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BROOKHAVEN NATIONAL LABORATORY SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1989

R.P. Miltenberger, B.A. Royce, S.S. Chalasani,
D. Morganelli, and J.R. Naidu

December 1990

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
UPTON, LONG ISLAND, NEW YORK 11973
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Contributors:

H. Bernstein
H. Bowen
M. Collins
J.T. Gilmartin
P.R. Hayde
R. Lagattolla
R. Litzke
W. Litzke
A. Meier
M. Rignola
C. Schopfer
T. Sperry
T. Steimers
M. Surico
J. Tichler

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BROOKHAVEN NATIONAL LABORATORY
SITE REPORT FOR CALENDAR YEAR 1989

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1.0 INTRODUCTION

1.1 Site Mission

Brookhaven National Laboratory (BNL) is managed by Associated Universities Inc. (AUI), under Department of Energy (DOE) Contract No. DE-AC02-76CH00016. AUI was formed in 1946 by a group of nine universities whose purpose was to create and manage a laboratory in the Northeast in order 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 camp.

Brookhaven carries out basic and applied research in the following fields: high-energy nuclear and solid state physics; fundamental material and structure 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

BNL is a multidisciplinary scientific research center located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to the metropolitan area and local communities are shown in Figures 1 and 2 respectively. About 1.37 million persons reside in Suffolk County [1] and about 0.41 million persons reside in Brookhaven Township, within which the Laboratory is situated. Approximately eight thousand persons reside within a half kilometer of the Laboratory boundary. The distribution of the resident population within 80 km of the BNL site is shown in Figure 1 and Appendix D, Table 1. The population distribution within 0.5 km of the BNL site is shown in Figure 2. Although much of the land area within a 16 km radius remains either forested or cultivated, there has been continuing residential and commercial development near the Laboratory during recent years.

The Laboratory site is shown in Figure 3. It consists of 21.3 square kilometers (2,130 hectares [ha]), most of which is wooded, except for a developed area of about 6.7 square kilometers (670 ha). The site terrain 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 portion of the Peconic River head waters. This area had been essentially dry from 1984 until the spring of 1989. The absence of flow is most likely related to the regional drought and lowering of the water table. Liquid effluents from the BNL Sewage Treatment Plant (STP) constituted the principle source of water in the tributary's river bed during the first three months of 1989. The BNL liquid effluents from the STP recharged to ground water prior to leaving the site boundary as is demonstrated by the lack of flow at the BNL site perimeter station, HQ from January to March. During the remaining part of the year, heavy rains produced flow upstream of the BNL Chlorine House (station EA) which provided sufficient additional flow to produce flow off-site from April to December.

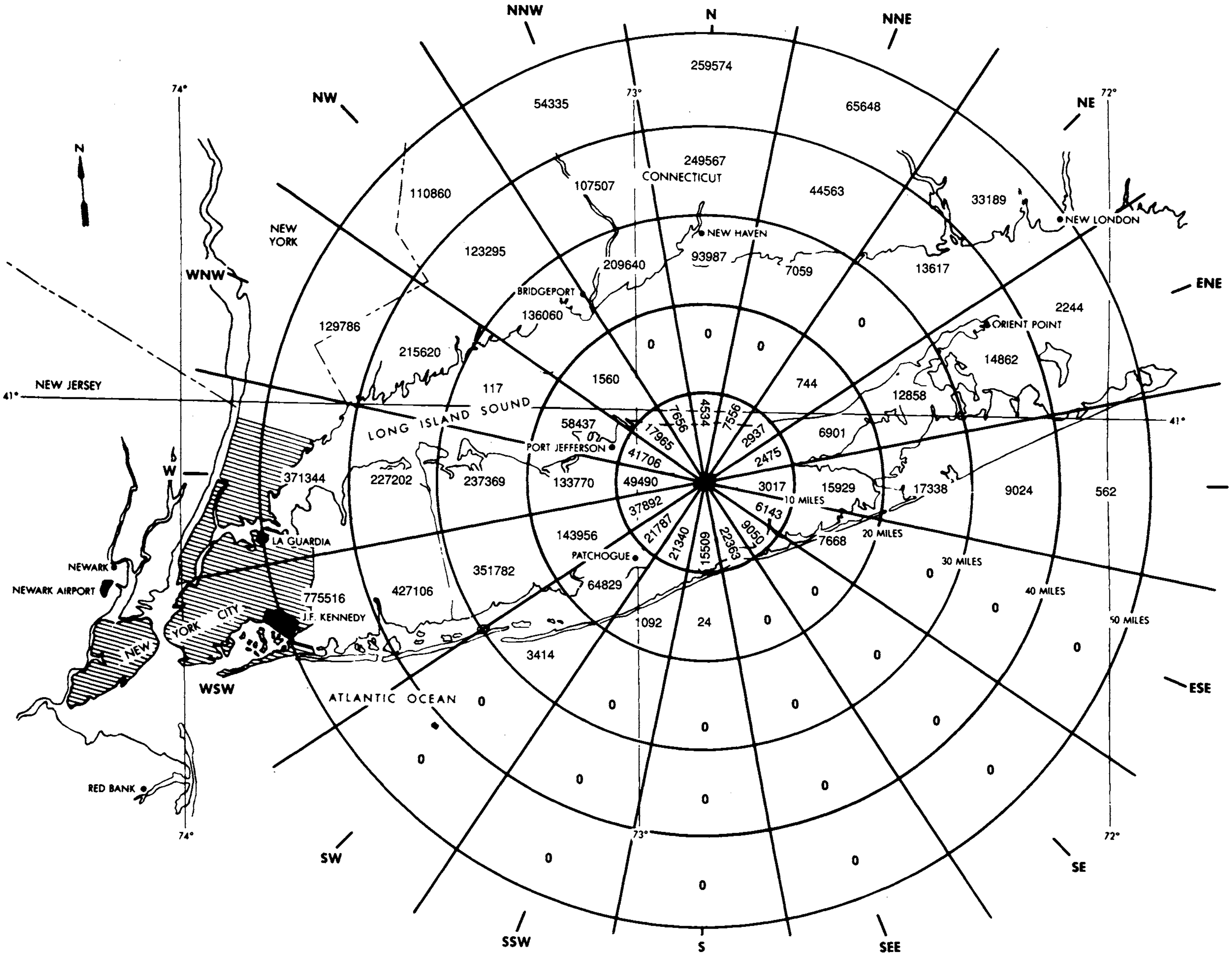


Figure 1: Resident Population Within 80 km Radius of BNL (1989)

BROOKHAVEN NATIONAL LABORATORY
LOCAL AND ON-SITE POPULATION DISTRIBUTION

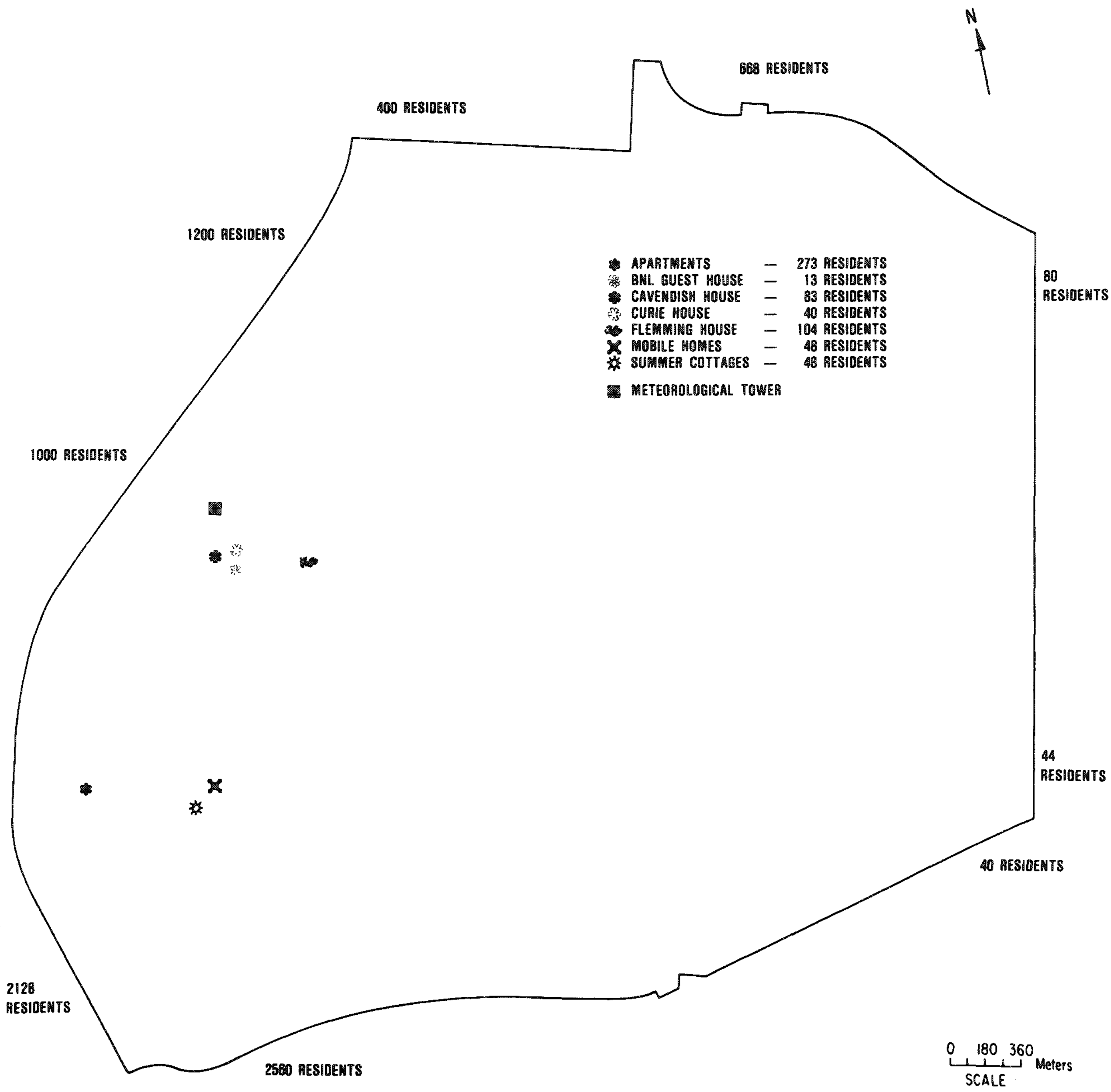


Figure 2: Brookhaven National Laboratory Local and On-site Population Distribution

Figure 3: Brookhaven National Laboratory Major Facilities

The Laboratory uses approximately 20 million liters of ground water per day to meet potable water plus heating and cooling requirements. Approximately 61% of the total pumpage was returned to the aquifer through on-site recharge basins. About 9% is discharged into the Peconic River Bed. Human consumption utilizes 2% of the total pumpage while evaporation and cesspool plus line losses account for 21% and 7% respectively.

In terms of meteorology, the Laboratory can be characterized, like most eastern seaboard areas, as a well-ventilated site. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall [2,3]. The 1989 annual wind rose for BNL is presented in Figure 4. The ten year average wind rose (1979 to 1988) for the BNL site is presented in Figure 5. The average temperature in 1989 was 9.9°C and the range was -9.4°C to 27.2°C. Monthly minimum, maximum, and average temperature data are presented in Appendix D, Table 2 and shown graphically in Figure 6.

Studies of Long Island hydrology and geology [4-7] in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are between 31 - 61 m thick, are generally sandy and highly permeable. Water penetrates these deposits readily and there is little direct run-off into surface streams, except during periods of intense precipitation. The total precipitation for 1989 was 174 cm, which is about 50 cm above the 40 year annual average. The historic and 1989 monthly precipitation data are presented in Figure 7 and 8 respectively. 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 ground water. The ground water in the vicinity of the Laboratory moves predominantly in a southerly direction to the Great South Bay [4-8], while taking a more easterly direction in the Peconic River watershed portions of the site. Ground water velocity is estimated to range from 30 to 45 cm/d [7].

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, and of other materials,

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.

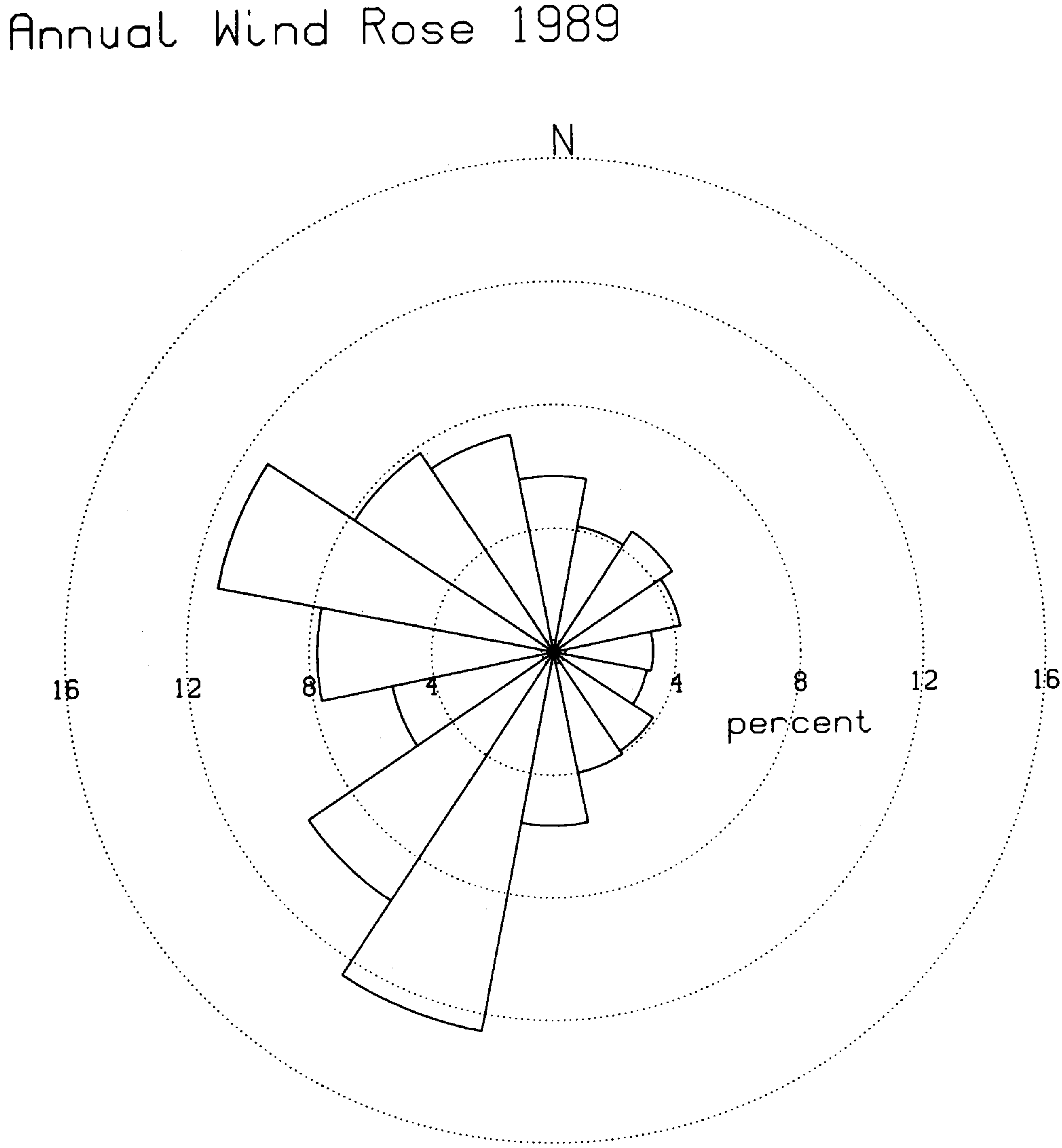


Figure 4: Brookhaven National Laboratory Annual Wind Rose for 1989

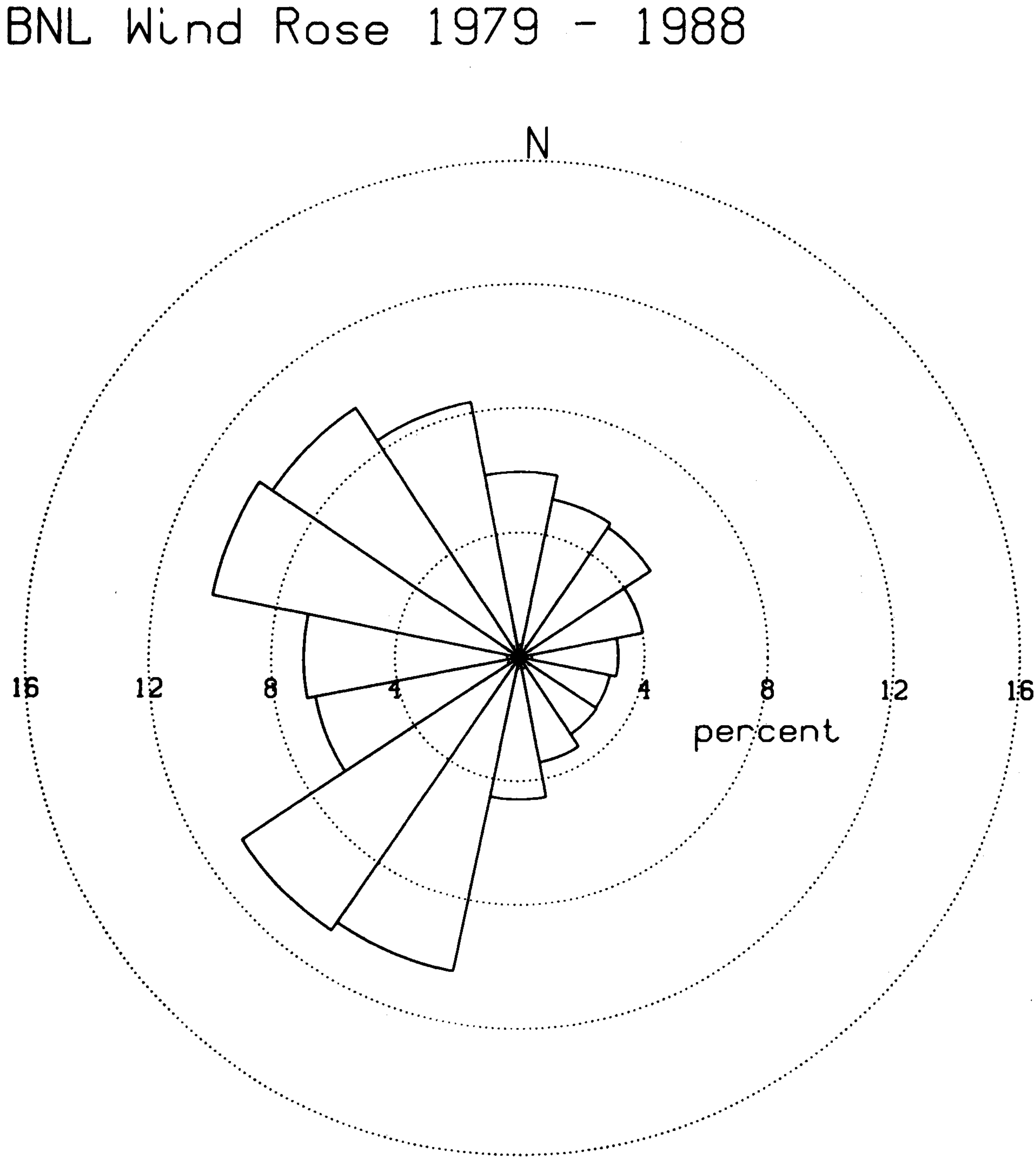


Figure 5: Brookhaven National Laboratory Historic Wind Rose 1979 to 1988

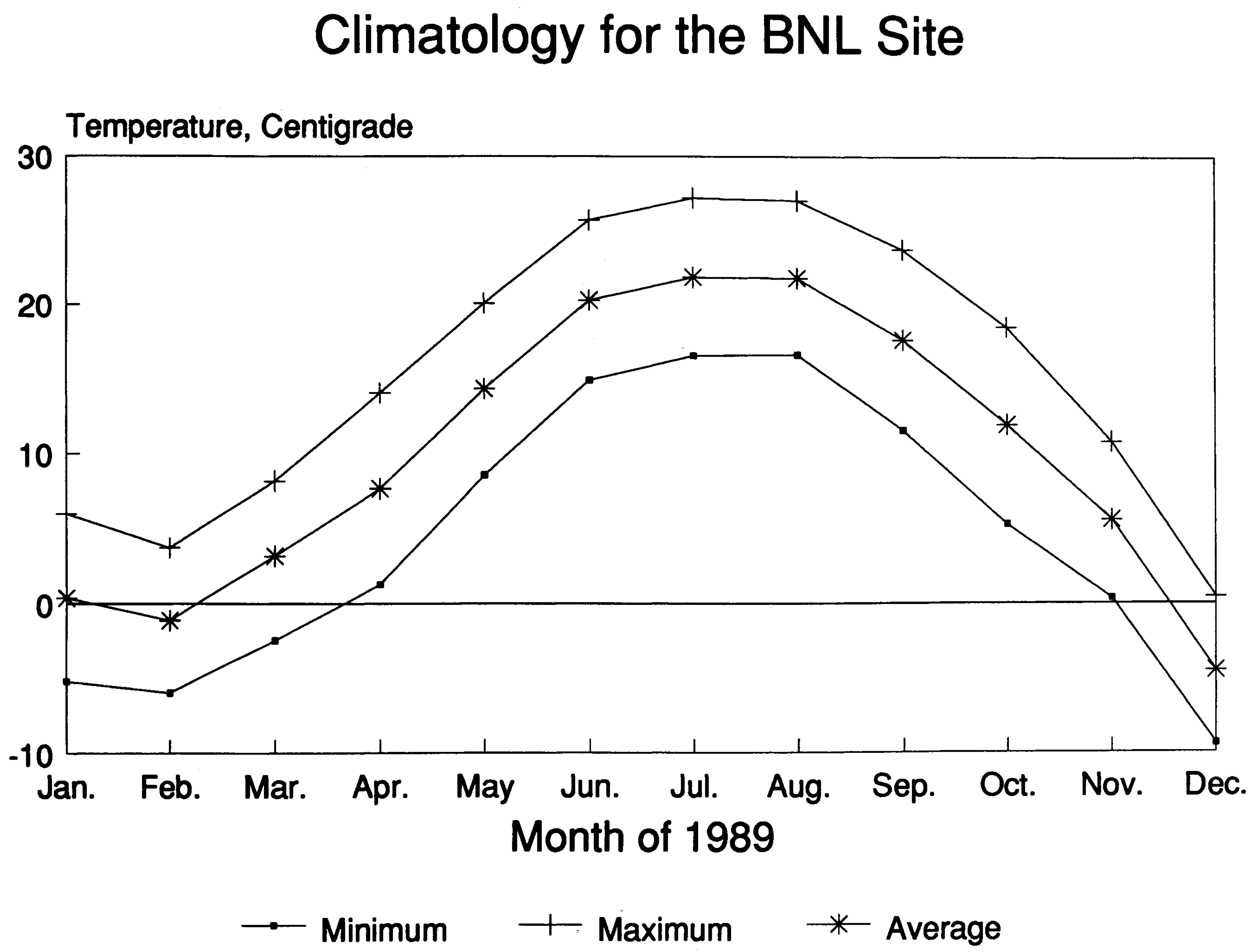


Figure 6: Brookhaven National Laboratory Annual Temperature Data - 1989

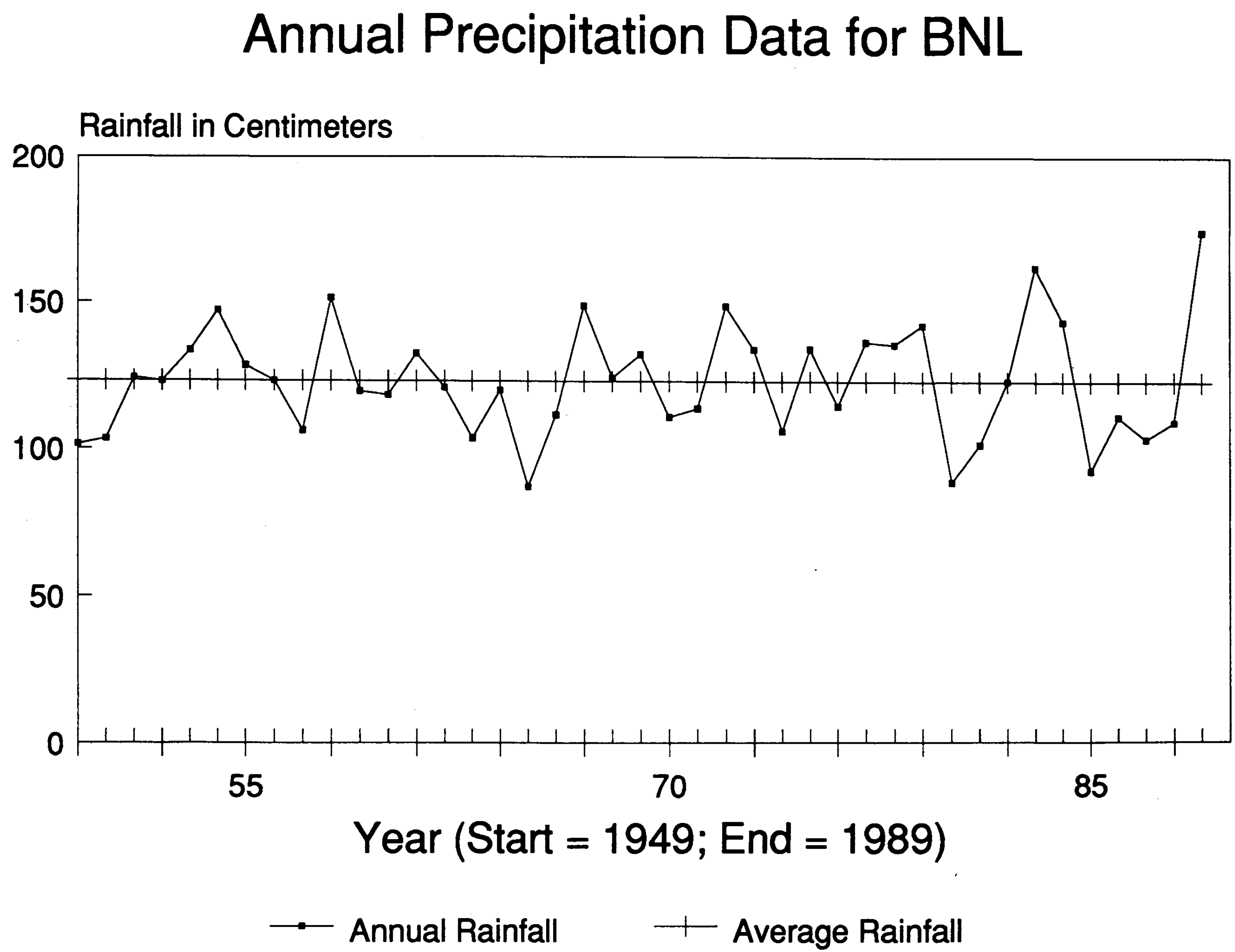


Figure 7: Brookhaven National Laboratory Annual Precipitation 1949 to 1989

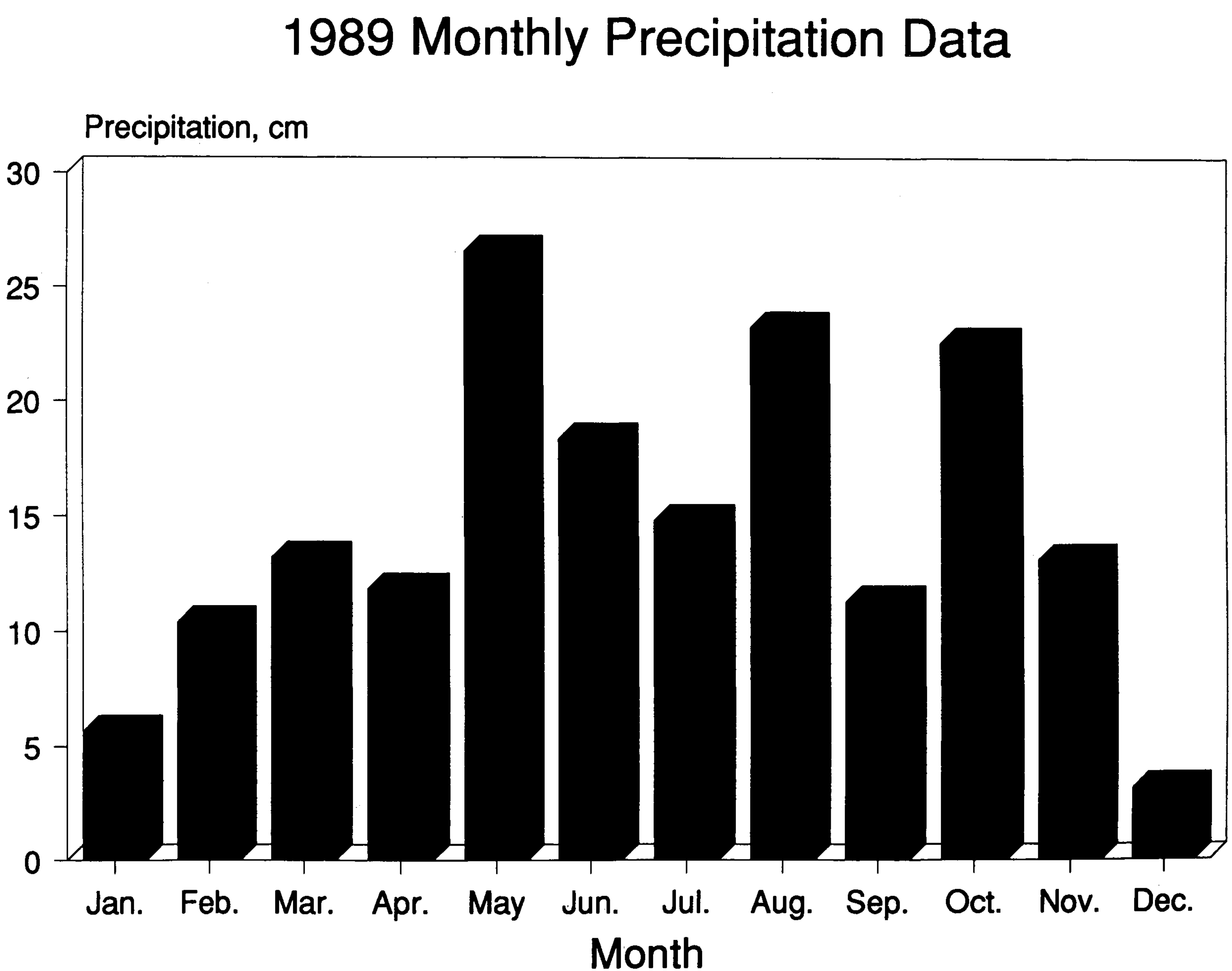


Figure 8: Brookhaven National Laboratory Monthly Precipitation for 1989

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

1. The High Flux Beam Reactor (HFBR) is fueled with enriched uranium, moderated and cooled by heavy water, and operated at a routine power level of 60 MW thermal.

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

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

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

5. The Tandem Van de Graaff, Vertical Accelerator, Cyclotron, and research Van de Graaff are used in medium energy physics investigations, as well as for special nuclide production. The heavy ions from the Tandem Van de Graaffs are injected into the AGS for use in 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 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 Graaffs and the AGS. The interconnection of these two facilities permits the injection of intermediate mass ions into the AGS where the ions can be accelerated to an energy of 15 GeV/amu. These ions are then extracted and sent to the AGS experimental area for physics research.

8. The Radiation Effects Facility (REF) is being used for proton radiation damage studies on aerospace and satellite components. The REF utilizes the 200 MeV negative hydrogen ion beam produced at the LINAC injector to the AGS.

9. The Neutral Beam Test Facility (NBTF) receives the 200 MeV negative hydrogen beam generated by the LINAC and neutralizes the beam to provide a neutral proton source for use in physics experiments. The facility will be used to study the effect of this type of radiation on aerospace, satellite and biological targets.

10. The AGS Booster, currently under construction, is a circular accelerator with a circumference of 200 meters that will receive either a proton beam from the LINAC or heavy ions from the Tandem Van de Graaff. The Booster will accelerate proton particles and heavy ions prior to injection into the AGS ring.

Additional programs involving irradiations and/or 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 Sciences (DAS). Special purpose radionuclides are developed and processed for general use under the joint auspices of the DAS and the Medical Department.

2.0 SUMMARY

The environmental monitoring program is conducted by the Environmental Protection Section of the Safety and Environmental Protection (S&EP) Division to determine whether operation of BNL facilities have met the applicable environmental standards and effluent control requirements. This program includes monitoring for both radiological and nonradiological parameters. This report summarizes the data for the external radiation levels; radioactivity in air, rain, potable water, surface water, ground water, soil, vegetation, and aquatic biota; water quality, metals, organics and petroleum products in ground water, surface water and potable water. Analytical results are reviewed by the S&EP staff and when required by permit conditions are transmitted to the appropriate regulatory agencies.

The data were evaluated using the appropriate environmental regulatory criteria. Detailed data for the calendar year 1989 are presented in Appendix D.

2.1 Airborne Effluents

Most of the airborne radioactive effluents at BNL originate from the HFBR, BLIP, MRR and the research Van de Graaff. Argon-41, oxygen-15, and tritium were the predominant radionuclides. In 1989, 1,936 Ci (71.6 TBq) of argon-41 were released from the MRR stack; 918 Ci (34.0 TBq) of oxygen-15 were released from BLIP; 30 Ci (1.1 TBq) of tritium gas and 70 Ci (2.59 TBq) of tritium in the form of water vapor were released from the 3 MeV Van de Graaff, Chemistry, and HFBR stacks. Much smaller quantities of airborne radioactive effluents were released from the Hot Laboratory, the Hazardous Waste Management Facility (HWMF), and the Chemistry Building.

2.2 Liquid Effluents

Liquid discharge limits for radiological and nonradiological parameters are subject to conditions listed in the BNL State Pollutant Discharge Elimination System (SPDES) Permit No. NY-000-5835 as issued by New York State Department of Environmental Conservation (NYSDEC). Radiological release concentrations for gross beta, radium and strontium-90 are also prescribed by the SPDES permit limitations. Other radionuclide discharge concentrations are governed by the U.S. DOE specified Radiation Concentration Guides (RCGs) [9]. Since such liquid discharges have the potential of contaminating the "Sole Source Aquifer" underlying the Laboratory, liquid effluent data are compared not only to the regulatory limits, but also to parameters listed in the Safe Drinking Water Act (SDWA).

Operations at the STP were generally within the limits specified by the SPDES permit. Radioactive concentrations in waste water entering the BNL STP returned to pre-1988 levels. Gross beta, cesium-137, and strontium-90 concentrations in chlorine house effluent remained higher than concentrations found in the influent. This condition is the result of continued low-level leaching of material adsorbed on the sand filter beds as a result of the 1988 unplanned release of cesium-137 and strontium-90 to the sanitary system. In 1989, discharges to the Peconic River met all radioactive components of the SPDES program. The principle radionuclides released to the Peconic River from liquid effluents discharged from the STP were: 2.5 Ci (0.093 TBq) of tritium, 0.015 Ci (0.55 GBq) of cesium-137 and 0.00098 Ci (0.036 GBq) of strontium-90. The annual average tritium concentration at the discharge point to the Peconic River was 0.08% of the RCGs [9] and only 12% of the BNL administrative limit. This represents a factor of 1.9 reduction in the tritium releases to the Peconic River from 1988 values. This reduction in source term was the result of a reduced HFBR operations schedule and increased efforts by the Reactor Division to minimize tritium discharges to the sanitary system. The annual average cesium-137 concentration was 0.078% of the RCG while strontium-90 concentrations were 9.6% of the SPDES limit.

Nonradiological parameters are monitored in accordance with the conditions of the SPDES permit. These parameters include residual chlorine, metals, pH, temperature, BOD_5, flow, suspended and total solids, fecal and total coliform and ammonia-nitrogen. Although there was a 99% compliance rate, several of these parameters periodically deviated from permit conditions. Specifically, there were 15 occurrences of low pH, four occurrences where residual chlorine slightly exceeded the discharge limit, one instance each where iron, ammonia-nitrogen and suspended solids were observed above their respective SPDES limits.

Periodically, NYSDEC performs compliance verification sampling. On January 27, 1989, representatives from NYSDEC collected a sample of the STP effluent (outfall no. 001). The results indicated the presence of mercury, nickel, total nitrogen and methylene chloride, parameters not found in the BNL SPDES permit. Based on these results, NYSDEC requested BNL to conduct a short term high intensity sampling program to verify the presence of these parameters in the STP effluent. BNL supplied NYSDEC with three years of monthly data for total nitrogen and conducted the sampling program for the other parameters. Samples collected during this program were analyzed by an off-site NYS certified laboratory. The results indicated that these parameters of concern were below the instrument detection limits in all samples collected during this program.

Liquid effluent discharged to the on-site recharge basins contained only trace quantities of radioactivity. These concentrations were all small fractions of the applicable guides or standards. If ingested directly and used as the sole source of drinking water, the concentrations detected would result in a dose of less than 0.04 mrem (0.0004 mSv) per year. Since recharge basins function as conduits to the underlying aquifer system, the nonradiological water quality parameters used in assessing the discharges were the New York State Drinking Water Standards (NYS DWS). Although discharges to recharge basins typically met NYS DWS, several exceptions were observed. At recharge basin HN (outfall 002) pH was recorded slightly above the maximum discharge limit of 8.5, while at recharge basin HO (outfall 003) pH was periodically observed to be below the minimum discharge limit of 6.5. Elevated iron concentrations were observed above NYS DWS at all recharge basins. However, only at basins HO and HS (outfall 005) did the annual average iron concentration exceed NYS discharge limits to ground water. In December 1989, a discharge of demineralizer backwash to recharge basin HT (outfall 006) resulted in the precipitation of copper onto the basin bed. This incident is being investigated under Unusual Occurrence Report (UOR) No. 89-29.

2.3 External Radiation Monitoring

Thermoluminescent dosimeters (TLDs) were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1989 was 63.2 ± 7.9 mrem (0.63 ± 0.079 mSv), while the off-site integrated dose was 58.4 ± 7.4 mrem (0.584 ± 0.074 mSv). These doses are essentially equal to those measured in 1988. The difference between the on-site and off-site integrated exposure is within the uncertainty of the measurement and is attributable to the higher terrestrial component of the natural background on-site [10], not BNL activities. These values are much lower than ambient exposure rates reported for the New York City area by the Environmental Protection Agency (EPA) for January to December, 1989 which predict an annual dose of about 81 mrem (0.81 mSv) [11,12,13,14].

2.4 Atmospheric Radioactivity

Tritium was the radioactive effluent detected most frequently in environmental air samples. The maximum annual average tritium concentration at the site boundary was 8.2 pCi/m^3 (0.30 Bq/m^3). This concentration would result in a committed effective dose equivalent of 0.0064 mrem (0.000064 mSv) to the maximally exposed individual residing at the site boundary for the entire year. Emissions of bromine-77, selenium-75, iodine-126 and mercury-203 from Building 801 were detectable during the month of May at the site boundary. The committed effective dose equivalent to the maximum individual resulting from the inhalation of the measured air concentration was 0.016 mrem (0.00016 mSv).

2.5 Radioactivity in Precipitation

In rainfall, the following radionuclides were detected: beryllium-7, cesium-137, radium-226, cerium-141, and strontium-90. The measured concentrations were consistent with typical washout values associated with atmospheric scrubbing [15] and are comparable with the 1989 data published by EPA for Yaphank, New York [11,12,13,14].

2.6 Soil and Vegetation

The off-site soil and vegetation sampling program is a cooperative effort between BNL and the Suffolk County Department of Health Services (SCDHS). Local farms situated around BNL were sampled semiannually. No nuclides attributable to Laboratory operations were detected in any of these samples.

In 1989, 22 surface soil samples were collected from on-site locations and analyzed for gamma activity. At the site perimeter and many central-site locations, the observed radionuclide concentrations were equivalent to those detected at off-site sample stations. Areas that had been identified by the 1983 EGG aerial survey [16] were resampled to assess current surface concentrations. No new areas were identified in this survey.

In addition, metals analyses were performed on surface soil samples collected from the current landfill and 16 of the 22 surface soil samples that were collected for gamma analysis. The soil data from surface samples indicate that land use near certain buildings has resulted in elevated concentrations of metals including antimony, arsenic, chromium, copper, lead, mercury, nickel and zinc.

Soil profile samples near the current landfill and hazardous waste management area were collected as part of the site soil characterization program. The samples were analyzed for metal and organic constituents. The data will be used to aid in determining the need/extent of remediation at this location.

2.7 Peconic River

The concentration of metals and other indices of water quality in the Peconic River were comparable to those in the STP effluent reflecting ambient levels and well within drinking water standards. At the former site boundary (Location HM), the annual average gross beta concentration was 10.9 pCi/L (0.40 Bq/L) or 22% of the NYS DWS; the average strontium-90 concentration was 0.44 pCi/L (0.016 Bq/L) or 6% of the NYS DWS; and the average tritium concentration was 1.0 nCi/L (37 Bq/L) or 5% of the NYS DWS. At the current site boundary (Location HQ), the annual average gross beta concentration was 6.4 pCi/L (0.24 Bq/L) or 13% of the NYS DWS and the average tritium concentration was 0.94 nCi/L (35 Bq/L) or 5% of the NYS DWS. Nuclide specific analyses were not performed at this location.

The Peconic River was sampled at four locations between the site boundary and Riverhead. In addition, the Carmen's River was sampled as the background location. Samples were analyzed for gross alpha, gross beta, tritium, strontium-90 and gamma emitting radionuclides. For the first time in five years there was flow leaving the site. As a result tritium, cesium-137 and strontium-90 were detected at downstream locations. At distances beyond two km from the site boundary, strontium-90 concentrations were equivalent to background location values while tritium and cesium-137 concentration were just above system detection limits. Direct ingestion of water collected at station HC at a rate of two liters per day for one year would result in a dose of less than 0.04 mrem (0.0004 mSv).

2.8 Aquatic Biological Surveillance

Fish samples were collected from BNL recharge basin HS, along the Peconic River at the outfall of the STP (Station EA), the former site boundary (Station HM), Donahue's Pond and Forge Pond and at the upstream locations of Swan Lake and Swan Pond. In calendar year 1989, gamma spectroscopy analysis was performed on samples collected in 1989 while strontium-90 results were received on samples collected in 1988. Both year's results are reported here. The Peconic River fish contained cesium-137 concentrations which ranged from background levels at Forge Pond (100 - 300 pCi/kg-wet [37-111 Bq/kg-wet]) to 11,000 pCi/kg-wet (407 Bq/kg-wet) at Station HM. Strontium-90 concentrations at Forge Pond ranged from 200 - 300 pCi/kg-wet [74-111 Bq/kg-wet] (twice background) to almost 4,700 pCi/kg-wet (174 Bq/kg-wet) at Station EA. Average concentrations found in control aquatic biota were subtracted from results for Peconic River sample stations. Only fish collected at off-site locations were used to calculate the maximum individual and collective doses. Based on these results, the maximum individual dose was estimated to be 0.9 mrem (0.009 mSv) and the collective dose was estimated to be 0.155 person-rem (0.0016 person-Sv).

Sediment and vegetation samples were collected and analyzed for gamma emitting radionuclides at control locations and along the Peconic River downstream of BNL effluent releases to Station T, located about three km beyond the site boundary. Elevated radionuclide concentrations in these parameters are observed out to Donahue's Pond.

2.9 Potable Water Supply

Gross alpha, beta and tritium concentrations in on-site potable well samples were generally at or near the minimum detection limit (MDL). The daily grab sample of potable water collected from a central building on-site exhibited the same results. The highest average tritium concentration in on-site potable well water (Well No. 4) was 650 pCi/L [24 Bq/L] (the MDL for tritium was typically 300 pCi/L [111 Bq/L]). This concentration if consumed for one year at a rate of two liters per day would correspond to a committed effective dose equivalent to the on-site resident of 0.03 mrem (0.0003 mSv). Other nuclides, including cesium-137, cobalt-60, sodium-22, and strontium-90 were detected in several wells. The strontium-90 concentration is consistent with off-site potable concentrations and is thus related to world-wide fallout. The committed effective dose equivalent from ingesting the maximum concentrations for the remaining radionuclides would be 0.015 mrem (0.00015 mSv) and the total dose from all radionuclides would be 0.045 mrem (0.00045 mSv) or 1.1% of the dose limit specified in the SDWA. These doses represent an upper limit to the dose actually received because the concentrations used to derive these doses were obtained from analyzing samples from the individual well heads and does not account for mixing that would occur when the water is distributed throughout the site.

Metal analyses performed on potable water samples indicate that silver, arsenic, cadmium, chromium, and zinc were not detected in any sample. Trace quantities of lead (0.002 mg/L), and manganese (0.05 - 0.07 mg/L) were detected in potable well water collected at the well head. All observed values of lead and manganese were substantially below the NYS DWS of 0.050 mg/L and 0.3 mg/L. Iron was detected in water collected at the well head from Well Nos. 4, 6, and 7. Water from these wells is treated at the BNL Water Treatment Plant prior to use in the domestic water distribution system. Sodium was detected in all potable wells in concentrations ranging from 9.2 to 15.9 mg/L.

In previous years, organic compounds had occasionally been detected in the BNL potable water supply wells in concentrations significantly below Federal and State DWS. The organic compound which had been detected most frequently was 1,1,1-trichloroethane. Prior to 1989, this compound had a DWS of 0.05 mg/L (50 µg/L). However, the New York State Department of Health (NYSDOH) adopted standards to limit organic chemical contamination of public drinking water supplies in 1989 [17]. These new DWS established a limit of 0.005 mg/L (5 µg/L) for 52 principal organic compounds (including 1,1,1-trichloroethane) which became effective on January 9, 1989.

During the course of the year, two potable wells were found to contain 1,1,1-trichloroethane in excess of the new DWS. In accordance with NYS potable water supply regulations, replicate samples were collected from each well to confirm the presence of 1,1,1-trichloroethane. Potable Well No. 10 was removed from service as a potable supply well in March 1989 and permanently removed from service in June 1989. The results of quarterly testing of Potable Well No. 11 in October found 1,1,1-trichloroethane in excess of the NYS DWS and the well was voluntarily removed from service as a potable supply. In accordance with NYS requirements, three samples were collected at one week intervals in November. The average was 8.3 µg/L for 1,1,1-trichloroethane and the well was permanently removed from service in December, 1989. BNL is investigating the purchase of carbon filtration units for these wells.

2.10 Ground Water Surveillance

Ground water surveillance data are compared to both RCGs and Drinking Water Standards. By comparing ground water data to the RCGs, the Laboratory can demonstrate that releases from past practices did not exceed regulatory limits in place at that time. Comparison of surveillance well data to EPA, NYSDEC and NYSDOH DWS, demonstrates the Laboratory's commitment to remediate ground water which does not meet current regulatory criteria and to protect the ground water resource as a future potable water supply.

2.10.1 Radiological Analyses

In 1989, 137 ground water surveillance wells were monitored for radiological parameters. Radiological data are presented grouped by sector of the BNL site. In the east sector of the site (meadow marsh-upland recharge area; Peconic River on-site including STP sand filter bed area and the Peconic River off-site), gross beta, tritium, and strontium-90 concentrations were detected which were above ambient concentrations only in the on-site areas near the Peconic River. Cobalt-60, cesium-137 and beryllium-7 were found in concentrations at or near the systems MDL in only two wells of the 24 that were monitored in this area. The observed concentrations are attributable to tile collection field losses at the STP and recharge of the Peconic River. In 1989, the highest annual average gross beta concentration was 9% of the NYS DWS concentration limit; tritium was 26% of the NYS DWS concentration limit; strontium-90 was 116% of the NYS DWS concentration limit (value based only on one measurement); cobalt-60 was 0.04% of the NYS DWS dose limit; cesium-137 was 0.1% of the NYS DWS dose limit and beryllium was 0.01% of the NYS DWS dose limit [17,18]. At a single surveillance well located adjacent to the Peconic River and several hundred meters downstream of the site boundary, all parameters were within ambient concentrations or below system detection limits except for strontium-90. The average strontium-90 concentration was 116% of the NYS DWS concentration limit.

Along the northwest, west and south boundary of the site, 19 wells were monitored. No activity above ambient levels or significantly in excess of the system MDL was found in ground water samples collected from these areas.

In the center of the site, 32 surveillance wells were monitored. Radionuclides detected in ground water samples that were attributable to BNL operations were found near the old Bubble Chamber area (Building 965), Building 811, Building 830, the Major Petroleum Facility (MPF) and near Building 118. The highest annual concentrations detected for this area expressed as a percent of the NYS DWS concentration limit were: 23% gross beta; 17% tritium; and 29% strontium-90. Radionuclides that are not regulated by concentration are regulated by dose. The highest annual concentration detected for the remaining radionuclides expressed in percent of the dose limit were: 0.02% beryllium-7; 3.2% sodium-22; 0.24% cesium-137; and 0.56% cobalt-60.

In addition to the BNL on-site surveillance wells, 24 off-site private potable wells were sampled and analyzed for gross alpha, gross beta, strontium90, tritium, and gamma emitting radionuclides as part of a cooperative program with the SCDHS. Detectable quantities of tritium were found in four off-site sampling stations. The annual average tritium concentrations at these locations were less than 11% of the DWS [19]. Except for naturally occurring potassium-40, no gamma emitting radionuclides were detected and strontium-90 values ranged between <0.1 and 0.74 pCi/L (<0.004 and 0.027 Bq/L) in private potable well water, which is typical for Long Island.

At the current and former landfill areas, 34 surveillance wells were monitored. The single highest average gross beta concentration observed was 60% of the applicable guide; the single highest average tritium concentration and strontium-90 concentration observed were 82% and 400% respectively of the DWS. Other radionuclides were detected at small fractions of the DWS dose limit. Only one of the 34 monitoring wells that were sampled exhibited concentrations that exceeded the DWS. Given the distance to the site boundary, the rate of movement for these radionuclides and radioactive decay, the radionuclide concentrations at the site boundary are anticipated to be substantially below the applicable standards.

Twenty-five ground water surveillance wells were monitored in the vicinity of the HWMF. The data from this ground water program indicate the presence of tritium, fission, and activation products. The single highest average concentration of tritium and strontium-90 was 10% and 422% respectively, of the DWS. The highest annual concentration detected for the remaining radionuclides detected expressed in percent of the DWS dose limit were: 0.06% cesium-137; 0.42% cobalt-60 and 0.46% sodium-22. Only one of the 25 monitoring wells that were sampled in this area exhibited concentrations that exceeded the NYS DWS.

2.10.2 Nonradiological Analyses

Iron and manganese were found in excess of the NYS DWS in several monitoring wells on-site. Lead concentrations exceeded NYS DWS at one on-site monitoring well. However, with the exception of wells which monitor the current landfill, the observed concentrations appear to be related to corrosion from the well casings or ambient conditions in Long Island ground water and not to Laboratory effluents. At the current landfill, the maximum concentrations of iron, and manganese, were 99 and 9.12 mg/L, respectively.

Chlorocarbons were detected in monitoring wells near the current landfill, control wells, wells which monitor the former landfill, and wells in the vicinity of the HWMF. Concentrations of trihalomethane compounds and benzene, toluene and xylene (BTX) were also detected at many of these locations. The highest concentrations of organic compounds in ground water were observed near the HWMF where the Laboratory initiated an aquifer restoration program in 1985. Because of this program, which operates with a greater than 95% reduction of organic concentrations, samples from wells in this area have indicated a significant reduction in organic concentrations compared to 1985, 1986 and 1987 data. It should be noted, however, with the lowering of the standard from 50 mg/L to 5 mg/L for volatile organic compounds (VOCs), a number of wells in the vicinity of former landfill, MPF, Waste Concentration Facility (WCF), the STP, sand filter beds and AGS area have organic concentrations that exceeded the lower limit.

An additional area under investigation is near the Central Steam Facility (CSF) where organic compounds were detected in soil during installation of ground water surveillance wells in 1986 to meet the requirements specified for a Major Petroleum Storage Facility. IT Corporation completed a study in 1988 to delineate the extent of soil and ground water contaminated by the 1977 spill of mineral spirits and No. 6 fuel oil [20,21]. As part of the MPF license requirements, seven new wells were installed during 1989. Monitoring results continue to confirm the findings presented in the IT Corporation report [20].

Analyses of ground water from 51 new wells installed around the site indicate 1,1,1-trichloroethane as the primary organic contaminant being detected in seven of these wells. The maximum concentration observed was 20 µg/L. With reference to primary metals, lead was detected above the NYS DWS in one well, No. 130-02, at a concentration of 0.064 mg/L. The initial analyses performed on ground water samples from the 51 new wells utilized EPA Contractor Laboratory Program (CLP) protocols. Mercury was detected above the NYS DWS in two wells, No. 58-01 and 37-01, at a concentration of 0.023 mg/L and 0.014 mg/L.

2.11 Off-Site Dose Estimates

For the year 1989, the collective committed effective dose-equivalent attributable to Laboratory operations, for the population up to distance of 80 km, was calculated to be 3.2 person-rem (0.032 person-Sv). This can be compared to a collective dose-equivalent to the same population of approximately 300,000 person-rem (3000 person-Sv) due to natural sources.

The committed effective dose-equivalent to the maximum individual resident at the site boundary (NNE Sector) from the air pathway is 0.12 mrem (0.0012 mSv). The maximum individual committed effective dose-equivalent from drinking water pathway (SSE Sector) is 0.1 mrem (0.001 mSv). The maximum individual committed effective dose-equivalent from the fish pathway is 0.9 mrem (0.009 mSv). The combined maximum individual dose equivalent is 1 mrem (0.01 mSv).

3.0 EFFLUENT EMISSIONS AND ENVIRONMENTAL SURVEILLANCE

The primary purpose of BNL effluent and environmental monitoring programs is to determine whether:

1. facility operations, waste treatment, and control systems functioned as designed to contain environmental pollutants, and

2. the applicable environmental standards and effluent control requirements were met.

This annual report for calendar year 1989 follows the recommendations given in the DOE Order 5400.1, General Environmental Protection Program [22,23,24].

3.1 Airborne Effluent Emissions

3.1.1 Radioactive Airborne Effluent Emissions

The locations of principle Laboratory facilities from which radioactive airborne effluents are released are shown in Figure 9. The installed on-line effluent monitors, sampling devices and amounts of effluents released during 1989 are presented in Appendix D, Table 3. Tritium was the only radionuclide detected routinely at the site boundary which was attributable to Laboratory operations. Releases of bromine-77, selenium-75, iodine-126 and mercury-203 during May from the Building 801 facility resulted in detectable activity at the site boundary during that month. The elevated releases were due to BLIP target processing problems.

Oxygen-15, which has a two minute half-life, is produced at the BLIP facility by the interaction of protons and water in the beam tubes and generated at an estimated rate of 6 mCi per microampere-hour (0.22 GBq per micro ampere-hour) [25]. Based on 153 milliampere-hours of operation, 918 Ci (34 TBq) of oxygen-15 was produced in the beam tubes at the BLIP facility during 1989 and released via the stack. Due to scheduled maintenance at the LINAC and AGS, BLIP did not operate during the months of August through November, 1989. Monthly effluent emissions are listed in Appendix D, Table 4.

Argon-41, which has a 110-minute half-life, is produced at the MRR by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the stack at an estimated rate of 2 Ci $MW^{-1}h^{-1}$ (74 GBq $MW^{-1}h^{-1}$). The estimated release for the MRR stack during 1989 was 1,936 Ci (72 TBq) of argon-41. Monthly effluent emissions are listed in Appendix D, Table 4.

The total tritiated water vapor released from the Laboratory research facilities during 1989 was 99 Ci (3.7 TBq). Of this total, 58.5 Ci (2.16 TBq) were released from the HFBR, 41 Ci (1.5 TBq) from the Van de Graaff, and the remainder from all other facilities. Appendix D, Tables 5 and 6 present monthly summaries of tritium release data.

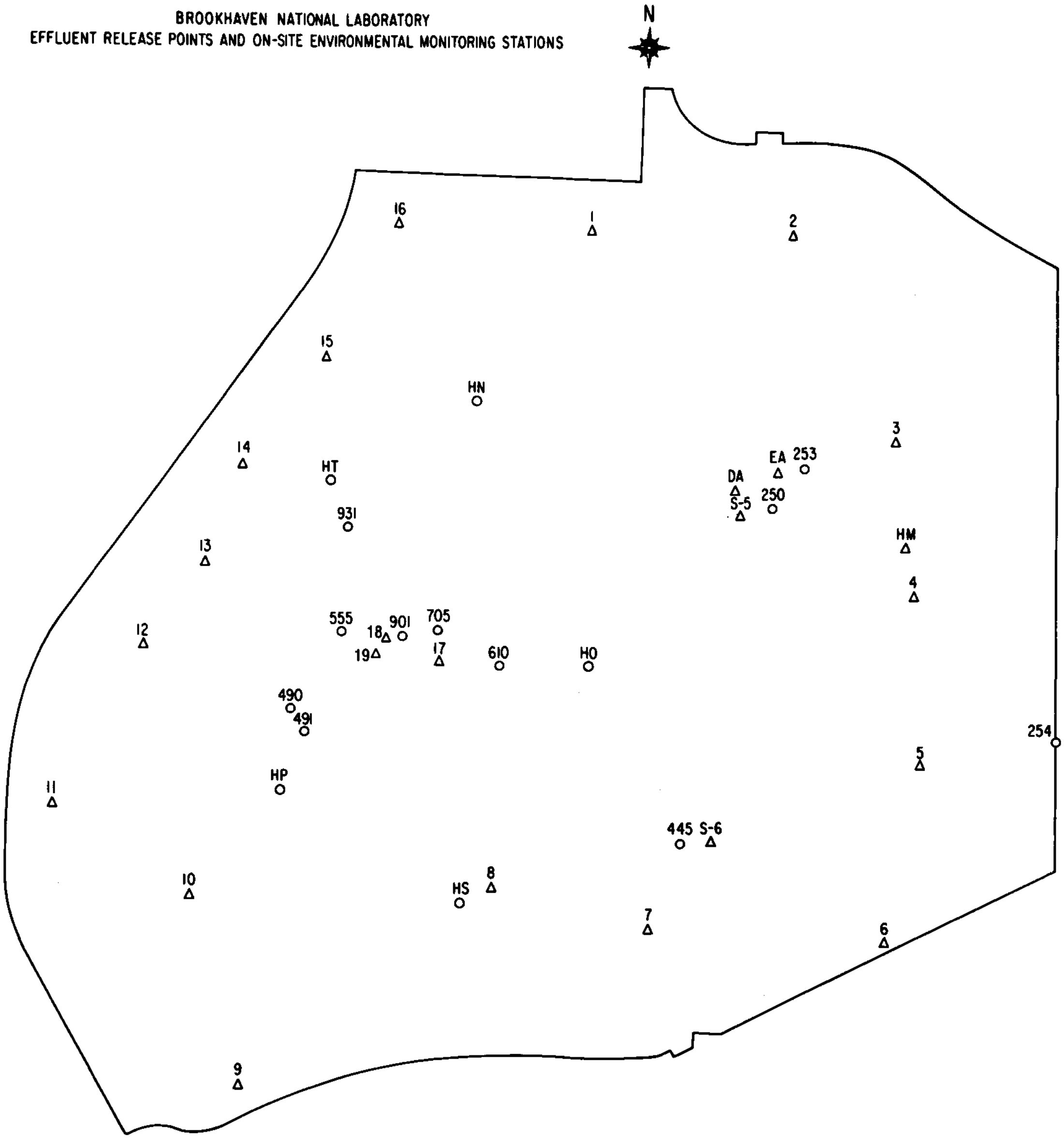
The Building 705 100-meter stack receives airborne effluents from three separate exhaust systems: the HFBR (Building 750) and the Hot Laboratory (Building 801) acid and non-acid lines. Gamma emitting nuclides released from the 100-meter stack are shown in Appendix D, Table 6. Bromine-82 and iodine-131 are present as a result of operations and experimental activities at the HFBR. The remaining radionuclides are released from the Hot Laboratory complex as the result of processing BLIP targets for the recovery of radioisotopes used by medical health practitioners. Releases from this facility in May and June resulted in detectable activity on site boundary particulate and charcoal filters during the release period and were caused by target processing problems. The activity, although measurable, resulted in an insignificant increase in the dose to the maximum person residing at the site boundary. At the BLIP facility, other radionuclides in addition to oxygen-15 can be produced and are periodically emitted into the environment. Appendix D, Table 7, summarizes the gamma emitting radionuclides released from this facility.

The Laboratory incinerates certain low-level radioactive wastes at the HWMF incinerator (Figure 9). The total quantities of the individual radionuclides in the incinerated materials during 1989 are shown in Appendix D, Table 8. Tritium was the radionuclide released from the incinerator in the largest quantity, 0.037 Ci (1.37 GBq). Site meteorological characteristics and administrative limits on the amount of material incinerated ensure that airborne concentrations at the site boundary are small fractions of the applicable standards.

3.1.2 Nonradioactive Airborne Effluent Emissions

The potential sources of elemental and hydrocarbon air pollutants emitted by BNL facilities and all environmental permits issued to the DOE at BNL are listed in Appendix D, Table 9. Under the air permits issued by the NYSDEC, five individual stacks require monitoring, three of which are associated with the combustion units at the CSF (Building 610). The other two emission points are associated with new sources at the Inhalation Toxicology Facility located at Building 490.

The CSF is located along the eastern perimeter of the developed portion of the BNL site. The CSF supplies steam for heating and cooling to all major facilities through the underground steam distribution and condensate grid. Since 1976, the CSF has utilized alternate liquid fuel (ALF) in the four high efficiency boiler units for the purpose of energy recovery. In 1989, the fraction of light feed stock (LFS) relative to total fuel consumption was approximately 7.9%. This is consistent with calendar year 1988; both years represent a substantial decrease from previous years. These LFS fuels typically have a weighted average sulfur content of 0.5% or less which is below the NYSDEC regulatory limit of 1% sulfur content in No. 6 oil [26]. NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum [26]. Stack testing, conducted in accordance with NYSDEC requirements, has demonstrated the mean fuel combustion efficiency over the entire range of boiler loading capacities to be greater than 99.9% for the individual boiler units firing ALF [27,28], thus providing greater combustion efficiency than required by state criteria. Standard Operating Procedures require all LFS samples to be analyzed for polychlorinated biphenyls (PCBs) prior to their use to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations.



△ 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

○ DESIGNATION	EFFLUENT RELEASE POINT
250	SAND FILTER BEDS
253	PECONIC R. STREAM BED
254	SITE BOUNDARY
490	MRC STACK
491	MRR STACK
555	CHEMISTRY STACK
705	HFBR STACK
901	VAN DE GRAAFF STACK
931	BLIF STACK
445	WASTE MANAGEMENT INCINERATOR
610	STEAM PLANT
HN	RECHARGE BASIN
HO	RECHARGE BASIN
HP	RECHARGE BASIN
HS	RECHARGE BASIN
HT	RECHARGE BASIN

SCALE: 0 180 360 Meters

Figure 9: Brookhaven National Laboratory Effluent Release Points and On-site Environmental Monitoring Stations

3.2 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 [29]. 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.

3.2.1 Liquid Waste Management

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

The HWMG also collects small quantities of liquid radioactive wastes from waste accumulation areas throughout the site. Depending on the radionuclide and its concentration, these wastes are either directly solidified at the HWMF or processed at the WCF. Buildings where large volumes (up to several hundred liters) of liquid radioactive waste are generated have dual waste handling systems. These systems are identified as "active" (D) and "inactive" (F). As shown in Figure 10, wastes placed into the D and F systems are collected in holdup tanks. After sampling and analysis, they are either authorized for release directly to the sanitary waste system if concentrations are within administrative guidelines for discharge [30] or are transferred to the WCF for processing. In 1989, authorized releases of F-waste to the sanitary system totaled 0.90 million liters with a total gross beta activity of 0.3 mCi (11 MBq) and a total tritium activity of 14 mCi (0.52 GBq). These values represent a factor of ten reduction in activity discharged with a six percent reduction in the volume of material. The reduction of tritium and gross beta activity released to the STP was accomplished by establishing a transport mechanism for the MRR to send resin column regeneration water to the WCF.

