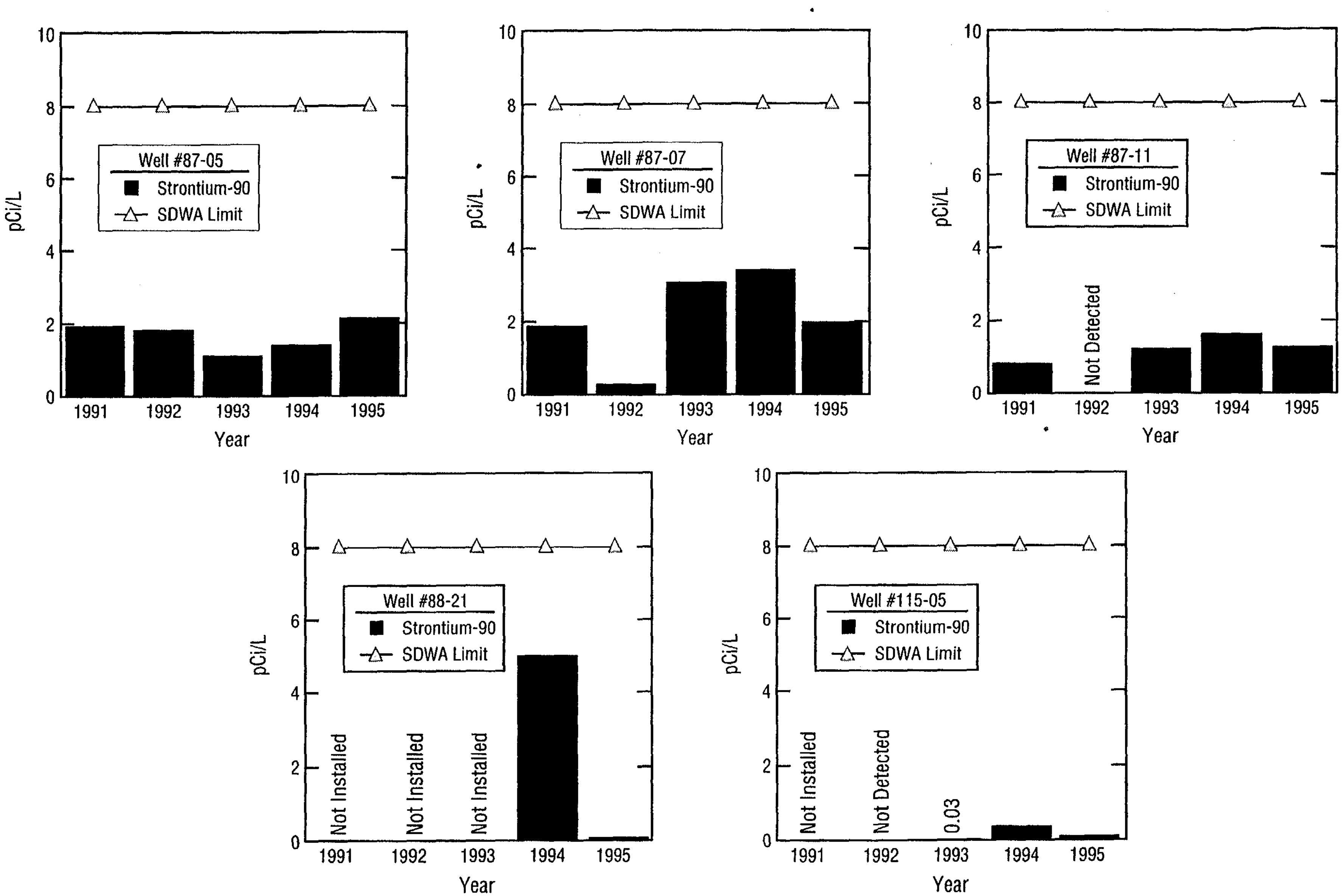


Figure 5-26 Yearly average Strontium-90 concentration in wells located in the Current Landfill area: Wells 87-05 and 87-11 are located at the downgradient margin of the landfill; Well 87-07 and 88-21 are located 75 m and 125 m downgradient of the landfill respectively; and, Well 115-05 is located at the site boundary, 1,225 m downgradient of the landfill.

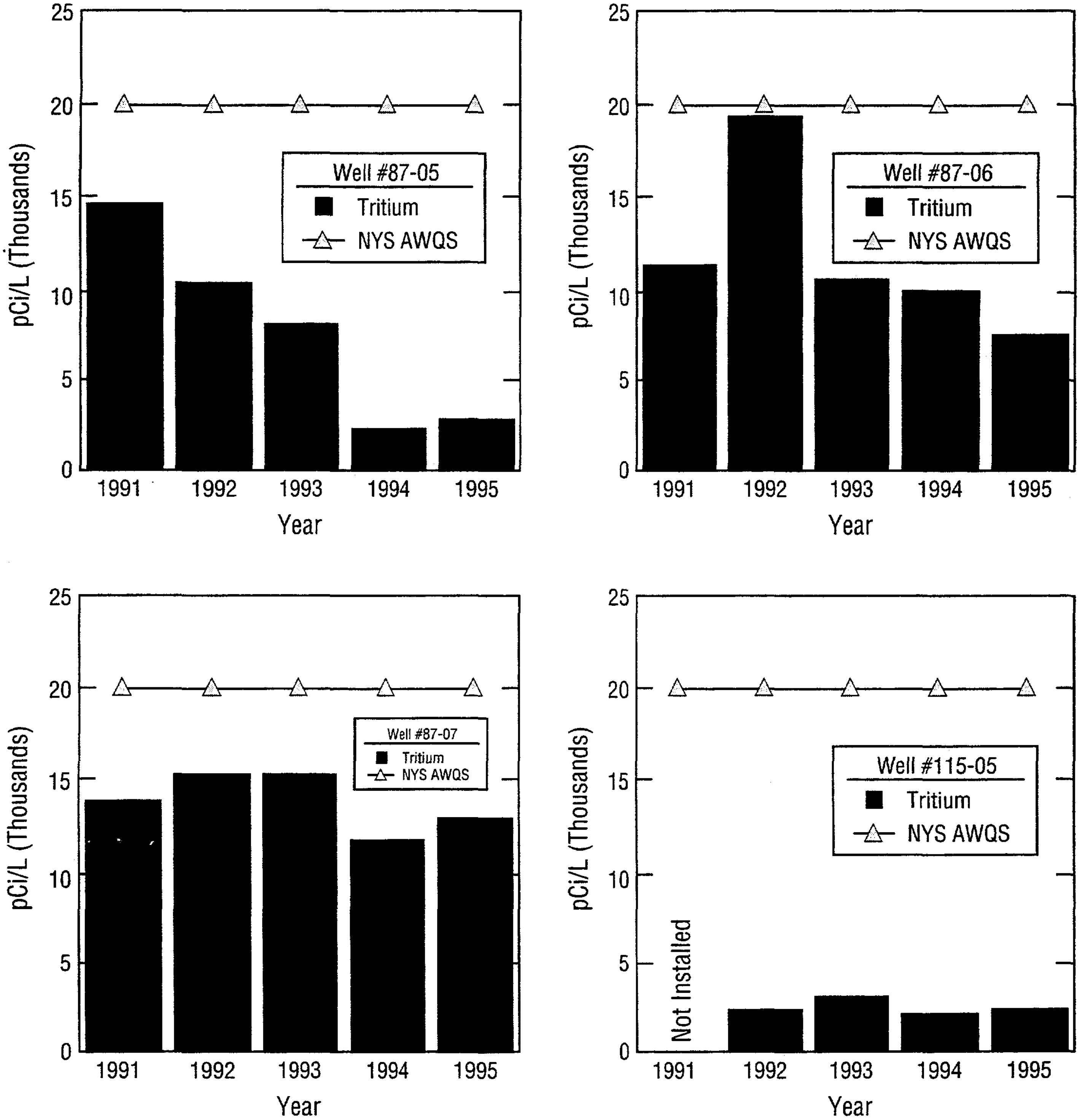


Figure 5-27 Yearly average Tritium concentration in wells located in the Current Landfill area: Wells 87-05 and 87-06 are located at the downgradient margin of the landfill; Well 87-07 is located 75 m downgradient of the landfill; and Well 115-05 is located at the site boundary, 1,225 m downgradient of the landfill.

for wells downgradient of this landfill (see Figure 5-27) show a decreasing trend for Wells 87-05 and 87-06 over the last five years. Wells 87-07 and 115-05 have been seen to maintain fairly consistent tritium concentrations over the same time period. Only trace quantities (less than 1 pCi/L [0.04 Bq/L]) of gamma-emitting radionuclides such as cesium-137 and cobalt-60 were detected in wells downgradient of the Current Landfill.

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 5-8. 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 40 pCi/L (1.5 Bq/L) was observed. This is five times greater than the SDWA limit. Five year trends of gross beta and strontium -90 activity at Well 97-03 (plotted in Figure 5-28) indicate a trend of increasing activity concentrations since 1992.

Hazardous Waste Management Facility: The current HWMF has been used to handle, process, and store radioactive materials since the late 1940s. Soil and groundwater media 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 5-8) 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 showed 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 5-49.

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 198 pCi/L (7.3 Bq/L) at Well 88-04. Trend data for beta activity in several wells is presented in Figure 5-29. 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 five years. In some cases, the additional beta activity in these wells appears to have been due to the presence of strontium -90, which was detected at levels above background in five wells south of the HWMF. Four of the five elevated concentration values were less than 5 pCi/L (0.2 Bq/L), though a maximum value of 91 pCi/L (3.4 Bq/L) was recorded at Well 88-04, which is on the immediate grounds of the HWMF. This concentration is 11 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 levels below drinking water standards before reaching the site boundary (CDM, 1996). Strontium-90 concentration trends in wells from this area are plotted in Figure 5-30. Generally increasing values have been seen in Wells 88-04 and 98-22.

Average tritium values downgradient of the HWMF were approximately 2,000 pCi/L (74 Bq/L), although a maximum value at Well 88-26 of 42,200 pCi/L (1,554 Bq/L) was observed. This is a factor of two greater than the SDWA limit. Samples from wells further south, closer to the Laboratory's boundary, showed reduced tritium concentrations of approximately 1,200 pCi/L (44 Bq/L), indicating that maximum concentrations are still located to the north, within BNL property. Trend plots of tritium activity are shown in Figure 5-31. No distinct trends are observable.

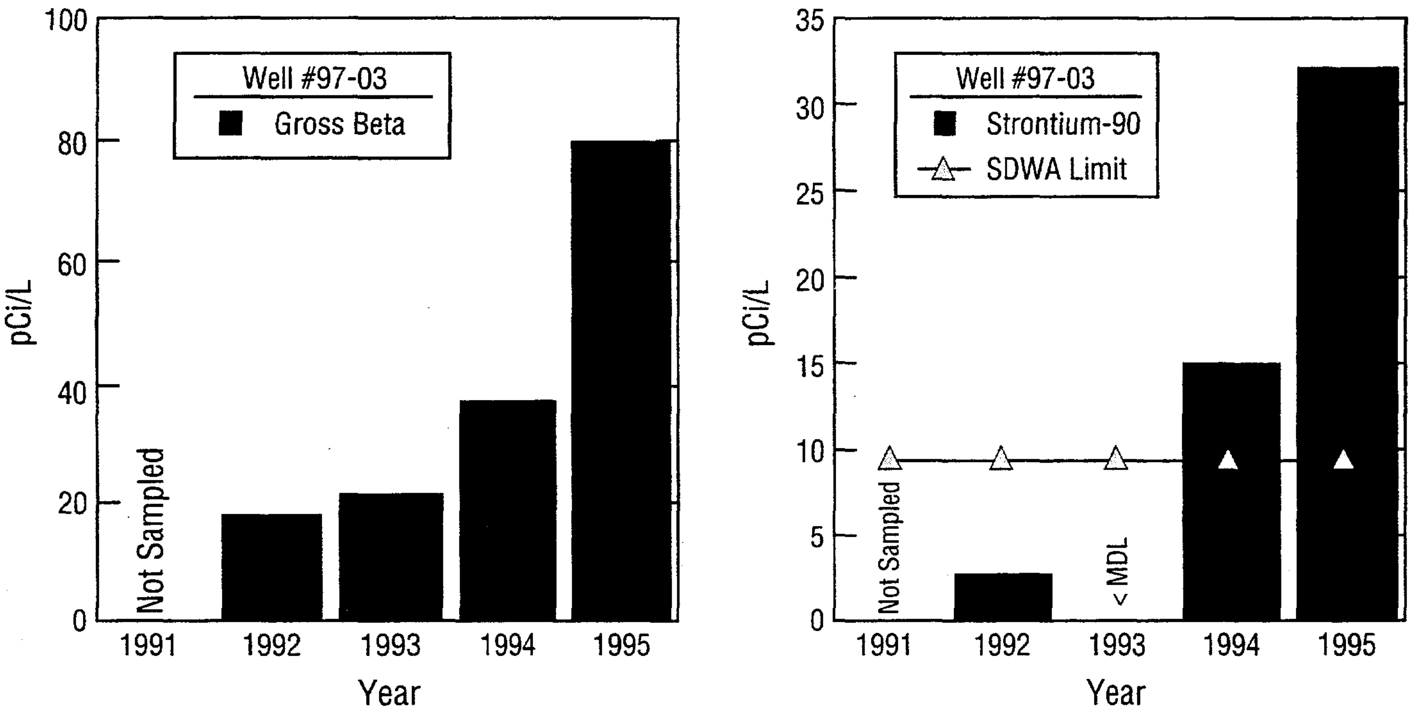


Figure 5-28 Yearly average Gross Beta and Strontium-90 concentration in a well located in the Former Landfill area: Well 97-03 is located at the downgradient margin of the landfill.

Table 5-49
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Area Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Co-60	Na-22	Be-7	Sr-90
			←			(pCi/L)				→
Hazardous Waste Management Area										
88-13(a)	3	Max.	1.52	2.60	167	ND	ND	ND	ND	0.20
		Avg.	0.29	1.36	46	ND	ND	ND	ND	(c)
88-14(a)	3	Max.	1.63	1.32	62	ND	0.14	ND	ND	0.21
		Avg.	0.83	1.14	-52	ND	0.14	ND	ND	(c)
88-20(a)	2	Max.	0.00	1.66	232	ND	ND	ND	ND	NA
		Avg.	-0.10	1.65	107	ND	ND	ND	ND	NA
88-03	3	Max.	1.02	10.70	820	6.41	ND	ND	ND	2.46
		Avg.	0.62	8.33	574	6.41	ND	ND	ND	1.67
88-04	3	Max.	8.43	198.00	5600	3.38	0.94	0.17	ND	90.81
		Avg.	5.28	151.83	3607	4.69	1.85	0.17	ND	66.18
88-24	3	Max.	1.19	16.20	4090	ND	ND	ND	30.30	4.81
		Avg.	0.80	12.88	3623	ND	ND	ND	30.30	4.65
88-26	3	Max.	1.35	20.70	42200	ND	ND	2.76	ND	5.96
		Avg.	0.68	15.85	24567	ND	ND	4.99	ND	5.73
98-07*	2	Max.	0.37	1.49	243	4.15	ND	ND	ND	NA
		Avg.	0.11	1.24	94	5.90	ND	ND	ND	NA
98-21	3	Max.	2.92	10.70	3110	ND	ND	1.70	ND	2.87
		Avg.	1.43	8.44	2350	ND	ND	1.93	ND	1.99
98-22*	2	Max.	0.95	12.70	73	3.82	ND	0.57	ND	4.57
		Avg.	0.89	11.01	70	5.03	ND	0.57	ND	(c)
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	5000	10000	1000000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	1.6	0.1

Additional results: 98-07 Zr-88, 0.36 pCi/L
98-22 Rb-83, 5.47 pCi/L

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) One sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed
ND: Not Detected.

Table 5-49 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Hazardous Waste Management Area Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40 (pCi/L)	Co-60	Cs-137	Be-7	Sr-90
Hazardous Waste Management Area										
98-57	3	Max.	3.66	8.58	546	5.18	ND	ND	ND	2.38
		Avg.	1.22	5.06	295	5.18	ND	ND	ND	2.13
98-58	3	Max.	2.01	18.50	274	ND	ND	0.22	ND	7.60
		Avg.	1.00	17.07	87	ND	ND	0.22	ND	7.31
98-59	2	Max.	2.11	(d)	1530	ND	0.71	ND	ND	-0.23
		Avg.	1.28	(d)	1280	ND	0.71	ND	ND	(c)
98-60	3	Max.	1.02	38.00	178	4.70	ND	ND	ND	0.27
		Avg.	0.48	15.78	44	4.70	ND	ND	ND	(c)
98-61	2	Max.	0.29	8.87	82	ND	ND	ND	ND	0.06
		Avg.	0.10	4.74	-9	ND	ND	ND	ND	(c)
108-13	3	Max.	1.53	1.30	825	5.41	ND	ND	ND	0.05
		Avg.	0.77	0.73	723	5.41	ND	ND	ND	(c)
108-14	3	Max.	1.84	0.45	1790	3.17	ND	ND	ND	-0.02
		Avg.	0.73	0.36	1350	3.61	ND	ND	ND	(c)
108-17	3	Max.	0.62	5.47	1280	6.35	ND	ND	ND	-0.11
		Avg.	0.32	3.98	1165	6.35	ND	ND	ND	-0.12
108-18	3	Max.	0.17	1.11	1130	ND	ND	ND	2.24	-0.07
		Avg.	0.04	0.78	908	ND	ND	ND	2.24	(c)
108-30	3	Max.	0.67	2.65	1230	ND	ND	ND	ND	0.33
		Avg.	0.03	1.14	984	ND	ND	ND	ND	(c)
108-31	2	Max.	0.18	1.27	1340	ND	ND	ND	ND	NA
		Avg.	0.09	0.76	1215	ND	ND	ND	ND	NA
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	5000	3000	1000000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	1.6	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) One sample collected for this analysis.
(d) Data voided based on QA review.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed
ND: Not Detected.

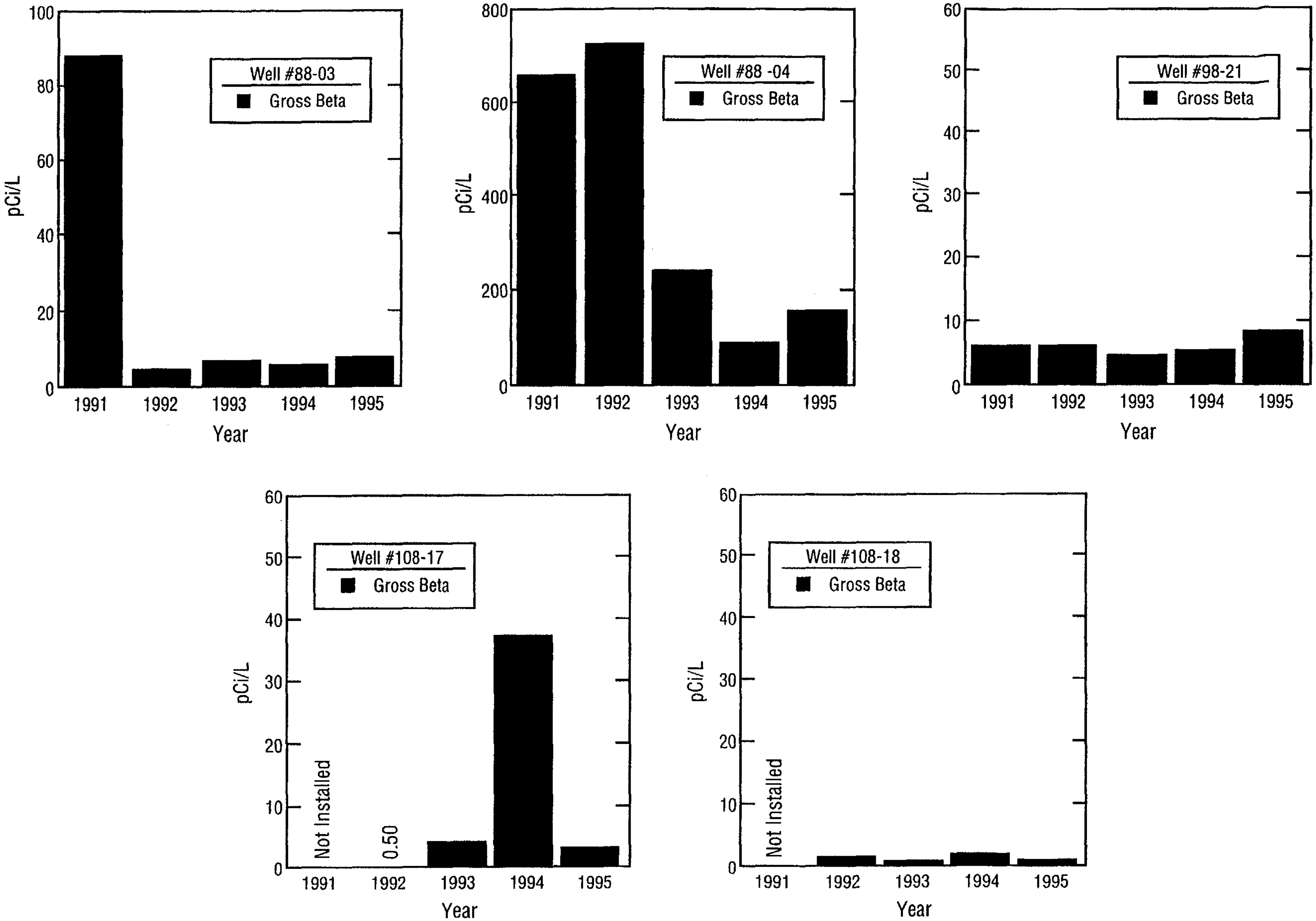


Figure 5-29 Yearly average Gross Beta concentration in wells located in the Hazardous Waste Management Facility area (HWMF): Wells 88-03 and 88-04 are located within the HWMF; Well 98-21 is located 110 m downgradient of the HWMF; and, Wells 108-17 and 108-18 are located at the site boundary, 680 m downgradient of HWMF.

