BNL--52322

DE92 013706

BROOKHAVEN NATIONAL LABORATORY SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1990

R.P. Miltenberger, B.A. Royce, and J.R. Naidu

Contributors:

H. Bernstein
H. Bowen
M. Collins
C. Decker
P.R. Hayde
R. Lagattolla
R. Litzke
W. Litzke
A. Meier
D. Morganelli
D. Paquette
G. Schroeder
T. Sperry
J. Steimers
M. Surico
J. Tichler
R. Thompson

January 1992

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
UPTON, LONG ISLAND, NEW YORK 11973

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes:
Printed Copy: A11; Microfiche Copy: A01

ACKNOWLEDGEMENTS

In addition to the contributors listed on the title page, there were many other individuals who assisted in the collection of data and preparation of this report. The editors express their gratitude to all these individuals. Two individual efforts however require special acknowledgement. Barbara Cox and Marie De Angelis were the individuals responsible for typing this report. The editors express their thanks and acknowledge their outstanding efforts.

DISTRIBUTION

Internal Distribution:

Department	Person
ADD	S. Musolino
	S. Osaki
	F. Thornhill
AGS	E. Lessard
	D. I. Lowenstein
	J. Spinner
BIO	F. Wm Studier
	N. Temple
BOOSTER	W. Weng
CHEM	C. Creutz
	N. Sutin
CS	A. Jens
	N. Satterly
	R. Spellman
DAS	P. Carr
	C. Krishna
	P. Michael
	L. Petrakis
DIRECTOR'S OFFICE	S. Baron
	M. Blume
	M. Davis
	G. Kinne
	H. Grahn
	E. Rohrer
	N. Samios
	M. Schwartz
	R. Setlow
DNE	W. Becker
	R. Duffey
INST	V. Radeka
	R. Richardson
MED	D. Joel
	G. Meinken
	H. Susskind
NSLS	K. Batchelor
	T. Dickinson
	D. McWhan
OER	A. Raphael
OMC	B. Breitenstein
	M. Sacker
PE	M. Bebon
	L. Jacobson
	J. Medaris
	E. Murphy
P&GA	K. Boehm
	J. Laurie
	M. Rosen
PHY	P. Bond
	C. Carlson
	J. Collins
	K. Einfeldt
	J. Throwe
PUBLIC REL.	A. Baittenger
RD	M. Brooks
	N. Houvener
S&EP	P. Bergh
	W. Casey
	N. Carter
	J. Dietz
	L. Emma
	C. Flood
	M. Haleem
	H. Kahnhauser
	A. Kuehner
	E. Lanning
	F. Marotta
	B. Pemberton
	R. Reciniello
	C. Weilandics
	P. Williams
	O White
S&M	M. Guacci
AUI	J. Hudis

External Distribution:

DOE Distribution:

Office of Environmental Guidance and Compliance (EH-23) - 5 copies
Office of Environmental Audit (EH-24) - 2 copies
Office of NEPA Project Assistance (EH-25) - 2 copies
Chicago Operations Office - 10 copies
Brookhaven Area Office - 10 copies
H. McCammon, Office of Health and Environmental Research - 1 copy

EPA Distribution: (2 copies each)

P. Giardina, Radiation Safety Program, U.S. EPA Region II
W. Gunther, U. S. EPA, Office of Radiological Programs, Washington, DC
J. Logsdon, U. S. EPA, Office of Radiological Safety Program

New York State:

R. Aldrich, NYS Department of Health (DOH)
P. Barbato, NYS Department of Environmental Conservation (NYSDEC)
R. Becherer, NYSDEC
G. Brezner, NYSDEC
F. Panek, NYSDEC
P. Roth, NYSDEC

Suffolk County:

D. Moran, Suffolk County Department of Health Services (SCDHS)
J. Pim, SCDHS
P. Ponturo, SCDHS
G. Tarulli, SCDHS

U.S. Congressman:

G. Hochbrueckner

General Distribution:

M. Awschalom, Fermilab
W. J. Bair, Pacific Northwest Laboratory
H. Beck, Environmental Measurements Laboratory
D. Bingham, United States Geological Survey
M. Cordaro, Long Island Lighting Company
J. Cossart, Fermilab
J. J. Fix, Pacific Northwest Laboratory
E. Gupton, Oak Ridge National Laboratory
E. P. Hardy, Environmental Measurements Laboratory
J. Hunter, Rutgers University
L. Johnson, Los Alamos Scientific Laboratory
L. Koppelman, Nassau-Suffolk Regional Planning Board

General Distribution: (continued)

G. L. Lindeken, Lawrence Livermore Laboratory
A. Nelson, Long Island Lighting Company
E. O'Connell, State University of New York, Stony Brook
C. M. Patterson, Savannah River Laboratory
H. W. Patterson, Lawrence Livermore Laboratory
K. R. Price, Pacific Northwest Laboratory
W. Reinig, Savannah River Laboratory
J. D. Sage, Bettis Atomic Power Laboratory
T. H. Schoenberg, Knolls Atomic Power Laboratory
J. Sedlet, Argonne National Laboratory
C. W. Sill, Idaho National Engineering Laboratory
J. Soldat, Pacific Northwest Laboratory

NOTE: Additional reports are distributed to interested parties responding to the BNL press release that announces the issuance of the report.

TABLE OF CONTENTS

FIGURES

FIGURES cont.

APPENDIX D TABLES

APPENDIX D TABLES cont.

APPENDIX D TABLES cont.

APPENDIX D TABLES cont.

APPENDIX D TABLES cont.

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

Brookhaven National Laboratory 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 1.40 million persons reside in Suffolk County[1] and about 0.43 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 headwaters. The Peconic River both recharges and receives water from the ground water aquifer depending on the hydrogeological potential. In times of drought the river water typically recharges to ground water while in times of normal to above normal precipitation, the river receives water from the aquifer. This area had been essentially dry from 1984 until the spring of 1989. Consequently, 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 but recharged to ground water prior to leaving the site boundary. Beginning in the second quarter of 1989 and continuing through

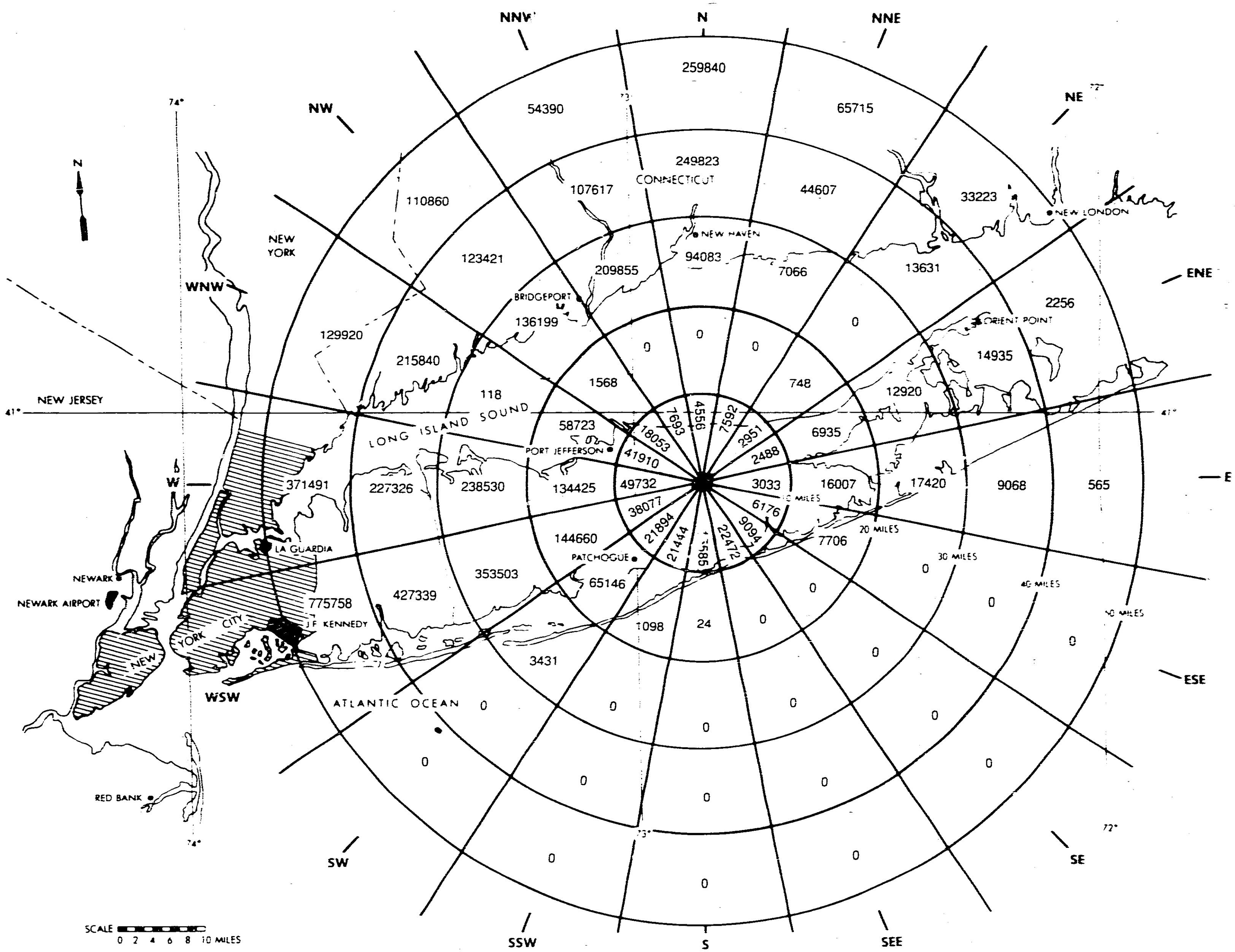


Figure 1: Resident Population within an 80 km radius of BNL (1990)

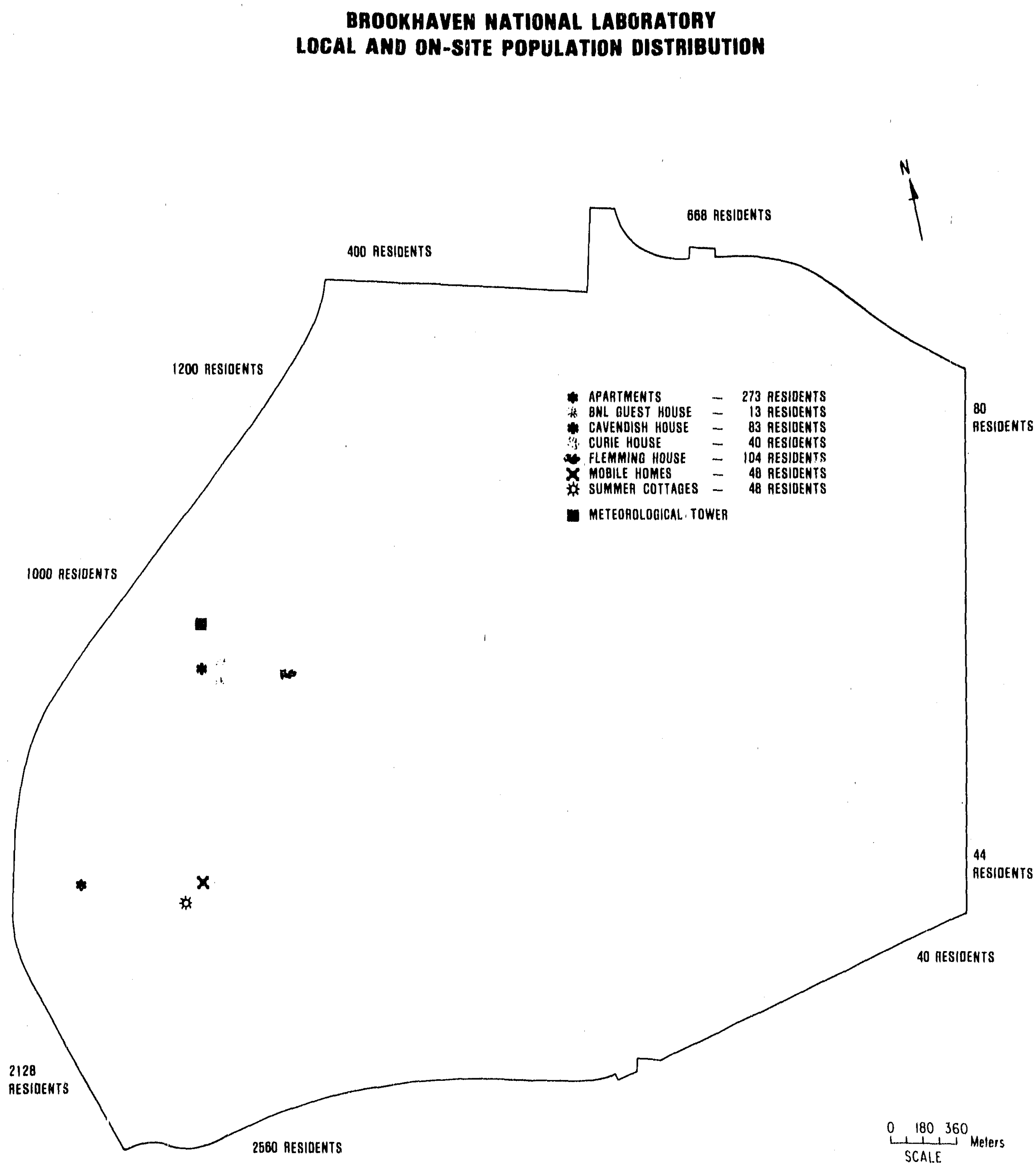


Figure 2: Brookhaven National Laboratory Local and On-Site Population Distribution