At the WCF, liquid waste is distilled to remove particulate, suspended and dissolved solids. The solidified residues from the evaporator are transferred to the HWMF for subsequent shipment and disposal at an authorized off-site disposal facility. The distillate, which contains tritium, is collected and transported to the STP. It is released into a lined hold-up pond where it mixes with precipitation and diverted effluent from the STP. This water is then pumped back to the STP at a controlled rate where it is added to the dosing tanks of the sand filter beds. This process permits a controlled release of liquid effluents and aids the Laboratory in achieving its administrative discharge concentration limit of 20,000 pCi/L (740 Bq/L) and the goal of 10,000 pCi/L (370 Bq/L). By comparison, the RCG [9] for tritium is 3,000,000 pCi/L (0.11 MBq/L).

3.2.2 Sanitary System Effluents

Primary treatment of the sanitary waste stream to remove suspended solids is provided by a 950,000 liter clarifier. The liquid effluent flows from the clarifier onto sand filter beds, from which about 80% of the water is recovered by an underlying tile field. This recovered water is then released into a small

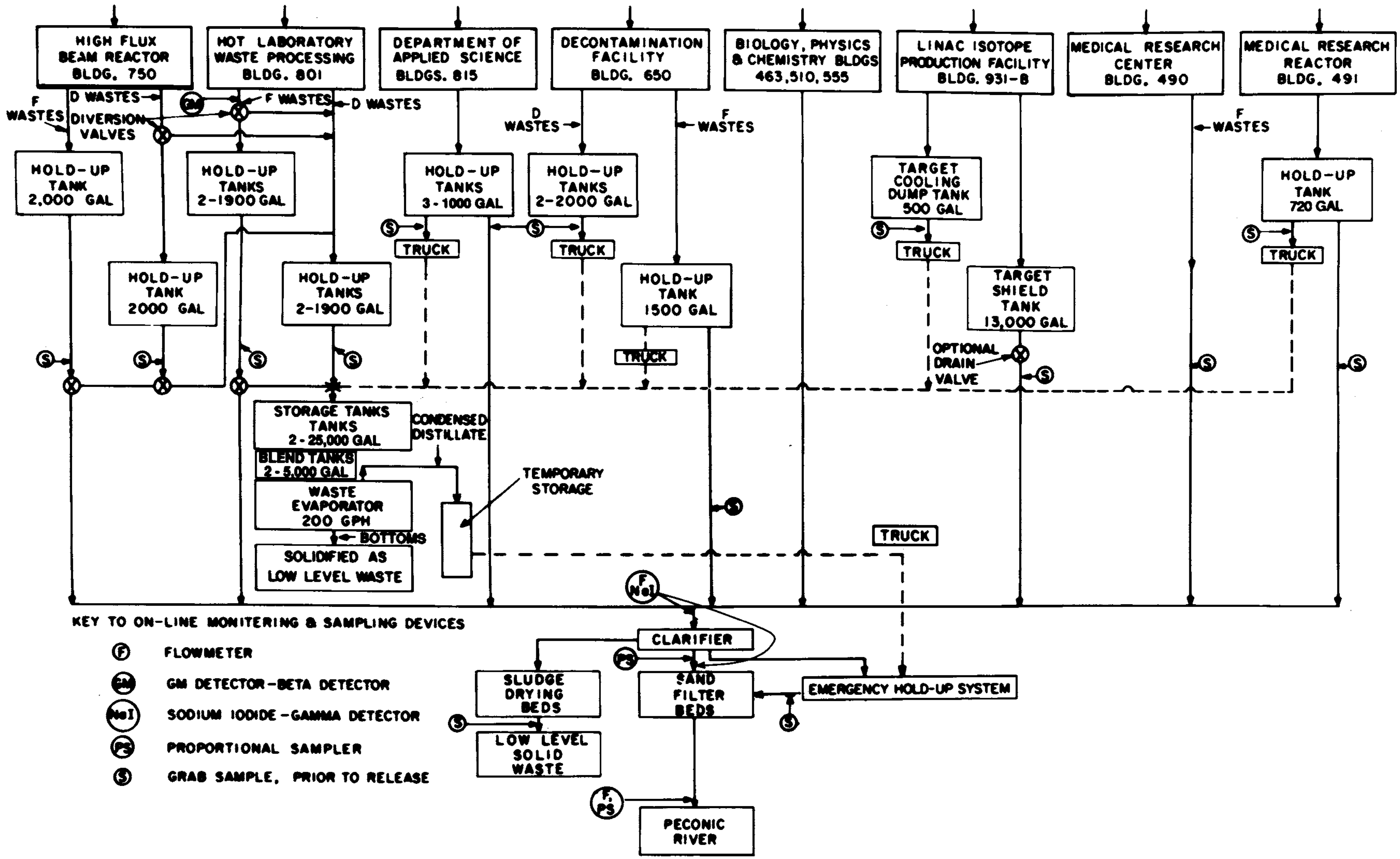


Figure 10: Liquid effluent systems Brookhaven National Laboratory.

stream that contributes to the headwaters of the Peconic River. In recent years, virtually all water released to this channel has recharged to ground water prior to reaching the site boundary. This condition existed in 1989 until April when heavy rains produced sufficient upstream contribution to result in the Peconic tributary on the BNL site to once again leave the site.

The effluent not collected by the tile fields, approximately 20%, is assumed to percolate to the ground water under the beds and/or evaporate. A schematic of the STP and its related sampling arrangements is shown in Figure 11. In addition to realtime monitoring of the clarifier influent for radioactivity, oil, pH and conductivity, plus realtime monitoring of clarifier effluent for radioactivity, volume proportional and grab samples were collected each working day at the STP for analysis.

In 1989, two significant improvements were made to the sanitary waste water system. First, an upstream station was constructed about 1.8 km upstream of the STP. The station was equipped with realtime radioactivity, pH and conductivity monitoring equipment and operated in "test" mode during the final quarter of 1989. The station provides about one hour advanced warning that liquid effluents which may exceed BNL effluent release criteria or SPDES limits have entered the system. The other major upgrade was the addition of a second emergency hold-up pond with a 15 million liter capacity. The total hold-up capability provided by the two holding ponds is in excess of 26.5 million liters.

3.2.2.1. Radiological Analyses

The proportional samples collected at Location DA, the effluent from the STP clarifier, and Location EA, the STP discharge point into the Peconic River, are analyzed daily for gross alpha, beta and tritium activities. An aliquot is composited for monthly strontium-90 and gamma spectroscopy analyses. The results of these measurements are reported in Appendix D, Tables 10 and 11. Current and historic trend plots of gross beta and tritium concentrations that were released to the Peconic River are presented in Figures 12 and 13. A total tritium activity trend plot is presented in Figure 14.

The gross alpha data at the STP is consistent with prior year's data. All results are essentially less than the system detection limit and have a mean value which approaches zero. This means that alpha concentration measurements for these locations are at background levels. The tritium concentrations decreased in 1989 on the average by about 50% and returned to 1986 and 1987 levels. This occurred in large part because the HFBR didn't operate the last six months of 1989. Controlled releases of WCF distillate from the STP emergency holding ponds continued in 1989 and is the reason that tritium discharges to the Peconic River are larger than influent contributions reported from sampling Location DA. The 1989 tritium concentrations discharged to the Peconic River were below regulatory standards and were within BNL administrative controls. The total tritium activity released into the sanitary system was 2.0 Ci (74 GBq) as compared to 4.1 Ci (152 GBq) in 1988. The tritium activity discharged from Location EA was 2.5 Ci (92.5 GBq) as compared to 3.6 Ci (133 GBq) in 1988. The strontium-90 and gamma emitting radionuclides entering the STP have returned to pre-1988 levels. At location EA, except for cesium-137 and strontium-90, the remaining concentrations are essentially constant with prior year's data [10].

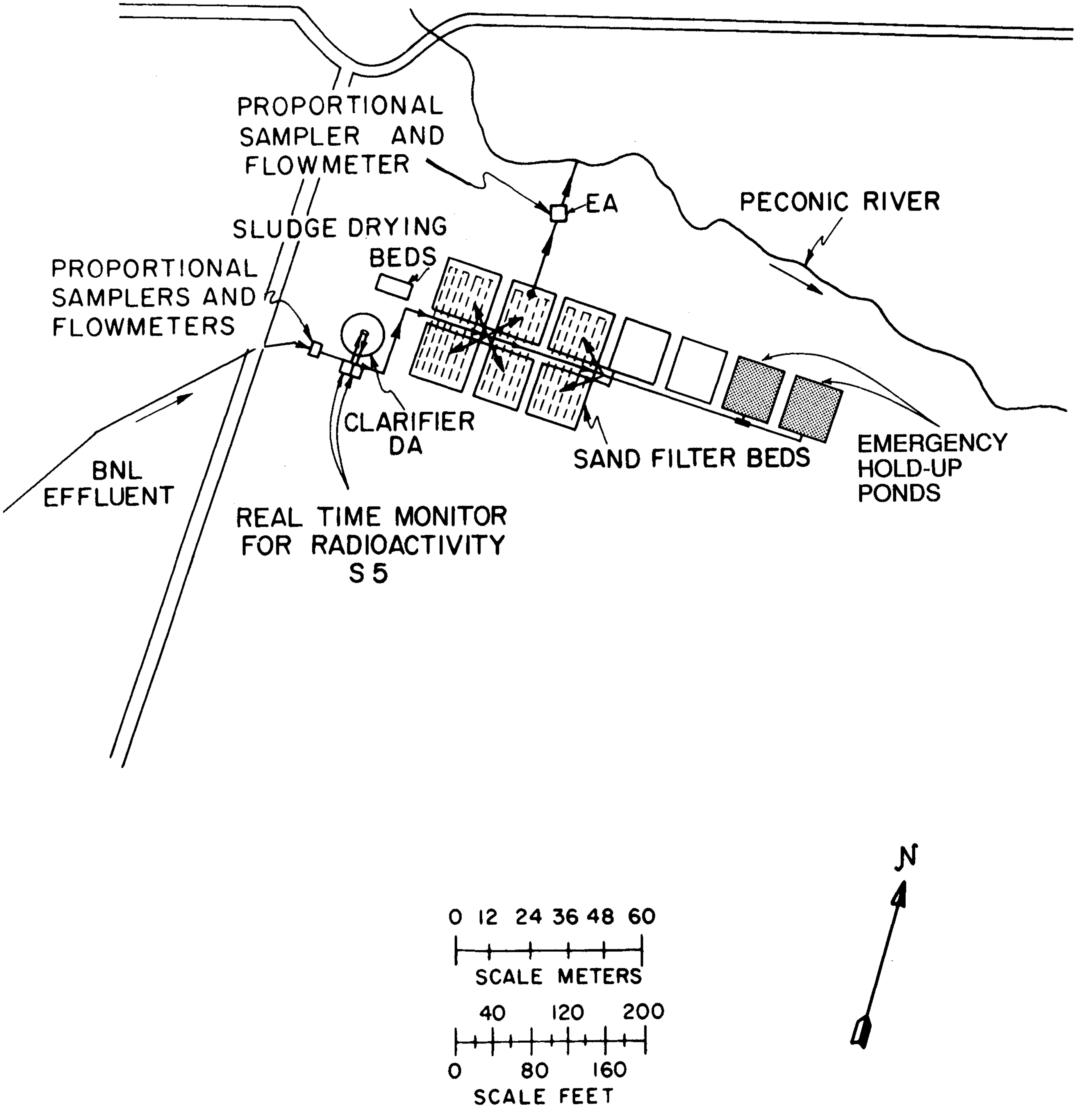


Figure 11: Sewage Treatment Plant Sampling Stations

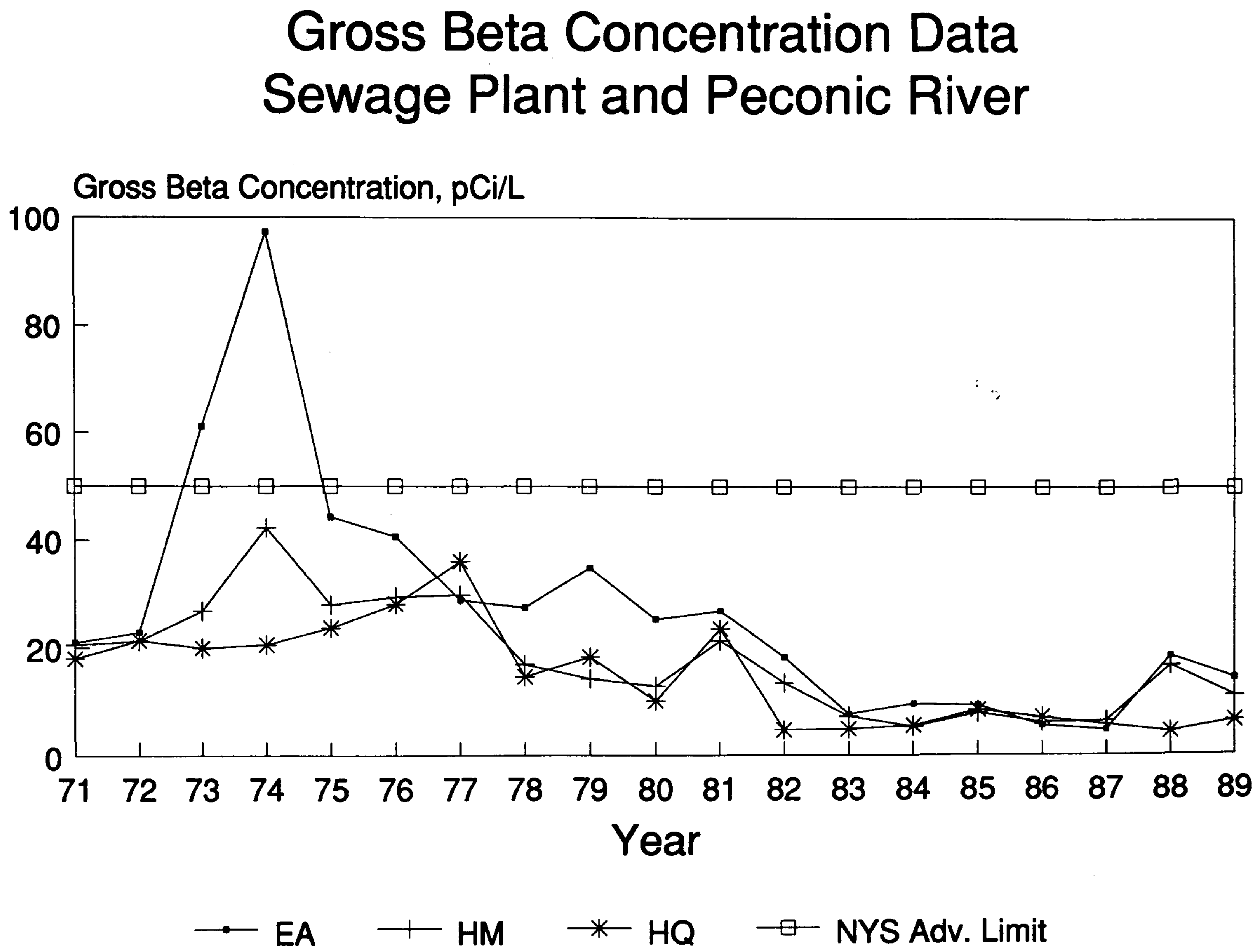


Figure 12: Trend Data - Gross Beta Concentration Data - Sewage Treatment Plant and Peconic River On-site 1971 to 1989

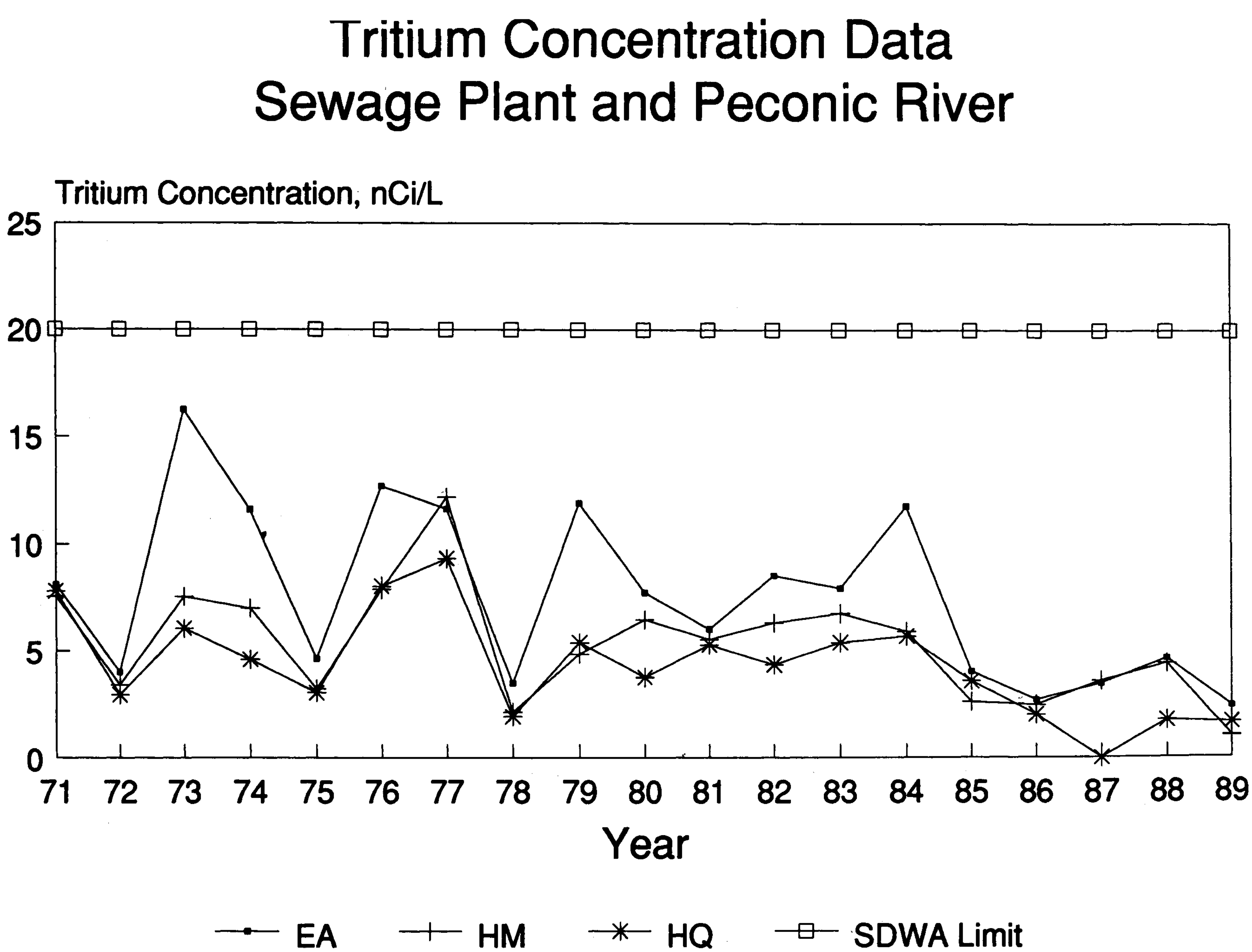


Figure 13: Trend Data – Tritium Concentration Data – Sewage Treatment Plant and Peconic River On-site 1971 to 1989

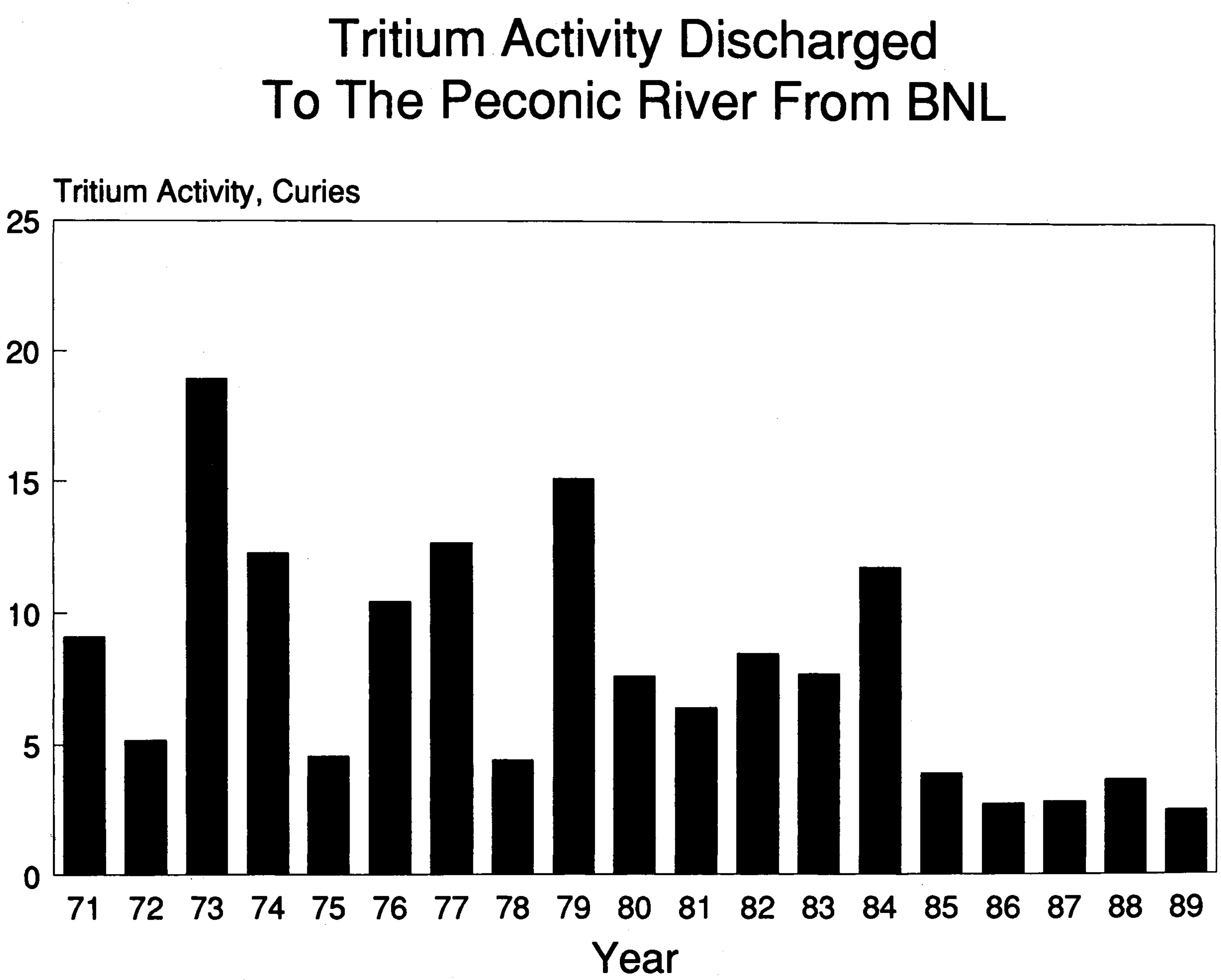


Figure 14: Trend Data - Tritium Activity Data - Sewage Treatment Plant and Peconic River On-site 1971 to 1989

Elevated cesium-137 and strontium-90 concentrations persist at Location EA due to residual leaching of these radionuclides from the sand filter beds. This activity is present due to an unplanned release on June 14 - 15, 1988. A discussion of the incident can be found in the 1988 BNL Site Annual Report [10].

The gross beta data for the STP effluent discharged to the Peconic River also remained influenced by the residual leaching of cesium-137 from the June, 1988 release. In 1989, gross beta concentrations at Location EA were essentially twice the influent concentrations. Cesium-137 concentrations in water collected from location EA were 26 times the concentration found in the clarifier effluent. Likewise, strontium-90 concentrations at location EA were about 3 times the concentrations that were detected at location DA. Although elevated, these concentrations at location EA did not result in any violation of the SPDES permit. If the BNL Administrative policy dose criteria of 4 mrem/yr were used for comparison, daily ingestion of water discharged by BNL to the Peconic River would result in an annual dose of 0.8 mrem or 20% of BNL's current discharge policy.

3.2.2.2 Nonradiological Analyses

The effluent from the Laboratory STP discharges into the Peconic River at location EA (Outfall No. 001) and is subject to the conditions of the SPDES Permit No. NY-000-5835, authorized by the NYSDEC. Discharge monitoring reports, which include analytical results, are submitted in accordance with the BNL SPDES permit on a monthly basis to the NYSDEC and the SCDHS. A summary of the nonradiological data for 1989 is shown in Appendix D, Table 12. The summary includes data required under the permit and additional analyses which were performed under the Laboratory's broader surveillance program. Operation of the STP resulted in a greater than 99% compliance rate in meeting permit requirements.

3.2.3 Recharge Basins

Figure 15 depicts the locations of BNL recharge basins within the physical complex. An overall schematic of water use at the Laboratory is shown in Figure 16. After use in "once through" heat exchangers and process cooling, approximately 12.2 million liters per day (MLD) of water was returned to the aquifer through on-site recharge basins; 1.94 MLD to basin HN located about 610 m northeast of the AGS; 5.80 MLD to basin HO about 670 m east of the HFBR; and 4.34 MLD to basin HP located 305 m south of the MRR. Recharge basins HS and HT receive a total of about 0.16 MLD.

A polyelectrolyte and dispersant was added to the AGS cooling and process water supply to keep the ambient iron in solution. Of the total AGS pumpage, approximately 0.61 MLD was discharged to the HN basin, and 5.2 MLD to the HO basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and was treated with inorganic polyphosphate and mercaptobenzothiozone to control corrosion and deposition of solids. The blowdown from this system (0.62 MLD) was also discharged to the HO basin. The MRR secondary cooling water (4.34 MLD) was adjusted to a neutral pH prior to use and then discharged to the MRR sump shown in Figure 15. Grab samples were collected at all recharge basins for analysis of water quality.

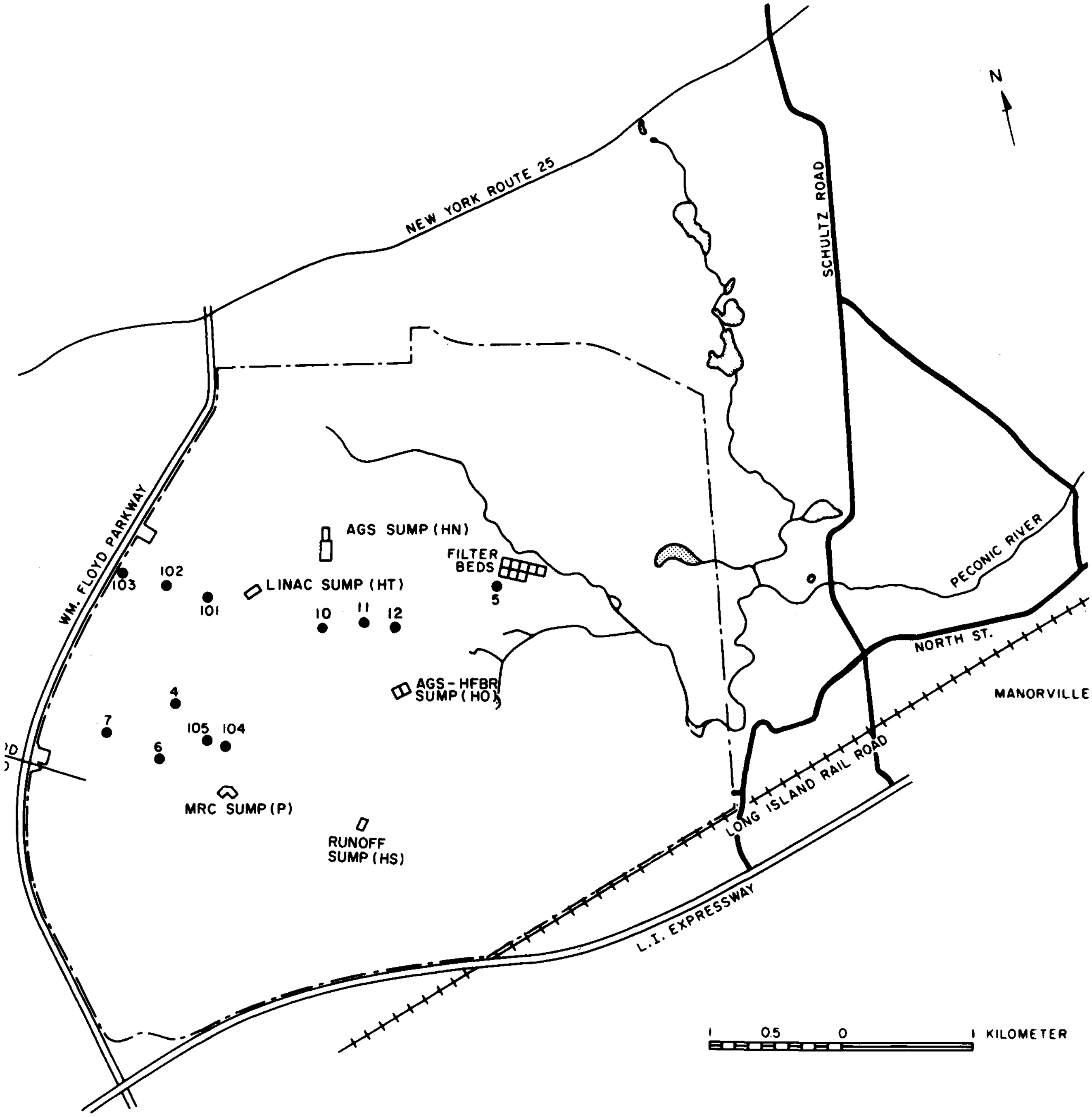


Figure 15:
On-Site: Potable and supply wells and recharge sumps.

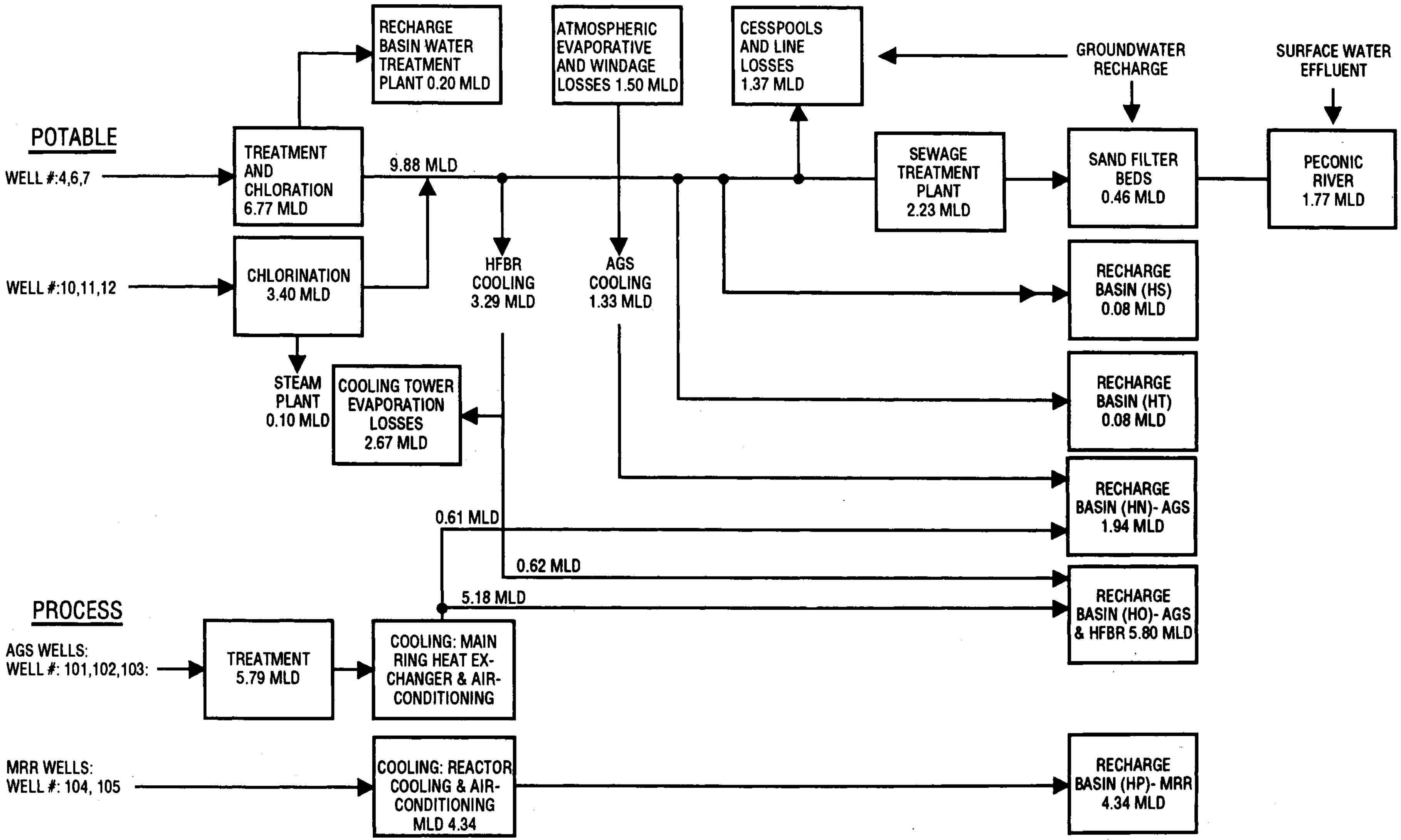


Figure 16: Brookhaven National Laboratory Schematic of Water Use And Flow

3.2.3.1 Recharge Basins - Radiological Analyses

Radiological results for recharge basin samples are reported in Appendix D, Table 13. The data indicates that trace quantities of activity were discharged to recharge basin HN. The activity detected at recharge basin HN results from the discharge of primary magnet rinse water into the recharge basin. The observed concentrations of beryllium-7 and sodium-22 result from high energy particle interactions in the cooling water at both the AGS and LINAC facilities. The presence of cobalt-60 is most likely due to activation of facility components and subsequent corrosion. No samples contained strontium-90 above the detection limit and for virtually all samples the tritium concentration was less than the system MDL. All concentrations detected were small fractions of effluent release limits. If a person ingested water from sump HN as the sole source of drinking water for one year, this would result in a committed effective dose equivalent of less than 0.04 mrem (0.0004 mSv).

3.2.3.2 Recharge Basins - Nonradiological Analyses

In 1989, approximately 12.2 MLD of water were discharged to the recharge basins. The BNL SPDES permit requires that records be maintained of the pH and the quantity of water discharged to these basins. The pH of this water ranged between 6.1 and 8.7. These values are slightly outside the discharge limits of 6.5 to 8.5. The results of selected water quality parameters are presented in Appendix D, Table 14. Water discharged to recharge basins was also sampled and analyzed for metals. The results of these analyses are presented in Appendix D, Table 15. Although discharges to recharge basins typically met NYS DWS, several exceptions were observed. At recharge basin HN (outfall 002) pH was recorded slightly above the maximum discharge limit of 8.5, while at recharge basin HO (outfall 003) pH was periodically observed to be below the minimum discharge limit of 6.5. Elevated iron concentrations were observed above NYS DWS at all recharge basins. However, only at basins HO and HS (outfall 005) did the annual average iron concentration exceed NYS discharge limits to ground water. In December 1989, a discharge of demineralizer backwash to recharge basin HT (outfall 006) resulted in the precipitation of copper onto the basin bed. This incident is being investigated under UOR 89-29.

3.3 Environmental Measurements and Analyses

3.3.1 External Radiation Monitoring

Dose-equivalent rates from gamma radiation at the site boundary, including natural background, weapons test fallout, and that attributable to Laboratory activities were determined through the use of CaF_2:Dy TLDs [31,32]. The locations of the on-site and off-site TLDs are shown in Figures 17 and 18, respectively. The TLDs were positioned using a standard 16 sector wind-rose with sector No. 1 centering on true North. The dose-equivalent rates observed are given in Appendix D, Table 16. The annual average dose-equivalent rate as indicated by all TLDs was 61.8 mrem/a (0.62 mSv/a). The dose-equivalent rate at the site boundary was 63.2 mrem/a (0.63 mSv/a), while the off-site average rate was 58.4 mrem/a (0.58 mSv/a). Differences between the on-site and off-site TLD dose-equivalent rate are the result of the terrestrial component of the external dose measurement [10].

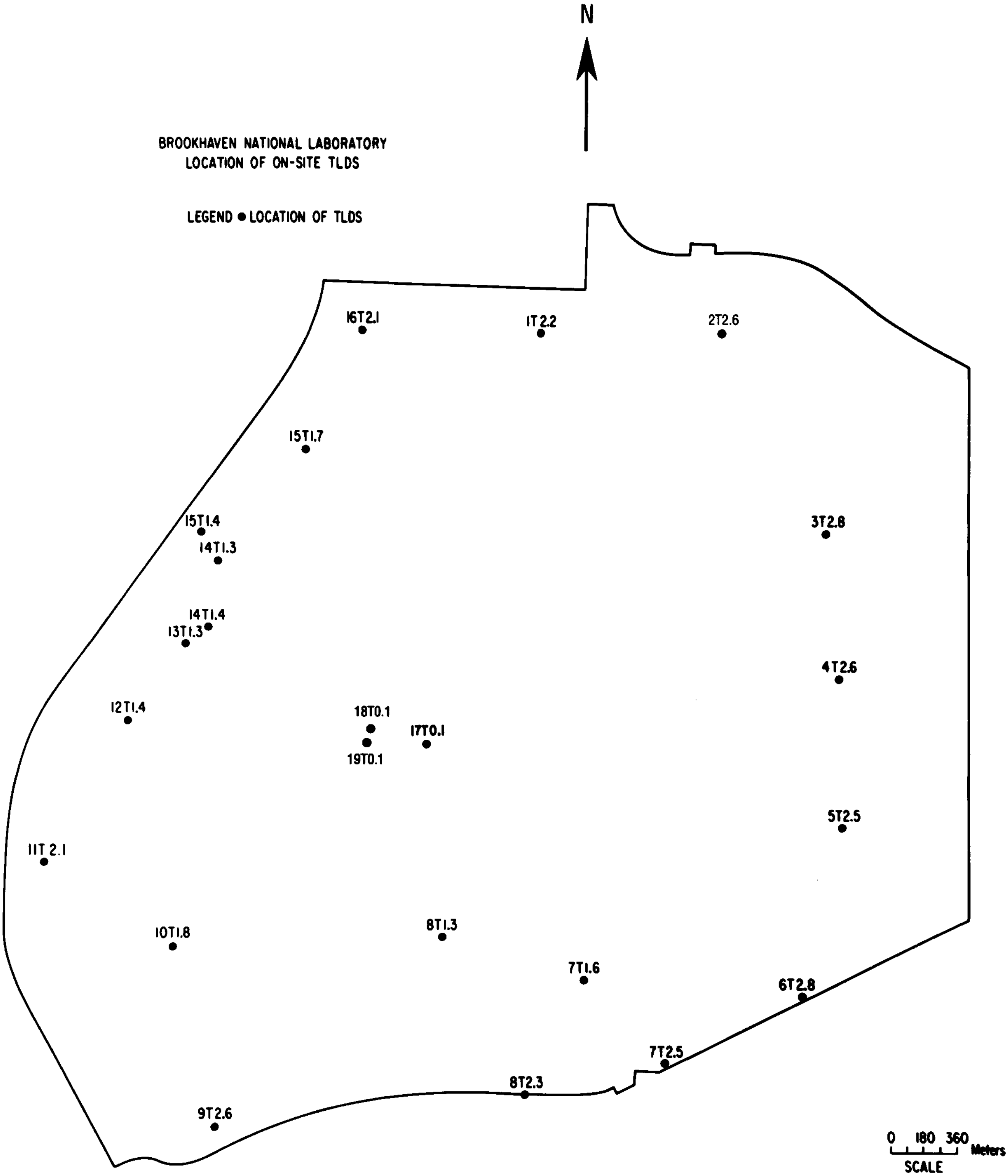


Figure 17: Brookhaven National Laboratory Location of On-site TLDs

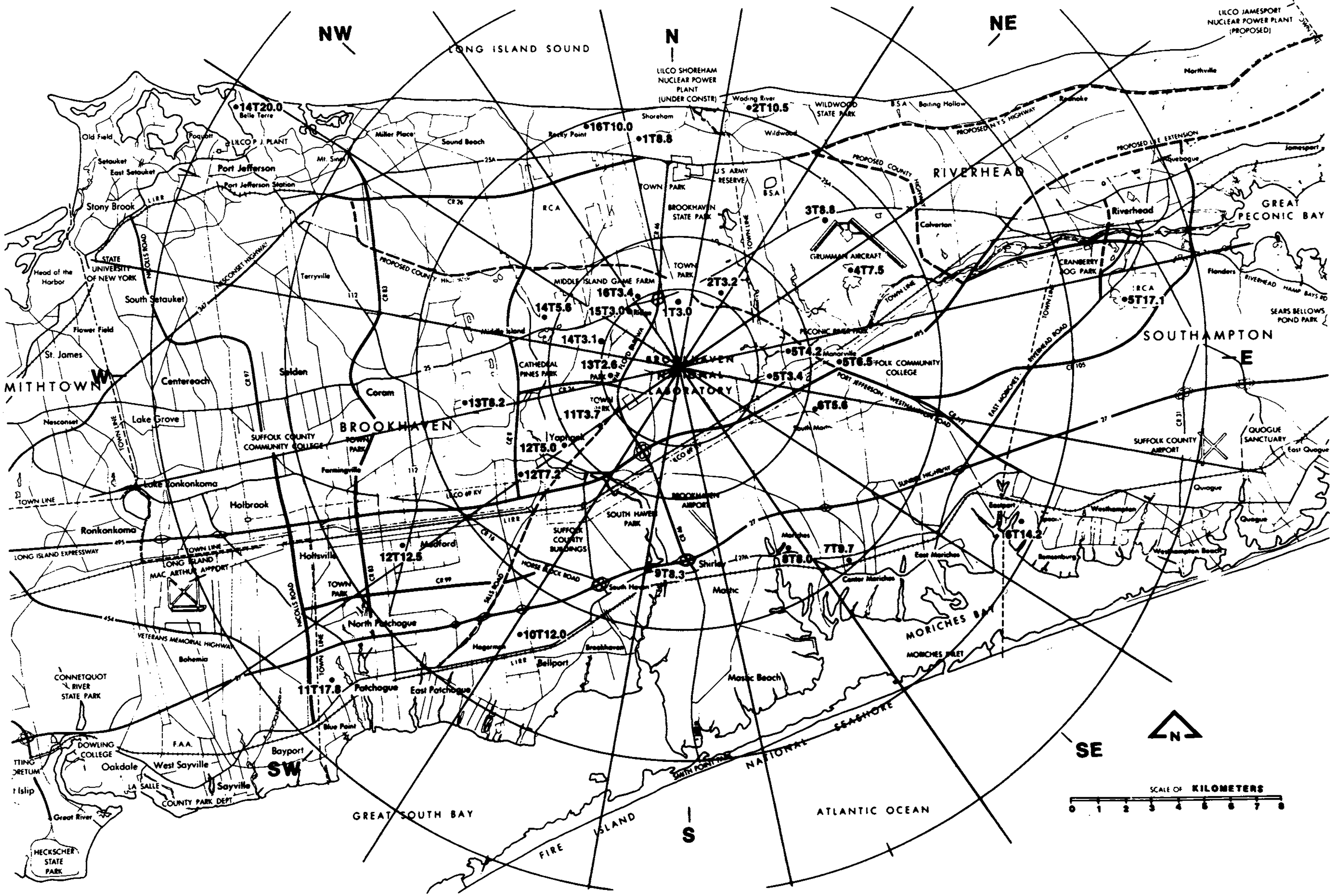


Figure 18: Location of Off-site TLDs

The maximum dose at the site boundary due to argon-41 and oxygen-15 airborne emissions were calculated using both AIRDOS-EPA [33] and DOE models as 0.1 mrem (0.001 mSv). This value is not measurable using today's best available technology.

3.3.2 Atmospheric Radioactivity

The Laboratory's environmental air monitoring program is designed to identify and quantify airborne radioactivity attributable to natural sources, to activities unrelated to the Laboratory (e.g., above ground nuclear weapon tests), and to Laboratory activities. The predominant radionuclides measured in air at the site boundary were tritium, fission products related to weapons test, fallout and beryllium-7 produced in the atmosphere as a result of cosmic particle interaction in the atmosphere. In May, 1989, emissions from the Building 801 Hot Laboratory were detected at the site boundary. This was the only month in 1989 when BNL airborne effluent (other than tritium) was detectable at a location other than the effluent release point.

3.3.2.1 Tritium Analyses

Sampling for tritium vapor was performed at six different on-site stations (shown in Figure 9). Location 6T had a duplicate sample train all year (identified as 6T1 and 6T2 in Appendix D Table 17) and air samples were routinely collected in the counting room (17Cr) and analytical lab (17L). The method of sampling was the collection of water vapor by drawing a stream of air through silica gel cartridges. The data collected from these stations are presented in Appendix D, Table 17. The maximum annual average tritium concentration at the site boundary was observed at Station 10T and was 8.2 pCi/m^3 (0.3 Bq/m^3). This air concentration would result in whole body dose from the inhalation and submersion pathways of 0.006 mrem (0.00006 mSv). By comparison, the National Council on Radiation Protection (NCRP) publication 91 recommends that 1 mrem (0.01 mSv) is a dose which is below regulatory concern [34].

The airborne tritium concentrations measured outside Building 535 (location 20T) reflect ambient air concentrations in the central part of the Laboratory site. The annual average air concentration at this location was 5.9 pCi/m^3 (0.22 Bq/m^3) and would represent a dose of 0.001 mrem (0.00001 mSv) to the typical BNL employee.

3.3.2.2 Radioactive Particulate

During 1989, positive displacement air pumps were operated at five on-site monitoring stations (16T2.1, 11T2.1, 6T2.8, 4T2.4, and S-6). The sampling media consisted of a 5-cm diameter air particulate filter followed by a 51.5 cm^3 canister of triethylene diamine-impregnated charcoal for the collection of radiohalogens. The air particulate samples were collected on a weekly basis and counted for gross alpha and beta activity using an anticoincidence proportional counter. In addition, analyses for gamma-emitting nuclides were performed on a monthly composite of the filter papers and on charcoal filter bed samples that had a sample period of one month. The gross alpha and beta analytical results are shown in Appendix D, Tables 18 through 22. Gamma-emitting radionuclides detected on the particulate and charcoal filters are reported in Appendix D, Tables 23 through 28. The presence of Chernobyl fallout, weapons test fallout from previous years, and cosmogenically produced radionuclides were detected by gamma spectroscopy at or near the systems minimum detectable activity levels. In May, 1989, BNL effluent from Building 801 was detected at the site boundary in charcoal filter samples. Residence at the location of the maximum observed concentration (16T2.1) would have resulted in a committed effective dose equivalent of 0.016 mrem (0.00016 mSv) as a result of inhaling the measured concentrations. This dose is below both the NCRP and EPA level of "de minimis".

3.3.3 Radioactivity in Precipitation

Pot-type rain collectors are situated at Locations S-5 and 11 (see Figure 9). Dry deposition and precipitation samples were collected on a weekly basis. Portions of each collection were processed for gross alpha, beta, and tritium analysis. A fraction of both the precipitation (wet) and dry deposition (dry) samples was composited for quarterly gamma analysis. Strontium-90 analyses were performed quarterly on precipitation samples. The data for 1989 are reported in Appendix D, Table 29 and reflect typical washout values associated with atmospheric scrubbing [15] and the presence of radioactive particulate resulting from cosmogenic production, nuclear weapons fallout and Chernobyl.

3.3.4 Radioactivity and Metals in Soil, Grass and Vegetation

The results of soil and grass sampling conducted at four locations in the vicinity of the site are shown in Appendix D, Table 30. The results are consistent with data collected in previous years [10]. No nuclides attributable to Laboratory operations were detected. The observed concentrations represent the contribution of primordial and cosmogenic sources, and weapons test fallout.

In addition to the off-site sampling program that was conducted in conjunction with the SCDHS, BNL conducted a surface soil sampling program at 22 on-site locations to determine radiological contaminants. Sixteen of these locations also had metals analyses performed. The criteria for selecting the sampling locations was developed to address three basic programmatic needs: establishment of background soil concentrations at site perimeter monitoring locations; confirmation of residual soil concentrations at locations identified in 1983 by the EG&G Aerial Measurements Group Radiological Survey; and, preliminary investigation of the impact produced by outdoor storage of shielding material.

Results of the sampling and analysis program are presented in Appendix D, Tables 31 and 32. The radiological concentration data are presented in 2 cm intervals and as a 6 cm depth soil core. This format was used to identify the presence of surface contamination. The radiological data indicate that certain locations have elevated cesium-137 concentrations. These areas were previously identified in 1983 and the area recently sampled to verify stabilization. Trace levels of activation product were detected in a shielding storage area near Building 912A and 811. Metals data indicate that outdoor storage of shield material results in increased metal concentrations particularly for chromium, copper, lead, nickel and zinc.

3.3.5 Peconic River Aquatic Surveillance

3.3.5.1 Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at six locations; HM, the location of the former site boundary approximately 790 meters downstream of the discharge point; HQ, located approximately 2.1 km downstream from the discharge point; HA and HB, located approximately 5 km downstream from the discharge point; HC, located approximately 7 km downstream of the discharge point; HR, located 21 km downstream from the discharge point, and Station HH, a control station located on the Carmens River, which is not influenced by BNL liquid effluent. The Peconic River sampling stations are identified in Figure 19. Routine grab sampling (three times per week) at the site boundary (Location HQ) commenced at the end of April following heavy precipitation which resulted in flow off-site for the first time in several years. Figure 20 provides an eighteen year review of liquid discharge volumes to the Peconic River and flow estimates for the Peconic River on-site. The data indicate that there was no measurable flow at the site boundary between 1983 and 1988. Non-quantifiable flow has existed at Location HM since 1984 due to vegetation growth in the river bed downstream of the weir. Between 1985 and 1988, water levels at Location HQ have been below the conduit which transports water from the BNL site to the weir at Location HQ. Vegetation growth below the weir is now too dense to permit flow measurement using the currently installed equipment. At Location HM, grab samples are collected typically three times each work week. Samples collected at Stations HR and HH were quarterly grab samples.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 33 and 34. The data indicate that gross beta and tritium are present above ambient levels at Locations HM and HQ. Cesium-137, and strontium-90 are present above ambient levels in BNL effluent waters at Location HM. Beyond Location HQ, the data suggests minimal, if any, impact due to BNL liquid effluent releases to the Peconic River.

3.3.5.2 Nonradiological Analyses

Measurements of selected nonradiological water quality parameters were performed at the former site boundary (Location HM). Analytical results are presented in Appendix D, Table 35. A pH range of 2.6 - 7.6 was observed at this location. The results for metal analyses are presented in Appendix D, Table 36. Metals such as silver, arsenic, chromium, and selenium were not detected. Cadmium and lead were occasionally detected at the lower limit of detection while concentrations of copper, manganese, and zinc were all below the NYS DWS. Iron was the only metal found in concentrations which exceeded the NYS DWS.

In 1989, surface water samples were also collected along the Peconic and Carmen's Rivers. These samples were analyzed for water quality parameters. The analytical results are presented in Appendix D, Table 37.

3.3.6 Aquatic Biological Surveillance

The Laboratory, in collaboration with the NYSDEC Fisheries Division, has an ongoing program for the collection of fish from the Peconic River and surrounding

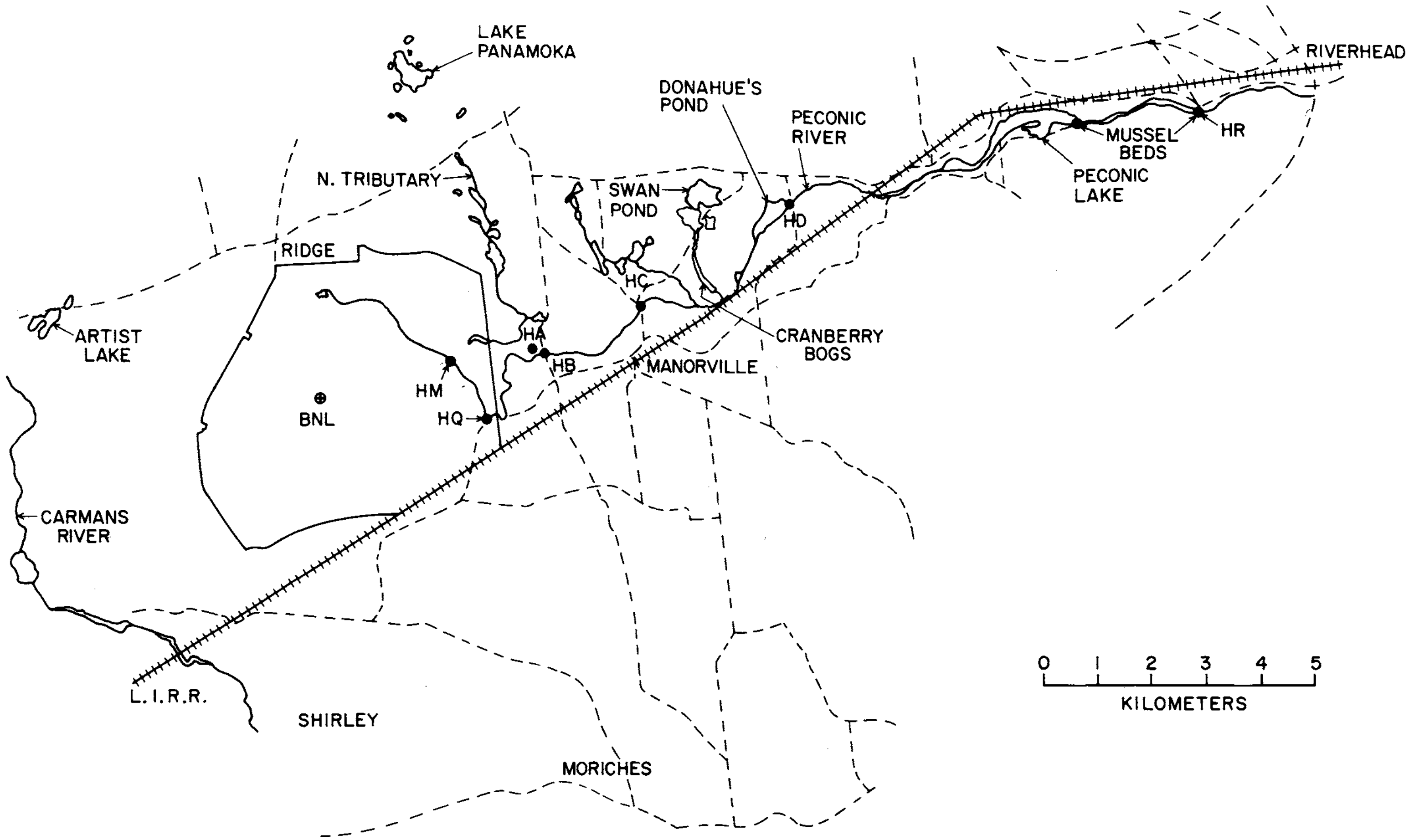


Figure 19: Peconic River Sampling Stations

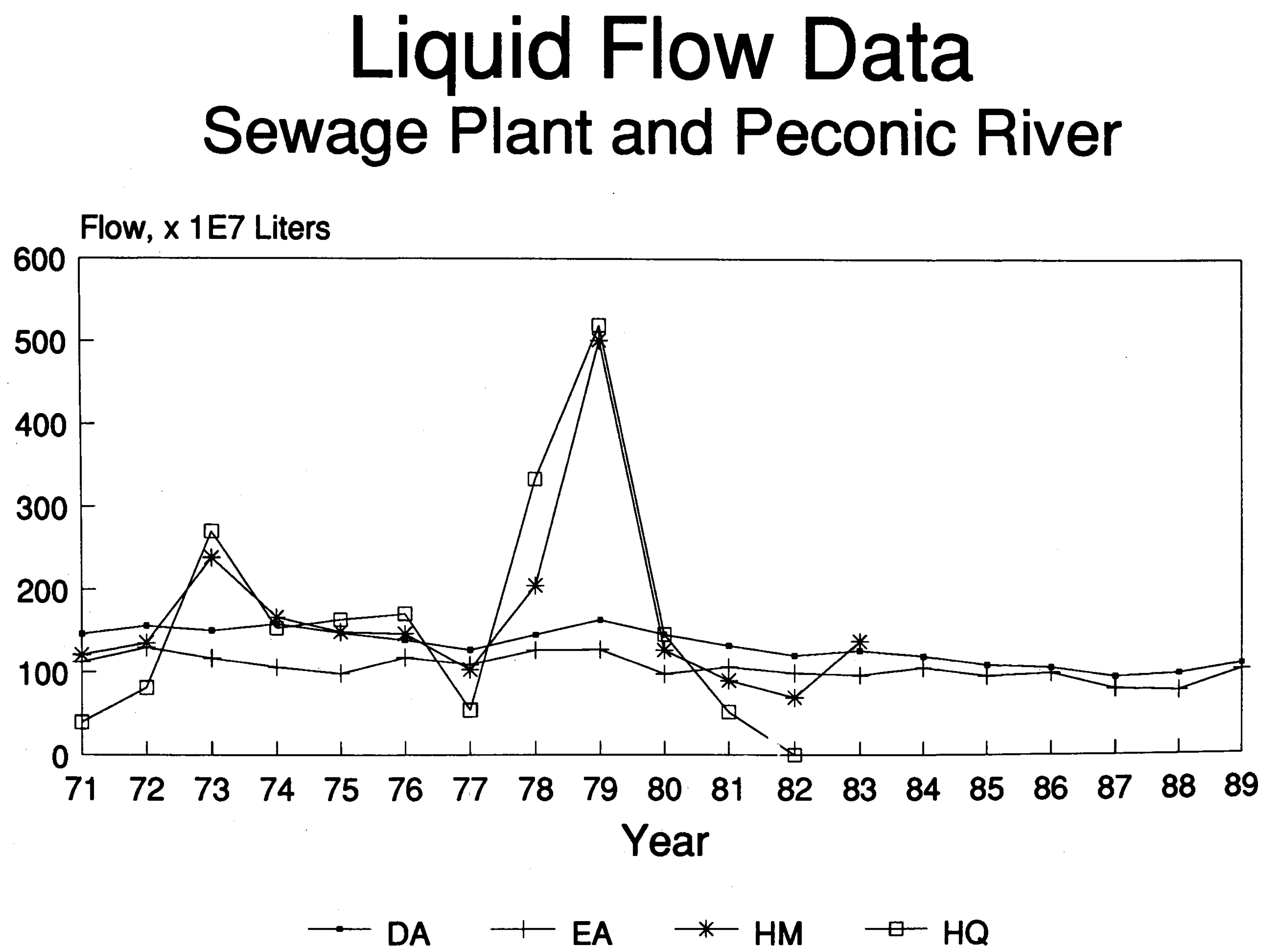


Figure 20: Liquid Flow Data - Sewage Treatment Plant and Peconic River On-site 1971 to 1989

fresh water bodies (Figure 19). In 1989, fish samples from the Peconic River were collected at Location HM and Forge Pond. Control samples were collected from Swan Lake and an on-site recharge basin (HS). Specific information regarding the sampling point, distance from the BNL effluent release point, species of fish collected and analytical results are presented in Appendix D, Table 38. In calendar year 1989, gamma spectroscopy analysis was performed on these samples. The Peconic River fish contained cesium-137 concentrations which ranged from background levels at Forge Pond (50 - 300 pCi/kg-wet [1.9 - 11.1 Bq/kg-wet]) to 11,000 pCi/kg-wet [407 Bq/kg-wet] at Location HM. In 1988, fish samples were collected from the Peconic River at Locations EA, HM, Donahue's Pond and Forge Pond. Control samples were collected from Swan Pond. These samples were analyzed for strontium-90 during 1989 and the results are also reported in Appendix D, Table 38. Typical concentrations at Swan Pond ranged from 30 to 200 pCi/kg-wet (1.1 to 74 Bq/kg-wet) while on-site strontium-90 concentrations in fish flesh ranged from 50 to 5,000 pCi/kg-wet (1.9 to 190 Bq/kg-wet).

The Forge Pond analytical data for cesium-137 is not statistically different from the control data and is due to weapons test fallout. Strontium-90 data from Forge and Donahue's Pond indicate the presence of levels that can be attributed to BNL releases. Cesium-137 and strontium-90 concentrations detected at Locations EA and HM are clearly related to BNL effluent discharges. The maximum individual and collective dose from the aquatic biological pathway was calculated based on the 1989 cesium-137 and 1988 strontium-90 concentrations that were observed in samples collected off-site. Based on these results, the maximum individual committed effective dose equivalent was estimated to be 0.91 mrem (0.0091 mSv) and the collective committed effective dose equivalent was estimated to be 0.155 person-rem (0.00155 person-Sv).

In addition to fish samples, sediment and vegetation samples were collected and analyzed for gamma emitting radionuclides. The results are presented in Appendix D, Table 39. Analytical data for water samples collected at the time of sampling are also presented in this table. The presence of cesium-137 and cobalt-60 concentrations indicate BNL related contribution. Other radionuclides detected in these samples are cosmogenic or primordial in origin.

3.3.7 Potable Water and Process Supply Wells

Potable Well Nos. 4, 6, 7, 10, 11, and 12 supplied the majority of potable water for use at BNL during 1989. Due to mechanical problems, Well No. 4 was used to supply potable water on a limited basis during the first quarter of 1989. This Well was used on a regular basis during the rest of the calendar year. Potable Well Nos. 10 and 11 were removed from service effective March and October 1989 respectively, because the average concentration of 1,1,1-trichloroethane exceeded the New York State DWS of 5 μg/L. Process supply Well Nos. 101, 102, and 103 were used periodically during 1989 to provide cooling water to the AGS facility. Process supply Well No. 104 provided secondary cooling water to the MRR.

The Laboratory's potable water wells and cooling water supply wells are screened from a depth of about 15 m to about 46 m, in the Upper Glacial aquifer, with one exception. Well No. 104 is screened at multiple depths: 40 to 43 m in the Upper Glacial and 60 to 90 m in the Magothy aquifer. As was shown in

Figure 15, most of these wells are located west or to the northeast and are upgradient of the Laboratory's principle facilities in the local ground water flow pattern. As was indicated in Figure 16, about 20.3 MLD were pumped from these wells in 1989. Grab samples were obtained from the potable wells and supply Well No. 104 on a quarterly basis and analyzed for radioactivity, water quality indices, metals, chlorocarbon compounds, trihalomethane compounds, and BTX.

Process supply Well Nos. 101, 102, and 103 were not sampled in 1989 by Safety and Environmental Protection Division (S&EP). Water chemistry analyses were performed by the facility operators as needed to meet their operational requirements.

3.3.7.1 Radiological Analyses

The average radionuclide concentrations are reported in Appendix D, Table 40. The presence of cobalt-60 and sodium-22 in Potable Well Nos. 10, 11, and 12 appears to be related to Laboratory operations. Radionuclide concentrations in potable water are all small fractions of the applicable water standards or guides and do not pose a safety or health risk to individuals who drink or use the water on-site. The dose resulting from consuming 100% of the daily water intake from the highest concentration water sources would result in a committed effective dose equivalent of 0.015 mrem (0.00015 mSv). Quality Control samples consisting of distilled and tap water from Building 535 are analyzed daily for gross alpha, gross beta and tritium. These results are presented in Appendix D, Table 41 and can be used for comparison with other ground water sample results.

3.3.7.2 Nonradiological Analyses

The water quality and metals data for the Laboratory potable supply wells are shown in Appendix D, Tables 42 and 43 respectively. With the exception of pH, indices of water quality such as nitrates, sulfates, and chlorides were all well within the limits established in the NYS DWS [17,18]. The pH values in these wells ranged from 5.7 - 7.7 and are typical of Long Island [35,36].

Samples from potable wells were analyzed monthly for residual chlorine and the presence of coliform bacteria. The analytical results were included in the monthly reports submitted to the SCDHS. The analyses indicated that bacteria were not detected in samples and the BNL potable supply is well within the requirements of the EPA National Primary Drinking Water Standards [19] and the New York State Sanitary Code [17].