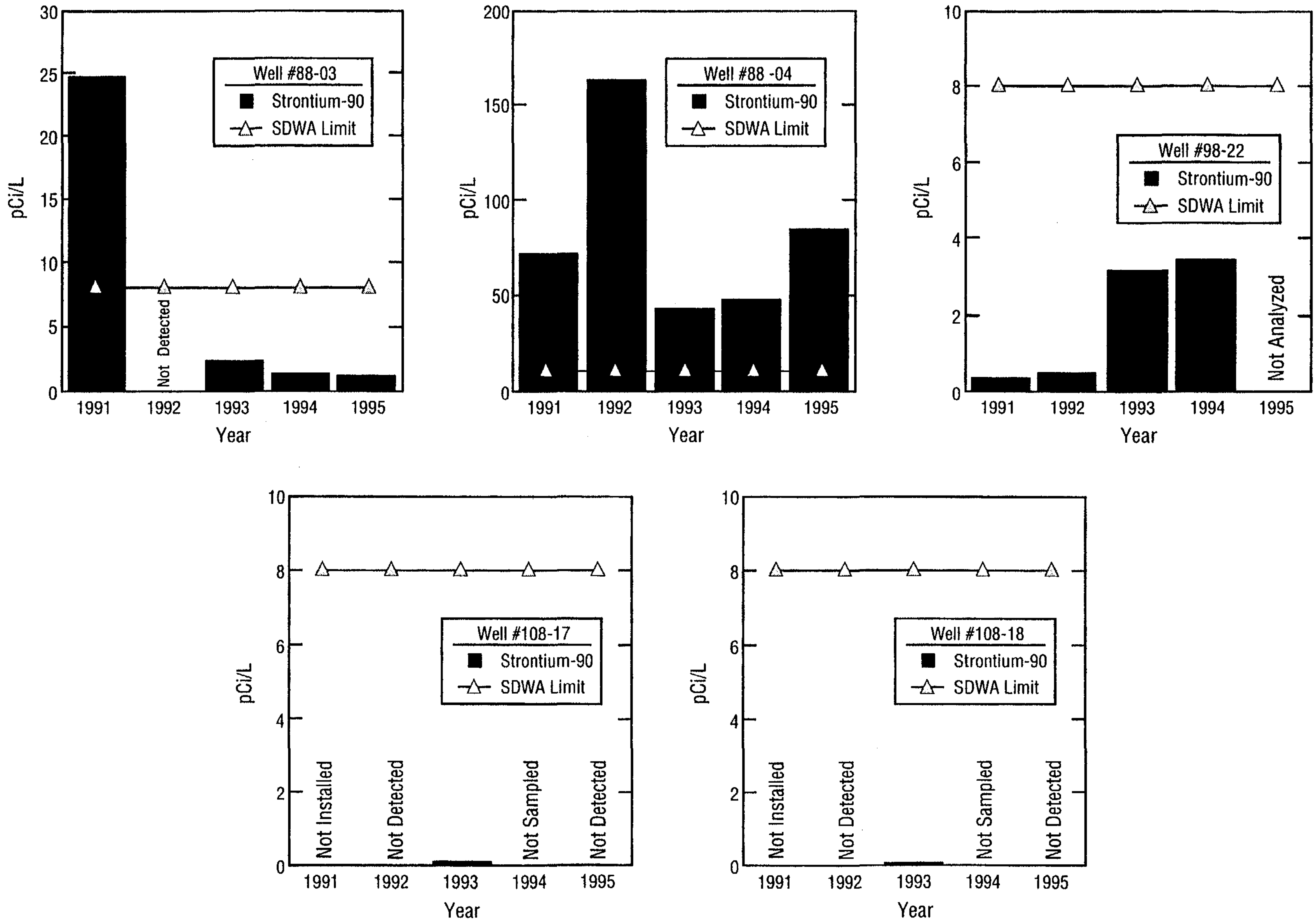


Figure 5-30 Yearly average Strontium-90 concentration in wells located in the Hazardous Waste Management Facility (HWMF) area: Wells 88-03 and 88-04 are located within the HWMF; Well 98-22 is located at the downgradient margin of the HWMF; and, Wells 108-17 and 108-18 are located at the site boundary, 680 m downgradient of HWMF.

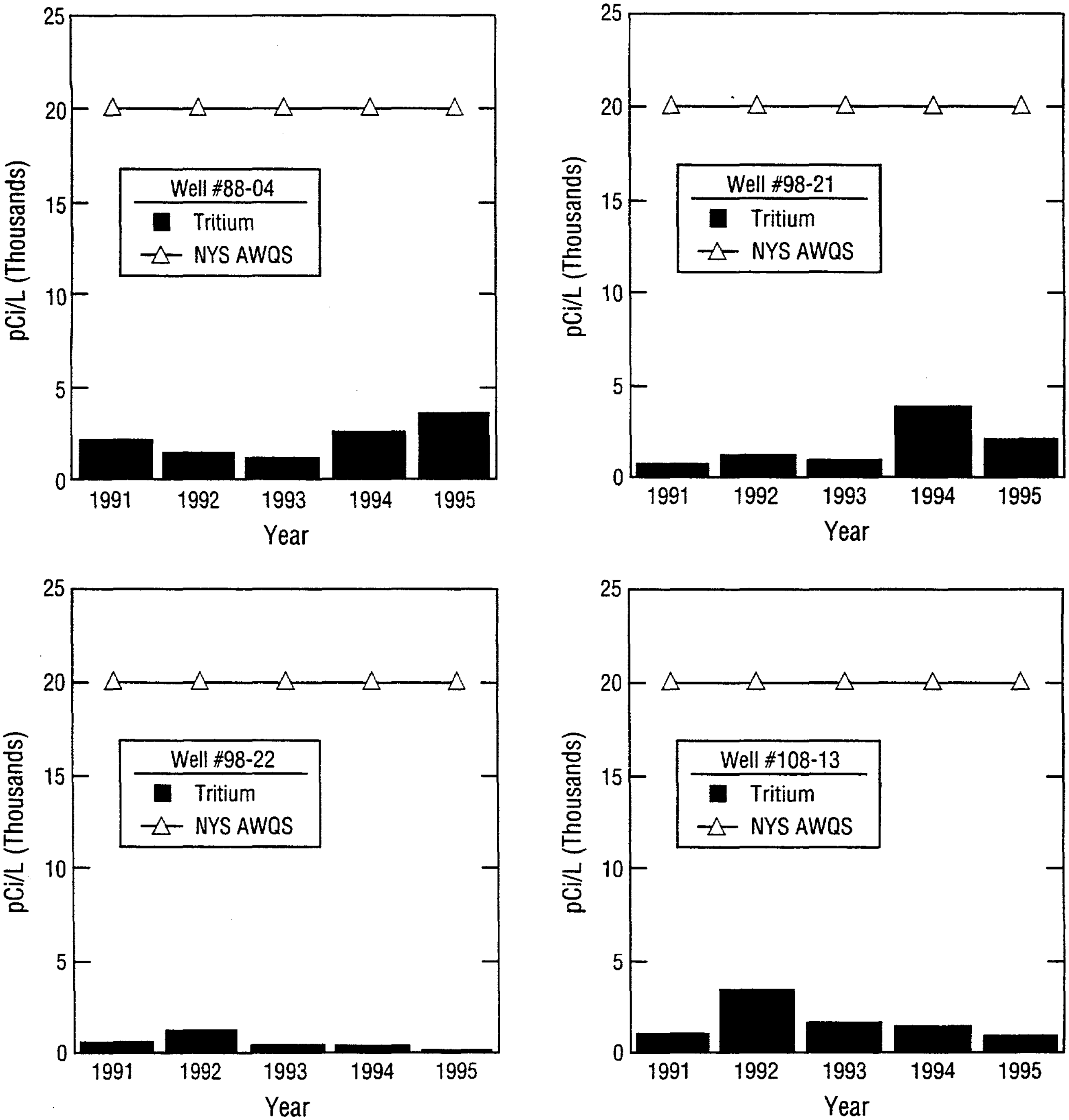


Figure 5-31 Yearly average concentration in wells located in the Hazardous Waste Management Facility area (HWMF): Well 88-04 is located within the HWMF; Well 98-22 is located at the downgradient margin of HWMF; Well 98-21 is located 110 m downgradient of the HWMF; and, Well 108-1 is located at the site boundary, 675 m downgradient of HWMF.

Cesium-137, cobalt-60, beryllium-7, and sodium-22 were detected in several downgradient wells. Maximum recorded values were 1.9 pCi/L (0.07 Bq/L), 0.7 pCi/L (0.03 Bq/L), 30 pCi/L (1.1 Bq/L), and 5 pCi/L (0.2 Bq/L), respectively. Cesium-137 was observed in three of the 18 downgradient wells sampled. The highest cesium-137 value was seen at Well 88-04, site of maximum gross beta and strontium -90 activity. All average and maximum concentrations of these nuclides were small fractions of the DOE DCGs.

Operable Unit III Areas

North and South Sectors: The northern and southern sectors lie outside or at the edges of the developed portion of the site, upgradient or beyond known or suspected groundwater contaminant plumes; Grids 07, 17, 18, 25, 118, 122, 126, and 130 are included (see Figures 5-2, -3, -10, and -11). Radiological results from these areas (see Table 5-50) showed gross alpha and beta activities that are consistent with ambient groundwater values. No unusual gamma-emitting radionuclides or tritium concentrations were found.

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 5-50). No unusual activity was found. This is as expected since most known contaminants in this area are of a chemical nature and not radioactive.

AGS and Waste Concentration Facility: Wells in the vicinity of these facilities are positioned in Grids 54, 64, and 65 (Figure 5-4). With the exception of Well 64-02, wells near the AGS generally showed gross alpha, beta, and tritium levels that were typical of environmental levels (see Table 5-51). Water samples from Well 64-02 showed elevated concentrations of tritium (1,450 pCi/L [54 Bq/L]) as well as the activation product sodium-22 (half-life = 2.6 years), which was measured at a concentration of 0.3 pCi/L (10 mBq/L). This is at the limit of detection for this nuclide. Cesium-137 was also detected in three of the 11 wells near the AGS, all at trace quantities of less than 1 pCi/L (0.04 Bq/L), and also near the analytical limit of detection.

The Waste Concentration Facility (Building 811) is used to reduce the volume of liquid radioactive wastes by removing suspended solids. Leakage from above-ground waste storage tanks and the storage of activated materials have caused groundwater contamination in the immediate area. Wells surrounding the WCF showed elevated gross alpha, gross beta and tritium activity; maximum concentrations were 15, 34, and 3,520 pCi/L (0.5, 1.3, and 130 Bq/L), respectively. Figure 5-32 shows gross beta activity trends in four wells located in Grid 65. No significant trends are apparent with the possible exception of Well 65-03 where a slight increase can be seen. Sodium-22 was consistently detected in each of the five wells sampled near the WCF at an average concentration of approximately 20 pCi/L (0.7 Bq/L), less than 1% of the DCG value. The maximum observed concentration was 30 pCi/L (1 Bq/L).

OU III Temporary Wells: As part of the OU III Phase I Groundwater Screening, a series of temporary vertical-profile wells were installed along the Laboratory's southern boundary. Locations of all temporary wells, designated "TW", are shown in Figure 5-20. Of the 46 temporary wells sampled, tritium was detected above the MDL in 11 instances (see Table 5-52). Concentrations ranging from 381 to 5,810 pCi/L (14 to 215 Bq/L)

Table 5-50
BNL Site Environmental Report for Calendar Year 1995
North and West Sector Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40 (pCi/L)	Be-7	Co-60	Cs-137	Sr-90
North Sector										
07-04	2	Max.	0.38	3.58	123	4.60	ND	ND	ND	NA
		Avg.	0.08	3.22	-58	4.60	ND	ND	ND	NA
17-01	2	Max.	0.24	3.21	73	ND	ND	ND	ND	NA
		Avg.	0.04	2.08	-18	ND	ND	ND	ND	NA
17-02	2	Max.	0.56	2.09	-19	ND	ND	ND	ND	NA
		Avg.	0.05	0.96	-83	ND	ND	ND	ND	NA
17-03	2	Max.	1.07	2.21	76	4.26	ND	ND	ND	NA
		Avg.	0.87	1.29	35	4.26	ND	ND	ND	NA
17-04	2	Max.	1.16	1.87	40	ND	ND	ND	ND	NA
		Avg.	0.52	0.63	-74	ND	ND	ND	ND	NA
18-01	2	Max.	0.35	1.89	144	ND	ND	ND	ND	NA
		Avg.	0.14	1.64	100	ND	ND	ND	ND	NA
18-02	2	Max.	0.08	1.55	85	ND	ND	ND	ND	NA
		Avg.	-0.27	1.55	2	ND	ND	ND	ND	NA
18-03	2	Max.	3.24	2.66	96	ND	ND	ND	ND	NA
		Avg.	1.84	2.66	39	ND	ND	ND	ND	NA
25-02	1	Max.	-1.12	1.57	115	ND	ND	ND	ND	NA
West Sector										
83-01	2	Max.	-0.29	0.89	75	2.70	1.87	ND	ND	0.01
		Avg.	-0.45	0.61	75	2.70	1.87	ND	ND	0.00
83-02	2	Max.	0.97	0.65	135	2.60	ND	ND	ND	0.04
		Avg.	0.44	0.65	70	2.60	ND	ND	ND	(c)
84-01	2	Max.	0.53	2.39	248	29.73	ND	ND	ND	NA
		Avg.	0.27	2.39	245	29.73	ND	ND	ND	NA
94-01	2	Max.	0.35	4.73	522	3.44	ND	ND	0.14	0.32
		Avg.	0.07	4.25	438	3.44	ND	ND	0.14	0.24
102-01	2	Max.	1.45	10.40	10	ND	ND	ND	ND	NA
		Avg.	0.92	6.44	-44	ND	ND	ND	ND	NA
103-01	2	Max.	15.70	1.91	66	3.01	3.02	0.15	ND	-0.07
		Avg.	7.78	1.91	45	3.01	3.02	0.15	ND	(c)
103-02	1	Max.	1.07	1.26	-10	2.45	ND	ND	ND	NA
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	1000000	5000	3000	8(b)
Typical MDL			0.9	2.5	380	3.9	1.6	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(C) Only one sample collected for this analysis.
Note: Well 101-01 was not sampled in 1995.

ND: Not Detected.
NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed

Table 5-50 (Continued)
BNL Site Environmental Report for Calendar Year 1995
South Boundary and Supply and Material Area Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium (pCi/L)	K-40	Sr-90
South Boundary							
118-01	2	Max.	0.17	1.22	181	3.07	0.08
		Avg.	-0.03	0.89	91	3.07	(c)
118-02	2	Max.	0.51	1.18	257	3.13	0.12
		Avg.	0.26	1.06	150	3.13	(c)
122-01	1	Max.	0.21	0.54	-238	ND	NA
122-02	1	Max.	0.57	1.11	35	ND	NA
122-04	1	Max.	0.21	0.83	-239	ND	NA
126-01	2	Max.	0.81	2.07	46	ND	0.02
		Avg.	0.45	1.59	0	ND	(c)
130-02	2	Max.	0.77	1.99	201	5.41	0.04
		Avg.	0.33	1.46	173	5.41	0.00
130-03	2	Max.	0.56	1.58	81	18.3	0.07
		Avg.	0.28	0.91	57	18.3	(c)
Supply & Material							
85-01(a)	1	Max.	1.63	6.88	100	ND	0.16
85-02(a)	1	Max.	2.14	1.01	61	4.66	0.07
85-03	1	Max.	0.88	2.15	-15	ND	0.15
86-21	1	Max.	2.08	3.01	84	ND	NA
96-06	2	Max.	0.87	1.50	88	1.96	0.19
		Avg.	0.60	1.30	-19	1.96	(c)
96-07	2	Max.	0.86	2.48	37	ND	0.12
		Avg.	0.83	2.14	-175	ND	(c)
105-02	1	Max.	0.00	0.49	400	ND	0.09
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not Analyzed
ND: Not Detected.