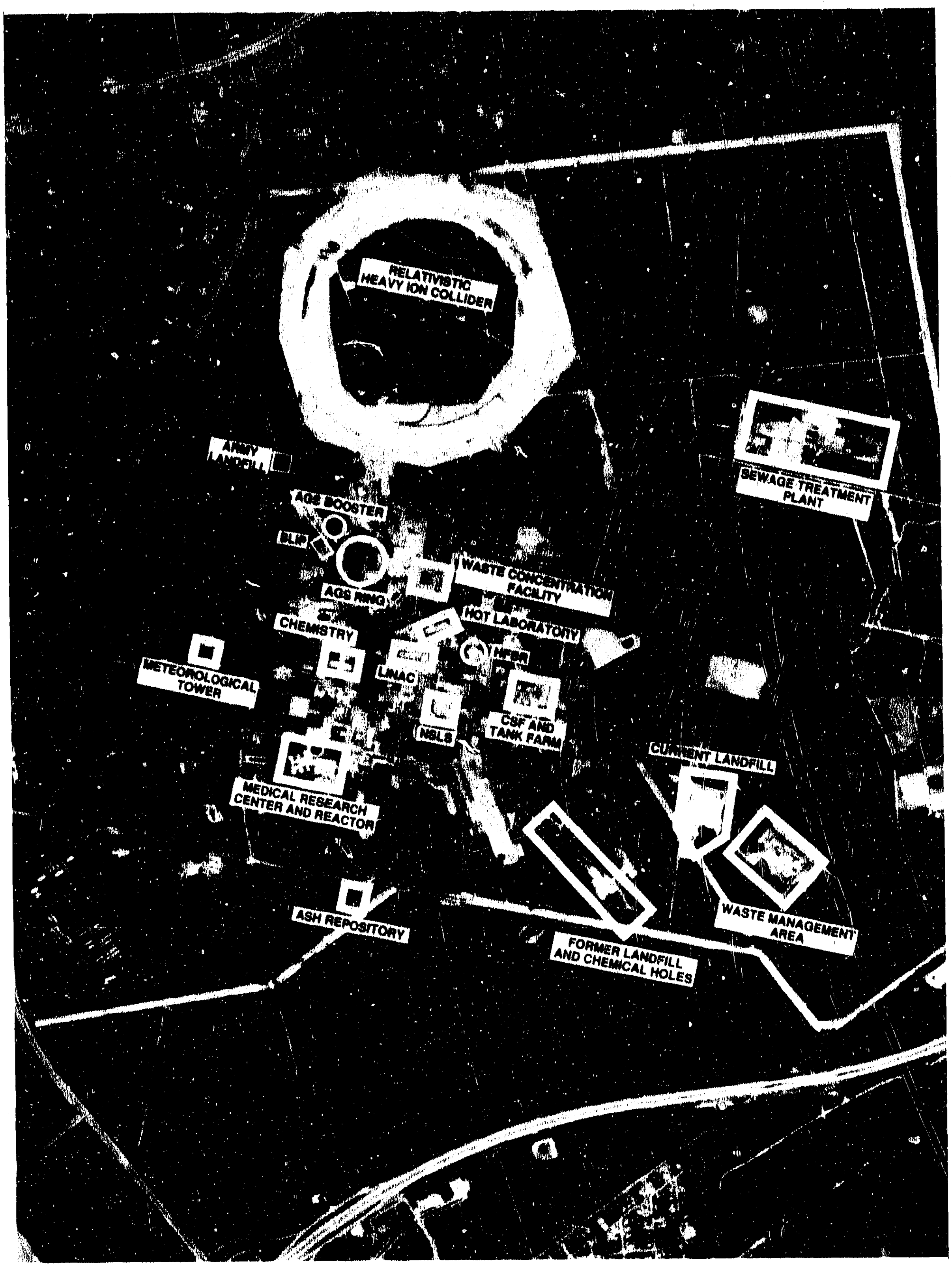


Figure 3: Major Facilities

1990, heavy rains produced flow upstream of the BNL Chlorine House (Location EA) which provided sufficient additional volume to produce flow off-site. In 1990, an estimated 0.8 million liters per day of water was added to the headwaters of the Peconic from ground water discharge.

The Laboratory uses approximately 16.7 million liters of ground water per day to meet potable water plus heating and cooling requirements. Approximately 41% of the total pumpage was returned to the aquifer through on-site recharge basins. About 15% is discharged into the Peconic River Bed. Human consumption utilizes 2% of the total pumpage while evaporation (cooling tower and wind losses) and cesspool plus line losses account for 31% and 10%, 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 1990 annual wind rose for BNL is presented in Figure 4. The ten year average wind rose (1980 to 1989) for the BNL site is presented in Figure 5. The joint frequency distribution for the period 1980 to 1990 is presented in Appendix D, Table 2. The average temperature in 1990 was 11.5° C and the range was -17.6° C to 33.3° C. Monthly minimum, maximum, and average temperature data are presented in Appendix D, Table 3 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 1990 was 135 cm, which is about 12 cm above the 40 year annual average. The historic and 1990 monthly precipitation data are presented in Figure 7 and 8, respectively. The monthly and annual precipitation data are also presented in Appendix D, Table 3. 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.

Ground water flow in the vicinity of BNL is controlled by many factors. The main ground water divide lies 2 to 8 kilometers south of Long Island Sound parallel to the Sound. East of BNL is a secondary ground water divide that defines the southern boundary of the area contributing ground water to the Peconic River. The exact location of the triple-point intersection of these two divides is not known and may be under BNL. South of these divides the ground water moves southward to Great South Bay and to Moriches streams. In general, the ground water from the area between the two branches of the divide moves out eastward to the Peconic River. North of the divide ground water moves northward to Long Island Sound. Pressure of a higher water table to the west of the BNL area generally inhibits movement towards the west. Variability in the direction of flow on the BNL site is a function of the hydraulic potential and is further complicated by the presence of clay deposits that accumulate perched water at several places plus the pumping/recharge of ground water that are part of BNL daily operations.