The majority of metals including silver, arsenic, cadmium, chromium, copper, mercury and lead were not detected in the Laboratory supply system or detected at concentrations near the analysis detection limit. Manganese and zinc were detected at trace levels. Iron was not detected in water samples collected at the well heads of Potable Well Nos. 10, 11, and 12. Iron was detected at ambient levels in Well Nos. 4, 6 and 7. The water from these latter wells is treated at the WTP to remove iron. Water distributed from the WTP (WTP-EFF) had no detectable iron. Sodium was detected in all wells at ambient concentrations.

Water samples are collected from the potable wells during the first month of each calendar quarter and are analyzed by a contractor laboratory which is certified by the NYSDOH for organic analyses in potable water. These samples are collected in order to monitor for compliance with NYSDOH requirements for a Community Water System and the National Interim Primary Drinking Water Regulations and are submitted to the DHS. The results of these compliance samples are presented in Appendix D, Table 44 and 45. These data indicate that the potable water at BNL met the NYS DWS or NYSDOH advisory limits [17,18,19], with the exception of Well No. 11 for 1,1,1-trichloroethane.

During the second or third month of each quarter, BNL also collects potable water samples which are analyzed on-site by S&EP for ten organic compounds. 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.

The BNL data indicated an average 1,1,1-trichloroethane concentration of 5 µg/L for Potable Wells Nos. 10 and 11, as compared to concentrations of 4 µg/L and 6.3 µg/L, respectively in the contractor laboratory analytical results. When potable water is determined to exceed DWS, the well with the identified contaminant is removed from service and tested in accordance with NYS protocols. The final decision to keep a well out of service or to permit use of the water is made following this testing phase. Potable Well 10 was observed to have contaminant concentrations in excess of the DWS in March 1989. It was removed from service at that time. The results of the intensive sampling and analysis program required by New York State indicated that Potable Well No. 10 water consistently showed levels exceeding the newly established NYS DWS of 5 µg/L (effective January 9, 1989). The decision to keep Well No. 10 out of service was made in July, 1989. Similarly, Well No. 11 was first observed to exhibit concentrations of 1,1,1-trichloroethane in excess of the DWS in October 1989. It was removed from service at that time. Intensive testing of Potable Well No. 11 resulted in the decision to keep this well out of service in December, 1989.

The results for 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene, (common contaminants detected in Long Island ground water) [35,36,37] are shown in Appendix D, Table 46. Trace amounts of 1,1,1-trichloroethane were detected in five potable wells and one supply well on the BNL site.

Water samples were also analyzed for trihalomethanes and BTX by BNL. These results are shown in Appendix D, Tables 47 and 48 respectively. In most cases, these compounds were either not detected in BNL potable water or detected in trace quantities which were below the NYS DWS.

3.3.8 Ground Water Surveillance

This network includes wells that are located both upgradient and downgradient of the following areas: on-site recharge basins, the STP sand filter beds, the Peconic River, the WCF, the CSF, the HWMF, the former landfill area, Building 650 sump, the army landfill ("X-26" site), and the current landfill. The location of all ground water surveillance wells is shown in Figure 21. Wells located in specific Sections (grids) of interest are shown in Figures 22 through 25. Appendix D Table 49 provides a cross reference index which assigns grid coordinates for each well to the location identifier which is used throughout the

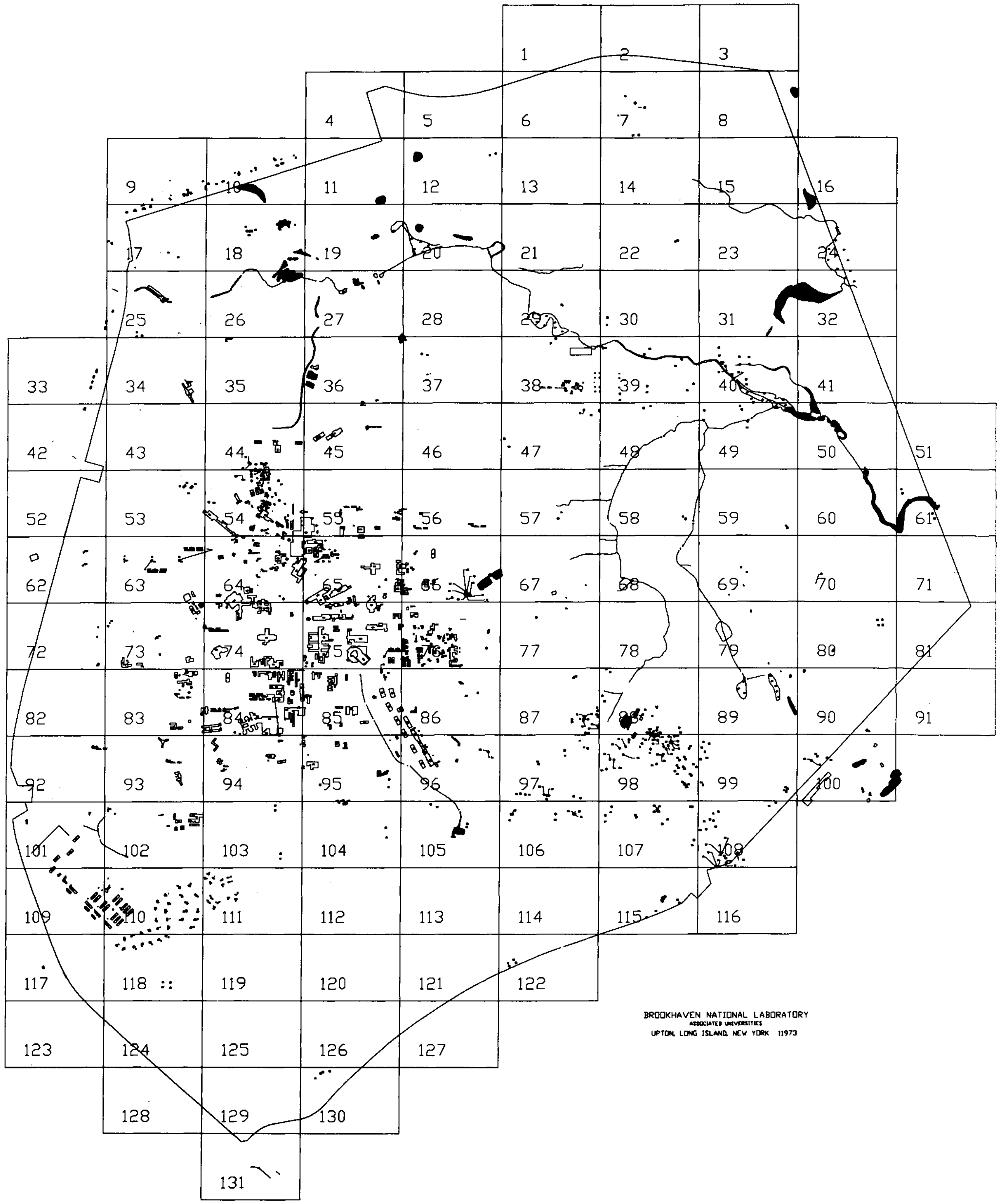


Figure 21: Location of Ground Water Monitoring Wells at Brookhaven National Laboratory

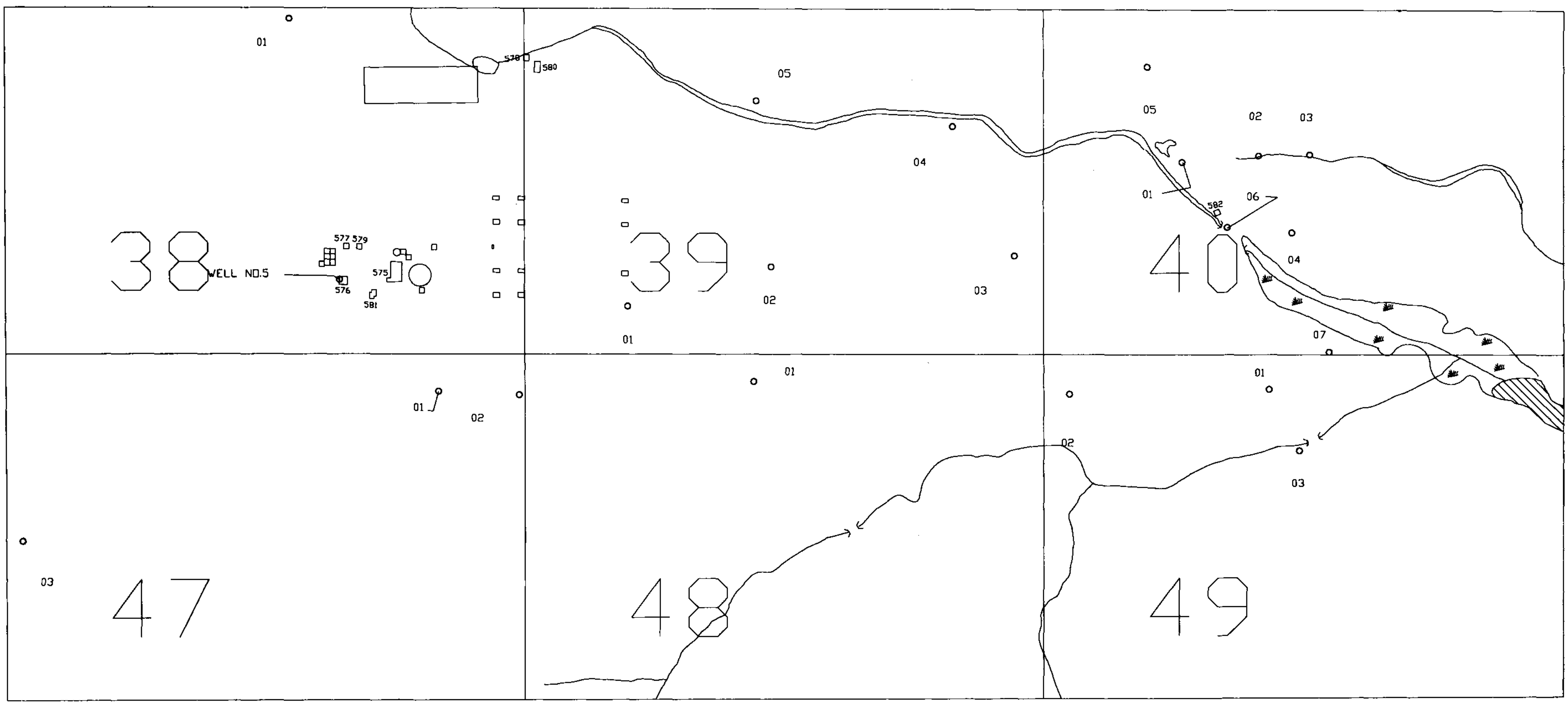


Figure 22: Ground Water Monitoring Wells - Peconic River Area

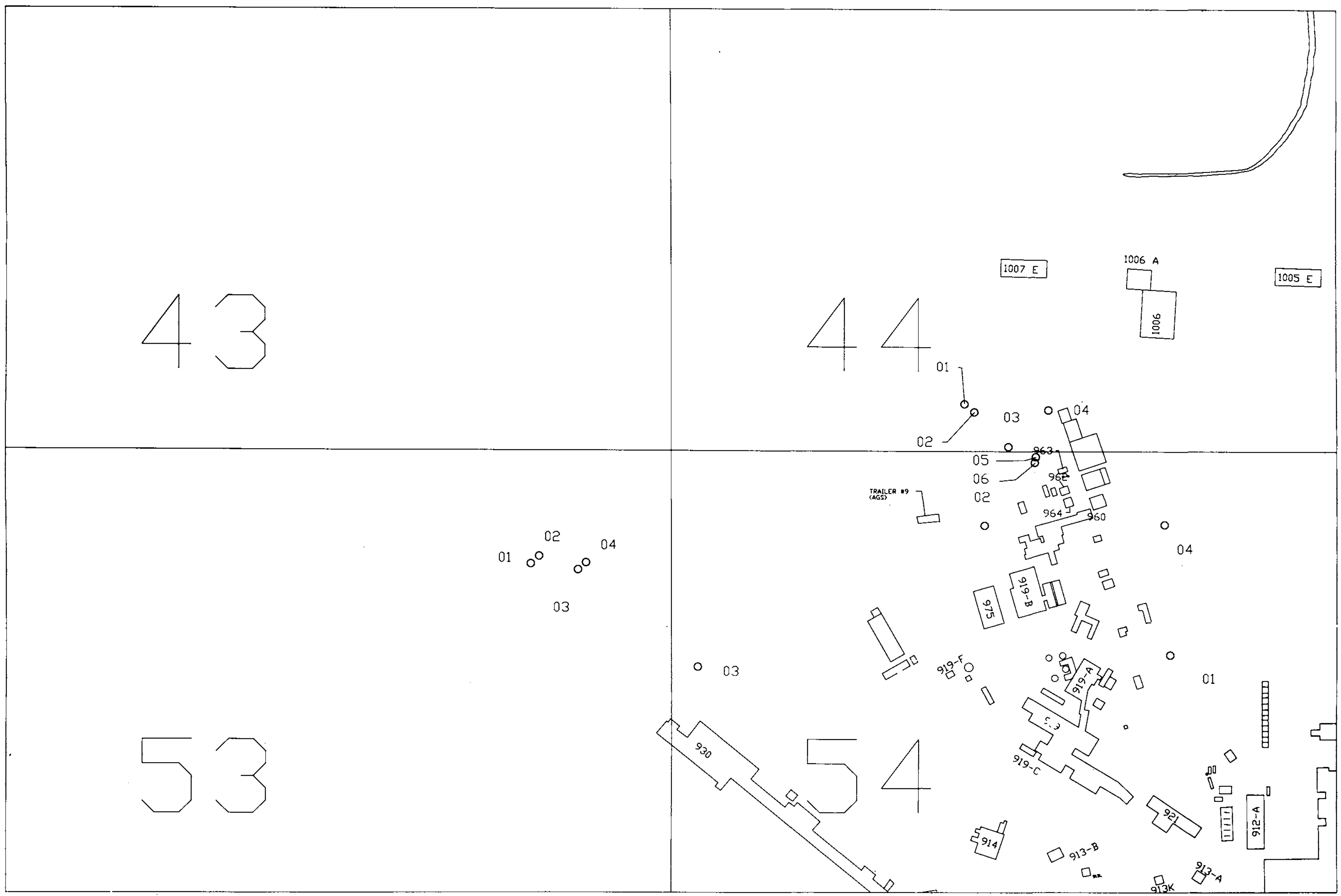
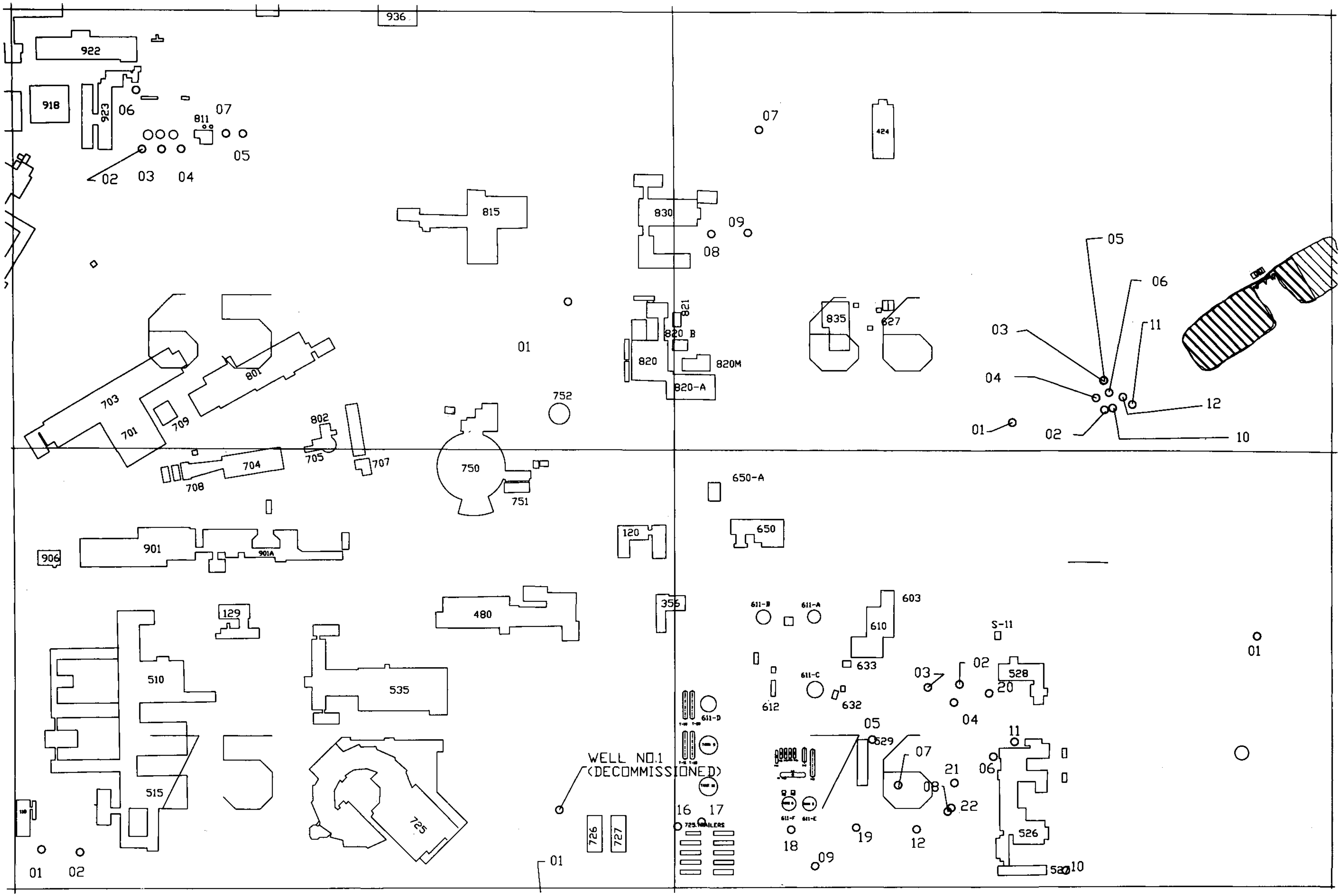


Figure 23: Ground Water Monitoring Wells - AGS Area



ɩgure 24: Ground Water Monitoring Wells – Central Portion of the Site

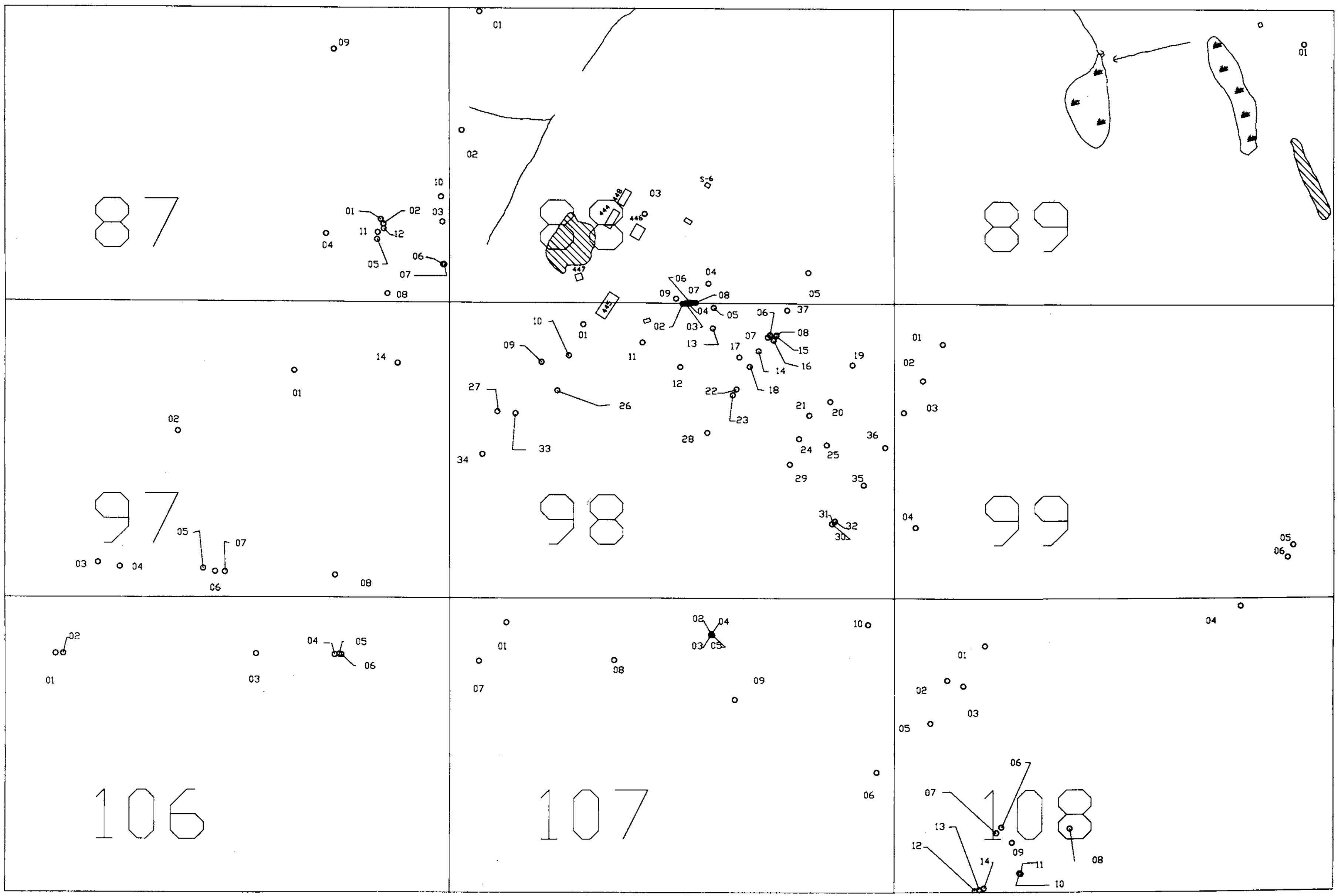


Figure 25: Ground Water Monitoring Wells - Waste Management and Landfill Areas

report. The data present in subsequent text and tables are compared to RCGs to determine compliance with operational limits and, because the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" [38], the data are also compared to the EPA [19] and NYS DWS [17,18].

3.3.8.1 Radiological Analyses

The yearly average concentrations of radionuclides in samples from the wells adjacent to the sand filter beds at the STP, downstream on the Peconic River and adjacent to the Meadow Marsh - Upland Recharge area are summarized in Appendix D, Table 51. The location of these wells is presented in Figures 21 and 22. Elevated gross beta and tritium concentrations have been found in on-site wells adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to losses from the tile collection field underlying the sand filter beds and from the recharge to ground water from the Peconic River in this area. In 1989, on-site gross beta ground water concentrations ranged from not detectable to 9% of the NYS DWS. Tritium concentrations ranged from detection limits to 26% of the NYS DWS. Strontium-90 concentrations ranged between 1% and 116% of the NYS DWS. Of the 15 wells monitoring these sites, only water collected from one of fifteen wells exceeded the NYS DWS for strontium-90 of 8 pCi/L and this well was sampled only once as per the 1989 sampling program schedule. Gamma-emitting radionuclides, although detectable at Well Nos. XA and 39-05, were far below applicable standards. Daily ingestion of water for one year from a well in this area that contained the maximum annual concentration observed in the sampling program for each specific radionuclide would result in a committed effective dose equivalent of 1.1 mrem (0.011 mSv) (28% of the NYS DWS). This dosimetric value is dominated by the single measurement of strontium-90 in Well XY (78% of the total) and thus, along with the conservative assumption that the highest concentrations from several different locations could migrate into a single well, represents a highly conservative estimate of the dose.

In 1989, the cooperative program between BNL and the SCDHS continued for the collection and analysis of samples from wells serving private homes. In this sampling program, samples were collected quarterly from 16 private drinking water wells in Suffolk County. Twelve of these sampling stations were from homes near the Laboratory, with the remainder from locations randomly selected by Suffolk County. A total of 24 different locations were sampled in 1989. Samples were analyzed for gross alpha, gross beta, and tritium on a quarterly basis, while analyses for strontium-90 and gamma spectroscopy were performed annually. Results from this program, presented in Appendix D, Table 52, indicate that tritium was detected in private well samples collected from four locations adjacent to the Laboratory. The private wells, screened at depths ranging from 50 to 200 feet, had annual average tritium concentrations that ranged from 351 to 2,250 pCi/L (13 to 83 Bq/L). Although above background, these data were consistent with data collected since 1979, and were less than 11% of concentration limits and 3% of the dose limit specified by the NYS DWS [19] for community water supplies. One gross beta concentration at sample location No. 4 was clearly above normally observed levels. Gamma spectroscopy results from the same location in 1988 indicated that the contaminant is potassium-40. The SCDHS data indicate that the water from this well also contained pesticide and fertilizer contaminants. The presence of elevated potassium concentrations is consistent with the agricultural product contamination that is also present in the water.

The data for the samples collected from control wells, wells in the northeast and west sectors, south boundary, central part of the BNL site, the current and former landfills, ash depository, and the hazardous waste management area are shown in Appendix D, Tables 53, 54, 55 and 56. At the former army landfill (Appendix D Table 53) most results were either below the system detection limits or typical of ground water not contaminated by laboratory operations, except for one measurement each at locations IT1D and IT2D. Well IT1D showed gross beta levels of 4 pCi/L (0.15 Bq/L) which is well below the NYS DWS of 50 pCi/L (1.9 Bq/L). Beryllium-7 was detected at a concentration of 11 pCi/L (0.41 Bq/L) in Well No. IT2D; which is comparatively insignificant relative to the RCG and would represent a committed effective dose of less than 0.001 mrem (0.00001 mSv) or 0.02% of the NYS DWS. The presence of these radionuclides was seen only in the deeper surveillance wells at this site. In addition, trace amounts of strontium-90 were detected in all of the wells monitoring this area. Strontium-90 concentrations were consistent with ambient concentrations detected at the north boundary wells.

In the vicinity of the WCF (Appendix D, Table 53), radiological results for ground water monitoring samples indicated the presence of sodium-22 in most samples and a slightly elevated strontium-90 concentration at locations D8 and D10. The sodium-22 concentrations are related to operational activities at the AGS (i.e. storage of activated components outside or soil activation due to beam target interaction). The observed concentrations from detected radionuclides are below the NYS DWS and would contribute less than 0.3 mrem (0.003 mSv) if consumed annually.

In reviewing radionuclide data (Appendix D, Table 53 and Figure 21) from wells installed either as BNL boundary wells (in the northwest, west and south sectors) or as facility-specific upgradient wells, radionuclide concentrations above ambient levels were observed in Well No. 12-01, a north boundary well and in Well No. 84-01, adjacent to the Medical Department. Well No. 12-01 showed a tritium concentration of 2,910 pCi/L (108 Bq/L) which is only 15% of the concentration limit in the NYS DWS and also shows an elevated concentration of strontium-90 (1.06 pCi/L [0.04 Bq/L]) approximately 13% of the concentration limit in the NYS DWS. Also sodium-22 was detected in samples from Well No. 84-01 at a concentration of 14.6 pCi/L (0.54 Bq/L). This concentration, if ingested routinely, would result in a committed effective dose equivalent of 0.13 mrem (0.0013 mSv) which is a small fraction of the NYS DWS.

At the Building 650 Sump area (Figure 24), only one well was capable of being sampled. The radiological data (Appendix D, Table 54) from this sample indicate trace levels of gross beta activity. The activity, although detected, is substantially below drinking water limits.

Ground water monitoring performed in the vicinity of the CSF (Appendix D, Table 54) indicated the presence of tritium, cobalt-60, cesium-137 and strontium-90. The observed concentrations, if ingested for an entire year, would result in less than 8% of the NYS DWS. Radionuclide results for ground water samples collected along Brookhaven Avenue between the Photography and Graphic Arts (P&GA) and the NSLS buildings contained trace quantities of tritium and sodium-22 and are presented in Appendix D, Table 54.

At the MPF, four new wells were monitored in 1989 and monitoring of wells D8 through D14 was discontinued. The change in monitoring practices occurred because the IT CSF Subsurface Contamination Investigation [20] determined that wells located near the CSF and WCF had been installed incorrectly. Wells D8 through D15 had been installed approximately 20 feet below the water table. While these wells are still useful monitoring tools for baseline purposes and investigations concerning center of the site activities, they do not serve their original intended purpose of monitoring operations at these facilities. The radiological results for the new wells are presented in Appendix D, Table 54. Tritium, cobalt-60, cesium-137 and strontium-90 were detected in some of these samples at concentrations significantly below the NYS DWS.

At the current landfill, (Appendix D, Table 55, Figure 25) elevated gross beta, tritium, fission and activation product concentrations were detected. The presence of these radionuclides in ground water samples is the result of BNL's past practice of placing low specific activity material on the landfill. This practice was discontinued in 1978. In general, all wells immediately down-gradient of the current landfill exhibited elevated gross beta, tritium, strontium-90, and sodium-22 concentrations. The annual average concentrations at each monitored location are below the nuclide specific concentration limits identified in the EPA DWS [19]. The committed effective dose equivalent as calculated by using the highest annual average concentration for each radio-nuclide detected in this area and an ingestion rate of two liters of water per day for one year, would be 1.2 mrem or 31% of the EPA DWS [19]. Wells W6 and 562 are upgradient wells and data from these wells can be used as baseline information to aid in the evaluation of the landfill's impact on water quality.

The radionuclide concentrations in ground water near the former landfill are generally much lower than the concentrations detected at the current landfill. Except for Well No. D6, most gross alpha, beta and tritium concentrations are at or below the system MDLs and are consistent with prior years data [10]. Data from Well No. D6 exhibit elevated gross beta and strontium-90 concentrations. The strontium-90 concentration is four times the value specified in the NYS DWS. Several well water samples from this area also contain trace quantities of fission and activation products. These concentrations are all below levels of regulatory concern. At the ash repository (Appendix D, Table 55) all results were at ambient concentrations or below the system detection limit.

The ground water monitoring program conducted at the HWMF (Figure 25) consists of a shallow well network located near the facility and a set of deeper wells that extends out from the facility in the direction of ground water flow. The radiological results for the samples collected from this program are presented in Appendix D, Table 56. The annual average concentration of strontium-90 exceeded the NYS DWS at two wells in this area. The two wells, locations MW2 and MW7A, had water concentrations that were 62% and 70% respectively of the gross beta NYS DWS while strontium-90 concentrations were 4.2 and 3.6 times the NYS DWS. The remaining sample locations show concentrations that range from $<$1% to 53% of the NYS DWS. The average tritium concentration at all wells was below the NYS DWS. Gamma emitting radionuclides that were detected at these sampling locations and are not specified in the DWS were compared to RCGs. Ground water concentrations at all site boundary stations were well within regulatory guidelines.

In addition to the routine ground water monitoring program, gross alpha, gross beta, and tritium analyses were performed on a monthly to quarterly basis for samples collected from the spray aeration project wells. These wells are indicated in Figure 25. The pumping Well Nos. PW1, PW2 and PW5 were inactive from January to April and were operated from April through December, 1989. Pumping Well Nos. PW3 and PW4 ran virtually all year. The radiological results from this sampling program are presented in Appendix D, Table 57. These data indicate that the gross beta activity declines with distance from the HWMF. Tritium concentrations were detected in all surveillance and spray aeration pumping wells. The tritium concentration increases with distance from the center of the HWMF until a relatively uniform concentration is reached near wells PW2 through PW4. In addition to tritium, low concentrations of strontium-90, below the NYS DWS were detected in the spray aeration project wells.

3.3.8.2 Nonradiological Analyses

The data for wells adjacent to the sand filter beds and downstream of the Peconic River on- and off-site (Figure 21 and 22), are shown in Appendix D, Tables 58 - 62. In general, the data for samples obtained from these wells were comparable to those observed during previous years [10]. The water quality data for this series of surveillance wells is reported in Appendix D, Table 58. Conductivity, chlorides, sulfates and nitrate-nitrogen were not significantly different than values observed in BNLs control wells. The pH ranged from 5.0 to 8.4 which shows a slightly wider variation in pH than observed in control wells. Cadmium, copper, lead, and zinc concentrations were detected in concentrations below NYS DWS [18]. Arsenic, chromium and silver concentrations were all less than or equal to the method minimum detectable concentration. Manganese concentrations that exceed NYS DWS were observed at two well locations, XC and X2, while iron concentrations that exceeded NYS DWS were observed in five monitoring wells. These metals were not observed in significant concentrations in either the influent or effluent from the STP. The observed concentrations of iron, lead, and manganese is believed to be the result of contamination from the metal casing since they were installed more than 20 years ago. Consequently low concentrations of these metals can be anticipated and are not likely to be associated with facility-specific operations.

These wells were also analyzed for chlorocarbon, trihalomethane and BTX compounds. As can be seen from the data in Appendix D, Tables 60 and 61, except for a single positive value of 1,1,1-trichloroethane and chloroform at Well XA, all results for chlorocarbon and trihalomethane compounds were below the system detection limits. All results for BTX, Appendix D, Table 62, were below the system detection limits.

The surveillance data for the current and former landfills, and ash repository wells are shown in Appendix D, Tables 63, 64, 65, 66 and 67. The BNL current landfill is operated in an interim capacity, while BNL and DOE complete consent orders with NYSDEC for the continued operation and closure of this facility. Data from wells monitoring the BNL current landfill are reported quarterly to NYSDEC.

The data from the current landfill wells indicate that the pH, ranged from 4.7 to 7.8, sulfates and nitrate-nitrogen concentrations were consistent with on-site control well data, and chromium was below detection limits. While the presence of conductivity, chlorides, mercury and zinc were detected at concentrations above ambient levels, these parameters were well below the NYS DWS. Lead was detected in most wells below the NYS DWS except for concentrations in well 1K which exceeded the standard by a factor of 1.4. Iron and manganese were detected at all wells in concentrations which exceeded the NYS DWS. The presence of most of these parameters in ground water samples collected from this area is consistent with landfill activities.

At the former landfill area, the pH ranged from 5.0 to 7.4 and water quality parameters were consistent with data from control wells. Silver, chromium, copper, arsenic and lead were not detected in water samples from these wells. Copper, zinc, manganese and iron were periodically detected at this location. Iron and manganese were observed in three wells and two wells respectively at average concentrations above the NYS DWS and are consistent with past landfill activities.

The ground water surveillance wells at the landfill areas and control wells were analyzed for chlorocarbon, trihalomethane and BTX compounds. At the current landfill, benzene was detected at downgradient well locations. Three of these concentrations exceeded NYS DWS. Toluene was detected in two wells, but exceeded NYS DWS in only one of these. The presence of xylene was indicated in six wells, with one exceeding NYS DWS. None of the other organic compounds which BNL analyzes for were detected consistently above method MDLs at the current landfill. At the former landfill, eight wells contained concentrations of 1,1,1-trichloroethane and four wells contained tetrachloroethylene, trichloroethylene, and chloroform. Only two wells (D3 and WQ) exceeded the NYSDOH advisory guideline for both 1,1,1-trichloroethane and tetrachloroethylene. All other compounds were well below applicable standards. Trace quantities of xylene were detected in two wells at the former landfill area. The wells at the landfill areas will continue to be sampled to monitor the impact of past or current BNL operations on the shallow portions of the underlying aquifer.

The average water quality and metals data for the HWMF are presented in Appendix D, Tables 68 and 69. Metals such as silver, chromium, and cadmium were not detected in any of the wells. Trace concentrations of arsenic, copper, mercury, manganese, lead and zinc were detected sporadically. Iron and manganese were detected at ambient (trace) levels and were consistently well below NYS DWS. In general, iron and to a lesser extent zinc concentrations declined slightly compared with 1988 data [10].

At the HWMF, the routine ground water monitoring program consists of a shallow well network located near the facility and a set of deeper wells that extend out from the facility in the direction of ground water flow. The results for organic analyses performed on samples collected from these wells are presented in Appendix D, Tables 70 - 72. The presence of 1,1,1-trichloroethane was observed in all but two (MW1 and 2L) of these surveillance wells. The average annual concentration of 1,1,1-trichloroethane exceeded the NYS DWS at monitoring Well Nos. MW13, MW10, MW2, MW3 and MW8. At Wells MW5 and MW7A, the average 1,1,1-trichloroethane concentrations equalled the NYS DWS. Trichloroethylene was observed in eight wells in 1989; however, NYS DWS were exceeded only in MW8 and MW13. Although tetrachloroethylene was detected in eight of these surveillance wells, it exceeded the NYSDOH advisory guidelines only at Well Nos. MW2, MW8, and MW13. The average annual concentration of 1,1,1-trichloroethane and tetrachloroethylene reported for Well No. MW2 in Appendix D, Table 70, is an underestimate of the true value. The concentration of these compounds in this sample exceeded that of the highest standard used to establish the instrument calibration curve. Since a replicate sample was not available, the value for this sample was reported as the upper limit of the calibration curve.

The average trihalomethane data from these surveillance wells are presented in Appendix D, Table 71. Chloroform was the only trihalomethane compound detected. It was observed in trace amounts in all but six wells and all values were below the NYS DWS. As can be seen from Appendix D, Table 72, benzene was detected in only trace concentrations in MW2, with xylene and toluene indicated at trace levels in MW5.

In addition to the shallow and deep surveillance well network, monitoring results are available from the five pumping wells used in the spray aeration project. These data are presented in Appendix D, Tables 73 - 77. Water quality parameters at these wells are consistent with control well results. Silver, cadmium, chromium, manganese and zinc were not detected at any of these wells. Copper was detected only in Well PW1 at a concentration well below NYS DWS. Both iron and lead concentrations exceeding NYS DWS were observed in PW1, but may be related to the well itself, since no other pumping or surveillance wells in the HWMF experienced comparable concentrations.

The spray aeration project was initiated in 1986 in order to remediate ground water contaminated with VOCs. Organic compound results are found in Appendix D, Tables 75 to 77. No detectable quantities of BTX, chlorodibromomethane, bromodichloromethane or bromoform were found. Detectable quantities of chloroform, trichloroethylene and tetrachloroethylene were found in wellhead samples from most of these locations. The compound 1,1,1-trichloroethane was detected in all spray aeration project wellhead samples. Using the pre- and post-spray data from the 1987 and 1988 sampling periods, the over-all pumping/spraying process is at least 95% efficient in the remediation of the ground water [10].

The 1,1,1-trichloroethane plume path has generally followed the pattern displayed by tritium during the 1987 and 1988 sampling periods; however, downtime of several of the pumping wells during the first quarter of 1989 has obscured this trend to some extent [10]. Based on the significant difference in iron concentrations observed between the landfill and HWM areas, both the tritium and organic contamination of ground water in this section of the site is believed to be the result of past activities at the HWMF and not related to operation of either the current or former landfill.

The MPF is the holding area for most fuels used at the CSF. The potential for ground water contamination in this area is monitored by one upgradient well and 13 downgradient wells. The results for water quality, metals, and organic analyses performed on samples collected from these surveillance wells are presented in Appendix D, Tables 78 through 82. The water quality parameters are consistent with ambient levels. Metals such as silver and arsenic were not detected in any of these wells and only trace concentrations of lead, cadmium, chromium, copper and zinc were observed periodically. Manganese was found in four of these wells in concentrations which exceeded NYS DWS. Mercury was found in two wells and iron in four wells which exceeded the NYS DWS.

Analyses of samples from this location for petroleum products identified the presence of BTX compounds at concentrations in excess of the NYS DWS in several of the new monitoring wells that straddle the surface of the water table. These wells were installed by IT Corporation during their Subsurface Contamination Investigation at the CSF [20] of a 1977 spill. Further discussion is presented in Section 8.1 of this report. The average annual concentration of toluene and xylene reported for Well No. IT1 in Appendix D, Table 82, is an underestimate of the true value. The concentration of these compounds in this sample exceeded that of the highest standard used to establish the instrument calibration curve. Since a replicate sample was not available, the value for this sample was reported as the upper limit of the calibration curve. Free product (oil floating on top of the ground water) was not observed at any of these locations.

The WCF was also monitored using five wells which surround this facility. The analytical results for water quality parameters and metals (presented in Appendix D, Tables 83 and 84) are typical of ambient levels. Silver, arsenic, cadmium, chromium and lead were not detected in any samples. Iron, copper and zinc were observed in all wells at this facility at trace levels below NYS DWS. Manganese was detected in a sample from the well upgradient to the WCF in excess of the NYS DWS. Organic analyses were performed on samples from this area; the average chlorocarbon data are presented in Appendix D, Table 85. 1,1,1-trichloroethane was detected in all samples from these wells exceeding NYS DWS. The average value reported for Well No. D10 is an underestimate of its true values. The concentration exceeded that of the highest standard used to establish the instrument calibration curve. Since a replicate sample was not available, the maximum value of the system calibration was used as the reported value. Trichloroethylene was detected in three wells, all below NYS DWS. Tetrachloroethylene was not detected in any samples from these wells. As can be seen in Appendix D, Tables 86 and 87, chloroform and xylene were detected sporadically in these surveillance wells, with xylene occurring above DWS only in Well No. D8.

No significant radiological or non-radiological ground water impacts were observed in the area of the AGS. This area was focused on by the DOE Environmental Survey as a storage area for scintillating fluids. In order to monitor ground water at this facility, DOE installed four monitoring wells during 1988, including both an upgradient and downgradient couplet (shallow/deep well combination).

4.0 OFF-SITE DOSE ESTIMATES

4.1 Dose Equivalents due to Airborne Effluents

The major radionuclides released from BNL airborne effluent discharge points were tritium, oxygen-15, and argon-41. The measured tritium concentrations and dose equivalents at the site boundary are shown in Appendix D, Table 101. The highest annual average site boundary concentration of tritium vapor was 8.23 pCi/m^3 (0.3 Bq/L) at monitoring location 10 (SSW Sector) and the committed effective dose equivalent (inhalation and skin absorption) was 0.006 mrem (0.00006 mSv) for the hypothetical individual residing at that location. By comparison, the site boundary tritium dose calculated using source term data and both AIRDOS-EPA and AIRDOS dispersion plus DOE dose conversion factors are presented in Appendix D, Table 102. The exposure rates due to argon-41 and oxygen-15 were not measured at the site boundary. The dose-equivalent rates for these radionuclides, calculated using both AIRDOS EPA and DOE dose conversion factors, are presented in Appendix D, Table 103. The maximum site-boundary dose-equivalent from argon-41 and oxygen-15 was calculated to be 0.098 mrem/a (0.00098 mSv/a). The maximum site boundary dose from all three radionuclides plus the radionuclides released in May from Building 801 was 0.120 mrem/a (0.0012 mSv/a). Figure 26 presents the site boundary dose as a function of direction for all airborne releases.

The collective (population) dose equivalent was estimated for radionuclides released to the airborne environment using measured effluent release data and recorded BNL meteorological parameters. Using actual source terms and meteorological data at the given release point should yield the best projection of airborne concentrations, and thus dose to the general population. This approach also minimizes the effects of local micrometeorological conditions which may exist, resulting in differences between the measured and expected tritium concentrations at the perimeter monitoring stations.

Collective total body doses resulting from the 10 meter, 45 meter, and 100 meter release heights are shown in Appendix D, Table 104. Argon-41 contributed essentially the entire collective dose equivalent 2.98 person-rem (0.0298 person-Sv). The dose equivalent contributions from tritium and radioiodines were 0.044 and 0.0002 person-rem (0.00044 and 0.000002 person-Sv), respectively. This is depicted graphically in Figure 27. The computer models AIRDOS-EPA and DOE dose conversion factors applied to AIRDOS estimated concentrations were both used to determine the collective and maximum individual dose estimates. In the text of this report, only doses computed using DOE dose conversion factors have been reported. The 1989 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 3.02 person-rem (0.03 person-Sv). This can be compared to the 1989 population collective dose-equivalent due to cosmic and terrestrial natural background of 300,000 person-rem (3,000 person-Sv). The Laboratory airborne releases comprised 0.0007% of the total dose due to natural background.

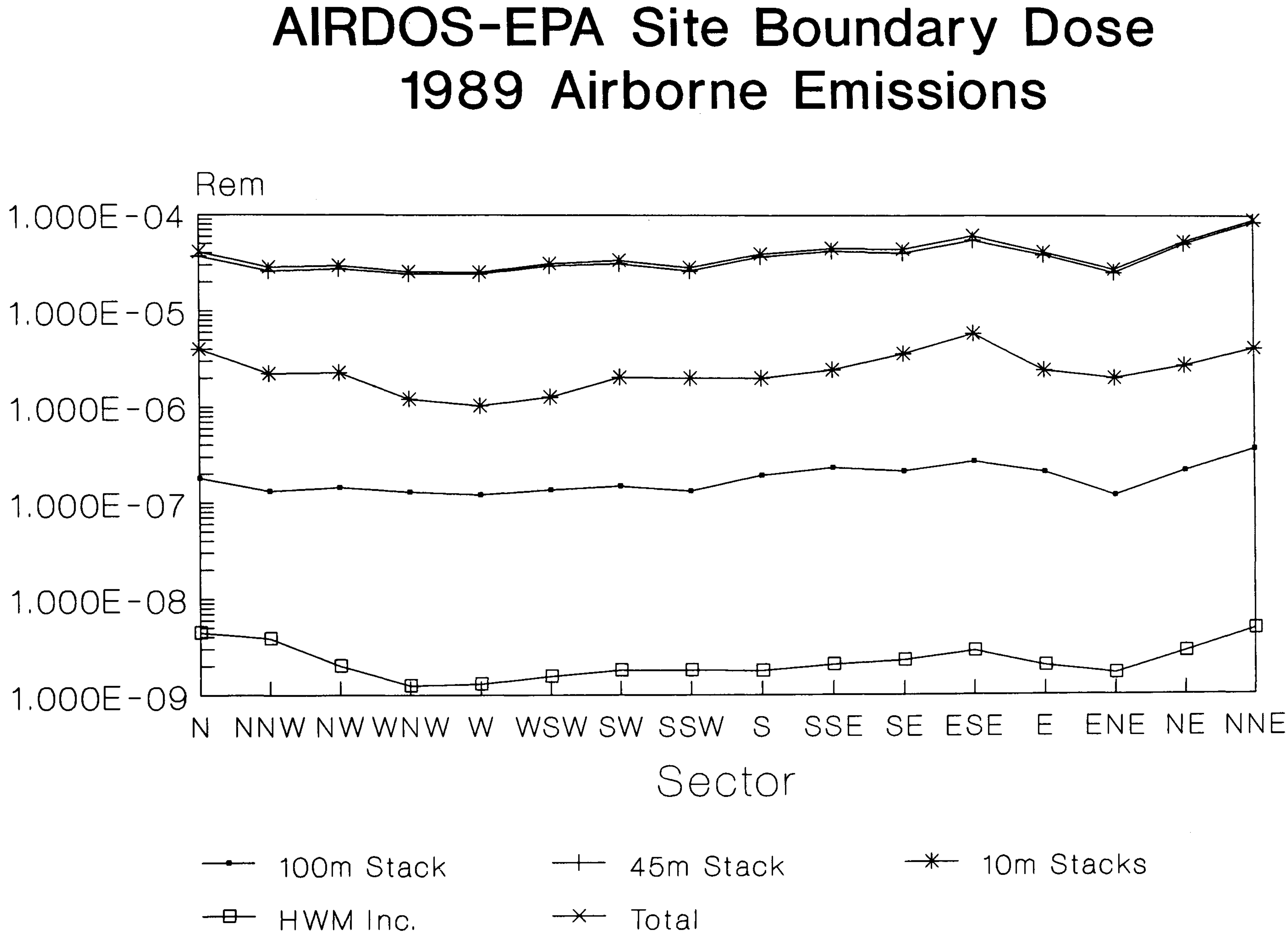


Figure 26: AIRDOS-EPA Site Boundary Dose 1989 Airborne Emissions

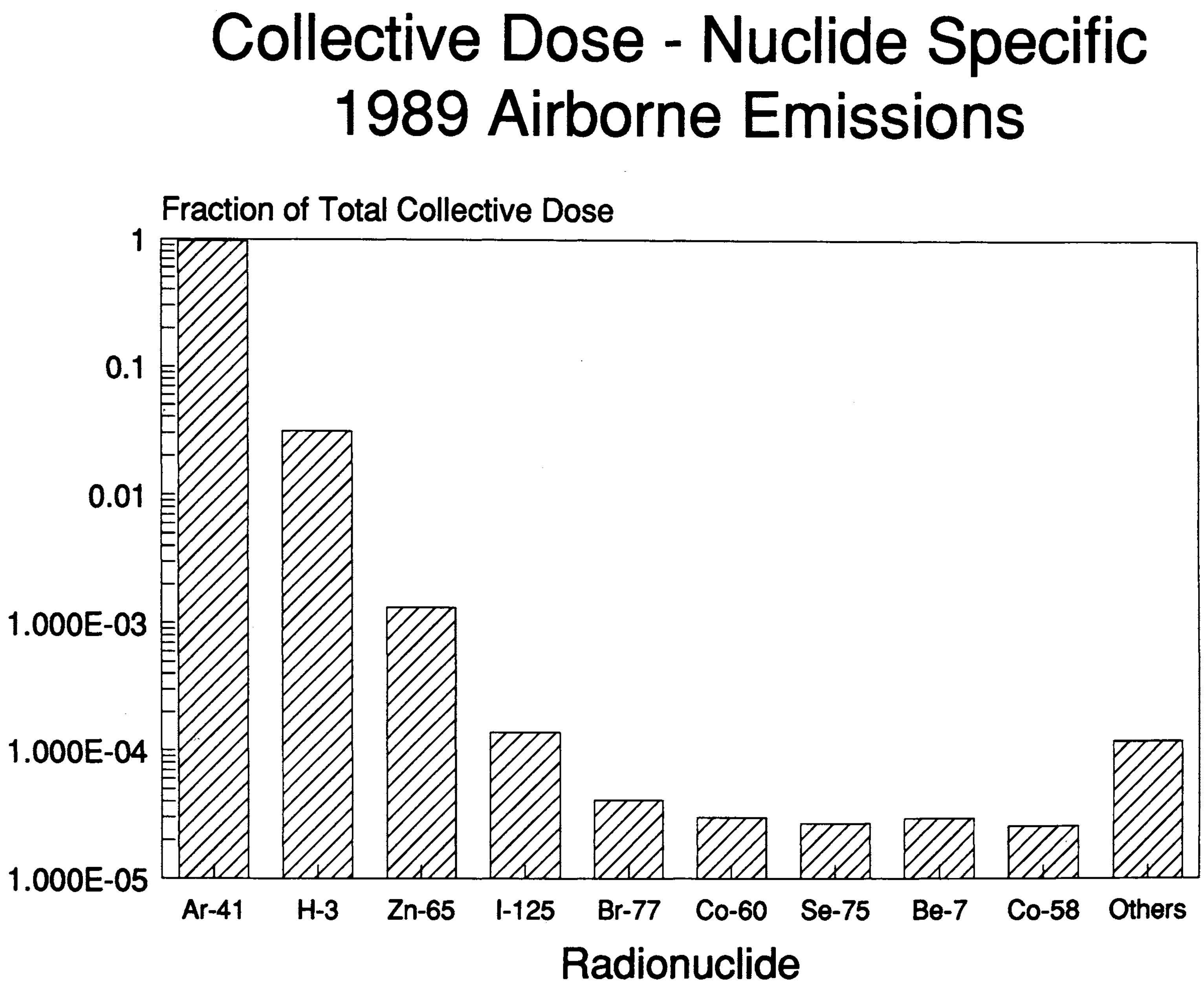


Figure 27: Collective Dose from Airborne Emissions in 1989

4.2 Dose Equivalents due to Liquid Effluents

Since the Peconic River is not used as a drinking water supply [39], nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. However, the Peconic River does recharge the aquifer and act as a limited source for sport fishing. In 1989, the collective dose equivalent resulting from the discharge of radioactive materials to the Peconic River has been computed by evaluating private potable water.

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 2,250 pCi/L (83 Bq/L). The average concentration for the group of positive tritium concentrations was 1,050 pCi/L (39 Bq/L). This corresponds to a committed effective dose equivalent to the maximum individual of 0.05 mrem (0.0005 mSv) and a collective dose equivalent to the population at risk (assumed to be not more than 500 persons) of 0.023 person-rem (0.00023 person-Sv). The data are summarized in Appendix D, Table 105.

The cesium-137 concentrations in fish samples collected from Peconic River and control locations are reported in Appendix D, Table 38. Using the method described in Appendix C, the maximum individual committed collective dose equivalent was calculated to be 0.91 mrem (0.0091 mSv). The population collective dose equivalent was calculated to be 0.155 person-rem (0.00155 person-Sv). The water and fish pathway dosimetric results are summarized in Appendix D, Table 105.

4.3 Collective (Population) Dose Equivalent

The collective (population) dose equivalent (total population dose) beyond the site boundary, within a radius of 80 km, attributed to Laboratory operations during 1989 was 3.2 person-rem (0.032 person-Sv) and was obtained by the summation of the doses from the pathways discussed previously in this report. The data are summarized in Appendix D, Table 106.

The collective dose equivalent due to external radiation from natural background to the population within an 80-km radius of the Laboratory, amounts to about 300,000 person-rem/a (3,000 person-Sv), to which about 97,000 person-rem/a (970 person-Sv) should be added for internal radioactivity from natural sources.

5.0 REGULATORY AFFAIRS

5.1 Brookhaven National Laboratory - Suffolk County Agreement

In September 1987, BNL formalized an agreement [40] with the County of Suffolk wherein these two organizations in the spirit of comity move to achieve the highest practical level of environmental protection to the citizens and lands of Suffolk County. While it is recognized that the Laboratory makes every effort to operate in compliance with all applicable Federal and State regulations, in accordance with this agreement, BNL has made a commitment to conform with the applicable environmental requirements of the Suffolk County Sanitary Codes related to public health and environmental protection. As a result of this agreement, several areas of activity have taken place since its formalization. These activities are discussed in more detail in Sections 5.1.1, 5.1.2, and 5.1.3 of this report. As a follow-up to routine activities and to ensure that information regarding issues of concern to both organizations reaches appropriate levels of management, senior management from SCDHS and BNL meet on a quarterly basis.

5.1.1 Facility Inspections

As part of this joint agreement, the Laboratory agreed to make their land and facilities available to representatives from the SCDHS to carry out their responsibilities in relation to the environmental requirements of the applicable Sanitary Codes. The objective of the SCDHS personnel in carrying out this responsibility, was to inspect all BNL facilities for compliance with Suffolk County Sanitary Codes Articles 6, 7, 10, and 12 [41,42,43,44]. The major areas to be evaluated during these inspections were storage tanks, drum storage areas, air emission points, and connections to the BNL STP. Inspections of BNL facilities were conducted on a weekly basis beginning in March 1988 and continuing until the end of the first quarter in 1989 at which time all BNL facilities had been inspected. Inspection findings and action plans were summarized in letters between BNL and SCDHS and periodically discussed at quarterly meetings.

5.1.2 Review of Engineering Design Drawings

BNL agreed to submit plans for construction that are regulated by Articles 6, 7, 10, and 12 [41,42,43,44] to the DHS for review for compliance with the environmental requirements of these codes. During 1989, a variety of engineering design drawings for the construction or modification of storage tanks, upgrading of drum storage areas, and connections to BNL STP were submitted to the DHS.

Two major construction projects that were reviewed by the DHS were the removal/replacement of underground storage tanks at Buildings 423 and 630, and connections to the BNL STP resulting from the elimination of existing cesspools at various locations on-site. DHS provided comments and approval for both projects. These projects and their status are discussed in further detail in Sections 7.1.1 and 7.1.2, respectively.

All comments provided by the DHS were reviewed and, where applicable, were incorporated into the final design plans. As part of the BNL engineering design review process, the collaboration with DHS on these reviews will continue in calendar year 1990.

5.1.3 Registration of Toxic Liquid Storage Facilities

The intent and purpose of Suffolk County Sanitary Code Article 12 [44] is to safeguard the water resources of the County from toxic and hazardous materials pollution. One of the requirements of this Article is that any facility in Suffolk County used to store toxic or hazardous materials, as defined by the DHS, must be registered with the DHS.

In accordance with Section 760-1207 of Article 12, BNL submitted Toxic and Hazardous Liquid Storage Registration Forms to the DHS in July, 1989. Approximately 200 storage facilities were registered in this submittal. Updates to this registration package will be submitted to the DHS as existing facilities are upgraded or new facilities are proposed.

5.2 SPDES Permit Renewal

BNL has a SPDES Permit from the NYSDEC which authorizes the discharge of the effluent from the STP to the Peconic River as well as the discharge of non-contact cooling water from various facility operations into five recharge basins on-site. This is issued by the NYSDEC and has a permit No. NY-000-5835. The expiration date for the BNL SPDES permit was May 1, 1988.

In accordance with the appropriate New York State SPDES permit regulations and procedures, BNL submitted an application package for the renewal of its SPDES permit to the NYSDEC on October 30, 1987. Under the NYS Uniform Procedures Act [45], when a permittee has made a timely and sufficient application for a permit, the existing permit does not expire until the application has been finally determined by the issuing agency. Therefore, the Laboratory has authorization to continue operating under the previous permit conditions.

Efforts on renewing the SPDES permit continued during calendar year 1989. These efforts centered on the preparation of requested materials on BNL operations including (1) mechanisms utilized to educate employees at BNL regarding the proper methods of handling and disposal of industrial wastes and (2) best management practices for waste management at BNL. This information was prepared in December 1989 and submitted to NYSDEC in January 1990.

5.3 Compliance with State Pollution Discharge Elimination System Discharge Limitations

Liquid effluent discharges to five recharge basins and the STP discharge to the Peconic River are subject to the conditions of the SPDES Permit Number NY-000-5835, authorized by the NYSDEC. Monthly reports are submitted to both the NYSDEC and the SCDHS which provide detailed analytical results and performance information regarding the operational activities at the STP. These data indicate a general compliance rate of greater than 99% for all parameters monitored. Monitoring data are presented in detail for this discharge point in Appendix D, Tables 10 - 12. Specific instances of noncompliance during 1989 include fifteen instances where pH measurements indicated liquid discharges between 5.4 and the

SPDES permit limit of 5.8; four occurrences of residual chlorine slightly in excess of the SPDES permit limit; and one instance each where ammonia-nitrogen, iron, and suspended solids were measured above their respective SPDES discharge limits. The pH of water that enters the STP is normally very close to neutral. As the liquid effluent passes through the sand filter beds, the pH is lowered by one pH unit. In an effort to correct for this, lime was applied to the sand filter beds. Since this practice was initiated there have been no pH excursions.

The SCDHS collects samples several times per year from the STP and conducts inspections of this facility on a quarterly basis for the NYS SPDES program. The analytical results of samples collected during 1989 have been within limits. The DHS inspections have typically rated the STP as satisfactory, however, on April 10, 1989 the SCDHS issued a Notice of Violation (NOV) regarding the condition of the sludge drying bed. The observations made by SCDHS essentially related to the placement of sludge on plastic lined sand beds. After receiving results for radiological and nonradiological parameters, which indicated the material as non-hazardous, the practice was to puncture the plastic and allow the water fraction of the sludge to drain into the sand. It was this aspect of the practice that was in question. The issue was resolved by presenting analytical data verifying that the material was non-hazardous and by removal of the sludge from the bed in early 1990. (See Section 6.6 of this report for more details).

The NYSDEC periodically collects samples from the STP. On January 27, 1989, representatives from the NYSDEC collected a sample of the STP effluent. The results indicated several compounds (mercury, nickel, and methylene chloride) in low concentrations that were not listed in the current SPDES permit. NYSDEC issued a NOV on March 31, 1989 and requested that BNL conduct a short term high intensity sampling program for these compounds to get more information on their anticipated concentrations for inclusion in the permit renewal. The sampling program was conducted during May, 1989. One sample was collected each week for three weeks. The results indicated all compounds to be below detection limits. This information was transmitted to NYSDEC in October, 1989.

At the recharge basins, flow and pH are the parameters that must be monitored under the conditions of the BNL SPDES permit. In addition, as part of the routine environmental monitoring program, water discharged to these basins are monitored for water quality, metals and radioactivity. The analytical results for samples collected from these basins are presented in Appendix D, Tables 13 - 15. These data indicate that except for pH and iron, the discharge to these basins met both the SPDES permit conditions and NYS DWS for metals and other water quality parameters.

A number of buildings at BNL are still served by cesspools that discharge to ground water. Although most of these pools receive only sanitary discharges, at twelve facilities the pools have the potential to receive industrial discharges from sinks and work areas. The industrial discharges to these cesspools are not in accordance with NYSDEC SPDES regulations and Articles 7 and 12 of the Suffolk County Sanitary Code [42,44].

BNL has a cesspool removal project to eliminate the pools servicing these facilities and connect these facilities to the site STP. NYSDEC was notified of this project in the 1987 SPDES renewal application and formally updated on

November 15, 1989. This project is discussed in more detail in Section 7.1.2 of this report.

5.3.1 Upstream Monitoring of Sewage Treatment Plant Influent

As part of corrective actions resulting from a June 1988 unplanned release of radioactive materials into the sanitary sewage system, a monitoring system was to be installed upstream of the sewage treatment plant that would provide advanced warning of liquid effluent streams that may have the potential to exceed SPDES permit conditions at the STP. A review of the sewer line system indicated that manhole #192, located about 50 meters down stream from the last point of entry into the sewer line system and about 1.8 km upstream from the STP, represented an ideal location. This placement offered the potential to collect an adequately mixed sample and provide approximately one hour of advanced warning prior to the effluent reaching the STP.

In 1989, a small weir was added into the sewer line in order to provide at least 45 cm of water at the monitoring point at all times; pH, conductivity and radioactivity measurement probes were installed in the waste stream; and, a small prefabricated building was placed beside the manhole to support the on-line monitoring activities at this location. Real-time monitoring of the waste stream was initiated in test mode during the fourth quarter of 1989. In this mode, pH, conductivity and radioactivity were observed by the instruments but not recorded or telemetried to any other location. By the end of calendar year 1989, sufficient testing had been completed to enable activation of the system for pH and conductivity. Addition of radioactive measurements and collection of grab samples under alarm conditions were scheduled for completion in the first quarter of 1990. When totally functional, the station will provide alarm status information for pH, conductivity and radioactivity both locally and telemetried to a constantly manned console at the Chilled Water Facility.

5.4 Landfill Permit Renewal

BNL operated the current landfill under a permit issued by the NYSDEC. This permit was up for renewal on April 30, 1988. In order to initiate activity for the renewal of this permit, BNL requested a meeting on February 17, 1988 with NYSDEC to discuss the proper course of action. Since iron had been reported in concentrations in excess of the NYS DWS in wells downgradient of the landfill and BNL was required to close its landfill in December 1990, NYSDEC decided that a Consent Order would be required for continued use of the landfill instead of a permit renewal.

NYSDEC submitted a draft Consent Order to DOE-BHO for review in September, 1988. Between 1988 and 1989, several meetings occurred to discuss a variety of issues associated with the Consent Order.

The negotiating parties experienced difficulties integrating the proposed Consent Order with the requirements of the proposed Interagency Agreement (IAG). Because of these difficulties a revised Consent Order was not received by the end of Calendar Year 1989.

5.5 PCB Consent Order

In October 1984, the Laboratory received off-specification military fuels containing PCBs in excess of 50 ppm. The Laboratory blended this material with other fuel resulting in 280,000 gallons of ALFs having a PCB concentration of approximately 80 ppm. 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, No. 4 and No. 5 [46]. The material has remained in storage since this time awaiting NYSDEC authorization to burn it.

Four separate areas of activities related to the PCB contaminated fuel in storage at the CSF occurred during 1989. These include (1) sampling/analysis of the fuel; (2) activities related to the expiration of the EPA Federal Facilities Compliance Agreement; (3) preparation and submittal of an off-site disposal plan to EPA; and (4) activities related to the receipt of a draft consent order from NYSDEC. These are discussed in more detail below.

BNL conducted a sampling program to analyze the contents of CSF tank No. 5 since the fuel had been in storage for several years. Three samples were collected in July; one each from the top, the middle and the bottom of the tank. The analyses, performed by the S&EP Analytical Chemistry Laboratory, indicated all PCB concentrations to be below 50 ppm.