Table 5-51
BNL Site Environmental Report for Calendar Year 1995
WCF, AGS and Building 830 Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Co-60	Cs-137	Na-22	Sr-90
			←			pCi/L				→
Waste Concentration Facility										
65-06(a)	1	Max.	1.07	25.30	1220	ND	ND	ND	23.20	0.48
65-02	2	Max.	4.90	13.50	246	6.03	ND	ND	14.30	NA
		Avg.	2.67	9.48	69	6.03	ND	ND	9.01	NA
65-03	2	Max.	15.30	25.90	206	2.55	ND	ND	28.20	NA
		Avg.	8.67	21.75	84	2.55	ND	ND	21.70	NA
65-04	2	Max.	9.06	34.50	1210	ND	ND	ND	30.40	NA
		Avg.	5.03	23.55	820	ND	ND	ND	22.00	NA
65-05	2	Max.	3.12	2.56	3480	ND	0.59	ND	7.44	0.18
		Avg.	3.12	2.56	2460	ND	0.59	ND	3.82	(c)
Alternating Gradient Synchrotron										
44-01(a)	1	Max.	-0.08	0.99	107	ND	ND	0.21	ND	NA
44-02(a)	2	Max.	6.11	-0.83	-55	ND	ND	0.21	ND	0.01
		Avg.	3.09	-0.83	-69	ND	ND	0.21	ND	(c)
54-01	2	Max.	0.95	6.69	368	ND	ND	0.21	ND	0.59
		Avg.	-0.34	4.01	196	ND	ND	0.21	ND	(c)
54-02	2	Max.	28.60	1.90	95	8.81	ND	0.59	ND	0.42
		Avg.	14.30	1.90	62	8.81	ND	0.59	ND	(c)
54-05	2	Max.	17.30	1.86	-5	4.99	ND	0.34	ND	0.09
		Avg.	8.65	1.86	-122	4.99	ND	0.34	ND	(c)
54-06	2	Max.	17.00	0.37	135	ND	ND	ND	ND	0.32
		Avg.	8.84	0.37	29	ND	ND	ND	ND	(c)
54-07	2	Max.	54.90	3.72	198	5.12	ND	ND	1.55	0.40
		Avg.	27.67	3.72	129	5.12	ND	ND	1.22	(c)
54-08	2	Max.	37.00	2.89	70	ND	ND	ND	ND	0.35
		Avg.	18.30	2.89	-30	ND	ND	ND	ND	(c)
64-01	2	Max.	1.52	4.07	283	5.37	ND	ND	0.27	0.30
		Avg.	0.91	3.42	253	4.99	ND	ND	0.27	(c)
64-02	2	Max.	5.10	24.10	1450	ND	ND	ND	ND	0.70
		Avg.	2.49	16.41	924	ND	ND	ND	ND	(c)
64-03	2	Max.	0.72	2.64	229	ND	ND	ND	ND	0.28
		Avg.	0.41	1.99	186	ND	ND	ND	ND	(c)
Building 830										
66-07(a)	1	Max.	-0.39	0.86	0	2.77	ND	ND	ND	NA
66-08	1	Max.	1.11	2.73	118	ND	ND	ND	ND	NA
66-09	1	Max.	0.60	2.31	222	ND	ND	ND	ND	0.08
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	5000	3000	10000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

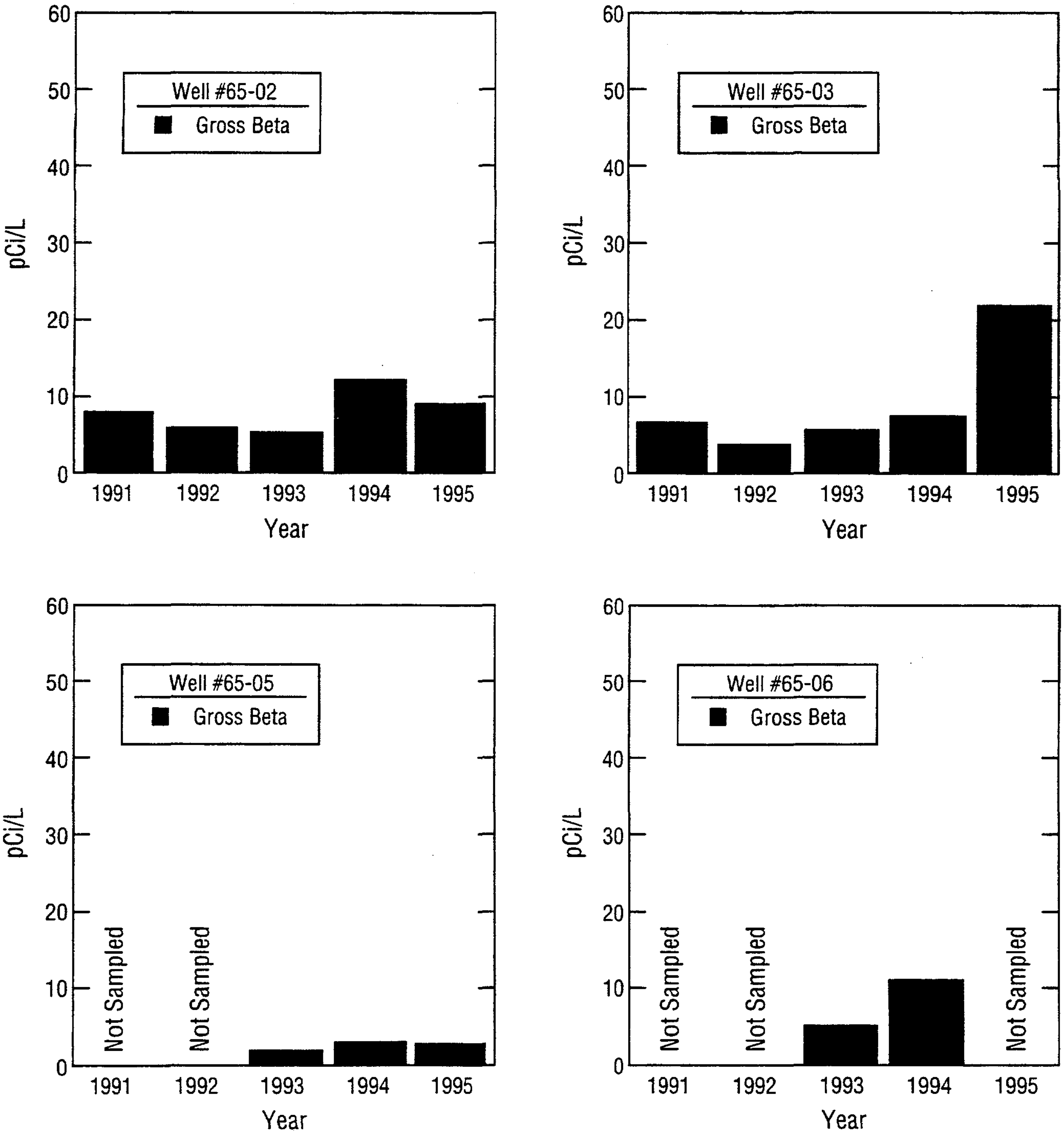


Figure 5-32 Yearly average Gross Beta concentration in wells located in the Waste Concentration Facility area (WCF): Wells 65-02, 65-03, and 65-05 are located at the downgradient margin of the WCF; and, Well 65-06 is located directly upgradient of the WCF.

Table 5-52
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase I: Vertical Profile Wells, Southern Sector
Highest Observed Tritium Concentrations in Temporary Wells

Well No.	Sample Intervals	Tritium (pCi/L)	Well No.	Sample Intervals	Tritium (pCi/L)	Well No.	Sample Intervals	Tritium (pCi/L)
TW-01	17	<390 [(a)]	TW-21	16	175	TW-37	14	173
TW-02	24	346	TW-22	18	87	TW-38	14	121
TW-03	16	166	TW-23	22	275	TW-39	14	531
TW-04	13	66	TW-24	23	1,770	TW-40	18	286
TW-05	15	162	TW-25	24	381	TW-41	17	394
TW-06	17	68	TW-26	20	23	TW-42	17	1,340
TW-08	15	277	TW-27	15	182	TW-43	14	150
TW-09	18	282	TW-28	15	12	TW-43RD	16	5,810
TW-11	17	190	TW-29	14	187	TW-44	15	475
TW-12	18	40	TW-30	14	18	TW-45	14	446
TW-14	20	-42	TW-31	14	-12			
TW-15	20	77	TW-32	10	25			
TW-16	21	185	TW-33	11	63			
TW-17	20	37	TW-34	11	602			
TW-18	20	210	TW-35	12	19			
TW-19	20	783	TW-35RD	18	282			
TW-20	15	35	TW-36	12	6			

(a) Initial value for this well was reported as 10,300 pCi/L. Samples from subsequent redrilling in 1996 determined that no tritium was detected at this location. Inital result considered erroneous, see text.

Notes:
1. This table contains data from the OU III Groundwater Screening Report.
2. Typical MDL for all tritium results shown = 390 pCi/L.
3. The New York State Drinking Water Standard for tritium is 20,000 pCi/L.
4. TW-07 and TW-10 were not installed, though later wells were numbered sequentially.

Table 5-53
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase II Off-Site Vertical Profile Wells
Highest Observed Tritium Concentrations

Well No.	Sample Intervals	Tritium (pCi/L)	Well No.	Sample Intervals	Tritium (pCi/L)
AOC 7 VP-06	14	799	AOC 15A TW-06	15	623
AOC 14 VP-10	11	-158	AOC 18 VP-07	15	5,620
AOC 14 VP-11	14	72	AOC 18 VP-08	15	699
AOC 14 VP-12	14	-56	AOC 18 VP-09	10	3,870
AOC 15A TW-01	16	-85	AOC 19 VP-04	14	284
AOC 15A TW-02	14	-24	AOC 19 VP-05	16	157
AOC 15A TW-03	14	320	AOC 26 VP-01	22	95
AOC 15A TW-04	15	141	AOC 26 VP-02	18	-72
AOC 15A TW-05	17	448	AOC 26 VP-03	17	-101

Notes:
1. Typical MDL for all tritium results shown = 360 pCi/L.
2. The Safe Drinking Water Act standard for tritium in drinking water is 20,000 pCi/L.
3. For detailed information on the vertical distribution of tritium in these wells, see
Groundwater Screening Report, Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.

were detected. Upon initial sampling, Well TW-01 registered a tritium value of 10,300 pCi/L (381 Bq/L). Because this result did not conform to predicted grounwater flow pathways and known tritium source areas, TW-01 was subsequently redrilled for confirmation. Analysis of the second sampling found no tritium, indicating that the initial sample result was likely in error. For further details, see the Groundwater Screening Report for OU III (ERM Northeast, 1996b).

Temporary wells were also installed off-site (designated "OS"), below the Laboratory's southern boundary as part of the OU III Phase III study. These wells were primarily installed to characterize the vertical and horizontal distribution of potential organic contaminants originating from sources within OU III, though samples collected from them were analyzed for tritium as well. No tritium above the MDL was found in any of these wells. Vertical profile wells installed by the SCDHS to the south of the BNL "OS" wells were also sampled and analyzed for tritium. Two wells, "A" and "B", showed results which were just above the 380 pCi/L (14 Bq/L) detection limit. Sample results are presented in Table 5-54.

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 66-07, -08, and -09 showed normal levels of gross alpha and beta activity. Neither tritium nor any other radionuclides attributable to BNL were observed.

Operable Unit IV Areas

Building 650: This building was used as a decontamination facility for the removal of radioactive material from heavy equipment. Drainage from decontamination operations were 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 5-5). Table 5-55 shows the groundwater radionuclide concentrations in the Building 650/Sump Outfall areas. Radiological analysis indicated the presence of tritium and strontium -90 at maximum concentrations of 1,890 and 15 pCi/L (70 and 0.5 Bq/L), respectively. The strontium-90 value is approximately twice the SDWA standard. Cesium-137 was detected in Well 76-28 at trace levels, less than 1 pCi/L (0.04 Bq/L).

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 Table 5-55.

Operable Unit V and VI Areas

Sewage Treatment Plant-Peconic River and Meadow Marsh - Upland Recharge Areas: In these areas, gross alpha activity values were typical of ambient groundwater values; gross beta activities were somewhat elevated with a maximum recorded value of 21 pCi/L (0.8 Bq/L); and tritium was detectable at elevated levels of up to 1,340 pCi/L (50 Bq/L). Cesium-137 and strontium -90 were detected at levels above those attributable to fallout; maximum concentrations were 11 and 9 pCi/L (0.4 and 0.3 Bq/L), respectively. 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

Table 5-54
BNL Site Environmental Report for Calendar Year 1995
Operable Unit III Remedial Investigation - Phase III Off-Site Verical Profile Wells
Highest Observed Tritium Concentrations

Well No.	Sample Intervals	Tritium (pCi/L)	Well No.	Sample Intervals	Tritium (pCi/L)
OS-1	22	181	OS-10	17	125
OS-2	16	63	OS-11	16	97
OS-3	17	130	OS-12	12	527
OS-4	19	68	OS-13	18	260
OS-5	21	-17	OS-14	15	154
OS-6	19	91	OS-15	17	264
OS-7	26	-98	SCDHS-A	13	429
OS-8	26	271	SCDHS-B	19	388
OS-9	22	169	SCDHS-C	5	148

Notes:
1. Typical MDL for all tritium results shown = 350 pCi/L.
2. The Safe Drinking Water Act standard for tritium in drinking water is 20,000 pCi/L.
3. SCDHS: Suffolk Co. Dept. of Health Services off-site well samples.
4. For detailed information on vertical distribution of tritium, see Groundwater Screening Report for Operable Unit III, Brookhaven National Laboratory, January 1996, ERM Northeast.

Table 5-55
BNL Site Environmental Report for Calendar Year 1995
MPF and Central Steam Facility Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Co-57	Cs-137	Mn-54	Sr-90
			◄			(pCi/L)				►
Major Petroleum Facility										
76-25(a)	1	Max.	0.00	0.81	-22	ND	ND	ND	ND	NA
76-16	1	Max.	0.10	1.41	71	ND	ND	ND	ND	0.21
76-17	1	Max.	0.48	1.53	71	ND	ND	ND	ND	0.39
76-18	1	Max.	0.33	0.89	85	ND	ND	ND	ND	NA
76-19	1	Max.	-2.46	(d)	151	ND	ND	ND	ND	0.21
Central Steam Facility										
76-24(a)	1	Max.	NA	NA	185	0.00	0.56	ND	0.33	3.02
76-02	2	Max.	0.11	2.26	94	3.96	ND	ND	ND	0.46
		Avg.	0.00	1.86	-4	3.96	ND	ND	ND	(c)
76-04	2	Max.	2.42	4.22	-6	ND	ND	ND	ND	0.45
		Avg.	1.21	1.91	-22	ND	ND	ND	ND	(c)
76-07	1	Max.	0.13	0.74	-123	ND	ND	ND	ND	NA
		Avg.	0.13	0.74	-123	ND	ND	ND	ND	NA
76-08	3	Max.	2.44	5.11	-60	ND	ND	ND	ND	NA
		Avg.	1.28	3.64	-144	ND	ND	ND	ND	NA
76-09	2	Max.	0.95	0.36	24	ND	ND	ND	ND	0.03
		Avg.	0.48	0.18	-4	ND	ND	ND	ND	(c)
76-20	1	Max.	NA	NA	18	ND	ND	ND	ND	0.76
		Avg.	NA	NA	(c)	ND	ND	ND	ND	(c)
76-21	2	Max.	2.37	1.63	220	2.24	ND	ND	ND	0.51
		Avg.	1.24	1.43	-11	2.24	ND	ND	ND	(c)
76-22	2	Max.	0.54	0.94	13	ND	ND	ND	ND	-0.04
		Avg.	0.27	0.29	-6	ND	ND	ND	ND	(c)
76-23	3	Max.	3.54	2.49	350	4.41	ND	0.16	ND	0.21
		Avg.	1.82	1.20	146	4.41	ND	0.16	ND	0.19
86-04	3	Max.	0.59	1.00	59	4.09	ND	0.18	ND	0.04
		Avg.	0.48	0.52	-6	4.09	ND	0.18	ND	-0.02
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	100000	3000	50000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.1	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.
(d) Data voided based on QA review.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

Table 5-55 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Central Steam Facility and Building 650 Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Be-7	Co-57	Co-60	Cs-137	Sr-90
			←				pCi/L				→
Central Steam Facility (cont.)											
86-05	2	Max.	0.44	0.56	-22	ND	ND	ND	ND	ND	-0.06
		Avg.	0.31	0.36	-77	ND	ND	ND	ND	ND	(c)
86-06	2	Max.	0.43	2.27	129	ND	ND	ND	ND	0.15	0.06
		Avg.	0.16	0.65	111	ND	ND	ND	ND	0.15	(c)
86-07	2	Max.	0.24	3.22	29	5.34	ND	ND	ND	0.10	0.16
		Avg.	0.19	3.00	-20	4.60	ND	ND	ND	0.10	(c)
86-08	2	Max.	0.40	2.41	164	2.53	ND	ND	ND	ND	0.01
		Avg.	0.29	1.16	63	2.53	ND	ND	ND	ND	(c)
86-09	2	Max.	0.11	1.37	6	2.29	ND	ND	ND	0.16	-0.18
		Avg.	0.00	1.02	-57	2.29	ND	ND	ND	0.16	(c)
105-05	1	Max.	1.27	0.41	102	2.22	ND	ND	ND	ND	0.23
105-06	1	Max.	1.46	2.31	-21	ND	ND	ND	ND	ND	0.04
105-07	1	Max.	0.64	54.50	77	ND	ND	ND	ND	ND	0.05
76-05	1	Max.	1.43	3.29	-158	103	ND	ND	ND	ND	NA
Building 650/ 650 Outfall											
66-17	2	Max.	0.21	0.16	236	ND	ND	ND	ND	ND	0.04
		Avg.	0.18	0.10	-7	ND	ND	ND	ND	ND	0.02
66-18	2	Max.	0.54	15.30	1890	2.87	ND	ND	ND	ND	0.23
		Avg.	0.20	7.79	857	2.87	ND	ND	ND	ND	0.17
76-13	2	Max.	NA	NA	-108	ND	ND	ND	ND	ND	15.18
		Avg.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	7.77
76-25	1	Max.	0.00	0.81	-22	3.24	ND	ND	ND	ND	0.12
76-26	3	Max.	-0.20	0.56	125	4.69	ND	ND	0.17	ND	0.55
		Avg.	-0.32	-0.36	-88	4.42	ND	ND	0.17	ND	0.43
76-27	1	Max.	NA	NA	77	ND	ND	ND	ND	ND	0.47
76-28	2	Max.	0.35	1.08	66	ND	5.88	ND	ND	0.83	0.13
		Avg.	(c)	(c)	47	ND	5.88	ND	ND	0.83	0.12
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	1000000	100000	5000	3000	8(b)
Typical MDL			0.9	2.5	380	3.9	1.6	0.1	0.2	0.2	0.1

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

of cesium-137 and strontium-90). Data are presented in Tables 5-56 and 5-57. Tritium concentration trends for the STP area and the Peconic River are shown in Figures 5-33 and 5-34. 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, 25 privately owned potable wells to the east of the Laboratory were sampled for radionuclides as part of a continuing cooperative program with the SCDHS. Sample collection was performed by County staff and analyses were carried out by the BNL ASL. Gross alpha and gross beta activities were typical of environmental water samples, although tritium concentrations above the analytical MDL were found in six private well samples (see Table 5-58). The annual average concentrations in these wells ranged from 1,430 to 2,380 pCi/L (53 to 88 Bq/L), or 7% to 12% of the SDWA standard. The maximum concentration observed in any private well was 2,520 pCi/L (93 Bq/L), or 13% of the SDWA standard. Ingestion of water throughout the year at the maximum concentration detected would lead to a committed effective dose equivalent of 0.1 mrem (1 μSv) to the individual consuming the water. By comparison, the typical dose that a U.S. citizens receives annually from the ingestion of naturally-occurring radionuclides is approximately 40 mrem (0.4 mSv)(NCRP, 1987).

Table 5-56
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant and Peconic River Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40 (pCi/L)	Be-7	Co-60	Cs-137	Sr-90
Sewage Treatment Plant and Peconic River										
29-01	1	Max.	NA	NA	0	ND	ND	ND	2.90	NA
37-01	1	Max.	NA	NA	82	ND	ND	ND	ND	NA
37-02(a)	2	Max.	NA	NA	16	ND	ND	ND	4.30	1.49
		Avg.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.92
37-03(a)	1	Max.	NA	NA	-18	ND	ND	ND	ND	NA
37-04(a)	1	Max.	NA	NA	-114	ND	ND	ND	ND	NA
38-01	2	Max.	NA	NA	138	4.12	ND	ND	7.30	0.78
		Avg.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.64
38-02	3	Max.	NA	NA	1460	2.28	ND	ND	6.80	1.49
		Avg.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0.92
38-03	3	Max.	NA	NA	276	ND	ND	ND	4.90	9.41
		Avg.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	8.16
38-04	1	Max.	NA	NA	19	ND	ND	ND	ND	2.19
38-05	3	Max.	0.43	2.81	215	1.90	ND	ND	5.00	0.03
		Avg.	0.04	1.77	51	1.90	ND	ND	2.59	-0.02
38-06	3	Max.	1.83	21.10	1050	ND	9.78	0.47	2.80	0.19
		Avg.	0.72	7.60	473	ND	9.78	0.47	2.80	0.00
39-05	3	Max.	0.46	1.73	1010	ND	17.40	0.76	0.62	1.11
		Avg.	0.32	0.37	639	ND	17.40	0.76	0.62	0.47
39-06	2	Max.	1.66	12.50	752	ND	ND	ND	ND	2.73
		Avg.	(c)	(c)	654	ND	ND	ND	ND	1.91
39-07	3	Max.	0.93	5.71	1330	4.97	ND	ND	1.40	1.37
		Avg.	0.78	4.31	763	4.97	ND	ND	1.40	1.00
39-08	3	Max.	0.56	5.59	1340	6.07	ND	ND	ND	1.97
		Avg.	0.28	5.05	866	6.07	ND	ND	ND	1.61
39-09	2	Max.	0.56	3.48	76	4.58	ND	ND	11.50	0.72
		Avg.	0.52	2.59	16	4.58	ND	ND	11.50	0.54
39-10	1	Max.	NA	NA	-14	ND	ND	ND	ND	NA
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	1000000	5000	3000	8(b)
Typical MDL			0.9	2.5	380	3.9	1.6	0.2	0.2	0.1

Note: This table includes radiological analysis data presented in the Operable Unit V Remedial Investigation Report.
(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.
NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

Table 5-56 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Sewage Treatment Plant and Peconic River Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	K-40	Cs-137	Sr-90
			←		(pCi/L)			→
Sewage Treatment Plant and Peconic River								
41-01	1	Max.	NA	NA	38	ND	-1.20	0.22
41-02	1	Max.	NA	NA	137	ND	6.50	0.03
41-03	1	Max.	NA	NA	73	ND	4.80	-0.18
47-03(a)	1	Max.	NA	NA	31	ND	8.40	NA
48-02	1	Max.	NA	NA	-69	145	0.60	1.34
49-04	1	Max.	NA	NA	-37	ND	-0.20	0.19
49-05	1	Max.	NA	NA	-109	ND	3.40	3.22
49-06	1	Max.	NA	NA	-78	ND	-0.76	0.27
60-01	2	Max.	14.40	(d)	567	ND	-4.74	1.64
		Avg.	(c)	(c)	292	(c)	(c)	(c)
61-04	1	Max.	NA	NA	51	ND	0.60	-0.12
61-05	1	Max.	NA	NA	1130	ND	-3.60	-0.22
DOE Order 5400.5 DCG			NS	NS	20000(b)	7000	3000	8(b)
Typical MDL			0.9	2.5	380	3.9	0.2	0.1

Note: This table includes radiological analysis data presented in the Operable Unit V Remedial Investigation Report.