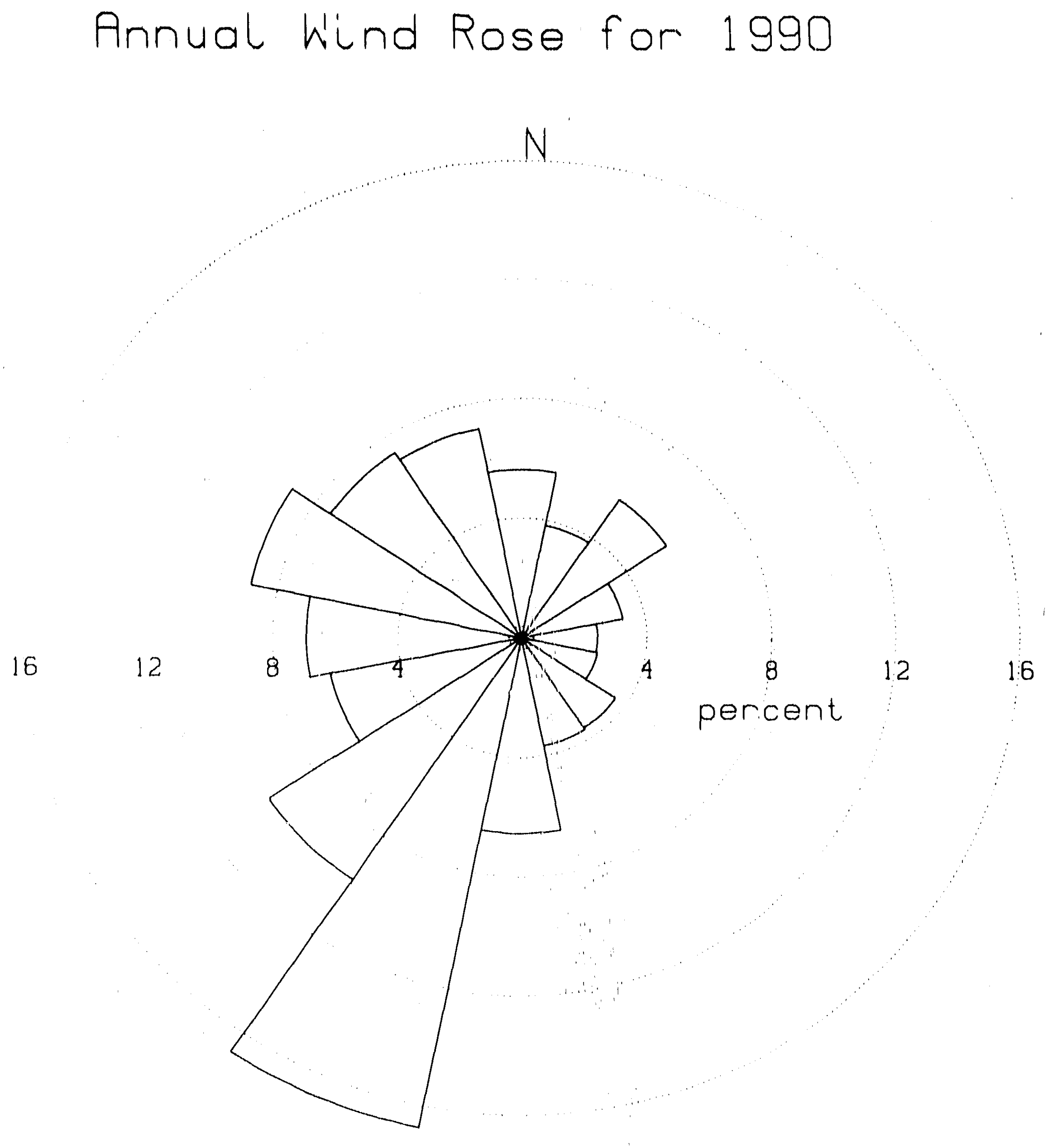


Figure 4: Annual Wind Rose for 1990

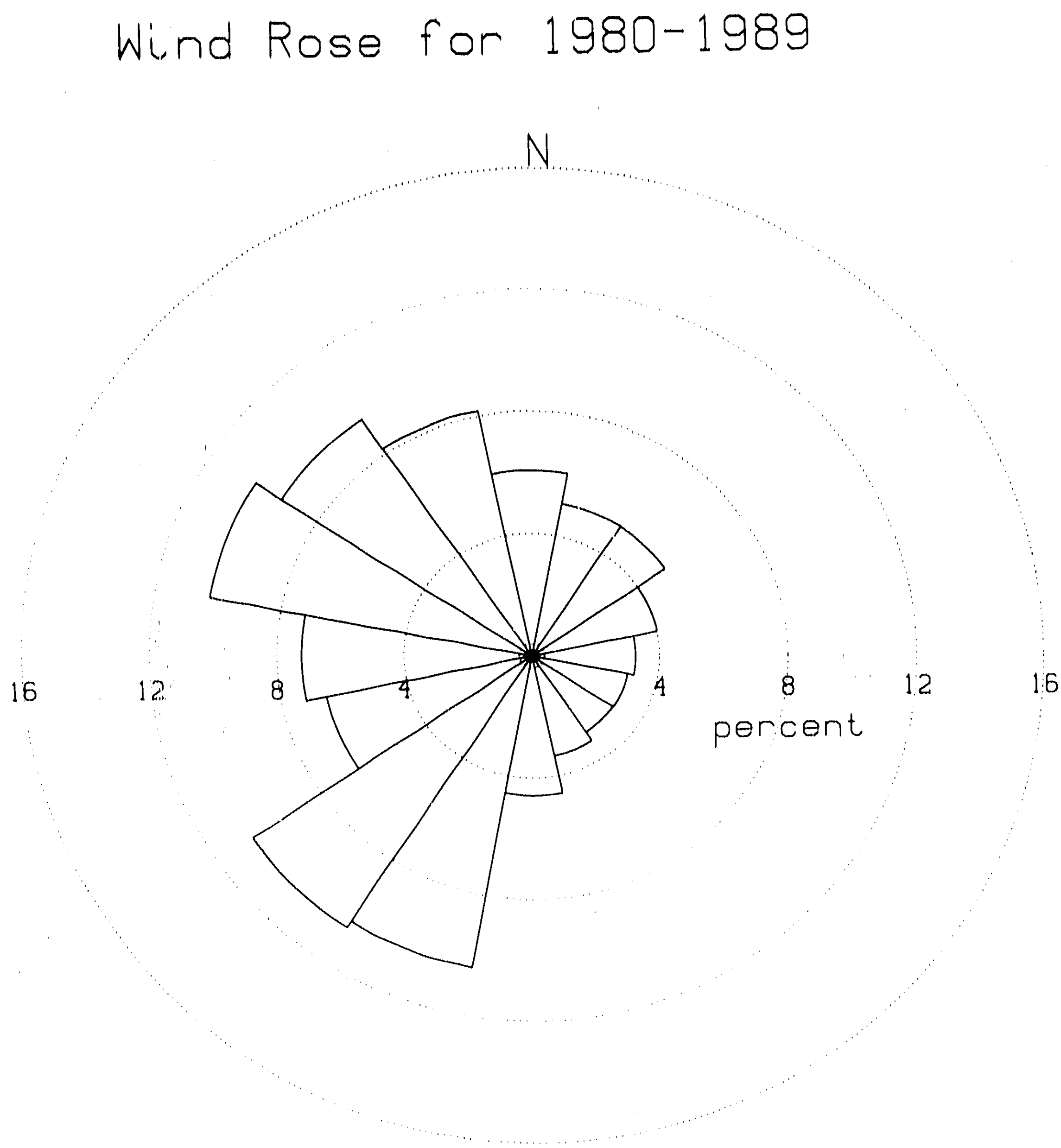


Figure 5: Wind Rose 1980 to 1989

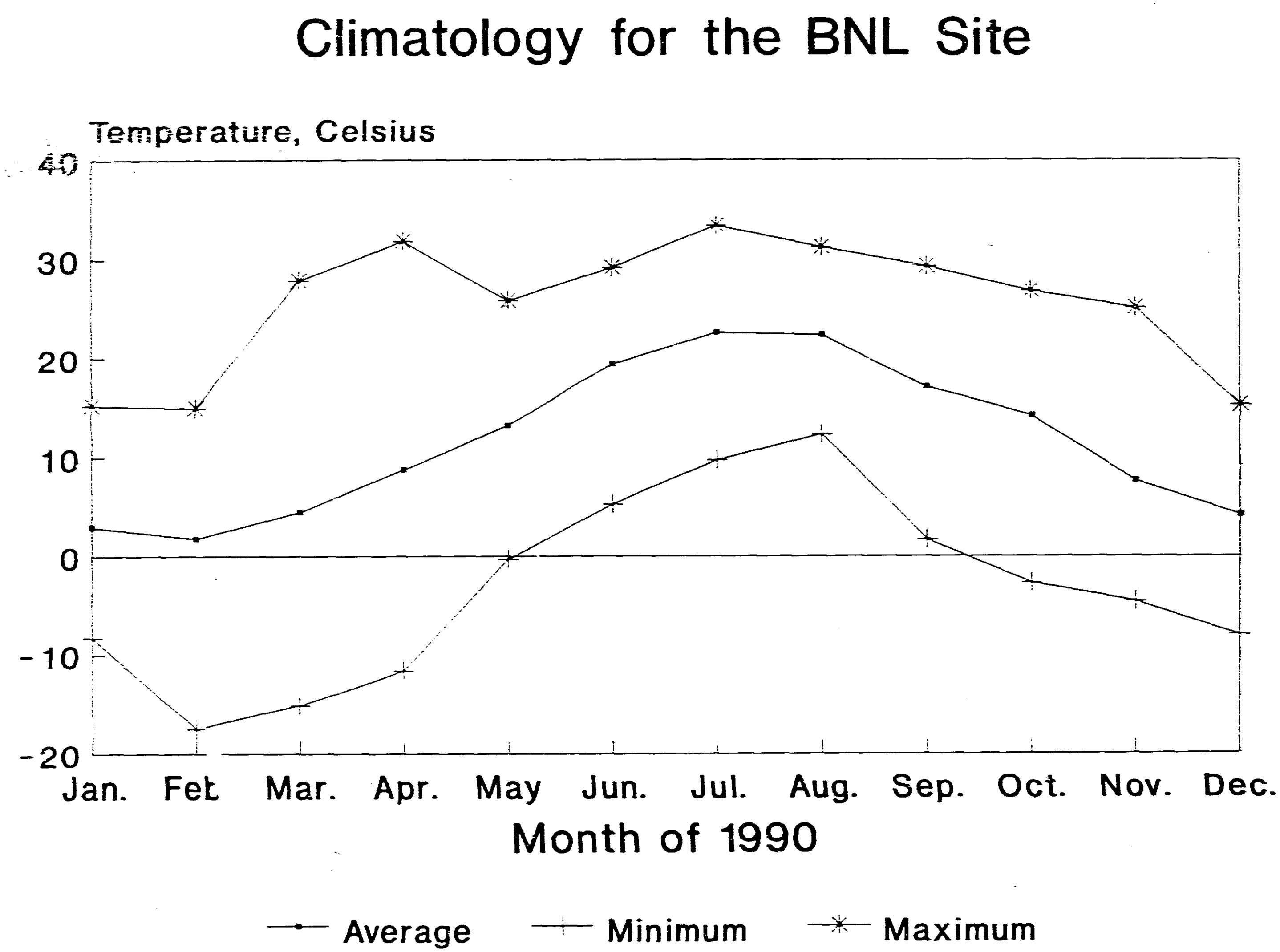


Figure 6: Climatology for the BNL Site – Temperature Data 1990

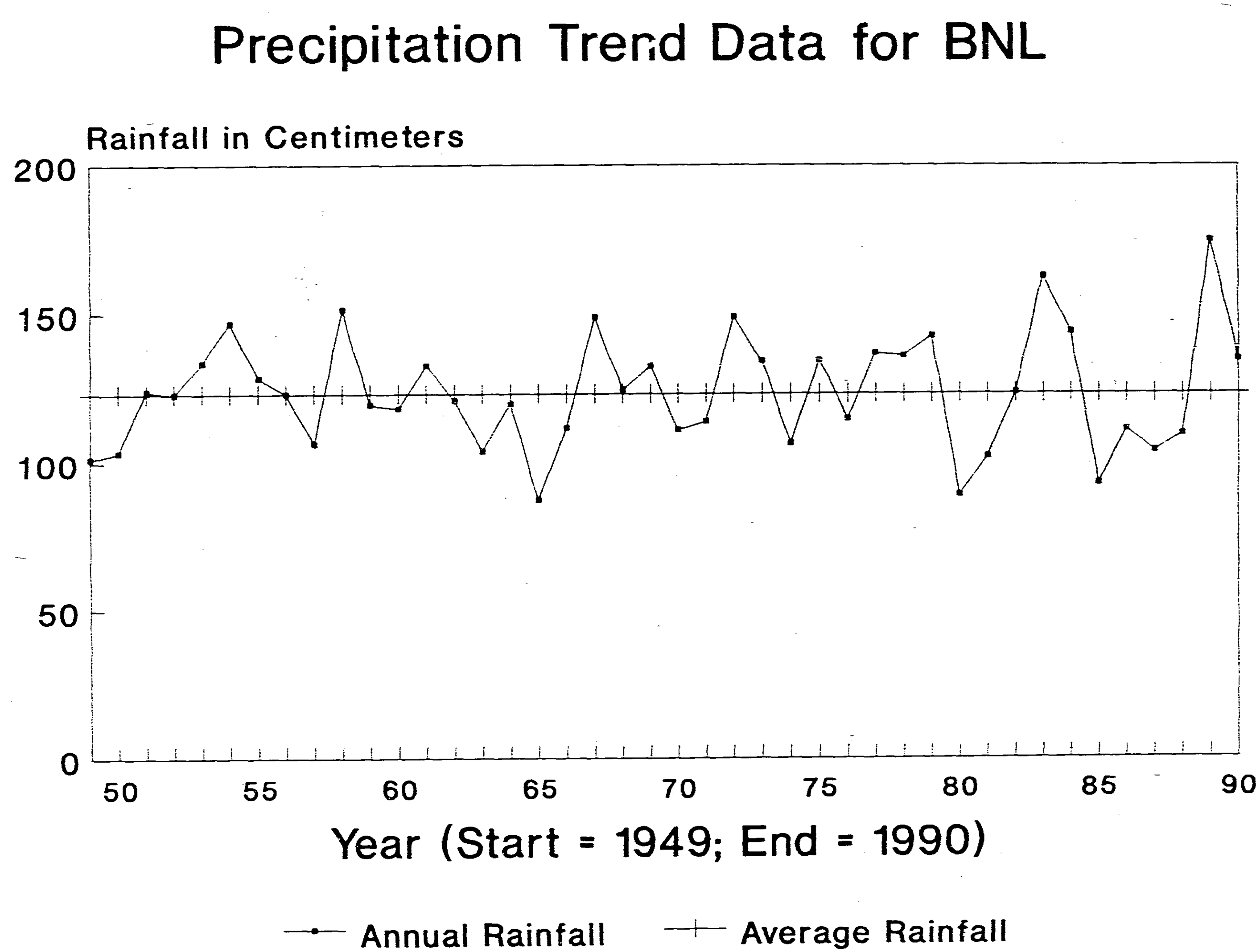


Figure 7: Precipitation Trend Data for BNL, 1949 to 1990

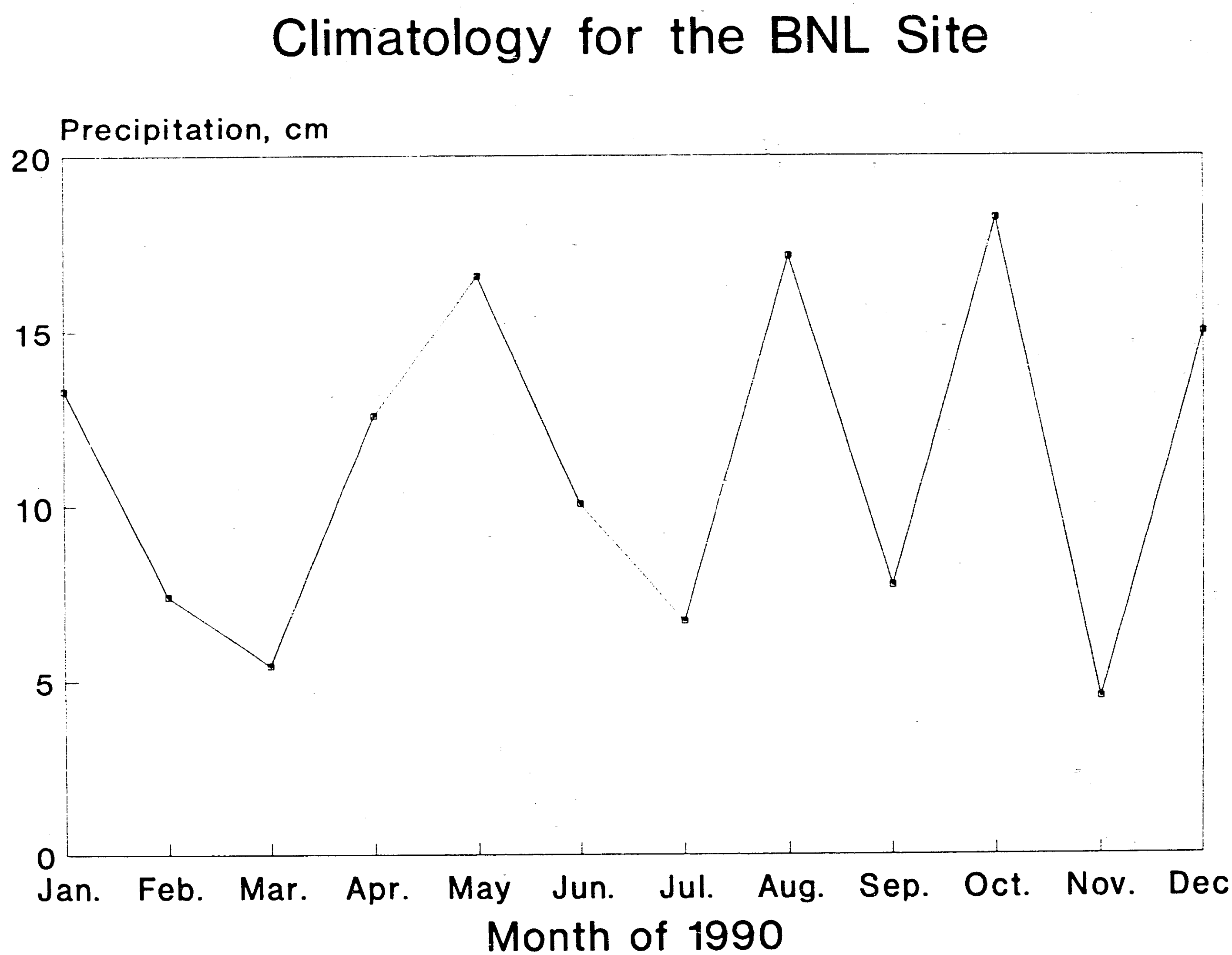


Figure 8: Climatology for the BNL Site Precipitation for 1990

In general, ground water in the northeast and northwest sections of the site flows towards the Peconic River. On the western portion of the site, ground water flow tends to be towards the south while along the southern and southeastern sections of the site the ground water flow tends to be towards the south to southeast. In all areas of the site, horizontal ground water velocity is estimated to range from 30 to 45 cm/d.[7] The site occupied by BNL has been identified by the Long Island Regional Planning Board[8] and Suffolk County as being over a deep recharge zone for Long Island. This implies that precipitation and surface water which recharges within this zone has the potential to replenish the lower aquifer systems (Magothy and/or Lloyds) which exist below the Upper Glacial Aquifer. The extent to which the BNL site contributes to deep flow recharge is currently under evaluation. However, it is estimated that up to two thirds of the recharge from rainfall moves into the deeper aquifers and that their recharge represents ten percent of the total recharge to the ground water system. If left unimpeded, these lower aquifers discharge to the Atlantic Ocean.

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.

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. In the past, this facility operated at a routine power level ranging from 40 to 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 can also be 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 produced by the stored electrons is used for VUV spectroscopy and for x-ray diffraction studies.

7. The Heavy Ion Transfer tunnel connects the coupled Tandem Van de 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.

1.4 Programmatic Changes in 1990

There were several modifications to the Site Environmental Monitoring Program in 1990. In general, these changes were designed to either enhance the environmental surveillance program, improve data quality or address regulatory compliance needs. Six changes were made at the beginning of 1990.

First, in an effort to locate all environmental monitoring locations on the BNL site mapping system, ground water surveillance wells were re-identified by the three digit sector number of the BNL site map in which they appear and a two digit sequence number. The resulting five digit code (Example 098-05) replaced all former well identifiers (Example MW13). This facilitated generation of a single map which located all ground water monitoring wells and provided the capability to produce a limitless variety of localized maps using CADCAM computerized technology. The second change provided a different method for assaying air particulate filters. Prior to 1990, ambient air particulate filters for the entire site were composited monthly and analyzed for gamma emitting radionuclides. Beginning in January, each sample location was analyzed weekly. The change provided location specific radionuclide concentration levels but did increase the system limits of detection. This change was made as a result of the 1989 Dames and Moore audit of the environmental monitoring program. The third change was the inclusion of ponded water near the Hazardous Waste Management Facility (HWMF) and the Current Landfill on the routine sampling schedule. Addition of these two locations to the routine sampling program was made in an effort to allocate time to obtain samples from this area where water is present on an intermittent basis.

The fourth change was the use of the CAP88 or AIRDOS-PC computer models for evaluation of impacts from radiological airborne effluents. The implementation of this evaluation system ended the use of the site specific BNL Gustiness method to model dispersion. This change was made to facilitate compliance with 40 CFR 61 Subpart H requirements. Down draft from the Building 705 stack was also included in airborne effluent assessment. The addition of routine analysis of water samples from the BNL recharge basins for volatile organic compounds (VOCs) to the analysis schedule was the fifth change. Finally, the certification for the Safety and Environmental Protection (S&EP) Division's Analytical Chemistry Laboratory for purgeable organic compounds analyses was changed from potable to nonpotable. While this change does not affect data quality or instrument detection limits, it did result in a minor change in the analytes reported.

In the second quarter of 1990, the largest change to the program occurred when ground water sampling at the Old Landfill, Current Landfill, and Hazardous Waste Management areas of the site was suspended from April to the early part of June. The suspension of the program was instituted in a effort to address issues raised by the DOE Tiger Team. During this period, Occupational Safety and Health Administration (OSHA) 1910.120 training occurred, a sampling health and safety plan was written, ground water well identification problems associated with conversion to the new grid identification system were investigated and sampling protocols were developed or reviewed. Although sampling resumed in June, most of the second quarter ground water schedule could not be completed due to time constraints and accessibility of sampling locations in June.

In the third quarter of 1990, monthly grab sampling of water entering the Peconic River from the BNL (STP) commenced in response to a New York State Department of Environmental Conservation (NYSDEC) State Pollution Discharge Elimination System (SPDES) Notice of Violation at this location. A grab sample collected by NYSDEC in March, 1990 identified the presence of organic compounds in the BNL effluent. Routine monitoring was implemented to verify the presence of organic compound in the STP effluent over a protracted period of time. During this quarter the sampling heights of thermoluninescent dosimeters (TLDs) and ambient tritium monitors was changed. Prior to this time, both sampling media were located at approximately three feet from the ground elevation. In September, TLDs were all moved to one meter off the ground while ambient air sampling stations had their intakes raised to approximately two meters. Finally, a quality assurance (QA) audit of BNL's strontium-90 contractor laboratory was performed in this quarter. The audit identified deviances from protocols and good laboratory practices that raised questions regarding the quality of results being generated. Arbitration between the company and BNL failed to resolve these concerns. During the period of negotiation, no samples were shipped for analysis. The contract was terminated in the fourth quarter. A contract for analysis of effluent samples was issued to another laboratory late in the fourth quarter while new contract specifications were being developed. The second laboratory analyzed the samples in a manner that also failed QA considerations. The remainder of the 1990 samples that require strontium-90 analysis were not analyzed and were held until a new contract could be awarded through the normal contract awards process. Fourth quarter strontium-90 data will be included in the 1991 Site Environmental Report (SER).

2.0 **SUMMARY**

The Environmental Monitoring (EM) Program is conducted by the Environmental Protection (EP) Section of the 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 non-radiological 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 (CY) 1990 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 1990, 1,046 Ci (38.7 TBq) of argon-41 were released from the MRR stack; 700 Ci (25.9 TBq) of oxygen-15 were released from BLIP; and 32 Ci (1.2 TBq) of tritium in the form of water vapor were released from the 3 MeV Van de Graaff, Chemistry, and HFBR stacks. In 1990, no elemental tritium was released from the 3 MeV Van de Graaff because tritium was not used as a source of ions. Much smaller quantities of airborne radioactive effluents were released from the Hot Laboratory and the HWMF.

2.2 Liquid Effluents

Liquid discharge limits for radiological and non-radiological parameters are subject to conditions listed in the BNL (SPDES) Permit No. NY-000-5835 as issued by 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 Derived Concentration Guides (DCGs).[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 (99.8%) within the limits specified by the SPDES permit. Radioactive concentrations in waste water entering the BNL STP continued to decline from 1988 levels. Gross beta and cesium-137 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 a 1988 unplanned release of cesium-137 and strontium-90 to the sanitary system. In 1990, 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: 1.4 Ci (0.051 TBq) of tritium, 0.0044 Ci (0.16

GBq) of cesium-137, 0.00059 Ci (0.022 GBq) of iodine-131 and 0.00007 Ci (0.0026 GBq) of strontium-90. The annual average tritium concentration at the discharge point to the Peconic River was 0.08% of the DCGs[9] and only 7.6% of the BNL administrative limit. This represents a factor of 1.6 reduction in the tritium releases to the Peconic River from 1989 values. This reduction in source term was the result of the HFBR not operating in 1990. The annual average cesium-137 concentration was 0.16% of the DCG (4% of the SDWA) while strontium-90 concentrations were 0.8% of the SPDES limit and 0.2% of the SDWA limit. Releases of iodine-131 were 0.02% of the DCG, 0.6% of the SDWA concentrations.