To confirm these results a total of six samples were collected at frequent depth intervals (every seven feet) to assess potential stratification. These samples were split with one set to be analyzed by S&EP and the second set of samples sent to an off-site laboratory for PCB analysis. The results of both on-site and off-site analyses also indicated that all samples contained PCBs in concentrations below 50 ppm. Despite the lower PCB concentrations, it is recognized that DOE/BNL are still bound to the EPA agreements because of the original violations of dilution.

As a result of the receipt and mixing of PCB contaminated jet fuel at BNL, DOE and EPA entered into a Federal Facilities Agreement in 1987. At the same time, EPA and AUI entered into a Consent Order/Final Order. Both documents authorize shipping the fuel off-site for disposal or incineration on-site in BNL's high efficiency industrial boilers at the CSF. The deadline for the start of burning the fuel in the boilers was September 4, 1989. If burning had not been initiated by this date, a plan for off-site disposal was required to be submitted. Also, permission must be obtained from NYS.

BHO counsel met with the EPA Region II Federal Facilities Manager on August 8th to discuss obtaining an extension to the September 4th deadline contained in the Federal Facilities Agreement. A formal letter requesting technical advice and assistance from EPA for negotiations with NYSDEC under Executive Order 12088 [47] was forwarded to EPA on August 17, 1989. It was also indicated in this letter that DOE would be investigating the possibility of burning the fuel as a removal action under Executive Order 12580 [48] and CERCLA.

In accordance with the Federal Facilities Agreement, a plan for off-site disposal was submitted to EPA on October 27, 1989. The time required to complete off-site disposal is dependent upon receipt of funding from DOE, the time required to subcontract to a qualified disposal firm, and the subcontractors's plant capacity to accommodate shipments from BNL. Off-site disposal could be completed within five to eight months once appropriate funding is identified.

A draft consent order was received from NYS on June 28, 1989. The draft order terms the burning of the fuel as an 'Interim Remedial Measure', citing NYS Environmental Conservation Law (ECL) Article 27 - Title 13 entitled "Inactive Hazardous Waste Disposal Sites" [49], and requires the submittal of a Superfund-type Workplan as well as all existing information on site-wide contamination at BNL. The draft order also reserves NYSDEC's right to require a RI/FS at the site after review of the information. It is the opinion of DOE-BHO and BNL that site-wide issues should be addressed in the RCRA/CERCLA Interagency Agreement (IAG) between DOE, EPA, and NYS. The draft NYSDEC consent order was discussed with NYS legal staff at an IAG meeting with EPA on November 21, 1989. DOE and EPA recommended that the site-wide cleanup issues contained in the draft order should be addressed in the IAG. NYSDEC indicated that a revised draft consent order could be expected early in 1990.

5.6 National Emission Standards for Hazardous Air Pollutant Authorization Applications

In 1989, BNL submitted four applications to EPA Region II in order to obtain compliance status with 40 CFR 61 Regulations on National Emissions Standards for Hazardous Air Pollutants (NESHAPs) [50]. The facilities that obtained authorizations to construct and operate in 1989 were the Radiation Therapy Facility (BNL-489-01), the Accelerator Test Facility (BNL-589-01), the Radiation Effects/Neutral Beam Test Facility (BNL-789-01) and the Physics Calorimeter Cleaning Room in Building 510 (BNL-689-01). These applications were filed after an EPA inspection in August 1989 when these facilities were identified to EPA by BNL as areas where work was in progress and that formal NESHAPs Applications may by required. Section 8.3 of this report discusses this issue in greater depth.

During the period between August 1989 and December 1989, several activities were reviewed for compliance with NESHAPs and were found to be exempt from filing: replacement of an x-ray machine at Building 490; replacement of an existing off-gas system for the experimental area at the HFBR; copper-64 experimental activities in Building 480; Inhalation Toxicology Facility at Building 490; "D Zero" activities in Building 1008; x-ray Lithography source - NSLS; and several historic facilities which were in operation prior to 1985. A summary of these decisions was sent to EPA at the end of 1989.

As of December 1989, the requirements for formal filing an application to EPA changed when the revised NESHAPs Standard was published in the Federal Register [51]. The revision, although requiring DOE Facilities to perform NESHAPs evaluations in a formal manner for modification or construction of facilities that routinely emit airborne radioactive material, only requires approval to construct or modify a facility by EPA if the site boundary effective dose equivalent exceeds 0.1 mrem (0.001 mSv) per year. A brief description of the source and documentation that the dose does not exceed 0.1 mrem (0.001 mSv) is to be provided in the annual report to EPA. This has a significant impact on BNL operations because it reduces the time that must be factored into research and operational activities for compliance with radioactive air emission standards by three to six months.

Other significant impacts of the new law are the detailed sampling program required to verify compliance and the use of a new computer code, CAP88, to assess impact [51]. The sampling requirements are scheduled for review in 1990. The risk assessment program CAP88 was used to evaluate the 1989 airborne effluent emissions data in addition to AIRDOS-EPA and DOE methods. The CAP88 maximum individual committed effective dose equivalent was calculated as 0.1 mrem (0.001 mSv) and the population dose was 3.09 person-rem (0.031 person-Sv) provided that BNL entered radionuclide emissions that were already in the radionuclide library of the program. This agrees well with the AIRDOS-EPA and DOE computed values for maximum individual (0.09 and 0.098 mrem) [0.0009 and 0.00098 mSv] and collective dose (2.78 and 3.02 person-rem) [0.0278 and 0.0302 person-Sv]. In order to obtain this level of agreement between the computer codes, certain accelerator produced isotopes which are small but routine releases from BNL facilities could not be included in the assessment. The exclusion of these radionuclides was necessitated because the most recent version of the CAP88 program did not include these radionuclides in its library. When these radionuclide release rates were entered, the program used dose conversion factors that were unrelated to the radionuclides and resulted in significantly increased estimates of the maximum individual dose (0.65 mrem) [0.0065 mSv] and collective dose (35.8 person-rem) [0.36 person-Sv]. Because the code did not permit user modification there did not appear to be a way to resolve this issue during execution of the computer code. Another difficulty encountered with CAP88 is that a standard agricultural regime is used. Although this is not a significant problem for BNL since typical releases are mostly noble gas or tritium, the program does not permit user defined agricultural patterns to be used. Thus the agricultural component of the CAP88 dose estimate will over-estimate the BNL impact because most food used for local consumption is imported into the area. These issues will be addressed further in 1990 as BNL implements use of this code to demonstrate compliance with NESHAPs regulations in 1990.

5.7 Audits and Appraisals

5.7.1 DOE Environmental Protection Appraisal

The DOE Chicago Operations Office conducted an Environmental Protection Appraisal of BNL from June 12 through 16, 1989. The areas of the environmental protection program that were appraised include the general administration of the environmental program, hazardous and radioactive waste management, toxic substance management, solid waste landfill operations, and effluent monitoring and reporting.

It was concluded that BNL performance be accorded a rating of "good" as defined in DOE Order 5000.2A. The Laboratory is therefore generally meeting expected standards of performance and the continued operation of BNL will not result in undue hazard to the health and safety of the public or contractor personnel, or to the public or private property. However, technical violations of environmental regulations designed to reduce risks were observed in three of the areas reviewed. These three were identified as:

1. PCB management.
2. Hazardous waste management.
3. Erosion control at the operating solid waste landfill.

BNL has developed a program to address these deficiencies. Updates are provided each quarter on the status of BNL's actions towards addressing these issues.

5.7.2 Environmental Evaluation of Brookhaven National Laboratory - CER Corporation

The DOE Chicago Operations Office contracted with CER Corporation to conduct an environmental evaluation of BNL during the period, October 22 - 27, 1989. The objective of this evaluation was to aid DOE and BNL personnel in identifying areas where greater emphasis was needed in order to achieve strict compliance with federal, state and local environmental regulations. The results of the evaluation were intended to assist BNL in identifying areas that may need further investigation, highlight environmental compliance issues which may require further action and provide guidelines to DOE and BNL on further corrective actions that may be necessary.

The report [52] concluded that there were no environmental problems which were considered to be an immediate threat to human life. No new significant environmental problems were identified from this evaluation that were not identified in the 1988 DOE Environmental Survey report [53]. However, the importance of characterizing and remediating soils and ground water contamination for the aquifer underlying BNL was stressed because of the aquifer designation as a "Sole Source" system.

In the area of regulatory compliance, BNL appeared to be pursuing all the permits that are applicable to the facility. It was recommended that the status of some permits in terms of written approvals of "interim status" from regulatory agencies was needed to document BNL's good faith efforts to comply with existing environmental regulations. BNL has used this document to prepare for the forthcoming Tiger Team Audit that is expected to occur in 1990.

5.7.3 Dames and Moore Appraisal of BNL Environmental Monitoring Program

Dames & Moore was commissioned in 1989 by the Environmental Protection Section, S&EP Division to conduct an appraisal of BNL's environmental monitoring program. This evaluation addressed:

1. Program compliance with applicable DOE Orders, Federal, State and Local regulations, and previous program audits. The program elements that were evaluated for compliance were: Air, Surface Water, Soil, Flora and Fauna, Ground Water, External Exposure, Liquid Releases, and Air Emissions.

2. The impact of planned program upgrades with respect to the level of compliance with applicable DOE Orders and regulations that are current and those that are in the process of being formulated.

3. Program activities which can be classified as and compared to industry Best Management Practice.

This report [54] also provided a list of recommendations for further program modifications and upgrades, and provided information concerning the programmatic impact of proposed DOE Orders 5400.5 [55] and 5400.XY [24]. Efforts are underway to incorporate these recommendations into the environmental monitoring program.

5.8 Oil Spills

During 1989, S&EP responded to a total of 15 environmental releases of oil or chemicals. Ten of these incidents involved small quantities of materials which were contained on asphalt, concrete or impervious surfaces. Cleanup procedures were instituted and there were no environmental impacts as a result of these occurrences.

Five of these releases required EPA, NYSDEC and SCDHS notification. Three of these spills were cleaned up and the associated contaminated absorbent and affected soil were sent off-site for disposal of in an approved manner. Two spills resulted in remedial actions that required continuous collaboration with the NYSDEC; these will be discussed in further detail in Sections 6.9 and 6.10 of this report.

5.9 Review of Engineering Design Drawings

New construction and facility renovation projects need safety and environmental reviews from conceptual design through completion of construction and prior to final occupancy to assure that basic safety and environmental protection requirements are provided. As part of the review team, the S&EP Environmental Protection staff members review these proposals and plans to assure that potential hazards are identified and potential environmental impacts are analyzed. In addition, these reviews are conducted to ensure that all necessary permits are obtained and that new construction or modifications comply with federal, state and local regulations. In calendar year 1989, between 20 to 25 of these types of reviews were performed.

5.10 Major Petroleum Facility (MPF)

The NYSDEC is required by Article 12 of the Navigation Law [56] to protect and preserve the lands and waters of New York State from all discharges of petroleum and specifically from major petroleum storage facilities. In order to fulfill this responsibility, all major petroleum storage facilities are required to be registered with the NYSDEC and must have a license to operate.

All major petroleum storage facilities are required to install ground water monitoring wells. The license has general conditions which include regular testing of monitoring wells for floating and dissolved product. Typically the testing for floating product can be performed by the owner of the facility; however, testing for dissolved product is required to be performed by a NYSDEC certified laboratory.

The BNL CSF supplies steam for heating and cooling to all major areas of the Laboratory through an underground distribution system. The MPF is the storage area for the fuels used at the CSF. BNL operates its MPF under a license (No. 01-1700) which is issued by the NYSDEC and renewed annually. The MPF license is contingent on several conditions. In addition to the general ground water monitoring conditions, specific conditions may be included from year to year.

In October 1988 it was learned that several of the wells used to monitor the MPF had been screened improperly. This information was provided to the NYSDEC. It was agreed that two wells recently installed in this area could be substituted for existing MPF monitoring wells and that additional wells would be installed downgradient of the MPF during 1989. The NYSDEC was informed that these additional wells would be installed in the spring of 1989.

BNL's MPF license expired on March 31, 1989. On April 28, 1989, the NYSDEC submitted a letter to BNL stating that the license would not be renewed. A meeting was held at NYSDEC to discuss the issues associated with this license in May 1989. There were two issues of concern to the NYSDEC. The first was that monitoring wells had not yet been installed to replace those which were improperly screened. In order to address this issue, BNL agreed to install four monitoring wells downgradient of the MPF. A representative from the NYSDEC visited the BNL site on May 22 to identify locations in the field for these wells.

Four wells were installed downgradient of the MPF by R&L Drillers during the period June 28 - July 6, 1989. These wells are designated as 76-16, 76-17, 76-18, and 76-19. Their approximate locations are shown in Figure 24. These wells are four inches in diameter and have screens, 20 feet in length, which straddle the water table. The well casings and screens are constructed of polyvinyl chloride (PVC). At the time of installation, depth to water in these wells ranged from approximately 30 to 35 feet.

NYSDEC and EPA were given advance notification regarding the schedule for installation of these wells. A representative from NYSDEC witnessed the installation of well 76-16. Samples were collected from these wells in August and analyzed for dissolved volatile organics by EPA Methods 601 and 602, and for petroleum products in water by NYSDOH Method 310-13. The analytical results for volatile organics indicated that tetrachloroethane was detected at 1 μg/L in well 76-16; no other volatile organic compounds were detected in any of these wells. In addition, dissolved petroleum products were not detected in any of these wells. The analytical results were submitted to NYSDEC in September, 1989.

The second issue of concern which NYSDEC had was with regard to the 1977 spill at the CSF. As discussed in the BNL Site Report for Calendar Year 1988 [10], IT Corp. had conducted a study in order to determine the extent of ground water contamination at the CSF resulting from the 1977 oil/mineral spirit spill. A copy of their final report [20] and a draft conceptual remediation plan [21] had been submitted to NYSDEC in November, 1988 however, no comments on these documents had been provided to BNL prior to the May meeting. NYSDEC indicated at the May meeting that they felt that the IT Corp. study [20] did not adequately delineate the extent of contamination resulting from the 1977 incident. In order to do so, NYSDEC requested BNL to install additional monitoring wells in this vicinity.

A meeting was held at BNL on August 16, 1989 to discuss the locations of the additional wells required to define the extent of contamination from the 1977 spill. The spill site was toured to better identify the locations of the wells. It was agreed that three additional wells would be installed; two of these wells were to be installed with screens straddling the water table and the third well was to be installed with a screen approximately 20 feet below the water table.

These wells were installed by R&L Drillers at the specified locations in the vicinity of the CSF during the week of December 7 -15, 1989. These wells are designated as 76-20, 76-21, and 76-22. Their approximate locations are shown in Figure 24. The well casings are PVC and are four inches in diameter. These wells have PVC screens which are 20 feet in length. At the time of installation, depth to water in these wells ranged from approximately 31 to 33 feet. NYSDEC was informed of the drilling schedule however was unable to observe any portion of the installation process.

Samples were collected from these wells on December 29th and submitted to a NYSDEC certified laboratory. The NYSDEC requested analyses for these wells to include volatile organics by EPA Methods 624 and 625, and petroleum products in water by NYSDOH Method 310-13. The analytical results indicate that only one compound, bis(2-Ethylhexyl)Phthalate, was detected at 68 µg/L in monitoring well 76-20. Three organic compounds were detected in monitoring well 76-21: total xylene at 17 µg/L, tetrachloroethane at 15 µg/L, and bis(2-Ethylhexyl)Phthalate at 100 µg/L. No organic compounds or petroleum products were detected in monitoring well 76-22. The analytical results were transmitted to the NYSDEC in February 1990.

5.11 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 NYS Legislature passed Article 40 of the ECL, (the Hazardous Substances Bulk Storage Act of 1986) [57]. This law required the NYSDEC to develop and enforce regulations governing the sale, storage, and handling of hazardous substances, as needed to prevent leaks and spills in New York State. A closely related law, ECL Article 37 [58], requires the NYSDEC to issue a list of substances defined as hazardous.

The DEC is implementing these hazardous substances bulk storage laws through five sets of Chemical Bulk Storage regulations as follows:

- 6 NYCRR 595 - Releases of Hazardous Substances - Reporting, Response and Corrective Action [59]
- 6 NYCRR 596 - Registration of Hazardous Substance Bulk Storage Tanks [60]
- 6 NYCRR 597 - List of Hazardous Substances [61]
- 6 NYCRR 598 - Standards for Storing and Handling Hazardous Substances [62]
- 6 NYCRR 599 - Standards for Constructing New Hazardous Substance Storage Facilities [63]

Parts 595 [59], 596 [60] and 597 [61] became effective on July 15, 1988. Under the law, owners of regulated tanks are responsible for registration. Tanks must be registered with the NYSDEC by July 15, 1989. Parts 598 [62] and 599 [63] are anticipated to be filed in 1989.

In accordance with Part 596 [60], BNL submitted application forms for the registration of Hazardous Substance Bulk Storage Tanks on July 13, 1989. Seventeen tanks, used primarily to store water treatment chemicals, were included in this registration package. This information will be updated every two years as required under the law and new facilities will be registered prior to installation.

6.0 ENVIRONMENTAL ASSESSMENTS

6.1 Biomonitoring of the STP Liquid Effluent

Analysis of the STP effluent, which discharges into the Peconic River, for water quality and radioactivity is an integral part the laboratory's environmental monitoring program. Biomonitoring, which monitors the impact of BNL effluent on aquatic biota, was added to the base monitoring effort in 1987. The results of the 1989 work are presented in this report.

The original study was designed to use brown or rainbow trout as an indicator species. In 1989, the species list was increased to include endemic species, such as blue gills, large mouth bass and golden shiner, in order to more closely relate to the local game fish species. The experimental set up consisted of a once through flow system of the effluent through an aquarium which contained the fish. Dissolved oxygen and temperature was monitored daily. Integrated water samples were collected in conjunction with fish sampling. Data collected in 1989 paralleled observations made in 1987 and 1988, in that there is short term rapid intake of the principal radionuclide cesium-137 that reaches equilibrium when the concentration in fish flesh is about 40 times the concentration found in the water. No differences were found between the trout species and the endemic species. Effluent characteristics seemed to promote good growth rate, thus testifying to the viability of the effluent stream.

6.2 Sewage Treatment Plant Line Loss Study

In response to both environmental audit issues and preliminary tracer studies by S&EP, Plant Engineering contracted Carlton and Sweat to determine the integrity of the five main sewer lines in the BNL system. Connections to buildings at the trunk lines were examined but lines from the buildings to the trunk lines were not covered in this study. The work involved review of construction designs, building material, maintenance records and a television survey of the lines. The contractor documented the construction material used in each part of the system, the age of the piping, the presence of pipe separation, pipe collapse and root intrusion and potential replacement/repair options. Plant Engineering has used this report as the basis for planned upgrade of STP sewer line facilities. The report essentially documents the preliminary conclusions drawn by the tracer studies that were reported in the 1988 BNL Site Report [10] that line losses of 8-15% are possible.

6.3 National Environmental Policy Act (NEPA)

In 1989 a number of significant steps were taken to incorporate the NEPA Documentation procedure [64]. Following the NEPA Workshop that was convened by DOE Chicago, the BNL NEPA Policy was finalized and submitted to DOE. At BNL, this policy was translated into a protocol that would guide the Departments and Division to achieve compliance. A total of 146 projects were provided with Environmental Evaluation Forms, as first step towards final NEPA Documentation.

Three projects required Action Description Memorandums (ADM) including the Relativistic Heavy Ion Collider (RHIC). In addition, a formal State Environmental Quality review for the Radiation Therapy facility, a joint project between

Medical Department, BNL and State University of New York, Stony Brook, New York was initiated and submitted.

Special projects that were addressed under NEPA were: Radiation Therapy Facility, Child Care Facility, Science Center, Asbestos removal, Inhalation Toxicology Facility, Chilled Water Facility, Booster Upgrade and Laboratory Modifications. Also, archaeological studies at BNL were initiated with the New York State.

6.4 Environmental Assessment for the RHIC

The Department of Energy on reviewing the preliminary Environmental Analysis that was prepared by BNL required that an ADM be prepared for submittal to DOE. Subsequent to the submission of the ADM, DOE made a decision that an Environmental Assessment would be required to be prepared to satisfy the requirement under NEPA. BNL has contracted with Dames & Moore to prepare this document.

6.5 Department/Division Safety Assessments

The S&EP Division has been conducting a multi-disciplinary Environmental, Safety and Health Assessment of the various Departments and Divisions at BNL. Environmental Protection (EP) Section participation in such assessments is part of the multi-disciplinary task force. The following guidelines were used by the EP Section staff in conducting such assessments:

1. Knowledge of Supervisors in areas of Environmental Protection requirements, such as applicable regulations, training availability, contacts for assistance in compliance issues.

2. Verification of compliance with Federal, State, Local and BNL Safety Manual effluent discharge limitations.

3. Definition of sources and location of potential contamination areas.

4. Effectiveness of effluent treatment and control.

5. Status of appraisal findings as defined by DOE, State, County and BNL appraisals.

The above criteria were used to assess the following departments and divisions in 1989:

- Photography, Graphics and Arts
- Physics
- Plant Engineering
- Staff Services
- Supply and Materials
- Accelerator Development Department
- Alternating Gradient Synchrotron

Each assessment resulted in a report that identified areas of concern which were conveyed to the respective Department/Divisions as observations or recommendations.

6.6 Environmental Assessment of Sewage Treatment Plant Sludge

The Laboratory removes floatable and settlable solids from the sanitary waste stream through the use of a clarifier. The material collected by this process is transferred to a sludge digester which has an operating capacity of about 300,000 liters. BNL transfers the sludge from the digester about once every five years. In 1987, the sludge was placed on a drying bed prior to its disposal. Samples collected at that time indicated that the sludge contained trace quantities of radioactive material (ie. concentrations near levels found in most ambient soil samples). Metals analysis performed on the sludge indicated that the material was not hazardous. In 1988, BNL submitted a request to NYSDEC to allow future wastes of this type to be disposed of as normal waste on a sanitary landfill. In 1989 the sludge was sampled again by dividing the drying bed area into eight equal sectors and collecting a sludge profile from each sector. The material was composited and analyzed for EP Toxicity and hazardous waste constituents. Upon receipt of this set of results, HWMG received the material for storage pending disposal as low-level radioactive waste.

6.7 Photographic Arts Buildings Liquid Effluent Sampling and Analysis

In response to a SCDHS request, BNL conducted sampling and analysis of liquid effluent obtained at P&GA Building effluent outfalls (Bldgs. 118 and 197) into the BNL sanitary sewer system. Selected organic and metal analyses were performed based on the SCDHS recommendations. Samples were collected using an automated sample collection system which collected a 15-20 ml aliquot of waste every 15 minutes over the course of an eight hour work day. Each building occupant was instructed to have all equipment within the building operating at the maximum output. No organics were detected in these samples and silver was the only metal detected that exceeded the NYS Code of Rules and Regulations 703.6 standard which SCDHS uses in their evaluations. Although silver concentrations at the STP did not exceed SPDES permit requirements, it was determined that best management practice would require state-of-the-art silver recovery units to be installed in each facility and that concentrated chemical developing solutions be collected and disposed of through the BNL HWMG.

6.8 Sampling and Remediation Activities at the BNL Paint Shop

During the 1988 Environmental Appraisal conducted by the Chicago Operations Office of the DOE, an area, approximately 1 x 2 m, near the BNL Paint Shop (Building 422) was identified as requiring characterization and possible remediation. The area, formerly used as a brush cleaning area, received a preliminary remediation by removing the visibly contaminated soil in August 1988. Clean sand was then applied to the area. In February 1989, 30 cm deep soil samples were collected to verify the extent of the remediation. The samples were analyzed for organic contamination and found to have residual organic concentrations. Additional remediation was performed in May 1989 when approximately 60 cm of soil were removed from the area. Shallow (15cm) soil samples from the base of the excavated area were collected and analyzed. These results indicated that the remediation was complete. These results were sent to DOE-Chicago Operations Office for their concurrence. In October 1989, the area was back-filled and the remediation effort terminated.

6.9 CSF Leaching Pit

On November 6, 1989, excavation began at a location south of the CSF, (Building 610), for the installation of a 1000 gallon underground propane tank. Although current utilities maps indicated that there were no utility lines underground at this location, the backhoe encountered an eight inch vitreous tile pipe approximately three to four feet below grade. The pipe cracked upon impact of the backhoe and approximately one to two gallons of what appeared to be number 6 oil leaked onto the ground. A section of pipe was cut and removed from the excavation. There appeared to be a small quantity of residual oil in the bottom of the pipe. The section of pipe and oil contaminated soil was placed into a DOT approved 55-gallon drum for appropriate disposal.

In an effort to determine the purpose that this pipe had served in the past and to determine what the pipe had been connected to previously, Plant Engineering personnel obtained design drawings of Building 610 dating back to the 1960's and 1950's. Based on their review of these drawings, it was learned that the pipe had connected floor drains in Building 610 to a leaching pit.

The backhoe was used to locate the cover to the leaching pit, which appeared to be less than one foot below grade. The surface soil around the cover was excavated to facilitate its removal. The cover of the leaching pit is made of concrete, approximately twelve inches thick, and has a standard metal manhole in it. The leaching pit has an outer diameter of approximately nine feet. The walls of the leaching pit were constructed using concrete cinder blocks lying on their side.

Upon removal of the cover, it was discovered that the pit contained a thick black tarry material which was similar in appearance to number six oil. A sounding stick was used to estimate the pit to be eleven feet deep and that there was approximately 53 inches of this material in the bottom of the pit. A sample of the material was collected and submitted to the S&EP Analytical Chemistry Laboratory for PCB analysis. The results indicated that the PCB concentration was below the instrument detection limit of 10 ppm.

EPA, NYSDEC, and SCDHS were notified on the day of the discovery. The spill report numbers, issued respectively, are 19776, 8907794, and 1989-1164. SCDHS inspected the site on November 8th and NYSDEC on November 13th.

A contract was initiated with a licensed hazardous materials hauler to have the contents pumped from the leaching pit. The material is currently being stored in a trailer tank at the CSF pending the finalization of the disposal plans.

Additional samples of the material were collected and submitted to an off-site EPA approved laboratory for priority pollutant analysis. The results of analysis indicate that the material is similar to No. six fuel oil but does contain some hazardous constituents as does virgin No. six oil. The analytical results were submitted to the NYSDEC for a determination on whether or not the material and thus the surrounding soil is hazardous. If the materials are not hazardous, the oil could be burned at BNL and the soil disposed of at a local landfill.

Immediate plans for additional cleanup include removing the leaching pit and any visibly contaminated soil once NYSDEC issues a determination. These activities are being coordinated with the EPA and NYSDEC RCRA, CERCLA and oil spill groups and the SCDHS. Longer term plans include soil gas surveys and soil borings in the area to determine the extent of contamination, if any; additional soil removal as required; and ground water monitoring wells and plume definition if necessary.

6.10 Discharge of Resin Column Regeneration Water to Recharge Basin HT (006)

Part of normal operations at BNL accelerator facilities is the use of highly purified water as primary cooling water for magnet, radio frequency and beam transport systems. Typically, domestic water (ie. ground water with metal stabilizing chemicals) is passed through ion exchange column systems in order to produce this ultra-pure demineralized water. The process is essential to ensure proper cooling of accerator component systems and prevent cooling channel blockage.

Periodically, these resin columns must be cleaned of the metals that were removed from the water. Typically, this is done by treating the system with acidic and basic solutions. Prior to 1990, these solutions were discharged directly to the recharge basin that received the normal cooling water outfall for the facility. In December 1989, the several hundred gallons of acidic/basic wash solutions from one such operation were discharged to the recharge basin. Once in the recharge basin, a combination of reduced temperature and changes in pH caused metals that were in solution to precipitate out into the bed of the basin. The principle contaminants in the back wash were copper and lead with both metals exceeding recharge basin discharge limits in the undiluted back wash. NYSDEC, EPA and SCDHS were informed of the release and the practice was terminated pending a complete review of the operation. This incident is being investigated under unusual occurrence report no. 89-29 [65]. During the review period, waste generated will be collected and disposed of through a commercial vendor.

6.11 Building 801 to 811 D-Waste Transfer Line Review

During construction/installation of the chilled water transport and return lines, excavation of soil that surrounded the "d-waste" transfer line that runs between Building 801 and 811 was required. Visual inspection and soil sampling below the transfer line for a distance of about 8 meters was conducted. No leaks were observed and radioactivity was not detected which exceeded ambient soil concentrations due to primordial and fallout radionuclides. Consequently, it was concluded that there was no evidence of leakage in the area examined.

7.0 SPECIAL PROJECTS

7.1 Status of Environmental Upgrades

7.1.1 General Plant Project to Upgrade Underground Storage Tanks

BNL has a 1.1 million dollar program to bring its storage tanks into compliance with the requirements of Suffolk County Sanitary Code, Articles 7 and 12 [42,44]. The funding for this program, which consists of three phases, began in FY88. The program was anticipated to be completed by the end of FY90, however it appears likely that additional funding will be required to complete the project.

The first phase of this program will address 23 underground storage tanks used to store aqueous radionuclides. Most of these tanks have no future use and have been out of service for many years. In order to facilitate removal of the tanks, samples of the liquids were collected where possible and analyzed. Six of these tanks were removed from the ground and three of these tanks were abandoned in place upon inspection and approval from the DHS.

To evaluate the contents of the remaining tanks, a contract was awarded during the first quarter of 1989 to an engineering consulting firm to develop a sampling and analysis plan. Their final plan [66] was submitted to BNL in July, 1989. A contract is anticipated to be awarded to implement this plan during the first quarter of 1990.

The second phase of this program will replace underground storage tanks with double walled tanks and associated piping at Buildings 423 and 630, which are storage facilities for gasoline and waste motor oil. In addition, seven underground fuel oil tanks will be retrofitted with overfill protection equipment. The engineering design drawings and specifications were completed and submitted to the DHS during 1989. A contract for this project was awarded during the last quarter of 1989 and construction is anticipated to commence during the first quarter of 1990. A separate portion of this program will provide secondary containment for several small outdoor aboveground storage tanks.

The third phase of this program will provide the upgrades necessary for any remaining outdoor aboveground storage tanks not completed during the previous phase. This project consists primarily of the replacement of two aboveground tanks used to store aqueous radionuclides at the BNL WCF (Building 811) and the installation of overfill protection on eight aboveground fuel oil tanks at the CSF (Building 610). Preliminary design work was initiated during the last quarter of 1989 although funding for this phase had not yet been received.

7.1.2 Closure of Cesspools

The NYSDOH has made a determination that industrial cesspools are no longer an acceptable means of waste disposal on Long Island. Discharges of this nature are prohibited by Title 6 of the New York Code of Rules and Regulations Part 751 as well as Suffolk County Sanitary Codes Articles 7 [42] and 12 [44] due to the sole source ground water aquifer [38].

A number of buildings at BNL are still served by cesspools that discharge to ground water. In order to address this issue, a study was conducted in 1985 to identify and evaluate those buildings served by cesspools for connection to the central sanitary sewage system. Twelve buildings served by cesspools were identified as potentially receiving industrial discharges from sinks and work areas. These facilities were included in a cesspool elimination project which would provide for connections to the site STP. Funding for this task was obtained through a line item project.

A contract for this work was awarded during the second quarter of 1989 and construction began in August, 1989. All facilities are anticipated to be connected to the BNL site STP during 1990.

NYSDEC was notified of this project in the 1987 SPDES renewal application and formally updated on November 15, 1989. The engineering design drawings and specifications for the connections of these facilities to the site STP were submitted to SCDHS for their review in March, 1989. These cesspools are included on the list of areas of concern under the IAG. The plans for sampling and closure of these cesspools will be developed with input from EPA, NYSDEC, and SCDHS.

7.1.3. Installation of Ground Water Monitoring Wells

IT Corporation conducted a site wide geohydrological investigation which integrated existing geohydrological information, data on well construction, well placement, screen depth and length. Water table contours were drawn and these data were used to develop recommendations regarding the expansion of the ground water monitoring program. This study formed the basis for the 1989 addition of 51 wells to the base program. The rationale used to place and position screens was based on ground water flow and water table contours, areas of potential ground water contamination, and the need for piezometric data. Appendix D, Table 93 summarizes this rationale. Drilling and installation of the 51 wells was performed by R&L Drilling Company and supervised by a hydrogeologic consultant with Roux Associates. All wells were constructed of 10 cm diameter PVC piping and screened for 20 feet with PVC screening. The S&EP EP Section Quality Assurance (QA) Officer provided oversight and QA/QC of the entire operation. In order to establish a baseline, these wells were initially sampled and analyzed as per the EPA-CLP protocol in August and September, 1989, respectively. A review of water quality, metals, and organic data are given in Appendix D, Tables 94 to 96. In Appendix D, Tables 95 and 96, results for a CLP compound are reported only if the compound is present in at least one sample.

7.1.4 Brookhaven National Laboratory CERCLA Interagency Agreement and Remedial Investigation/Feasibility Study (RI/FS)

In July 1989, EPA proposed placing BNL on the National Priority List (NPL). In November 1989, the action was finalized when the revised SUPERFUND List was published in the Federal Register [67]. Following the listing of BNL on the National Priority List as a SUPERFUND site, a major impact on the Environmental Protection activities is anticipated. Towards this end, the S&EP EP Section has been coordinating with the Environmental Restoration group, S&EP Hazardous Waste Management Section, activities that will need to be addressed in order to meet the requirements of the IAG and RI/FS program. Key areas where major roles are anticipated include:

1. review of sampling and analysis programs in support of characterization and assessment activities;

2. installation and abandoning of monitoring wells on-site;

3. participation in the tri-party IAG negotiations that began in November between DOE, EPA, and NYSDEC as technical members;

4. preparation of reports and protocols for review by DOE, EPA and NYSDEC; and

5. participating in site visits of the federal and State SUPERFUND Staff.

7.2 Environmental Awareness Training

Near the end of 1987 and throughout 1988, Black and Veatch Consultants were developing environmental awareness training guides for use by the S&EP EP Section in site-wide training programs. The guides consisted of a review of federal, state and local environmental regulations, lists of good work-place practices and waste management practices. The final product was delivered in 1989. Distribution of this and other environmental related information to Laboratory staff commenced in early 1990.

7.3 Summer Students Projects

7.3.1 Peconic River Ecological Study

In collaboration with the NYSDEC, S&EP EP Section staff members and two Health Physics Summer Training Program students participated in an ecological study along the length of the Peconic River. This is part of the EP Sections' environmental monitoring program. Sampling for fish, mussels, water, sediment, and vegetation was done at specific locations in the river. Every attempt was made to collect the same species of fish, mussels and vegetation from each of the sampling stations to achieve appropriate comparisons between stations along the length of the river and distance away from BNL. These samples were processed and analyzed, principally, for gamma and strontium-90 activity. Data from this study is discussed in Section 3.3.6 of this report.

7.3.2 Calibration of STP Radiation Monitoring System

The receipt of new detectors, electronics, strip chart recorders and a multichannel analyzer necessitated the calibration of this equipment prior to installation and use at the STP clarifier influent, clarifier effluent and manhole #197 monitoring locations. The calibration of these instruments constituted one project in the Health Physics Summer Training Program that was conducted between June and September 1989. The project included development of a calibration geometry that would be representative of the three monitoring conditions, construction of calibration curves in units of absolute response rate and effluent discharge rate curves in units of concentration per unit count rate for each detector and development of the calibration protocols. The final step in the process was determining the proper alarm set-point. Because three matched detectors and sets of electronics were purchased and the calibration curves were identical for all detectors, a single alarm set-point was selected which corresponded to a committed effective dose equivalent of four millirem (0.04 mSv) if two liters of the effluent were ingested.

7.4 Quality Assurance Program

BNL has implemented DOE Order CH 5700.6 by developing policies, responsibilities, and providing generic guidance procedures for the development of quality assurance programs that are appropriate to ensure the achievement of Laboratory objectives [68]. The generic BNL QA Program [69] complies with all of the 18 basic requirements of ANSI/ASME NQA-1. 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 [70]. A designated QA officer has been appointed to review procedures and activities within the S&EP EP Section and to assure that environmental and effluent monitoring or upgrade programs comply with the S&EP, BNL and DOE QA Programs. All environmental programs receive QA Category 2 review. At the field sampling and laboratory level, quality of information is assured by following the established protocols and participation in interlaboratory QA programs. The S&EP Analytical Chemistry Laboratory is certified by NYSDOH for purgeables, metals and anions under potable and water chemistry. The S&EP Analytical Chemistry Laboratory is also certified by the National Institute of Standards and Technology for the analysis of asbestos. The S&EP Radiological Laboratory participates in the DOE Environmental Measurements Laboratory QA Program. The quality assurance officer coordinates and participates in audits to assure that the QA program and procedures are being followed and that problems are identified and corrected.

7.5 Release of Sewage Treatment Plant Emergency Holding Pond #1 Water

In June 1988, an unplanned release of radioactive material required that STP lined holding pond #1 be used to minimize the release of this material to the Peconic River. Plans to process this water for removal of the cesium-137 and strontium-90 components required almost one year to develop and were implemented in May 1989. During the planning interval, a new lined holding pond was constructed and pond #1 continued to receive liquid material in the form of both precipitation and tritiated distillate from the BNL WCF. When the project was ready to commence operation, the pond contained nearly 11 million liters of water that required processing. The material used to remove the cesium and strontium was clinoptilolite. The process passed pond #1 water into one of three parallel lines each containing two clinoptilolite filters at a rate of about 280 liters per minute. The processed water was monitored via an in-line radiation monitor and then discharged to emergency holding pond #2. The water in pond #2 was then pumped back to the sand filter beds at a rate of about 120 liters per minute. This latter pump rate was dictated by the tritium concentration in the water and the desire to keep discharge concentrations less than the BNL administrative control concentration of 10,000 pCi/L (370 Bq/L). The water released to pond #2 contained less than 50 pCi/L (1.9 Bq/L) of cesium-137, a factor of 30 reduction in the water concentration. The process resulted in minimal changes in location

EA cesium-137 or strontium-90 discharge concentrations. During this processing, all SPDES permit requirements were achieved. The project was completed in July 1989.

7.6 Multimedia Environmental Pollution Assessment

The DOE Environmental Survey entered into the third phase of its program. Phase I and II consisted of an on-site review of the program in 1987, and sampling and analysis of the environment in 1988. In Phase III, DOE began to incorporate the findings from the on-site visit and the results of the sampling and analysis program into an assessment phase to determine the impact of BNL's operations on the environment. The model used by DOE was the "Multi-Media Environmental Pollution Assessment".

In carrying out this program BNL was involved in a number of steps, which were:

1. Data Accuracy Review. This required a review of all the data that will be used in the model for accuracy, and also to provide any new data that would enhance the applicability of the model to site-specific conditions.

2. Participate in workshops that would provide guidance in addressing data requirements, specifically in the ranking of the units (Findings), Record of Assumptions (where literature values were used instead of site-specific values), and understanding the working of the model as it is used for the final ranking in terms of Hazard Potential Index.

3. Data accuracy review of the DOE sampling and analysis program. This program is continuing.

7.7 Off-Site Ground Water Contamination

In one well of a couplet (Nos. 130-01 and 130-02, located in the southwest section of the site near the south boundary) installed as part of the 51 well addition to the ground water program, low level VOC contamination was detected (Appendix D, Table 96). These wells, were screened at approximately 28 feet and 78 feet below the water table, respectively. VOC's were not detected in the shallow well. However, samples from the deeper screen interval indicated trace levels of 1,1-dichlorethane, chloroform, and trichlorethene and 1,1,1-trichloroethane at concentrations which exceeded the NYS DWS. BNL contacted the SCDHS in December 1989 regarding these data and transmitted this information for their evaluation.

Upon review of the BNL data, the SCDHS embarked on a ground water surveillance survey of nearby private potable wells which evaluated water concentrations for these compounds. By May 1990, the SCDHS evaluation had identified five private potable wells in the North Shirley area that had significant contamination of 1,1,1-trichlorethane.

BNL retained the services of Geraghty & Miller, a private ground water consulting firm to investigate any possible connection between the Lab and this problem. The subsequent acquisition of synoptic water level measurements and preparation of water table elevation maps demonstrated that ground water flow in the southwest corner of the Lab was primarily in a southerly direction. This information, together with BNL and SCDHS ground water quality results, and organic results obtained from cesspool and sludge, cooling water and shallow ground water samples collected within an industrial complex located south of BNL, led to the confirmation by SCDHS that the source of private well contamination was consistent with the operations and waste disposal practices of a facility within the industrial complex.

7.8 <u>Sampling and Analysis of New Monitoring Wells and Soils Using USEPA Contract Laboratory Program (CLP) Protocols:</u>

All the samples collected for the environmental monitoring program are routinely analyzed for specific metals, anions, organics, and radionuclides. The rationale for monitoring only specific analytes on a routine basis is that they are known or suspected to be present on-site.

However, in order to fully characterize ground water and soils on-site for nonradiological parameters, a comprehensive sampling and analysis program based on EPA's CERCLA methods was initiated in 1989. Also, this complete site characterization is important since BNL is included as one of the sites on EPA's NPL. The characterization process involves collecting water and soil samples strictly according to EPA's "Compendium of Superfund Field Operations" [71] manual and analysis by "Contract Laboratory Program (CLP)" protocols [72]. These two protocols have very extensive QA/QC, tested analytical methodology, data documentation, and data verification procedures which assure results with a known quality. Under the CLP protocol, approximately 150 target compounds are monitored including volatiles, extractables (semivolatiles), PCB/pesticides, and metals. Also, any extraneous compounds other than target compounds present in the sample are analyzed. This analysis scheme gives a very comprehensive picture of nonradioactive contaminants present in the samples. The same protocols are routinely used by EPA to characterize and cleanup superfund sites.

Since this effort of sampling and analysis is beyond the scope of BNL, a contract was awarded to an off-site CLP laboratory, Kemron, for this purpose. The 51 newly installed monitoring wells and 77 soil samples collected from the current landfill and HWMF were included in this study. The data received from Kemron were audited according to data validation protocols developed by EPA [72] and the data were found to be acceptable. The summarized data are presented in Appendix D, Tables 95 through 100. Only samples with positively identified compounds above their MDLs are listed, with the exception of volatile compounds where they are reported even if present below MDL because of their significance.

The primary organic contaminant in monitoring wells is 1,1,1-trichloroethane with highest concentration (0.020 mg/L) found in Well No. 108-13 (Appendix D, Table 96). Compounds like chloroform, 1,1-dichloroethylene, benzene, 1,1-dichloroethane, and trichloroethylene were found below or near the MDL in some of the wells. Interestingly, the gaseous compound, chloroethane was found in Well Nos. 98-33 and 98-34 down gradient of current landfill which, presumably could be formed due to degradation of 1,1,1-trichloroethane in the landfill. In the soil samples collected from the current landfill and HWMF, no volatile compounds of any significance were found. However, some polynuclear aromatic compounds (PNA) were identified in many of the soil samples at or significantly above MDLs (Appendix D, Tables 98 and 100). The presence of PNA compounds in the soil samples is significant in that they are the principal constituents of fuel oils used on-site. No PCB/pesticides were found in the soil samples.

In the monitoring well and soil samples, metals like aluminum, iron, manganese, sodium, calcium, and zinc seem to be ubiquitous in varying concentrations (Appendix D, Tables 95, 97, and 99). Lead was detected in some wells below NYS limits except in Well No. 130-02 in which it was found at 0.064 mg/L. Chromium, copper, lead, and vanadium were found in many current landfill and HWMF soils.

As a part of routine environmental monitoring program at BNL, some of the 51 new wells were resampled for VOCs in November, 1989 and analyzed by BNL to confirm the results of the initial CLP analysis. As can be seen in Appendix D, Table 96, there is close agreement between the two sets of data. The presence of chloroethane and 1,1-dichloroethylene could not be confirmed in the BNL study due to prohibitive costs involved in modifying the existing BNL GC/MS configuration to analyze these more volatile compounds.

7.9 Evaluation of Biodegradable Liquid Scintillation Cocktails

In an effort to reduce the amount of mixed waste generated at BNL, the HWMG requested that all users evaluate the possibility of replacing toluene and xylene based liquid scintillation cocktails with biodegradable cocktails. Several departments completed their evaluations and began converting to the new cocktails in 1989. Others will make this conversion in 1990. Once a user makes this transition, processed liquid scintillation samples can be classified by their radioactive material component. Many of the samples processed could potentially be low specific activity material and meet the requirements published by the Nuclear Regulatory Commission in 10 CFR Part 20 [73] for direct disposal to a sanitary system. In 1989, BNL submitted a request to NYSDEC that would permit users who generate low specific activity non hazardous liquid scintillation samples (less than 0.05 µCi/ml [1,850 Bq/ml] of tritium or carbon-14) to dispose of this material via the sanitary system. This method of discharge would have a 1 Curie (37 GBq) per year activity limit and require complete documentation of the discharges by the user which would be audited on a periodic basis. While the NYSDEC is reviewing this application for hazardous constituents in the cocktail, BNL continues to collect and dispose of this material as low-level radioactive waste.

7.10 Environmental Survey of BNL Site by DOE

In 1988, DOE conducted an environmental survey to assess the nature and extent of contamination on the BNL site. This survey included sampling by DOE field team and analysis by Oak Ridge National Laboratory for specific radionuclides and nonradioactive parameters. The nonradioactive list contained volatiles, base/neutral/acids, and PCB/pesticides and all these parameters were analyzed using EPA CLP protocols.

The analytical data with appropriate QA/QC were submitted to BNL in draft form which was audited by BNL staff chemist for compliance according to CLP data audit procedures [72]. The data were found to contain many major and minor non-compliances/deficiencies and didn't meet the intent and purpose of CLP protocols. Consequently, the data could not be used with confidence for quantitative purposes to assess the level of contamination; however, the data were used to make qualitative judgments to identify areas of concern.

7.11 BNL S&EP Analytical Laboratory Renovation

In the first quarter of calendar year 1989, due to renovation and expansion of the S&EP analytical laboratory, some of the analysis could not be performed in-house. Accordingly, all the samples collected during the first quarter were sent to an off-site laboratory for analysis. Since analysis was performed by two different laboratories, for some of the parameters, different detection limits were given for the same parameter which is reflected in many tables. These detection limits are documented in Appendix C for ready reference.

7.12 Impact of Down-Draft at the 100 Meter Stack on Site Boundary Tritium Concentrations

Historic and present comparisons of projected site boundary air concentrations using AIRDOS-EPA or BNL projection codes versus measured values indicated that measured values typically are higher than the projected values by a factor of two. BNL has reviewed the potential for an unmonitored release through examinations of the tritium purchase inventory and department inspections and has eliminated this potential as a source of the discrepancy. One known meteorological phenomena at BNL that was not included in the coding used to project site boundary dose was the impact of down-draft on releases from the 100 meter stack. This stack was originally designed to receive 2,800 cubic meters per minute (cmm) air effluent from the Brookhaven Graphite Research Reactor (BGRR). Since the BGRR ceased operation in the late 1960's, typical air flow rates into the stack have been on the order of 280 to 560 cmm. This reduction in flow rate has resulted in air effluents not having sufficient exit velocity to clear the stack under all atmospheric conditions.

Particulate and charcoal filter samples collected in the base of this stack routinely show the presence of radionuclides that enter the air stream at the base and intermediate heights of the stack. This means that down-drafting is occurring periodically throughout the year. Using 1989 meteorological conditions and 1989 tritium release data for the 100 meter stack, the AIRDOS-EPA code was run assuming the release location was the same but the release height was reduced to ground level. The impact of changing the release height was to increase the expected air concentrations by a factor of 60. In order to account for a factor of two difference between the site boundary and modeled air concentrations, the down-draft condition would need to occur only 3.3 percent of the time (12 days per year). Because the samples that historically indicated the presence of the down-draft phenomena are collected on a weekly basis it is difficult to quantify the exact number of times per year that this occurs. In 1989, 60% of the samples collected exhibited this problem. This effort was sufficient to satisfy BNL that down-draft needs to be included in future computer code estimates of site boundary concentrations and is the primary reason that the modelling and measured data disagree in a biased manner.

8.0 COMPLIANCE SUMMARY

Sections 5 and 6 of this report address in detail various aspects of BNL's efforts at maintaining the site in compliance with appropriate federal, state and local regulations. This section provides a brief summary of information regarding existing facilities, operations or environmental data which are not in compliance with environmental regulations.

8.1 Ground Water Contamination in Excess of the DWS and 6 NYCRR Part 703

Because BNL is situated on a sole source aquifer (class GA as defined in 6 NYCRR 703), radiological and non-radiological environmental monitoring data obtained from the ground water monitoring program are compared to the NYS DWS and concentration limits defined in 6 NYCRR 703. The following information lists the locations where ground water monitoring data indicates that these limits have been exceeded and provides a summary of the remedial actions that have been planned or are currently in place.

Location	Status/Comments
Potable wells	Potable well supply distribution systems serving over 3000 persons, such as those in service at BNL, are regulated by the NYSDOH. Regulatory requirements for these potable supply wells includes quarterly sampling for volatile organic compounds. Prior to January 9, 1989, the NYS DWS for 1,1,1-trichlorethane (TCA) was 50 µg/L and all current BNL on-site potable supply wells showed concentrations well within that limit. After January 9, 1989, the standard for TCA was reduced to 5 µg/L [17]. In BNL's January 1989 routine sampling and analysis program, a 1,1,1-trichloroethane concentration of 4.5 µg/L was detected in a water sample collected from potable Well 10. A January SCDHS analysis of Well 10 water produced similar results. Water sampling data from Well 10 in March indicated that concentrations had exceeded the NYS DWS. As a result of this data, Well 10 underwent intensive sampling over a 4 week period beginning in June, 1989. During this period, Well 10 was pumped for 8 hours/day, 5 days/week and sampled weekly. The final average TCA concentration during the test period was 5.5 µg/L which resulted in a removal of Well 10 from the potable Well distribution system in July, 1989. During the July, 1989 intensive sampling of Well 10, a sample taken from Well 11, similarly began to show elevated TCA concentrations. Analytical results from an October 1989 sample of Well 11 indicated the presence of TCA at a concentration of 8 µg/L. A four week intensive sampling of Well 11 beginning in November, 1989 confirmed an average TCA concentration of 8.3 µg/L. Well 11 was removed from the potable water distribution system when this data became available in December, 1989. Investigations regarding the feasibility of

installing water treatment systems at one or both Wells is scheduled for 1990.

CSF

Soil and ground water in the vicinity of the CSF are contaminated with organic compounds which would require remedial action as a result of a 1977 spill. IT Corporation will begin planning for a remedial investigation of this area of concern in 1990. Sporadic occurrences of iron and mercury above NYS DWS have also been observed, but there is no regularity to the data. IT Corporation's investigation and monitoring will further evaluate these parameters. Xylene concentrations in Wells No. IT4 and 76-21 only slightly exceeded NYS DWS, however, significantly higher BTX concentrations were measured in Well IT1.

HWMA

Remediation for organic contamination detected southeast of the HWMA continues into its fourth year. Although prior years data has indicated a 95% removal efficiency by means of air stripping the VOC's, the lack of spray aeration samples from the pumping wells does not permit a similar comparison to be made in 1989. Surveillance wells in the HWMA area, however, indicated that TCA and TCE concentrations exceeded DWS in four wells and two wells, respectively. A single pumping well showed iron and lead concentrations exceeding DWS, but all other surveillance and pumping wells indicated only trace levels of these analytes. Strontium-90 concentrations exceeded NYS DWS in two locations. This area is scheduled for an RI/FS under the IAG.

Old Landfill

Iron, manganese, and BTX contamination consistent with former disposal activities has been documented at this formerly utilized site. Benzene and toluene exceeded DWS in three wells and two wells respectively. Iron and manganese concentrations also exceeded NYS DWS in three and two wells respectively. Strontium-90 was detected in excess of NYS DWS in one well. The former landfill site and its associated contaminant plume are scheduled for RI/FS under the IAG.

Current Landfill

The current landfill is characterized by the same types of contaminants as the old landfill site and is slated to close at the end of 1990 to comply with the Long Island Landfill Law. In 1990, BNL expects the commencement of a remedial investigation/feasibility study for this area too. Nearly all of the downgradient wells at the current landfill site show iron concentrations exceeding DWS, with manganese also exceeding drinking water in these wells, but less frequently. Benzene, toluene, and xylene exceeded DWS in three wells, one well and one well, respectively.

WCF

Ground water contamination is primarily indicated by the presence of TCA exceeding DWS in all wells in that area. Although BTX compounds have sporadically been detected, only

	one well showed a xylene concentration in excess of DWS. Because these wells are screened twenty feet below the water table, the source of contamination is not defined.
Sewage Treatment Plant	During 1989, one on-site well adjacent to the Peconic River and located downgradient of the STP showed a Sr-90 concentration in excess of the EPA DWS. The location was sampled only once in 1989. Further sampling and analysis in 1990 will determine if additional actions are required.

8.2 SPDES Permit

There are five recharge basins and one discharge to the Peconic River that are governed by the SPDES permit. In 1989, the following deviations from the permit requirements occurred:

Location	Status/Comments
Recharge Basins	At one recharge basin, outfall no. 002, pH was recorded slightly above the discharge limit. At another recharge basin, outfall no. 003, pH was measured at 6.1 which is below the minimum discharge limit of 6.5. Elevated iron concentrations were observed above NYS DWS at all recharge basins. However, only two of the five recharge basins had an average iron concentration in excess of NYS discharge limits to ground water.
New Recharge Basin	In 1989 it was determined that the recharge basin used to recharge water from the HWMA ground water remediation does not need to be listed on the permit because the recharge of the water is governed by CERCLA.
STP Effluent	There were fifteen instances where the pH was recorded below the minimum discharge limit of 5.8. It should be noted however, that the influent to the STP is typically around 6.6 -7.2. The pH of the treated water drops approximately one pH unit as it passes through the large surface area of the sand filter beds. Treatment of the sand filter beds with lime was instituted and this action resulted in pH concentrations which met the conditions in the SPDES permit for the remainder of the year. There were four occurrences where residual chlorine was measured slightly above the SPDES discharge limit. In addition, during 1989 there was one instance each where iron, ammonia-nitrogen, and suspended solids were observed above their respective SPDES discharge limits. Note that these last items represent one time events and not continuing activities.
Cesspools	The cesspool removal project is in progress. A contract was awarded during the second quarter of 1989; construction began in August 1989 and is anticipated to be completed in 1990.

8.3 Radioactive Airborne Effluent Emissions Governed by NESHAPS

EPA Region II issued a total of five authorizations for construction during 1989. The first authorization was received in February for the RHIC (BNL-388-01). This authorization is a carry-over from a 1988 application. Four other authorizations were received between October and December. The applications for these facilities were submitted in September, approximately six weeks after an EPA Region II inspection where BNL identified the four facilities to EPA as being in potential violation of 40 CFR 61 Subpart H [50]. EPA issued a notice of deficiency to which BNL responded by the submission of the appropriate applications. The facilities that received authorizations were: the RTF (BNL-489-01); the ATF (BNL-589-01); the Calorimeter Enclosure at Building 510 (BNL-689-01) and the REF/NBTF (BNL-789-01). In addition to the submission of four applications in 1989, BNL made six determinations of no need to file. A summary of these decisions was submitted to EPA Region II in the fourth quarter of 1989.

8.4 State Air Laws

During 1989, BNL evaluated a variety of air emission sources for the requirement of Certificates to Operate (COs) from the NYSDEC. 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. The number of sources and their status are described below:

No.	Status/Comments
5	Applications for COs for general processes, exhaust and/or ventilation systems were submitted to NYSDEC in July, 1989. This closed a commitment made during the environmental appraisal conducted by DOE-Chicago in May, 1988.
3	Applications for COs were submitted to NYSDEC in September, 1989; two for general processes, exhaust and/or ventilation systems, and one for a stationary combustion unit.
17	Applications for COs for general processes, exhaust and/or ventilation systems were submitted to NYSDEC in October, 1989.
10	Air emission sources were inspected by a representative from NYSDEC in October, 1989 in order to provide guidance on compliance requirements of infrequently used existing small sources.
25	Air emission sources were determined by NYSDEC not to require applications for COs.
6	COs for existing combustion units were canceled in November, 1989. These units are either no longer in use, or are exempt from permit requirements under 6NYCRR, Section 201 as a result of a change to No. 2 fuel oil.
2	COs were issued by NYSDEC for new sources in December, 1989.

8.5 Suffolk County Sanitary Codes

During 1989, BNL has made progress in bringing a number of storage facilities which are not in complete compliance with the requirements of SCDHS. The applicable regulations are the Suffolk County Sanitary Code, Articles 7 and 12 [42,44]. The approximate number of storage facilities and their status is described below:

No.	Status/Comments
5	Underground tanks currently used to store aqueous radionuclides will be replaced by double-walled tanks and associated piping. These tanks are included on the list of areas of concern to be addressed as a removal action under the IAG. All actions conducted for this removal action will be in accordance with the IAG.
4	Underground tanks formerly designed for storing aqueous radionuclides were removed from the ground in the presence of a representative from the DHS in February 1989.
1	Underground tank used to store scintillation oil at Building 965 was removed and inspected by a representative from the DHS in August 1989.
3	Underground tanks were abandoned in place with approval from and inspections conducted by DHS.
6	Overfill protection equipment was obtained for six large aboveground storage tanks at the CSF. This equipment was installed on four of these tanks by the end of 1989; the remaining two will be installed by the first quarter of 1990.
6	Engineering design drawings and specifications were prepared for the replacement of underground hazardous materials (gasoline and waste motor oil) storage tanks. A contract for this project was awarded during the last quarter of 1989; these tanks will be replaced in the first quarter of 1990.
6 - 8	Underground petroleum storage tanks will be equipped with overfill protection in the first quarter of 1990.
8 - 12	Outdoor aboveground tanks will be equipped with overfill protection in 1990.
6 - 7	Outdoor aboveground storage tanks will be upgraded to comply with requirements for overfill protection and secondary containment in 1990 or 1991.
	Indoor storage facilities, including tanks and drum storage areas, will be evaluated for compliance requirements.

APPENDIX A

A.1 Glossary of Terms

ADM	- Action Description Memorandum
AGS	- Alternating Gradient Synchrotron
ALF	- Alternate Liquid Fuels
AUI	- Associated Universities Inc.
BGRR	- Brookhaven Graphite Research Reactor
BHO	- Brookhaven Area Office
BLIP	- Brookhaven LINAC Isotope Production Facility
BNL	- Brookhaven National Laboratory
BTX	- Benzene Toluene Xylene
CLP	- Contractor Laboratory Program
COs	- Certificates to Operate
CSF	- Central Steam Facility
DAS	- Department of Applied Science
DOE	- Department of Energy
DOT	- Department of Transporation
DWS	- Drinking Water Standard
ECL	- Environmental Conservation Law
EP	- Environmental Protection
EPA	- Environmental Protection Agency
HFBR	- High Flux Beam Reactor
HWMF	- Hazardous Waste Management Facility
HWMG	- Hazardous Waste Management Group
IAG	- Interagency Agreement
LFS	- Light Feed Stocks
LINAC	- Linear Accelerator
MDC	- Minimum Detection Concentration
MDL	- Minimum Detection Limit
MPF	- Major Petroleum Facility
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NA	- Not Analyzed
NBTF	- Neutral Beam Test Facility
NCRP	- National Council on Radiation Protection
ND	- Not Detected
NEPA	- National Environmental Policy Act
NESHAPS	- National Emission Standards for Hazardous Air Pollutants
NOV	- Notice of Violation
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
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
PCB	- Polychlorinated biphenyls
P&GA	- Photography and Graphic Arts

PNA	- Polynuclear Aromatics
PVC	- Polyvinyl Chloride
QA	- Quality Assurance
RCG	- Radiation Concentration Guide
RI/FS	- Remedial Investigation/Feasibility Study
REF	- Radiation Effects Facility
RHIC	- Relativistic Heavy Ion Collider
SCDHS	- Suffolk County Department of Health Services
SDWA	- Safe Drinking Water Act
S&EP	- Safety and Environmental Protection
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
TCA	- 1,1,1-Trichloroethane
TLD	- Thermoluminescent Dosimeters
VOC	- Volatile Organic Compound
VUV	- Vacuum Ultraviolet
WCF	- Waste Concentration Facility

A.2 Glossary of Units

a	- Annum
Bq	- Becquerel
Bq/L	- Becquerel per liter
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
$CiMW^{-1}h^{-1}$	- Curie per megawatt hour
cm	- Centimeter
cm/d	- Centimeters per day
cmm	- 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/a	- Millirem per annum
mrem/yr	- Millirem per year
mSv	- milli seivert
mSv/a	- milli seivert/annum
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
ppb	- Parts per billion
ppm	- Parts per million
rem	- Unit of radiation dose equivalent
TBq	- Tetra Becquerel
μCi	- Microcuries
μCi/L	- Microcuries per liter
μg/L	- Micrograms per liter

APPENDIX B

METHODOLOGIES

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

Dispersion (X/Q) was calculated for release elevations as listed in Appendix D, Table 1, at each of the 16 directional sectors, and for 5 distance increments (1.6-16 km, 16-32 km, 32-48 km, 48-64 km, and 64-80 km) from the center of the site using AIRDOS-EPA. The 1988 site meteorology as measured at 10 and 100 meter elevations was used to calculate the annual average dispersion for the midpoint of a given sector and distance. The radionuclide specific release rates (Ci/yr) from the HFBR stack, the Chemistry Building roof vent, the Van de Graaff roof vent, the BLIP stack, and the Hazardous Waste Management Incinerator stack were used to estimate the air concentrations at a given sector and distance. The air concentration, multiplied by the adult breathing rate (22.8 m^3/d), the number of days per year, the dose conversion factor for a given radionuclide as provided by the RADRISK data base, and the dispersion and population values for that sector and distance resulted in the population nuclide-specific dose equivalent for each sector with distance. This procedure was conducted for each radionuclide. The dose equivalents were then summed to obtain the total population dose equivalent resulting from BNL operations. The total dose, as estimated by the AIRDOS-EPA program, also calculates the contribution from the submersion, ingestion, shoreline, and recreational pathways as a result of an atmospheric release. To calculate the maximum individual dose, the population value is set to unity and the dispersion parameter for the site boundary is substituted into the described method.

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 present along with the basic assumptions used in the calculation. For the maximum individual, the highest annual average tritium concentration, as measured from a single potable well was used to calculate the total quantity of tritium ingested via the drinking water pathway. For the collective dose equivalent calculation, 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 = Population at risk

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the population at risk in this area was assumed to be approximately 500.

3. Methodology for Dose-Equivalent Calculations - Fish Ingestion Pathway

In order to estimate the collective dose equivalent from the fish consumption pathway, the following procedure was utilized:

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 [74].

c. Committed Dose Equivalent Tables [75] were used to get the 50 year Committed Dose Equivalent Factor - rem/µCi intake.

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

^{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 prior to use for dosimetric purposes.

4. Data Processing

Analytical results of the environmental and effluent monitoring programs are reported in the tables of Appendix D. The data presented in these tables were generated as described below.

First, gross alpha, beta, and tritium results are reported as the net measured quantity. When only one sample was analyzed, results could be positive, zero, or negative. When the average concentration is reported, the average was computed by averaging the volume-weighted measured quantity. Because measured quantities were used throughout the report for these parameters, the reader should examine Appendix C to determine the typical analytical sensitivity for a particular parameter prior to deciding the importance of a result. Data which are less than the MDC of the analytical technique should not be considered as positive results. Only data which exceed the MDC were used as positive results.

Second, gamma spectroscopy, strontium-90, and chemical analytical results were not converted to the new data presentation format; measured concentrations that were less than or equal to the MDC, while reported, were not used to compute average concentration levels. All MDC values were evaluated as if the results were zero. This explains occasional instances where the MDC is several times larger than the calculated annual average concentration.

Finally, if an analysis was performed and the result was less than the MDC of the system, the concentration was generally reported as not detected (ND). Appendix C presents typical minimum detectable concentrations for the analyses performed on environmental and effluent samples.

APPENDIX C

The following is a list of typical Minimum Detectable Limits and Concentrations for the various analyses performed on environmental and effluent samples.