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.
(d) Data voided based on QA review.

NS: None Specified. ND: Not Detected.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.

Table 5-57
BNL Site Environmental Report for Calendar Year 1995
Meadow Marsh and Upland Recharge Area Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	Sr-90
			← (pCi/L) →			
Meadow Marsh / Upland Recharge Area						
58-01(a)	1	Max.	0.33	1.90	ND	0.65
58-02(a)	1	Max.	0.55	1.60	ND	-0.22
58-03(a)	1	Max.	0.35	0.80	ND	0.04
67-01(a)	1	Max.	0.99	2.50	ND	0.40
69-10	1	Max.	ND	7.70	ND	ND
70-01	1	Max.	ND	ND	ND	ND
78-01	1	Max.	ND	ND	ND	ND
79-17	1	Max.	ND	ND	ND	2.40
80-02	3	Max.	0.22	1.61	-19	ND
		Avg.	0.04	0.81	-22	(c)
80-03	4	Max.	0.16	1.51	128	1.90
		Avg.	-0.03	0.77	-78	(c)
80-04	1	Max.	-0.04	1.80	ND	0.16
80-11 *	1	Max.	0.46	-0.02	ND	-0.32
89-01	1	Max.	ND	3.40	ND	-0.28
89-13	1	Max.	0.20	-1.00	ND	0.18
89-14	1	Max.	0.04	-0.84	ND	-0.40
DOE Order 5400.5 DCG			NS	NS	20000(b)	8(b)
Typical MDL*			2.1	3.4	410	0.7

Note: This table contains data from the Operable Unit VI Remedial Investigation report.

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

* Analysis performed by off-site laboratory; MDLs may differ from typical BNL ASL values.

Table 5-57 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Meadow Marsh and Upland Recharge Area Groundwater Radioactivity Data

Well	No. of Samples		Gross Alpha	Gross Beta	Tritium	Sr-90
			← (pCi/L)			→
Meadow Marsh / Upland Recharge Area						
90-02	2	Max.	0.31	2.39	140	NA
		Avg.	0.15	1.58	64	NA
90-03	1	Max.	0.53	0.74	269	NA
99-05	2	Max.	0.29	0.17	19	-0.03
		Avg.	-0.01	-2.16	6	(c)
99-06	2	Max.	0.62	1.34	-32	NA
		Avg.	0.35	0.86	-45	NA
99-10	1	Max.	-0.15	0.18	-130	-0.02
99-11	1	Max.	0.52	-0.71	-270	-0.37
100-03	1	Max.	0.00	1.36	13	0.01
100-04	1	Max.	6.99	-8.88	-415	-0.49
100-10	1	Max.	0.52	4.00	-220	0.13
100-11	1	Max.	0.11	-0.41	-48	-0.16
100-12	1	Max.	-0.22	0.17	-72	-0.55
100-13	1	Max.	0.94	3.40	-21	0.22
100-14	1	Max.	0.19	0.00	-120	-0.05
DOE Order 5400.5 DCG			NS	NS	20000(b)	8(b)
Typical MDL*			2.1	3.4	410	0.7

Note: This table contains data from the Operable Unit VI Remedial Investigation report.

(a) Upgradient well.
(b) NYS Drinking Water Standard shown.
(c) Only one sample collected for this analysis.

NS: None Specified.
MDL: Minimum Detection Limit.
NA: Not analyzed for this parameter.
ND: Not Detected.

* Analysis performed by off-site laboratory; MDLs may differ from typical BNL ASL values.

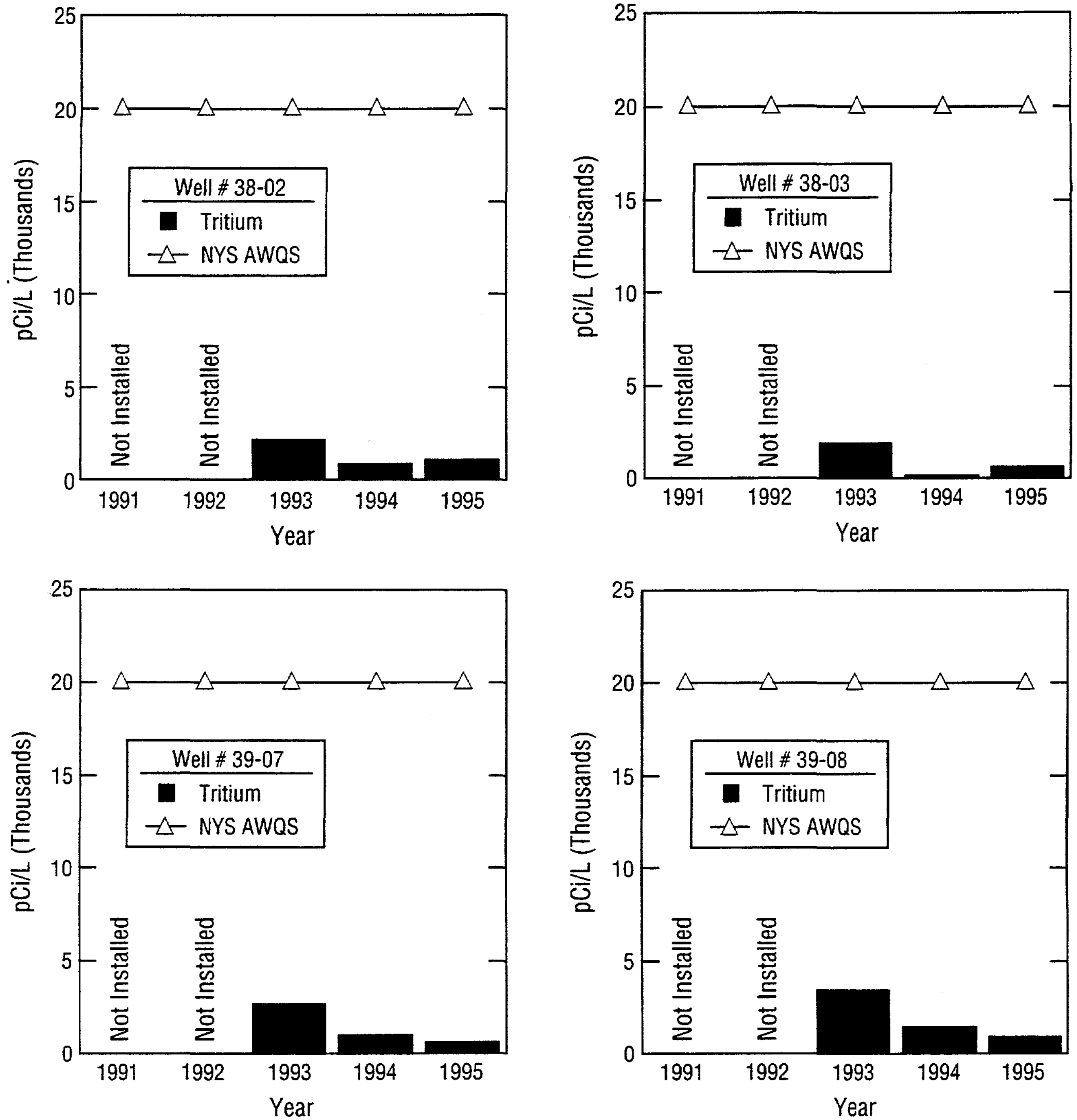


Figure 5-33 Yearly average Tritium concentration in wells located in the Sewage Treatment Plant area (STP): Wells 38-02, 38-03, 39-07 and 39-08 are located in the STP filter bed areas.

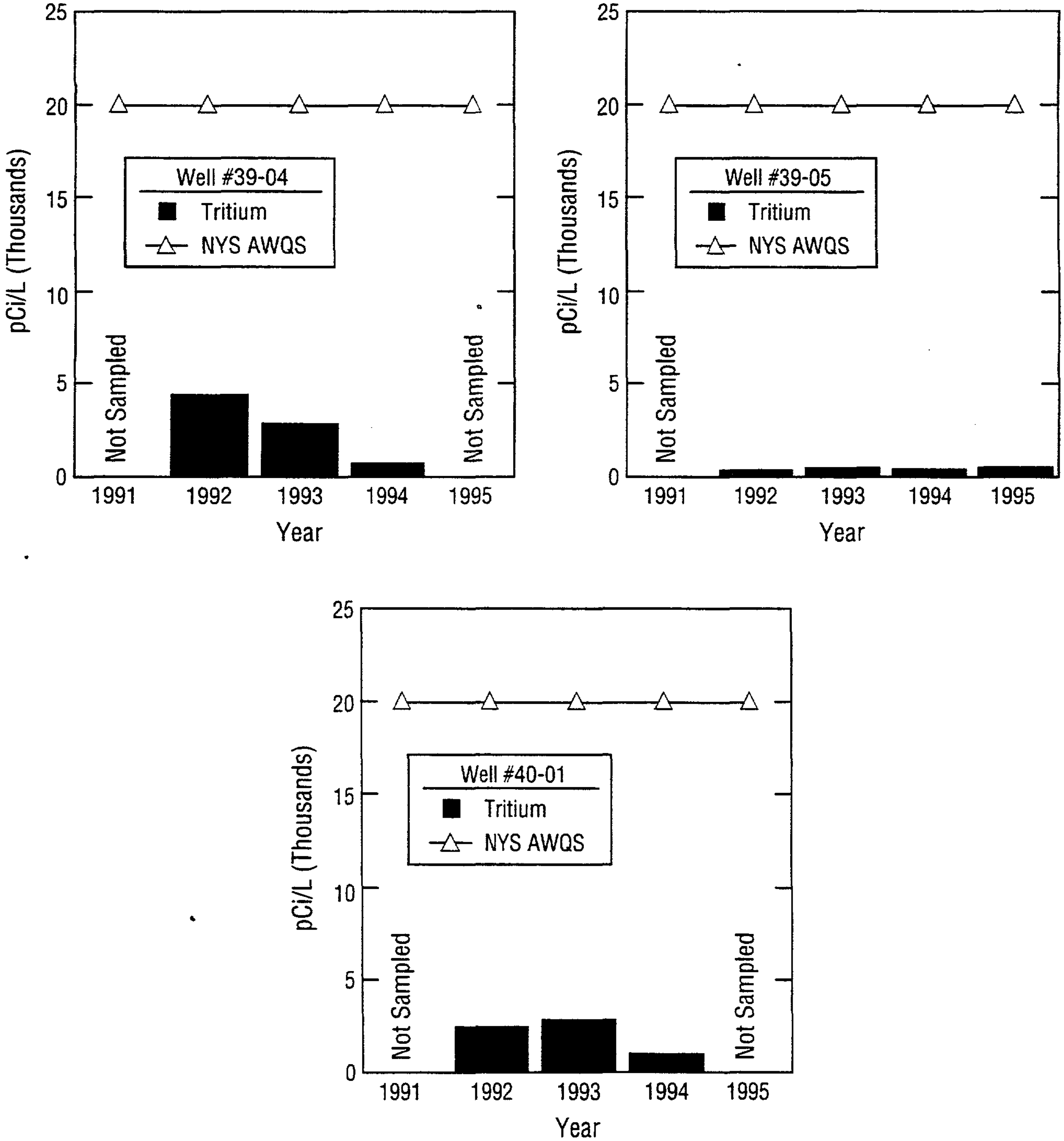


Figure 5-34 Yearly average Tritium concentration in wells located in the Peconic River area: Wells 39-05, 39-04 and 40-01 are located 310 m, 440 m, and 670 m downstream of EA respectively.

Table 5-58
BNL Site Environmental Report for Calendar Year 1995
Off-Site Potable Well Radiological Analysis Data

Sample Location	No. of Samples	Gross Alpha Max.	Gross Alpha Avg.	Gross Beta Max.	Gross Beta Avg.	Tritium Max.	Tritium Avg.
		(pCi/L)					
1	3	1.78	0.89	1.69	1.53	59	-37
2	3	1.36	0.85	1.28	0.57	191	61
3	3	0.72	0.42	1.28	0.89	119	-62
4	3	0.83	0.57	1.14	0.16	0	-15
5	3	1.84	1.33	2.28	0.93	1,430	907
6	3	0.29	0.16	0.85	0.19	209	-5
7	3	2.58	1.26	2.55	1.36	2,520	1,448
8	3	1.47	0.92	6.06	0.92	2,220	1,853
9	2	1.68	1.00	18.10	9.15	24	7
10	2	0.59	0.45	1.87	0.98	39	-2
11	2	0.51	0.42	1.11	-0.54	1,390	734
12	2	0.63	0.62	0.66	-0.64	48	-67
13	2	1.08	0.73	0.91	0.52	1,960	1,830
14	2	0.64	0.38	0.21	-0.47	126	93
15	1	0.50		0.73		-29	
16	1	0.51		1.95		2,380	
17	1	0.55		0.73		15	
18	1	1.03		0.57		-10	
19	1	0.60		0.77		-46	
20	1	0.61		1.46		109	
21	1	1.24		4.21		-215	
22	1	0.21		0.99		-171	
23	1	0.00		1.15		95	
24*	1	-0.99		(b)		54	
25	1	0.49		2.51		-53	
26	1	0.20		-2.84		-73	
SDWA Limit		15 (a)		NS		20,000	
Typical MDL		0.9		2.5		380	

* Peconic River sample.
SDWA: Safe Drinking Water Act
MDL: Minimum Detection Limit.
NS: Not Specified.

(a) Including radium-226, but excluding radon and uranium.
(b) Data voided based on QA review.

Table 5-58 (Continued)
BNL Site Environmental Report for Calendar Year 1995
Off-Site Potable Well Radiological Analysis Data

Sample Location	No. of Samples	Be-7	K-40	Mn-54 (pCi/L)	Pb-214	Sr-90
1	1	ND	3.07	ND	ND	-0.03
2	1	ND	ND	ND	ND	0.19
3	1	ND	ND	ND	ND	-0.04
4	1	ND	4.69	ND	ND	0.04
5	1	ND	ND	ND	ND	0.07
6	1	ND	ND	ND	ND	0.04
7	1	ND	ND	ND	ND	0.03
8	1	ND	ND	ND	ND	-0.02
10	1	ND	ND	ND	ND	0.15
11	1	ND	ND	ND	1.01	0.08
12	1	ND	ND	ND	ND	0.03
13	1	ND	ND	ND	ND	0.14
14	1	ND	ND	ND	ND	0.08
23	1	ND	ND	ND	ND	-0.01
24*	1	ND	2.38	ND	ND	0.47
25	1	2.07	2.45	0.15	ND	0.05
DOE Order 5400.5 DCG		1,000,000	7,000	50,000	200,000	8[a]
SDWA Limit[b]		40,000	280	2,000	8,000	8
Typical MDL		1.6	3.9	0.2	---	0.1

(a) SDWA limit shown.
(b) Limit is calculated as 4% of the DCG to obtain concentration which would produce 4 mrem committed effective dose equivalent (with the exception of Sr-90 which is specified by the Act).

Note: Well locations 26 and 15 through 22 were not sampled for gamma analysis.

DCG: Derived Concentration Guide.
ND: Not Detected.

* Peconic River sample.

6.0 Radiological Dose Assessment - G.L Schroeder

6.1 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 sources. This model is designed to be relatively simple and 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 is a change from previous years in which 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 new position. This has the effect of somewhat reducing the total dose from the airborne pathway as compared to previous years.

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 had to be assumed for purposes of dose evaluation. The conservative assumption was made that the inventory in the pond at the conclusion of 1995 represented the inventory throughout the year. The tritium inventory of Pond No. 1 was the greater of the two ponds at approximately 1.3 Ci (48.1 GBq). (Pond No.2 also contained tritiated water, but at a much lower concentration with a source term of about 50 mCi [1.85 GBq].) This value is based on detected concentrations of tritium and a measurement 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 0.0009 mrem/yr (9E-6 mSv/yr). This value is unmeasurable by the most sophisticated instrumentation and indistinguishable from background radiation levels.

In 1995, the effective dose equivalent to the MEI adjacent to the NNE boundary of the site was 0.06 mrem (0.6 μSv). Argon-41 released from the BMRR contributed 94% of this dose. By comparison, this is 217 times less than the EPA airborne dose limit of 10 mrem (0.1 mSv) and 6,521 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.

6.2 Effective Dose Equivalent Calculations - Water Pathways

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 and also serves as a limited resource for sport fishing. 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 significant radionuclide detected in any of the private wells that were sampled. The maximum tritium concentration observed in a residential well throughout 1995 was 2,520 pCi/L (93 Bq/L). This is eight 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 0.1 mrem (1 μSv). (See Appendix B for a description of the calculational methods.) This represents 3% of the 4 mrem (40 μSv) dose limit specified for this pathway by the SDWA. This data is summarized in Table 6-1.

Calculations were also made to determine the potential dose to an individual consuming fish taken from Donahue's Pond. Cesium-137 was detected in fish samples originating in Donahue's Pond at levels above those observed in fish taken from the lower lake of the Carmans River, a control location not influenced by BNL effluents. The maximum net concentration of cesium-137 observed in fish from Donahue's Pond (following subtraction of background levels) was 615 pCi/kg (23 Bq/kg). For dose evaluation purposes, the hypothetical individual is assumed to eat seven kilograms of fish during the course of the year. Consumption at this rate and concentration would result in a maximum committed EDE of 0.2 mrem (2 μSv). By comparison, the average individual EDE caused by the ingestion of naturally-ocurring radionuclides in the U.S. is about 40 mrem (0.4 mSv) per year (NCRP, 1987). (This does not include any potential contribution from strontium -90 since strontium-90 measurements were unavailable at the time of this writing.)

Table 6-1
BNL Site Environmental Report for Calendar Year 1995
Summary of Dose From All Environmental Pathways

Pathway	Primary Contributing Radionuclide	Maximum Individual CEDE (mrem)	Regulatory Pathway Limit (mrem)	Collective CEDE (person-mrem)
Air	Ar-41	0.06	10	3200
Water	H-3	0.12	4	60
Fish [1]	Cs-137	0.20	NS	100
Total		0.38	100	3360

[1]Excluding any potential Sr-90 contribution.
Note: 1 mrem = 0.01 mSv.