Non-radiological 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 99.8% compliance rate, several of these parameters periodically deviated from permit conditions. Specifically, there were five occurrences where suspended solids exceeded the maximum daily value of 10 mg/L with the highest occurrence being three times the SPDES permit limit and one instance where total coliform was observed above the SPDES limits. The presence of elevated suspended solids was believed to be a result of actions taken by the STP operator to control pH.

Periodically, NYSDEC performs compliance verification sampling. On March 13, 1990, representatives from NYSDEC collected a grab sample of the STP effluent (Outfall 001). The results indicated the presence of 1,1,1-trichloroethane (TCA), a parameter not listed in the BNL SPDES permit, at a concentration of 39 ppb. The TCA concentration was 78% of surface water discharge limits. Based on these results, NYSDEC requested BNL to add collection and analysis of monthly grab sample from Outfall 001 to the EM Program in order to verify the presence of this compound in the STP effluent. Brookhaven National Laboratory modified the EM Program and added VOC results to the Monthly Discharge Monitoring Report in July, 1990. Samples collected for VOC analysis were analyzed by an off-site NYS certified laboratory. The results indicated that TCA was below the instrument detection limits in all samples collected during this period.

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 the recharge basin water were to be used as the sole source of drinking water, the resultant dose from direct ingestion at the concentrations detected would be equivalent to a dose of less than 0.01 mrem (0.0001 mSv) per year. Since recharge basins function as conduits to the underlying aquifer system, the non-radiological 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 Basins HN (Outfall 002), HO (Outfall 003), and HS (Outfall 005), pH was periodically observed to be below the minimum discharge limit of 6.5. The lowest observed pH was 4.8 at Recharge Basin HS. This basin receives principally storm water run-off from paved areas. Precipitation at BNL has a pH that typically is around 5.0. Elevated iron concentrations were observed above NYS DWS at Recharge Basins HN, HO, and HS at concentrations ranging from 1.3 to 1.9 times the NYS DWS of 0.3 ppm. It should be noted that NYS has specific standards for discharges to ground water. These discharges were within this standard for iron.

As part of the SPDES permit renewal process, BNL collected samples from recharge basins for organic analyses. The results, which were submitted to NYSDEC in February, 1990, observed the presence of TCA in Basin HP. As part of their compliance verification process, NYSDEC collected samples from BNL recharge basins on March 13, 1990. The results of the analyses performed on these samples indicated the presence of TCA at Recharge Basin HP (Outfall 004) at a concentration that exceeded the effluent limitation by a factor of four. At the Water Treatment Plant (WTP) Recharge Basin (Outfall 007), iron was detected at a concentration that exceeded the effluent limitation by a factor of seven. Based on these data, a Notice of Violation (NOV) was issued. The source of the TCA was identified as ground water obtained from Supply Wells 104 and 105 which provided secondary cooling to the MRR. The use of these wells was terminated upon the determination that they were the source of the organic contamination. The elevated iron concentrations at the WTP recharge basins are the result of the backwash discharge from the WTP iron removal system. The NYSDEC is modifying the proposed SPDES permit to require iron monitoring requirements. Brookhaven National Laboratory is also developing a program to evaluate the impact of discharging WTP backwash to the recharge basin.

2.3 External Radiation Monitoring

Thermoluminescent dosimeters were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1990 was 61.2 ± 7.5 mrem (0.61 ± 0.075 mSv), while the off-site integrated dose was 60.3 ± 6.3 mrem (0.60 ± 0.06 mSv). These doses are essentially equal to those measured in 1989. 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 typically reported for the New York City area by the Environmental Protection Agency (EPA) which predict an annual dose of about 80 mrem (0.80 mSv).[11-14]

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 7.9 pCi/m^3 (0.29 Bq/m^3). This concentration would result in a committed effective dose equivalent of 0.0062 mrem (0.000062 mSv) to the maximally exposed individual residing at the site boundary for the entire year. At Station 16T2.1, iodine-126 was detected on one of the January, 1990 air particulate filters. No unusual releases occurred from any facility during January and the charcoal filter for the sample period did not contain detectable concentrations of iodine-126. This result is believed to be suspicious in nature. The committed effective dose equivalent to the maximum individual resulting from the inhalation of the measured air concentration would be 0.001 mrem (0.00001 mSv) if the datum is valid.

2.5 Radioactivity in Precipitation

In rainfall, only beryllium-7 and strontium-90 were detected. The measured concentrations were consistent with typical washout values associated with atmospheric scrubbing[15] and are comparable with the 1989 and 1990 data published by EPA for Yaphank, New York.[11-14]

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 in July, 1990. No nuclides attributable to Laboratory operations were detected in any of these samples.

2.7 Surface Water

The Peconic River was sampled at three locations on-site and four locations between the site boundary and Riverhead. In addition, Carmans River was sampled as the background location and Halfmoon Pond was sampled as part of a special study. In general, Peconic and Carmans River samples were analyzed for gross alpha, gross beta, tritium, strontium-90, and gamma emitting radionuclides. Surface water samples were also analyzed for field parameters such as pH, conductivity, and dissolved oxygen. Peconic River samples from the former site boundary (Location HM) were also analyzed for metals and water quality parameters.

Radiological results from samples collected at the former site boundary (Location HM) indicate that the annual average gross beta concentration was 4.98 pCi/L (0.18 Bq/L) or 10% of the NYS DWS; the average strontium-90 concentration was 0.06 pCi/L (0.002 Bq/L) or 0.8% of the NYS DWS; the average cesium-137 concentration was 2.0 pCi/L (0.074 Bq/L) or 2% of the SDWA; and the average tritium concentration was 0.8 nCi/L (30 Bq/L) or 4% of the NYS DWS. At the current site boundary (Location HQ), the annual average gross beta concentration was 4.6 pCi/L (0.17 Bq/L) or 9% of the NYS DWS and the average tritium concentration was 1.03 nCi/L (38 Bq/L) or 5% of the NYS DWS. Nuclide specific gamma analyses were performed at this location with cesium-137 being the principal isotope detected at a concentration of 1.8 pCi/L (0.067 Bq/L) or 2% of the SDWA.

The Carmans River and Peconic River off-site were sampled in the first, third, and fourth quarter of 1990. No sampling was performed in the second quarter due to activities related to the DOE Tiger Team Assessment.[16] In Carmans River water, the average gross beta concentration was 1.0 pCi/L (0.037 Bq/L) and the average strontium-90 concentration was 0.18 pCi/L (0.007 Bq/L). These values represent ambient background. Average gross beta concentrations in the Peconic River were uniform and ranged from 1.53 pCi/L (0.057) Bq/L) to 1.88 pCi/L (0.07 Bq/L) or 3-4% of the NYS DWS. Tritium concentrations decrease with distance from BNL with the closest off-site sampling point (Location HA) having an average concentration of 480 pCi/L (17.9 Bq/L) or 2% of the NYS DWS while samples collected at the Riverhead sampling point (Location HR) had an average concentration of 280 pCi/L (10.4 Bq/L) or 1.4% of the NYS DWS. Nuclide specific analyses indicated that strontium-90 concentrations were consistent with ambient levels and ranged from 0.12 pCi/L (0.004 Bq/L) to 0.54 pCi/L (0.02 Bq/L). Cesium-137 was detected periodically in downstream water samples. The observations did not follow site release patterns. The average cesium-137 concentrations detected ranged from 0.17 pCi/L (0.006 Bq/L) to 0.60 pCi/L (0.02 Bq/L), or 0.1 to 0.5% of the SDWA. Direct ingestion for one year of 2 liters of water per day containing the maximum observed cesium-137, strontium-90, and tritium concentration would result in a committed effective dose equivalent of 0.1 mrem (0.001 mSv) at all locations.

Field and water quality parameters were consistent with both past observations and control data. Metal data for analyses performed on monthly samples collected from Location HM indicated that iron was the only parameter that exceeded NYS DWS. Effluent from the BNL STP to the Peconic River had an iron concentration 0.16 ppm. The high values of iron in the Peconic River water are the result of ground water recharge into the Peconic River.

2.8 Aquatic Biological Surveillance

Fish samples were collected along the Peconic River at the outfall of the STP (Location EA), the former site boundary (Location HM), Donahue's Pond, and Forge Pond, at the upstream location of Swan Pond and at a control location along Carmans River. In CY 1990, only gamma spectroscopy analysis was performed on samples collected. Strontium-90 analyses were not performed due to failure of the contract laboratory to meet quality assurance objectives and the inability to issue a new contract prior to the first quarter of 1991. For dose assessment purposes the strontium-90 to cesium-137 ratio as reported in the 1989 BNL SER has been used to estimate the strontium-90 component of the fish-ingestion pathway. The Peconic River fish contained cesium-137 concentrations which ranged from near background levels at Forge Pond (100 - 460 pCi/kg-wet [3.7-17 Bq/kg-wet]) to 1,650 pCi/kg-wet (61 Bq/kg-wet) at Location 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 0.75 mrem (0.0075 mSv) and the collective dose was estimated to be 0.375 person-rem (0.00375 person-Sv). No sediment or aquatic vegetation samples were collected in 1990.

2.9 Potable Water Supply

Gross alpha, gross beta, and tritium concentrations in samples collected from on-site potable wells were generally at or below the minimum detection limit (MDL). The daily grab sample of potable water collected from a central building on-site exhibited the same results. Tritium concentrations in on-site potable well water were at or below the MDL of 300 pCi/L (11 Bq/L). Strontium-90 concentrations were at or below the MDL of 0.1 pCi/L (0.004 Bq/L) and consistent with concentrations in off-site wells. Only cesium-137 and beryllium-7 were detected above MDL levels at annual average concentrations of 0.13 pCi/L (0.005 Bq/L) and 11 pCi/L (0.4 Bq/L) respectively. These concentrations, 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 0.005 mrem (0.00005 mSv). 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, cadmium, chromium, and mercury were not detected in any sample analyzed. Trace quantities of lead (0.005 mg/L), manganese (0.02 - 0.14 mg/L), and copper (0.09 mg/L) were detected in potable well water collected at the well head. All observed values of lead, manganese, and copper were below their respective NYS DWS of 0.050 mg/L, 0.3 mg/L and 1.0 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 WTP prior to use in the domestic water distribution system. Sodium was detected in all potable wells in concentrations ranging from 3.3 to 13.0 mg/L.

In order to demonstrate compliance with federal and state DWS for organic compounds, potable water is sampled quarterly and sent to an off-site certified Laboratory for analysis. In October, 1990, water from Potable Well 4 was detected to have TCA at a concentration of 7.5 μg/L which exceeds the NYS DWS of 5 μg/L.[17] The well was voluntarily removed from service.

Prior to obtaining these results, BNL was concerned with the increasing concentrations of TCA being observed in this well during previous quarterly sampling. In an effort to further investigate this, a testing program was developed to evaluate the ability of the existing processes at the BNL WTP to removed organic compounds. To ensure the merit of this testing program, the proposed protocol was discussed with a representative from the SCDHS.

The testing program was conducted in October, 1990. A package was prepared describing the test protocol and analytical results, and submitted to the SCDHS for their review and evaluation. A decision from the DHS is anticipated to be issued during the first quarter of 1991.

In 1989, TCA concentrations that exceeded NYS DWS were observed at Potable Wells 10 and 11. A carbon filtration system was purchased for Potable Well 11. Installation of this device is expected to be completed in 1991. A similar system will be purchased for Potable Well 10.

2.10 Ground Water Surveillance

Ground water surveillance data are compared to both DCGs and DWS values in this report. The DCG for a given radionuclide represents the concentration which would yield a committed effective dose equivalent of 100 mrem (1 mSv) if an individual were to consume two liters of the liquid per day for one year. Comparison of data to these concentrations permits evaluation of discharge limit impacts and provides a historic framework to evaluate past practices. Comparison of surveillance well data to EPA, NYSDEC, New York State Department of Health (NYSDOH) and DOE DWS provides a mechanism to evaluate the radiological and non-radiological levels of contamination relative to current standards. The Laboratory is committed to remediate ground water which does not meet current regulatory criteria to the levels prescribed in the Interagency Agreement (IAG).

2.10.1 Radiological Analyses

In 1990, 98 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), eight ground water wells were monitored. Gross beta and tritium concentrations were detected which were above ambient concentrations in the on-site areas near the Peconic River. Also, at an off-site well that is adjacent to the Peconic River and within several hundred meters of the site boundary, elevated gross beta, tritium, and strontium-90 concentration were detected. Radionuclide concentrations near the Meadow Marsh-upland recharge area were at ambient levels. Observed concentrations in on-site Peconic River area wells are attributable to tile collection field losses at the STP and recharge of the Peconic River. In 1990, the highest annual average gross beta concentration was 7% of the NYS DWS concentration limit[18]; tritium was 11% of the NYS DWS concentration limit; strontium-90 was 8% of the NYS DWS concentration limit. At a single surveillance well located adjacent to the Peconic River and several hundred meters downstream of the site boundary, the annual average gross beta concentration was 11% of the NYS DWS; the tritium concentration was 9% of the NYS DWS and the strontium-90 concentration was 24% of the NYS DWS concentration limit. No gamma emitting radionuclides were detected at any well in this area.

Along the northwest, west, and south boundary of the site, 13 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 except for gross beta activity observed in March, 1990 samples from Well 130-02, a south boundary well. The samples were milky in color and believed to contain bentonite clay from the well packing which would explain both the color and elevated gross beta activity.

In the center of the site, 27 surveillance wells were monitored. Radionuclides detected in ground water samples that were attributable to BNL operations were found in the vicinity of Building 811, Building 830, the Major Petroleum Facility (MPF), and Building 725. The highest annual average concentrations detected for this area expressed as a percent of the NYS DWS concentration limit were: 12% gross beta; 2.4% tritium; and 14% 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: 1.4% sodium-22; 0.11% cesium-137; and 0.09% cobalt-60.

In addition to the BNL on-site surveillance wells, 20 off-site private potable wells and three locations along the Peconic River near the site boundary were sampled and analyzed for gross alpha, gross beta, strontium-90, tritium, and gamma emitting radionuclides as part of a cooperative program with the SCDHS. Detectable quantities of tritium were found in three off-site sampling locations: two private potable wells and one Peconic River sampling point. The annual average tritium concentrations at the two private well locations was 10% of the DWS.[19] Except for naturally occurring potassium-40, no gamma emitting radionuclides were detected in private well water and strontium-90 values ranged between <0.1 and 0.2 pCi/L (<0.004 and 0.007 Bq/L) in private potable well water, which is typical for Long Island.

At the landfill areas (Current, Former, and Ashfill), 28 surveillance wells were monitored. The single highest average gross beta concentration observed was 35% of the applicable guide; the single highest average tritium concentration and strontium-90 concentration observed were 95% and 63%, respectively of the DWS. Other radionuclides were detected at small fractions of the DWS dose limit. None of the monitoring wells that were sampled exhibited concentrations that exceeded the DWS, although water from Well 87-08 (1K) at the Current Landfill is very close to the tritium DWS. Given the distance to the site boundary, decay will occur in transit which will result in radionuclide concentrations at the site boundary that are substantially below the applicable standard.