Nuclide	Matrix	Aliquot (ml)	MDC (μCi/ml)	MDL (μCi)
Gross alpha	water	1	2E-7	3E-7
		100	2E-9	
		500	5E-10	
Gross beta	water	1	6E-7	6E-7
		100	6E-9	
		500	1E-9	
Tritium	water	1	1.3E-6	1.3E-6
		7	3.0E-7	

Nuclide	300g MDL μCi/g	300ml MDL μCi/ml	12000ml MDL μCi/ml	Charcoal MDC μCi
^{7}Be	7.4E-8	9.8E-8	1.6E-9	9.3E-6
^{22}Na	9.4E-9	1.2E-8	2.0E-10	1.4E-6
^{40}K	1.8E-7	2.3E-7	3.9E-9	2.7E-5
^{48}Sc	1.1E-8	1.4E-8	2.3E-10	1.6E-6
^{51}Cr	7.6E-8	1.0E-7	1.6E-9	9.0E-6
^{54}Mn	8.4E-9	1.1E-8	1.8E-10	1.1E-6
^{56}Mn	2.2E-7	2.8E-7	4.7E-9	3.1E-5
^{57}Co	7.2E-9	9.2E-9	1.4E-10	7.5E-7
^{58}Co	8.3E-9	1.1E-8	1.8E-10	1.1E-6
^{60}Co	1.1E-8	1.4E-8	2.3E-10	1.5E-6
^{65}Zn	2.1E-8	2.2E-8	4.5E-10	3.0E-6
^{134}Cs	1.1E-8	1.4E-8	2.2E-10	1.4E-6
^{137}Cs	9.5E-9	1.2E-8	2.0E-10	1.3E-6
^{226}Ra	2.6E-8	3.0E-8	5.0E-10	2.9E-6
^{228}Th	2.1E-8	2.7E-8	4.3E-10	2.4E-6
^{82}Br	1.2E-8	1.6E-8	2.6E-10	1.6E-6
^{113}Sn	1.2E-8	1.6E-8	2.6E-10	1.4E-6
^{124}I	1.3E-8	1.7E-8	2.7E-10	1.7E-6
^{126}I	2.3E-8	3.3E-8	5.2E-10	2.8E-6
^{131}I	9.4E-9	1.3E-8	2.1E-10	1.1E-6
^{133}I	1.2E-8	1.6E-8	2.6E-10	1.6E-6
^{123}Xe	6.6E-7	8.6E-7	1.3E-8	7.3E-5
^{127}Xe	1.0E-8	1.3E-8	1.0E-10	1.2E-6

Constituent	TYPICAL DETECTION LIMITS BNL	Off-Site Labs
	(All concentration values in mg/L where noted)	
Ag	0.025	0.010
As	0.005	0.050
Cd	0.001	0.005
Cr	0.005	0.010
Cu	0.05	0.050
Fe	0.075	0.075
Hg	0.0002	0.0002
Mn	0.05	0.050
Na	1.0	1.0
Pb	0.005	0.02
Zn	0.02	0.02
Ammonia-N	0.02	NA
Nitrate-N	1.0	NA
Specific Conductance	10 µmhos/cm	NA
Chlorides	4.0	NA
Sulfates	4.0	NA
1,1,1-trichloroethane	0.002	0.005
trichloroethylene	0.002	0.005
tetrachloroethylene	0.002	0.005
chloroform	0.003	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

NA = Not applicable.

APPENDIX D

TABULATED ANALYTICAL RESULTS

Table 1
BNL Site Environmental Report for Calendar Year 1989
Resident Population Distribution Within 80 km of BNL

Sector	0-16 Km	16-32 Km	32-48 Km	48-64 Km	64-80 Km	Total	Remarks
SSW	21,340	1,092	0	0	0	22,432	Beyond 32 Km - Atlantic Ocean
SW	21,787	64,829	3,414	0	0	90,030	Beyond 48 Km - Atlantic Ocean
WSW	37,892	143,956	351,782	427,106	775,516	1,736,252	Beyond 80 Km - Part of New York City
W	49,490	133,770	237,369	227,202	371,344	1,019,175	Beyond 80 Km - New York City
WNW	41,706	58,437	117	215,620	129,786	445,666	Between 32 Km and 48 Km - Long Island Sound
NW	17,965	1,560	136,060	123,295	110,860	389,740	Between 32 Km and 48 Km - Long Island Sound
NNW	7,656	0	209,640	107,507	54,335	379,138	Between 16 Km and 32 Km - Long Island Sound
N	4,534	0	93,987	249,567	259,574	607,662	Between 16 Km and 32 Km - Long Island Sound
NNE	7,556	0	7,059	44,563	65,648	124,826	Between 16 Km and 32 Km - Long Island Sound
NE	2,937	744	0	13,617	33,189	50,487	Between 32 Km and 48 Km - Long Island Sound
ENE	2,475	6,901	12,858	14,862	2,244	39,340	North Fork of Long Island
E	3,017	15,929	17,336	9,024	562	45,870	South Fork of Long Island and Atlantic Ocean
ESE	6,143	7,668	0	0	0	13,811	Long Island; Beyond 32 Km - Atlantic Ocean
SE	9,050	0	0	0	0	9,050	Beyond 16 Km - Atlantic Ocean
SSE	22,363	0	0	0	0	22,363	Beyond 16 Km - Atlantic Ocean
S	15,509	24	0	0	0	15,533	Beyond 32 Km - Atlantic Ocean
TOTAL	271,420	434,910	1,069,624	1,432,363	1,803,058	5,011,375	

Note: Population distribution obtained from LILCO estimates.

Table 2
BNL Site Environmental Report for Calendar Year 1989
Summary of Climatology Data at BNL for 1989

Month	Temperature, °C			Precipitation
	Min.	Max.	Avg.	cm
January	-5.2	6.0	0.4	5.66
February	-5.9	3.7	-1.1	10.39
March	-2.4	8.2	3.2	13.21
April	1.3	14.1	7.7	11.84
May	8.6	20.1	14.3	26.59
June	14.9	25.7	20.3	18.39
July	16.6	27.2	21.9	14.83
August	16.7	27.1	21.8	23.29
September	11.6	23.8	17.7	11.30
October	5.3	18.6	11.9	22.61
November	0.3	10.8	5.6	13.11
December	-9.4	0.4	-4.5	3.18
Annual	-9.4	27.2	9.9	174.40
40 Year Average			9.8	123.01

Note: Minimum and maximum temperatures listed for each month represent monthly average minimum and maximum values.

Table 3
BNL Site Environmental Report for Calendar Year 1989
Atmospheric Effluent Release Locations and Radionuclide Activity

Release Point Building No.[a]	Facility	Release Height[b] (meters)	Principal Radionuclide	On-Line Monitoring	Fixed Sampling Devices	Amount Released During 1989 (Ci)
491	Medical Research Reactor Stack[c]	45.7	^{41}Ar	Moving tape for radioparticulates	Charcoal for radioiodines	1,936.
555	Chemistry Roof Stack	16	Tritium	None	Dessicant for tritium vapor	0.059
705	High Flux Beam Reactor	97.5	Tritium ^{82}Br ^{131}I	None	Dessicant for tritium vapor, particulate filter for gross beta analysis, and charcoal filter for radioiodines	58.5 0.0007 0.000019
705	Hot Laboratory	97.5	^{77}Br ^{124}I ^{68}Ga ^{126}I ^{83}Rb ^{84}Rb ^{69}Ge ^{65}Zn	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	0.019 0.00012 0.101 0.00033 0.0071 0.0033 0.0047 0.0036
901	Van de Graff Accelerator	21	Tritium for tritium	Kanne chamber	Dessicant for tritium vapor	30 (gas) 10 (vapor)
931	Linac Isotope[d] Facility	20	^{15}O Tritium ^{7}Be	G-M Detector for radioactive gases	Dessicant for tritium vapor, particulate filter for gross beta, and charcoal filter for radionuclides	918. 0.046 0.0013
445	Incinerator	8.7	See Table 8	None	None	See Table 8

(a) Locations shown in Figure 9.
(b) Above ground level.
(c) Calculated from reported operating time and "one-time" measured emission rate at 3MW power level.
(d) Calculated from reported operating and estimated production rate at 180 uamp full beam current.

Table 4
BNL Site Environmental Report for Calendar Year 1989
Noble Gas Releases from The Medical Research Reactor (MRR)
and the Brookhaven Linear Isotope Production Facility (BLIP)

Month	Bldg 491 MRR Ar-41	Bldg 931 BLIP O-15
	<------------ Ci	------------>
January	180.5	114.0
February	127.8	107.3
March	184.7	194.9
April	133.0	203.8
May	131.1	188.2
June	202.7	59.1
July	147.8	13.6
August	192.8	0.0
September	138.8	0.0
October	173.6	0.0
November	158.7	0.0
December	164.6	36.7
Total	1936.1	917.7

The BLIP Facility did not operater in August, September, October, or November due to scheduled down time at the AGS and Linac.

Table 5
BNL Site Environmental Report for Calendar Year 1989
Tritium Releases from 10-m Stacks

Month	Bldg 931 BLIP	Bldg 555 Chem.	Bldg 444 HWM Comp. **	Bldg 445 HWM Inc.	Bldg 901A Van de Graaf Vapor*	Bldg 901A Van de Graaf Gas*	Total Monthly Tritium Releases
	<----------	----------	----------	mCi	----------	----------	---------->
January	1.7	1.9	1.8	16.0	120.0	1097.0	149.1
February	4.2	6.2	1.8		425.0	3810.0	463.9
March	1.8	6.2	2.6		646.0	2400.0	673.4
April	1.5	29.6	2.6		6.9	1110.0	48.3
May	5.2	10.5	2.6		2430.0	2230.0	2463.9
June	0.5	0.2	4.3	0.1	253.0	1650.0	269.6
July	0.5	1.3	4.3		49.1	3110.0	76.9
August	27.7	2.7	2.6		206.0	2150.0	254.0
September	2.1	0.2	0.4		420.0	5020.0	457.7
October	0.1	0.2	0.4		320.0	2510.0	338.2
November	0.5	0.0	0.5	20.7	2770.0	2510.0	2809.3
December	0.2	0.0			2770.0	2510.0	2787.8
Total	45.9	58.9	23.7	36.8	10416.0	30107.0	10792.0

Blank data fields indicate that sample results were below the system detection limits or that no releases occurred during that month.

* The elemental tritium values listed for Bldg. 901 from October to December were estimated from the first nine months of operation. In the final three months of 1989, the Kanne Chamber was out of service.

**The Bldg. 445 waste compactor is run intermittantly over the course of the year. Effluent samples reflect integrated releases of several months. The activity listed for a given month is the time averaged release for the sample period.

Table 6
BNL Site Environmental Report for Calendar Year 1989
Airborne Effluent Releases via Building 705 100-m Stack

		Facility: HFBR 1989								Hot Lab 1989								
Month	Flow cc	H-3	Br-82 mCi	I-131	Flow cc	Br-77	Se-75	Be-7	Xe-127	Ga-68	Co-58 mCi	Zn-65	Rb-83	Rb-84	Ge-69	I-126	Br-82	I-124
January	1.52E+13	1.03E+04	1.30E-01	1.90E-04	3.31E+13	3.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E-01	0.00E+00	0.00E+00	0.00E+00
February	1.96E+13	4.71E+03	4.51E-01	1.60E-04	2.89E+13	1.50E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00
March	1.52E+13	7.69E+03	8.32E-02	1.37E-02	3.12E+13	2.60E-01	4.00E-02	0.00E+00	4.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	0.00E+00	0.00E+00
April	2.44E+13	2.01E+04	1.97E-03	4.07E-03	3.62E+13	1.10E+00	1.00E-02	7.00E-02	3.38E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E-02	0.00E+00	0.00E+00
May	1.18E+13	1.24E+03	1.90E-02	3.40E-04	2.70E+13	7.01E+00	9.00E-02	1.00E-02	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E-02	1.50E-01	5.00E-02
June	1.10E+13	5.84E+02	1.86E-02	1.10E-04	3.05E+13	8.60E+00	4.00E-02	0.00E+00	0.00E+00	9.95E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.29E+00	6.00E-02	2.70E-01	7.00E-02
July	1.68E+13	5.16E+03	0.00E+00	0.00E+00	3.66E+13	0.00E+00	2.00E-02	1.00E-02	3.50E-01	2.80E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
August	1.14E+13	3.74E+03	0.00E+00	0.00E+00	2.87E+13	0.00E+00	0.00E+00	3.30E-01	2.00E-02	8.20E-01	1.40E-01	3.55E+00	7.05E+00	3.32E+00	0.00E+00	5.00E-02	0.00E+00	0.00E+00
September	1.45E+13	3.73E+03	0.00E+00	0.00E+00	3.69E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-02	0.00E+00	0.00E+00
October	1.85E+13	7.17E+02	0.00E+00	0.00E+00	2.82E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
November	1.10E+13	1.77E+02	0.00E+00	0.00E+00	2.99E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
December	1.45E+13	3.59E+02	0.00E+00	0.00E+00	3.54E+13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.84E+14	5.85E+04	7.04E-01	1.86E-02	3.83E+14	1.85E+01	2.00E-01	4.20E-01	4.23E+00	1.01E+02	1.40E-01	3.55E+00	7.05E+00	3.32E+00	4.73E+00	3.30E-01	4.20E-01	1.20E-01
Average Conc. pCi/m³		3.18E+05	3.83E+00	1.01E-01		4.84E+01	5.23E-01	1.10E+00	1.11E+01	2.63E+02	3.66E-01	9.28E+00	1.84E+01	8.68E+00	1.24E+01	8.63E-01	1.10E+00	3.14E-01

Table 7
BNL Site Environmental Report for Calendar Year 1989
Airborne Effluent Releases via Building 931 10-m Stack

Facility: BLIP Total Charcoal and Filter Paper

Month	Flow cc	Be-7	Xe-127	Xe-125	Mn-54	Co-57	Zn-65	I-123	Rb-84	Co-60
		<------------			mCi					------------>
January	8.54E+11	4.04E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
February	5.37E+11	9.21E-03	4.60E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
March	7.95E+11	2.52E-01	0.00E+00	1.17E-02	0.00E+00	0.00E+00	4.15E-03	9.94E-03	2.14E-03	0.00E+00
April	7.76E+11	4.19E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
May	5.93E+11	1.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
June	8.19E+11	3.81E-01	0.00E+00	0.00E+00	3.10E-04	1.60E-04	8.60E-04	0.00E+00	0.00E+00	0.00E+00
July	4.82E+11	2.20E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
August	6.01E+11	2.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
September	1.02E+12	4.40E-04	0.00E+00	0.00E+00	2.24E-03	6.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
October	7.55E+11	1.44E-01	0.00E+00	0.00E+00	8.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
November	5.76E+11	1.13E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
December	8.81E+11	1.34E-01	0.00E+00	0.00E+00	1.94E-03	6.80E-04	0.00E+00	0.00E+00	0.00E+00	1.11E-03
Total	8.69E+12	1.30E+00	4.60E-04	1.17E-02	5.31E-03	1.48E-03	5.01E-03	9.94E-03	2.14E-03	1.11E-03
Average Conc. pCi/m^3		1.49E+02	5.29E-02	1.35E+00	6.11E-01	1.70E-01	5.76E-01	1.14E+00	2.46E-01	1.28E-01

Table 8
BNL Site Environmental Report for Calendar Year 1989
Estimated Radioactivity in Incinerated Material

Month in 1989	H-3	I-125	C-14	Ru-103	P-32	S-35	Cr-51	Tl-204	Co-57
	<---			μCi					--->
January	16000	180	40	RNI	RNI	RNI	400	RNI	RNI
February									
March									
April									
May									
June	91	21.54	RNI	RNI	43.3	13.8	RNI	RNI	4.75
July									
August									
September									
October									
November	20701	8	3	0.023	1	1	42	1	0.045
December									
Total	36792	209.54	43	0.023	44.3	14.8	442	1	4.795

Incinerator operated only in January, June, and November.
RNI = Radionuclide not incinerate during the operational period.

Table 9
BNL Site Environmental Report for Calendar Year 1989
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	11-29-91
197	blueprint machine	NYSDEC-Air Quality	472200 3491 19701	11-29-91
197	degreaser tank	NYSDEC-Air Quality	submitted 7-89, status pending	
197	acid metal cleaning	NYSDEC-Air Quality	submitted 7-89, status pending	
197	welding shop	NYSDEC-Air Quality	submitted 10-89, status pending	
206	cyclone G-10	NYSDEC-Air Quality	submitted 10-89, status pending	
207	belt sander	NYSDEC-Air Quality	submitted 10-89, status pending	
208	lead melting	NYSDEC-Air Quality	472200 3491 20801	11-29-91
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802	11-29-91
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803	11-29-91
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804	11-29-91
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202	11-29-91
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203	11-29-91
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42204	11-29-91
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205	11-29-91
423	combustion unit	NYSDEC-Air Quality	472200 3491 42304	Cancelled 11-89
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	11-29-91
452	combustion unit	NYSDEC-Air Quality	472200 3491 45204	Cancelled 11-89
452	parts cleaner tank	NYSDEC-Air Qualtiy	submitted 7-89, status pending	
457	combustion unit	NYSDEC-Air Quality	472200 3491 45704	Cancelled 11-89
457	sulfite dispensing	NYSDEC-Air Quality	submitted 10-89, status pending	
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46201	11-29-91
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202	11-29-91
473	vapor degreaser	NYSDEC-Air Quality	submitted 7-89, status pending	
479	combustion unit	NYSDEC-Air Quality	472200 3491 47904	Cancelled 11-89
479	cyclone G-10	NYSDEC-Air Quality	submitted 10-89, status pending	
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49001	12-7-90
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49002	12-7-90
493	combustion unit	NYSDEC-Air Quality	472200 3491 49304	Cancelled 11-89
493	incinerator	NYSDEC-Air Quality	472200 3491 493AO	11-29-91
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	11-29-91
510	calorimeter enclosure	U.S.EPA - NESHAPS	BNL-689-01	None
526	polymer mix booth	NYSDEC-Air Quality	submitted 10-89, status pending	
526	polymer weighing	NYSDEC-Air Quality	submitted 10-89, status pending	
535B	plating tank	NYSDEC-Air Quality	" 10-89 " "	
535B	etching machine	NYSDEC-Air Quality	" 10-89 " "	
535B	PC board process	NYSDEC-Air Quality	" 10-89 " "	
555	scrubber (1)	NYSDEC-Air Quality	" 10-89 " "	
555	scrubber (2)	NYSDEC-Air Quality	" 10-89 " "	
610	combustion unit	NYSDEC-Air Quality	472200 3491 6101A	2-22-93
610	combustion unit - ALF	NYSDEC-Air Quality	472200 3491 61004	11-29-91
610	combustion unit - ALF	NYSDEC-Air Quality	472200 3491 61005	11-29-91
610	combustion unit	NYSDEC-Air Quality	submitted 9-89, status pending	
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001	11-29-91
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002	11-29-91
705	building ventilation	U.S. EPA - NESHAPS	BNL-288-01	None
725	blueprint machine	NYSDEC-Air Quality	submitted 10-89, status pending	
820	accelerator test facility	U.S.EPA - NESHAPS	BNL-589-01	None
901	tin lead solder	NYSDEC-Air Quality	submitted 10-89, status pending	
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301	11-29-91
903	cyclone G-10	NYSDEC-Air Quality	submitted 10-89, status pending	
905	vapor degreaser	NYSDEC-Air Quality	" 7-89 " "	
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101	11-29-91
922	cyclone exhaust	NYSDEC-Air Quality	submitted 10-89, status pending	
T30	combustion unit	NYSDEC-Air Quality	472200 3491 T3004	Cancelled 11-89
	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(e)	major petroleum facility	NYSDEC-Water Quality	1-1700	3-31-90
STP(a) & RCB(b)	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005835	under review for renewal;I.O.S.
CLF(c)	current landfill	NYSDEC-Solid Waste	52-S-20	under review for renewal;I.O.S.
HWMF(d)	waste management	NYSDEC-Hazardous Waste	NYS ID No. 789 005 385	I.O.S.
BNL Site	chem tanks-HSBSRC	NYSDEC	1-000263	7-27-91

(a) Sewage Treatment Plant.
(b) Recharge basins.
(c) Current landfill.
(d) Hazardous Waste Management Facility.
(e) Central Steam Facility.
I.O.S. = Interim Operating Status.
HSBSRC = Hazardous Substance Bulk Storage Registration Certificate.

Table 10

BNL Site Environmental Report for Calendar Year 1989

Sewage Treatment Plant Influent and Effluent Gross Alpha, Gross Beta, and Tritium Concentrations

Month	Flow, Liters	Gross Alpha Concentration Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Concentration Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Concentration Avg.	Tritium Min.	Tritium Max.
		<----------			pCi/L					---------->
Sample Location Station DA - Clarifier Effluent										
January	7.69E+07	0.17	-2.10	1.50	5.10	-0.19	14.00	1500	-1200	8700
February	7.24E+07	-0.35	-2.10	1.00	12.00	3.60	90.00	-98	-9700	7800
March	8.32E+07	0.09	-1.00	2.10	8.10	3.40	22.00	550	-1000	4400
April	8.04E+07	0.29	0.77	1.50	6.50	0.00	23.00	2600	-94	7300
May	1.07E+08	0.19	-2.30	1.50	9.20	1.10	23.00	1500	-300	5300
June	1.03E+08	-0.44	-2.10	1.50	12.00	3.40	28.00	3600	-410	8700
July	1.13E+08	-0.49	-2.60	1.50	5.60	0.94	11.00	3400	1900	6200
August	1.12E+08	-0.01	-2.10	1.80	8.10	1.10	37.00	3100	-970	13000
September	9.36E+07	0.10	-2.60	1.50	4.60	1.90	9.30	2800	-210	8300
October	1.05E+08	0.00	-1.80	1.50	2.80	-2.80	9.40	910	-620	4000
November	9.04E+07	0.41	-0.77	1.80	4.40	0.00	8.10	340	-130	4700
December	7.16E+07	0.23	-2.30	1.50	5.60	0.94	11.00	150	-4100	1900
Avg. Conc.(pCi/L)		0.00041	-2.60	2.10	6.98	-2.80	90.00	1826	-9700	13000
Total Release (L or mCi)	1.11E+09	0.00046			7.74			2024		
Sample Location - Station EA - Chlorine House Effluent										
January	6.36E+07	0.49	-1.79	2.05	21.10	5.29	56.30	1370	-585	1700
February	5.48E+07	0.04	-1.28	1.54	15.60	2.89	29.30	296	-1370	1930
March	7.86E+07	0.30	-0.77	2.30	16.90	4.34	28.30	754	-969	4580
April	7.50E+07	0.04	-1.02	1.79	17.70	6.99	94.20	4050	100	36600
May	1.05E+08	0.17	-2.81	2.05	15.50	6.20	30.60	1400	-613	4600
June	1.03E+08	-0.31	-2.56	1.79	15.80	9.07	21.30	4850	0	8480
July	9.64E+07	-0.03	-1.79	1.79	14.00	6.42	26.10	4160	2210	6560
August	1.02E+08	-0.04	-1.02	1.02	14.70	9.44	28.00	3220	-4410	13500
September	7.49E+07	0.04	-1.79	3.07	14.30	7.55	21.50	3000	-478	7200
October	9.98E+07	0.34	-1.28	1.54	9.40	4.16	1.95	1990	1520	3890
November	8.98E+07	0.61	-1.02	2.05	9.12	3.59	17.90	1710	204	4910
December	7.13E+07	0.45	-1.28	1.79	9.21	4.53	14.20	744	-3760	5500
Avg. Conc.(pCi/L)		0.16	-2.81	3.07	14.24	2.89	94.20	2438	-4410	36600
Total Release (L or mCi)	1.02E+09	0.16			14.45			2475		
SPDES Limits		3.0 (Ra-226)			1000.0			Not Listed		
NYS Drinking Water Standards		15.0			50.0			20,000		
Typical Minimum Detection Limit (MDL)		2.7			5.7			1,200		

Table 11

BNL Site Environmental Report for Calendar Year 1989

Sewage Treatment Plant Influent and Effluent Gamma Spectroscopy and Strontium-90 Concentrations

Month	Flow L	Na-22	Mn-54	Co-60	Cs-137	K-40	Rb-83	Zn-65	Be-7	Sr-90
		pCi/L								
Sample Location - Station DA - Clarifier Input										
January	7.69E+07	0.15	0.04	0.17	1.05	2.10	MDL	MDL	MDL	MDL
February	7.24E+07	MDL	MDL	MDL	1.00	2.76	MDL	MDL	MDL	MDL
March	8.32E+07	MDL	MDL	MDL	0.73	2.43	MDL	MDL	MDL	0.27
April	8.04E+07	MDL	MDL	0.19	0.85	4.47	MDL	MDL	MDL	MDL
May	1.07E+08	0.07	MDL	0.07	0.57	1.99	0.41	MDL	MDL	0.21
June	1.03E+08	MDL	MDL	0.55	0.38	2.06	MDL	0.07	MDL	0.39
July	1.13E+08	0.02	MDL	0.06	0.42	2.21	MDL	MDL	0.33	0.31
August	1.12E+08	MDL	MDL	MDL	1.17	1.34	MDL	MDL	MDL	0.28
September	9.36E+07	MDL	MDL	MDL	0.27	2.17	MDL	MDL	MDL	0.55
October	1.05E+08	MDL	MDL	0.05	0.26	2.71	MDL	0.08	MDL	1.30
November	9.04E+07	MDL	MDL	0.05	0.50	2.66	MDL	0.04	0.92	0.33
December	7.16E+07	MDL	MDL	MDL	0.36	2.95	MDL	MDL	0.30	0.06
Avg. Conc.(pCi/L)		0.02	MDL	0.10	0.61	2.42	0.04	0.02	0.13	0.34
Total Release (L or mCi)	1.11E+09	0.02	MDL	0.11	0.68	2.67	0.04	0.02	0.14	0.37
Sample Location - Station EA - Chlorine House Effluent										
January	6.36E+07	0.42	MDL	0.28	23.40	4.78	MDL	MDL	MDL	MDL
February	5.48E+07	0.08	MDL	0.14	21.70	3.10	MDL	MDL	MDL	0.58
March	7.86E+07	0.08	MDL	0.11	23.30	3.20	MDL	0.18	MDL	1.49
April	7.50E+07	MDL	MDL	0.17	17.80	3.79	MDL	MDL	MDL	MDL
May	1.05E+08	0.22	0.05	0.17	29.30	4.99	0.48	0.16	MDL	0.45
June	1.03E+08	MDL	MDL	0.13	13.60	2.08	MDL	MDL	MDL	1.73
July	9.64E+07	0.03	MDL	0.08	9.59	2.12	MDL	MDL	MDL	1.28
August	1.02E+08	0.20	MDL	0.17	16.20	1.36	MDL	MDL	MDL	0.35
September	7.49E+07	MDL	MDL	0.07	14.80	3.14	MDL	MDL	MDL	0.05
October	9.98E+07	MDL	MDL	0.04	6.74	1.71	MDL	0.12	MDL	3.50
November	8.98E+07	0.07	MDL	MDL	6.51	2.90	MDL	MDL	MDL	0.74
December	7.13E+07	0.02	MDL	0.05	7.27	2.06	MDL	MDL	MDL	0.35
Avg. Conc.(pCi/L)		0.09	0.01	0.11	15.57	2.86	0.05	0.04	MDL	0.96
Total Release (L or mCi)	1.02E+09	0.09	0.01	0.12	15.80	2.91	0.05	0.04	MDL	0.98
SPDES Limit		----	----	-----	----	----	----	----	---	10.0
NYS Drinking Water Standards		----	----	----	----	----	----	----	---	8.0
Radiation Conc. Guide		30,000	90,000	30,000	20,000	----	NL	100,000	2,000,000	----
Typical MDL		0.20	0.18	0.23	0.20	3.9	0.30	0.45	1.6	0.1

Table 12
BNL Site Environmental Report for Calendar Year 1989
Sewage Treatment Plant[a]
Average Water Quality and Metals Data

	Sewage Treatment Plant Influent (DA)	Sewage Treatment Plant Effluent (EA)	SPDES Effluent Limitation
pH (SU)	2.8 - 11.5	5.4 - 7.6	5.8 - 9.0
Conductivity (umhos/cm)	(b)	204	(c)
Temperature maximum (°C)	26	24	32
Total coliform (per 100 ml)	NA	1,561	10,000
Fecal coliform (per 100 ml)	NA	220	2,000
<u>Results in mg/L</u>			
Dissolved Oxygen	NA	8.4	(c)
Chlorides	NA	56.6	(c)
Settleable Solids	0.8	0.0	0.1
Suspended Solids - max	232.0	14.0	10.0
- avg	37.2	0.6	5.0
BOD5 - max	61.2	5.1	20.0
- avg	21.4	2.4	10.0
Ammonia-Nitrogen	NA	0.29	2.0
Nitrate-Nitrogen	NA	4.2	(c)
Total Phosphorous	0.37	0.36	(c)
Sulfates	NA	17.1	(c)
Ag	<0.017	<0.02	0.05
Cd	<0.0005	0.0005	(c)
Cr	<0.0005	<0.0005	(c)
Cu	0.052	0.07	0.40
Fe	0.29	0.20	0.60
Mn	<0.05	<0.05	(c)
Na	22.1	21.6	(c)
Pb	0.046	0.007	0.067
Zn	0.49	0.07	0.30

NA: Not Analyzed.
(a) Locations shown in Figure 9.
(b) Metered.
(c) Effluent limitation not specified.

Table 13
BNL Site Environmental Report for Calendar Year 1989
Radioactivity Detected in On-Site Recharge Basin Water

Location	Sample Date	Gross Alpha	Gross Beta	Tritium	Be-7	Na-22	Co-57	Co-58	Mn-54	Zn-65	Cs-137	Sr-90
		<-----					pCi/L					----->
HN	28-Mar-89	0.410	38.200	-29	149.00	0.76	0.35	1.10	0.46	0.62	MDL	NA
	19-Jun-89	0.410	4.800	436	MDL	1.86	MDL	MDL	MDL	MDL	1.23	NA
	18-Oct-89	0.051	2.340	93	3.57	1.10	0.84	MDL	0.50	MDL	MDL	NA
	Avg. Conc.	0.290	15.113	167	50.86	1.24	0.40	0.37	0.32	0.21	0.41	NA
HO	04-Jan-89	0.205	1.850	-289	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	28-Mar-89	0.051	1.400	-259	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	19-Jun-89	0.358	0.793	454	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.205	1.348	-31	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
HP	05-Jan-89	0.307	2.040	173	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	19-Jun-89	0.051	1.400	54	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	18-Oct-89	0.000	3.320	-26	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.119	2.253	67	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
HS	28-Mar-89	1.020	1.020	518	2.14	MDL	MDL	MDL	MDL	MDL	MDL	NA
	19-Jun-89	0.051	1.740	472	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	18-Oct-89	-0.051	2.150	-103	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.340	1.637	296	0.71	MDL	MDL	MDL	MDL	MDL	MDL	NA
HT	05-Jan-89	0.256	0.642	0	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	28-Mar-89	0.051	1.360	-86	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	19-Jun-89	0.205	0.340	690	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	18-Oct-89	0.154	0.038	5	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.167	0.595	152	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
Typical MDL		0.53	1.2	300	1.6	0.20	0.14	0.18	0.18	0.45	0.20	0.10
SPDES Limit		3.0 (Ra-226)	1000.0	Not Listed		----	----	----	----	----	----	10.0
NYS Drinking Water Standard		15	50	20,000	---	----	----	----	----	----	----	8.0

Table 14
BNL Site Environmental Report for Calendar Year 1989
Water Quality Data in On-Site Recharge Basins

Location[a]	pH (SU)	Temperature Avg.	Min. °C	Max.	Conductivity Avg.	Min. (umhos/cm)	Max.	Chlorides Avg.	Min.	Max.	Sulfates Avg.	Min.	Max.	Nitrate-Nitrogen Avg.	Min.	Max.
								<-------------		mg/L	-------------					--->
HN	7.1 - 8.7	19	14	26	71	61	80	12.6	9.7	15.5	7.9	9.0	6.8	<1.0		
HO	6.1 - 6.7	19	11	25	120	120	120	16.3	13.2	17.9	10.7	8.5	12.7	<1.0		
HP	6.5 - 8.4	15	12	19	139	100	177	20.5	20.2	20.8	14.0	13.7	14.4	<1.0		
HT	6.8 - 8.3	19	13	24	117	110	133	18.6	16.7	21.7	10.0	9.6	10.6	<1.0		
HS	6.6 - 7.3	19	14	25	86	80	94	7.6	7.2	8.0	3.2	<4.0	6.4	<1.0		
NYS Drinking Water Standards	6.5 - 8.5	[b]			[b]			250.0			250.0			10.0		

[a] Locations of recharge basins are shown in Figure 15.
[b] No standard specified.

Table 15
BNL Site Environmental Report for Calendar Year 1989
Average Metals Data in On-Site Recharge Basins

Parameter	Location[(a)]					NYS Drinking Water Standards
	HN	HO	HP	HT	HS	
	<------------------		mg/L		------------------>	
No. of Samples*	3 (1)	3 (2)	3 (1)	4 (2)	3 (1)	
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
As	<0.05	<0.05	<0.005	<0.05	<0.05	0.025
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Cu	0.05	0.01	0.01	0.02	<0.05	1.0
Fe	0.42	1.49	0.53	0.55	0.65	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0003	0.002
Mn	0.01	0.20	0.08	0.03	0.03	0.3
Na	6.1	12.3	14.5	9.7	5.3	(b)
Pb	0.002	<0.02	<0.02	<0.02	<0.02	0.025
Zn	0.08	0.02	<0.02	0.03	0.03	5.0

(a) Locations of recharge basins are shown in Figure 15.
(b) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 16
BNL Site Environmental Report for Calendar Year 1989
External Dose-Equivalent Rates for All TLD Locations

Location	First Period Dose mrem	Second Period Dose mrem	Third Period Dose mrem	Total Measured Dose in CY89 mrem	Period Measured in CY89 d	Annual Dose mrem/y
1T2.2	Lost	17.47	Lost	17.47	117	54.49
1T3.0	13.00	12.65	18.88	44.53	289	56.25
1T8.8	11.19	13.16	12.54	36.89	307	43.86
2T2.4(S13)	Lost	19.05	Lost	19.05	117	59.44
2T2.6	Lost	19.37	Lost	19.37	117	60.43
2T3.2	15.73	15.68	23.15	54.57	296	67.29
3T2.8	Lost	Lost	13.68	13.68	96	52.01
3T8.8	13.11	17.02	Lost	30.13	196	56.12
4T2.4	Lost	Lost	12.64	12.64	96	48.05
4T2.6	15.05	14.08	18.72	47.85	296	59.00
4T7.5	13.11	16.11	17.43	46.65	303	56.19
5T2.5	Lost	23.18	Lost	23.18	117	72.32
5T4.2	10.15	18.40	17.41	45.95	296	56.67
5T6.5	12.54	15.81	17.86	46.21	303	55.66
5T17.1	13.69	14.93	14.18	42.80	307	50.89
6T2.8(P7)	15.07	20.64	18.24	53.95	304	64.77
6T5.6	11.97	13.34	17.74	43.04	296	53.08
6T14.2	13.03	15.61	Lost	28.64	197	53.06
7T1.6	Lost	26.36	25.93	52.29	213	89.60
7T2.5	16.30	20.82	23.23	60.36	303	72.71
7T9.7	13.30	13.84	13.44	40.57	307	48.24
8T1.3	Lost	23.66	24.62	48.28	213	82.74
8T2.3	Lost	12.54	17.72	30.26	191	57.82
8T8.0	12.88	14.57	20.69	48.15	296	59.37
9T8.3	13.91	18.40	21.51	53.82	296	66.37
10T1.8	16.55	22.55	20.98	60.07	304	72.13
10T3.7	16.18	18.58	23.52	58.28	315	67.53
10T9.3	16.76	16.67	21.84	55.27	296	68.16
10T12.0	16.46	17.10	16.27	49.83	307	59.24
11T2.1(P4)	15.56	19.69	17.72	52.97	304	63.60
11T3.7	14.93	13.53	17.57	46.03	303	55.45
11T17.8	12.64	13.16	13.29	39.09	307	46.47
12T1.4	17.17	23.66	21.37	62.19	304	74.67
12T5.0	12.31	15.81	19.71	47.83	296	58.97
12T7.2	12.88	18.39	18.30	49.57	303	59.71
12T12.5	16.72	16.29	16.57	49.58	307	58.94
13T1.3	16.80	24.45	19.80	61.05	304	73.30
13T1.4	16.46	Lost	15.82	32.28	207	56.92
13T2.6	13.68	19.46	19.46	52.59	303	63.36
13T8.2	11.40	14.08	17.90	43.38	296	53.49
14T1.3	Lost	23.34	Lost	23.34	117	72.82
14T5.6	18.96	16.96	18.06	53.98	307	64.18
15T1.4	18.03	18.58	15.89	52.50	305	62.83
15T1.4	24.88	Lost	20.00	44.88	206	79.53
15T3.0	13.22	14.82	19.05	47.09	296	58.07
16T2.1(P2)	Lost	19.37	Lost	19.37	117	60.43
16T3.4	13.57	17.63	18.88	50.08	303	60.32
BLDG-197	19.88	26.20	22.15	68.23	304	81.92
BLDG-907	16.05	18.90	16.29	51.24	304	61.52
GUN BARREL	4.20	3.95	4.56	12.71	278	16.69
GUN BARREL	4.33	5.24	5.25	14.83	322	16.81
GUN BARREL	4.10	4.48	4.93	13.51	294	16.77
GUN BARREL	4.87	5.32	5.81	16.00	316	18.48
Annual Average All Locations						61.84 ± 9.9
Annual Average All Gun Barrel Tlds						17.19 ± 0.75
Annual Average On-site TLDs (Excluding Bldg. 197, Bldg. 907, 7T1.6, 8T1.3)						63.21 ± 7.9
Annual Average All Off-Site Tlds						58.39 ± 7.4

Table 17
BNL Site Environmental Report for Calendar Year 1989
Ambient Air Tritium Concentrations at Perimeter and Control Locations

Sample Date	2T	3T	4T	5T	6T1	6T2	7T	8T	9T	10T	11T	12T	13T	14T	15T	16T	17L	17CR	20T
	Location pCi/m³																		
06-Jan-89	-0.67	-1.29	-2.11	-0.34	0.67	0.11	1.62	0.00	-1.44	-0.60	1.57	0.13	-0.61	-0.74	-0.87	0.00	0.40	2.30	1.03
12-Jan-89	0.64	0.09	0.26	0.00	-0.31	-4.71	3.40	3.18	0.14	0.94	0.80	-2.28	2.86	1.05	0.86	6.91	2.67	1.58	1.40
20-Jan-89	0.14	1.22	-2.55	-8.07	-0.53	-5.68	-2.44	-3.63	-1.86	-1.54	-3.42	-0.40	-1.24	-0.96	-2.34	-2.67	60.50	128.72	-0.47
26-Jan-89	-3.33	-1.61	-3.28	0.91	-1.88	3.34	1.35	1.79	0.65	-2.39	-3.52	-0.42	3.80	-1.08	2.04	1.18	3.55	0.00	2.40
01-Feb-89	0.00	-1.51	-0.69	0.72	-1.20	-1.17	-0.55	-3.61	-1.56	-0.95	1.30	0.38	-1.29	-1.89	0.00	-4.75	-3.53	4.38	2.25
09-Feb-89	0.26	0.50	-2.65	-0.95	0.98	-0.55	-0.89	-0.39	0.48	0.77	-1.09	0.42	0.67	-1.36	0.00	0.64	1.97	-0.54	0.40
16-Feb-89	-0.57	0.49	-0.84	-7.50	-0.93	-0.72	-1.93	-1.02	-3.42	1.18	-2.64	-1.14	-1.39	0.42	2.05	2.99	-2.27	0.88	2.37
23-Feb-89	0.00	-1.30	0.00	0.00	0.45	1.01	1.35	1.63	0.00	1.15	-5.32	-0.87	0.00	-1.91	-0.89	-0.77	0.38	1.45	2.86
28-Feb-89	0.49	15.96	0.00	0.00	0.00	0.00	0.00	0.00	0.53	-1.66	0.69	0.74	-1.42	-1.53	0.32	-4.20	1.50	0.91	0.00
08-Mar-89	5.55	0.00	39.62	1.84	8.62	-2.08	0.00	0.00	0.00	-1.17	0.00	-20.55	-6.12	13.73	-24.82	1.69	20.72	3.21	-0.63
16-Mar-89	-0.22	0.43	-3.08	-3.10	0.00	-1.30	0.32	-0.14	0.00	-1.44	-2.64	-66.49	-0.89	0.59	0.93	-2.08	2.13	0.00	-0.35
24-Mar-89	1.35	0.00	-0.36	-4.30	0.86	-0.78	0.00	-0.54	-0.33	-1.00	-0.24	-0.39	0.55	-0.48	-1.20	-0.24	21.85	1.33	0.00
31-Mar-89	1.66	0.45	-4.63	-7.31	0.00	-0.95	-0.23	-0.55	-6.85	-0.75	0.22	-0.95	-2.59	-0.26	3.12	0.82	0.71	0.69	-1.15
07-Apr-89	1.04	-1.95	-1.10	-0.49	4.30	-1.65	0.21	0.00	-2.52	0.25	-0.71	0.49	0.25	-2.42	0.15	0.25	8.27	0.21	0.47
14-Apr-89	1.16	1.36	0.58	-0.41	2.13	0.39	4.42	-0.22	-1.50	-0.58	-0.82	-0.58	0.28	0.87	-0.47	0.92	5.25	2.80	0.55
21-Apr-89	0.46	0.35	-3.70	1.09	0.70	-0.37	1.96	1.08	-1.12	0.27	0.39	-0.75	-6.11	-0.57	-6.19	0.00	5.11	3.19	0.00
28-Apr-89	-0.25	-8.41	-0.31	0.83	-1.52	0.16	2.34	-0.28	-0.15	-2.24	3.45	-1.91	-113.71	69.15	-3.60	-0.46	5.98	10.50	2.09
05-May-89	0.00	-0.92	-3.93	0.00	-2.41	8.23	0.00	7.28	10.00	0.28	-8.29	-4.58	0.00	138.08	0.74	1.99	1.52	1.29	45.01
12-May-89	-0.69	5.00	1.96	-1.02	-2.24	-0.85	-0.23	-0.28	1.20	1.20	-0.94	-1.48	0.00	-0.33	-0.63	4.10	0.00	2.95	-0.41
19-May-89	7.41	0.00	2.14	1.12	-3.29	1.69	-7.30	16.70	0.41	3.63	3.46	4.73	2.98	0.10	12.97	-1.71	3.39	4.93	4.47
25-May-89	-3.18	-14.54	-16.05	-19.35	-3.77	-20.90	-20.80	2.10	-15.20	-15.72	5.85	-13.72	0.00	-21.66	-18.00	-20.10	4.10	8.49	2.62
31-May-89	0.00	-1.24	-1.84	-0.46	2.73	1.54	0.83	18.54	0.00	-1.01	2.10	2.43	0.00	-0.83	-2.52	0.32	-4.50	-10.72	8.54
08-Jun-89	0.00	0.46	0.00	0.67	0.00	39.69	2.23	1.97	9.71	82.63	6.18	2.62	0.00	14.23	2.16	3.73	275.21	11.64	7.13
16-Jun-89	0.00	6.69	2.70	1.05	0.00	0.02	7.28	4.03	4.32	0.44	-0.62	9.42	-1.33	5.61	0.00	-3.08	823.55	4.68	5.29
22-Jun-89	3.82	2.37	0.00	-2.98	0.44	14.43	-2.00	5.21	3.61	16.51	16.50	-2.48	9.49	0.08	0.00	21.61	131.23	10.89	-0.17
30-Jun-89	-2.97	1.53	2.25	7.01	1.19	5.55	7.97	2.96	-1.38	-3.57	-1.65	1.78	5.25	-1.00	9.40	2.37	251.82	49.88	12.36
07-Jul-89	-1.23	1.63	2.17	0.14	1.37	0.61	-1.78	-0.47	-0.05	3.38	-1.89	2.30	0.00	-0.11	5.54	8.41	107.81	21.06	0.00
13-Jul-89	-0.42	22.12	10.94	0.31	1.08	0.92	8.78	17.57	-3.34	7.78	-1.64	-2.95	0.00	-0.89	3.23	3.54	5.69	19.83	0.00
20-Jul-89	3.20	18.14	1.51	8.68	0.00	2.05	3.60	15.78	1.73	-2.30	33.74	18.28	0.00	0.00	1.23	0.00	24.96	11.88	0.00
25-Jul-89	9.17	4.66	13.38	7.52	-1.05	2.81	5.54	3.33	0.18	3.58	5.21	0.38	3.96	4.30	2.22	19.26	5.14	14.83	-2.28
31-Jul-89	-0.04	30.46	0.00	-0.22	0.70	77.20	8.46	0.69	0.58	1.91	3.25	1.92	0.80	0.00	11.99	15.52	32.05	22.95	0.00
09-Aug-89	3.67	0.29	0.00	42.31	0.00	26.14	6.57	18.20	20.26	39.09	0.22	17.04	21.24	3.64	47.41	22.46	19.59	17.91	0.00
16-Aug-89	1.31	22.77	0.00	27.62	10.28	16.41	1.81	22.29	34.20	61.93	19.55	7.13	62.99	0.00	3.19	5.85	8.52	18.97	0.00
24-Aug-89	8.14	29.03	24.04	4.33	1.13	6.19	12.38	4.31	14.90	5.86	7.56	25.22	8.74	0.00	0.02	0.46	51.28	12.51	31.04
31-Aug-89	0.00	6.96	17.27	12.70	-0.29	0.00	17.08	1.65	6.81	10.65	1.54	-0.08	6.95	18.25	42.88	10.57	29.86	26.52	15.98
08-Sep-89	0.00	19.46	30.07	-2.52	2.77	10.18	6.02	13.80	24.40	1.94	5.55	5.72	17.73	11.02	0.00	16.43	5.28	9.16	9.56
15-Sep-89	0.00	13.82	0.00	3.73	-1.27	11.44	2.15	0.45	12.99	0.00	23.35	46.25	8.77	15.94	0.00	26.63	14.38	15.15	38.68
22-Sep-89	-9.10	-2.45	-6.53	-2.74	-2.12	-0.58	-0.73	-5.88	-1.00	0.00	0.18	0.60	0.48	-2.72	0.00	5.70	0.00	4.10	2.20
29-Sep-89	-0.48	-6.53	-4.05	-3.18	0.00	0.00	-0.74	-2.80	0.00	-1.84	1.58	0.64	-0.95	-0.77	-0.04	2.78	15.87	6.71	2.41
05-Oct-89	0.24	-0.95	0.70	-6.33	4.43	3.60	0.52	-2.29	0.00	1.99	0.21	-1.00	1.06	-27.40	3.13	1.52	0.85	3.87	4.57
12-Oct-89	2.38	0.70	-2.06	4.06	15.86	0.00	-0.27	4.85	0.34	-0.55	1.40	1.14	0.79	-2.57	4.82	2.93	3.68	3.85	3.02
19-Oct-89	0.94	-1.45	1.33	0.32	3.95	0.32	3.47	2.53	2.28	-3.71	1.53	2.44	-1.93	0.00	-1.02	0.00	6.77	2.71	1.86
26-Oct-89	0.13	-3.82	-8.41	1.31	13.43	6.49	2.22	0.88	11.70	0.00	1.30	1.94	-0.02	0.00	-2.24	0.24	6.79	4.50	31.80
31-Oct-89	-1.17	-0.08	-0.50	0.72	1.74	0.00	1.50	0.00	1.47	0.79	1.15	4.19	0.00	0.00	0.00	1.74	5.78	4.82	0.00
08-Nov-89	-0.03	2.52	0.71	1.53	0.00	0.00	-1.31	2.55	0.52	0.99	-1.88	1.36	1.35	0.92	-1.12	0.00	26.99	39.46	22.95
15-Nov-89	-5.64	-1.45	-1.17	1.19	0.25	1.90	1.51	5.06	0.03	161.97	-0.50	-0.72	3.19	1.78	4.24	0.27	8.57	9.96	1.68
22-Nov-89	-0.64	-0.55	8.54	-1.83	0.00	-1.08	-0.52	1.64	-1.70	-0.66	-2.89	-3.47	-3.56	-1.76	-1.62	-2.07	5.06	-2.67	-0.26
30-Nov-89	1.99	-0.35	0.28	0.39	2.31	2.25	-0.20	-0.58	3.06	0.00	-0.12	-0.92	-0.71	0.00	-0.99	0.27	12.16	5.31	4.83
08-Dec-89	-0.44	0.17	2.40	1.32	0.20	0.00	0.00	0.00	-0.68	0.09	-0.27	0.00	1.59	1.37	0.48	-2.07	20.50	3.54	0.54
14-Dec-89	0.00	0.09	0.00	0.00	-0.28	1.73	0.00	0.00	3.38	2.62	-0.07	0.00	0.00	-0.12	-0.50	0.27	1.19	539.60	0.00
21-Dec-89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.41	0.00	0.00	0.00	-2.07	6.42	21.96	0.00
02-Jan-90	-2.92	0.00	-3.82	0.00	-0.19	-0.68	-0.46	0.40	-0.06	-1.97	-0.71	0.28	0.12	-0.56	-2.83	0.27	2.97	2.99	-0.20
Flow Wt Avg., pCi/m³	0.40	2.79	1.76	1.71	0.87	4.55	1.79	3.17	2.66	8.18	1.91	0.94	1.50	5.81	1.39	3.08	37.36	21.72	5.91

TABLE 18
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha and Beta Concentrations on Air Particulate Filters
from Location 16T2.1

Month	Flow m^3	Gross Alpha			Gross Beta		
		Avg.	Min.	Max.	Avg.	Min.	Max.
		<-----------------		pCi/m^3			--------------------->
January	435.4	0.00270	0.00150	0.00406	0.0379	0.0326	0.0557
February	378.9	0.00149	0.00021	0.00347	0.0387	0.0319	0.0477
March	424.9	0.00241	0.00164	0.00306	0.0420	0.0260	0.0652
April	384.6	0.00100	0.00000	0.00213	0.0352	0.0321	0.0393
May	460.5	0.00284	0.00182	0.00343	0.0623	0.0306	0.1140
June	420.3	0.00170	0.00061	0.00341	0.0360	0.0237	0.0748
July	437.6	0.00310	0.00155	0.00504	0.0431	0.0317	0.0520
August	439.1	0.00187	-0.00023	0.00359	0.0334	0.0238	0.0477
September	406.9	0.00172	0.00052	0.00215	0.0357	0.0274	0.0437
October	443.8	0.00254	0.00122	0.00812	0.0465	0.0348	0.0899
November	302.1	0.00271	0.00188	0.00344	0.0410	0.0325	0.0489
December	401.0	0.00319	0.00210	0.00426	0.0472	0.0411	0.0537
Annual Average	411.3	0.00228	-0.00023	0.00812	0.0418	0.0237	0.1140
Typical MDL		0.002			0.007		

TABLE 19
1989 BNL Site Environmental Report for Calendar Year 1989
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location 11T2.1

Month	Flow m^3	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.
		<-----------------		pCi/m^3	----------------->		
January	461.0	0.00200	0.00103	0.00434	0.0499	0.0427	0.0582
February	401.7	0.00140	-0.00019	0.00255	0.0407	0.0370	0.0472
March	446.8	0.00160	0.00067	0.00201	0.0380	0.0327	0.0459
April	402.8	0.00178	0.00102	0.00254	0.0395	0.0334	0.0517
May	480.3	0.00101	0.00000	0.00203	0.0339	0.0287	0.0401
June	432.2	0.00130	0.00000	0.00247	0.0430	0.0212	0.0971
July	452.6	0.00249	0.00152	0.00383	0.0415	0.0339	0.0500
August	454.2	0.00147	0.00000	0.00281	0.0399	0.0349	0.0477
September	420.4	0.00222	0.00126	0.00300	0.0372	0.0243	0.0511
October	460.0	0.00289	0.00000	0.00489	0.0518	0.0358	0.0895
November	426.2	0.00180	0.00076	0.00269	0.0349	0.0049	0.0475
December	414.2	0.00272	0.00201	0.00437	0.0499	0.0441	0.0550
Annual Average	437.7	0.00189	-0.00019	0.00489	0.0417	0.0049	0.0971
Typical MDL		0.002			0.006		

Table 20
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha and Beta Concentrations on Air Particulate Filters
from Location 6T2.8

Month	Flow m^3	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.
		<----------------		pCi/m^3		---------------->	
January	427.5	0.00215	-0.00039	0.00560	0.0513	0.0475	0.0558
February	279.4	0.00183	0.00065	0.00333	0.0456	0.0419	0.0519
March	400.8	0.00294	0.00191	0.00486	0.0418	0.0344	0.0477
April	379.9	0.00074	0.00000	0.00189	0.0314	0.0289	0.0340
May	452.8	0.00279	0.00244	0.00306	0.0424	0.0366	0.0508
June	411.0	0.00180	0.00000	0.00340	0.0312	0.0229	0.0447
July	424.8	0.00251	0.00148	0.00425	0.0365	0.0188	0.0538
August	428.6	0.00167	0.00091	0.00306	0.0375	0.0268	0.0470
September	301.9	0.00194	0.00186	0.00200	0.0363	0.0306	0.0435
October	450.7	0.00250	0.00091	0.00545	0.0480	0.0326	0.0818
November	415.3	0.00130	0.00053	0.00231	0.0407	0.0347	0.0468
December	400.3	0.00185	0.00079	0.00267	0.0474	0.0421	0.0532
Annual Average	397.8	0.00203	-0.00039	0.00560	0.0409	0.0188	0.0818
Typical MDL		0.002			0.007		

Table 21
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha and Beta Concentrations on Air Particulate Filters
from Location 4T2.4

Month	Flow m^3	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.
		<------	------	------ pCi/m^3	------	------	------>
January	450.1	0.00193	0.00000	0.00467	0.0479	0.0367	0.0589
February	392.4	0.00182	0.00061	0.00364	0.0389	0.0366	0.0413
March	437.6	0.00205	0.00128	0.00274	0.0371	0.0337	0.0424
April	394.6	0.00130	0.00078	0.00233	0.0344	0.0313	0.0412
May	465.2	0.00160	0.00060	0.00285	0.0405	0.0257	0.0798
June	424.6	0.00157	0.00068	0.00300	0.0462	0.0292	0.0850
July	402.2	0.00274	0.00071	0.00427	0.0369	0.0274	0.0486
August	444.4	0.00138	0.00111	0.00154	0.0343	0.0299	0.0386
September	413.0	0.00181	0.00026	0.00279	0.0336	0.0260	0.0383
October	454.4	0.00270	0.00150	0.00360	0.0494	0.0398	0.0776
November	421.0	0.00171	0.00022	0.00396	0.0373	0.0338	0.0399
December	403.2	0.00248	0.00026	0.00581	0.0480	0.0396	0.0610
Annual Average	425.2	0.00192	0.00000	0.00581	0.0405	0.0257	0.0850
Typical MDL		0.002			0.006		

TABLE 22
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha and Beta Concentrations on Air Particulate Filters
from Location S6

Month	Flow m^3	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.
		<----------------		pCi/m^3		---------------->	
January	375.3	0.00761	0.00064	0.03230	0.13426	0.06730	0.22400
February	371.3	0.00862	0.00189	0.03000	0.12180	0.00816	0.21600
March	417.1	0.00706	0.00000	0.02250	0.12057	0.01760	0.37800
April	362.8	0.01073	-0.00570	0.02510	0.13527	0.05470	0.31000
May	447.7	0.01198	-0.00190	0.15900	0.11074	0.01490	0.22600
June	408.2	0.00734	0.00000	0.02060	0.13224	0.02230	0.43600
July	406.7	0.00762	0.00000	0.01530	0.11478	0.04580	0.29400
August	413.9	0.01874	-0.00130	0.43100	0.17147	0.01590	1.01000
September	406.0	0.00471	-0.01100	0.01520	0.12843	0.04400	0.23700
October	404.7	0.00714	-0.00062	0.01840	0.14520	0.02390	0.30200
November	412.6	0.00186	-0.00902	0.01730	0.11267	0.03690	0.24100
December	398.2	0.00701	-0.00367	0.02460	0.14599	0.06120	0.23800
Annual Average	402.0	0.00839	-0.01100	0.43100	0.1309	0.0082	1.0100
Typical MDL		0.009			0.029		

Table 23
BNL Site Environmental Report for Calendar Year 1989
Composite Air Particulate Filter Radionuclide Data

Month	Flow m^3	Be-7	Cs-137	K-40	Ra-226	Th-228	Se-75	Co-60	Ga-68	Cr-51	Mn-54	Hg-203
		<----------				pCi/m^3						---------->
January	3.45E+03	0.0672	0.001	0.024	0.0026	0.001	MDL	MDL	MDL	MDL	MDL	MDL
February	3.08E+03	0.0449	0.001	0.017	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
March	3.44E+03	0.0532	0.001	0.019	MDL	MDL	0.001	0.002	MDL	0.138	0.00045	0.001
April	3.15E+03	0.0602	0.000	0.021	MDL	MDL	0.002	MDL	MDL	MDL	MDL	MDL
May	3.80E+03	0.0408	0.001	0.020	MDL	MDL	0.002	MDL	MDL	MDL	MDL	MDL
June	3.41E+03	0.0349	MDL	0.015	MDL	MDL	0.003	0.001	0.023	MDL	MDL	MDL
July	3.62E+03	0.0891	0.001	0.021	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
August	3.52E+03	0.0421	0.016	0.016	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
September	3.22E+03	0.0401	0.002	0.019	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
October	3.50E+03	0.0467	0.001	0.017	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
November	3.39E+03	0.0547	0.035	0.018	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
December	3.28E+03	MDL	0.001	0.024	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
Annual Average	3.41E+03	0.0481	0.0051	0.0192	0.0002	0.0001	0.0007	0.0003	0.0019	0.0116	0.00004	0.0001
Typical MDL		0.003	0.0004	0.008	0.0008	0.0007	0.0004	0.0004	0.0004	0.003	0.0003	0.0003

Table 24
BNL Site Environmental Report for Calendar Year 1989
Radionuclides Detected on Charcoal Filter Samples From Location 16T2.1

Month	Flow m^3	Cs-137	K-40	Ra-226	Co-58	Se-75	Br-77	I-126	Hg-203
		<--------			pCi/m^3				-------->
January	4.35E+02	MDL	0.269	MDL	MDL	MDL	MDL	MDL	MDL
February	3.79E+02	MDL	0.232	MDL	MDL	MDL	MDL	MDL	MDL
March	4.25E+02	0.0041	0.523	MDL	MDL	MDL	MDL	MDL	MDL
April	3.85E+02	0.0027	0.534	MDL	MDL	MDL	MDL	MDL	MDL
May	4.61E+02	MDL	0.418	MDL	0.007	0.645	8.820	0.288	0.267
June	4.20E+02	0.0049	0.412	MDL	MDL	MDL	MDL	MDL	MDL
July	4.38E+02	0.0028	0.457	0.024	MDL	MDL	MDL	MDL	MDL
August	4.39E+02	0.0045	0.506	MDL	MDL	MDL	MDL	MDL	MDL
September	4.07E+02	0.0074	0.545	MDL	MDL	MDL	MDL	MDL	MDL
October	4.44E+02	MDL	0.453	0.050	MDL	MDL	MDL	MDL	MDL
November	4.13E+02	MDL	0.463	MDL	MDL	MDL	MDL	MDL	MDL
December	4.01E+02	0.0068	0.585	0.020	MDL	MDL	MDL	MDL	MDL
Annual Average	4.21E+02	0.0027	0.450	0.008	0.001	0.059	0.805	0.026	0.024
Typical MDL		0.0031	0.064	0.007	0.003	0.004	0.013	0.007	0.003

Table 25
BNL Site Environmental Report for Calendar Year 1989
Radionuclides Detected on Charcoal Filter Samples from Location 11T2.1

Month	Flow m^3	Cs-137	K-40	Th-228
		<--------------	pCi/m3	--------------->
January	4.61E+02	0.0027	0.507	MDL
February	4.02E+02	0.0030	0.515	MDL
March	4.47E+02	0.0036	0.510	MDL
April	4.03E+02	0.0024	0.761	MDL
May	4.80E+02	MDL	0.073	MDL
June	4.32E+02	0.0047	0.393	MDL
July	4.53E+02	MDL	0.563	MDL
August	4.54E+02	MDL	0.368	MDL
September	4.20E+02	MDL	0.531	MDL
October	4.60E+02	MDL	0.499	0.007
November	4.26E+02	0.0057	0.468	MDL
December	4.14E+02	0.0044	0.438	MDL
Annual Average	4.38E+02	0.0022	0.464	0.001
Typical MDL		0.0030	0.062	0.005

Table 26
BNL Site Environmental Report for Calendar Year 1989
Radionuclides Detected on Charcoal Filter Samples from Location 6T2.8

Month	Flow m^3	Cs-137	K-40	Ra-226	Se-75	Hg-203
		<------------------		pCi/m3		---------------->
January	4.27E+02	0.0022	0.491	MDL	MDL	MDL
February	2.79E+02	MDL	0.608	MDL	MDL	MDL
March	4.01E+02	MDL	0.402	MDL	MDL	MDL
April	3.80E+02	MDL	0.619	MDL	MDL	MDL
May	4.53E+02	0.0042	0.381	0.040	0.061	0.023
June	4.11E+02	0.0039	0.440	MDL	MDL	MDL
July	4.25E+02	0.0051	0.442	MDL	MDL	MDL
August	4.29E+02	0.0047	0.495	MDL	MDL	MDL
September	3.02E+02	0.0098	0.684	MDL	MDL	MDL
October	4.51E+02	0.0081	0.455	MDL	MDL	MDL
November	4.15E+02	0.0047	0.494	MDL	MDL	MDL
December	4.00E+02	0.0079	0.460	MDL	MDL	MDL
Annual Average	3.98E+02	0.0043	0.488	0.004	0.006	0.002
Typical MDL		0.0033	0.068	0.007	0.004	0.003

Table 27
BNL Site Environmental Report for Calendar Year 1989
Radionuclides Detected on Charcoal Filter Samples from Location 4T2.4

Month	Flow m^3	Cs-137	K-40	Ra-226	Se-75	I-126	Hg-203
		<----		pCi/m3			---->
January	4.50E+02	0.0031	0.566	MDL	MDL	MDL	MDL
February	3.92E+02	MDL	0.561	MDL	MDL	MDL	MDL
March	4.38E+02	MDL	0.522	0.017	MDL	MDL	MDL
April	3.95E+02	0.0020	0.600	MDL	MDL	MDL	MDL
May	4.65E+02	0.0035	0.384	0.091	0.082	0.037	0.032
June	4.25E+02	0.0027	0.401	0.012	MDL	MDL	MDL
July	4.02E+02	MDL	0.509	MDL	MDL	MDL	MDL
August	4.44E+02	MDL	0.408	MDL	MDL	MDL	MDL
September	4.13E+02	0.0057	0.651	MDL	MDL	MDL	MDL
October	4.54E+02	MDL	0.563	MDL	MDL	MDL	MDL
November	4.21E+02	0.0085	0.386	MDL	MDL	MDL	MDL
December	4.03E+02	0.0034	0.500	MDL	MDL	MDL	MDL
Annual Average	4.25E+02	0.0024	0.502	0.011	0.008	0.003	0.003
Typical MDL		0.0031	0.064	0.007	0.004	0.007	0.003

Table 28
BNL Site Environmental Report for Calendar Year 1989
Radionuclides Detected on Charcoal Filter Samples from Location S6

Month	Flow m^3	Cs-137	K-40	Ra-226
		<------------	pCi/m3	----------->
January	3.75E+02	MDL	0.560	0.023
February	3.71E+02	MDL	0.591	MDL
March	4.17E+02	MDL	0.530	MDL
April	3.63E+02	MDL	0.766	MDL
May	4.48E+02	MDL	0.113	0.025
June	4.08E+02	MDL	0.662	MDL
July	4.07E+02	0.0045	0.608	MDL
August	4.14E+02	0.0053	0.785	MDL
September	4.05E+02	0.0089	0.475	MDL
October	4.05E+02	0.0060	0.466	MDL
November	4.13E+02	0.0062	0.480	0.008
December	3.98E+02	MDL	0.755	MDL
Annual Average	4.02E+02	0.0026	0.560	0.005
Typical MDL		0.0033	0.067	0.007