CEDE = Committed Effective Dose Equivalent.
NS = None Currently Specified

6.3 Collective Dose Equivalent

While the EDE is the parameter used to measure dose to an exposed individual, the *collective dose equivalent* is used as a measure of the exposure to a population. Population data for the area within an 80 kilometer radius of the BNL site is used in calculating the collective dose by the CAP88-PC model. 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 2.8 person-rem (0.03 person-Sv). This constitutes 87% of the total 3.2 person-rem (0.003 person-Sv) collective dose for the population within 80 km of the Laboratory.

The collective dose equivalent to a population using the private water source described in Section 6.2 (assumed to be not more than 500 persons) would be 0.06 person-rem (0.0006 person-Sv). Finally, the total number of individuals who routinely consume fish taken from Forge Pond and Donahue's Pond was conservatively estimated to be no greater than 625 (LILCO, 1995), leading to a calculated collective population EDE of 0.1 person-mrem (0.001 person-Sv).

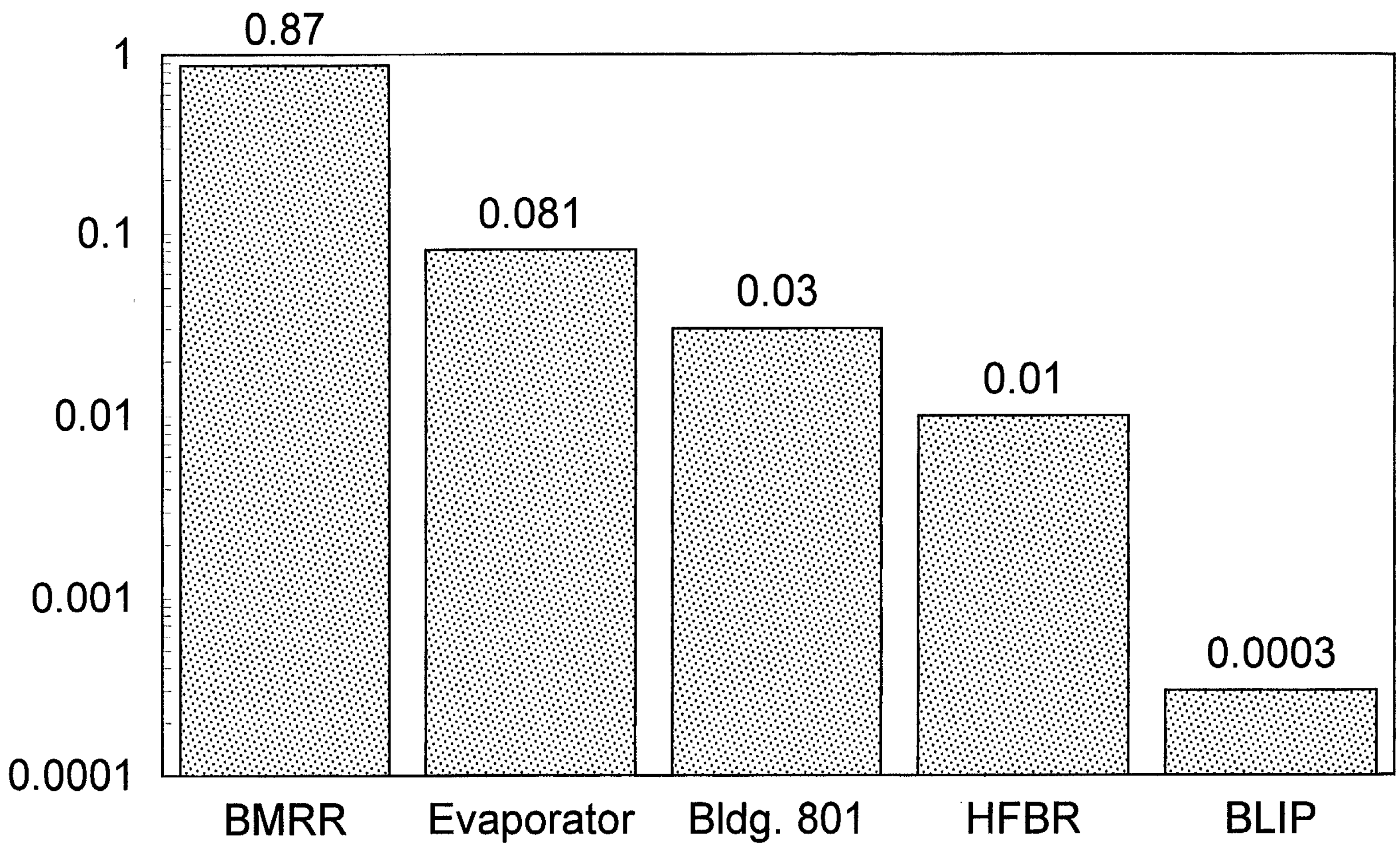
By comparison, the collective dose due to external radiation from natural background to the population within an 80 km radius of the Laboratory amounts to approximately 291,000 person-rem (2,910 person-Sv), and about 196,800 person-rem (1,968 person-Sv) from internal radioactivity in the body from natural sources (excluding potential radon contributions). A graph of the respective facility contributions to the calculated collective dose are shown in Figure 6-1.

6.4 Summary and Conclusion

Calculations of effective dose equivalents from all BNL facilities which have the potential to release radionuclides to the atmosphere indicate that doses from 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). Using EPA-supplied models, the effective dose equivalent to the maximally exposed individual living at the site boundary was calculated to be 0.06 mrem/yr (0.0006 mSv/yr), or less than 1% of the 10 mrem/yr public air pathway dose limit. The EDE to an individual who consumes water and fish at the highest concentrations of radionuclides observed in all samples collected in 1995 would receive an additional 0.2 mrem (excluding any potential strontium-90 contribution). The total dose to the maximally exposed individual from all pathways is 0.4% of the 100 mrem/yr (1mSv) DOE limit established for the protection of public and environment. This total represents approximately 0.1% of the dose received annually by an individual from natural background sources including radon (NCRP, 1987). These maximum credible doses demonstrate that in 1995, BNL's radiological effluents had no impact on the health of the public or environment in the surrounding area.

Fraction of Total Collective Dose

by Facility - 1995



Note: Incinerator contribution to Collective Committed EDE is <0.0001.

Figure 6-1

7.0 QUALITY ASSURANCE PROGRAM - S. L. K. Briggs

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 is headed by the QM Manager who coordinates and evaluates QA for the entire 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 EM Section integrated both these elements and the additional environmental QA requirements of DOE Order 5400.1 into the sampling, analysis, and data handling activities. The implementing procedures of the EM Section SOP manuals 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), comprise the EM QA Program for the environmental surveillance and effluent monitoring programs.

The objectives of the EM Section QA Program are to ensure that management provides planning, organization, direction, control, and support to achieve the objectives of the environmental program; that the line managers achieve quality in their product or services; and that overall performance is reviewed and evaluated using a rigorous assessment process. This program was developed to ensure full 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 EM sampling, analysis, and database activities and their adherence to the QA program. Annual self-assessments of the EM activities by the EM group leaders identify areas needing attention. Furthermore, the analytical laboratories participate in interlaboratory 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, other regulatory agencies, and other independent groups periodically audit the EM Section.

A major activity for the EM Section is ensuring that environmental media are sampled and analyzed in a way that provides representative, defensible data. The QA program fulfills this 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, into the environmental surveillance and effluent monitoring programs. The S&EP EM program uses an onsite ASL and offsite contractor laboratories for radiological and nonradiological analyses. 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 Analytical Services Laboratory is certified by the NYSDOH, Environmental Laboratory Approval Program (ELAP) for specific analytes identified below.

7.1 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 1995, the laboratory was certified by NYSDOH ELAP for potable and non potable analysis of gross alpha and beta, photon emitters, tritium, and strontium-89 and -90 environmental samples, and analyzes proficiency samples as part of the ELAP certification program. The results of these intercomparison studies are presented in Tables 7-1 through 7-3, respectively. During 1995, the ASL tested and used an alternative analytical method for determining strontium-90 that was not approved by NYSDOH (see appendix C).

Overall, the ASL performance in the EML intercomparison study was acceptable in 90% of the analyses. Thirty-four of fifty EML analyses were within established acceptance limits showing excellent agreement with the known value; three of fifty were within upper and lower warning limits demonstrating satisfactory agreement; four analyses fell outside the acceptance limits; and the remaining nine were not analyzed.

Review of the QC data for the unacceptable cobalt-60 analyses on a vegetation matrix showed no problem associated with the sample preparation, analytical process, or data calculations. Because there was no vegetation sampling during 1995, these results do not characterize the quality of any data presented in this SER.

The unacceptable gross alpha and gross beta results, both in the EML study as well as the NERL-LV and NYSDOH studies presented below, revealed that an elevated background existed during the analysis of 100 ml evaporation water sample types due to a contaminated blank sample planchette. The elevated baseline affected the validity of all daily gross beta samples collected at the STP, and in a few isolated instances groundwater samples which required dilution from 500 ml to 100 ml due to high solids content. As a result, these particular types of gross beta measurements made between January and November of 1995 were voided. This problem did not affect the gross beta measurements for air samples or the analyses of 500 ml groundwater samples. Upon installation of a new instrument in December 1995, including preparation of a new blank planchette, the problem was resolved.

The interpretation of the gross beta intercomparison data was confounded by the EML air filter sample results. It was determined that the analyzer efficiency using the laboratory's standard air filter geometry was lower than the actual efficiency of the blind test sample. This resulted in an overestimation of the gross alpha and beta activity on the air filter test sample only. However, since the intercomparison filter was of a different type than those used in the BNL EM program, regular EM air filter results were unaffected.

Table 7-1
BNL Site Environmental Report for Calendar Year 1995
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Matrix	Units	Isotope	Date	EML	BNL	Ratio	Comments
Air Filter	pCi/Filter	Alpha	Mar-95	86.9	104.5	1.20	
			Sep-95	89.1	106.9	1.20	
		Beta	Mar-95	50.0	80.2	1.61	Not Acceptable
			Sep-95	30.2	56.4	1.87	Warning
		Ce-144	Mar-95	2462.4	2052.0	0.83	
			Sep-95	1406.7	1258.2	0.89	
		Co-57	Mar-95	342.9	305.1	0.89	
			Sep-95	396.9	364.5	0.92	
		Co-60	Mar-95	101.5	91.0	0.90	
			Sep-95	880.2	788.4	0.90	
		Cs-134	Mar-95	155.3	143.1	0.92	
			Sep-95	483.3	421.2	0.87	
		Cs-137	Mar-95	142.6	140.4	0.98	
			Sep-95	195.8	190.4	0.97	
		Mn-54	Mar-95	127.2	126.9	1.00	
			Sep-95	144.2	144.7	1.00	
		Ru-106	Sep-95	459.0	445.5	0.97	
		Sb-125	Mar-95	254.3	251.9	0.99	
			Sep-95	307.8	326.7	1.06	
		Sr-90	Mar-95	20.0	NA		
			Sep-95	28.6	NA		
Soil	pCi/g	Cs-137	Mar-95	7182.0	8154.0	1.14	
			Sep-95	5589.0	5400.0	0.97	
		K-40	Mar-95	10368.0	10206.0	0.98	
			Sep-95	10179.0	8235.0	0.81	
		Sr-90	Mar-95	305.1	NA		
			Sep-95	210.9	NA		

NA = Not Analyzed

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 7-1 (Continued)
BNL Site Environmental Report for Calendar Year 1995
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Matrix	Units	Isotope	Date	EML	BNL	Ratio	Comments
Vegetation	pCi/g	Co-60	Mar-95	259.2	164.7	0.64	Not Acceptable
			Sep-95	247.6	148.5	0.60	Not Acceptable
		Cs-137	Mar-95	3159.0	2970.0	0.94	
			Sep-95	2624.4	2527.2	0.96	
		K-40	Mar-95	27810.0	22140.0	0.80	
			Sep-95	9504.0	7722.0	0.81	
		Sr-90	Mar-95	13824.0	NA		
			Sep-95	15849.0	NA		
Water	pCi/L	Alpha	Mar-95	36180.0	NA		
			Sep-95	35370.0	10827.0	0.31	Not Acceptable
		Beta	Mar-95	17631.0	NA		
			Sep-95	11070.0	11178.0	1.01	
		Co-60	Mar-95	5292.0	5562.0	1.05	
			Sep-95	5292.0	5400.0	1.02	
		Cs-134	Mar-95	2254.5	2592.0	1.15	
		Cs-137	Mar-95	2073.6	2592.0	1.25	Warning
			Sep-95	2030.4	2281.5	1.12	
		H-3	Mar-95	1628.1	1530.9	0.94	
			Sep-95	4536.0	3726.0	0.82	
		Mn-54	Mar-95	1174.5	1304.1	1.11	
			Sep-95	1212.3	1344.6	1.11	
		Sr-90	Mar-95	64.8	48.6	0.75	Warning
			Sep-95	54.0	NA		

NA = Not Analyzed

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 7-2
BNL Site Environmental Report for Calendar Year 1995
BNL Quality Assessment Program Results
National Exposure Research Laboratory (NERL-LV)

Matrix	Units	Isotope	Date	NERL	BNL	Ratio	Comments
Air	pCi/L	Alpha	Aug-95	25	30.23	1.21	
		Beta	Aug-95	86.6	104.9	1.21	>3std dev
		Cs-137	Aug-95	25	40.67	1.63	outlier
		Sr-90	Aug-95	30	NA		
Milk	pCi/L	Cs-137	Sep-95	50	63	1.26	outlier
		I-131	Sep-95	99	ND		Not detected
		K	Sep-95	1654	1702.3	1.03	
		Sr-90	Sep-95	15	NA		
Water	pCi/L	Ba-133	Nov-95	99	97	0.98	
		Ba-133	Jun-95	79	88.3	1.12	
		Co-60	Jun-95	40	38.0	0.95	
		Co-60	Nov-95	60	58.7	0.98	
		Cs-134	Jun-95	50	55.3	1.11	outlier
		Cs-134	Nov-95	40	37.7	0.94	
		Cs-137	Jun-95	35	47.7	1.36	
		Cs-137	Nov-95	49	55.3	1.13	
		Zn-65	Jun-95	76	275	3.62	outlier
		Zn-65	Nov-95	125	456	3.65	outlier
Water	pCi/L	H-3	Mar-95	7435	7093.3	0.95	
		H-3	Aug-95	4872	4570	0.94	

NA = Not Analyzed
ND = Not Detected

NOTE: Comment column provides NERL evaluation of analytical performance which is based 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.

Table 7-3
BNL Site Environmental Report for Calendar Year 1995
BNL Potable Water Radiochemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (pCi/L)	BNL (pCi/L)	Ratio	Comments
Alpha	Oct-95	18	16.54	0.92	
		79	78.2	0.99	
Beta	Oct-95	15	-12.21	-0.81	Unacceptable
		102	95.17	0.93	

Beta results not formally evaluated by ELAP

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.

Overall, the ASL performance in the NERL intercomparison study was acceptable in 65% of the analyses. The NERL-LV comparisons resulted in excellent agreement for five of the seventeen analyses, within 1σ of the known value; good agreement for four analyses, within 2σ of the known; two of seventeen analyses between 2 and 3σ; and the remaining six sample analyses > 3σ. In addition, one isotope was not detected because the sample's activity was four times lower than the minimum detectable activity of the ASL instrumentation.

Investigation of the unacceptable analyses revealed two issues. A calculation error due to an incorrect value in the gamma energy library for zinc-65 abundance accounted for two outliers, which was corrected upon identification. A review of the gamma isotopes detected in 1995 samples showed that no zinc-65 was measured, even with this positive bias, therefore this error did not affect any analytical data reported. Varying results for cesium-137 in consecutive intercomparisons prompted an in-depth study of the data. It was found that a sample's final activity varied depending on the detector used to make the measurement. A detector-to-detector comparison was conducted and revealed a bias between detectors. Further review showed that two of these detectors were used in the analysis of the performance evaluation samples. This prompted the ASL management to remove them from service.

Lastly, the radiological results from the ELAP proficiency test for gross alpha and beta showed excellent agreement for three of the four analyses, within 10% of the known value; however the one remaining analysis was unacceptable due to the elevated background noted above.

Figures 7-1 and 7-2 summarize the internal quality control program for the radiological instruments. Figure 7-1 shows the annual mean and 99% confidence interval for the alpha, beta, and tritium analyzers' efficiency, as determined by a daily calibration standard. Figure 7-2 compares the mean and 99% confidence intervals of the cesium-137 energy for each gamma detector, measured by a daily calibration standard. The actual 661.65 KeV cesium-137 gamma energy line is shown as a solid line. Confirming the detector bias discussed above, the plot shows that two detectors exceeded the acceptance band of ±1 KeV. Due to the positive bias of detector 6 it was replaced in January 1996, while the variability of detectors 3 and 8 resulted in their being taken out of service in June 1996. Except for these instances, the gamma detectors operated within ±0.90 KeV.

The ASL performed an alternative strontium-90 method developed at the DOE Argonne National Laboratory (described in Appendix C). Figure 7-3 compares the mean and 99% confidence interval of the deviation from the calibration standard for each detector. The plot shows that the mean percent deviation from the calibration standards was within ±2%, but negatively biased. The variability in detector 4 resulted in a 99% confidence interval of ±6%. However, no individual efficiency check was measured greater than ±3% for this detector. All remaining detectors operated within the ±5% acceptance band. Samples spiked with strontium-90 yielded mean recoveries of 90% ±16% confirming a negative bias. The variability of the first six months of 1995 was brought within control during the remaining half of the year, resulting in acceptable recoveries. However, overall the strontium-90 data presented in this report can be characterized as underestimated by approximately 10%.