Twenty-two ground water surveillance wells were monitored in the vicinity of the HWMF. The data from this ground water program indicates the presence of tritium, fission, and activation products. The single highest average concentration of tritium and strontium-90 was 27% and 760%, respectively of the DWS. The highest annual concentration for the remaining radionuclides detected expressed in percent of the DWS dose limit were: 0.28% cobalt-60 and 0.04% sodium-22. Three of the 22 monitoring wells that were sampled in this area exhibited concentrations that exceeded the NYS DWS for strontium-90; 88-04 (MW2); 98-02 (WC); and 98-29 (MW7A).

2.10.2 Non-radiological Analyses

In the east sector of the site (Meadow Marsh-upland recharge area; Peconic River on-site; and Peconic River off-site) water quality, metals, and VOC analyses were performed on eight ground water surveillance wells. Water quality data indicated that the pH was typically below the NYS DWS of 6.5 to 8.5 but within typical observations of ground water that is upgradient of the BNL site. Other water quality parameters were all within the DWS. Iron and manganese were the only metals observed in concentrations that exceeded the DWS. Like low pH, elevated concentrations of iron and manganese are endemic to Long Island. At the observed concentration, the presence of these metals is not reflective of BNL operations. The VOCs were not detected in ground water collected from this area of the site.

In the landfill and ash repository section of the site, water quality, metals and VOC analyses were performed on 28 ground water surveillance wells. Water quality data indicated that the pH was typically below the NYS DWS of 6.5 to 8.5 but within the range of values observed at locations upgradient of potential site impact. Other water quality parameters were within DWS. Conductivity measurements at the current landfill wells reflect the landfill's impact. Most conductivity values in this area were greater than 150 umhos/cm while upgradient values typically ranged from 50 to 150 umhos/cm. There is no specified standard for conductivity. Metals analysis indicated that water from one of the nine wells at the former landfill exceeded the DWS for manganese. At the current landfill, fourteen of the eighteen wells in this area exceeded the iron and/or manganese standard. All other metals concentrations were below the DWS. Organic data for the Current Landfill area indicates that annual average concentrations of dichloroethane (DCA) were detected above the DWS at three wells ranging from 6 to 11 μg/L; benzene, ethylbenzene, and toluene were each detected in one well above the DWS at concentrations of 9, 8, and 12 μg/L, respectively. Organic compounds were not detected from ground water surveillance wells that monitor the former landfill and the ash repository.

In the Hazardous Waste Management (HWM) and Spray Aeration Project areas, twenty-two ground water surveillance wells were monitored for water quality, metals, and VOCs. Water quality data indicated that the pH was typically below the NYS DWS of 6.5 - 8.5 but within the range of values observed at locations upgradient of potential site impact. Other water quality parameters were below the applicable NYS DWS. Conductivity values were all in the 50 - 150 umhos/cm range. Results of metals analyses performed on ground water from this area indicated that all compounds were below the applicable NYS DWS. Volatile organic results for ground water samples collected from this area indicate that TCA, tetrachloroethylene (PCE), and dichloroethylene (DCE) were detected at concentrations that exceeded the NYS DWS. Specifically, two wells near the HWM facility, 88-04 (MW2) and 98-02 (WC) had concentrations of TCA that ranged from 85 to 1000 μg/L. Well 88-04 also had PCE concentrations greater than 150 μg/L while well 98-02 had DCE concentrations of 52 μg/L. Near the BNL site boundary, TCA concentrations ranged from 8 to 30 ppb at three Wells: 108-13, 108-05, and 108-12. No other organic compounds were detected in this area of the site.

In the central part of the site, 28 ground water surveillance wells were monitored for water quality parameters, metals, and VOCs. Water quality data indicated that the pH was typically below the NYS DWS of 6.5 -8.5 but within the range of values observed at locations upgradient of potential site impact. Other water quality parameters were below the applicable NYS DWS. Conductivity values were generally all in the 50 - 150 umhos/cm range however two wells in the Central Steam Facility (CSF) area, 76-05 (IT5), and 76-06 (IT2), had conductivity values in the 300 - 350 umhos/cm range while four wells (54-05 [DOE Well 556], 65-03 [D10], 65-04 [D11], and 65-02 [D9]) in the AGS - Building 811 area, had conductivity values in the 150 -250 umhos/cm range. Results from metals analyses of ground water from this area indicated that all compounds were below the applicable NYS DWS except for iron and manganese. At the CSF, water from Wells 76-04 (IT1) and 76-06 (IT2) exceeded the 0.3 mg/L iron NYS DWS while water from Wells 76-04 (IT1) and 76-08 (IT4) contained manganese concentrations in excess of the 0.3 mg/L NYS DWS. The iron concentration in water from Well 44-04 (DOE Well 558) also exceeded the NYS DWS. Volatile organic results for ground water samples collected from this area indicate that TCA, trichloroethylene (TCE), PCE, DCA, benzene, ethylbenzene, toluene, and o-zylene were detected at concentrations that exceeded the NYS DWS in ground water sampled from seven wells located at the CSF. The maximum observed annual average concentration for each of these compounds was: 22 μg/L of TCA; 33 μg/L of TCE; 130 μg/L of PCE; 5 μg/L of DCA; 12 μg/L of benzene; 100 μg/L of ethylbenzene; 480 μg/L of toluene and 60 μg/L of o-xylene. The NYS DWS for each of these compounds is 5 μg/L. No other organic compounds were detected in this area of the site.

In the north, west, and southern parts of the site, 13 ground water surveillance wells were monitored for water quality parameters, metals, and VOCs. Water quality data indicated that the pH was typically below the NYS DWS of 6.5 - 8.5 but within the range of values observed at locations upgradient of potential site impact. Other water quality parameters were below the applicable NYS DWS.

Conductivity values were all in the 50 - 155 umhos/cm range. Results from metals analyses of ground water from this area indicated that all compounds except iron and manganese were below the applicable NYS DWS. Iron concentrations exceeded NYS DWS at two wells on the north boundary and one well along the south boundary. Manganese concentrations exceeded NYS DWS at one well on the north boundary and one well on the west boundary. Volatile organic results for ground water samples collected from this area indicate that only TCA was detected in concentrations that exceeded NYS DWS. The TCA was observed at a concentration of 9 μg/L at both a well along the western side of the site designed to monitor the impact of operations at the BNL Paint Shop and along the southern boundary.

2.11 Off-Site Dose Estimates

For the year 1990, the collective committed effective dose-equivalent attributable to Laboratory operations, for the population up to a distance of 80 km, was calculated to be 1.8 person-rem (0.018 person-Sv). This can be compared to a collective dose-equivalent to the same population of approximately 290,000 person-rem (2900 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 0.066 mrem (0.00066 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 0.75 mrem (0.0075 mSv). The combined maximum individual dose equivalent is 0.9 mrem (0.009 mSv). This dose represents 0.9% of the maximum individual annual dose limit of 100 mrem (1 mSv) and 1.6% of the annual cosmic plus terrestrial external dose of about 60 mrem (0.60 mSv).

2.12 Quality Assurance Program

Brookhaven National Laboratory has implemented DOE Order CH 5700.6[20] by developing policies, responsibilities, and providing generic guidance procedures for the development of QA programs that are appropriate to ensure the achievement of Laboratory objectives.[21] 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.[22] Established protocols that document the specific activities of the EM program are collected in the S&EP EP Section QA Manual. A designated QA Officer was appointed to review procedures and activities within the EP Section and to assure that environmental and effluent monitoring or upgrade programs comply with the S&EP, BNL, and DOE QA objectives.

The level of quality control and quality assurance activities depend on the nature and frequency of measurements. Checks on instrument performance and on overall quality of the data were made with measurement control charts and with certified control organization. Samples were processed with quality control, which included using blanks, replicates, and spikes. The analytical laboratories participated in interlaboratory QA programs organized by DOE, EPA, and NYSDEC agencies.

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 CY 1990 follows the recommendations given in the DOE Order 5400.1, General Environmental Protection Program.[23]

3.1 Airborne Effluent Emissions

3.1.1 Radioactive Airborne Effluent Emissions

The locations of principle Laboratory facilities from which radioactive airborne effluents were released during 1990 are shown in Figure 9. The installed on-line effluent monitors, sampling devices, and amounts of effluents released during 1990 are presented in Appendix D, Table 4. Tritium was the only radionuclide detected routinely at the site boundary which was attributable to Laboratory operations. Iodine-126 was detected on one site boundary particulate filter during the month of January but not on the corresponding charcoal filter. There were no unusual effluent releases or processes that would explain the presence of this radionuclide during the sample interval. Furthermore, because the radionuclide was detected on only the particulate filter and not the corresponding charcoal filter, there is some question as to the validity of the datum point. The datum is presented because there was no technical justification for removal. It should be viewed as an outlier whose validity is questionable.

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).[24] Based on 117 milliampere-hours of operation, 700 Ci (26 TBq) of oxygen-15 was produced in the beam tubes at the BLIP facility during 1990 and released via the Building 931 stack. Due to scheduled maintenance at the LINAC and AGS, BLIP did not operate during the months of June through December, 1990. Monthly effluent emissions are listed in Appendix D, Table 5.

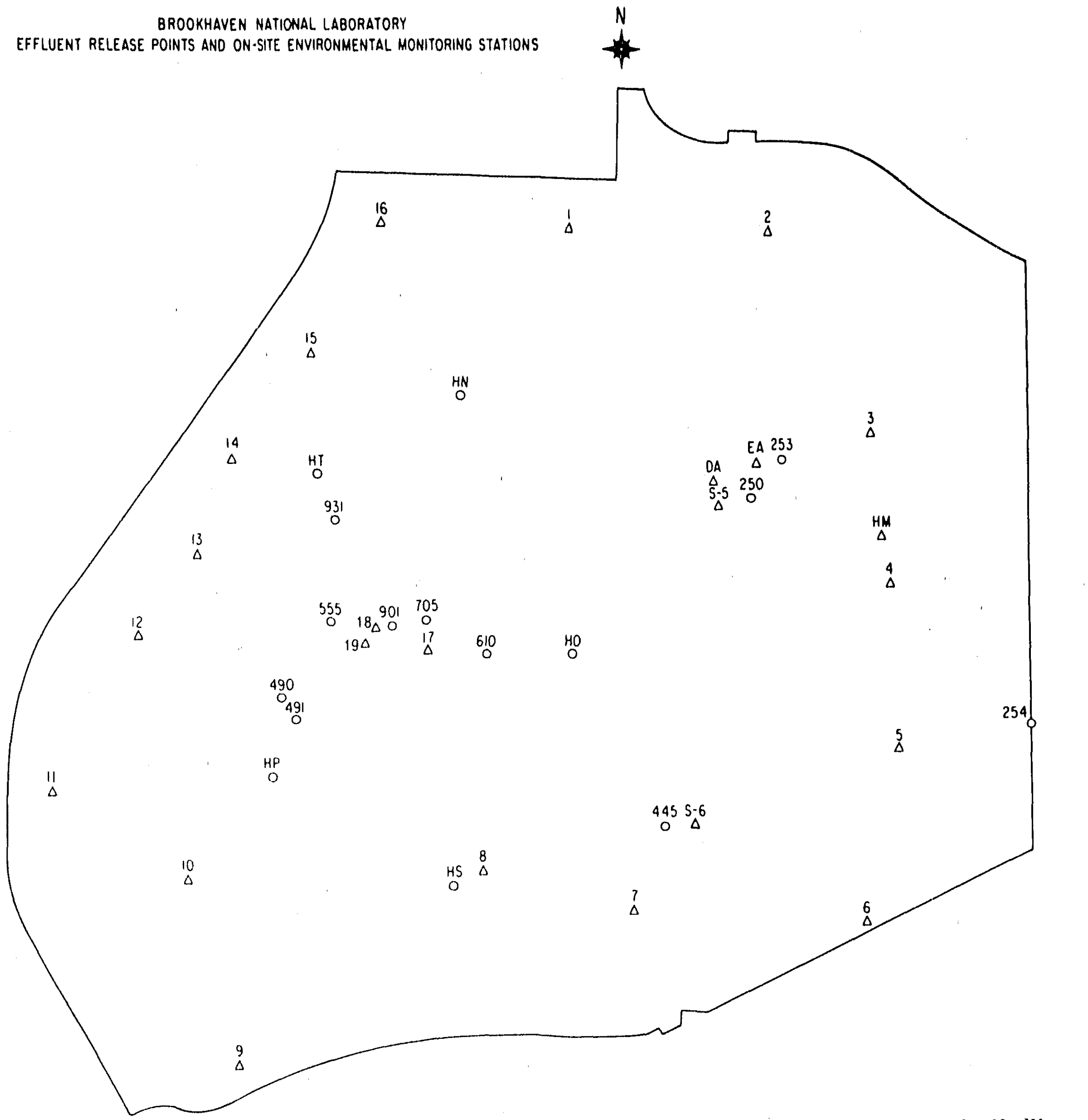
Argon-41, which has a 110-minute half-life, is produced at the MRR by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the Building 491 stack at an estimated rate of 2.1 Ci $MW^{-1}h^{-1}$ (78 GBq $MW^{-1}h^{-1}$). The estimated release for the MRR stack during 1990 was 1,046 Ci (39 TBq) of argon-41. Monthly effluent emissions are listed in Appendix D, Table 5. The MRR did not operate from April through July, 1990 due to SPDES issues related to the discharge of secondary cooling water. A detailed discussion of this issue is discussed in Section 3.2.3.2 of this report. During the April to July time period, modifications to the secondary cooling system were made so that BNL's potable water could be used to supply secondary cooling water. The MRR commenced operation in August at 1 MW using water supplied by the potable water system. From August to the end of the year, the MRR operated at the reduced power level.

The total tritiated water vapor released from the Laboratory research facilities during 1990 was 31.8 Ci (1.2 TBq). Of this total, 24.3 Ci (0.9 TBq) were released from the HFBR, 4.4 Ci (0.16 TBq) from the Van de Graaff, and the remainder from all other facilities. Appendix D, Tables 6 and 7 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, Tables 7, 8, and 9. Tritium is the major radionuclide released from the HFBR. Because the HFBR did not operate in 1990, tritium releases are substantially lower than prior year's releases. The HFBR is scheduled to resume operation in 1991. Tritium releases from this facility will increase when the facility comes on-line and research activities are resumed. The Hot Laboratory complex air effluent release from the acid and non-acid off-gas systems are reported in Appendix D, Tables 8 and 9, respectively. These releases are the result of processing BLIP targets for the recovery of radioisotopes used by medical health practitioners. Releases from this facility were at their maximum during the period of March through May. This corresponded to an increase in work load in anticipation of the summer shut-down of the facility. In 1990, releases of gallium-68, zinc-65 and rubidium were significantly lower than in 1989 while other radionuclides, such as bromine-77 and the iodines, exhibited an increase in the release rate by a factor of three to nine. Releases from this facility were not detected by air sampling at the site boundary. Appendix D, Tables 8 and 9 appear to indicate that no releases occurred in February 1990. This is an anomaly of the data presentation. The sample media were installed in January and removed in early March. The amount released during February are shown in the January values.