Table 29
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Precipitation (Wet and Dry) at Location 4T2.4 and 11T2.1

Location	Sample Type	Month	Precipitation Collected cc	Gross Alpha	Gross Beta	Tritium	Be-7	K-40	Ra-226	Cs-137	Ce-141	Sr-90
				<----------				nCi/m²				---------->
S-5	Dry	January	0	0.002	-0.008	-18.049						
		February	0	0.005	-0.002	-13.750						
		March	0	0.002	-0.012	-12.195	1.500	MDL	MDL	0.063	MDL	NA
		April	0	0.011	0.006	-10.915						
		May	0	0.002	0.065	-12.287						
		June	0	0.003	-0.138	-8.720	MDL	MDL	MDL	MDL	MDL	NA
		July	0	-0.008	0.242	3.262						
		August	0	-0.008	-0.115	-3.933						
		September	0	-0.003	0.008	-5.152	MDL	MDL	MDL	MDL	MDL	NA
		October	0	-0.002	0.026	3.323						
		November	0	-0.011	0.023	-2.500						
		December	0	NA	NA	NA	MDL	MDL	MDL	MDL	MDL	NA
		Total		**-0.008**	**0.095**	**-80.915**	**1.500**	**MDL**	**MDL**	**0.063**	**0.000**	**0.000**
S-5	Wet	January	4160	0.013	0.043	-176.927						
		February	6160	0.014	0.082	-327.720						
		March	5960	0.000	0.041	-326.165	13.625	0.794	MDL	MDL	MDL	0.025
		April	5360	0.004	0.062	-22.143						
		May	18740	0.015	0.606	-115.125						
		June	10450	0.016	0.018	-26.921	19.592	MDL	3.360	MDL	MDL	-0.063
		July	10960	0.000	-0.632	-28.068						
		August	15660	0.368	2.793	52.280						
		September	7540	0.000	0.017	-49.769	7.342	MDL	MDL	MDL	MDL	0.036
		October	11000	-0.060	-0.050	24.985						
		November	12000	-0.038	0.291	19.939						
		December	0	NA	NA	NA	7.047	9.116	MDL	MDL	MDL	-0.004
		Total	**107990**	**0.331**	**3.271**	**-975.634**	**47.607**	**9.910**	**3.360**	**MDL**	**MDL**	**-0.005**
11	Dry	January	0	0.002	0.017	-12.896						
		February	0	0.006	0.008	-10.335						
		March	0	0.002	0.009	-3.049	1.756	MDL	0.457	MDL	MDL	NA
		April	0	0.002	0.078	-9.329						
		May	0	0.000	0.010	-8.049						
		June	0	0.009	0.000	-6.555	MDL	MDL	MDL	MDL	MDL	NA
		July	0	-0.016	0.092	3.262						
		August	0	0.000	0.063	3.720						
		September	0	-0.005	-0.005	-6.768	MDL	MDL	1.884	MDL	MDL	NA
		October	0	-0.005	0.015	5.244						
		November	0	-0.006	0.001	11.159						
		December	0	NA	NA	NA	MDL	MDL	MDL	MDL	2.707	NA
		Total		**-0.011**	**0.290**	**-33.598**	**1.756**	**MDL**	**2.341**	**MDL**	**2.707**	**NA**
11	Wet	January	3660	0.003	0.019	-183.558						
		February	6380	0.005	-0.037	-378.326						
		March	6100	0.000	0.081	-212.942	11.834	0.288	MDL	MDL	MDL	0.025
		April	5500	0.009	0.367	-22.721						
		May	17620	0.055	0.376	-9.218						
		June	10800	0.008	0.062	-40.994	41.378	MDL	2.281	MDL	MDL	0.026
		July	7260	-0.085	0.334	14.719						
		August	15340	-0.061	2.572	-48.873						
		September	6600	0.000	0.000	0.000	13.888	MDL	4.807	MDL	MDL	-0.031
		October	3740	-0.015	0.063	11.117						
		November	11500	-0.046	0.165	20.160						
		December	0	NA	NA	NA	11.314	MDL	MDL	MDL	MDL	-0.063
		Total	**94500**	**-0.127**	**4.003**	**-850.635**	**78.414**	**0.288**	**7.088**	**MDL**	**MDL**	**-0.043**
Typical MDL				0.004	0.009	.032	0.30	0.71	0.09	0.04	0.03	0.006

NA = Not Analyzed
Notes: 1. Gamma Spectroscopy and strontium-90 analysis performed on quarterly composite samples.
2. There was insufficient precipitation during December to collect a sample.
3. Rain Collector area at each station is 0.0656 m²

Table 30
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in
Vegetation and Soil in the Vicinity of BNL

Location	Matrix	Sample Date	Be-7	Cs-137	K-40	Ra-226	Th-228
			<----------------		pCi/g		---------------->
Fink's Farm	Soil	6/12/89	0.16	0.07	3.20	0.28	0.40
NYS Game Farm (Ridge)	Soil	6/12/89	1.08	0.41	2.83	0.17	0.26
		10/25/90	0.15	0.11	2.93	0.10	0.33
		avg.	0.62	0.26	2.88	0.13	0.29
Yaphank Honor Farm	Soil	6/12/89	0.20	0.20	5.30	0.57	0.68
		10/25/90	1.08	0.11	3.80	0.30	0.87
		avg.	0.64	0.15	4.55	0.44	0.78
Berenzy Farm	Soil	6/12/89	0.14	0.22	9.02	0.70	1.22
		10/25/90	MDL	0.12	3.37	2.70	0.67
		avg.	0.07	0.17	6.20	1.70	0.94
Fink's Farm	Grass	6/12/89	0.39	MDL	2.58	MDL	MDL
NYS Game Farm (Ridge)	Grass	6/12/89	0.37	0.06	1.45	MDL	MDL
		10/25/90	2.71	0.14	6.03	MDL	MDL
		avg.	1.54	0.10	3.74	MDL	MDL
Yaphank Honor Farm	Grass	6/12/89	0.35	MDL	2.74	MDL	0.10
		10/25/90	1.03	MDL	3.00	MDL	0.04
		avg.	0.69	MDL	2.87	MDL	0.07
	Strawberry	6/12/89	MDL	MDL	1.28	MDL	MDL
Berenzy Farm	Grass	6/12/89	MDL	MDL	2.57	MDL	MDL
		10/25/90	1.61	0.08	5.57	MDL	MDL
		avg.	0.81	0.04	4.07	MDL	MDL
Typical MDL			0.074	0.010	0.18	0.026	0.021

Table 31
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in
Soil at Locations within the BNL Site

Location	Matrix	Depth	Sample Date	Be-7	Cs-137	K-40	Ra-226	Th-228	Co-60	Co-57	Na-22	Mn-54
				<----------					pCi/g			---------->
Site Perimiter Location 16T	Soil	0 - 5 cm	10/23/89	MDL	0.25	4.96	0.34	0.28	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	MDL	7.21	0.52	1.37	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.25	5.09	0.38	0.63	MDL	MDL	MDL	MDL
		avg.		MDL	0.16	5.75	0.41	0.76	MDL	MDL	MDL	MDL
Site Perimiter Location 11T	Soil	0 - 5 cm	10/23/89	MDL	0.47	4.84	0.46	0.58	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.47	3.39	0.44	0.60	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.28	5.93	0.90	0.77	MDL	MDL	MDL	MDL
		avg.		MDL	0.41	4.72	0.60	0.65	MDL	MDL	MDL	MDL
Site Perimiter Location 6T	Soil	0 - 5 cm	10/23/89	MDL	1.01	9.30	0.81	1.32	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.48	7.78	0.44	0.62	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.16	5.50	0.27	0.44	MDL	MDL	MDL	MDL
		avg.		MDL	0.55	7.53	0.51	0.79	MDL	MDL	MDL	MDL
Site Perimiter Location 4T	Soil	0 - 5 cm	10/23/89	MDL	0.34	5.30	0.94	0.37	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.55	4.00	0.30	0.85	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	5.61	0.74	0.48	MDL	MDL	MDL	MDL
		avg.		MDL	0.30	4.97	0.66	0.57	MDL	MDL	MDL	MDL
Site Perimiter North Gate	Soil	0 - 5 cm	10/23/89	MDL	0.73	6.73	0.61	0.50	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.52	4.31	0.68	0.33	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.40	1.89	0.44	0.44	MDL	MDL	MDL	MDL
		avg.		MDL	0.55	4.31	0.58	0.42	MDL	MDL	MDL	MDL
EM Location S6	Soil	0 - 5 cm	10/23/89	MDL	1.53	7.00	1.00	0.63	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.97	8.26	0.48	1.30	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.37	8.50	0.71	0.74	MDL	MDL	MDL	MDL
		avg.		MDL	0.96	7.92	0.71	0.89	MDL	MDL	MDL	MDL
Building 555	Soil	0 - 5 cm	10/26/89	MDL	251	3.56	0.75	0.51	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	304	5.36	0.62	0.76	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	137	5.62	0.63	0.88	MDL	MDL	MDL	MDL
		avg.		MDL	231	4.85	0.67	0.72	MDL	MDL	MDL	MDL
Building 490	Soil	0 - 5 cm	10/25/89	MDL	281	5.67	0.57	0.92	0.16	MDL	MDL	MDL
		5 - 10 cm		MDL	245	8.23	0.64	0.74	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	38.7	6.00	0.35	0.64	MDL	MDL	MDL	MDL
		avg.		MDL	188.2	6.63	0.52	0.77	0.05	MDL	MDL	MDL
Building 355	Soil	0 - 5 cm	10/25/89	MDL	46	6.43	0.91	0.55	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	66.8	4.56	0.38	0.53	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	27.6	3.6	0.69	0.42	MDL	MDL	MDL	MDL
		avg.		MDL	46.8	4.86	0.66	0.50	MDL	MDL	MDL	MDL
Brookhaven Center	Soil	0 - 5 cm	10/25/89	MDL	11.7	5.00	0.63	0.40	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	12.6	5.65	0.52	0.50	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	10.8	4.71	0.72	0.73	0.08	MDL	MDL	MDL
		avg.		MDL	11.7	5.12	0.62	0.54	0.03	MDL	MDL	MDL
Old Landfill	Soil	0 - 5 cm	10/26/89	MDL	6.0	4.85	0.76	0.48	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	5.2	3.72	0.73	0.43	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	13.6	10.7	0.70	0.63	MDL	MDL	MDL	MDL
		avg.		MDL	8.3	6.42	0.73	0.52	MDL	MDL	MDL	MDL
Building 912A Sample 1	Soil	0 - 5 cm	12/07/89	MDL	MDL	5.68	MDL	MDL	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	MDL	5.98	MDL	MDL	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	4.95	MDL	MDL	MDL	MDL	MDL	MDL
		avg.		MDL	MDL	5.54	MDL	MDL	MDL	MDL	MDL	MDL
Building 912A Sample 2	Soil	0 - 5 cm	12/07/89	MDL	MDL	5.74	0.21	MDL	0.85	0.16	0.28	0.093
		5 - 10 cm		MDL	MDL	5.43	0.30	0.27	0.34	MDL	0.19	MDL
		10 - 15 cm		MDL	MDL	3.85	0.38	0.38	0.16	MDL	0.34	MDL
		avg.		MDL	MDL	5.01	0.30	0.22	0.45	0.05	0.27	0.031
Building 912A Sample 3	Soil	0 - 5 cm	12/07/89	MDL	0.10	4.97	0.29	MDL	MDL	MDL	MDL	0.073
		5 - 10 cm		MDL	MDL	4.29	MDL	0.27	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	3.88	1.27	0.36	MDL	MDL	MDL	MDL
		avg.		MDL	0.03	4.38	0.52	0.21	MDL	MDL	MDL	0.024
Building 912A Sample 4	Soil	0 - 5 cm	12/07/89	MDL	0.15	5.17	0.22	0.20	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	MDL	5.87	2.36	0.57	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	5.19	1.47	0.41	MDL	MDL	MDL	MDL
		avg.		MDL	0.05	5.41	1.35	0.39	MDL	MDL	MDL	MDL
Building 912A Sample 5	Soil	0 - 5 cm	12/07/89	MDL	MDL	4.52	1.03	0.36	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	MDL	5.09	0.61	0.43	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	6.7	0.14	0.37	MDL	MDL	MDL	MDL
		avg.		MDL	MDL	5.44	0.59	0.39	MDL	MDL	MDL	MDL
Building 811 Sample 2	Soil	0 - 5 cm	12/07/89	MDL	0.30	6.9	MDL	MDL	0.17	MDL	MDL	MDL
		5 - 10 cm		MDL	0.22	7.0	0.48	0.46	0.14	MDL	MDL	MDL
		10 - 15 cm		MDL	0.13	8.8	0.48	0.56	MDL	MDL	MDL	MDL
		avg.		MDL	0.21	7.6	0.32	0.34	0.100	MDL	MDL	MDL
Building 811 Sample 3	Soil	0 - 5 cm	12/07/89	MDL	0.43	7.7	MDL	MDL	0.85	MDL	MDL	MDL
		5 - 10 cm		MDL	MDL	9.1	0.34	0.16	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.15	4.7	0.25	0.47	MDL	MDL	MDL	MDL
		avg.		MDL	0.19	7.2	0.20	0.21	0.28	MDL	MDL	MDL
Building 811 Sample 4	Soil	0 - 5 cm	12/07/89	MDL	0.34	8.89	0.43	0.20	MDL	MDL	MDL	MDL
		5 - 10 cm		MDL	0.13	10.2	MDL	MDL	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	0.16	8.8	0.39	0.58	MDL	MDL	MDL	MDL
		avg.		MDL	0.20	9.3	0.27	0.26	MDL	MDL	MDL	MDL
Metal Scrap Yard	Soil	0 - 5 cm	12/07/89	MDL	0.42	9.3	0.25	0.23	0.60	MDL	MDL	MDL
		5 - 10 cm		MDL	0.20	11.3	0.42	0.25	MDL	MDL	MDL	MDL
		10 - 15 cm		MDL	MDL	13.3	0.668	0.152	MDL	MDL	MDL	MDL
		avg.		MDL	0.21	11.3	0.5	0.210	0.20	MDL	MDL	MDL
Building 936	Soil	0 - 15 cm	12/06/89	MDL	0.11	6.2	0.34	0.35	MDL	MDL	MDL	MDL
				MDL								
Building 931	Soil	0 - 15 cm	12/06/89	MDL	0.392	12.6	0.86	0.70	MDL	MDL	MDL	MDL
STP Sand Pile	Soil	0 - 15 cm	10/24/89	MDL	1.29	2.2	0.97	0.25	0.28	0.16	MDL	MDL
Typical MDL				0.074	0.01	0.18	0.026	0.021	0.011	0.007	0.010	0.008

Table 32
BNL Site Environmental Report for Calendar Year 1989
On-Site Soil Metal Concentration Data

Location	Sample Date	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
		<------						ppm dry						------>
North Gate	10/23/89	5.0	2.0	1.0	1.0	9.7	5.7	54.7	0.1	23.7	1.0	5.0	10.0	24.0
Location S6	10/24/89	5.0	2.0	1.0	1.0	11.3	10.4	25.3	0.1	10.2	1.0	5.0	10.0	42.7
Location 6T	10/24/89	5.0	2.0	1.0	1.0	7.2	13.4	328.0	0.1	10.0	1.0	5.0	10.0	78.0
Location 4T	10/24/89	5.0	2.0	1.0	1.0	9.8	12.4	37.4	0.1	10.0	1.0	5.0	10.0	60.0
Location 11T	10/24/89	5.0	2.0	1.0	1.0	13.4	8.9	58.5	0.5	10.0	1.0	5.0	10.0	43.0
Location 16T	10/25/89	5.0	2.0	1.0	1.0	10.0	5.0	32.3	0.1	10.0	1.0	5.0	10.0	35.6
Bldg. 490	10/25/89	5.0	3.3	1.0	1.0	11.2	8.4	24.2	2.8	10.0	1.0	5.0	10.0	38.5
Bldg. 936	12/06/89	5.0	2.0	1.0	1.0	10.1	73.8	28.1	0.1	16.2	1.0	5.0	10.0	46.0
Bldg. 912-1	12/07/89	7.7	2.0	1.3	1.0	14.3	64.2	267.0	0.1	17.9	1.0	5.0	10.0	68.4
Bldg. 912-2	12/07/89	12.8	5.1	1.1	1.0	25.0	55.2	67.3	0.1	42.6	1.0	5.0	10.0	73.4
Bldg. 912-3	12/07/89	10.2	2.2	1.0	1.0	25.9	49.8	43.8	0.1	38.0	1.0	5.0	10.0	114.0
Bldg. 912-4	12/07/89	6.7	2.0	1.1	1.0	17.6	60.8	81.3	0.1	29.7	1.0	5.0	10.0	258.0
Bldg. 912-5	12/07/89	11.0	5.7	1.1	1.0	9.7	55.5	80.5	0.1	17.8	1.0	5.0	10.0	460.0
Bldg. 811-1	12/07/89	18.2	7.1	1.0	1.0	360.0	168.0	120.0	1.9	657.0	1.0	5.0	10.0	160.0
Bldg. 811-2	12/07/89	22.1	3.6	1.0	1.0	67.2	55.8	103.0	0.2	166.0	1.0	5.0	10.0	121.0
Bldg. 811-3	12/07/89	27.1	11.2	1.0	1.0	170.0	62.1	502.0	0.7	390.0	1.0	5.0	10.0	82.4
Blank		5.0	2.0	1.0	1.0	5.0	5.0	5.0	0.1	10.0	1.0	5.0	10.0	5.0

Table 33
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha, Gross Beta, and Tritium Concentrations in
Peconic River and Carmen's River Surface Water Samples

Sample Location	Month	Number of Samples	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.
			<------------------------				pCi/L		------------------------>		
HM	January	11	0.347	-1.280	1.280	19.260	7.370	41.900	1028	-498	3600
	February	11	0.209	-1.020	1.790	13.821	2.550	19.600	317	-868	1550
	March	14	0.601	-1.280	2.560	16.268	9.250	24.200	300	-486	1390
	April	12	0.213	-0.770	1.280	13.648	4.160	28.500	2158	-207	6510
	May	13	0.452	-2.050	1.280	11.498	3.400	19.100	604	-1120	4390
	June	13	0.020	-2.300	1.540	11.298	4.720	18.900	2953	1040	5590
	July	11	0.232	-1.540	2.300	10.246	3.210	18.500	2472	486	4550
	August	13	0.118	-1.020	1.280	11.557	3.020	19.800	1393	-5240	3840
	September	12	0.427	-1.790	2.560	8.515	0.000	17.800	988	-1100	3120
	October	13	0.413	-0.512	2.560	6.521	2.460	12.800	595	-469	1360
	November	11	0.581	-1.280	3.070	4.637	1.320	8.690	-85	-1190	645
	December	13	0.769	-0.770	1.540	4.210	-0.760	8.310	-285	-3860	684
	Total/Avg.	147	0.369	-2.300	3.070	10.935	-0.760	41.900	1030	-5240	6510
HQ	January	0			No Sample Collected - Sample Point Dry						
	February	0			No Sample Collected - Sample Point Dry						
	March	0			No Sample Collected - Sample Point Dry						
	April	2	0.077	0.051	0.102	4.891	-0.189	9.970	1695	0	3390
	May	11	0.006	-1.020	0.461	8.416	4.570	12.500	840	-201	6100
	June	13	0.130	-0.100	0.461	8.605	5.630	12.100	2129	0	4330
	July	12	-0.050	-0.510	0.205	6.090	2.340	11.600	1699	467	3460
	August	13	-0.138	-1.280	1.540	6.062	1.890	10.800	236	-5310	2630
	September	10	0.844	-0.260	1.790	7.312	3.210	11.000	976	49	2870
	October	13	0.392	-1.280	1.020	5.462	0.944	10.000	766	-312	2030
	November	11	0.256	-0.510	1.540	4.568	0.567	8.310	297	-499	1230
	December	8	0.512	-0.510	2.050	3.660	1.510	7.370	296	-3190	2630
	Total/Avg.	91	0.218	-1.280	2.050	6.373	-0.189	12.500	940	-5310	6100
HA	March	1	0.410			1.440			-403		
	October	1	-0.210			1.850			57		
	Total/Avg.	2	0.100	-0.210	0.410	1.645	1.440	1.850	-173	-403	57
HB	March	1	0.154			1.320			-29		
	June	1	0.256			2.150			2040		
	October	1	-0.150			2.380			-114		
	Total/Avg.	3	0.087	-0.150	0.256	1.950	1.320	2.380	632	-114	2040
HC	March	1	0.102			1.470			-230		
	June	1	0.205			1.660			1420		
	October	1	0.000			2.420			-15		
	Total/Avg.	3	0.102	0.000	0.205	1.850	1.470	2.420	391	-230	1420
HR	January	1	0.256			1.810			NA		
	March	1	-0.150			0.907			-259		
	June	1	0.256			3.820			1590		
	October	1	-0.051			1.810			-10		
	Total/Avg.	4	0.078	-0.150	0.256	2.087	0.907	3.820	440	-259	1590
HH	January	1	0.512			0.944			NA		
	March	1	0.102			1.210			-202		
	October	1	-0.100			1.470			-129		
	Total/Avg.	3	0.171	-0.100	0.512	1.208	0.944	1.470	-165	-202	-129
	Typical MDL		0.53			1.2			300		

Table 34
BNL Site Environmental Report for Calendar Year 1989
Nuclide Specific Concentrations in Peconic and Carmens River Surface Water Samples

Month	Aliquot, Liters	Na-22	Co-60	Cs-137	K-40	Sr-90
		<--------------------		pCi/L		------------>
Station HM - Peconic River - On Site						
January	13.44	1.50	0.32	64.60	4.70	0.89
February	15.79	MDL	MDL	25.90	3.81	0.81
March	10.50	0.34	0.20	58.70	9.90	0.81
April	20.13	MDL	MDL	9.75	MDL	0.15
May	15.50	0.33	0.16	9.66	1.45	0.15
June	95.26	MDL	MDL	2.11	1.88	0.15
July	119.09	MDL	MDL	0.01	MDL	0.52
August	119.01	MDL	MDL	0.08	MDL	0.52
September	11.50	MDL	MDL	11.90	8.32	0.52
October	17.00	MDL	0.59	5.02	MDL	0.44
November	12.00	MDL	MDL	4.21	MDL	0.44
December	15.00	MDL	MDL	3.08	3.79	0.44
Annual	464.21	0.06	0.04	5.97	1.25	0.44
Station HA - Peconic River, Off-Site						
1st Qtr.	12.00	MDL	MDL	MDL	MDL	0.70
2nd Qtr.	12.00	MDL	MDL	2.06	MDL	MDL
4th Qtr.	12.00	0.16	MDL	1.37	MDL	0.33
Annual	36.00	0.05	MDL	0.46	MDL	0.34
Station HB - Peconic River, Off-Site						
1st Qtr.	12.00	MDL	MDL	0.29	MDL	0.60
2nd Qtr.	12.00	MDL	MDL	1.41	1.90	0.11
4th Qtr.	12.00	MDL	MDL	0.88	MDL	0.42
Annual	36.00	MDL	MDL	0.86	0.63	0.38
Station HC - Peconic River , Off-Site						
1st Qtr.	12.00	MDL	1.67	MDL	MDL	0.20
2nd Qtr.	12.00	MDL	MDL	0.66	1.94	0.15
4th Qtr.	12.00	MDL	MDL	MDL	MDL	0.23
Annual	36.00	MDL	0.56	0.22	0.65	0.19
Station HR - Peconic River, Off-Site						
1st Qtr.	12.00	MDL	MDL	MDL	2.50	0.30
2nd Qtr.	12.00	MDL	MDL	0.12	MDL	0.23
4th Qtr.	12.00	MDL	MDL	0.69	4.14	-0.22
Annual	36.00	MDL	MDL	0.27	2.21	0.10
Station HH						
1st Qtr.	12.00	MDL	MDL	MDL	1.27	0.30
2nd Qtr.	12.00	MDL	MDL	MDL	0.90	0.07
4th Qtr.	12.00	MDL	MDL	MDL	1.04	0.02
Annual	36.00	MDL	MDL	MDL	1.07	0.13
Typical MDL for 12 L Sample		0.20	0.23	0.20	3.9	0.1

Table 35
BNL Site Environmental Report for Calendar Year 1989
Peconic River Water Quality Data

Location	Sample Period	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
				Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
							<------	------	------	------	mg/L	------	------	------	------>
HM	January	11 (5)	3.1 - 6.8	NA			34.8	27.4	50.1	16.3	15.9	16.8	2.3	<1.0	4.4
	February	11 (4)	4.3 - 6.3	NA			27.3	23.4	29.5	15.0	14.1	15.9	2.6	<1.0	3.9
	March	13 (4)	3.2 - 6.9	NA			32.1	20.3	42.3	14.6	14.2	15.0	4.5	3.5	7.1
	April	12 (4)	3.4 - 7.0	188	110	330	41.1	29.3	64.3	14.7	13.1	15.6	4.2	4.0	4.4
	May	13 (4)	3.6 - 6.5	143	40	260	24.8	12.1	31.8	13.5	9.2	16.3	3.4	1.6	4.2
	June	13 (3)	5.9 - 7.2	124	90	160	20.9	17.6	23.8	11.8	11.1	12.2	2.1	1.6	2.6
	July	11 (5)	5.7 - 7.0	127	60	200	18.5	15.5	22.6	13.1	10.9	14.9	2.4	1.3	3.4
	August	13 (4)	3.5 - 7.2	151	60	360	22.9	21.9	24.3	12.0	10.4	15.7	1.4	<1.0	3.0
	September	11 (3)	5.4 - 7.6	161	53	298	28.5	25.3	31.9	11.5	11.2	11.9	2.4	2.3	2.6
	October	13 (5)	5.2 - 7.2	125	85	162	27.8	16.4	54.0	10.6	7.9	12.3	1.5	1.0	2.2
	November	12 (3)	2.6 - 6.0	209	59	771	30.3	23.9	34.9	7.8	6.9	8.7	<1.0		
	December	13 (4)	3.9 - 7.1	113	70	352	25.9	18.9	34.6	16.5	9.9	33.3	1.3	1.2	1.6
NYS Drinking Water Standards			6.5 - 8.5	(a)			250.0			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH and conductivity; number inside parenthesis inside parenthesis represents number of samples analyzed for chlorides, sulfates, and nitrate-nitrogen.

Table 36
BNL Site Environmental Report for Calendar Year 1989
Peconic River Average Metals Data

Location	Sample Period	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Se	Zn
		<------						mg/L					------>
HM	January	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	February	<0.010	<0.005	<0.005	<0.010	0.110	0.380	<0.002	0.020	22.400	<0.02	<0.005	0.100
	March	<0.010	<0.050	<0.005	<0.010	0.110	0.140	0.009	0.030	14.800	<0.02	<0.005	0.150
	April	<0.010	<0.050	<0.005	<0.010	0.070	0.120	0.002	0.040	12.900	<0.02	<0.005	0.080
	May	<0.025	NA	0.001	<0.005	<0.050	0.390	NA	0.050	14.500	<0.005	NA	0.050
	June	<0.025	NA	0.001	<0.005	0.320	0.200	NA	<0.050	14.200	<0.005	NA	0.030
	July	<0.025	NA	<0.001	<0.005	0.140	<0.075	NA	<0.050	14.100	<0.005	NA	0.030
	August	<0.025	NA	0.001	<0.005	0.170	0.560	NA	0.120	13.300	0.005	NA	0.040
	September	<0.025	NA	<0.001	<0.005	0.070	1.110	NA	0.130	15.300	<0.005	NA	0.020
	October	<0.025	NA	0.001	<0.005	<0.050	0.890	NA	0.170	11.600	<0.005	NA	0.030
	November	<0.025	NA	<0.001	<0.005	0.110	0.960	NA	0.090	10.700	<0.005	NA	0.040
	December	<0.025	NA	<0.001	<0.005	<0.050	1.100	NA	0.080	14.400	<0.005	NA	0.030
NYS Drinking Water Standard		0.025	0.025	0.010	0.050	1.000	0.300	0.002	0.300	(a)	0.025	0.02	5.000

NA = Not Analyzed
(a) = No Standard Specified.

Table 37
BNL Site Environmental Report for Calendar Year 1989
Water Quality Parameters for Surface Water Samples
Collected Along the Peconic and Carmens River

River	Sample Location	Number of Samples	PH	Conductivity			Temperature			Dissolved Oxygen		
			(SU)	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
				<------	umhos/cm	---->	<-----	°C	---->	<------	mg/L	---->
Peconic	HE	3 (2)	(4.5 - 6.9)	36.8	20	50	14.7	10	19	3.4	2.2	4.6
	HA	2 (1)	(4.2 - 5.2)	126.0			9.0	9	16	11.6		
	HB	2 (1)	(4.3 - 5.7)	67.0	50	54	19.0	15	23	36.0		
	HC	3 (2)	(4.2 - 6.6)	83.0	40	126	17.3	9	27	10.1	8	12.2
	HR	3 (2)	(5.8 - 6.6)	77.0	60	94	17.7	10	27	10.4	8.2	12.6
Carmens	HH	3 (2)	(6.3 - 6.9)	169.0	138	200	16.7	10	22	9.8	8.6	11

Note: The number in brackets indicates that for some parameters less than the number of samples collected were analyzed.

Table 38
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Fish

Sample Location	Sample Date	ID #	Distance from BNL Discharge, km	Species	Dry/Wet Ratio	Cs-137 Conc. pCi/kg dry	Cs-137 Conc. pCi/kg wet	net Cs-137 Conc. pCi/kg wet	K-40 Conc. pCi/kg dry	K-40 Conc. pCi/kg wet	net K-40 Conc. pCi/kg wet	Sr-90 Conc. pCi/kg dry	Sr-90 Conc. pCi/kg wet	net Sr-90 Conc. pCi/kg wet
Swan Lake	08/02/89	388	Control	Gold Shiner	0.23	887	204	NA	12700	2921	NA	SNA	SNA	SNA
	08/02/89	365-368		Pumpkin Seed	0.25	902	226	NA	14200	3550	NA	SNA	SNA	SNA
Station HS	09/07/89	399A	On-Site Recharge Basin	Large Mouth Bass - Flesh	0.25	593	148	NA	12100	3025	NA	SNA	SNA	SNA
	09/07/89	399B		Large Mouth Bass - Bone	0.39	151	59	NA	6160	2402	NA	SNA	SNA	SNA
	09/07/89	400A		Gold Fish - Flesh	0.23	180	41	NA	15000	3450	NA	SNA	SNA	SNA
	09/07/89	400B		Gold Fish	0.30	97	29	NA	6410	1923	NA	SNA	SNA	SNA
STP Aquarium	09/07/89	395	0	Large Mouth Bass	0.25	747	187	NA	13900	3475	NA	SNA	SNA	SNA
Station HM	09/07/89	396A	0.8	Pumpkin Seed - Flesh	0.26	26400	6864	6639	12600	3276	-274	SNA	SNA	SNA
	09/07/89	396B		Pumpkin Seed - Bone & Viscera	0.35	23200	8120	7894	MDL	0	-3550	SNA	SNA	SNA
	09/07/89	397B		Sun Fish - Bone & Viscera	0.38	22800	8664	NA	4090	1554	NA	SNA	SNA	SNA
	09/07/89	397A		Sun Fish - Flesh	0.36	30600	11016	NA	6780	2441	NA	SNA	SNA	SNA
	09/07/89	398A		Pickerel - Flesh	0.31	12560	3894	NA	11700	3627	NA	SNA	SNA	SNA
	09/07/89	398B		Pickerel - Bone & Viscera	0.48	19400	9312	NA	15700	7536	NA	SNA	SNA	SNA
Forge Pond Peconic River Riverhead	07/18/89	371-374	20	Blue Gill	0.29	793	230	NA	11300	3277	NA	SNA	SNA	SNA
	07/31/89	377		Cat Fish	0.24	355	85	NA	12500	3000	NA	SNA	SNA	SNA
	08/02/89	384-385		Cat Fish	0.18	1540	277	NA	9250	1665	NA	SNA	SNA	SNA
	07/31/89	378-382		Large Mouth Bass	0.25	669	167	NA	8990	2248	NA	SNA	SNA	SNA
	08/02/89	386-387		Gold Shiner	0.22	943	207	3	10900	2398	-523	SNA	SNA	SNA
	08/02/89	390		Pumpkin Seed	0.24	637	153	-73	14700	3528	-22	SNA	SNA	SNA
	08/02/89	389,391-393		Pumpkin Seed - Flesh	0.26	361	94	-132	10200	2652	-898	SNA	SNA	SNA
	08/02/89	389,391-393		Pumpkin Seed - Bone & Viscera	0.32	143	46	-180	5030	1610	-1940	SNA	SNA	SNA
	08/02/89	375		Mussels	0.22	257	57	NA	1020	224		SNA	SNA	SNA
Swan Pond Peconic River Upstream Calverton	08/20/88	314B	Control	Blue Gill	0.35	SNA	SNA	SNA	SNA	SNA	SNA	500	175	NA
	08/02/88	314A		Blue Gill	0.35	SNA	SNA	SNA	SNA	SNA	SNA	330	115	NA
	07/26/88	324-325		Catfish	0.19	SNA	SNA	SNA	SNA	SNA	SNA	170	32	NA
	07/26/88	327		Catfish	0.24	SNA	SNA	SNA	SNA	SNA	SNA	750	180	NA
	07/26/88	321		Pumpkin Seed	0.29	SNA	SNA	SNA	SNA	SNA	SNA	360	104	NA
STP - Aquarium	04/04/88	323	0	Trout	0.58	SNA	SNA	SNA	SNA	SNA	SNA	130	75	NA
	03/04/88	322		Trout	0.72	SNA	SNA	SNA	SNA	SNA	SNA	48	35	NA
Station EA	07/29/88	318A	0	Brown Bull Head	0.53	12200	6466	NA	12500	6625	NA	8050	4267	NA
	07/29/88	318B		Brown Bull Head	0.53	12800	6784	NA	11600	6148	NA	9030	4786	NA
	07/29/88	320A		Large Mouth Bass	0.47	SNA	SNA	SNA	SNA	SNA	SNA	10930	5137	NA
	07/29/88	320B		Large Mouth Bass	0.47	SNA	SNA	SNA	SNA	SNA	SNA	11590	5447	NA
	07/29/88	319A		Pickerel	0.34	SNA	SNA	SNA	SNA	SNA	SNA	5430	1846	NA
	07/29/88	317A		Pumpkin Seed	0.60	SNA	SNA	SNA	SNA	SNA	SNA	7920	4752	4647.6
	07/29/88	317B		Pumpkin Seed	0.60	SNA	SNA	SNA	SNA	SNA	SNA	7830	4698	4593.6
Station HM	07/26/88	315	0.8	Pumpkin Seed	0.39	SNA	SNA	SNA	SNA	SNA	SNA	5510	2149	2044.5
	07/26/88	316A		Pumpkin Seed	0.31	SNA	SNA	SNA	SNA	SNA	SNA	1780	552	447.4
	07/26/88	316B		Pumpkin Seed	0.31	32300	10013	NA	65200	20212	NA			
Donahue's Pond Peconic River Calverton	07/27/88	339	10	Blue Gill	0.29	SNA	SNA	SNA	SNA	SNA	SNA	2650	769	623.25
	07/27/88	338		Blue Gill	0.29	SNA	SNA	SNA	SNA	SNA	SNA	3580	1038	892.95
	07/29/88	341-342		Catfish	0.27	SNA	SNA	SNA	SNA	SNA	SNA	1350	365	258.35
	07/27/88	346-347		Catfish	0.30	SNA	SNA	SNA	SNA	SNA	SNA	460	138	31.85
	07/27/88	343		Catfish	0.32	SNA	SNA	SNA	SNA	SNA	SNA	530	170	63.45
	07/27/88	344-345		Catfish	0.26	SNA	SNA	SNA	SNA	SNA	SNA	1640	426	320.25
	07/27/88	348		Catfish	0.25	SNA	SNA	SNA	SNA	SNA	SNA	1410	353	246.35
	07/27/88	340 A&B		Catfish	0.21	SNA	SNA	SNA	SNA	SNA	SNA	990	208	101.75
	07/27/88	335		Pumpkin Seed	0.27	SNA	SNA	SNA	SNA	SNA	SNA	2580	697	592.2
	07/28/88	336		Pumpkin Seed	0.29	SNA	SNA	SNA	SNA	SNA	SNA	1450	420	316.1
	07/27/88	337		Pumpkin Seed	0.21	SNA	SNA	SNA	SNA	SNA	SNA	2220	466	361.8
	07/27/88	334		Pumpkin Seed	0.28	SNA	SNA	SNA	SNA	SNA	SNA	2810	787	682.4
Forge Pond Peconic River Riverhead	07/28/88	328&333		Blue Gill	0.28	SNA	SNA	SNA	SNA	SNA	SNA	1050	294	148.75
	07/28/88	331-332		Blue Gill	0.24	SNA	SNA	SNA	SNA	SNA	SNA	830	199	53.95
	07/28/88	329-330		Blue Gill	0.25	SNA	SNA	SNA	SNA	SNA	SNA	960	240	94.75
	07/28/88	326		Large Mouth Bass	0.27	SNA	SNA	SNA	SNA	SNA	SNA	460	124	NA
Typical MDL						57	---	---	1080	---	---	8	---	-----

NA = Not Applicable
SNA = Sample Not Analyzed in Reporting Year

Table 39
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Aquatic Sediment and Vegetation Samples

Sample Location	Sample Date	Distance from BNL Discharge, km	Sample Matrix	Ratio Dry/Wet	Be-7 Conc. pCi/kg dry	Be-7 Conc. pCi/kg wet	Co-60 Conc. pCi/kg dry	Co-60 Conc. pCi/kg wet	Cs-137 Conc. pCi/kg dry	Cs-137 Conc. pCi/kg wet	K-40 Conc. pCi/kg dry	K-40 Conc. pCi/kg wet	Ra-226 Conc. pCi/kg dry	Ra-226 Conc. pCi/kg wet	Th-228 Conc. pCi/kg dry	Th-228 Conc. pCi/kg wet
Station HS BNL On-Site Recharge Basin	09/17/89	0	Sediment	0.79	934	738	MDL	MDL	298	235	3120	2465	MDL	MDL	430	340
Station HM-PR BNL On-Site	09/17/89	0.8	Sediment	0.74	MDL	MDL	29.4	21.8	685	507	2580	1909	MDL	MDL	300	222
Carmens River	09/17/89	Control	Sediment	0.82	MDL	MDL	MDL	MDL	MDL	MDL	1830	1501	280	230	333	273
Donahue's Pond	08/01/89	2.5	Water	NA	NA	MDL	NA	MDL	NA	MDL	NA	MDL	NA	MDL	NA	MDL
Station HM-PR	09/17/89	0.8	Water	NA	NA	3.4	NA	MDL	NA	MDL	NA	12.6	NA	MDL	NA	MDL
Station HS	09/17/89	0	Water	NA	NA	MDL	NA	2.3	NA	7.9	NA	MDL	NA	MDL	NA	MDL
Carmens River	09/17/89	Control	Water	NA	NA	MDL	NA	MDL	NA	MDL	NA	2.1	NA	MDL	NA	MDL
Station T-PR	07/18/89	3.0	Vegetation	0.07	3370	236	MDL	MDL	1190	83	21900	1533	MDL	MDL	MDL	MDL
Donahue's Pond	08/01/89	2.5	Vegetation	0.15	3040	456	219	32.9	461	69	29500	4425	MDL	MDL	MDL	MDL
Donahue's Pond	08/01/89	2.5		0.08	MDL	MDL	MDL	MDL	MDL	MDL	96900	7752	MDL	MDL	MDL	MDL
Swan Pond	08/02/89	2.0		0.09	MDL	MDL	MDL	MDL	MDL	MDL	54900	4941	MDL	MDL	MDL	MDL
Station HM-PR	09/17/89	0.8	Vegetation (Shoots)	0.18	2200	396	230	41.4	7000	1260	21200	3816	MDL	MDL	MDL	MDL
Donahue's Pond	08/01/89	2.5	Vegetation (Roots)	0.09	MDL	MDL	MDL	MDL	39800	3582	MDL	MDL	MDL	MDL	MDL	MDL
Donahue's Pond	08/01/89	2.5	Vegetation (Roots)	0.05	MDL	MDL	466	23.3	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
Swan Pond	08/02/89	2.5		0.08	MDL	MDL	MDL	MDL	786	63	9220	738	MDL	MDL	MDL	MDL
Station HS	09/17/89	0		0.21	763	160	13	2.7	32	7	647	136	MDL	MDL	MDL	MDL
Station HM-PR	09/17/89	0.8		0.49	1240	608	313	153.4	3670	1798	4260	2087	MDL	MDL	MDL	MDL
Typical MDL		---		---	450	----	66	----	57	----	1080	----	150	---	120	---

PR = Peconic River.

Table 40
BNL Site Environmental Report for Calendar Year 1989
On-Site Potable and Cooling Water Radionuclide Concentration Data

Sample Location	Sample Date	Gross Alpha	Gross Beta	Tritium	Cs-137	K-40	Ra-226	Na-22	Co-60	Sr-90
		<----------			pCi/L					---------->
F1 (WTP-IN)	15-Feb-89	0.205	0.264	-604	MDL	1.59	MDL	MDL	MDL	0.00
	16-May-89	0.000	1.780	-284	MDL	MDL	MDL	MDL	MDL	0.13
	10-Aug-89	0.205	0.378	1370	NA	NA	NA	NA	NA	0.24
	Avg. Conc.	**0.137**	**0.807**	**161**	**MDL**	**0.80**	**MDL**	**MDL**	**MDL**	**0.12**
F2 (WTP-OUT)	15-Feb-89	0.307	0.453	-525	MDL	MDL	MDL	MDL	MDL	0.00
	16-May-89	0.000	1.960	-139	NA	NA	NA	NA	NA	0.09
	10-Aug-89	0.102	0.906	1410	MDL	MDL	MDL	MDL	MDL	0.03
	Avg. Conc.	**0.136**	**1.106**	**249**	**MDL**	**MDL**	**MDL**	**MDL**	**MDL**	**0.04**
FD (4)	16-May-89	0.205	1.170	-251	MDL	MDL	MDL	MDL	MDL	0.11
	10-Aug-89	0.102	0.755	1160	MDL	MDL	MDL	MDL	MDL	0.39
	Avg. Conc.	**0.154**	**0.962**	**454**	**MDL**	**MDL**	**MDL**	**MDL**	**MDL**	**0.25**
FE ((5)	15-Feb-89	0.205	0.831	131	0.19	3.19	1.79	MDL	MDL	0.20
	10-Aug-89	-0.150	0.869	1170	MDL	MDL	MDL	MDL	MDL	-0.07
	Avg. Conc.	**0.028**	**0.850**	**651**	**0.10**	**1.60**	**0.90**	**MDL**	**MDL**	**0.07**
FF (6)	15-Feb-89	0.205	0.453	-552	MDL	MDL	MDL	MDL	MDL	0.00
	16-May-89	0.819	1.360	-284	MDL	MDL	MDL	MDL	MDL	0.25
	10-Aug-89	-0.100	0.907	1300	0.45	7.30	MDL	MDL	MDL	0.43
	Avg. Conc.	**0.308**	**0.907**	**155**	**0.15**	**2.43**	**MDL**	**MDL**	**MDC**	**0.23**
FG (7)	15-Feb-89	0.461	0.529	-630	MDL	MDL	MDL	MDL	MDL	0.00
	16-May-89	NA	NA	NA	MDL	MDL	MDL	MDL	MDL	0.02
	10-Aug-89	0.102	0.416	1270	MDL	MDL	MDL	MDL	MDL	0.41
	Avg. Conc.	**0.281**	**0.473**	**320**	**MDL**	**MDL**	**MDL**	**MDL**	**MDL**	**0.14**
FK (104)	16-May-89	0.000	1.250	28	MDL	MDL	MDL	MDL	MDL	0.23
	10-Aug-89	0.000	1.210	1480	MDL	MDL	MDL	MDL	MDL	0.14
	Avg. Conc.	**0.000**	**1.230**	**754**	**MDL**	**MDL**	**MDL**	**MDL**	**MDL**	**0.19**
FO (10)	15-Feb-89	0.051	-0.076	-473	MDL	MDL	MDL	MDL	MDL	0.10
	16-May-89	0.410	1.100	56	MDL	MDL	MDL	0.26	0.47	0.02
	10-Aug-89	0.102	1.130	1610	MDL	MDL	MDL	MDL	0.45	0.81
	Avg. Conc.	**0.188**	**0.718**	**398**	**MDL**	**MDL**	**MDL**	**0.09**	**0.31**	**0.31**
FP (11)	15-Feb-89	0.256	0.680	-210	MDL	MDL	MDL	MDL	MDL	0.10
	16-May-89	0.154	1.550	139	MDL	MDL	MDL	0.56	MDL	0.18
	10-Aug-89	-0.100	0.453	1540	MDL	MDL	MDL	0.79	MDL	0.02
	Avg. Conc.	**0.103**	**0.894**	**490**	**MDL**	**MDL**	**MDL**	**0.45**	**MDL**	**0.10**
FQ (12)	15-Feb-89	0.154	0.907	-368	MDL	MDL	MDL	MDL	MDL	0.20
	16-May-89	-0.512	1.130	-223	MDL	MDL	MDL	MDL	MDL	0.16
	10-Aug-89	0.000	1.060	1480	0.39	MDL	MDL	MDL	0.39	0.38
	Avg. Conc.	**-0.119**	**1.032**	**296**	**0.130**	**MDL**	**MDL**	**MDL**	**0.130**	**0.25**
NYS Drinking Water Standard		15.0	50.0	20,000	----	---	---	---	---	8.0
Radiation Concentration Guide		----	----	----	20,000	---	---	30,000	30,000	---
Typical MDL =		0.53	1.2	300	0.2	3.9	0.5	0.2	0.23	0.1

MDL = Minimum Detectable Limit.
NA = Not Analyzed.

Table 41
BNL Site Environmental Report for Calendar Year 1989
Gross Alpha, Beta, and Tritium Concentrations in
Potable Water and Distilled Water from Building 535B

Sample Location	Month	Number of Samples	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.
			<--------	pCi/L	-------->	<-------	pCi/L	-------->	<-------	pCi/L	-------->
FN	January	20	0.243	-1.540	2.050	2.229	-2.270	6.990	-228	-1160	512
(Bldg.	February	18	0.057	-1.540	1.540	1.814	-3.400	7.550	-531	-6850	1740
535B	March	23	0.157	-2.050	2.050	2.381	-2.080	13.600	-301	-1830	694
Potable	April	20	0.153	-1.280	1.790	1.435	-2.640	4.720	1579	-901	19500
Water)	May	21	0.255	-1.790	1.790	3.175	-0.380	9.070	1227	-2040	30500
	June	22	-0.034	-2.050	1.790	5.841	-2.080	38.200	196	-1330	1930
	July	18	0.834	-1.540	7.368	2.077	-1.130	8.500	-196	-945	2130
	August	23	-0.059	-2.050	0.768	2.152	-3.970	8.880	-738	-7430	795
	September	20	0.192	-1.790	2.050	1.866	-2.270	5.100	-330	-1250	486
	October	22	0.291	-1.020	2.560	2.951	-1.890	11.000	-96	-1090	667
	November	19	0.484	-1.540	2.300	1.929	-2.080	5.290	-286	-1270	865
	December	20	0.524	-1.020	1.790	3.079	-3.210	9.250	-231	-4060	797
	Avg. Conc.		0.247	-2.050	7.368	2.615	-3.970	38.200	5.50	-7430	30500
ZB	January	20	0.281	-1.540	1.280	0.590	-2.640	4.910	-165	-1090	1070
(Dist.	February	18	-0.299	-1.540	0.512	0.293	-2.270	3.210	-690	-7750	967
Water)	March	23	0.022	-1.790	1.540	0.386	-2.460	3.970	-70	-694	705
	April	20	0.089	-0.770	1.540	0.886	-2.300	4.910	-136	-1180	1290
	May	21	0.134	-2.050	2.050	1.605	-2.830	13.500	-204	-1620	1230
	June	22	-0.104	-3.070	1.540	2.003	-2.460	12.500	91	-1090	2310
	July	18	-0.406	-1.790	0.768	1.622	-3.590	6.990	-379	-1240	254
	August	23	-2.394	-51.200	1.020	-1.348	-42.000	5.850	-458	-7380	3820
	September	20	-0.140	-1.790	0.768	1.114	-3.400	6.610	-235	-1130	794
	October	22	0.025	-1.790	1.540	1.607	-3.400	9.100	-143	-1520	903
	November	19	0.242	-1.280	2.560	0.894	-3.210	5.850	-454	-2060	303
	December	20	0.243	-1.540	1.790	-0.189	-4.530	6.230	-92	-4140	712
	Avg. Conc.		-0.212	-51.200	2.560	0.774	-42.000	13.500	-236	-7750	3820
	Typical Minimum Detectable Concentration		2.300			5.700			1300		

Table 42
BNL Site Environmental Report for Calendar Year 1989
Potable Water and Process Supply Wells
Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity Avg. (umhos/cm)	Conductivity Min.	Conductivity Max.	Chlorides Avg. (mg/L)	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
WTP-IN	3 (2)	5.9 - 6.0	90	80	100	19.6	15.2	21.9	10.5	9.3	11.6	<1.0		
WTP-EFF	3 (2)	6.0 - 7.7	105	100	110	20.4	18.2	21.6	10.4	9.6	11.3	<1.0		
4 (FD)	2 (2)	5.7 - 7.0	90	80	100	10.6	6.4	14.9	9.7	9.2	10.2	<1.0		
6 (FF)	3 (2)	6.0 - 6.5	85	80	90	20.0	16.8	23.3	11.9	9.3	13.6	<1.0		
7 (FG)	3 (2)	5.7 - 6.0	85	80	90	17.8	12.0	27.6	10.3	8.5	13.4	<1.0		
10 (FO)	3 (2)	6.0 - 6.4	70	60	80	12.7	10.5	14.6	10.3	9.7	11.4	<1.0		
11 (FP)	3 (2)	5.7 - 6.3	80	60	100	14.5	14.1	14.8	12.9	12.3	13.4	<1.0		
12 (FQ)	3 (2)	6.2 - 7.0	95	60	130	18.8	16.8	21.0	14.8	13.2	16.9	<1.0		
5 (FE)	2 (1)	6.0 - 6.3	20			10.2	5.6	14.9	9.9	9.2	10.6	<1.0		
104 (FK)	2 (2)	6.0 - 7.1	115	100	130	20.3	20.9	19.8	14.2	13.6	14.7	<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.00			250.0			10.0		

(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and

Table 43
BNL Site Environmental Report for Calendar Year 1989
Potable Water and Process Supply Wells, Average Metals Data

	WTP-IN (F1)	WTP-EFF (F2)	Well No. 4 (FD)	Well No. 5 (FE)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	Well No. 104 (FK)	NYS Drinking Water Standard
No. of Samples*	3 (1)	3 (1)	2 (0)	2 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	2 (0)	
Ag	<0.025	<0.025	<0.025	<0.025	0.003	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
As	<0.005	<0.005	NA	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	0.025
Cd	<0.005	<0.005	<0.0005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	0.01
Cr	0.01	0.003	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	0.05
Cu	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0
Fe	1.47	0.16	2.58	0.23	3.26	1.18	0.077	0.04	0.04	0.62	0.3
Hg	<0.0002	<0.0002	NA	<0.0002	<0.0002	0.0005	<0.0002	0.0012	0.001	NA	0.002
Mn	0.11	<0.05	0.2	<0.05	0.06	0.04	<0.05	<0.05	<0.05	0.1	0.3
Na	11.2	10.7	9.2	4.5	13.2	11.2	10.0	11.1	15.9	14.9	(a)
Pb	<0.02	<0.02	0.007	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.005	0.025
Zn	0.02	0.02	<0.02	0.18	0.02	0.02	0.02	0.02	0.08	<0.02	5.0

NA: Not Analyzed.
(a) No standard specified.
WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.
*Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 44
BNL Site Environmental Report for Calendar Year 1989
Potable Water Wells,
Average Halogenated Organic Compound Data

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)	Typical MDL	NYS Drinking Water Standard
	<------------------			mg/L		------------------>		
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Chloromethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Vinyl Chloride	ND	ND	ND	ND	ND	ND	0.0005	0.002
Bromomethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Chloroethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Fluorotrichloromethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1-dichloroethene	ND	0.0002	ND	0.0002	0.0002	ND	0.0005	0.005
Dichloromethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1-dichloroethane	ND	0.0001	ND	0.0008	0.0013	0.0001	0.0005	0.005
cis-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	0.0005	0.005
2,2-dichloropropane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Bromochloromethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Chloroform	0.0056	0.0001	ND	0.0011	0.0005	0.0012	0.0005	0.100
1,1,1-trichloroethane	0.0011	0.0022	ND	0.0058	0.007	0.0013	0.0005	0.005
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1-dichloropropene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1,2-trichloroethene	ND	0.0006	ND	0.0004	ND	ND	0.0005	0.005
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Dibromomethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Bromodichloromethane	0.0018	ND	ND	0.001	ND	ND	0.0005	0.005
trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	0.0005	0.005
cis-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	0.0005	0.005

Table 44 (continued)
BNL Site Environmental Report for Calendar Year 1989
Potable Water Wells,
Average Halogenated Organic Compound Data

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)	Typical MDL	NYS Drinking Water Standard
	<------			mg/L		------>		
1,1,2,2-tetrachloroethene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,3-dichloropropane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Chlorodibromomethane	0.0003	ND	ND	0.0006	ND	ND	0.0005	0.005
Chlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
Bromoform	ND	ND	ND	0.0001	ND	ND	0.0005	0.100
Bromobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2,3-trichloropropane	ND	ND	ND	ND	ND	ND	0.0005	0.005
2-chlorotoluene	ND	ND	ND	ND	ND	ND	0.0005	0.005
4-chlorotoluene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2-dichlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005

ND: Not detected.
MDL: Minimum Detection Limit.
Note: Analysis was performed three times for Wells 4 (FD) and 7 (FG), nine times for Well 11 (FP) and eleven times for Well 10 (FO); all other potable wells were analyzed quarterly during the year by a NYS certified contract Laboratory.

Table 45
BNL Site Environmental Report for Calendar Year 1989
Potable Water Wells,
Average Non-Halogenated Organic Compound Data

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)	Typical MDL	NYS Drinking Water Standards
	<------	------	------	mg/L	------	------>		
Benzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Toluene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Ethylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
m-xylene	ND	ND	ND	ND	ND	ND	0.0005	0.005
p-xylene	ND	ND	ND	ND	ND	ND	0.0005	0.005
o-xylene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Styrene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Isopropylbenezene	ND	ND	ND	ND	ND	ND	0.0005	0.005
n-propylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,3,5-trimethylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
tert-butylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
1,2,4-trimethylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
sec-butylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
p-isopropylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
n-butylbenzene	ND	ND	ND	ND	ND	ND	0.0005	0.005
Naphthalene	ND	ND	ND	ND	ND	ND	0.0050	0.005

ND: Not detected.
MDL: Minimum Detection Limit.
Note: Analysis was performed three times for Wells 4 (FD), 7 (FG) and 10 (FO); all other potable wells were analyzed quarterly during the year by a NYS certified contract Laboratory.

Table 46
BNL Site Environmental Report for Calendar Year 1989
Potable Water and Supply Wells,
Chlorocarbon Data

Well ID	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<-------------------------	mg/L	------------------------->
WTP-IN	2(1)*	Avg:	0.001	ND	ND
		Min:			
		Max:			
WTP-EFF	2	Avg:	ND	ND	ND
		Min:			
		Max:			
4 (FD)	1	Avg:	NA	ND	ND
		Min:			
		Max:			
6 (FF)	4	Avg:	0.002	0.001	ND
		Min:	ND	ND	
		Max:	0.003	0.002	
7 (FG)	3	Avg:	0.001	ND	0.001
		Min:	ND		ND
		Max:	0.001		0.003
10 (FO)	5	Avg:	0.007	0.001	ND
		Min:	0.005	ND	
		Max:	0.017	0.001	
11 (FP)	4	Avg:	0.007	ND	ND
		Min:	0.005		
		Max:	0.010		
12 (FQ)	3	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.002		
5 (FE)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
104 (FK)	2(1)*	Avg:	0.013	0.001	ND
		Min:		ND	
		Max:		0.002	
NYS Drinking Water Standards			0.005[a]	0.005	0.005[a]
Typical MDL			0.002	0.002	0.002

ND: Not detected. WTP-IN: Water Treatment Plant Influent.
MDL: Minimum Detection Limit. WTP-EFF: Water Treatment Plant Effluent.
[a] NYSDOH standard adopted January 9, 1989.
* Number inside parenthesis represents the number of 1,1,1-trichloroethane samples analyzed.

Table 47
BNL Site Environmental Report for Calendar Year 1989
Potable Water and Supply Wells,
Trihalomethane Data

Well ID	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<----------	mg/L	---------->	
WTP-IN	2	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.002			
WTP-EFF	2	Avg:	0.007	0.003	0.004	ND
		Min:	0.005		0.005	
		Max:	0.009		0.007	
4 (FD)	1	Avg:	0.003	ND	ND	ND
		Min:				
		Max:				
6 (FF)	4	Avg:	0.003	ND	0.001	ND
		Min:	ND		ND	
		Max:	0.011		0.006	
7 (FG)	3	Avg:	0.004	0.001	0.002	ND
		Min:	ND	ND	ND	
		Max:	0.012	0.002	0.005	
10 (FO)	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
11 (FP)	4	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
12 (FQ)	3	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.002			
5 (FE)	2	Avg:	0.002	ND	ND	ND
		Min:	ND			
		Max:	0.003			
104 (FK)	2	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.002			
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.003	0.002	0.002	0.002

MDL: Minimum Dection Limits.
ND: Not detected.
WTP-IN: Water Treatment Plant Influent
WTP-EFF: Water Treatment Plant Effluent

Table 48
BNL Site Environmental Report for Calendar Year 1989
Potable Water and Supply Wells,
BTX Data

Well ID	No. of Samples		benzene	toluene	xylene
			<----------------	mg/L	---------------->
WTP-IN	2	Avg:	ND	ND	ND
		Min:			
		Max:			
WTP-EFF	2	Avg:	ND	ND	ND
		Min:			
		Max:			
4 (FD)	1	Avg:	ND	ND	ND
		Min:			
		Max:			
6 (FF)	4	Avg:	ND	ND	ND
		Min:			
		Max:			
7 (FG)	3	Avg:	ND	ND	ND
		Min:			
		Max:			
10 (FO)	5	Avg:	ND	ND	ND
		Min:			
		Max:			
11 (FP)	4	Avg:	ND	ND	ND
		Min:			
		Max:			
12 (FQ)	3	Avg:	ND	ND	ND
		Min:			
		Max:			
5 (FE)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
104 (FK)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.005	0.005[a]	0.005[a]
Typical MDL			0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not detected.
WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.
(a) NYSDOH standard adopted January 9, 1989.

Table 49
BNL Site Environmental Report for Calendar Year 1989
Monitoring Well Identification Cross Reference

Area	Sample Location	Grid Number
North	12-01	12-01
Boundary	18-01	18-01
	18-02	18-02
	18-03	18-03
	560	25-02
	561	25-01
RHC	37-01	37-01
Army	IT1D	53-02
Landfill	IT1S	53-01
	IT2D	53-03
	IT2S	53-04
AGS	556	54-05
Area	557	54-05
	558	44-02
	559	44-01
Bldg. 811	65-01	65-01
	D10	65-03
	D11	65-04
	D12	65-05
	D8	65-06
	D9	65-02
West Side	101-01	101-01
of Site	72-01	72-01
	82-02	NL
	83-01	83-01
	83-02	83-02
	84-01	84-01
South	118-01	118-01
Boundary	118-02	118-02
	122-01	122-01
	122-02	122-02
	130-01	130-01
	130-02	130-02
650	2E	77-01
Sump		

Area	Sample Location	Grid Number
Bldg. 830	66-07	66-71
	66-08	66-08
	66-09	66-09
Central	D15	76-09
Steam	IT1	76-04
Facility	IT2	76-06
	IT3	76-10
	IT4	76-08
	IT5	76-05
Major	76-16	76-16
Petrol.	76-17	76-17
Facility	76-18	76-18
	76-19	76-19
PGA &	75-01	75-01
NSLS	75-02	75-02
	75-03	85-01
	75-04	85-02
Meadow	100-03	100-03
Marsh	70-01	70-01
Upland	89-01	89-01
Recharge	90-01	90-01
Area		
Peconic	22-01	22-01
River	38-01	38-01
On-Site	39-05	39-05
	47-03	47-03
	58-01	58-01
	XA	39-01
	XB	47-01
	XC	47-02
	XD	48-01
	XI	49-02
	XJ	39-03
	XN	49-03
	XO	40-05
	XT	00-XT
	XY	40-04

Area	Sample Location	Grid Number
Peconic	80-02	80-02
River	80-03	80-03
Off-Site	X1	61-01
	X2	61-02
	X4	00-X4
HWMA	107-10	107-10
	108-13	108-13
	108-14	108-14
	2L	98-20
	2M	98-24
	2N	98-29
	99-04	99-04
	99-05	99-05
	99-06	99-06
	MW1	88-03
	MW2	88-04
	MW3	98-07
	MW4	98-22
	MW5	98-21
	MW6	98-19
	MW7A	98-30
	MW7B	98-32
	MW8	108-03
	MW10	108-12
	MW11	108-08
	MW12	108-05
	MW13	108-01
	D17	108-07
	PW1	98-16
	PW2	98-25
	PW3	108-02
	PW4	108-09
	PW5	98-05
Ashfill	D20	104-01
Current	107-07	107-07
Landfill	107-08	107-08
	107-09	107-09
	1K	87-05
	2C	87-07
	62	87-09
	563	87-10
	564	87-11
	565	87-12
	97-14	97-14

Area	Sample Location	Grid Number
Current	98-33	98-33
Landfill	98-34	98-34
(Continued)	W6	88-01
	W9	87-06
	WO	106-01
	WP	106-03
	WQ	106-05
	WR	87-01
	WS	87-03
	WT	88-02
Old	115-01	115-01
Landfill	115-02	115-03
	115-03	115-03
	IJ	97-08
	D1	97-05
	D16	96-03
	D18	106-04
	D2	97-01
	D3	97-02
	D4	96-04
	D5	96-02
	D6	97-03
	D7	105-01

NL = Not Listed.