During the calendar year 1995, there were no onsite audits of the radiological analytical processes. In response to a 1994 NYSDOH ELAP audit finding challenging the analysis of undistilled groundwater samples for tritium, a side-by-side comparison of distilled versus undistilled samples was made. Two hundred and thirty-nine samples were analyzed in duplicate; once by the EPA 906.0 method (including distillation) and once

Figure 7-1

1995 Calibration Standard Summary

Alpha, Beta, and Tritium Efficiency

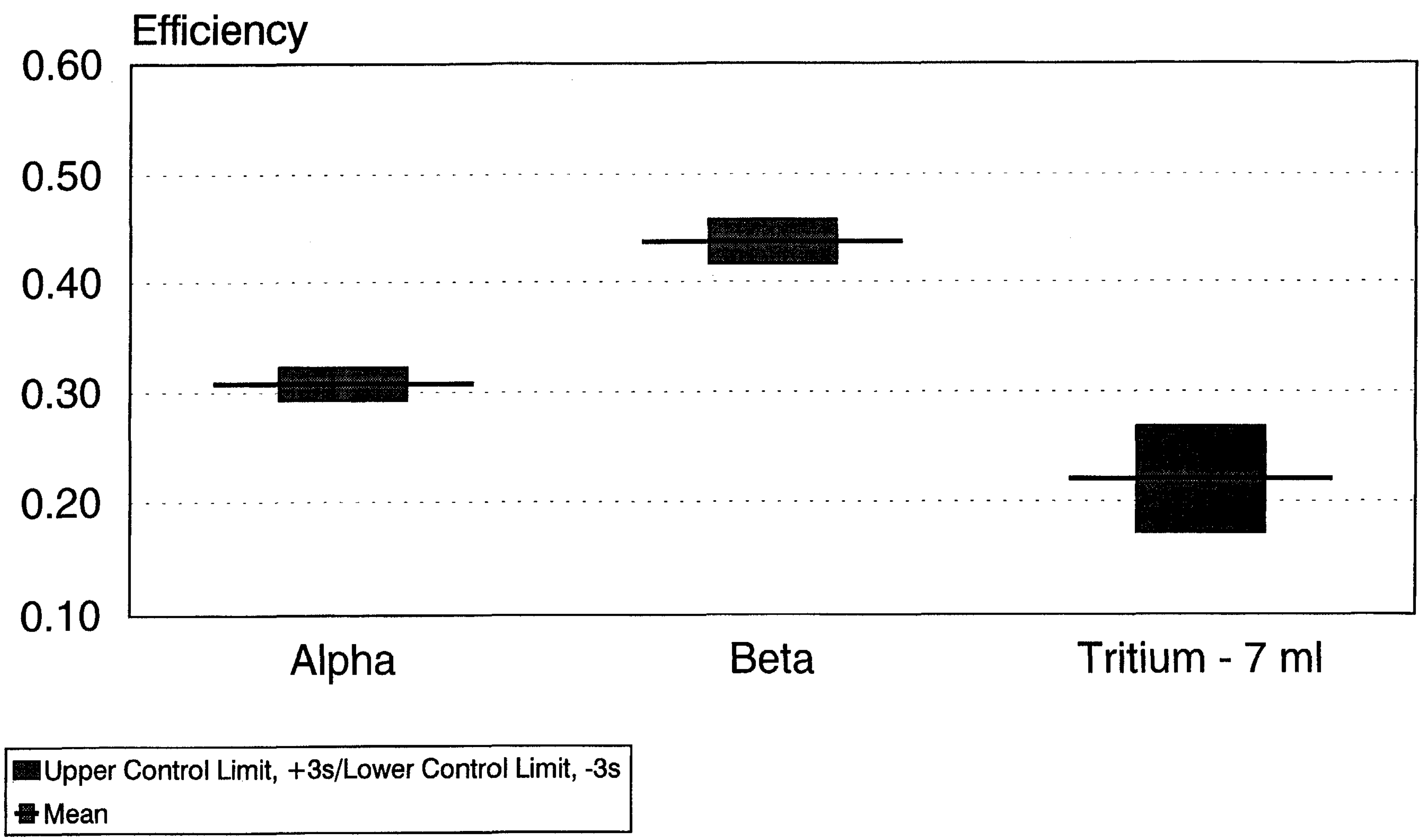


Figure 7-2

1995 Gamma Calibration Standard Summary
Cesium-137 Energy

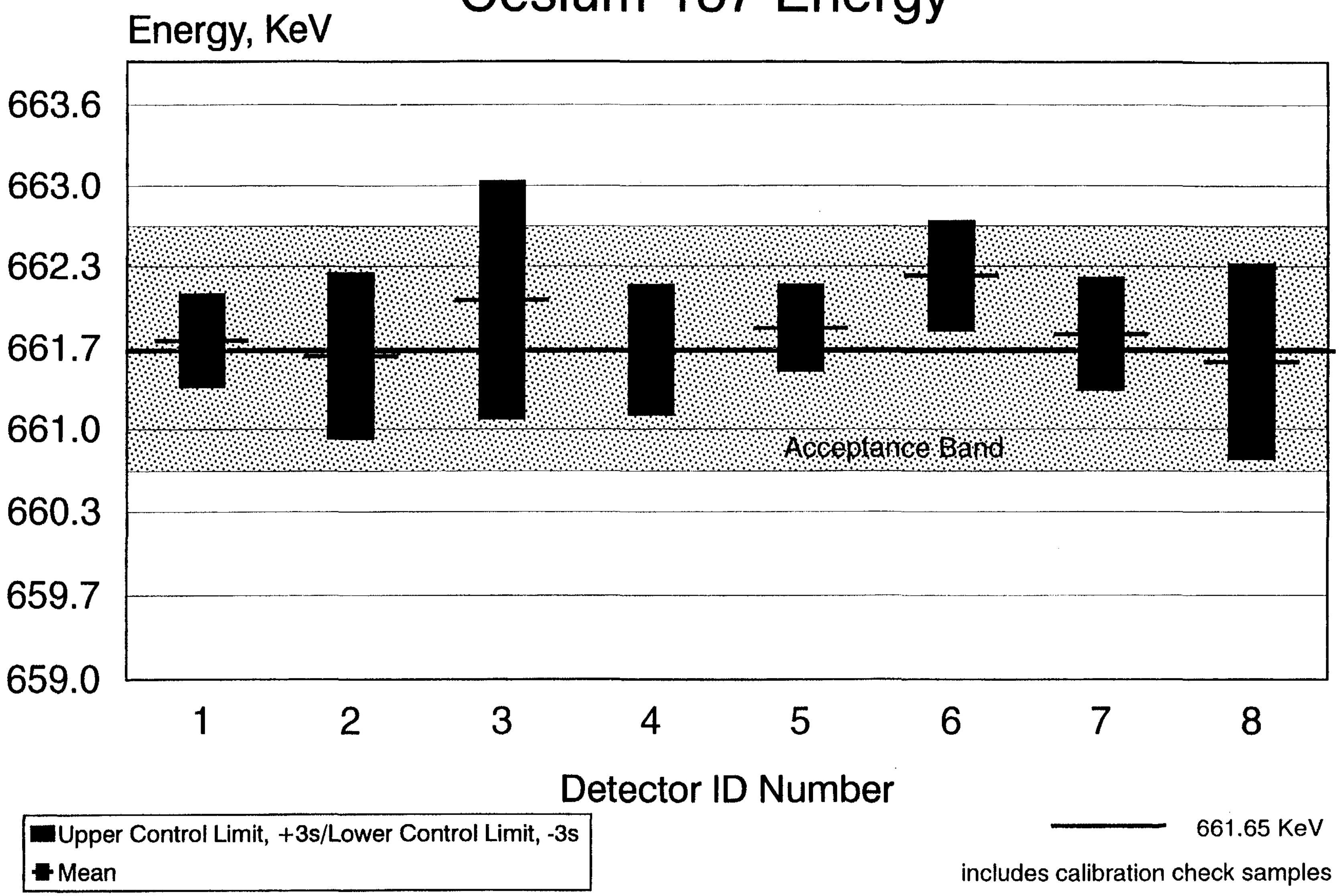
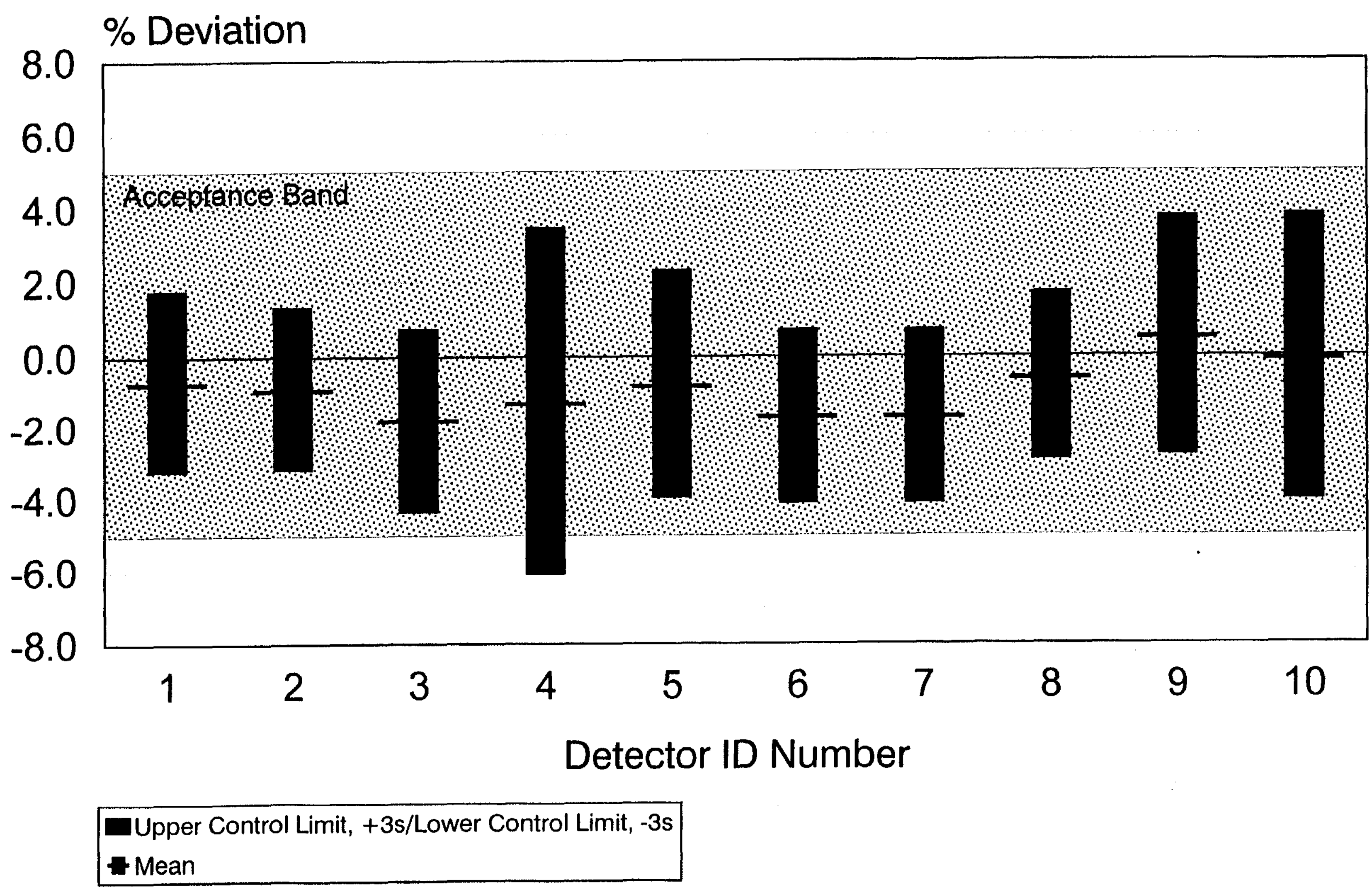


Figure 7-3

1995 Strontium-90 Efficiency Deviation Summary

Percent Deviation from Standards



by the BNL direct addition method (undistilled). The data is presented in Figure 7-4. A linear regression analysis shows excellent agreement between the two preparation methods, with an intercept of 6.82e-08 µCi/L, a slope of .95, and a correlation of 0.999. This data supports the validity of the BNL groundwater tritium data that was not distilled before analysis.

7.2 Nonradiological Analyses

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. These compounds are benzene, toluene, xylene, ethylbenzene, chloroform, DCA, DCE, TCA, TCE, and PCE.

Tables 7-4 and 7-5, respectively, present the results of organic and inorganic proficiency samples analyzed for this certification program. The results show that 100% of all nonradiological proficiency samples performed for NYSDOH in 1995 were within acceptance limits. There was excellent agreement, within ±10%, in eleven of twenty organic analyses . The remaining nine tests fell within ±21% of the known value, showing good agreement. Results from the inorganic proficiency samples showed excellent agreement, within ±10%, in forty-seven of the fifty-two analyses, with forty analyses being within 5% of the known value. Good agreement, within ±14%, was found in the remaining five. These results confirm the validity of the data presented in this report.

The ASL also participated in the EPA Environmental Monitoring Systems Laboratory (EMSL-CI) water pollution and water supply performance evaluation studies. Tables 7-6 and 7-7, respectively, give the results of these studies. Overall, the ASL performance in the EMSL-CI water pollution intercomparison study (WP034) was acceptable in 88% of the analyses. The performance was excellent for twenty-seven of the twenty-eight inorganic analyses, and six of the fourteen organic analyses. The organic results exceeded the warning limits in four of the fourteen organic analyses; however, they were not acceptable for four organic and one inorganic parameters. Table 7-7 shows the results from two EMSL-CI water supply studies (WS035 and WS036). Acceptable performance was found in 95% of the comparisons.

Review of the lead and the cadmium results in these EMSL-CI studies showed that dilution factors were not applied correctly to these particular test samples. As such, it does not imply that the cadmium and lead data presented in this SER are in error. The QC data for the organic analyses containing these EMSL-CI samples did not reveal the cause for this overestimation. It was concluded that this error was isolated because proficiency samples from NYSDOH ELAP the following month showed excellent performance for several of these same analytes.

Figures 7-5 and 7-6 summarize the internal quality control program for the ion chromatography and atomic absorption methods used for inorganic analyses. Figure 7-5 presents the annual mean and 99% confidence interval for reference check and calibration check sample recoveries analyzed in each metal or

Figure 4

Linear Correlation of Distilled vs. Undistilled ^3H Results (5/18/95 Through 9/21/95)

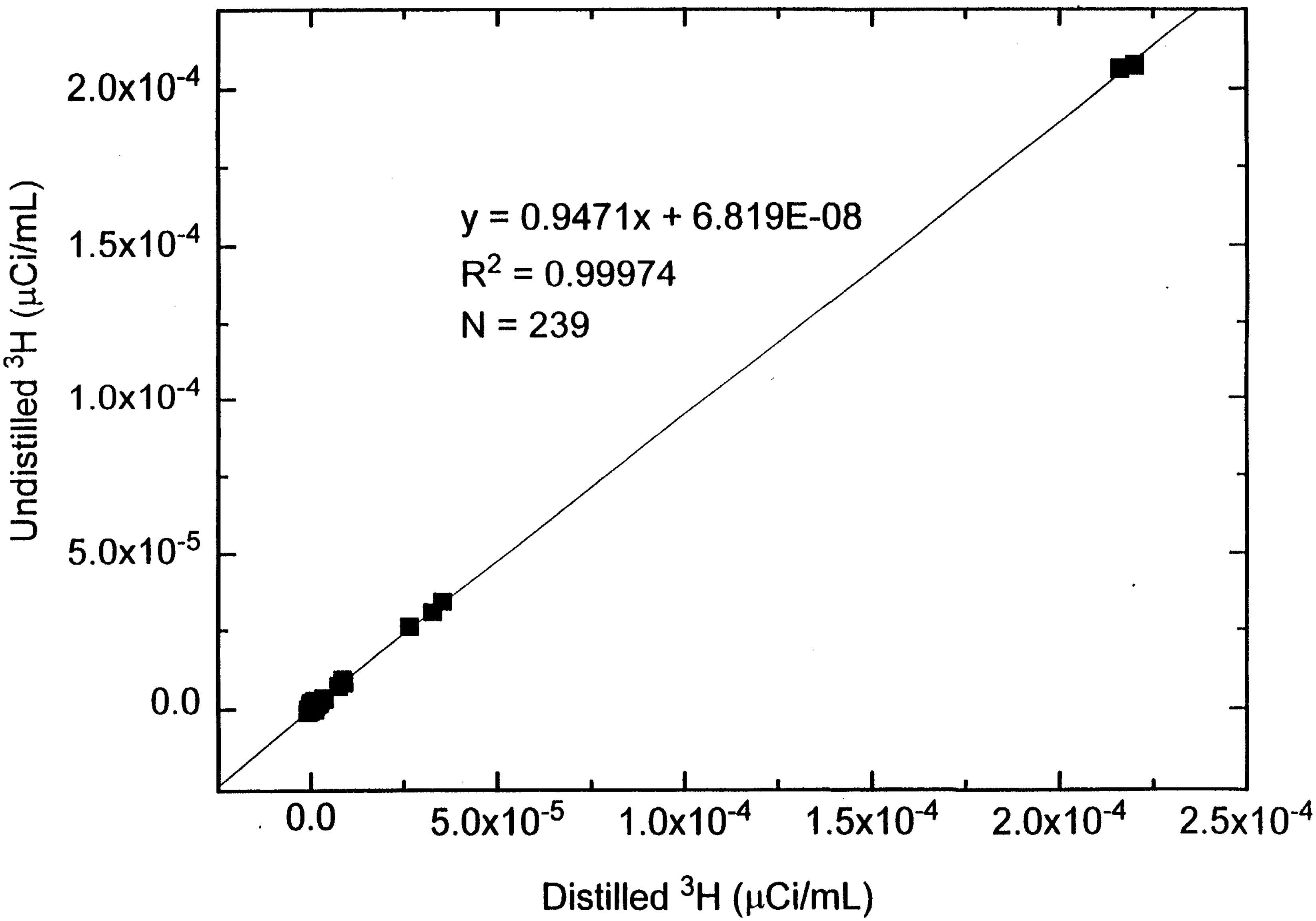


Table 7-4
BNL Site Environmental Report for Calendar Year 1995
BNL Non-potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comments
Benzene	Jan-95	18.4	15.9	0.86	
		43	37	0.86	
	Jul-95	25.2	23	0.91	
		65	58.9	0.91	
Tetrachloroethene	Jan-95	14.3	16.7	1.17	
		31.7	38.4	1.21	
	Jul-95	24.6	24.3	0.99	
		57.9	55.5	0.96	
Toluene	Jan-95	20.6	19.2	0.93	
		47.5	44.5	0.94	
	Jul-95	28.3	24.9	0.88	
		59.1	48.2	0.82	
Total Xylene	Jan-95	18	21.3	1.18	
		29.9	35.9	1.20	
	Jul-95	19	21.8	1.15	
		44.7	47.2	1.06	
Trichloroethene	Jan-95	13.1	13.7	1.05	
		34.8	36.4	1.05	
	Jul-95	22.2	22.6	1.02	
		54.6	55.5	1.02	

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 7-5
BNL Site Environmental Report for Calendar Year 1995
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comments
Cadmium	Apr-95	5.00	5.65	1.13	
		7.50	8.45	1.13	
	Oct-95	4.17	4.20	1.01	
		6.67	6.90	1.03	
Chloride	Apr-95	59.60	58.80	0.99	
		237.00	227.00	0.96	
	Oct-95	16.80	16.50	0.98	
		165.00	170.00	1.03	
Chromium	Apr-95	25.00	25.10	1.00	
		66.70	71.00	1.06	
	Oct-95	16.70	17.70	1.06	
		83.30	94.70	1.14	
Copper	Apr-95	417.00	418.00	1.00	
		833.00	835.00	1.00	
	Oct-95	133.00	140.00	1.05	
		1250.00	1290.00	1.03	
Iron	Apr-95	249.00	253.00	1.02	
		448.00	460.00	1.03	
	Oct-95	117.00	109.00	0.93	
		421.00	413.00	0.98	
Lead	Apr-95	25.00	27.90	1.12	
		41.70	45.30	1.09	
	Oct-95	11.70	12.30	1.05	
		31.70	35.70	1.13	
Manganese	Apr-95	117.00	116.00	0.99	
		288.00	284.00	0.99	
	Oct-95	84.00	84.00	1.00	
		168.00	169.00	1.01	
Mercury	Apr-95	3.82	3.86	1.01	
		6.67	6.23	0.93	
	Oct-95	1.15	1.13	0.98	
		6.26	6.77	1.08	
Nitrate (as N)	Apr-95	3.96	4.10	1.04	
		7.90	8.38	1.06	
	Oct-95	1.19	1.22	1.03	
		5.65	5.73	1.01	
Silver	Apr-95	26.60	27.00	1.02	
		36.80	36.00	0.98	
	Oct-95	15.10	14.60	0.97	
		33.70	34.00	1.01	

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 7-5 (Continued)
BNL Site Environmental Report for Calendar Year 1995
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP (ug/L)	BNL (ug/L)	Ratio	Comments
Sodium	Apr-95	683.00	710.00	1.04	
		1680.00	1640.00	0.98	
	Oct-95	432.00	445.00	1.03	
		1020.00	1070.00	1.05	
Sulfate (as SO4)	Apr-95	95.50	96.30	1.01	
		141.00	141.00	1.00	
	Oct-95	46.00	46.30	1.01	
		210.00	213.00	1.01	
Zinc	Apr-95	421.00	421.00	1.00	
		2680.00	2670.00	1.00	
	Oct-95	286.00	275.00	0.96	
		1520.00	1510.00	0.99	

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 7-6
BNL Site Environmental Report for Calendar Year 1995
BNL Water Pollution Performance Evaluation Studies
USEPA Environmental Monitoring Systems Laboratory - Cincinnati