In addition to radionuclides released during the processing of targets from the BLIP Facility, other radionuclides in addition to oxygen-15 are produced at the BLIP Facility and are periodically emitted into the environment. Appendix D, Table 10 summarizes the gamma emitting radionuclides released from this facility. The predominant radionuclide released in 1990 was beryllium-7 (0.37 mCi [0.014 GBq]). The activity released was approximately four times smaller in 1990 than in 1989.

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 11. Tritium was the radionuclide released from the incinerator in the largest quantity, 0.0016 Ci (0.059 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.



0 180 360 Meters
SCALE

△ 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

O 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

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

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 12. 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 1990, the fraction of light feed stock (LFS) relative to total fuel consumption was approximately 1.5%. 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.[25] The NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum.[25] 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,[26,27] 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.

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.[28] 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 Waste Concentration Facility (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[29] or are

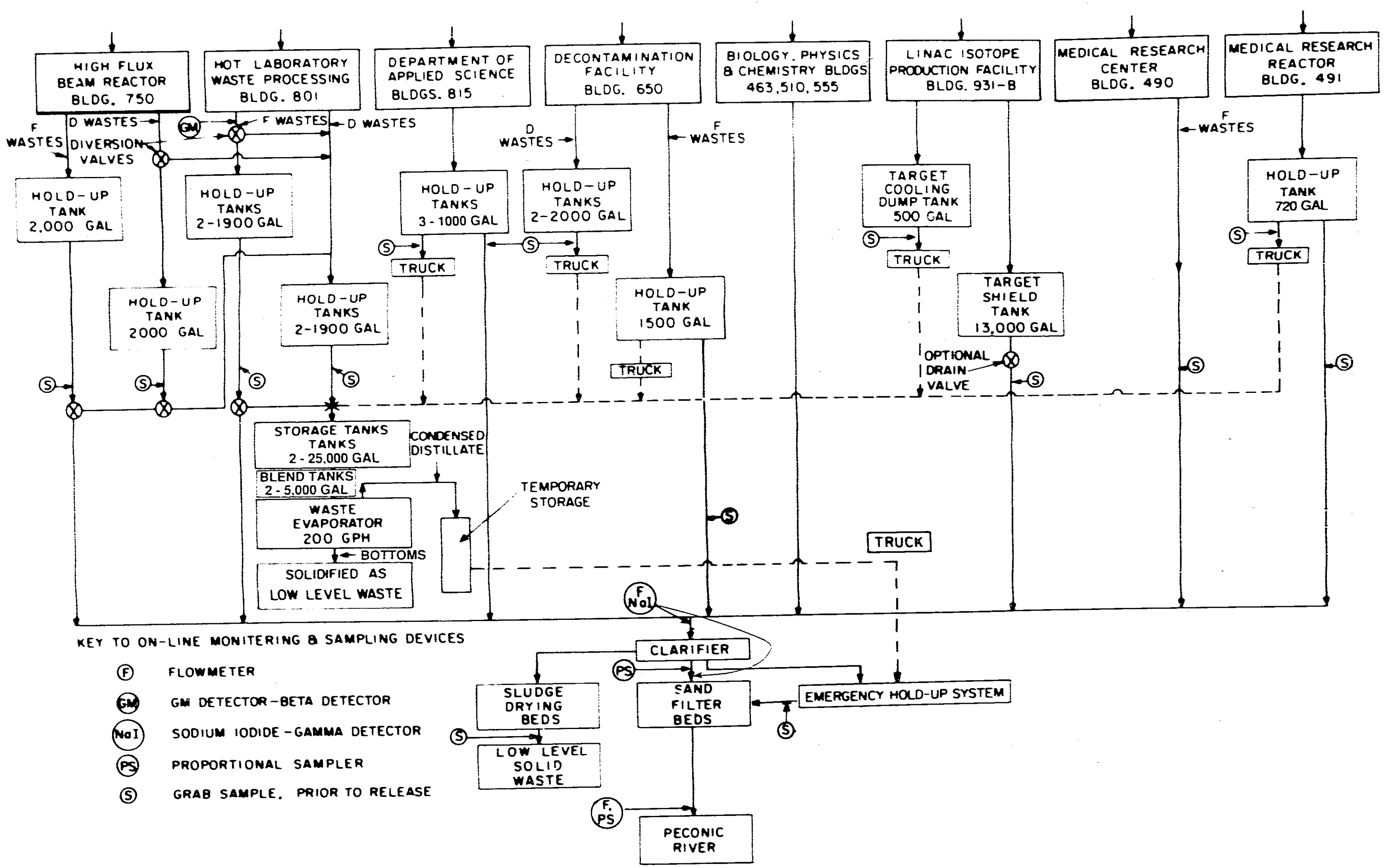


Figure 10: Liquid Effluent Systems Brookhaven National Laboratory

transferred to the WCF for processing. In 1990, authorized releases of F-waste to the sanitary system totaled 1.03 million liters with a total gross beta activity of 0.47 mCi (17 MBq) and a total tritium activity of 22 mCi (0.81 GBq). The volume of material released in 1990 represents a ten percent increase over 1989 while the tritium and gross beta activity released increased by factor of 1.6. Although the total activity released in 1990 is higher than in 1989, these releases remain significantly lower than pre-1989 values.

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 DCG[9] for tritium is 2,000,000 pCi/L (0.074 MBq/L). In 1990, approximately 68,100 liters of distillate containing 0.85 Ci (31.6 GBq) of tritium was placed into the lined holding pond.

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 85% of the water is recovered by an underlying tile field. This recovered water is then released into a small stream that contributes to the headwaters of the Peconic River. The Peconic River is an intermittent stream within the BNL site. From the mid 1980's until April of 1989, virtually all water released to this channel recharged to ground water prior to reaching the site boundary. Beginning in April, 1989 and continuing throughout 1990, 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 15% in 1990, 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. Real time monitoring of the clarifier influent for radioactivity, pH and conductivity, takes place at two locations: about 1.8 km upstream of the STP and as the influent is about to enter the clarifier. The upstream station provides about one hour of advanced warning that liquid effluents which may exceed BNL effluent release criteria or SPDES limits have entered the system. At the clarifier, an oil monitor examines STP influent for the presence of oil. Effluent leaving the clarifier is monitored a third time for radioactivity. Effluent that does not meet BNL and/or SPDES effluent release criteria are diverted to one of two lined holding ponds with a 26.5 million liter capacity until the effluent meets the release criteria. Material diverted to the holding pond is evaluated for treatment and released when the addition of this material will not result in exceeding BNL SPDES or administrative release criteria.

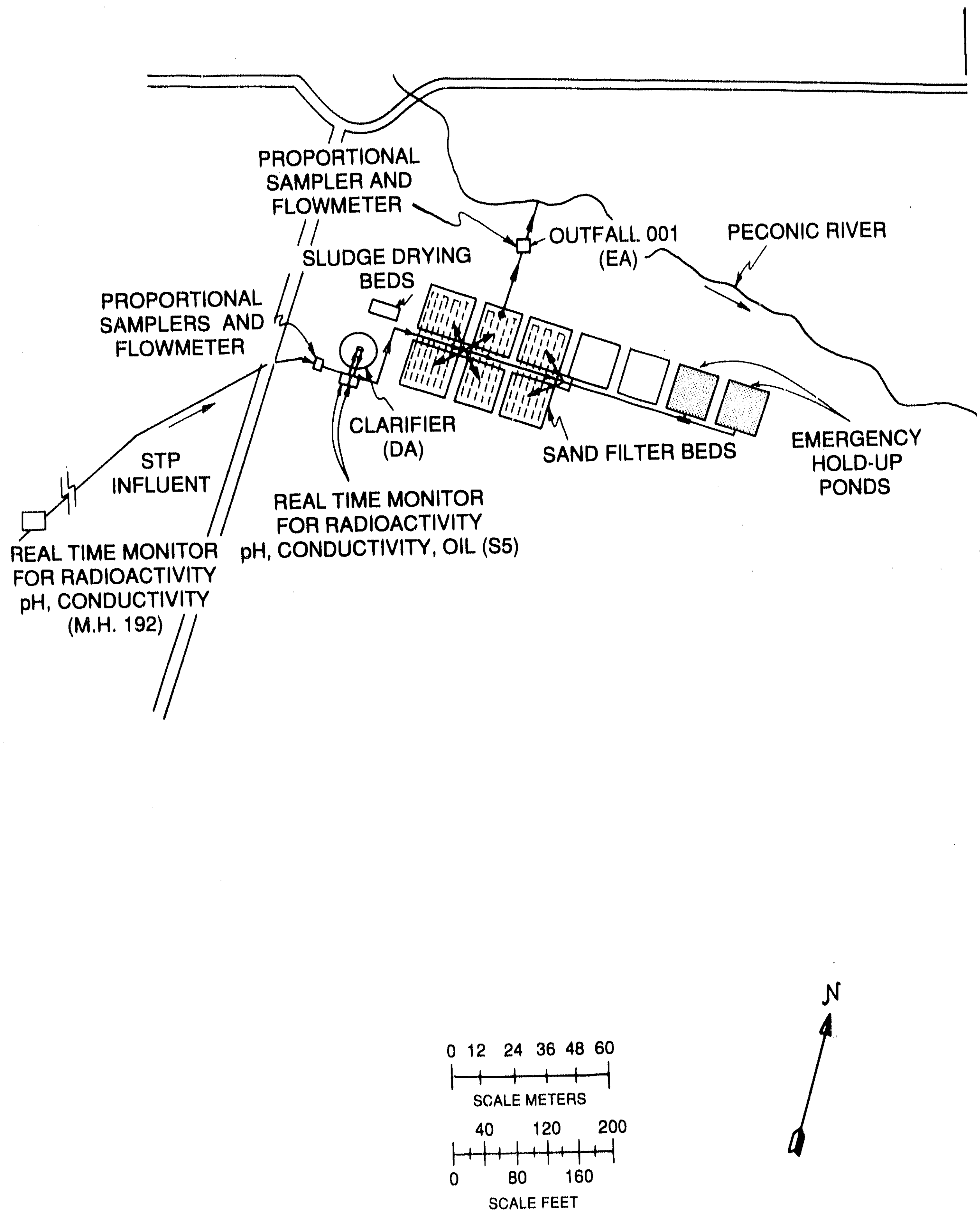


Figure 11: Sewage Treatment Plant - Sampling Stations

In addition to real time monitoring, the clarifier effluent (Location DA) and the outfall to the Peconic River (Location EA) are monitored for radiological and non-radiological parameters through a combination of volume proportional and grab samples.

3.2.2.1 Radiological Analyses

The proportional samples collected at Location DA, the effluent from the STP clarifier, Location EA, and 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 13 and 14. Five year 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 from 1971 to the present is presented in Figure 14.

The gross alpha data at the STP are 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 1990 on the average by about 40% below 1989 levels. This occurred in large part because the HFBR didn't operate for the entire year. Controlled releases of WCF distillate from the STP emergency holding ponds continued in 1990 and is the reason that tritium discharges to the Peconic River are larger than influent contributions reported from sampling Location DA. The 1990 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 1.3 Ci (48 GBq) as compared to 2.0 Ci (74 GBq) in 1989. The tritium activity discharged from Location EA was 1.4 Ci (51 GBq) as compared to 2.5 Ci (92.5 GBq) in 1989. The concentrations of strontium-90 and gamma emitting radionuclides entering the STP returned to pre-1988 levels. At Location DA, all radionuclide concentrations were at or below pre-1988 levels. At Location EA, except for cesium-137, the remaining concentrations are essentially constant with prior year's data.[10] Elevated cesium-137 concentrations persist at Location EA due to residual leaching of this radionuclide 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 SER.[10] In 1990, cesium-137 concentrations were still four times pre-1988 values.

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 1990, gross beta concentrations at Location EA were essentially 1.6 times the influent concentrations. Cesium-137 concentrations in water collected from Location EA were 25 times the concentration found in the clarifier effluent which is consistent with 1989 data. Strontium-90 concentrations at Location EA were about 1.5 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. Finally, strontium-90 data are reported here and throughout the report only for the first three quarters of 1990. Fourth quarter 1990 samples were not analyzed in time for inclusion in the 1990 report but will be included in the 1991 report. 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 0.2 mrem (0.002 mSv) or 5% of BNL's current discharge policy.