Table 50
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Field Blanks

Month	Gross Alpha	Gross Beta	Tritium	K-40	Ra-226	Th-228	Cs-137	Sr-90
	<-------------------------			pCi/L				------------------------->
January	NA	NA	NA	MDC	MDC	MDC	MDC	0.00
February	0.00	-0.49	-525	MDC	0.52	MDC	MDC	0.00
March	-0.31	0.00	-282	1.7	MDC	MDC	MDC	0.20
April	0.05	-0.64	0.00	3.79	MDC	0.322	MDC	0.00
May	0.10	1.51	-572	4.63	MDC	MDC	MDC	4.32
June	0.15	-0.11	0.00	MDC	MDC	MDC	0.45	0.18
August	-0.05	0.30	150	MDC	MDC	MDC	MDC	NA
September	0.00	-0.26	-259	MDC	MDC	MDC	MDC	0.01
October	-0.10	0.49	0.00	MDC	MDC	MDC	MDC	NA
November	0.15	0.45	-302	2.48	3.68	MDC	MDC	0.11
December	NA	NA	NA	2.18	MDC	MDC	MDC	0.36
Average	0.00	0.14	-199	1.34	0.38	0.03	0.04	0.52
Minimum	-0.31	-0.64	-572	0.00	0.00	0.00	0.00	0.00
Maximum	0.15	1.51	150	4.63	3.68	0.32	0.45	4.32
Typical MDC	0.53	1.20	300	3.9	0.50	0.43	0.20	0.10

NA = Not Analyzed
MDC = Not Detected Above Minimum Detectable Concentration

Table 51
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Ground Water at the Upland Recharge Meadow Marsh Area, the Area Adjacent to the Peconic River On-Site and the Peconic River Off-Site

Area	Sample Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			Sr-90			Co-60			Cs-137			Be-7		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
			<-----										pCi/L											---->
Meadow	100-03	1	1.740	1.740	1.740	3.440	3.440	3.440	-100	-100	-100	0.20	0.20	0.20	MDL			MDL			MDL		
Marsh	70-01	1	0.461	0.461	0.461	2.610	2.610	2.610	-328	-328	-328	0.37	0.37	0.37	MDL			MDL			MDL		
Upland	89-01	2	0.128	0.102	0.128	1.890	1.020	1.890	-373	-528	-373	0.20	0.18	0.20	MDL			MDL			MDL		
Recharge Area	90-01	2	-0.050	-0.100	-0.050	1.755	1.510	1.755	-220	-239	-220	0.26	0.25	0.26	MDL			MDL			MDL		
Peconic	22-01	1	0.102	0.102	0.102	1.360	1.360	1.360	509	509	509	0.77	0.77	0.77	MDL			MDL			MDL		
River	38-01	2	0.307	0.256	0.358	4.365	1.930	6.800	5169	137	10200	0.74	0.69	0.79	MDL			MDL			MDL		
On-Site	39-05	2	0.461	0.410	0.512	2.550	1.780	3.320	2310	1910	2710	0.48	0.34	0.62	MDL			MDL			2.88	0.00	5.75
	47-03	1	-0.410	-0.410	-0.410	1.810	1.810	1.810	-169	-169	-169	0.10	0.10	0.10	MDL			MDL			MDL		
	58-01	1	0.154	0.154	0.154	2.570	2.570	2.570	-312	-312	-312	0.37	0.37	0.37	MDL			MDL			MDL		
	XA	3	0.240	-0.100	0.461	3.450	2.800	4.340	2737	2360	3330	0.87	0.38	1.40	0.08	0.00	0.24	0.15	0.00	0.45	MDL		
	XB	3	0.051	0.000	0.102	1.840	1.440	2.570	178	-149	590	1.33	0.50	2.52	MDL			MDL			MDL		
	XC	3	0.461	0.154	0.614	1.537	1.320	1.700	200	-59	613	0.23	0.00	0.70	MDL			MDL			MDL		
	XD	3	0.034	0.000	0.051	1.650	0.340	3.930	1370	-119	4120	0.18	0.00	0.47	MDL			MDL			MDL		
	XI	1	0.154	0.154	0.154	1.280	1.280	1.280	217	217	217	0.27	0.27	0.27	MDL			MDL			MDL		
	XJ	1	0.000	0.000	0.000	1.023	1.023	1.023	152	152	152	0.43	0.43	0.43	MDL			MDL			MDL		
	XN	1	NA			NA			NA			0.54	0.54	0.54	MDL			MDL			MDL		
	XO	1	NA			NA			NA			0.62	0.62	0.62	MDL			MDL			MDL		
	XT	1	NA			NA			NA			0.11	0.11	0.11	MDL			MDL			MDL		
	XY	1	NA			NA			NA			9.31	9.31	9.31	MDL			MDL			MDL		
Peconic	80-02	1	-0.260	-0.260	-0.260	1.620	1.620	1.620	-486	-486	-486	0.13	0.13	0.13	MDL			MDL			MDL		
River	80-03	1	-0.210	-0.210	-0.210	1.250	1.250	1.250	-418	-418	-418	0.01	0.01	0.01	MDL			MDL			MDL		
Off-Site	X1	1	0.358	0.358	0.358	1.170	1.170	1.170	-417	-417	-417	0.60	0.60	0.60	MDL			MDL			MDL		
	X2	3	0.016	-0.260	0.256	1.057	0.151	1.850	791	-148	1340	0.04	0.00	0.11	MDL			MDL			MDL		
	X4	3	0.222	0.051	0.410	3.400	3.170	3.550	303	-179	781	1.16	0.09	1.90	MDL			MDL			MDL		
NYS Drinking Water Standard			15			50			20,000			8.0			NL			NL			NL		
Radiation Concentration Guide			---			---						---			30,000			20,000			2,000,000		
Typical MDL			0.53			1.2			300			0.1			0.23			0.20			1.6		

MDL = Minimum Detection Level.
NA = Not Analyzed.
NL = Not Listed.

Table 52
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Off-Site Potable Water

Sample Location	Number of Samples	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.	K-40	C-137	Sr-90
		<-----					pCi/L						----->
1	4	0.013	-0.100	0.100	0.567	0.110	1.100	-258	-374	-200	23.80	MDL	-0.02
2	3	0.154	-0.150	0.461	-0.036	-0.260	0.151	-277	-324	-230	MDL	MDL	NS
3	4	0.026	-0.100	0.102	1.897	1.470	2.380	-18	-288	341	10.30	MDL	0.30
4*	1	0.100			12.500			-86			NS	NS	0.33
5	1	0.000			1.100			-259			NS	NS	NS
6	4	0.153	0.100	0.307	0.368	-0.190	1.020	-65	-260	262	MDL	MDL	0.13
7	4	0.065	-0.150	0.256	0.880	0.378	1.440	-224	-307	-56	MDL	MDL	0.14
8	4	0.230	0.050	0.358	0.369	-0.300	0.831	2250	1680	3070	4.95	MDL	0.12
9	1	0.051			-0.075			351			NS	NS	0.06
10	4	0.089	-0.051	0.205	1.103	0.604	1.620	-150	-340	11	MDL	MDL	0.17
11	1	-0.310			0.227			MDL			3.48	MDL	NS
12	4	-0.103	-0.410	0.200	0.397	-0.110	0.755	-174	-230	-111	MDL	MDL	-0.11
13	3	-0.053	-0.260	0.100	0.226	-0.340	0.567	-216	-442	-92	NS	NS	0.17
14	3	0.154	0.051	0.256	5.123	3.360	7.590	847	241	1300	MDL	MDL	0.74
15	3	0.359	0.256	0.512	0.930	0.340	1.280	-76	-428	459	MDL	MDL	0.62
16	1	-0.100			0.567			MDL			MDL	MDL	0.13
17	4	-0.027	-0.260	0.460	0.405	-0.076	0.680	-162	-461	58	MDL	MDL	0.13
18	3	0.000	-0.260	0.260	2.330	2.040	2.570	-212	-346	-79	MDL	MDL	NS
19	1	0.102			0.264			-143			NS	NS	NS
20	1	-0.260			0.453			41			NS	NS	0.18
21	4	0.114	0.000	0.205	0.197	-0.190	0.450	-65	-324	286	MDL	MDL	-0.03
22	1	0.154			1.590			5			NS	NS	NS
23	1	0.000			2.300			-95			NS	NS	0.13
24	4	0.150	0.000	0.256	1.748	0.870	3.060	614	-86	1290	MDL	MDL	0.02
NYS Drinking Water Standard		15.0			50			20,000			-	-	8
Typical MDLs		0.53			1.3			300			3.9	0.20	0.1

NS = Not Sampled.
MDL = Result less than the Minimum Detectable Limit.
*Elevated Gross Beta due to Potassium-40 activity.

Table 53
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Ground Water - Northeast Sector, West Sector and South Boundary of the BNL Site

Area	No. of Samp.	Sample Location	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.	Na-22 Avg.	Na-22 Min.	Na-22 Max.	Co-60 Avg.	Co-60 Min.	Co-60 Max.	Cs-137 Avg.	Cs-137 Min.	Cs-137 Max.	Be-7 Avg.	Be-7 Min.	Be-7 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
			<------											pCi/L												------>
North Boundary	1	12-01	0.051	0.051	0.051	1.060	1.060	1.060	2910	2910	2910	MDL			MDL			MDL			MDL			1.080	1.080	1.080
	2	18-01	0.256	0.205	0.307	1.210	1.100	1.320	-86	-89	-83	MDL			MDL			MDL			MDL			0.630	0.590	0.670
	2	18-02	0.001	-0.100	0.102	0.529	0.491	0.567	-82	-109	-56	MDL			MDL			MDL			MDL			0.255	0.230	0.280
	2	18-03	0.181	-0.150	0.512	1.492	0.755	2.230	-145	-232	-57	MDL			MDL			MDL			MDL			0.790	0.190	1.390
	4	560	0.217	-0.310	0.512	0.662	0.151	1.100	-448	-685	-173	MDL			MDL			MDL			MDL			0.103	0.000	0.270
	4	561	0.025	-0.310	0.256	3.610	1.060	6.950	-211	-397	-7	MDL			MDL			MDL			MDL			0.343	0.200	0.530
RHC	1	37-01	0.307	0.307	0.307	3.060	3.060	3.060	206	206	206	MDL			MDL			MDL			MDL			0.077	0.077	0.077
Army Landfill	3	IT1D	-0.035	-0.210	0.205	3.883	0.529	10.100	-225	-385	0	MDL			MDL			MDL			MDL			0.247	0.000	0.640
	3	IT1S	-0.136	-0.560	0.102	0.754	0.189	1.470	-301	-402	-243	MDL			MDL			MDL			MDL			0.103	-0.110	0.420
	3	IT2D	0.015	-0.110	0.205	0.467	-0.300	1.550	-88	-259	109	MDL			MDL			MDL			10.667	0.000	32.000	0.147	0.000	0.310
	3	IT2S	0.085	0.051	0.102	0.408	0.264	0.507	10	-338	427	MDL			MDL			MDL			MDL			0.267	0.200	0.400
AGS Area	4	556	0.167	0.051	0.256	2.750	2.120	3.890	-84	-248	26	0.151	0.000	0.454	MDL			MDL			MDL			0.595	0.200	1.160
	4	557	0.128	0.102	0.205	1.002	0.340	2.270	-265	-416	-132	MDL			MDL			MDL			MDL			0.245	0.000	0.870
	4	558	0.179	0.051	0.358	1.030	0.604	1.780	-99	-433	528	MDL			MDL			MDL			MDL			0.005	-0.010	0.030
	4	559	0.154	-0.051	0.307	2.785	0.000	6.230	-76	-489	586	MDL			MDL			MDL			MDL			0.810	0.500	1.100
Bldg. 811	2	65-01	-0.076	-0.100	-0.051	3.195	3.140	3.250	87	-42	217	1.415	0.000	2.830	MDL			MDL			MDL			0.635	0.500	0.770
	2	D10	0.256	0.154	0.358	2.795	2.640	2.950	565	50	1080	0.856	0.402	1.310	MDL			MDL			MDL			1.215	0.930	1.500
	2	D11	0.128	0.000	0.256	1.320	1.170	1.470	204	-252	660	0.224	0.000	0.448	MDL			MDL			MDL			0.430	0.400	0.460
	1	D12	0.102	0.102	0.102	1.170	1.170	1.170	-252	-252	-252	0.922	0.922	0.922	MDL			MDL			MDL			0.000	0.000	0.000
	1	D8	0.205	0.205	0.205	2.080	2.080	2.080	239	239	239	0.380	0.380	0.380	MDL			MDL			MDL			2.300	2.300	2.300
	2	D9	0.307	0.307	0.307	2.475	2.000	2.950	745	-151	1640	0.223	0.000	0.445	0.253	0.000	0.506	0.263	0.000	0.526	MDL			0.865	0.600	1.130
West Side of Site	2	101-01	0.154	0.000	0.307	1.925	1.850	2.000	-417	-449	-384	MDL			MDL			MDL			MDL			0.245	0.240	0.250
	1	72-01	0.205	0.205	0.205	0.907	0.907	0.907	-562	-562	-562	MDL			MDL			MDL			MDL			0.320	0.320	0.320
	1	82-02	0.512	0.512	0.512	1.440	1.440	1.440	-211	-211	-211	MDL			MDL			MDL			MDL			0.110	0.110	0.110
	2	83-01	0.077	0.000	0.154	0.454	0.378	0.529	8	0	16	MDL			MDL			MDL			MDL			0.090	0.030	0.150
	1	83-02	0.411	0.411	0.411	1.470	1.470	1.470	273	273	273	MDL			MDL			MDL			MDL			0.130	0.130	0.130
	1	84-01	0.102	0.102	0.102	2.120	2.120	2.120	157	157	157	14.600	14.600	14.600	MDL			MDL			MDL			0.280	0.280	0.280
South Boundary	1	118-01	1.280	1.280	1.280	3.970	3.970	3.970	-6	-6	-6	MDL			MDL			MDL			MDL			0.040	0.040	0.040
	1	118-02	0.205	0.205	0.205	0.491	0.491	0.491	5	5	5	MDL			MDL			MDL			MDL			0.210	0.210	0.210
	1	122-01	0.717	0.717	0.717	2.870	2.870	2.870	-124	-124	-124	MDL			MDL			MDL			MDL			-0.050	-0.050	-0.050
	1	122-02	0.256	0.256	0.256	0.944	0.944	0.944	-74	-74	-74	MDL			MDL			MDL			MDL			0.160	0.160	0.160
	2	130-01	0.307	0.307	0.307	0.755	-0.680	2.190	136	-169	441	MDL			MDL			MDL			MDL			-0.025	-0.090	-0.040
	2	130-02	0.205	0.154	0.256	0.907	0.831	0.982	341	127	555	MDL			MDL			MDL			MDL			0.110	0.050	0.170
NYS Drinking Water Standard			15.0			50.0			20,000			---			---			---			---			8.0		

Table 54
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Ground Water Within the Central Part Of the BNL Site

Area	Sample Location	Number of Samples	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.	Na-22 Avg.	Na-22 Min.	Na-22 Max.	Co-60 Avg.	Co-60 Min.	Co-60 Max.	Cs-137 Avg.	Cs-137 Min.	Cs-137 Max.
			<------									pCi/L											------>
650 Sump	2E	1	-0.100	-0.100	-0.100	0.793	0.793	0.793	-3390	-3390	-3390	0.50	0.50	0.50	MDL			MDL			MDL		
Bldg. 830	66-07	2	-0.131	-0.210	-0.051	1.040	1.020	1.060	69	44	93	0.13	0.10	0.16	0.13	0.00	0.26	0.23	0.00	0.45	MDL		
	66-08	4	0.027	-0.150	0.154	1.644	0.755	2.270	1102	67	2440	0.24	0.15	0.35	MDL			MDL			MDL		
	66-09	2	-0.205	-0.310	-0.100	1.494	0.378	2.610	57	-5	119	-0.08	-0.13	-0.03	MDL			MDL			MDL		
	D15	2	0.102	0.102	0.102	0.888	0.793	0.982	-126	-222	-30	0.15	0.10	0.20	MDL			1.19	0.88	1.50	MDL		
Central Steam Facility	IT1	2	0.435	0.256	0.614	3.135	2.300	3.970	-544	-776	-312	0.59	0.50	0.68	MDL			MDL			MDL		
	IT2	2	0.384	0.051	0.717	4.625	3.850	5.400	1	-167	168	1.32	0.54	2.10	MDL			0.09	0.00	0.18	MDL		
	IT3	2	0.077	0.051	0.102	2.610	2.120	3.100	-115	-208	-22	0.60	0.60	0.60	MDL			MDL			MDL		
	IT4	2	0.102	0.102	0.102	0.887	0.755	1.020	3429	-223	7080	0.35	0.30	0.40	MDL			0.16	0.00	0.32	MDL		
	IT5	2	0.256	0.102	0.410	1.135	0.000	2.270	-128	-227	-30	0.37	0.30	0.44	MDL			MDL			0.39	0.00	0.79
Major Petrol. Facility	76-16	1	2.560	2.560	2.560	10.300	10.300	10.300	1070	1070	1070	0.24	0.24	0.24	MDL			MDL			MDL		
	76-17	1	2.560	2.560	2.560	11.200	11.200	11.200	1130	1130	1130	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	76-18	1	3.430	3.430	3.430	11.400	11.400	11.400	962	962	962	0.90	0.90	0.90	MDL			MDL			MDL		
	76-19	1	2.460	2.460	2.460	10.100	10.100	10.100	996	996	996	0.40	0.40	0.40	MDL			MDL			MDL		
PGA & NSLS	75-01	2	-0.104	-0.310	0.102	2.435	2.150	2.720	543	484	603	0.31	0.22	0.39	1.26	0.00	2.51	MDL			MDL		
	75-02	2	0.002	-0.150	0.154	2.660	2.640	2.680	1570	1470	1670	0.21	0.02	0.39	MDL			MDL			MDL		
	75-03	2	0.155	-0.100	0.410	1.433	0.907	1.960	-384	-488	-280	0.06	-0.07	0.18	MDL			MDL			MDL		
	75-04	2	0.720	-0.150	1.590	1.755	1.210	2.300	32	-16	79	0.11	0.11	0.12	MDL			MDL			MDL		
NYS Drinking Water Stanard			15.0			50.0			20,000			8			---			---			---		
Radiation Concentration Guides			---			---			----			---			30,000			30,000			20,000		
Typical MDL			0.53			1.20			300			0.1			0.20			0.23			0.20		

NA = Not Analyzed.

Table 55
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Ground Water in the Vicinity of the Ashfill, Current Landfill and Former Landfill

Area	Sample Location	Number of Samples	Gross Alpha Avg.	Gross Alpha Min.	Gross Alpha Max.	Gross Beta Avg.	Gross Beta Min.	Gross Beta Max.	Tritium Avg.	Tritium Min.	Tritium Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.	Na-22 Avg.	Na-22 Min.	Na-22 Max.	Cs-137 Avg.	Cs-137 Min.	Cs-137 Max.	Co-60 Avg.	Co-60 Min.	Co-60 Max.	Mn-54 Avg.	Mn-54 Min.	Mn-54 Max.	Co-58 Avg.	Co-58 Min.	Co-58 Max.
			<----										pCi/L																---->
Ashfill	D20	3	0.001	-0.100	0.102	1.184	0.491	1.780	-138	-219	-85	0.25	0.06	0.60	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
Current Landfill	107-07	2	0.281	0.000	0.563	2.060	1.850	2.270	753	417	1090	0.00	-0.01	0.01	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	107-08	2	0.205	0.205	0.205	1.321	0.831	1.810	2690	2690	2690	0.23	0.08	0.37	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	107-09	2	0.358	0.154	0.563	1.624	0.227	3.020	719	417	1020	0.03	0.03	0.04	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	1K	3	0.666	-0.051	1.230	12.833	11.400	14.100	2303	646	5610	2.33	1.25	3.15	0.51	0.00	1.15	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	2C	3	0.444	0.154	0.921	17.533	16.700	19.000	5905	604	9520	4.94	2.30	7.70	0.06	0.00	0.17	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	562	3	0.154	-0.100	0.358	1.136	0.718	1.440	359	-470	1340	0.32	0.05	0.70	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	563	2	0.358	0.102	0.614	12.840	4.080	21.600	-362	-1040	317	2.06	0.46	5.50	0.71	0.19	1.18	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	564	4	0.461	0.051	0.870	12.400	10.200	15.000	8817	-4520	19800	1.84	0.69	3.07	0.23	0.00	0.70	0.40	0.30	0.45	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	565	3	0.563	0.410	0.717	2.697	2.380	2.950	-1060	-4910	2360	0.18	-0.03	0.57	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.08	0.00	0.25	0.07	0.00	0.21
	97-14	3	0.681	0.102	1.480	1.660	0.340	3.510	707	-122	1830	0.65	0.00	1.93	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	98-33	3	0.444	0.154	0.973	4.203	4.000	4.380	1583	1390	1970	0.18	0.00	0.33	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	98-34	3	0.222	0.154	0.358	6.017	4.720	7.890	3039	126	6550	0.82	0.00	1.43	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	W6	3	0.069	-0.150	0.307	0.669	-0.038	1.100	-0	-210	119	0.26	0.10	0.41	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	W9	4	0.743	0.512	1.130	16.800	14.300	20.200	16405	1020	57300	2.27	0.64	4.30	0.15	0.00	0.35	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WO	1	-0.051	-0.051	-0.051	0.113	0.113	0.113	-252	-252	-252	0.00	0.00	0.00	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WP	2	-0.025	-0.051	0.000	0.207	-0.190	0.604	-379	-505	-253	0.04	0.00	0.07	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WQ	1	0.000	0.000	0.000	-0.076	-0.076	-0.076	-404	-404	-404	0.00	0.00	0.00	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WR	3	0.239	0.102	0.358	10.403	8.420	13.500	2853	-310	6230	1.77	0.63	2.50	0.17	0.17	0.17	0.25	0.19	0.35	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WS	4	0.498	-0.100	1.070	18.725	14.800	21.500	2961	183	9030	2.01	0.46	3.30	0.44	0.00	0.77	0.06	0.00	0.24	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	WT	4	0.717	0.410	0.870	4.945	1.700	14.000	206	-235	785	1.39	0.00	4.80	MDL	MDL	MDL	0.03	0.00	0.12	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
Old Landfill	115-01	1	0.870	0.870	0.870	1.510	1.510	1.510	56	56	56	0.15	0.15	0.15	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	115-02	1	1.090	1.090	1.090	1.700	1.700	1.700	-106	-106	-106	0.11	0.11	0.11	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	115-03	1	0.307	0.307	0.307	0.755	0.755	0.755	-161	-161	-161	0.14	0.14	0.14	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	1J	3	-0.134	-0.200	-0.051	1.425	0.416	3.140	-159	-397	103	0.03	-0.09	0.19	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D1	4	0.013	-0.100	0.102	2.305	1.060	4.160	-1076	-3670	-191	0.19	0.01	0.40	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D16	4	0.027	-0.150	0.358	1.673	0.831	2.270	-276	-538	-26	0.01	-0.05	0.08	MDL	MDL	MDL	MDL	MDL	MDL	0.21	0.00	0.44	MDL	MDL	MDL	MDL	MDL	MDL
	D18	4	-0.128	-0.210	-0.051	1.028	-0.190	3.320	-299	-397	-237	0.09	0.00	0.19	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D2	4	-0.088	-0.150	0.000	1.519	0.567	2.380	-2	-440	418	0.08	-0.01	0.26	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D3	4	0.064	-0.051	0.205	1.825	0.529	4.160	-297	-612	37	0.37	0.00	0.59	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D4	4	-0.025	-0.100	0.051	1.852	0.000	3.930	-190	-465	127	0.51	0.30	0.85	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D5	4	-0.038	-0.102	0.102	0.888	0.302	1.360	-292	-482	-153	0.18	-0.05	0.50	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D6	4	-0.140	-0.260	0.000	30.150	18.000	54.600	-248	-482	-52	32.04	14.60	50.05	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
	D7	4	-0.011	-0.150	0.205	0.896	0.453	1.280	-165	-517	72	0.18	0.0	0.46	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
NYS Drinking Water Standard			15.0			50.0			20,000			8.0			---			---			---			---			---		

Table 56
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations in Ground Water in the Vicinity of the Hazardous Waste Management Area

Sample Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			Sr-90			Na-22			Co-60			Cs-137		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------										pCi/L										------>
107-10	3	0.392	0.102	0.819	1.787	1.620	1.930	1321	364	2250	0.13	0.03	0.23	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
108-13	2	0.869	0.307	1.430	2.530	1.470	3.590	517	486	549	-0.04	-0.17	0.10	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
108-14	2	-0.070	-0.140	0.000	0.679	0.038	1.320	-88	-212	36	-0.02	-0.06	0.03	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
2L	1	0.051	0.051	0.051	2.800	2.800	2.800	123	123	123	1.50	1.50	1.50	0.24	0.24	0.24	MDL	MDL	MDL	MDL	MDL	MDL
2M	1	0.102	0.102	0.102	1.890	1.890	1.890	162	162	162	0.60	0.60	0.60	0.22	0.22	0.22	MDL	MDL	MDL	MDL	MDL	MDL
2N	1	0.358	0.358	0.358	3.850	3.850	3.850	160	160	160	2.60	2.60	2.60	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
99-04	2	0.869	0.307	1.430	1.076	0.982	1.170	283	0	566	0.04	0.04	0.04	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
99-05	1	2.250	2.250	2.250	5.060	5.060	5.060	5	5	5	0.05	0.05	0.05	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
99-06	1	0.307	0.307	0.307	1.060	1.060	1.060	-72	-72	-72	-0.03	-0.03	-0.03	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW1	4	-0.140	-0.460	0.051	2.722	1.590	3.820	1536	294	3550	1.69	1.20	2.93	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW2	4	-0.052	-0.310	0.051	30.725	12.900	51.300	1231	393	2280	33.76	5.17	69.30	2.11	0.00	4.82	0.88	0.00	1.59	0.07	0.00	0.17
MW3	4	0.025	-0.260	0.307	1.398	0.604	2.040	715	144	2210	-0.00	-0.15	0.09	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW4	2	0.051	0.051	0.051	2.590	2.420	2.760	1047	275	1820	1.24	0.96	1.60	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW5	4	0.269	0.051	0.512	6.422	1.320	9.220	1823	133	3320	0.97	0.15	2.94	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW6	4	0.128	-0.051	0.358	1.485	0.642	3.140	1923	141	4650	4.27	0.06	14.00	0.44	0.00	0.84	MDL	MDL	MDL	MDL	MDL	MDL
MW7A	4	0.141	0.051	0.307	35.175	12.800	58.800	1371	142	2220	28.50	5.30	49.99	0.04	0.00	0.11	MDL	MDL	MDL	MDL	MDL	MDL
MW7B	3	0.137	0.000	0.205	0.995	0.604	1.280	2007	1370	2570	0.06	-0.16	0.20	0.12	0.00	0.37	MDL	MDL	MDL	MDL	MDL	MDL
MW8	4	0.230	0.102	0.358	2.655	1.890	3.400	1141	362	1790	-0.01	-0.18	0.20	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW10	3	0.256	0.205	0.307	3.727	2.830	4.500	536	-692	1170	0.54	0.13	1.30	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW11	3	0.000	-0.100	0.154	2.417	2.070	2.720	384	327	441	0.20	0.00	0.40	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
MW12	4	0.192	0.000	0.512	2.645	1.740	3.020	1428	184	2910	0.07	-0.01	0.16	0.19	0.00	0.42	MDL	MDL	MDL	MDL	MDL	MDL
MW13	4	0.205	0.000	0.512	1.630	1.130	2.300	1132	124	2350	-0.06	-0.14	0.02	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
D17	2	0.154	0.102	0.205	0.928	0.416	1.440	1070	1070	1070	0.09	0.00	0.20	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL
NYS Drinking Water standard		15			50			20,000			8			---			----			----		
Radiation Concentraton Guide		---			--			----			--			30,000			30,000			20,000		
Typical MDL		0.53			1.2			300			0.1			0.20			0.23			0.20		

Table 57
BNL Site Environmental Report for Calendar Year 1989
Radionuclide Concentrations
in Recovery Wells

Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			K-40			Sr-90		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<----------						pCi/L								---------->
PW1	4	0.10	-0.10	0.21	2.17	0.98	2.98	1488	1170	1710	MDL			1.23	1.21	1.25
PW2	5	-0.03	-0.31	0.26	2.99	1.29	5.29	3895	1310	6310	MDL			1.47	0.93	2.02
PW3	10	0.13	-0.20	0.46	1.82	0.11	6.19	1260	-73	3590	MDL			0.14	0.10	0.17
PW4	9	0.01	-0.51	0.26	1.39	0.64	2.04	3111	208	11100	1.70	MDL	3.40	0.11	0.05	0.16
PW5	5	0.10	-0.21	0.51	4.33	2.64	7.44	1923	883	4640	3.78	MDL	7.94	2.41	1.25	3.56
NYS Drinking Water Standards		15.0			50.0			20,000			----			8.0		
Typical MDL		0.53	----	----	1.2	----	----	300	---	----	3.9	---	----	0.1	----	----

Table 58
BNL Site Environmental Report for Calendar Year 1989
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
						<-------			mg/l					------->
On-Site														
XA	3(2)	6.0 - 6.1	180	160	200	21.1	20.0	21.9	17.3	14.6	21.0	7.5	5.8	8.9
XB	3(2)	5.6 - 6.0	60	60	60	8.7	7.9	9.3	3.0	<4.0	4.6	<1.0		
XC	2(2)	5.5 - 6.0	30	30	30	7.0	6.3	7.7	5.4	4.9	5.8	<1.0		
XD	3(2)	5.0 - 6.0	25	20	30	8.6	7.7	10.1	5.2	4.3	5.7	<1.0		
XI	1(1)	8.4	400			5.9			8.7			<1.0		
XJ	1(1)	8.1	300			4.2			6.8			<1.0		
XY	1(1)	6.0	800			4.3			29.0			<1.0		
XO	1(1)	6.0	550			9.8			10.4			<1.0		
XN	1(1)	6.0	500			4.3			<4.0			<1.0		
Off-Site														
X1	1(0)	5.2	NA			8.3			10.0			<1.0		
X2	3(2)	5.5 - 6.0	95	90	100	14.4	10.6	16.5	19.3	15.5	22.7	<1.0		
X4	2(2)	5.5 - 6.1	97	93	100	11.8	10.4	13.2	19.1	13.1	25.0	<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.0			250.0			10.0		

NA: Not Analyzed.
*Number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and nitrate-nitrogen; number inside parenthesis represents number of samples analyzed for conductivity.

Table 59
BNL Site Environmental Report for Calendar Year 1989
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples*	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<------					mg/L					------>
On-Site												
XA	3 (1)	<0.025	<0.05	0.0006	<0.01	0.01	0.35	<0.0002	0.003	20.5	0.002	0.34
XB	3 (1)	<0.025	<0.05	<0.005	<0.01	<0.05	0.45	<0.0002	0.06	4.5	<0.02	4.8
XC	3 (1)	<0.025	<0.05	<0.005	<0.01	0.003	0.88	<0.0002	0.46	4.4	<0.02	0.65
XD	3 (1)	<0.025	<0.05	<0.005	<0.01	0.003	0.05	<0.0003	0.01	4.4	<0.02	0.53
XI	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.26	NA	<0.05	4.2	<0.005	0.07
XJ	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.24	NA	0.07	3.3	<0.005	0.17
XY	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	0.07	3.1	<0.005	0.85
XO	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	0.13	7.1	<0.005	0.91
XN	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	5.9	NA	0.11	2.3	<0.005	1.1
Off-Site												
X1	1 (1)	<0.01	<0.05	<0.005	<0.01	0.02	0.07	<0.0002	0.05	3.5	<0.02	0.53
X2	3 (1)	<0.025	<0.05	<0.005	<0.01	0.01	0.03	<0.0002	1.27	14.5	<0.02	0.56
X4	3 (1)	<0.025	<0.05	<0.005	<0.01	0.01	0.58	<0.0002	0.01	11.6	0.002	0.15
NYS Drinking Water Standards		0.05	0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 60
BNL Site Environmental Report for Calendar Year 1989
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane Avg.	Min.	Max.	trichloroethylene Avg.	Min.	Max.	tetrachloroethylene Avg.	Min.	Max.
		<----			mg/L					---->
On-Site										
XA	1	0.006			ND			ND		
XB	2	ND			ND			ND		
XC	2	ND			ND			ND		
XD	2	ND			ND			ND		
XI	1	ND			ND			ND		
XJ	1	ND			ND			ND		
XO	1	ND			ND			ND		
XN	1	ND			ND			ND		
Off-Site										
X2	1	ND			ND			ND		
X4	1	ND			ND			ND		
NYS Drinking Water Standards		0.005[a]			0.005			0.005[a]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
[a] NYSDOH standard adopted January 9, 1989.

Table 61
BNL Site Environmental Report for Calendar Year 1989
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples	chloroform			chlorodibromo-methane			bromodichloro-methane			bromoform		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------ mg/L ------>											
On-Site													
XA	1	0.003			ND			ND			ND		
XB	2	ND			ND			ND			ND		
XC	2	ND			ND			ND			ND		
XD	2	ND			ND			ND			ND		
XI	1	ND			ND			ND			ND		
XJ	1	ND			ND			ND			ND		
XO	1	ND			ND			ND			ND		
XN	1	ND			ND			ND			ND		
Off-Site													
X2	1	ND			ND			ND			ND		
X4	1	ND			ND			ND			ND		
NYS Drinking Water Standards		0.100			0.100			0.100			0.100		
Typical MDL		0.003			0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.

Table 62
BNL Site Environmental Report for Calendar Year 1989
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, BTX Data

Well ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	toluene Avg.	toluene Min.	toluene Max.	xylene Avg.	xylene Min.	xylene Max.
		<--------				mg/L				-------->
On-Site										
XA	1	ND			ND			ND		
XB	2	ND			ND			ND		
XC	2	ND			ND			ND		
XD	2	ND			ND			ND		
XI	1	ND			ND			ND		
XJ	1	ND			ND			ND		
XO	1	ND			ND			ND		
XN	1	ND			ND			ND		
Off-Site										
X2	1	ND			ND			ND		
X4	1	ND			ND			ND		
NYS Drinking Water Standards		0.005			0.005[(a)]			0.005[(a)]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 63
BNL Site Environmental Report for Calendar Year 1989
Landfill Areas and On-Site Control Wells,
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity Avg.	Conductivity Min. (umhos/cm)	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
						<------			mg/l					------>
Current Landfill														
W6	4 (3)	6.1 - 7.8	268	210	305	16.1	8.6	34.3	13.7	9.4	20.0	<1.0		
562	4 (3)	5.6 - 6.9	91	60	132	13.4	10.7	15.4	11.7	11.3	12.4	<1.0		
WR	4 (3)	6.1 - 6.3	419	136	560	48.8	26.4	92.7	11.0	<4.0	27.4	<1.0		
WS	4 (3)	6.1 - 6.2	901	720	1000	56.8	45.3	67.7	9.2	7.3	10.8	<1.0		
WT	4 (3)	4.7 - 7.0	234	220	243	49.4	45.2	54.6	26.2	24.6	27.4	<1.0		
563	4 (3)	5.7 - 6.6	548	365	860	56.0	10.9	100.0	48.6	5.3	67.5	<1.0		
1K	4 (3)	6.1 - 7.0	992	880	1107	53.4	30.9	69.8	4.4	<4.0	9.3	<1.0		
2C	4 (3)	5.4 - 6.3	912	680	1117	55.8	37.8	70.5	4.6	<4.0	10.6	<1.0		
W9	4 (3)	6.1 - 6.3	648	103	940	37.4	24.3	51.8	17.5	4.5	29.5	<1.0		
564	4 (3)	5.8 - 7.0	1004	880	1143	37.6	15.6	55.4	7.8	<4.0	14.7	<1.0		
565	4 (3)	5.9 - 7.3	249	140	327	20.9	10.1	47.2	11.4	<4.0	15.9	<1.0		
Former Landfill														
D1	4 (3)	5.3 - 5.6	111	100	120	6.6	5.8	7.8	16.5	15.2	17.2	1.3	<1.0	1.9
D2	3 (2)	5.5 - 6.5	46	40	52	8.3	7.7	8.9	8.9	7.9	10.2	<1.0		
D3	4 (3)	5.2 - 5.7	100	30	220	2.3	<4.0	5.2	7.9	6.9	10.3	<1.0		
D4	4 (3)	5.5 - 5.7	81	60	104	6.9	6.3	7.7	10.7	8.7	13.6	<1.0		
D5	4 (3)	5.5 - 6.1	118	110	125	24.8	19.2	33.9	15.6	14.8	16.8	<1.0		
D6	4 (3)	6.0 - 6.9	279	30	556	12.7	8.1	18.0	51.6	36.6	79.4	2.5	<1.0	5.8
1J	3 (2)	5.5 - 6.1	43	40	46	6.9	6.2	7.7	5.9	5.0	6.8	<1.0		
D18	3 (2)	5.5 - 5.8	37	30	43	6.5	6.2	7.2	8.5	8.0	9.0	<1.0		
WQ	1 (0)	5.6	NA			10.9			5.0			<1.0		
WP	3 (1)	5.0 - 7.4	78			9.4	7.8	10.7	6.0	5.1	7.7	<1.0		
WO	1 (0)	6.3	NA			10.5			8.3			<1.0		
D16	4 (3)	5.6 - 6.3	82	70	97	9.6	8.6	10.5	19.2	17.3	20.7	<1.0		
D7	4 (2)	6.0 - 6.3	84	67	100	9.9	<4.0	17.9	6.8	<4.0	13.0	<1.0		
Ash Repository														
D20	4 (2)	6.2 - 6.3	105	90	120	13.8	11.9	15.6	8.1	7.5	8.9	<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.0			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and nitrate-nitrogen; number inside parenthesis represents number of samples analyzed for conductivity.

Table 64
BNL Site Report for Calendar Year 1989
Landfill Areas and On-Site Control Wells,
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples*	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<-----					mg/L					----->
On-Site												
W6	4 (2)	0.018	<0.05	<0.005	<0.01	0.005	1.02	<0.0002	0.24	6.56	<0.02	0.24
562	4 (1)	0.005	0.007	<0.005	<0.01	0.003	2.74	0.0016	1.0	8.83	<0.02	0.03
WR	4 (2)	<0.025	<0.05	<0.005	<0.01	0.003	58.55	0.0003	2.23	29.6	0.0075	0.30
WS	4 (2)	<0.025	<0.05	<0.005	<0.01	0.008	79.6	<0.0002	2.03	38.73	0.0075	0.10
WT	4 (2)	0.008	<0.05	<0.005	<0.01	0.008	0.66	0.0003	0.14	18.86	0.015	2.51
563	4 (1)	<0.025	<0.005	<0.005	<0.01	0.003	42.52	<0.0002	9.12	44.18	0.0015	0.38
1K	4 (2)	<0.025	0.02	<0.005	<0.01	0.008	78.0	<0.0002	2.4	36.0	0.03	0.21
2C	4 (2)	<0.025	0.005	<0.005	<0.01	0.002	57.0	<0.0002	1.8	36.0	0.01	0.02
W9	4 (2)	<0.025	<0.05	<0.005	<0.01	0.01	72.38	0.0002	1.97	27.73	0.0125	0.16
564	4 (1)	0.005	<0.005	<0.005	<0.01	0.003	99.0	<0.0002	4.75	27.43	0.01	0.035
565	4 (1)	<0.025	<0.005	<0.005	<0.01	0.008	24.3	<0.0002	4.58	15.33	<0.02	0.01
Former Landfill												
D1	4 (1)	<0.025	<0.005	<0.005	<0.01	0.005	0.02	<0.0002	1.14	4.1	<0.02	0.005
D2	3 (1)	<0.025	<0.005	<0.005	<0.01	0.01	0.06	<0.0002	0.003	6.0	<0.02	0.03
D3	4 (1)	0.003	<0.005	<0.005	<0.01	0.005	0.05	<0.0002	0.05	3.5	<0.02	0.02
D4	4 (1)	<0.025	<0.005	<0.005	<0.01	0.003	0.03	0.0006	0.005	4.9	<0.02	0.008
D5	4 (1)	<0.025	<0.005	<0.005	<0.01	0.008	0.03	<0.0002	0.025	21.9	<0.02	0.01
D6	4 (1)	<0.025	<0.005	<0.005	<0.01	0.01	0.04	<0.0002	1.73	10.7	<0.02	0.05
1J	2 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.22	NA	<0.05	4.6	<0.005	0.007
D18	4 (1)	<0.025	<0.005	<0.005	<0.01	0.005	0.02	<0.0002	<0.05	4.7	<0.02	0.005
WQ	1 (1)	<0.01	<0.005	<0.005	<0.01	0.03	7.8	<0.0002	0.25	6.6	<0.02	0.03
WP	3 (1)	<0.025	<0.005	0.0002	<0.01	<0.02	2.82	0.0003	0.16	5.2	<0.02	0.007
WO	1 (1)	<0.01	<0.005	<0.005	<0.01	0.02	0.87	<0.0002	0.06	7.0	<0.02	0.03
D16	4 (1)	<0.025	<0.005	<0.005	<0.01	0.008	0.10	<0.0002	<0.05	6.8	<0.02	0.005
D7	4 (1)	<0.025	<0.005	<0.005	0.003	0.01	0.06	<0.0002	<0.05	11.1	<0.02	0.005
Ash Repository												
D20	4 (1)	0.013	<0.005	<0.005	<0.01	0.005	0.03	<0.0002	0.01	11.9	<0.02	0.005
NYS Drinking Water Standards		0.05	0.025	0.01	0.05	1.0	0.3	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 65
BNL Site Environmental Report for Calendar Year 1989
Landfill Areas
Ground Water Surveillance Wells, Chlorocarbon Data

Well	No. of Samples	1,1,1-trichloroethane Avg.	Min.	Max.	trichloroethylene Avg.	Min.	Max.	tetrachloroethylene Avg.	Min.	Max.
		<----			mg/L					---->
Current Landfill										
W6	4	ND			ND			ND		
562	3	ND			ND			ND		
WR	4	ND			ND			ND		
WS	4	0.0004	ND	0.0015	ND			ND		
WT	4	0.0004	ND	0.0015	ND			ND		
563	3	ND			ND			ND		
1K	4	ND			ND			ND		
2C	4	0.0004	ND	0.0015	ND			ND		
W9	4	ND			ND			ND		
564	4	ND			ND			ND		
565	2	ND			ND			ND		
Former Landfill										
D1	3	0.001	ND	0.002	0.0004	ND	0.001	0.0006	ND	0.002
D2	3	ND			ND			ND		
D3	4	0.007	0.005	0.012	0.0003	ND	0.001	0.012	0.007	0.017
D4	2	ND			ND			ND		
D5	3	ND			ND			ND		
D6	3	0.001	ND	0.003	ND			ND		
1J	3	ND			ND			ND		
D18	4	0.0004	ND	0.0015	ND			ND		
WQ	1	0.053			ND			0.008		
WP	2	0.002	ND	0.004	0.001	ND	0.002	0.001	ND	0.002
WO	1	ND			ND			ND		
D16	3	0.002	0.001	0.004	0.0004	ND	0.001	ND		
D7	4	0.0003	ND	0.0012	ND			ND		
Ash Repository										
D20	4	0.0003	ND	0.001	0.0003	ND	0.001	ND		
NYS Drinking Water Standards		0.005[a]			0.005			0.005[a]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 66
BNL Site Environmental Report for Calendar Year 1989
Landfill Areas
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples*	chloroform			chlorodibromo-methane			bromodichloro-methane			bromoform		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<-----						mg/L					----->
Current Landfill													
W6	4 (3)	ND			ND			ND			ND		
562	3 (3)	ND			ND			ND			ND		
WR	4 (4)	ND			ND			ND			ND		
WS	4 (4)	ND			ND			ND			ND		
WT	4 (3)	ND			ND			ND			ND		
563	3 (3)	ND			ND			ND			ND		
1K	4 (4)	ND			ND			ND			ND		
2C	4 (4)	ND			ND			ND			ND		
W9	4 (3)	ND			ND			ND			ND		
564	4 (2)	ND			ND			ND			ND		
565	2 (1)	ND			ND			ND			ND		
Former Landfill													
D1	3 (1)	ND			ND			ND			ND		
D2	3 (2)	0.001	ND	0.002	ND			ND			ND		
D3	4 (2)	0.009	0.003	0.013	ND			ND			ND		
D4	2 (1)	ND			ND			ND			ND		
D5	3 (1)	ND			ND			ND			ND		
D6	3 (1)	ND			ND			ND			ND		
1J	3 (1)	ND			ND			ND			ND		
D18	4 (2)	0.003	0.002	0.003	ND			ND			ND		
WQ	1 (1)	0.014			ND			ND			ND		
WP	2 (2)	0.001	ND	0.003	ND			0.001	ND	0.002	ND		
WO	1 (1)	ND			ND			ND			ND		
D16	3 (1)	ND			ND			ND			ND		
D7	4 (2)	ND			ND			ND			ND		
Ash Repository													
D20	4 (2)	ND			ND			ND			ND		
NYS Drinking Water Standards		0.100			0.100			0.100			0.100		
Typical MDL		0.003			0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
*Number inside parenthesis represents number of samples analyzed for bromoform; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 67
BNL Site Environmental Report for Calendar Year 1989
Landfill Areas
Ground Water Surveillance Wells, BTX Data

Well ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	toluene Avg.	toluene Min.	toluene Max.	xylene Avg.	xylene Min.	xylene Max.
		<------------------ mg/L						------------------>		
Current Landfill										
W6	4	ND			ND			ND		
562	3	ND			ND			ND		
WR	4	0.005	0.004	0.007	ND			0.004	0.002	0.014
WS	4	0.003	0.002	0.004	ND			0.002	ND	0.005
WT	4	ND			ND			ND		
563	3	0.002	ND	0.005	ND			0.001	ND	0.002
1K	4	0.007	0.004	0.010	0.001	ND	0.002	0.006	0.001	0.010
2C	4	0.010	0.006	0.015	ND			0.004	0.002	0.007
W9	4	0.004	0.001	0.008	ND			0.001	ND	0.002
564	4	0.011	0.004	0.015	0.008	ND	0.030	0.001	ND	0.002
565	2	0.003	0.002	0.003	ND			ND		
Former Landfill										
D1	3	ND			ND			ND		
D2	3	0.001	ND	0.002	ND			0.003	ND	0.006
D3	4	ND			ND			ND		
D4	2	ND			ND			ND		
D5	3	ND			ND			0.001	ND	0.001
D6	3	ND			ND			ND		
1J	3	ND			ND			ND		
D18	4	ND			ND			0.0004	ND	0.001
WQ	1	ND			ND				ND	
WP	2	ND			ND			0.002	ND	0.004
WO	1	ND			ND				0.001	
D16	3	ND			ND				ND	
D7	4	ND			ND				ND	
Ash Repository										
D20	4	ND			ND			0.0004	ND	0.001
NYS Drinking Water Standards		0.005			0.005[a]			0.005[a]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 68
BNL Site Environmental Report for Calendar Year 1989
Waste Management Area
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg. (umhos/cm)	Min.	Max.	Avg. <---	Min.	Max.	Avg.	Min. mg/L	Max.	Avg.	Min.	Max. --->
MW1	4 (3)	4.2 - 6.0	62	50	70	7.7	6.9	8.5	10.2	8.3	12.1	1.2	<1.0	2.2
MW2	4 (3)	4.6 - 6.0	112	90	157	5.2	<4.0	7.5	24.8	21.7	32.8	1.6	<1.0	2.7
MW3	4 (3)	5.0 - 6.5	58	50	63	11.3	10.2	12.5	11.9	9.7	14.1	<1.0		
MW4	3 (3)	5.4 - 5.7	60	59	60	11.2	10.7	11.5	11.9	11.2	13.1	<1.0		
MW6	4 (3)	5.2 - 6.5	53	38	70	12.1	11.5	13.0	13.5	12.0	14.5	<1.0		
2L	1 (1)	6.7	NA			10.1			13.3			<1.0		
2M	1 (1)	6.0	NA			10.3			12.8			<1.0		
2N	1 (1)	5.4	NA			10.0			12.6			<1.0		
MW5	4 (3)	5.0 - 6.6	49	40	60	10.4	9.4	12.1	13.1	11.0	14.6	<1.0		
MW7A	4 (3)	4.0 - 6.0	30	20	40	10.6	9.5	11.8	12.9	11.5	14.4	<1.0		
MW7B	4 (3)	5.1 - 6.0	29	20	38	10.7	9.1	12.3	11.7	11.1	13.1	<1.0		
MW13	4 (3)	4.6 - 6.4	53	30	69	11.5	9.2	13.3	13.4	12.2	16.2	<1.0		
MW8	4 (3)	5.0 - 5.9	52	30	66	11.2	10.2	12.6	13.4	11.9	15.0	<1.0		
MW12	4 (3)	5.0 - 6.2	50	20	69	11.5	8.6	13.5	15.9	15.6	16.6	<1.0		
MW11	4 (3)	5.0 - 6.1	54	50	60	7.2	6.2	8.4	12.5	12.1	13.5	<1.0		
MW10	4 (3)	5.2 - 7.0	80	80	81	9.9	7.6	11.3	17.5	14.6	21.1	<1.0		
D17	3 (2)	5.2 - 6.1	45	40	50	8.3	7.5	9.1	11.3	10.6	11.9	<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.0			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and nitrate-nitrogen; number inside parenthesis represents number of samples analyzed for conductivity.

Table 69
BNL Site Environmental Report for Calendar Year 1989
Waste Management Area
Ground Water Surveillance Wells Average Metals Data

Well ID	No. of Samples*	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<----						mg/L				---->
MW1	4 (1)	<0.025	<0.05	<0.0005	<0.005	0.005	0.04	0.0002	0.07	6.7	0.005	0.01
MW2	4 (1)	<0.025	<0.05	<0.0005	<0.005	<0.05	0.002	0.0002	<0.05	4.8	<0.005	<0.02
MW3	4 (1)	<0.025	<0.05	<0.0005	<0.005	0.07	0.002	0.0003	<0.05	7.1	<0.005	0.04
MW4	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.07	NA	<0.05	7.7	<0.005	<0.02
MW6	4 (1)	<0.025	<0.005	<0.0005	<0.005	0.005	0.025	<0.0002	0.0025	8.4	<0.005	<0.02
2L	1 (1)	<0.025	<0.005	<0.0005	<0.01	0.02	0.09	<0.0002	0.05	8.5	<0.02	0.07
MW5	4 (1)	<0.025	<0.005	<0.0005	<0.005	0.005	0.12	<0.0002	<0.05	7.5	0.008	0.02
2M	1 (1)	<0.01	<0.05	<0.005	<0.01	0.01	0.08	0.0012	0.02	4.8	<0.02	0.03
2N	1 (1)	<0.01	<0.005	<0.005	<0.01	0.06	0.09	<0.0002	0.02	7.6	<0.02	0.08
MW7A	4 (1)	<0.025	<0.05	<0.0005	<0.005	0.0025	0.007	<0.0002	<0.05	6.9	0.002	0.01
MW7B	4 (1)	<0.025	<0.05	<0.0005	<0.005	0.0025	0.04	0.001	0.005	6.7	<0.005	0.008
MW13	4 (1)	<0.025	0.02	<0.0005	<0.005	0.005	0.05	0.0003	0.005	7.3	<0.005	0.02
MW8	4 (1)	<0.025	<0.05	<0.0005	<0.005	0.005	0.06	<0.0002	0.0025	8.3	<0.005	0.02
MW12	4 (1)	<0.025	<0.05	<0.0005	<0.005	<0.05	0.06	0.0004	0.005	6.8	<0.005	0.008
MW11	4 (1)	<0.025	<0.005	<0.0005	<0.005	0.005	0.02	<0.0002	<0.05	5.8	<0.005	0.02
MW10	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.03	NA	<0.05	6.8	<0.005	<0.02
D17	3 (1)	<0.025	0.02	<0.0005	<0.005	0.007	0.02	0.0003	0.003	5.4	<0.005	0.007
NYS Drinking Water Standards		0.05	0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 70
BNL Site Environmental Report for Calendar Year 1989
Waste Management Area
Ground Water Surveillance Wells, Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane Avg.	Min.	Max.	trichloroethylene Avg.	Min.	Max.	tetrachloroethylene Avg.	Min.	Max.
		<------------	------------	------------	------------	mg/L	------------	------------	------------	------------>
MW1	4	ND			ND			ND		
MW2	4	0.054*	0.026	0.082	0.0003	ND	0.001	0.170*	0.039*	0.349
MW3	4	0.006	ND	0.018	0.0007	ND	0.001	0.0005	ND	0.002
MW4	2	0.002	ND	0.003	ND			ND		
MW6	4	0.004	ND	0.010	ND			0.0002	ND	0.001
2L	1	ND			ND			ND		
MW5	4	0.005	ND	0.014	0.001	ND	0.003	0.001	ND	0.002
MW7A	4	0.005	ND	0.008	0.001	ND	0.001	0.001	ND	0.002
MW7B	4	0.002	ND	0.006	0.0004	ND	0.001	0.0004	ND	0.002
MW13	2	0.031	0.006	0.056	0.022	0.006	0.039	0.007	0.003	0.011
MW8	4	0.292	0.040	0.548	0.194	0.034	0.380	0.021	0.007	0.045
MW12	3	0.003	0.002	0.007	ND			ND		
MW11	3	0.004	ND	0.007	0.002	ND	0.005	ND		
MW10	3	0.033	0.002	0.065	ND			ND		
D17	3	0.003	0.001	0.004	ND			ND		
NYS Drinking Water Standards		0.005[a]				0.005			0.005[a]	
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
* Value reported is underestimated, see Section 3.3.8.2 in text for discussion.
(a) NYSDOH standard adopted January 9, 1989.

Table 71
BNL Site Environmental Report for Calendar Year 1989
Waste Management Area
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples	chloroform			chlorodibromo-methane			bromodichloro-methane			bromoform		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------ mg/L ------>											
MW1	4	ND			ND			ND			ND		
MW2	4	0.018	ND	0.069	ND			ND			ND		
MW3	4	ND			ND			ND			ND		
MW4	2	0.0005	ND	0.001	ND			ND			ND		
MW6	4	0.001	ND	0.004	ND			ND			ND		
2L	1	ND			ND			ND			ND		
MW5	4	0.002	ND	0.006	ND			ND			ND		
MW7A	4	0.002	ND	0.004	ND			ND			ND		
MW7B	4	0.0004	ND	0.002	ND			ND			ND		
MW13	2	0.006	0.002	0.011	ND			ND			ND		
MW8	4	0.010	0.004	0.017	ND			ND			ND		
MW12	3	0.001	ND	0.002	ND			ND			ND		
MW11	3	ND			ND			ND			ND		
MW10	3	ND			ND			ND			ND		
D17	3	ND			ND			ND			ND		
NYS Drinking Water Standards		0.100			0.100			0.100			0.100		
Typical MDL		0.003			0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.

Table 72
BNL Site Environmental Report for Calendar Year 1989
Waste Management Area
Ground Water Surveillance Wells, BTX Data

Well ID	No. of Samples	benzene			toluene			xylene		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------------------------			mg/L	----------------				----->
MW1	4	ND			ND			ND		
MW2	4	0.0002	ND	0.0009	ND			ND		
MW3	4	ND			ND			ND		
MW4	2	ND			ND			ND		
MW6	4	ND			ND			ND		
2L	1	ND			ND			ND		
MW5	4	ND			0.0007	ND	0.003	0.0008	ND	0.003
MW7A	4	ND			ND			ND		
MW7B	4	ND			ND			ND		
MW13	2	ND			ND			ND		
MW8	4	ND			ND			ND		
MW12	3	ND			ND			ND		
MW11	3	ND			ND			ND		
MW10	3	ND			ND			ND		
D17	3	ND			ND			ND		
NYS Drinking Water Standards		0.005			0.005[a]			0.005[a]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 73
BNL Site Environmental Report for Calendar Year 1989
Ground Water Restoration Project at
Waste Management Area
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
						<--- mg/L								--->
PW1	1 (2)	6.0	70			11.8	11.5	12.0	15.3	12.2	18.4	<1.0		
PW2	1 (2)	5.0	60			10.8	10.3	11.2	11.6	11.5	11.7	<1.0		
PW3	1 (2)	5.0	70			11.6	11.1	12.1	10.6	10.3	10.8	<1.0		
PW4	1 (2)	5.0	60			8.9	8.8	9.0	9.6	9.5	9.7	<1.0		
PW5	1 (2)	5.2	70			12.8	12.0	13.5	11.3	10.5	12.0	<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.00			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH and conductivity; number inside parenthesis represents number of samples analyzed for chlorides, sulfates, and nitrate-nitrogen.

Table 74
BNL Site Environmental Report for Calendar Year 1989
Ground Water Restoration Project at Waste Management Area
Average Metals Data

	Well ID					NYS Drinking Water Standard
	PW1	PW2	PW3	PW4	PW5	
	<------------------		mg/L		------------------>	
Number of samples	2	2	2	2	2	
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	0.09	<0.05	<0.05	<0.05	<0.05	1.0
Fe	1.70	0.09	<0.075	<0.075	<0.075	0.3
Hg	NA	NA	NA	NA	NA	0.002
Mn	<0.05	<0.05	<0.05	<0.05	<0.05	0.3
Na	8.0	7.4	7.9	6.0	8.8	(a)
Pb	0.044	0.004	<0.005	<0.005	<0.005	0.025
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	5.0

NA: Not Analyzed.
(a) No standard specified.

Table 75
BNL Site Environmental Report for Calendar Year 1989
Ground Water Restoration Project at Waste Management Area
Chlorocarbon Data

Well ID	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<------------	mg/L	------------>
PW1	4	Avg:	0.002	ND	ND
		Min:	0.001		
		Max:	0.003		
PW2	4	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.003		
PW3	7	Avg:	0.022	0.009	0.010
		Min:	0.008	0.002	0.002
		Max:	0.046	0.021	0.039
PW4	6	Avg:	0.017	0.002	0.001
		Min:	0.007	0.001	ND
		Max:	0.027	0.002	0.003
PW5	2	Avg:	0.011	ND	0.002
		Min:	0.008		ND
		Max:	0.013		0.003
NYS Drinking Water Standards			0.005[a]	0.005	0.005[a]
Typical MDL			0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not Detected.
[a] NYSDOH standard adopted January 9, 1989.

Table 76
BNL Site Environmental Report for Calendar Year 1989
Ground Water Restoration Project at Waste Management Area
Trihalomethane Data

Well ID	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<----------	mg/L	----------	---------->
PW1	4	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.002			
PW2	4	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW3	7	Avg:	0.003	ND	ND	ND
		Min:	ND			
		Max:	0.004			
PW4	6	Avg:	0.002	ND	ND	ND
		Min:	0.002			
		Max:	0.003			
PW5	2	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.002			
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.003	0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not Detected.

Table 77
BNL Site Environmental Report for Calendar Year 1989
Ground Water Restoration Project at Waste Management Area
BTX Data

Well ID	No. of Samples**		benzene	toluene	xylene
			<----------------	mg/L	---------------->
PW1	4 (2)	Avg: Min: Max:	ND	ND	ND
PW2	4 (3)	Avg: Min: Max:	ND	ND	ND
PW3	7 (6)	Avg: Min: Max:	ND	ND	ND
PW4	6 (5)	Avg: Min: Max:	ND	ND	ND
PW5	2 (2)	Avg: Min: Max:	ND	ND	ND
NYS Drinking Water Standards			0.005	0.005[a]	0.005[a]
Typical MDL			0.002	0.002	0.002

MDL: Minimum Detection Limit
ND: Not Detected.
** Number in parenthesis indicates number of xylene samples.
[a] NYSDOH standard adopted January 9, 1989.

Table 78
BNL Site Environmental Report for Calendar Year 1989
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
						<-----			mg/L					----->
66-08**	2 (2)	5.7 - 6.3	106	100	110	12.4	11.0	13.8	16.2	16.0	16.4	1.05	1.0	1.1
76-16	1 (1)	6.0	120	---	---	12.8	----	----	15.8	----	----	4.1	---	---
76-17	1 (1)	6.0	140	---	---	11.1	----	----	23.0	----	----	2.2	---	---
76-18	1 (1)	NA	100	---	---	6.1	----	----	22.2	----	----	1.7	---	---
76-19	1 (1)	NA	100	---	---	12.4	----	----	24.1	----	----	<1.0	---	---
76-20	1 (1)	6.1	199	---	---	26.8	----	----	30.8	----	----	1.8	---	---
76-21	1 (1)	6.0	67	---	---	9.1	----	----	15.7	----	----	<1.0	---	---
76-22	1 (1)	6.3	117	---	---	21.3	----	----	16.9	----	----	<1.0	---	---
D15	2 (1)	5.8 - 6.3	125	---	---	16.7	15.6	17.8	18.5	16.0	21.0	<1.0	---	---
IT1	2 (1)	6.1 - 6.2	297	---	---	20.6	16.7	24.5	21.1	19.2	23.0	<1.0	---	---
IT2	2 (1)	6.1 - 6.7	200	---	---	16.0	15.1	16.8	25.5	20.1	30.8	1.2	1.0	1.4
IT3	2 (1)	5.9 - 6.4	120	---	---	12.1	11.9	12.2	23.6	23.6	23.6	1.8	1.6	2.0
IT4	2 (1)	6.0 - 6.6	100	---	---	16.5	16.0	17.0	18.7	16.5	20.9	0.7	<1.0	1.4
IT5	2 (1)	5.6 - 6.0	112	---	---	11.7	11.5	11.9	21.3	18.2	24.3	1.6	1.4	1.8
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.0			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed only for conductivity; number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and nitrate-nitrogen.
** Upgradient well

Table 79
BNL Site Environmental Report for Calendar Year 1989
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples*	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<---					mg/L					--->
66-08**	2	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	8.3	<0.005	<0.02
76-18	1	<0.025	NA	0.0005	<0.005	<0.05	0.78	NA	0.19	8.6	<0.005	<0.02
76-19	1	<0.025	NA	<0.0005	0.006	<0.05	8.00	NA	0.52	6.2	<0.005	0.04
76-20	1	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	21.6	<0.005	<0.02
76-21	1	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	0.51	4.5	<0.005	<0.02
76-22	1	<0.025	NA	<0.0005	<0.005	<0.05	0.08	NA	<0.05	18.0	<0.005	<0.02
D15	2 (1)	<0.025	<0.05	<0.005	0.015	0.015	0.06	<0.0002	0.71	14.7	<0.005	0.02
IT1	4 (1)	<0.025	<0.05	0.0004	<0.005	0.003	17.5	0.0082	4.2	14.9	<0.005	0.02
IT2	2 (1)	<0.025	<0.01	<0.005	<0.005	0.01	2.6	<0.0002	0.28	11.0	<0.005	0.01
IT3	2 (1)	<0.025	<0.05	<0.005	<0.005	0.005	0.01	0.001	<0.05	11.4	<0.005	0.05
IT4	2 (1)	<0.025	<0.05	<0.005	<0.005	<0.05	0.02	<0.0002	0.03	12.4	<0.005	0.03
IT5	2 (1)	<0.025	<0.05	<0.005	<0.005	<0.05	0.13	0.0096	0.21	11.7	0.01	0.025
NYS Drinking Water Standards		0.05		0.01	0.05	1.0	0.3	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
**Upgradient well.

Table 80
BNL Site Environmental Report for Calendar Year 1989
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Chlorocarbon Data

Well ID	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<------ mg/L	------	------>
66-08**	1	Avg:	ND	ND	ND
		Min:			
		Max:			
IT1	1	Avg:	0.116	0.053	0.053
		Min:			
		Max:			
IT2	2	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.002		
IT3	1	Avg:	0.009	ND	ND
		Min:			
		Max:			
IT4	2	Avg:	0.011	0.003	0.022
		Min:	0.004	0.001	0.011
		Max:	0.018	0.005	0.033
IT5	1	Avg:	0.002	0.002	0.024
		Min:			
		Max:			
76-16	1	Avg:	NA	ND	ND
		Min:			
		Max:			
76-17	1	Avg:	NA	ND	0.003
		Min:			
		Max:			
76-18	1	Avg:	NA	ND	ND
		Min:			
		Max:			
76-19	1	Avg:	NA	ND	ND
		Min:			
		Max:			
76-20	2	Avg:	0.0007	ND	0.0007
		Min:	ND		ND
		Max:	0.001		0.001
76-21	2	Avg:	ND	ND	0.010
		Min:			0.004
		Max:			0.015
76-22	2	Avg:	ND	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.005[(a)]	0.005	0.005[(a)]
Typical MDL			0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not Detected.
NA: Not Analyzed.
[(a)] NYSDOH Standard adopted January 9, 1989.
**Upgradient Well.

Table 81
BNL Site Environmental Report for Calendar Year 1989
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<------------------	mg/L	------------------	------------------>
66-08**	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
IT1	1	Avg:	0.006	ND	ND	ND
		Min:				
		Max:				
IT2	2	Avg.	ND	ND	ND	ND
		Min:				
		Max:				
IT3	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
IT4	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
IT5	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-16	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-17	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-18	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-19	1	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-20	2	Avg:	0.002	ND	ND	ND
		Min:	ND			
		Max:	0.003			
76-21	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-22	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.003	0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not Detected.
**Upgradient Well.