Analyte	Units	Date	BNL	EMSL-CI	Ratio	Comments
Cd	ug/l	Jun-95	13.4	13	1.03	
		Jun-95	229	210	1.09	
Cr	ug/l	Jun-95	99.8	97.2	1.03	
		Jun-95	375	361	1.04	
Cu	ug/l	Jun-95	49.8	50.4	0.99	
		Jun-95	895	890	1.01	
Fe	ug/l	Jun-95	620	626	0.99	
		Jun-95	969	941	1.03	
Hg	ug/l	Jun-95	1.34	1.33	1.01	
		Jun-95	1.75	1.76	0.99	
Mn	ug/l	Jun-95	276	281	0.98	
		Jun-95	1427	1400	1.02	
Pb	ug/l	Jun-95	207	190	1.09	
		Jun-95	1380	500	2.76	Not acceptable
Zn	ug/l	Jun-95	476	484	0.98	
		Jun-95	972	967	1.01	
Ag	ug/l	Jun-95	36	36.9	0.98	
		Jun-95	255	260	0.98	
Na	mg/l	Jun-95	30.6	29.5	1.04	
		Jun-95	18.7	18.1	1.03	
Cl	mg/l	Jun-95	54.2	55.9	0.97	
		Jun-95	237.6	246	0.97	
SO4	mg/l	Jun-95	54.2	52	1.04	
		Jun-95	7.84	8.1	0.97	
NO3 - N	mg/l	Jun-95	5.83	6.02	0.97	
		Jun-95	22.5	23.1	0.97	
Total Residual Cl	mg/l	Jun-95	1.07	1.1	0.97	
		Jun-95	0.15	0.16	0.94	
Chloroform	ug/l	Jun-95	86	58.3	1.48	Not acceptable
		Jun-95	25.7	17.8	1.44	Not acceptable
TCA	ug/l	Jun-95	58.9	48.1	1.22	Warning
		Jun-95	24.8	18.6	1.33	Not acceptable
TCE	ug/l	Jun-95	72.6	57.4	1.26	Warning
		Jun-95	18.4	13.3	1.38	Not acceptable
PCE	ug/l	Jun-95	55	54.2	1.01	
		Jun-95	20.5	16.6	1.23	Warning
Benzene	ug/l	Jun-95	13	11.4	1.14	
		Jun-95	52.9	49.1	1.08	
Ethylbenzene	ug/l	Jun-95	21.4	18.1	1.18	
		Jun-95	48.4	46.1	1.05	
Toluene	ug/l	Jun-95	23.6	19.8	1.19	Warning
		Jun-95	61.1	64.3	0.95	

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 7-7
BNL Site Environmental Report for Calendar Year 1995
BNL Water Supply Performance Evaluation Studies
USEPA Environmental Monitoring Systems Laboratory - Cincinnati

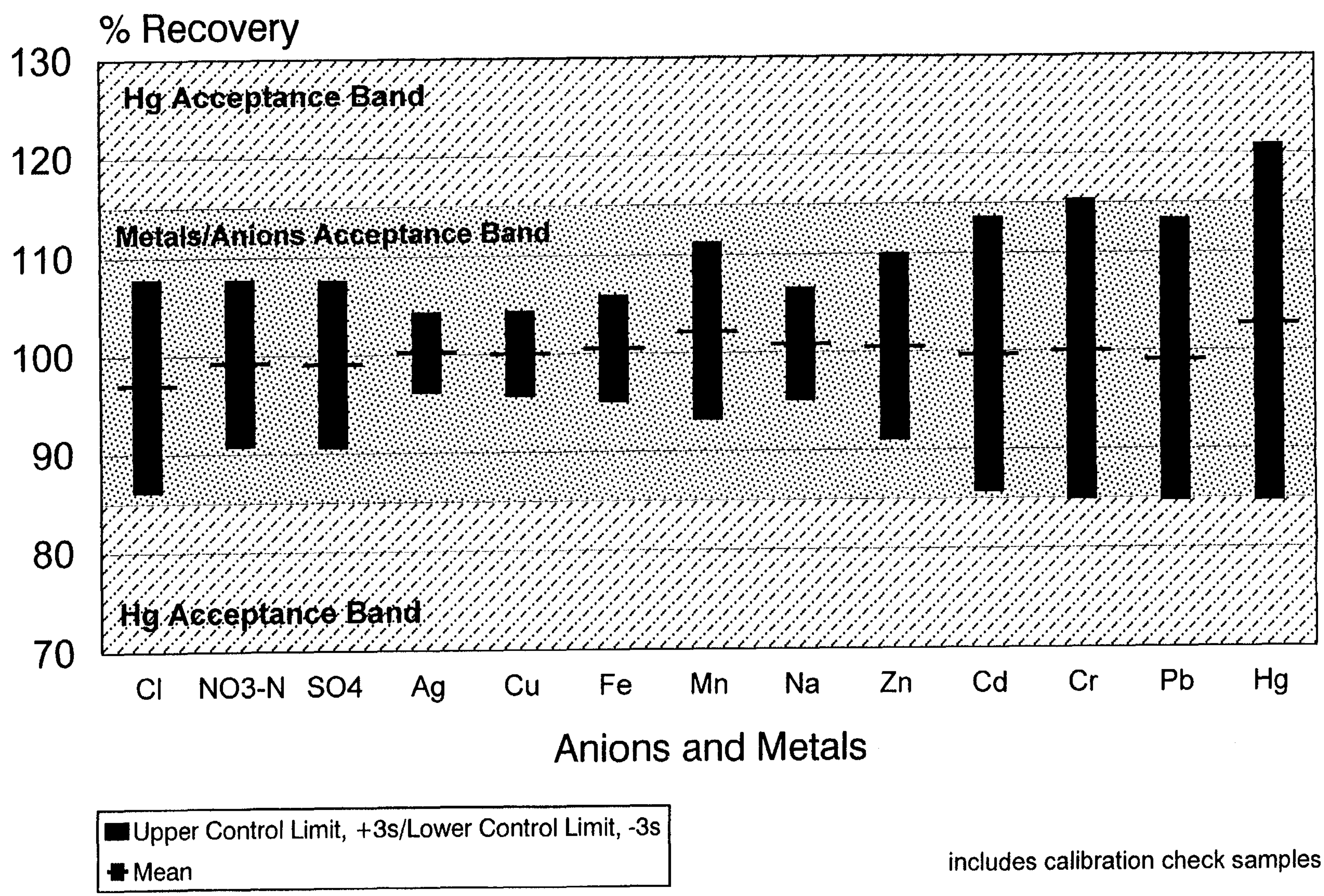
Analyte	Units	Date	BNL	EMSL-CI	Ratio	Comments
Cd	ug/l	Jan-95	<0.5	2.8		Not acceptable
		Aug-95	32.3	34	0.95	
Cr	ug/l	Jan-95	114	119	0.96	
		Aug-95	43.1	37.8	1.14	
Pb	ug/l	Jan-95	66.7	64.1	1.04	
		Aug-95	41.8	39	1.07	
Hg	ug/l	Jan-95	0.71	0.897	0.79	
		Aug-95	2.78	3	0.93	
Ag	ug/l	Jan-95	75	76.2	0.98	
		Aug-95	52	54.2	0.96	
Cu	ug/l	Jan-95	1370	1400	0.98	
		Aug-95	621	630	0.99	
Mn	ug/l	Jan-95	103	98	1.05	
		Aug-95	983	970	1.01	
Zn	ug/l	Jan-95	804	818	0.98	
		Aug-95	1390	1410	0.99	
NO3 - N	mg/l	Jan-95	5.1	5.2	0.98	
		Aug-95	2.86	2.9	0.99	
Na	mg/l	Jan-95	22.4	22.2	1.01	
SO4	mg/l	Jan-95	6.47	6.4	1.01	
		Aug-95	78.8	81	0.97	
Total Residual Cl	mg/l	Jan-95	2.6	3	0.87	
		Aug-95	0.55	0.562	0.98	
Chloroform	ug/l	Jan-95	12.5	12	1.04	
		Aug-95	23.5	21.7	1.08	
DCE	ug/l	Jan-95	15	13.9	1.08	
		Aug-95	9.6	8.49	1.13	
TCA	ug/l	Jan-95	8.23	8.78	0.94	
		Aug-95	14.8	14.5	1.02	
TCE	ug/l	Jan-95	6.21	6.13	1.01	
		Aug-95	17.4	17.4	1.00	
Benzene	ug/l	Jan-95	13.8	14	0.99	
		Aug-95	7.48	7.49	1.00	
PCE	ug/l	Jan-95	11.9	11.6	1.03	
		Aug-95	19	18.5	1.03	
Toluene	ug/l	Jan-95	9.4	9.92	0.95	
		Aug-95	12.9	13.2	0.98	
Ethylbenzene	ug/l	Jan-95	12.6	13.6	0.93	
		Aug-95	14.6	14.8	0.99	
Total Xylenes	ug/l	Jan-95	19.7	17.4	1.13	
		Aug-95	12.8	10.4	1.23	Not acceptable

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.

Figure 7-5

1995 Reference Check Sample Summary

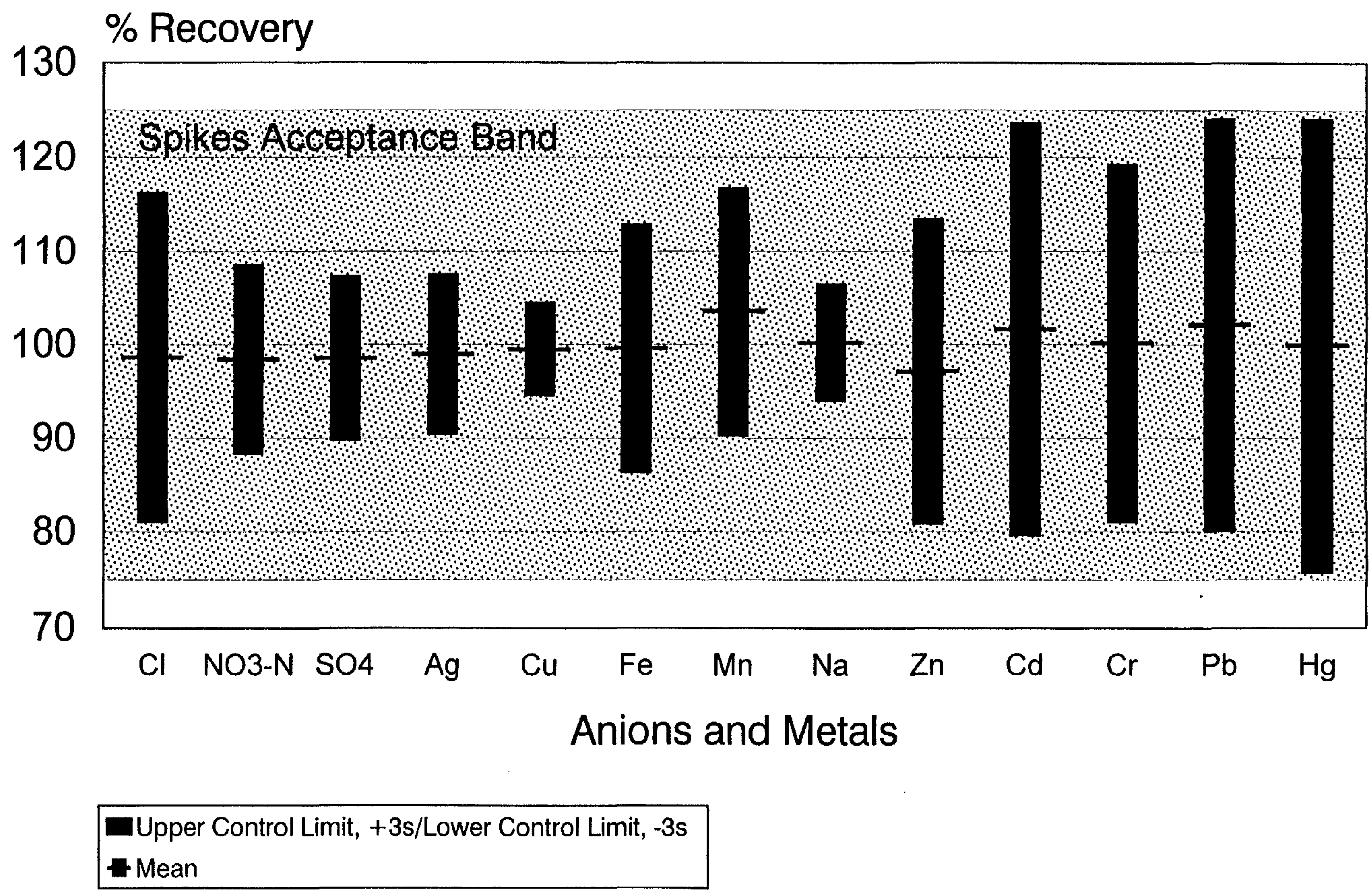
Inorganic Analysis



includes calibration check samples

Figure 7-6

1995 Spike Recovery Summary
Inorganic Analysis



anion sample batch. The anions were ±14% and the metals ±15% of the target value, except for mercury which was ±21%. The shaded area on the plot shows the acceptance band for the various analyses. Figure 7-6 gives the mean and 99% confidence interval of the spike recoveries for the analyzers used. All data from the spiked samples were within the ±25% acceptance limit. This confirms that all inorganic data generated for this report met the QC requirements for its method.

Figures 7-7 through 7-9 shows the results of the internal quality control program for the gas chromatography/mass spectroscopy method used for organic analyses. Figure 7-7 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 ±21% of the known concentration. Figure 7-7 presents the same summary for surrogate and spike recoveries for this organic analysis method. The method's performance was ±16% of the target value for the surrogates, which just exceeds the acceptance limit of ±15%, and ±16% for the spikes, well within the acceptance limits of ±25%. Lastly, the precision of the method was measured by analyzing duplicate samples; Figure 7-9 depicts the results as relative percent difference. All duplicate analyses showed excellent agreement and were within ±10%. This confirms that the organic data generated for this report met the QC requirements for its method.

During May 1995, NYSDOH audited the nonradiological analytical processes onsite. Of the four nonconformances, two required no corrective action after additional information was provided to ELAP, one pertained to data management, and one was associated with sample collection methods. A corrective action plan was developed by the ASL Supervisor and accepted by NYSDOH ELAP.

7.3 Contractor Laboratories

Samples collected for regulatory compliance purposes (such as SPDES discharges monitoring reports, WTP monthly reports, and the CSF semiannual report) are analyzed by offsite contractor laboratories certified in the respective analyses. Contractors also augment the capabilities of the onsite laboratory, for example, strontium-90 and Toxic Characteristic Leachate Procedure (TCLP), when the demand on the S&EP Division ASL exceeds its capability. The laboratory has a person dedicated to specifying contract and technical requirements, which include applicable certifications for each analytical method. This person also reviews the incoming data package to ensure that it complies with the specification before the data is reported. These commercial laboratories are periodically audited by the supervisor and QA Officer to verify competence in analytical methodology and implementation of a comprehensive QA program; however, none were audited in 1995.

The contract laboratory responsible for analyzing the SPDES samples is required to participate in the NPDES Performance Evaluation Study; the results are presented in Table 7-8. Nine of the twenty-one analyses showed excellent agreement, within 10%. The fathead minnow and *Cerlodaphnia* chronic data were acceptable, however six analyses were unacceptable. This same contractor participated in the EMSL-CI Water Pollution Performance Evaluation Study (WP033). The results given in Table 7-9 for the same SPDES parameters show acceptable agreement for twenty-four of thirty analyses. However, four samples were outside the warning limit, and two samples were outside their acceptance limits. Overall, this contractor laboratory performed acceptably in 84% of the intercomparisons.