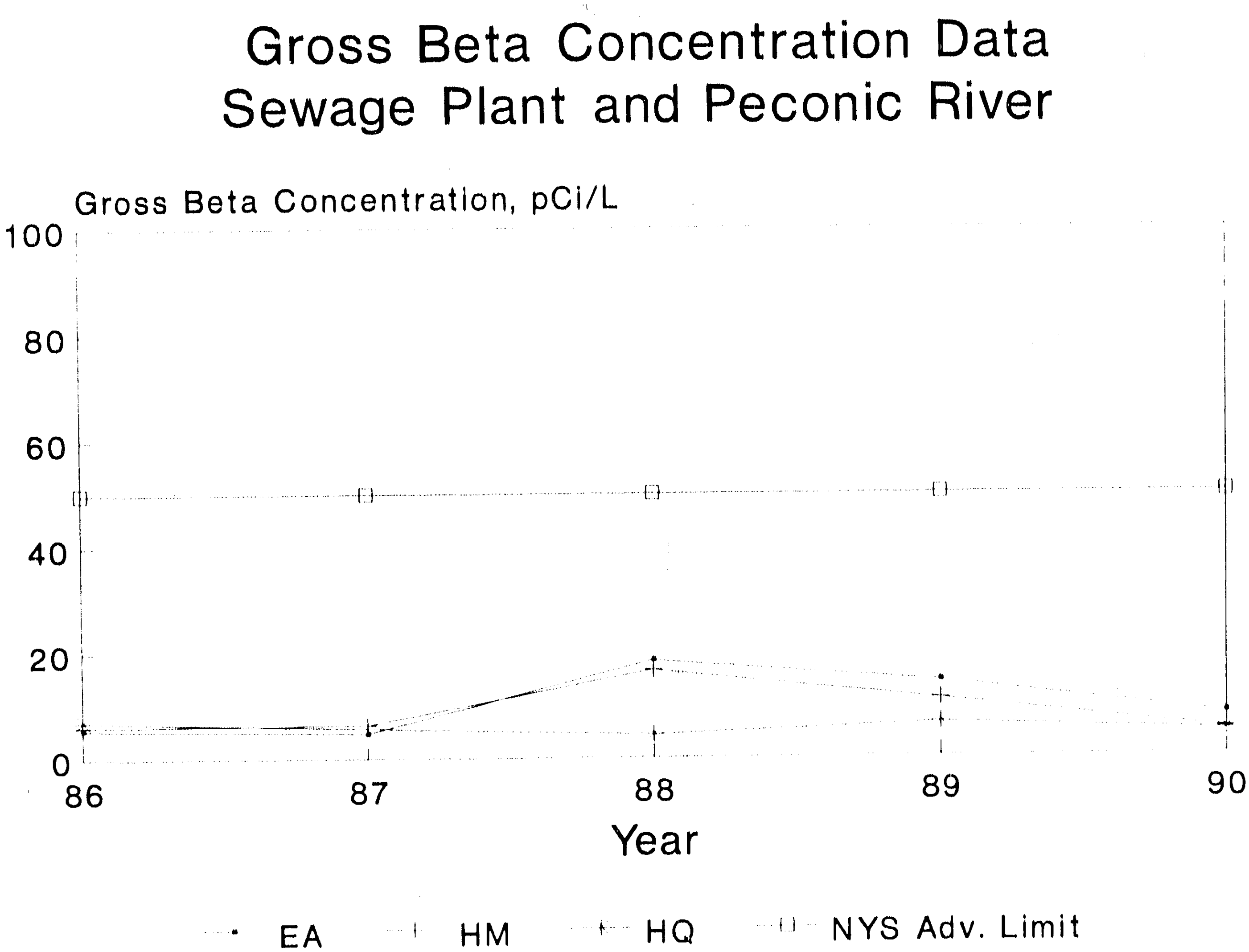


Figure 12: Gross Beta Concentration Data - Sewage Plant and Peconic River

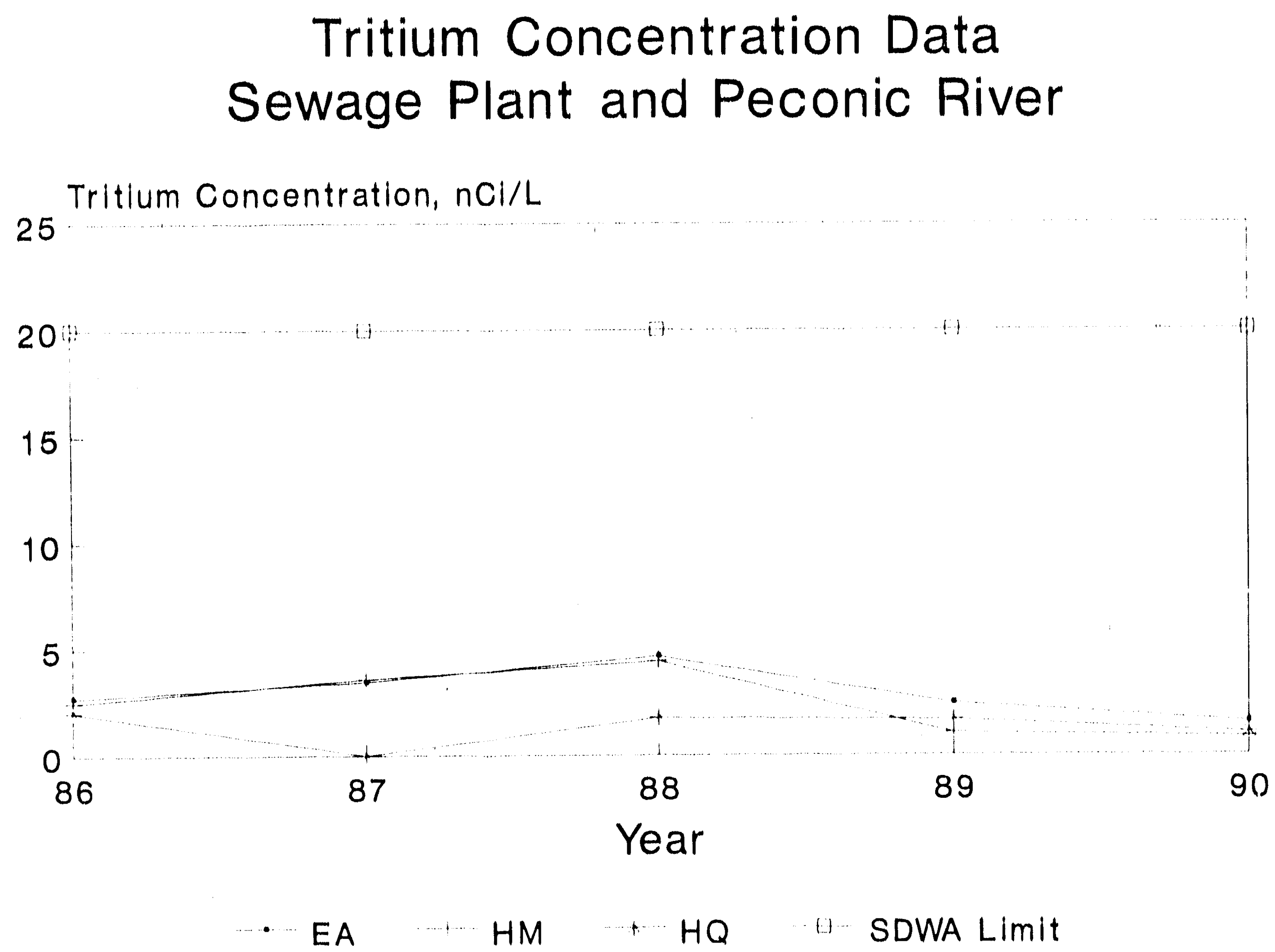


Figure 13: Tritium Concentration Data - Sewage Plant and Peconic River

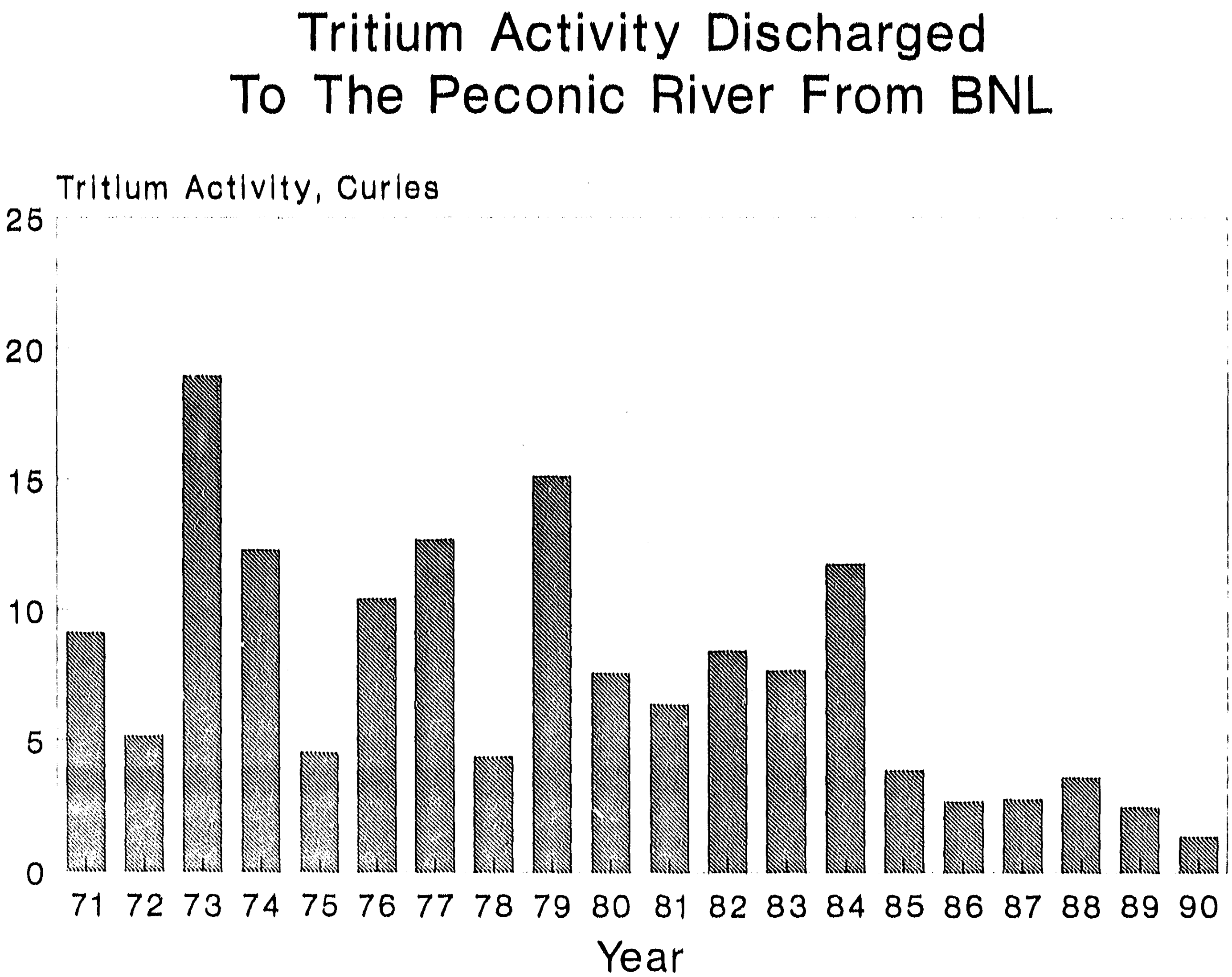


Figure 14: Tritium Activity Discharged to the Peconic River from BNL 1971 to 1990

3.2.2.2 Non-radiological Analyses

The effluent from the Laboratory STP discharges into the Peconic River at Location EA (Outfall 001) and is subject to the conditions of the SPDES Permit No. NY-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 non-radiological data for 1990 is shown in Appendix D, Table 15. 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 99.8% compliance rate in meeting permit requirements. A compliance summary is presented in Appendix D, Table 16. In 1990, monthly grab samples of Outfall 001 effluent for volatile organic analysis was initiated in July due to the presence of TCA in a SPDES compliance verification sample that was collected in March, 1990 by New York State. Six months of grab samples collected at approximately 0930 hours during the first week of each month have indicated that all results are below the system detection limits.

Figures 15 through 23 present the maximum monthly concentrations and the average loading of copper, iron, lead, silver, and zinc. Plotted along with the observed concentrations are the current SPDES permit limits and the proposed limits for the resubmitted SPDES permit. While all metals concentrations are well within the existing permit conditions, the proposed revised SPDES permit would establish lower acceptable release concentrations. In the cases of copper and zinc, the proposed discharge limits on allowed releases could necessitate stricter source control in order to assure compliance. In addition, in order to demonstrate compliance with the proposed discharge limits for lead and silver, an instrument detection limit with greater sensitivity will be required.

3.2.3 Recharge Basins

Figure 24 depicts the locations of BNL recharge basins within the physical complex. An overall schematic of water use at the Laboratory is shown in Figure 25. After use in "once through" heat exchangers and process cooling, approximately 6.78 million liters per day (MLD) of water was returned to the aquifer through on-site recharge basins; 2.04 MLD to Basin HN (Outfall 002) located about 610 m northeast of the AGS; 4.13 MLD to Basin HO (Outfall 003) about 670 m east of the HFBR; and 0.41 MLD to Basin HP (Outfall 004) located 305 m south of the MRR. Recharge Basins HS (Outfall 005) and HT (Outfall 006) receive a total of about 0.20 MLD. Discharge of cooling water to recharge basin HO was reduced from 1989 levels because the HFBR did not operate in 1990. The recharge volume to Basin HP is a factor of ten lower than in 1989 because secondary cooling for the MRR was supplied by the potable water system for six months and the MRR did not operate for three months.

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 2.04 MLD was discharged to the HN Basin, and 3.4 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 (0.77 MLD) was also discharged to the HO Basin. The MRR secondary cooling water (0.41 MLD) was adjusted to a neutral pH prior to use and then discharged to the MRR sump as shown in Figure 24. Grab samples were collected at all recharge basins for water quality analysis as part of the routine EM program.