Table 82
BNL Site Environmental Report for Calendar Year 1989
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Petroleum Product Data

Well ID	No. of Samples		benzene	toluene	xylene	free product
			<----------------	mg/L	------------------>	
66-08**	3 (8)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
IT1	2 (6)	Avg:	0.378	6.4	4.65	ND
		Min:	0.316	1.8··	4.0··	
		Max:	0.440	11.0	5.3	
IT2	2 (0)	Avg.	ND	ND	ND	NR
		Min:				
		Max:				
IT3	1 (0)	Avg:	ND	ND	ND	NR
		Min:				
		Max:				
IT4	2 (0)	Avg:	ND	ND	0.009	NR
		Min:			ND	
		Max:			0.018	
IT5	2 (6)	Avg:	0.002	0.008	ND	ND
		Min:	ND	ND		
		Max:	0.003	0.015		
76-16	1 (6)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-17	1 (6)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-18	1 (6)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-19	1 (6)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
76-20	2 (0)	Avg:	ND	ND	ND	NR
		Min:	ND			
		Max:	ND			
76-21	2 (0)	Avg:	ND	ND	0.008	ND
		Min:			ND	
		Max:			0.017	
76-22	2 (0)	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.003	0.002	0.002	0.002

MDL: Minimum Detection Limit.
ND: Not Detected.
NR: Not Required.
* Number inside parenthesis represents number of samples analyzed for free product; number outside parenthesis represents number of benzene, toluene, and xylene samples.
** Upgradient well.
(a) NYSDOH standard adopted January 9, 1989.
·· Value reported is underestimated, see Section 3.3.8.2 in text for discussion.

Table 83
BNL Site Environmental Report for Calendar Year 1989
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
						<---- mg/L								---->
D8	1 (0)	5.8	NA			21.6			19.4			<1.0		
D9	2 (1)	5.9 - 6.1	202			27.3	22.1	32.6	19.4	15.9	23.0	4.6	<1.0	9.1
D10	2 (1)	6.1 - 6.6	187			36.9	29.4	44.4	17.5	15.3	19.7	0.8	<1.0	1.5
D11	2 (1)	6.3 - 6.4	169			25.9	21.7	30.0	15.6	15.0	16.3	2.2	1.7	2.7
D12	1 (0)	6.2	NA			26.9			23.4			2.7		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.00			250.0			10.0		

NA: Not Analyzed.
(a) No standard specified.

* Number inside parenthesis represents number of samples analyzed for conductivity; number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and nitrate-nitrogen.

Table 84
BNL Site Environmental Report for Calendar Year 1989
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Average Metals Data

	Well ID					NYS Drinking Water Standards
	D8	D9	D10	D11	D12	
	<----	----	mg/L	----	---->	
No. of Samples*	1 (1)	2 (1)	2 (1)	2 (1)	1 (1)	
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
As	<0.005	<0.005	<0.005	<0.005	<0.005	0.025
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Cu	0.02	0.01	0.02	0.01	0.02	1.0
Fe	0.09	0.05	0.06	0.06	0.08	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.002
Mn	1.7	<0.05	<0.05	<0.05	<0.01	0.3
Na	17.3	17.9	23.4	16.6	17.9	(a)
Pb	<0.02	<0.02	<0.02	<0.02	<0.02	0.025
Zn	0.03	0.02	0.02	0.14	0.07	5.0

* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(a) No standard specified.

Table 85
BNL Site Environmental Report for Calendar Year 1989
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane			trichloroethylene			tetrachloroethylene		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<-------------------------				mg/L				------------------------->
D8	1	0.008			0.001			ND		
D9	2	0.043	0.005	0.081	0.002	ND	0.004	ND		
D10	1	0.060*			NA			ND		
D11	-	NA			NA			NA		
D12	1	0.042			0.002			ND		
NYS Drinking Water Standards		0.005[a]				0.005			0.005[a]	
Typical MDL		0.002			0.002			0.002		

MDL: Minimim Detection Limit.
ND: Not Detected.
* Value reported is underestimated, see discussion in Section 3.3.8.2 of the report.
(a) NYSDOH standard adopted January 9, 1989.

Table 86
BNL Site Environmental Report for Calendar Year 1989
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples	chloroform			chlorodibromo-methane			bromodichloro-methane			bromoform		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------					mg/L						------>
D8	1	ND			ND			ND			ND		
D9	2	0.001	ND	0.001	ND			ND			ND		
D10	1	0.003			NA			ND			ND		
D11	-	NA			NA			NA			NA		
D12	1	ND			ND			ND			ND		
NYS Drinking Water Standards		0.100			0.100			0.100			0.100		
Typical MDL		0.003			0.002			0.002			0.002		

MDL: Minimum Detection Limit
NA: Not Analyzed.
ND: Not Detected.

Table 87
BNL Site Environmental Report for Calendar Year 1989
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, BTX Data

Well ID	No. of Samples	benzene			toluene			xylene		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<--- mg/L --->								
D8	2	ND			ND			0.003	ND	0.006
D9	2	ND			ND			0.001	ND	0.001
D10	1	ND			ND			ND		
D11	-	NA			NA			NA		
D12	1	ND			ND			0.001		
NYS Drinking Water Standards		0.005			0.005(a)			0.005(a)		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
NA: Not Analyzed.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 88
BNL Site Environmental Report for Calendar Year 1989
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)			Chlorides			Sulfates			Nitrate-Nitrogen		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
						<-------			mg/L					------->
Northwest Sector														
560	4 (3)	5.0 - 5.6	157	110	208	41.8	37.8	47.1	15.3	13.9	16.8	<1.0		
561	4 (3)	5.0 - 6.4	114	90	139	16.3	13.6	20.3	15.5	12.3	22.6	<1.0		
IT1S	3 (3)	5.6 - 6.7	32	20	40	8.1	5.1	10.2	9.8	9.2	10.2	<1.0		
IT1D	3 (3)	5.0 - 6.4	102	20	240	2.7	<4.0	8.0	9.5	8.6	9.9	<1.0		
IT2S	3 (3)	5.5 - 5.7	45	40	54	10.0	9.3	10.4	9.1	8.5	10.1	<1.0		
IT2D	3 (3)	5.3 - 5.7	67	60	80	7.5	7.2	7.9	9.2	8.5	9.5	0.3	<1.0	1.0
AGS Area														
556	4 (3)	5.5 - 6.1	193	169	210	6.3	<4.0	14.1	35.4	22.6	47.4	1.3	<1.0	2.6
557	4 (3)	5.1 - 5.9	115	67	198	3.7	<4.0	5.5	18.1	12.1	30.7	1.4	<1.0	2.6
558	4 (3)	4.8 - 6.0	197	40	500	1.1	<4.0	4.6	11.4	8.5	13.3	0.7	<1.0	1.5
559	4 (3)	4.8 - 5.9	324	80	800	4.6	<4.0	6.6	21.8	19.5	25.5	<1.0		
Bldg. 650 Sump														
2E	1 (1)	5.0	60			8.3			13.4			<1.0		
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.00			250.0			10.0		

(a) No standard specified.
* Number outside parenthesis represents number of samples analyzed for pH, chlorides, sulfates, and

Table 89
BNL Site Environmental Report for Calendar Year 1989
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples*	Ag	As	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<----					mg/L					---->
Northwest Sector												
560	3 (1)	<0.01	<0.05	<0.005	0.007	0.003	0.13	<0.0002	0.01	32.1	0.002	0.02
561	3 (1)	<0.01	<0.05	<0.005	<0.01	0.01	0.01	<0.0002	0.05	15.1	<0.02	0.01
IT1S	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	5.2	<0.005	<0.02
IT1D	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	4.3	<0.005	<0.02
IT2S	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	5.7	<0.005	<0.02
IT2D	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	6.7	<0.005	<0.02
AGS Area												
556	4 (1)	<0.01	<0.005	<0.005	<0.01	0.01	0.03	<0.0002	0.02	8.5	<0.02	0.01
557	3 (0)	<0.025	NA	<0.0005	<0.005	<0.05	0.03	NA	<0.05	8.5	<0.005	<0.02
558	4 (1)	<0.01	<0.005	<0.005	<0.01	0.01	0.15	<0.0002	0.01	3.7	<0.02	0.01
559	4 (1)	<0.01	<0.005	<0.005	<0.01	0.01	0.04	<0.0002	0.01	5.2	<0.02	0.02
Bldg. 650 Sump												
2E	1 (0)	<0.025	NA	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	7.0	<0.005	<0.02
NYS Drinking Water Standards		0.05	0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.
(a) No standard specified.
* Number inside parenthesis represents number of samples analyzed for As and Hg; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 90
BNL Site Environmental Report for Calendar Year 1989
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane Avg.	Min.	Max.	trichloroethylene Avg.	Min.	Max.	tetrachloroethylene Avg.	Min.	Max.
		<------------			mg/L			------------>		
Northwest Sector										
560	4	ND			ND			ND		
561	3	0.001	ND	0.004	0.001	ND	0.003	ND		
IT1S	2	ND			ND			ND		
IT1D	2	ND			ND			ND		
IT2S	2	ND			ND			ND		
IT2D	1	ND			ND			ND		
AGS Area										
556	4	0.004	0.002	0.006	ND			0.001	ND	0.002
557	4	ND			ND			ND		
558	4	ND			ND			ND		
559	3	ND			ND			ND		
Bldg. 650 Sump										
2E	1	ND			ND			ND		
NYS Drinking Water Standards		0.005[(a)]			0.005			0.005[(a)]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 91
BNL Site Environmental Report for Calendar Year 1989
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Trihalomethane Data

Well ID	No. of Samples*	chloroform			chlorodibromo-methane			bromodichloro-methane			bromoform		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<------ mg/L ------>											
Northwest Sector													
560	4 (3)	ND			ND			ND			ND		
561	3 (3)	ND			ND			ND			ND		
IT1S	2 (1)	ND			ND			ND			ND		
IT1D	2 (1)	ND			ND			ND			ND		
IT2S	2 (2)	ND			ND			ND			ND		
IT2D	1 (1)	ND			ND			ND			ND		
AGS Area													
556	4 (2)	ND			ND			ND			ND		
557	4 (2)	ND			ND			ND			ND		
558	4 (2)	ND			ND			ND			ND		
559	3 (1)	0.0004	ND	0.001	ND			ND			ND		
Bldg 650 Sump													
2E	1 (1)	ND			ND			ND			ND		
NYS Drinking Water Standards		0.100			0.100			0.100			0.100		
Typical MDL		0.003			0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
* Number inside parenthesis represents number of samples analyzed for bromoform; number outside parenthesis represents number of samples analyzed for all other parameters.

Table 92
BNL Site Environmental Report for Calendar Year 1989
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, BTX Data

Well ID	No. of Samples	benzene			toluene			xylene		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<--- mg/L --->								
Northtwest Sector										
560	4	ND			ND			0.0003	ND	0.001
561	3	ND			ND			ND		
IT1S	2	ND			ND			ND		
IT1D	2	ND			ND			ND		
IT2S	2	ND			ND			ND		
IT2D	1	ND			ND			ND		
AGS Area										
556	4	ND			ND			ND		
557	4	ND			ND			ND		
558	4	ND			ND			ND		
559	3	ND			ND			ND		
Bldg. 650 Sump										
2E	1	ND			ND			ND		
NYS Drinking Water Standards		0.005			0.005[a]			0.005[a]		
Typical MDL		0.002			0.002			0.002		

MDL: Minimum Detection Limit.
ND: Not Detected.
(a) NYSDOH standard adopted January 9, 1989.

Table 93
BNL Site Environmental Report for Calendar Year 1989
Rationale for Location of the 51 New Monitoring Wells

Well No.	Location	Screen Range Ft.	Depth to H2O Ft.	Well Location Rationale
12-01	N FIREBREAK/NE SECTION	20-40	26	BACKGROUND/PIEZOMETRIC
18-01	N OF RHIC	5-35	10	BACKGROUND/PIEZOMETRIC
18-02	N OF RHIC	65-85	10	BACKGROUND/PIEZOMETRIC
18-03	N.RHIC	130-150	10	BACKGROUND/PIEZOMETRIC
22-01	E FIREBREAK/NE SECTION	13-33	18	BACKGROUND/PIEZOMETRIC
37-01	FIREBREAK/SE OF RHIC	20-40	25	BACKGROUND/PIEZOMETRIC
38-01	NW OF STP	5-25	10	UPGRADIENT OF STP/PECONIC RIVER
39-05	PECONIC R/N OF STP POND #1	4-24	8	PECONIC RIVER/STP
47-03	FIREBREAK/SW OF STP	36-56	36	BACKGROUND/PIEZOMETRIC
58-01	FIREBREAK/S OF STP POND #2	5-25	10	BACKGROUND/PIEZOMETRIC/UPLAND RECHARGE/STP
64-01	INTERSECT OF COSMOTRON	25-55	43	AGS COMPLEX
65-01	SW COR.OF R.ROAD-RUTHERFORD	42-62	47	AGS COMPLEX/UPGRADIENT OF WCF
66-07	NE OF BLDG # 830	65-85	46	UPGRADIENT OF BLDG # 830/DOWN GRADIENT OF WELL #11
66-08	SE OF BLDG # 830	35-55	45	DOWNGRADIENT OF BLDG # 830
66-09	SE OF BLDG # 830	75-95	45	DOWNGRADIENT OF BLDG # 830/UPGRADIENT OF CSF (MPF PERMIT)
70-01	E FIREBREAK/E UPLAND RECHARGE	15-35	20	UPLAND RECHARGE AREA/PIEZOMETRIC
72-01	W OF BLDG # 51	36-56	42	DOWNGRADIENT OF RECHARGE BASIN
75-01	SW OF BLDG # 118	40-60	45	TCE SPILLS/PHYSICS BUBBLE CHAMBER EXPERIMENTS
75-02	E OF BLDG # 118	40-60	45	TCE SPILLS/PHYSICS BUBBLE CHAMBER EXPERIMENTS
75-03	SE OF BLDG # 725	60-90	35	VOCs (TCE) CONTAMINATION IN WELL #1
75-04	SE OF BLDG # 725	130-160	35	VOCs (TCE) CONTAMINATION IN WELL #1
80-02	E OF NORTH STREET	35-55	13	SITE BOUNDARY/DOWNGRADIENT OF PECONIC RIVER/PIEZOMETRIC
80-03	E OF NORTH STREET	75-95	13	SITE BOUNDARY/DOWNGRADIENT OF PECONIC RIVER/PIEZOMETRIC
83-01	NW OF BLDG # 422	70-100	51	SPRAY PAINTING SHOP/POTENTIAL FOR WELL #2 CONTAMINATION
83-02	S OF BLDG # 244	120-150	50	CARPENTER SHOP/PAINT SHOP CESSPOOL CONTAMINATION
84-01	SW OF MEDICAL PAVILION	55-85	70	BACKGROUND/PIEZOMETRIC
89-01	S OF MEADOW MARSH	10-30	16	DOWNGRADIENT OF MEADOW MARSH EFFLUENT DISCHARGE POINT
90-01	S OF MEADOW MARSH	15-35	17	DOWNGRADIENT OF MEADOW MARSH EFFLUENT DISCHARGE POINT
97-14	S OF LANDFILL	60-80	19.5	DOWNGRADIENT OF LANDFILL
98-33	FIRE BREAK/S OF HWM	60-80	17	DOWNGRADIENT OF LANDFILL
98-34	FIRE BREAK/S OF HWM	60-80	20	DOWNGRADIENT OF LANDFILL
99-04	SE OF HWMA	110-130	12	DOWNGRADIENT OF HWMA/TCE-TCA PLUME
99-05	W OF LILCO SUBSTATION	35-55	12	DOWNGRADIENT OF HWMA/TCE-TCA PLUME
99-06	W OF LILCO SUBSTATION	75-95	12	DOWNGRADIENT OF HWMA/TCE-TCA PLUME
100-03	N OF LILCO SUBSTATION	30-50	11	DOWNGRADIENT OF MEADOW MARSH EFFLUENT DISCHARGE POINT
101-01	MAIN GATE	45-65	50	SITE BOUNDARY/PIEZOMETRIC
107-07	FIREBREAK/SOUTH OF HWMA	93-113	29	DOWNGRADIENT OF LANDFILL
107-08	FIREBREAK/SOUTH OF HWMA	80-100	17	DOWNGRADIENT OF LANDFILL
107-09	FIREBREAK/S OF HWMA	80-100	17	DOWNGRADIENT OF LANDFILL
107-10	SE OF HWMA	110-130	14	DOWNGRADIENT OF LANDFILL/HWMA
108-13	RAILROAD Y/S FIREBREAK	45-65	25	DOWNGRADIENT OF LANDFILL/HWMA
108-14	RAILROAD Y/S FIREBREAK	85-105	25	DOWNGRADIENT OF LANDFILL/HWMA
115-01	S BOUNDARY INTERSECT	40-60	17	DOWNGRADIENT OF CURRENT/FORMER LANDFILL; SITE BOUNDARY/PIEZOMETRIC
115-02	S BOUNDARY INTERSECT	81-101	17	DOWNGRADIENT OF FORMER/CURRENT LANDFILL; SITE BOUNDARY/PIEZOMETRIC
115-03	S BOUNDARY INTERSECT	110-130	17	DOWNGRADIENT OF FORMER/CURRENT LANDFILL; SITE BOUNDARY/PIEZOMETRIC
118-01	FIREBREAK/S OF RES. TRAILERS	70-90	50	SITE BOUNDARY/RESIDENTIAL CESSPOOLS/PIEZOMETRIC
118-02	FIREBREAK/S OF RES. TRAILERS	110-130	50	SITE BOUNDARY/RESIDENTIAL CESSPOOLS/PIEZOMETRIC
122-01	CENTRAL SOUTH BOUNDARY	45-65	25	SITE BOUNDARY/PIEZOMETRIC
122-02	CENTRAL SOUTH BOUNDARY	85-105	25	SITE BOUNDARY/PIEZOMETRIC
130-01	SOUTH GATE	50-80	48	SITE BOUNDARY/PIEZOMETRIC
130-02	SOUTH GATE	105-125	48	SITE BOUNDARY/PIEZOMETRIC

Table 94
BNL Site Environmental Annual Report for Calendar Year 1989
Water Quality Data for Wells Installed in 1989

Location	No. of Samples	pH Range (SU)	Conductivity Avg.	Conductivity Min.	Conductivity Max.	Temperature Avg.	Temperature Min.	Temperature Max.	Dissolved Oxygen Avg.	Dissolved Oxygen Min.	Dissolved Oxygen Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
			<------ umhos/cm ---->			<--------- °C ---------->			<---------- mg/L											---------->
18-01	1	5.4	48.0			13.0			2.8			11.2			6.9			-1.0		
18-02	1	5.6	46.0			11.0			7.8			-4.0			10.9			-1.0		
18-03	1	6.7	156.0			12.0			9.8			11.7			11.9			1.2		
38-01	1	4.3	60.0			12.0			5.9			-4.0			20.2			-1.0		
39-05	1	5.5	76.0			9.0			4.6			13.2			9.0			-1.0		
65-01	1	5.9	388.0			16.0			1.9			43.7			11.9			1.3		
66-07	1	6.1	124.0			15.0			9.9			20.6			16.4			-1.0		
66-08	3 (2)	5.7 - 7.0	105.7	100	110	15.7	15	16	9.9	9.2	10.6	12.4	11	13.8	16.2	16	16.4	1.1	1	1.1
66-09	1	6.7	118.0			16.0			10.0			18.9			15.7			-1.0		
75-01	1	6.7	353.0			12.0			12.5			31.5			28.0			4.4		
75-02	1	6.1	347.0			14.0			8.9			34.6			62.3			4.8		
75-03	1	6.0	65.0			12.0			7.4			10.4			7.2			-1.0		
75-04	1	5.1	81.0			13.0			9.6			16.4			17.6			-1.0		
76-16	1	6.0	120.0			19.0			9.6			12.8			15.8			4.1		
76-17	1	6.0	140.0			16.0			9.8			11.1			23.0			2.2		
76-18	1	7.0	100.0			15.0			5.6			6.1			22.2			1.7		
76-19	1	6.0	100.0			16.0			6.4			12.4			24.1			-1.0		
76-20	1	6.1	199.0			13.0			9.9			26.8			30.8			1.8		
76-21	1	6.0	67.0			13.0			7.4			9.1			15.7			-1.0		
76-22	1	6.3	117.0			12.0			7.6			21.3			16.9			-1.0		
83-01	1	6.5	86.0			11.0			9.1			19.5			14.2			-1.0		
83-02	1	6.1	108.0			12.0			4.6			14.6			14.9			-1.0		
89-01	1	5.7	69.0			12.0			15.3			-4.0			13.3			1.9		
90-01	1	5.6	69.0			12.0			11.0			5.0			10.8			2.3		
97-14	1	5.6	93.0			13.0			4.0			18.6			9.4			-1.0		
98-33	1	5.9	247.0			11.0			3.2			25.2			17.9			-1.0		
98-34	1	6.1	406.0			11.0			2.3			32.3			15.0			-1.0		
101-01	1	5.8	204.0			10.0			12.1			60.0			18.5			1.2		
107-07	1	6.1	308.0			11.0			5.6			40.2			16.5			-1.0		
107-08	1	6.4	175.0			10.0			3.4			21.4			16.0			-1.0		
107-09	1	6.9	116.0			12.0			7.0			14.2			6.0			-1.0		
107-10	1	6.2	89.0			12.0			11.4			14.0			26.6			-1.0		
108-13	1	4.8	63.0			9.0			9.1			8.5			15.9			-1.0		
108-14	1	5.8	71.0			9.0			73.0			14.0			10.3			-1.0		
115-03	1	6.1	56.0			10.0			7.3			6.4			21.4			-1.0		
130-01	1	5.2	64.0			7.0			12.0			13.1			11.4			-1.0		
130-02	1	9.3	167.0			9.0			6.7			28.4			20.2			1.3		
NYS Drinking Water Standard		6.5 - 8.5	(a)			(a)			(a)			250.0			250.0			10.0		

Value in parenthese for number of samples indicates the number of samples analyzed for chlorides, sulfates and nitrates.

Table 95
BNL Site Environmental Report for Calendar Year 1989
Metals Analytical Results for New Monitoring Wells Installed During 1989

Well #	Location	Screen Range Ft.	Depth to H2O Ft.	BA	CN-	CR	HG	PB	CU	FE	MN	NA	ZN	AL	CA	CO	MG	NI
				Primary Metals - Regulated For Health Based Concerns ug/L					Secondary Metals - Regulated For Nuisance Or Aesthetic Concerns ug/L					Metals For Which No Standards Are Promulgated ug/L				
12-01	N FIREBREAK/NE SECTION	20-40	26	BDL	BDL	BDL	BDL	6.9	29	1800	100	5800	34	1300	BDL	BDL	BDL	BDL
18-01	N OF RHIC	5-35	10	BDL	BDL	BDL	BDL	7.1	230	7500	230	6200	58	3100	5300	BDL	BDL	BDL
18-02	N OF RHIC	65-85	10	BDL	BDL	BDL	BDL	4.5	62	590	170	7100	42	BDL	5100	BDL	BDL	BDL
18-02	DUPLICATE	65-85	10	BDL	BDL	BDL	BDL	9.9	62	830	180	6700	48	BDL	5400	BDL	BDL	BDL
18-03	N.RHIC	130-150	10	BDL	BDL	BDL	BDL	5.5	BDL	1100	77	11000	75	500	18000	BDL	7200	BDL
22-01	E FIREBREAK/NE SECTION	13-33	18	BDL	BDL	BDL	BDL	4.7	43	520	26	5300	34	460	BDL	BDL	BDL	BDL
37-01	FIREBREAK/SE OF RHIC	20-40	25	BDL	BDL	BDL	14	12	59	1100	740	7900	200	850	6000	BDL	BDL	BDL
38-01	NW OF STP	5-25	10	BDL	BDL	BDL	BDL	7.6	57	4900	200	6400	41	3900	BDL	BDL	BDL	BDL
39-05	PECONIC R/N OF STP POND #1	4-24	8	BDL	BDL	BDL	BDL	6.9	42	470	44	11000	95	BDL	BDL	BDL	BDL	BDL
47-03	FIREBREAK/SW OF STP	36-56	36	BDL	BDL	BDL	BDL	5.9	BDL	550	31	6000	42	680	BDL	BDL	BDL	BDL
58-01	FIREBREAK/S OF STP POND # 2	5-25	10	BDL	BDL	BDL	23	12	47	5800	270	7400	95	3200	BDL	BDL	BDL	BDL
58-01	DUPLICATE	5-25	10	BDL	BDL	BDL	19	11	BDL	5100	260	7000	55	2700	BDL	BDL	BDL	BDL
64-01	INTERSECT OF COSMOTRON	25-55	43	BDL	BDL	BDL	BDL	4.8	61	660	39	22000	93	330	20000	BDL	BDL	BDL
65-1(D-8)	WCF - NW CORNER	42-62	47	BDL	BDL	12	BDL	8.2	38	150	7700	18000	88	BDL	7600	16	BDL	BDL
66-07	NE OF BLDG# 830	65-85	46	BDL	BDL	BDL	BDL	5.1	59	740	22	22000	62	BDL	BDL	BDL	BDL	BDL
66-08	SE OF BLDG# 830	35-55	45	BDL	BDL	19	BDL	9	29	390	36	12000	91	BDL	7900	BDL	BDL	BDL
66-09	SE OF BLDG.# 830	75-95	45	BDL	BDL	14	BDL	9.5	43	270	28	20000	55	BDL	5100	BDL	BDL	BDL
70-01	E FIREBREAK/E UPLAND RECHARGE	15-35	20	BDL	BDL	BDL	BDL	11	290	4500	440	7700	170	3400	BDL	BDL	BDL	50
72-01	W OF BLDG. #51	36-56	42	BDL	BDL	BDL	BDL	BDL	30	310	100	8300	110	340	BDL	BDL	BDL	BDL
75-01	SW OF BLDG. # 118	40-60	45	BDL	BDL	BDL	BDL	8.2	120	630	34	24000	100	300	28000	BDL	BDL	120
75-02	E OF BLDG.# 118	40-60	45	BDL	10	BDL	BDL	5.5	BDL	670	51	28000	39	240	23000	BDL	BDL	BDL
75-04	SE OF BLDG.# 725	130-160	35	BDL	BDL	BDL	BDL	14	BDL	2800	270	40000	70	3500	7100	BDL	BDL	BDL
80-02	E OF NORTH STREET	35-55	13	BDL	BDL	BDL	BDL	8.8	BDL	490	23	6400	56	260	BDL	BDL	BDL	BDL
80-03	E OF NORTH STREET	75-95	13	BDL	BDL	BDL	BDL	7.1	52	170	BDL	7700	58	BDL	BDL	BDL	BDL	BDL
83-01	NW OF BLDG.# 422	70-100	51	BDL	10	18	BDL	8.1	27	350	50	16000	120	BDL	6700	BDL	BDL	BDL
83-02	S OF BLDG. # 244	120-150	50	BDL	BDL	BDL	BDL	6.5	BDL	1300	400	18000	45	410	6900	BDL	BDL	BDL
84-01	SW OF MEDICAL PAVILION	55-85	70	BDL	BDL	BDL	BDL	19	BDL	1800	54	7500	63	280	BDL	BDL	BDL	BDL
89-01	S OF MEADOW MARSH	10-30	16	BDL	BDL	BDL	BDL	4.6	BDL	280	87	BDL	44	BDL	7100	BDL	BDL	BDL
90-01	S OF MEADOW MARSH	15-35	17	BDL	BDL	BDL	BDL	5.1	BDL	100	55	5000	68	BDL	7000	BDL	BDL	BDL
97-14	S OF LANDFILL	60-80	19.5	BDL	BDL	BDL	BDL	BDL	BDL	200	250	5200	44	BDL	BDL	BDL	BDL	BDL
98-33	FIRE BREAK/S OF HWM	60-80	17	BDL	BDL	BDL	BDL	BDL	BDL	460	7900	5200	43	240	6900	BDL	BDL	BDL
98-34	FIRE BREAK/S OF HWM	60-80	20	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3400	7200	91	BDL	8300	BDL	BDL	BDL
99-04	DUPLICATE	110-130	12	BDL	BDL	BDL	BDL	BDL	BDL	180	BDL	BDL	66	BDL	BDL	BDL	BDL	BDL
99-04	SE OF HWMA	110-130	12	BDL	BDL	BDL	BDL	BDL	BDL	160	BDL	BDL	53	BDL	BDL	BDL	BDL	BDL
99-05	W OF LILCO SUBSTATION	35-55	12	BDL	BDL	BDL	BDL	BDL	BDL	6000	240	BDL	75	2100	BDL	BDL	BDL	BDL
99-06	W OF LILCO SUBSTATION	75-95	12	BDL	BDL	BDL	BDL	BDL	BDL	470	59	BDL	61	240	BDL	BDL	BDL	BDL
100-03	N OF LILCO SUBSTATION	30-50	11	BDL	BDL	BDL	BDL	7.6	BDL	1900	120	5900	75	1400	BDL	BDL	BDL	BDL
107-09	DUPLICATE	80-100	17	BDL	BDL	BDL	BDL	5	BDL	200	130	12000	63	90	6600	BDL	BDL	BDL
107-09	FIREBREAK/S OF HWMA	80-100	17	BDL	BDL	BDL	BDL	6.1	BDL	1300	130	11000	91	100	6600	BDL	BDL	BDL
107-10	SE OF HWMA	110-130	14	BDL	BDL	BDL	BDL	BDL	190	200	76	10000	80	BDL	BDL	BDL	BDL	BDL
108-13	RAILROAD Y/S FIREBREAK	45-65	25	BDL	BDL	BDL	BDL	3.4	BDL	1400	180	BDL	150	850	BDL	BDL	BDL	BDL
108-14	RAILROAD Y/S FIREBREAK	85-105	25	BDL	BDL	BDL	BDL	3.4	BDL	290	120	BDL	170	BDL	BDL	BDL	BDL	40
115-01	S BOUNDARY INTERSECT	40-60	17	BDL	BDL	BDL	BDL	BDL	BDL	2100	320	8100	51	600	BDL	BDL	BDL	BDL
115-02	S BOUNDARY INTERSECT	81-101	17	BDL	BDL	BDL	0.85	BDL	25	810	68	6400	67	600	BDL	BDL	BDL	BDL
115-03	S BOUNDARY INTERSECT	110-130	17	BDL	BDL	BDL	BDL	BDL	BDL	250	96	10000	43	240	BDL	BDL	BDL	BDL
118-01	FIREBREAK/S OF RES. TRAILERS	70-90	50	BDL	BDL	BDL	BDL	8.4	BDL	1800	220	17000	78	1100	5000	BDL	BDL	BDL
118-02	FIREBREAK/S OF RES. TRAILERS	110-130	50	BDL	BDL	BDL	BDL	5	33	220	400	13000	88	180	7200	BDL	BDL	BDL
122-01	CENTRAL SOUTH BOUNDARY	45-65	25	BDL	BDL	BDL	BDL	11	BDL	1600	210	7300	110	1200	BDL	BDL	BDL	BDL
122-02	CENTRAL SOUTH BOUNDARY	85-105	25	BDL	BDL	BDL	BDL	8.2	BDL	1700	410	16000	98	740	6500	BDL	BDL	BDL
130-01	SOUTH GATE	50-80	48	BDL	BDL	BDL	BDL	16	BDL	1900	350	15000	170	1100	BDL	BDL	BDL	BDL
	DETECTION LIMITS(ug/L) BDL: BELOW DETECTION LIMIT			200	10	10	0.2	3	25	100	15	5000	20	50*	5000	7*	5000	40
	NYSDWL (ug/L); Part 5 NYS Sanitary Code			1000	200	50	2	50	200**	300	300	270000	5000	NL	NL	NL	NL	NL

NL = Not Listed

* These detection limits are instrument detection limits(IDL). IDLs are lower than the CRDL which has been reported in other analytes in this table. IDLs are because the CRDL for aluminum and cobalt are in excess of the NYSDWS.

** Two limits were listed. The 200 ug/L value is reported in NYSCRR Part 170. In NYSCRR Part 5, the limit is listed as 1000 ug/L. The most restrictive value is reported here.

Table 96
BNL Site Environmental Report for Calendar Year 1989
Organic Analytical Results for New Monitoring Wells

Well No.	Location	Sample Collect Date	Screen Range Ft.	Depth to H2O Ft.	Diphenyl ether	TCA	1,1Di-Chloro ethylene	Chloro-form	Acetone	Phenol	Benzene	Toluene	Chloro-ethane	1,1,di-chloro-ethane	Methyl-chloride	TCE
					<----	----	----	----	----	----	µg/L	----	----	----	----	---->
18-02	NORTH OF RHIC	11/89	65-85	10	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
18-03	NORTH OF RHIC	9/89	130-150	10	BDL	3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
		11/89			NA	7	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
38-01	NW OF STP	11/89	5-25	10	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
39-05	PECONIC R/N OF STP POND#1	11/89	4-24	8	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
64-01	ITERSECT COSMOS/	9/89	25-55	43	BDL	17	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
65-01(D8)	WCF NW CORNER	9/89	42-62	47	BDL	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
65-01	SW COR. R.ROAD-RUTHERFORD	11/89	42-62	47	NA	3.23	NA	BDL	BDL	NA	2.13	BDL	NA	NA	BDL	BDL
66-07	NORTHEAST OF BLDG.#830	11/89	65-85	46	NA	BDL	NA	0.99	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
66-08	SOUTHEAST OF BLDG.#830	11/89	35-55	45	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
66-09	SOUTHEAST OF BLDG.#830	9/89	75-95	45	BDL	BDL	BDL	BDL	BDL	19	BDL	BDL	BDL	BDL	BDL	BDL
		11/89			NA	BDL	NA	0.98	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
70-01	E FIREBREAK/E UPLAND	11/89	15-35	20	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
75-01	WEST OF BLDG.#51	11/89	40-60	45	NA	1.6	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
75-02	EAST OF BLDG.#118	9/89	40-60	45	BDL	15	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
		11/89			NA	21	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
75-03	SE OF BLDG.#725	9/89	60-90	35	BDL	15	BDL	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
		11/89			NA	BDL	NA	0.9	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
75-04	SE OF BLDG.#725	11/89	130-160	35	NA	6.8	NA	3.06	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
83-02	SOUTH OF BLDG.#244	9/89	120-150	50	BDL	BDL	BDL	BDL	60	BDL	BDL	BDL	BDL	BDL	BDL	BDL
		11/89			NA	10.1	NA	1.41	>80	NA	BDL	BDL	NA	NA	BDL	NA
89-01	S OF MEADOW MARSH	11/89	10-30	16	NA	BDL	NA	BDL	25.9	NA	BDL	BDL	NA	NA	BDL	BDL
89-01F	FIELD DUPLICATE	11/89			NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
98-33	FIREBREAK/S OF HWMA	9/89	60-80	17	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18	6	BDL	BDL
		11/89			NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
98-34	FIREBREAK/S OF HWMA	9/89	60-80	20	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	15	7	BDL	BDL
		11/89			NA	BDL	NA	BDL	BDL	NA	3.04	BDL	NA	NA	BDL	NA
101-01	MAIN GATE	11/89	45-65	50	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
107-07	FIREBREAK/S OF HWMA	9/89	93-113	29	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	55	BDL
		11/89			NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
107-08	FIREBREAK/S OF HWMA	9/89	80-100	17	9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7	BDL	5
		11/89			NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
107-09	FIREBREAK/S OF HWMA	11/89	80-100	17	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
107-10	SE OF HWMA	11/89	110-130	14	NA	1.46	NA	1.27	BDL	NA	BDL	BDL	NA	NA	BDL	NA
108-13	RAILROAD Y/S OF FIREBREAK	9/89	45-65	25	BDL	20	BDL	BDL	BDL	BDL	3	4	BDL	BDL	BDL	BDL
		11/89			NA	14.2	NA	BDL	BDL	NA	0.95	3.48	NA	NA	BDL	BDL
108-14	RAILROAD Y/S OF FIREBREAK	9/89	85-105	25	BDL	BDL	BDL	BDL	160	BDL	4	5	BDL	BDL	BDL	BDL
		11/89			NA	BDL	NA	1.05	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
115-01	S BOUNDARY/EXPY/RAILROAD	9/89	40-60	17	BDL	BDL	BDL	6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
115-03	S BOUNDARY/EXPY/RAILROAD	11/89	110-130	17	NA	BDL	NA	1.35	BDL	NA	BDL	BDL	NA	NA	BDL	NA
130-01	SOUTHGATE	11/89	50-80	48	NA	BDL	NA	BDL	BDL	NA	BDL	BDL	NA	NA	BDL	BDL
130-02	SOUTHGATE	9/89	105-125	48	BDL	11	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
		11/89			NA	11.4	NA	1.23	BDL	NA	BDL	BDL	NA	NA	BDL	4.32

BDL = BELOW DETECTION LIMIT

Table 97
BNL Site Environmental Report for Calendar Year 1989
Metals Analytical Results for Landfill Soil Samples

al	CL-1 0-6"	CL-1 5-7'	CL-1 20-22'	CL-2 0-6"	CL-2 3-5'	CL-2 9-11'	CL-3 0-6"	CL-3 3-5'	CL-3 5-7'	CL-4 0-6"	CL-4 0-6" Dup	CL-4 3-5'	Det.Lim (ppm)
	<------						mg/Kg (ppm)					------>	
	6300	1600	640	4400	10,000	3200	12,000	6900	11000	2400	3400	7500	4000/D.W
	2.0	BDL	BDL	BDL	3.0	BDL	7.4	6.3	4.0	BDL	BDL	3.1	100/D.W
	BDL	BDL	BDL	6500	2400	1000	4800	1900	1500	17,000	BDL	1100	100000/D.W
	6.7	2.6	4.1	4.8	12	6.1	10	10	14	2.3	5.2	9.5	200/D.W
	8.7	BDL	4.5	17	18	14	21	28	28	9.7	11	9.9	500/D.W
	6400	2100	1800	7100	8300	8000	14,000	6000	10,000	4700	5200	6100	2000/D.W
	3.6	2.7	3.6	3.8	13	3.8	3.3	6.2	5.5	8.7	8.1	12	20/D.W
	BDL	BDL	BDL	3200	2300	BDL	3200	1800	2800	10,000	BDL	1300	
000/D.W													
	74	33	52	200	70	200	270	82	110	71	75	46	300/D.W
	BDL	3.1	7.7	12	8.6	BDL	12	14	12	BDL	BDL	BDL	800/D.W
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1200	1200	BDL	BDL	BDL	
000/D.W													
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
000/D.W													
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.9	BDL	BDL	BDL	200/D.W
	12	BDL	BDL	17	20	10	27	14	22	BDL	BDL	13	1000/D.W
	36	20	27	78	44	24	150	66	64	68	88	28	400/D.W
	BDL	BDL	BDL	BDL	BDL	BDL	0.2	BDL	BDL	BDL	BDL	BDL	4/D.W
nide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Wt(%) W.)	96	97	98	85	85	93	72	81	79	84	83	88	

BNL Site Environmental Report for Calendar Year 1989
Metals Analytical Results for Landfill Soil Samples

al	CL-5 0-6"	CL-5 3-5'	CL-5 9-11'	CL-6 0-6"	CL-6 3-5'	CL-6 9-11'	CL-7 0-6"	CL-7 5-7'	CL-7 15-17'	CL-8 0-6"	CL-8 5-7'	CL-8 15-17'	Det.Lim (ppm)
	<------						mg/Kg (ppm)					------>	
	6200	7500	6700	2400	1400	1800	5100	820	660	7300	2000	840	4000/D.W
	3.0	BDL	BDL	BDL	BDL	2.2	BDL	BDL	BDL	4.7	2.7	BDL	100/D.W
	12,000	1400	1300	1400	1100	1600	1200	900	960	BDL	1100	BDL	
000/D.W													
	7.7	12	8.1	4.5	4.7	28	2.9	3.0	3.9	8.7	3.5	2.8	200/D.W
	67	16	17	26	63	71	27	6.9	6.5	11	34	9.4	500/D.W
	5800	7800	10,000	3500	2300	3400	7700	1400	1300	6500	2700	1400	2000/D.W
	9.4	6.1	7.6	4.8	BDL	BDL	5.1	2.0	2.1	9.8	1.2	BDL	20/D.W
	7200	1800	2000	BDL	BDL	BDL	1600	BDL	BDL	BDL	BDL	BDL	
000/D.W													
	76	71	150	25	20	60	77	30	27	48	35	23	300/D.W
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	31	BDL	BDL	800/D.W
	BDL	BDL	BDL	1000	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
000/D.W													
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
000/D.W													
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	200/D.W
	12	20	18	BDL	BDL	BDL	26	BDL	BDL	12	BDL	BDL	1000/D.W
	44	34	35	120	31	27	30	16	20	40	15	14	400/D.W
	BDL	BDL	BDL	BDL	0.2	BDL	BDL	BDL	0.4	0.2	BDL	BDL	4/D.W
ide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Wt(%) .)	89	85	76	91	94	92	98	97	97	96	97	96	

Table 97 (Continued)
BNL Site Environmental Report for Calendar Year 1989
Metals Analytical Results for Landfill Soil Samples

Metal	CL-9 0-6"	CL-9 5-7'	CL-9 15-17'	CL-10 0-6"	CL-10 3-5'	CL-10 5-7'	CL-11 0-6"	CL-11 9-11'	CL-12 0-6'	CL-12 3-5'	CL-12 5-7'	Det.Lim (ppm)
	<----------						mg/Kg (ppm)				---------->	
Al	6400	4700	7300	1200	3200	42,000	4000	1500	6500	7000	8100	4000/D.W
As	3.9	5.0	14	BDL	BDL	BDL	2.0	3.1	3.3	4.7	BDL	100/D.W
Ca	920	1200	1100	BDL	1100	8700	BDL	BDL	1900	1000	1400	100000/D.W
Cr	7.8	5.7	9.1	5.7	5.5	49	7.1	2.4	7.7	9.5	10	200/D.W
Cu	17	19	12	7.6	9.5	160	11	12	28	14	17	500/D.W
Fe	8100	4600	8300	2600	3600	45,000	4700	2300	7200	8800	11,000	2000/D.W
Pb	3.8	1.7	1.8	4.0	5.4	10	2.5	0.9	12	7.0	9.8	20/D.W
Mg	BDL	BDL	1100	BDL	BDL	7300	BDL	BDL	1500	1500	2400	100000/D.W
Mn	140	28	95	BDL	28	420	59	27	92	91	140	300/D.W
Ni	BDL	BDL	BDL	150	BDL	BDL	11	13	9.2	BDL	BDL	800/D.W
Na	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
K	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1200	100000/D.W
Tl	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDl	BDL	BDL	BDL	200/D.W
V	13	BDL	13	BDL	BDL	82	BDL	BDL	13	19	18	1000/D.W
Zn	48	24	26	60	32	970	49	24	39	29	51	400/D.W
Hg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4/D.W
Cyanide	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Dry Wt(%) (D.W.)	89	90	90	96	93	92	94	95	88	84	80	

BNL Site Environmental Report for Calendar Year 1989
Metals Analytical Results for Landfill Soil Samples

Metal	CL-13 0-6"	CL-13 1-3'	CL-13 8-10'	CL-14 0-6"	CL-14 3-5'	CL-14 7-9'	CL-15 0-6"	CL-15 3-5'	CL-15 5-7'	Det.Lim (ppm)
	<----------					mg/Kg (ppm)			---------->	
Al	5000	7000	13,000	6100	7300	12,000	7200	7600	9800	4000/D.W
As	BDL	3.2	6.8	6.6	9.0	5.6	3.9	4.7	BDL	100/D.W
Ca	BDL	BDL	BDL	1000	1300	BDL	3000	1600	1500	100000/D.W
Cr	6.4	9.2	16	8.1	9	14	7.1	15	13	200/D.W
Cu	5.4	7.2	23	5.5	8	18	16	17	22	500/D.W
Fe	4600	6100	17,000	5500	8900	16,000	9500	4700	7900	2000/D.W
Pb	6.6	7.5	11	1.1	1.6	8.3	2.3	4.7	17	20/D.W
Mg	BDL	BDL	3900	BDL	2300	3600	2300	1400	2400	100000/D.W
Mn	71	56	250	57	79	220	100	77	100	300/D.W
Ni	BDL	BDL	17	BDL	10	18	23	13	11	800/D.W
Na	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
K	BDL	BDL	1900	BDL	BDL	1600	BDL	BDL	1200	100000/D.W
Tl	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.0	BDL	200/D.W
V	BDL	11	27	10	20	26	17	10	19	1000/D.W
Zn	25	26	60	23	32	59	68	45	49	400/D.W
Hg	BDL	BDL	BDL	BDL	BDL	0.2	BDL	BDL	BDL	4/D.W
Cyanide	1.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Dry Wt(%) (D.W.)	89	85	78	92	80	92	92	85	78	

Table 98
BNL Site Report for Calendar Year 1989
Organic* Analytical Results for Landfill Soil Samples

Compound	g/kg (ppb)** CL-1 0-6"	CL-2 0-6"	CL-3 0-6"	CL-3 3-5'	CL-3 5-7'	CL-5 0-6"	CL-5 3-5'	CL-6 0-6"	CL-7 15-17"
Isophorone	370	BDL	420	BDL	BDL	BDL	BDL	BDL	BDL
Phenanthrene	2400	200	660	BDL	BDL	1200	290	BDL	BDL
Anthracene	370	BDL	BDL	BDL	BDL	380	BDL	BDL	BDL
Fluoranthene	2300	430	1600	450	BDL	1800	320	290	BDL
Pyrene	1800	350	1500	420	BDL	1500	240	280	BDL
Benzo(a)anthracene	830	260	820	230	BDL	790	BDL	BDL	BDL
Chrysene	950	310	950	250	BDL	820	BDL	BDL	BDL
Benzo(b)fluoranthene	790	250	1000	250	BDL	640	BDL	BDL	BDL
Benzo(k)fluoranthene	620	250	760	210	BDL	570	BDL	BDL	BDL
Benzo(a)pyrene	740	260	910	240	BDL	680	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	460	BDL	600	BDL	BDL	490	BDL	BDL	BDL
Benzo(g,h,i)perylene	440	BDL	670	BDL	BDL	600	BDL	BDL	BDL
Bis-(2-ethylhexyl)phthlate	5300	BDL	BDL	BDL	71,000	BDL	BDL	BDL	430
Percent Dry Weight (D.W.)	96	85	72	81	79	92	86	89	97
Typical Det.Limits (CRQL) g/Kg	330 x 100/ D.W.								

BDL = Below Detection Limit

* In most of the samples, other extraneous compounds, which are not CLP target compounds, are also identified.

** Compounds which are detected at concentrations that are between the instrument detection limit (IDL) and the method detection limit (CRQL) are also reported. Concentrations of those compounds may not be accurate but compound identification is correct.

BNL Site Report for Calendar Year 1989
Organic Analytical Results for Landfill Soil Samples

Compound	g/Kg (ppb)** CL-8 0-6"	CL-9 0-6"	CL-11 0-6"	CL-13 0-6"	CL-14 0-6"	CL-14 3-5'	CL-15 0-6"	CL-15 3-5'
Isophorone	BDL	BDL	BDL	430	400	BDL	BDL	BDL
Phenanthrene	2100	BDL	430	BDL	BDL	690	690	BDL
Anthracene	830	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	5400	390	550	290	540	560	1600	BDL
Pyrene	4000	340	520	290	490	510	1400	BDL
Benzo(a)anthracene	2500	210	BDL	BDL	270	260	770	BDL
Chrysene	2600	240	BDL	190	290	260	880	BDL
Benzo(b)fluoranthene	2000	260	BDL	250	380	220	820	BDL
Benzo(k)fluoranthene	1900	190	BDL	BDL	200	210	630	BDL
Benzo(a)pyrene	2200	BDL	BDL	BDL	290	210	780	BDL
Indeno(1,2,3-cd)pyrene	1400	BDL	BDL	210	280	BDL	600	BDL
Benzo(g,h,i)perylene	1400	BDL	BDL	BDL	300	BDL	580	BDL
Bis-(2-ethylhexyl)phthlate	BDL	BDL	BDL	1100	BDL	BDL	BDL	1500
Percent Dry Weight (D.W.)	97	92	94	89	92	80	92	85
Typical Det.Limits (CRQL) g/Kg	330 x 100/ D.W.							

BDL = Below Detection Limit

* In most of the samples, other extraneous compounds, which are not CLP target compounds, are also identified.

** Compounds which are detected at concentrations that are between the instrument detection limit (IDL) and the method detection limit (CRQL) are also reported. Concentrations of those compounds may not be accurate but compound identification is correct.

Table 99
BNL Site Environmental Annual Report for Calendar Year 1989
HWMA Soil Samples (Metals)
mg/Kg(ppm)

Metal	HWS-1 0-6"	HWS-1 1-3'	HWS-2 0-6"	HWS-2 2-4'	HWS-3 0-6"	HWS-3 1-3'	HWS-5 0-6"	HWS-5 1-3'	HWS-6 0-6"	HWS-6 1-3'	HWS-7 0-6"	HWS-7 1-3'	Det.Lim (ppm)
Al	5500	5700	3900	4200	8600	5700	6100	2900	8600	7000	8600	6500	4000/D.W
As	BDL	3.9	3.2	BDL	5.5	BDL	2.8	BDL	6.6	4.9	BDL	4.2	100/D.W
Ca	1400	1900	1500	1200	1600	1300	1600	1300	1600	1400	1500	1200	100000/D.W
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Cr	5.6	11	6.8	5.4	7.7	6.1	5.1	3.9	7.7	6.7	8.4	7.4	200/D.W
Cu	24	15	12	10	14	8.0	13	10	12	7.2	8.6	7.9	500/D.W
Fe	5100	1400	3500	2000	7000	2100	5000	1700	6400	3200	6400	2600	2000/D.W
Pb	11	12	14	10	8.0	10	9.0	4.3	7.4	7.1	5.9	7.2	20/D.W
Mg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
Mn	64	18	20	18	47	25	33	17	35	30	50	20	300/D.W
Ni	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	800/D.W
Na	BDL	1200	BDL	BDL	BDL	1100	1200	1200	1200	1200	1200	1100	100000/D.W
V	BDL	BDL	BDL	BDL	14	BDL	BDL	BDL	15	BDL	14	BDL	1000/D.W
Zn	28	51	33	19	26	21	33	50	32	21	24	27	400/D.W
Ba	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4000/D.W
	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	200/D.W
%Dry Wt. (D.W.)	90	88	82	86	82	85	86	88	81	89	84	89	

BDL= Below Detection Limit

HWMA Soil Samples (Metals)
mg/Kg(ppm)

Metal	HWS-8 0-6"	HWS-8 1-3'	HWS-9 0-6"	HWS-9 1-3'	HWS-10 0-6"	HWS-10 3-4'	HWS-11 0-6"	HWS-12 0-6"	HWS-12 2-4'	HWS-13 0-6"	HWS-13 3-5'	HWS-14 0-6"	HWS-14 2-4'	Det.Lim (ppm)
Al	8400	4000	7900	3200	3300	8100	7000	7900	6500	3300	7400	7500	9700	4000/D.W
As	8.4	5.0	6.8	4.2	19	13	9.4	9.1	9.1	2.9	8.6	9.5	11	100/D.W
Ca	1500	1400	1200	1200	BDL	BDL	BDL	2700	BDL	BDL	BDL	2200	BDL	100000/D.
Cd	BDL	1.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100/D.W
Cr	8.0	9.8	7.7	3.0	BDL	8.3	9.6	8.9	8.0	6.2	11	5.9	11	200/D.W
Cu	12	14	9.4	5.7	73	10	12	9.7	8.5	BDL	8.2	32	8.1	500/D.W
Fe	6400	3600	6300	1000	18,000	6600	4100	8100	5400	1700	3700	11,000	6900	2000/D.W
Pb	6.7	7.3	19	1.5	26	6.1	7.9	8.1	4.9	8.5	4.8	16	5.2	20/D.W
Mg	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2100	BDL	BDL	BDL	BDL	BDL	100000/D.
Mn	34	52	32	9.8	20	33	24	84	99	8.3	26	190	34	300/D.W
Ni	BDL	9.3	BDL	BDL	16	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	800/D.W
Na	1200	1200	BDL	1200	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.
V	16	13	13	BDL	25	BDL	BDL	15	BDL	BDL	BDL	16	14	1000/D.W
Zn	28	19	26	19	28	27	37	36	19	18	63	49	22	400/D.W
Ba	BDL	BDL	BDL	BDL	290	46	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4000/D.W
Ag	BDL	6.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	200/D.W
%Dry Wt. (D.W.)	84	88	90	88	70	87	75	77	89	81	84	78	90	

BDL= Below Detection Limit

HWMA Soil Samples (Metals)
mg/Kg(ppm)

	HWS-15 0-6"	HWS-15 0-6" dup	HWS-15 3-5'	HWS-16 0-6"	HWS-16 2-4'	HWS-17 0-6"	HWS-4 0-6"	HWS-4 1-3'	Det.Lim (ppm)
Al	5600	5200	6000	8200	7200	7600	3200	8200	4000/D.W
As	7.4	7.8	8.6	9.1	7.8	8.9	2.4	9.9	100/D.W
Ca	2200	2200	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
Cd	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.6	100/D.W
Cr	7.2	6.8	10	9.1	7.7	9.4	7.0	11	200/D.W
Cu	6.8	5.9	9.3	BDL	7.6	BDL	6.9	BDL	500/D.W
Fe	4100	3800	4600	4100	5800	6300	3400	7200	2000/D.W
Pb	13	11	5.0	4.3	14	12	3.7	16	20/D.W
Mg	1300	1100	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
Mn	43	30	42	32	51	29	29	44	300/D.W
Ni	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.2	800/D.W
Na	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100000/D.W
V	BDL	BDL	13	11	15	14	BDL	14	1000/D.W
Zn	33	30	35	35	35	35	23	28	400/D.W
Ba	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4000/D.W
Ag	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	200/D.W
%Dry Wt. (D.W.)	79	82	84	93	84	84	90	87	

BDL = Below Detection Limit

Table 100
BNL Site Environmental Report for Calendar Year 1989
HWMA Soil Analysis (Organic)*

Compound	µg/Kg (ppb)					
	HWS-3 0-6"	HWS-3 1-3'	HWS-10 3-4'	HWS-14 0-6"	HWS-14 2-4'	HWS-16 2-4'
Phenanthrene	BDL	BDL	1800	2300	BDL	BDL
Anthracene	BDL	BDL	500	BDL	BDL	BDL
Fluoranthene	BDL	BDL	1600	3400	BDL	BDL
Pyrene	BDL	BDL	1900	4200	BDL	BDL
Benzo(a)anthracene	BDL	BDL	740	1500	BDL	BDL
Chrysene	BDL	BDL	850	2200	BDL	BDL
Benzo(b)fluoranthene	BDL	BDL	620	2000	BDL	BDL
Benzo(k)fluoranthene	BDL	BDL	430	1400	BDL	BDL
Benzo(a)pyrene	BDL	BDL	640	1600	BDL	BDL
Indeno(1,2,3-cd)pyrene	BDL	BDL	460	1300	BDL	BDL
Benzo(g,h,i)perylene	BDL	BDL	500	1600	BDL	BDL
Bis(2-ethylhexyl)phthalt	BDL	BDL	BDL	BDL	36,000	1700
4,4'-DDE (pest)	25	20	BDL	BDL	BDL	BDL
4,4'-DDT (pest)	52	BDL	BDL	BDL	BDL	BDL
% Dry weight (D.W.)	82	85	87	79	72	84

BDL = Below detection limit
* In most of the samples, other extraneous compounds which are not CLP Target compounds are also identified.
No VOCs were found in any samples

Table 101
BNL Site Environmental Report for Calendar Year 1989
Tritium Committed Effective Dose Equivalent
at the Site Boundary Monitoring Stations

Location ID	Sector ID	Annual Average Air Conc. pCi/m^3	Committed Effective Dose Equivalent mrem*
1T	N	NM	NM
2T	NNE	0.40	0.0003
3T	NE	2.79	0.0022
4T	ENE	1.76	0.0014
5T	E	1.71	0.0013
6T	ESE	0.87	0.0007
7T	SE	1.79	0.0014
8T	SSE	3.17	0.0025
9T	S	2.66	0.0021
10T	SSW	8.18	0.0064
11T	SW	1.91	0.0015
12T	WSW	0.94	0.0007
13T	W	1.50	0.0012
14T	WNW	5.81	0.0046
15T	NW	1.39	0.0011
16T	NNW	3.08	0.0024
20T	Central Site	5.91	0.0046

NM = Not Measured due to vandalism.

Maximum Site Perimeter Dose is: 0.0064 mrem

* Committed Effective Dose Equivalent includes the contribution from the air inhalation and submersion pathways. ICRP Publication No. 30 dose conversion factors used.

Table 102
BNL Site Environmental Report for Calendar Year 1989
Site Boundary Tritium Committed Effective Dose Equivalent
Calculated and Measured Values

Direction	AIRDOS Calculations All Sources mrem	DOE Dose Conversion Factors, AIRDOS Meteorology mrem	Measured Committed Effective Dose Equivalent mrem*
N	0.0017	0.0009	NM
NNE	0.0019	0.0010	0.0003
NE	0.0018	0.0009	0.0022
ENE	0.0013	0.0006	0.0014
E	0.0012	0.0006	0.0013
ESE	0.0012	0.0006	0.0007
SE	0.0010	0.0005	0.0014
SSE	0.0009	0.0004	0.0025
S	0.0007	0.0004	0.0021
SSW	0.0007	0.0004	0.0064
SW	0.0008	0.0004	0.0015
WSW	0.0005	0.0002	0.0007
W	0.0004	0.0002	0.0012
WNW	0.0005	0.0003	0.0046
NW	0.0010	0.0005	0.0011
NNW	0.0012	0.0006	0.0024

NM = Not Measured due to vandalism.

* Committed Effective Dose Equivalent includes the contribution from the air inhalation and submersion pathways. ICRP Publication No. 30 dose conversion factors used.

Table 103
BNL Site Environmental Report for Calendar Year 1989
External Exposure Rates at the Site Boundary
from Argon-41 and Oxygen-15

Direction	AIRDOS Ar-41* mrem	AIRDOS O-15* mrem	AIRDOS Total* mrem	DOE Ar-41** mrem	DOE O-15** mrem	DOE Total** mrem
N	0.037	0.002	0.039	0.041	0.003	0.044
NNE	0.085	0.003	0.088	0.095	0.003	0.098
NE	0.051	0.001	0.052	0.056	0.001	0.058
ENE	0.026	0.001	0.027	0.029	0.001	0.029
E	0.039	0.001	0.041	0.044	0.002	0.045
ESE	0.055	0.005	0.060	0.061	0.005	0.066
SE	0.041	0.003	0.043	0.045	0.003	0.048
SSE	0.042	0.002	0.044	0.047	0.002	0.049
S	0.037	0.001	0.039	0.041	0.002	0.043
SSW	0.026	0.001	0.028	0.029	0.002	0.031
SW	0.032	0.001	0.033	0.035	0.002	0.036
WSW	0.030	0.001	0.031	0.033	0.001	0.034
W	0.024	0.001	0.025	0.027	0.001	0.028
WNW	0.024	0.001	0.025	0.027	0.001	0.028
NW	0.028	0.001	0.029	0.031	0.002	0.032
NNW	0.026	0.001	0.027	0.029	0.001	0.030

* Ar-41 and O-15 dose calculated using AIRDOS-EPA computer code.

** Ar-41 and O-15 dose calculation using AIRDOS-EPA dispersion model and DOE dose confersion factors.

Table 104
BNL Site Environmental Report For Calendar Year 1989
Collective Dose - BNL 1989 Airborne Emissions

Nuclide	Major Facility	Dept.	AIRDOS Total Body Dose person-rem	DOE CDDE Dose person-rem	AIRDOS Thyroid Dose person-rem	DOE Thyroid Dose person-rem
Ar-41	MRR	Reactor	2.68E+00	2.98E+00		
H-3	VdG	DAS	7.68E-02	3.92E-02		
H-3	HFBR	Reactor	9.88E-03	5.04E-03		
Zn-65	Hot Lab	Medical	3.68E-03	1.84E-03		
I-125	HWM	S&EP	3.87E-04	1.16E-04	3.87E-03	3.94E-03
H-3	HWM	S&EP	1.44E-04	7.32E-05		
Br-77	Hot Lab	Medical	1.14E-04	1.82E-05		
Co-60	BLIP	Medical	8.31E-05	3.16E-05		
Se-75	Hot Lab	Medical	7.52E-05	1.14E-04		
Be-7	BLIP	Medical	7.32E-05	3.08E-05		
Co-58	Hot Lab	Medical	7.16E-05	2.58E-05		
I-126	Hot Lab	Medical	5.37E-05	5.37E-05	8.10E-04	8.10E-04
Rb-83	Hot Lab	Medical	1.86E-04	1.86E-04		
O-15	BLIP	Medical	3.40E-05	3.84E-05		
Br-82	Hot Lab	Medical	3.15E-05	2.45E-05		
Mn-54	BLIP	Medical	2.67E-05	1.44E-05		
Rb-84	Hot Lab	Medical	1.16E-04	1.16E-04		
Zn-65	BLIP	Medical	1.52E-05	7.61E-06		
Ga-68	Hot Lab	Medical	7.48E-05	7.48E-05		
Cr-51	HWM	S&EP	1.40E-05	4.78E-06		
Be-7	Hot Lab	Medical	8.20E-06	3.44E-06		
Co-57	HWM	S&EP	5.92E-06	2.01E-06		
Ge-69	Hot Lab	Medical	2.13E-05	2.13E-05		
I-124	Hot Lab	Medical	3.83E-06	3.83E-06	9.07E-05	9.07E-05
P-32	HWM	S&EP	3.79E-06	6.68E-06		
I-131	HFBR	Reactor	3.49E-06	1.05E-06	3.14E-05	3.20E-05
C-14	HWM	S&EP	2.23E-06	4.30E-04		
Rb-84	BLIP	Medical	5.16E-07	9.08E-07		
Co-57	BLIP	Medical	1.52E-06	5.17E-07		
Xe-127	Hot Lab	Medical	6.91E-07	6.91E-07		
Tl-204	HWM	S&EP	1.57E-08	1.57E-08		
S-35	HWM	S&EP	8.44E-08	5.13E-07		
I-123	BLIP	Medical	6.76E-08	1.96E-08	4.55E-07	4.42E-07
Xe-125	BLIP	Medical	4.13E-08	4.13E-08		
Ru-103	HWM	S&EP	1.43E-08	5.15E-09		
Xe-127	BLIP	Medical	3.07E-09	3.07E-09		
Total			2.77E+00	3.02E+00	4.80E-03	4.88E-03

Table 105
BNL Site Environmental Report for Calendar Year 1989
Collective and Maximum Individual Committed Effective Dose Equivalent (CEDE) from the Water Pathway

Pathway	Nuclide	Max. Ind. CEDE mrem	Max. Ind. Bone Dose mrem	Collective CEDE person-mrem	Collective Bone person-mrem
Drinking Water	H-3	0.103	NA	23	NA
Fish	Cs-137	0.097	NA	10	NA
	Sr-90	0.813	10	145	1780
All Ingestion Pathways		1.013	10	178	1780

NA = Not Applicable.

Table 106
BNL Site Environmental Report for Calendar Year 1989
Collective Dose from All Pathways

Pathway	DOE Committed Plus Effective Collective Dose person-mrem	AIRDOS Collective Dose person-mrem	DOE Collective Thyroid Dose person-mrem	AIRDOS Collective Thyroid Dose person-mrem	DOE Collective Bone Dose person-mrem
Air	3020	2770	4.88	4.8	NA
Water	23	NA	NA	NA	NA
Fish	155	NA	NA	NA	1780
All Pathways	3198	2770	5	5	1780

APPENDIX E

QUALITY CONTROL AND QUALITY ASSURANCE

Quality control and quality assurance activities were dependent on the nature and frequency of measurement. Checks on instrument performance and on overall quality of the data were made with measurement control charts and with certified control organization. Up to 10% of all samples processed were connected with quality control, and these included blanks, replicates and spikes. Where possible, analysts participated in blind round robin tests organized by DOE, EPA, or NYSDEC.

Quality assurance activities are coordinated by an individual whose function is to audit laboratory records, document any deviations from protocols, and verify that laboratory functions were in accordance with established norms.

APPENDIX F

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