Figure 7-7

1995 Reference Check Sample Summary
Organic Analysis

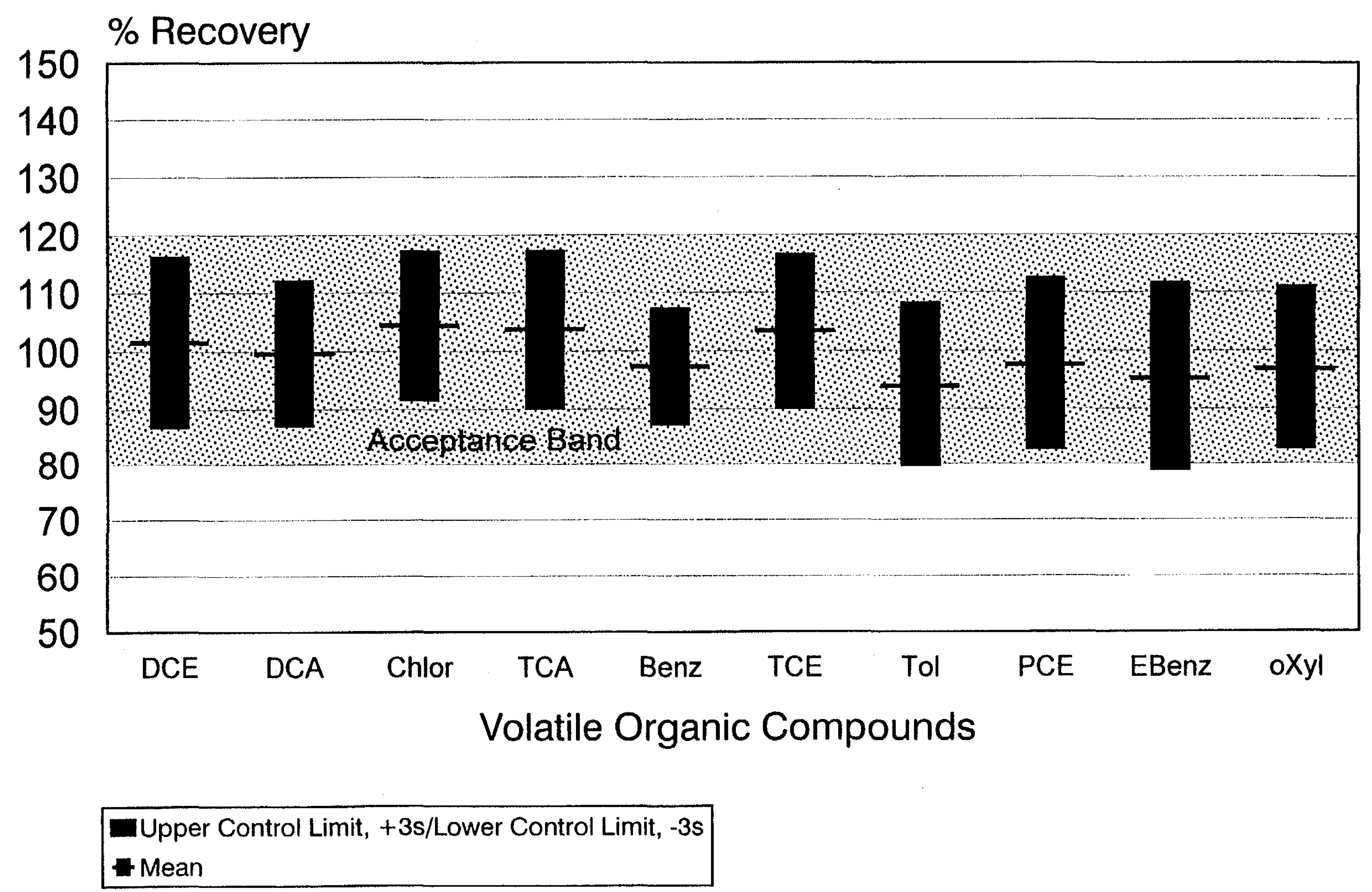


Figure 7-8

1995 Surrogate and Spike Recoveries Summaries
Organic Analysis

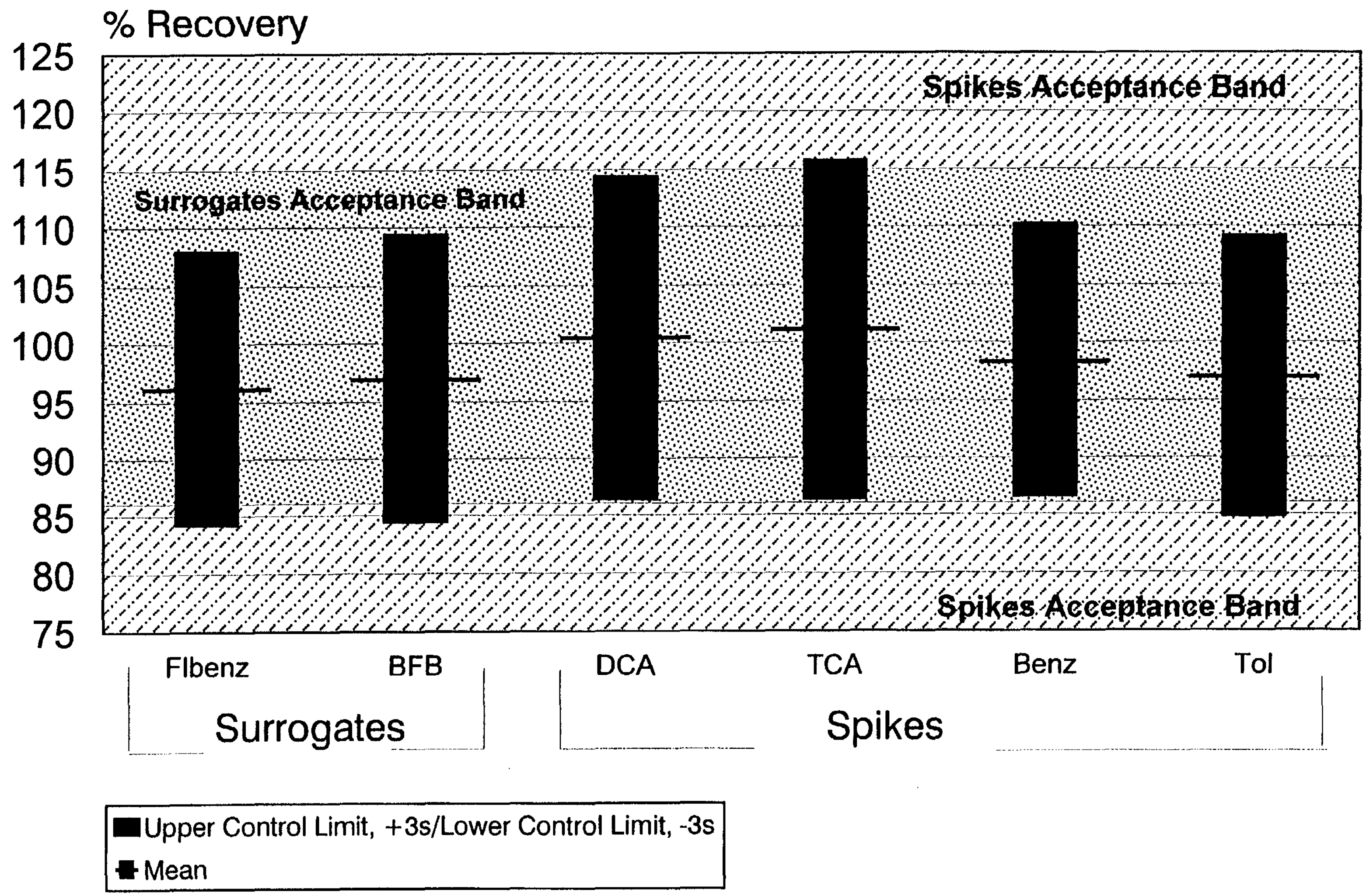


Figure 7-9

1995 Duplicates Summary
Organic Analysis

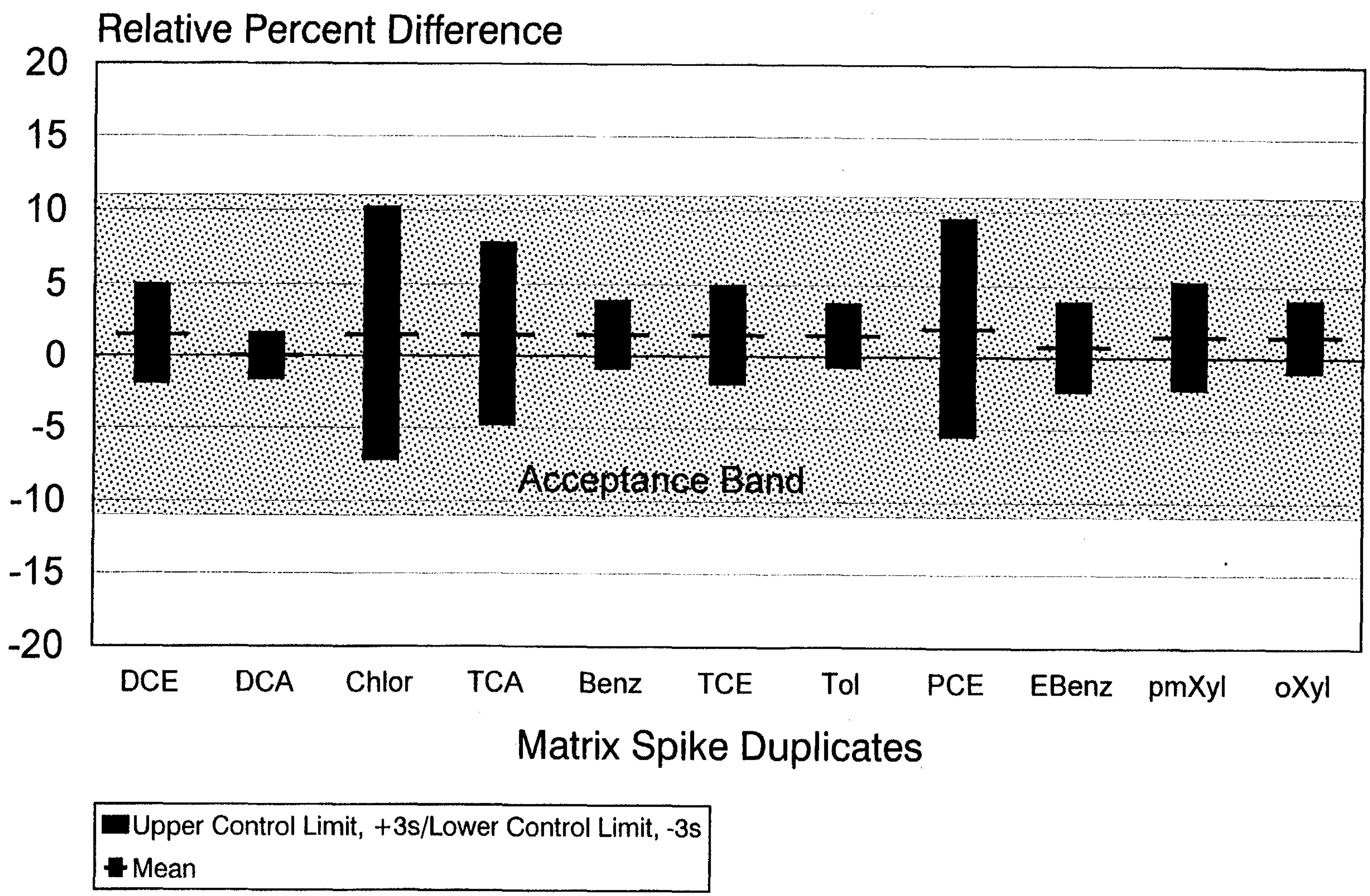


Table 7-8
BNL Site Environmental Report for Calendar Year 1995
BNL Contractor Laboratory Performance Evaluation Study
BNL National Pollution Discharge Elimination System (NPDES)

Analyte	Units	Date	Reported	NPDES	Ratio	Comments
Cu	ug/l	Apr-95	1090	890	1.22	Not Acceptable
Fe	ug/l	Apr-95	1200	941	1.28	Not Acceptable
Pb	ug/l	Apr-95	499	500	1.00	
Ni	ug/l	Apr-95	834	780	1.07	
Zn	ug/l	Apr-95	1020	967	1.05	
pH			9.06	9	1.01	
TSS	mg/l	Apr-95	14.8	23	0.64	Not Acceptable
Oil and Grease	mg/l	Apr-95	16.2	16.4	0.99	
Ammonia - N	mg/l	Apr-95	3.57	3.9	0.92	
NO3 - N	mg/l	Apr-95	24	23.1	1.04	
Kjeldahl - N	mg/l	Apr-95	26.1	16	1.63	Not Acceptable
5 Day BOD	mg/l	Apr-95	12	9.99	1.20	
Total Cyanide	mg/l	Apr-95	0.685	0.74	0.93	
Total Phenolics	mg/l	Apr-95	0.073	0.381	0.19	Not Acceptable
Total Residual Cl	mg/l	Apr-95	1.09	0.16	6.81	Not Acceptable
Fathead Minnow Chronic Data -						
Survival, NOEC	%	Apr-95	12.5	25	0.50	
Growth, IC25	%	Apr-95	31.6	39.9	0.79	
Growth, NOEC	%	Apr-95	12.5	25	0.50	
Cerlodaphnia Chronic Data						
Survival, NOEC	%	Apr-95	25	25	1.00	
Growth, IC25	%	Apr-95	16.1	27.2	0.59	
Growth, NOEC	%	Apr-95	12.5	25	0.50	

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.

Table 7-9
BNL Site Environmental Report for Calendar Year 1995
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	Jun-95	48.4	50.4	0.96	
	ug/l	Jun-95	973	890	1.09	Warning
Fe	ug/l	Jun-95	613	626	0.98	
	ug/l	Jun-95	958	941	1.02	
Pb	ug/l	Jun-95	187	190	0.98	
	ug/l	Jun-95	510	500	1.02	
Ni	ug/l	Jun-95	82.4	80.9	1.02	
	ug/l	Jun-95	896	780	1.15	Not Acceptable
Zn	ug/l	Jun-95	522	484	1.08	
	ug/l	Jun-95	1080	967	1.12	Warning
pH		Jun-95	7.6	7.6	1.00	
		Jun-95	8.93	9	0.99	
TSS	mg/l	Jun-95	33	38	0.87	
	mg/l	Jun-95	22	23	0.96	
Oil and Grease	mg/l	Jun-95	11.6	11	1.05	
	mg/l	Jun-95	16.2	16.4	0.99	
Ammonia - N	mg/l	Jun-95	7.92	8.8	0.90	
	mg/l	Jun-95	3.3	3.9	0.85	
NO3 - N	mg/l	Jun-95	5.42	6.02	0.90	
	mg/l	Jun-95	20.8	23.1	0.90	
Kjeldahl - N	mg/l	Jun-95	2.44	3.71	0.66	Not acceptable
	mg/l	Jun-95	17.1	16	1.07	
5 Day BOD	mg/l	Jun-95	31	30.2	1.03	
	mg/l	Jun-95	10	9.99	1.00	
Total Cyanide	mg/l	Jun-95	0.12	0.12	1.00	
	mg/l	Jun-95	0.73	0.74	0.99	
Total Phenolics	mg/l	Jun-95	0.03	0.0413	0.73	
	mg/l	Jun-95	0.31	0.381	0.81	
Total Residual Cl	mg/l	Jun-95	0.85	1.1	0.77	Warning
	mg/l	Jun-95	0.25	0.16	1.56	Warning

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.

As a result of these performance evaluations, an in-depth investigation was conducted. A corrective action plan included actions by both BNL and the contractor to ensure the quality of data procured, such as an internal review of all analytical systems by the contractor, close monitoring by BNL to ensure that the contractor took corrective action, verification of results using split sample analysis, and evaluation of alternate analytical services.

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 that meets the specific needs of the project.

APPENDIX A

A.1 Glossary of Terms

AGS	- Alternating Gradient Synchrotron
AOC	- Area of Concern
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
EMSL-LV	- Environmental Measurements Systems Laboratory - Las Vegas
EP	- Environmental Protection
EPA	- Environmental Protection Agency
EPIP	- Environmental Protection Implementation Plan (EPIP)
EPS	- Environmental Protection Section
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

A.1 Glossary of Terms (Continued)

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	- Operational 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 Recovery Act
RI/FS	- Remedial Investigation/Feasibility Study
RHIC	- Relativistic Heavy Ion Collider
RSD	- Response Strategy Document
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
SEPD	- Safety and Environmental Protection Division
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
TTA	- Tiger Team Assessment

A.1 Glossary of Terms (Continued)

VOC	- Volatile Organic Compound
WCF	- Waste Concentration Facility
WSRRSA	- Wild, Scenic, and Recreational River Systems Act
WTP	- Water Treatment Plant

A.2 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)

S. S. Chalasani, R. Gaschott, and G. L. Schroeder

1. Methodology for Dose-Equivalent Calculations - Atmospheric Release Pathway

Dispersion of airborne radioactive material was calculated for each of the 16 compass sectors using the CAP88 dose model. CY 1995 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. Method for Tritium Dose-Equivalent Calculations - Potable Water Ingestion 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:

$$H = AI \cdot DCF \cdot P$$

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 population at risk was assumed to be approximately 500.

3. Methodology for Dose-Equivalent Calculations - 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/kg wet weight, as this is the form in which the fish is used.

b. The average fish consumption for an individual who does recreational fishing in the Peconic River was based on a study done by the NYSDEC which suggests that the consumption rate is 7 kg/yr (NYSDEC, 1985).

c. Committed Dose Equivalent Tables (DOE, 1988) were used to get the 50-year Committed Dose Equivalent Factor - rem/μCi intake.

The following factors for the ingestion pathway for the radionuclides were identified:

^{3}H: 6.3E-05 rem/μCi intake

^{90}Sr: 1.3E-01 rem/μCi intake

^{137}Cs: 5.0E-02 rem/μCi intake

d. Calculation:

Intake (7 kg/yr) x Activity in flesh μCi/kg
x Factor rem/μCi intake = rem

e. Because there is a cesium-137 background, as determined by the control location data, this background was subtracted from all data before use for dosimetry.

4. 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, "A 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 below.

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

Nuclide	300g (soil) MDL (μCi/g)	300ml (water) MDL (μCi/ml)	12000ml (water) MDL (μCi/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
^{113}Sn	1E-8	2E-8	3E-10
^{124}I	1E-8	2E-8	3E-10
^{126}I	2E-8	3E-8	5E-10
^{131}I	9E-9	1E-8	2E-10
^{133}I	1E-8	2E-8	3E-10
^{123}Xe	7E-7	9E-7	1E-8
^{127}Xe	1E-8	1E-8	1E-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.

Constituent (All concentration values in mg/L except where noted)		
	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 umhos/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

APPENDIX C
(INSTRUMENTATION AND ANALYTICAL METHODS)

S.S Chalasani and R. R. Gaschott

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.

1. Radiological: Gross alpha, gross beta, gamma, tritium, and strontium-90.

2. Nonradiological: 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:

1(a). <u>Gross Alpha and Gross Beta Analysis - Water Matrix</u>

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.

1(b). <u>Gross Alpha and Gross Beta Analysis - Air Particulate Matrix</u>

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.

1(c). 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.

1(d). 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.

1(e). 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.

1(f). 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.

2(a). 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.

2(b). 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.

2(c). 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.

2(d). 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

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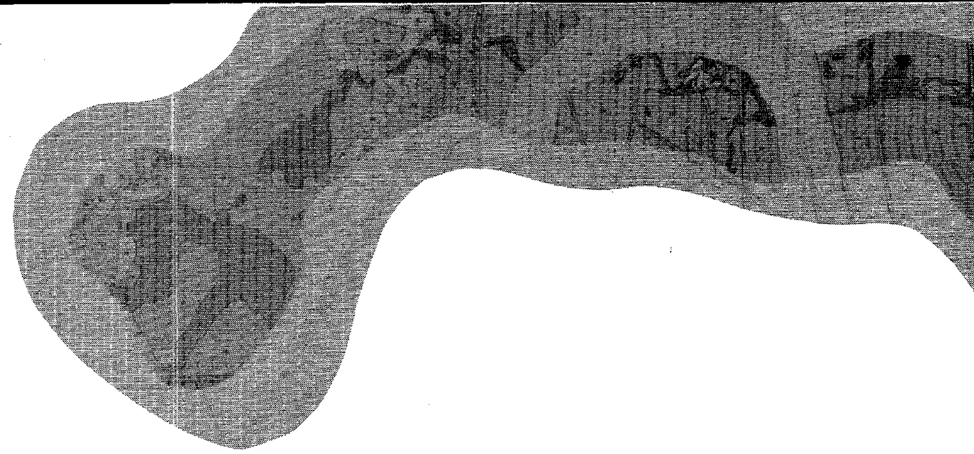
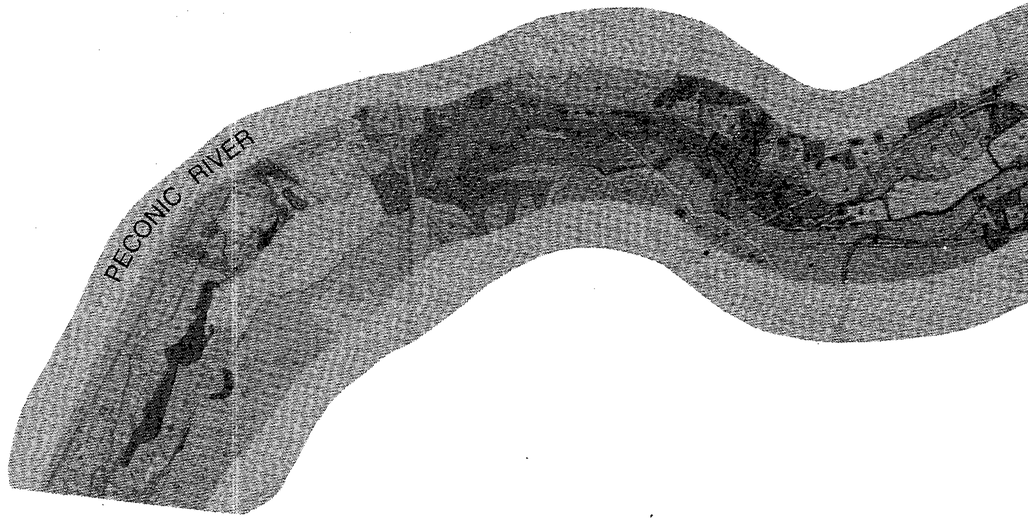
which was quire extensive along the River. However, the extent of pollution created by duck farm effluents that were discharged into the River almost killed the River and these farms were banned unless they met the requirements of the strict discharge permits. Today, due to consistent efforts from citizens and the regulatory agencies, the River is back to its almost pristine quality, and is one of the few areas on the Island where canoeing can still be done on a river in essentially its original state. It is also a haven for sports fishermen who find the River challenging as they cast in a river that is abundant with fish and try their skills at catching largemouth bass and pickerel.

The Peconic River system derives flow from areas as far west as BNL, and perched marshlands located just west of William Floyd Parkway, although this flow across the western portion of the Laboratory is intermittent, usually occurring only after heavy rainfalls or during times of high water table elevations. From its nebulous beginnings, the River is approximately 12 miles long to its mouth where it merges with the Great Peconic Bay (Flanders Bay). Stream flow at the downstream (eastern) boundary of BNL is often minimal, but overall has been estimated to average (0.6 mgd). From here, the River flows eastward along a gentle valley north of what geologists call the Ronkonkoma moraine, a slight ridge formed by an accumulation of materials deposited by the glacier. The River is somewhat unusual in that its water is supplied mainly from the underlying groundwater rather than from drainage run-offs and tributary streams. A significant portion (on the order of 25%) of the precipitation recharged within the Peconic River watershed area leaves the groundwater system via stream flow, primarily the Peconic River. It is considered as the longest groundwater fed River in New York State. Further east, at Wading River-Manorville Road, flow averages 2 mgd, but has been measured to vary from 1 to 28 mgd, reflecting water table fluctuations and the intensity of rainfall events. Flow on the lower Peconic River, as measured at the USGS gauging station located 0.4 miles west of Riverhead, has ranged from 10.4 mgd (1966) to 43.9(1984), with a long-term (1942-1992) average of 24.0 mgd; an estimated 4mgd or 6% of the long-term average flow, is run-off. At the mouth of the River, just east of the County Route 105, the average total freshwater flow rate is estimated to be 34 mgd, which includes 14 mgd of groundwater estimated by the USGS to be discharged to the River downstream of the USGS gauging station.The majority of the wetlands within the Pine barrens are found near the River (approximately 2,000 acres). These wetlands are found along the River's headwaters and its many tributaries.

The Peconic River in its entirety is placed under the jurisdiction of the Wild Scenic and Recreational Rivers Act (Federal and State). This law is enacted through the State's Article 15 of the Environmental Conservation Law. Different sections of the River are designated scenic and recreational. Discharges to the River are governed by the provisions of the Clean Water Act through the NPDES (SPDES) program. Since 1988, Congress has added the Peconic River Estuary to the National Estuary Program. This Program is aimed at assuring that significant estuaries are protected and preserved from pollution, development and overuse.

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