MAXIMUM EFFLUENT CONCENTRATION OF COPPER DISCHARGED FROM BNL'S STP, 1986 - 1990

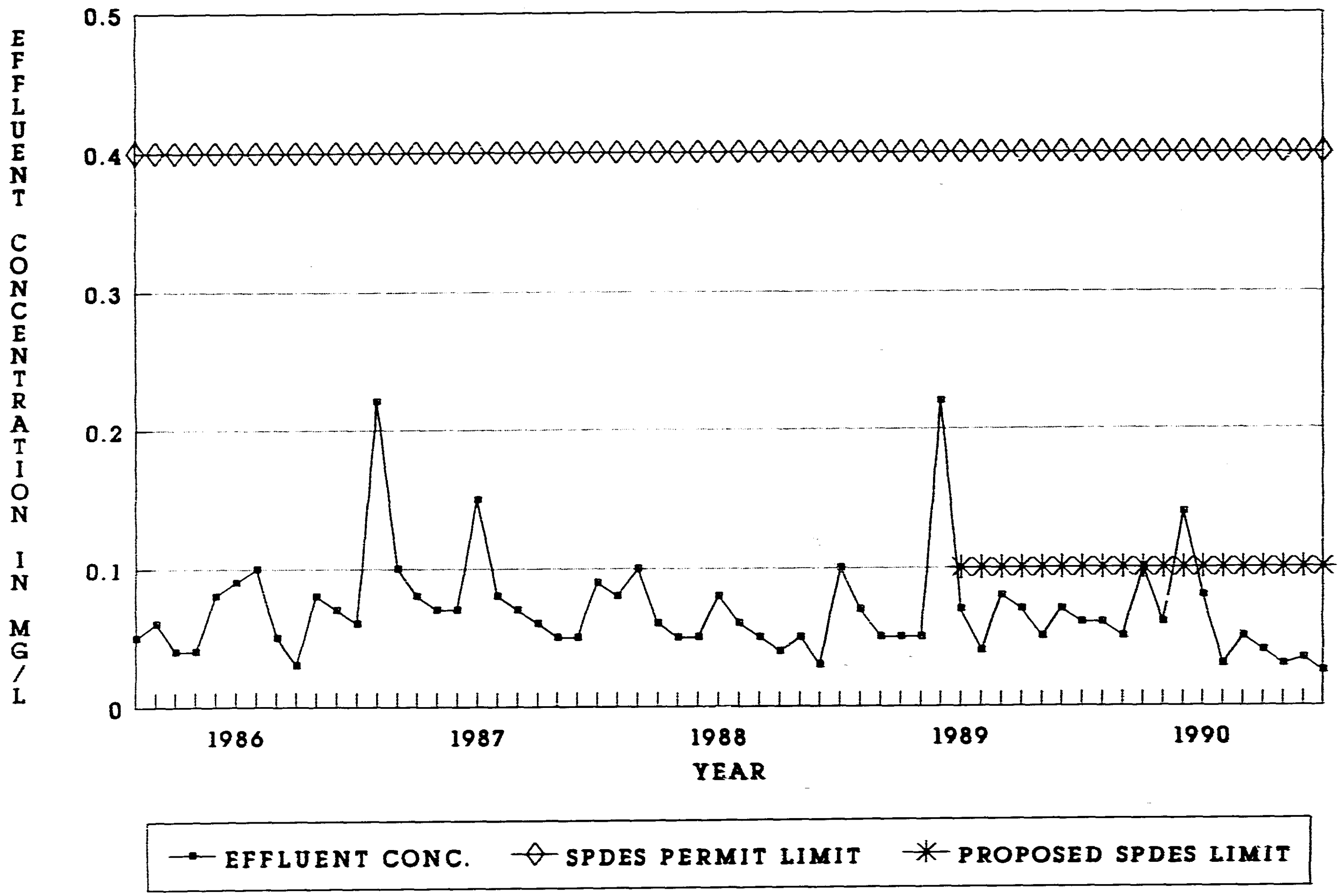


Figure 15: Maximum Effluent Concentration of Copper Discharged from BNL's STP

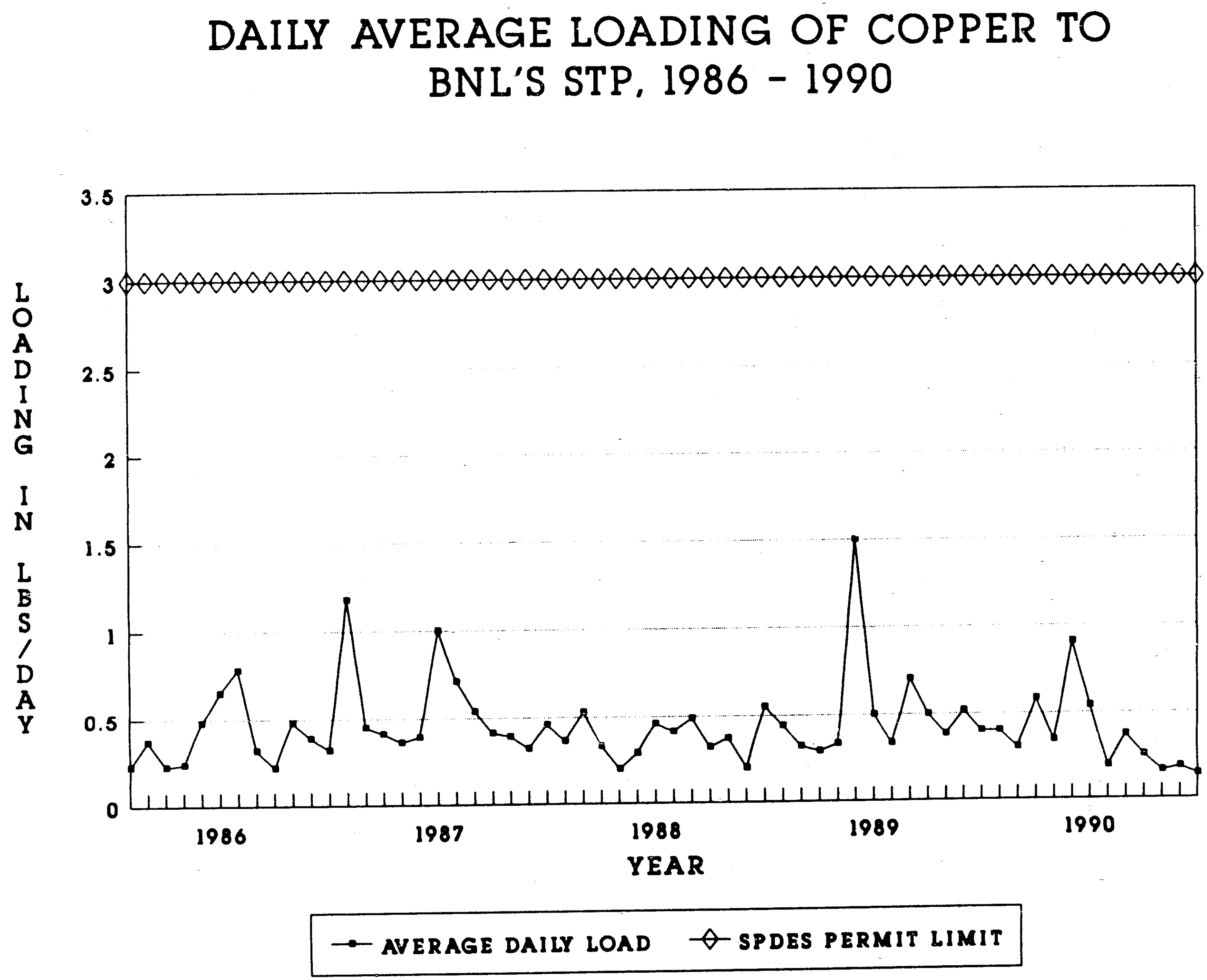


Figure 16: Daily Average Loading of Copper to BNL's STP, 1986 - 1990

MAXIMUM EFFLUENT CONCENTRATION OF IRON DISCHARGED BY BNL'S STP, 1986 - 1990

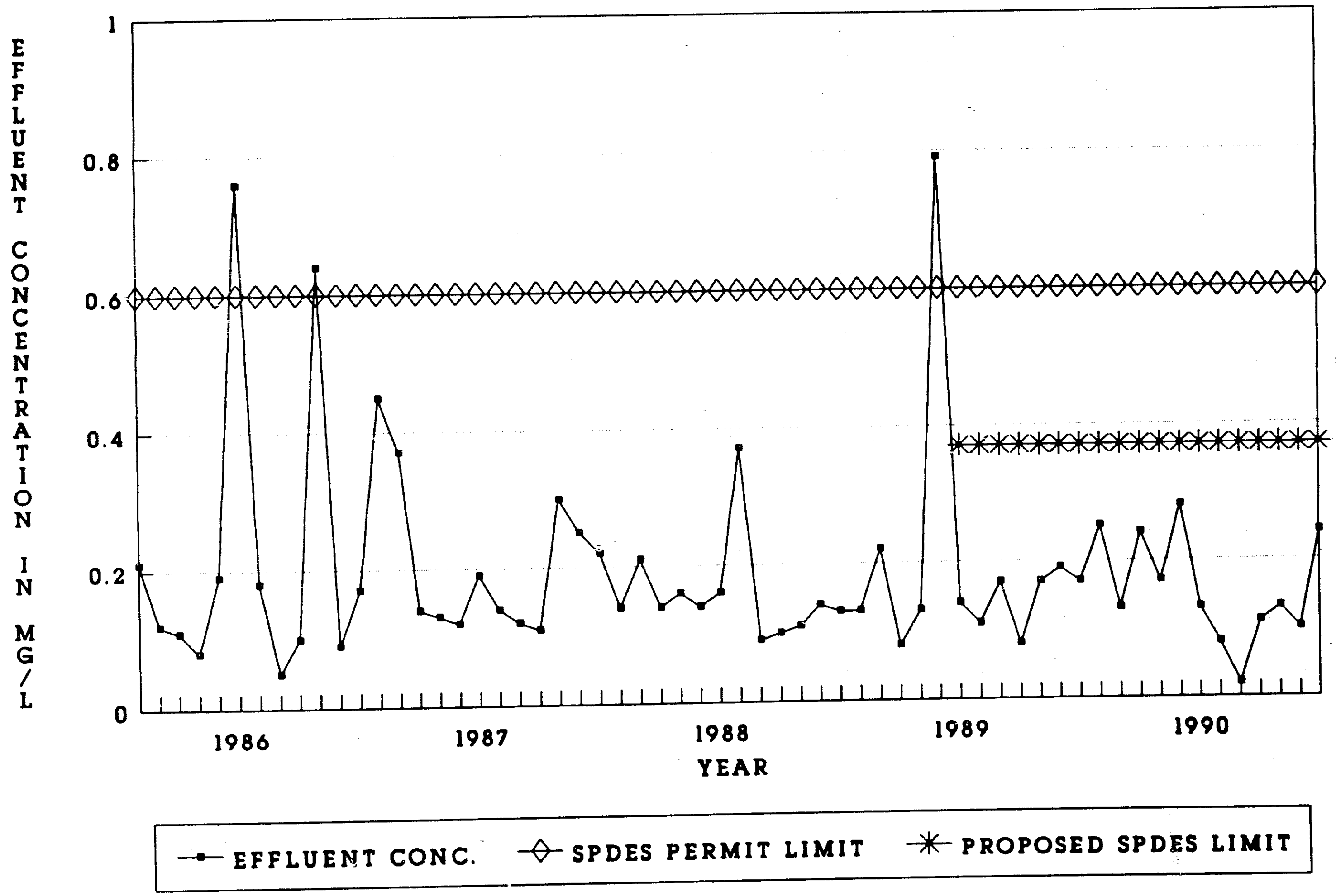


Figure 17: Maximum Effluent Concentration of Iron Discharged by BNL's STP

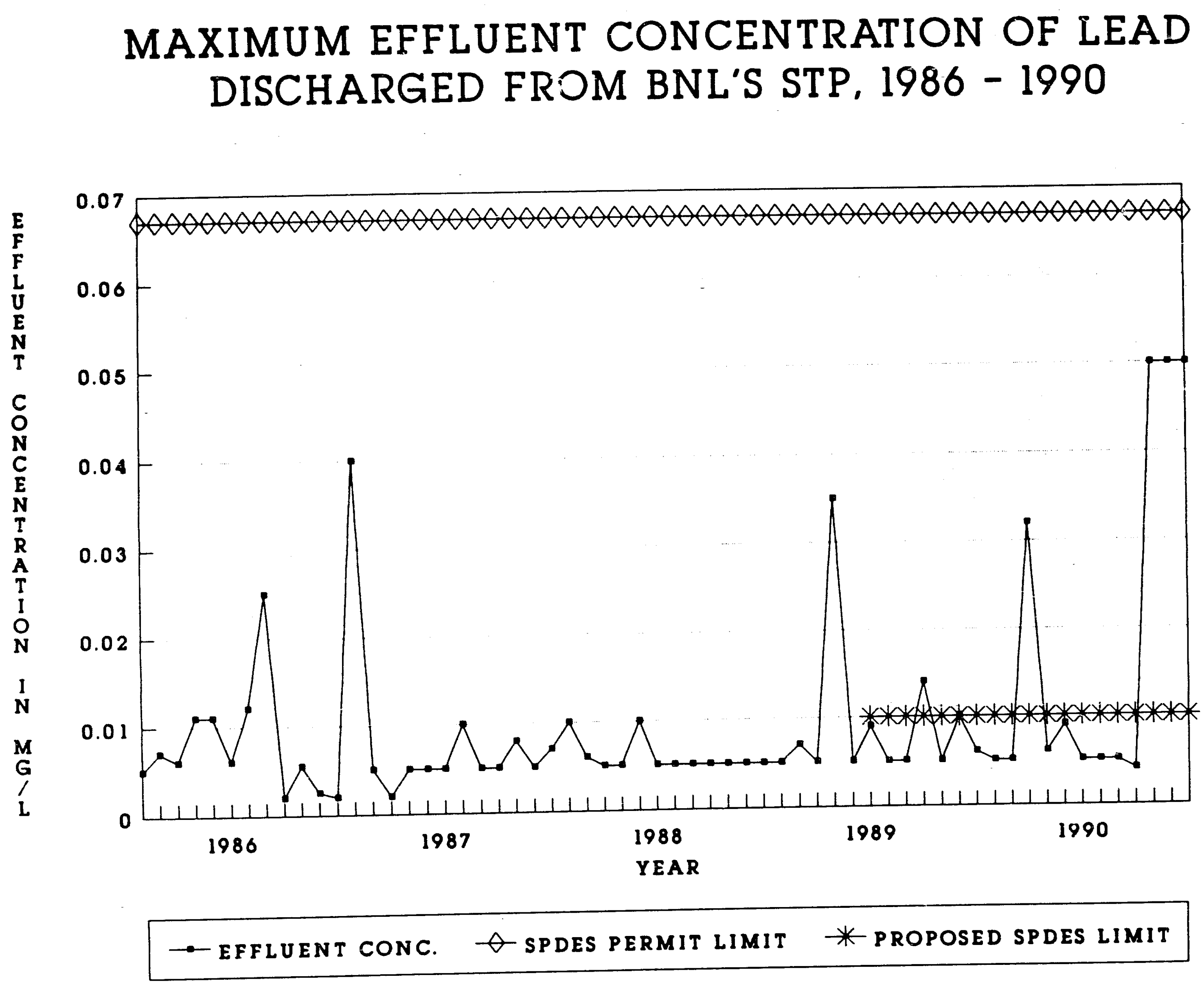


Figure 18: Maximum Effluent Concentration of Lead Discharged from BNL's STP

DAILY AVERAGE LOADING OF LEAD TO BNL'S STP, 1986 - 1990

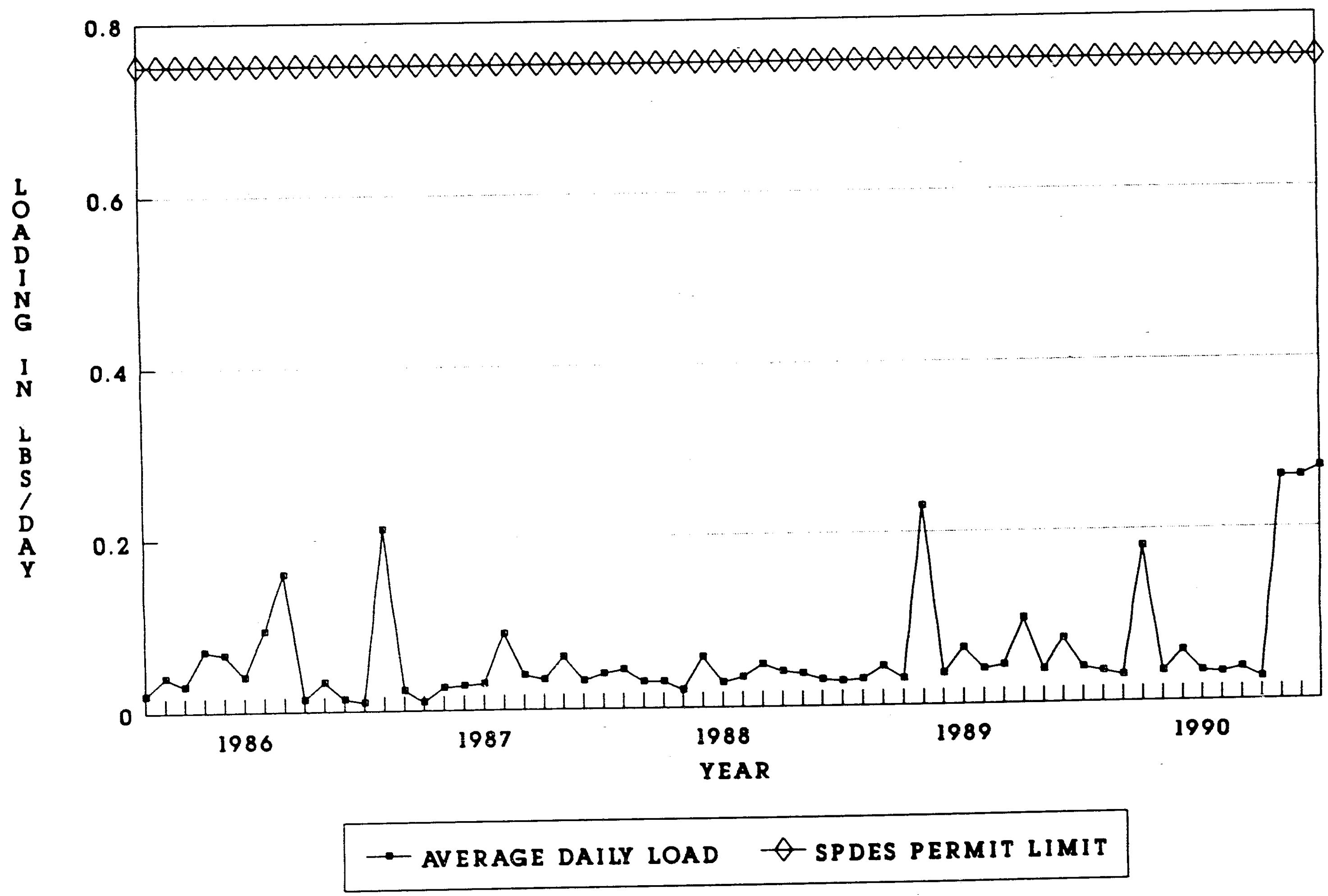


Figure 19: Daily Average Loading of Lead to BNL's STP, 1986 - 1990

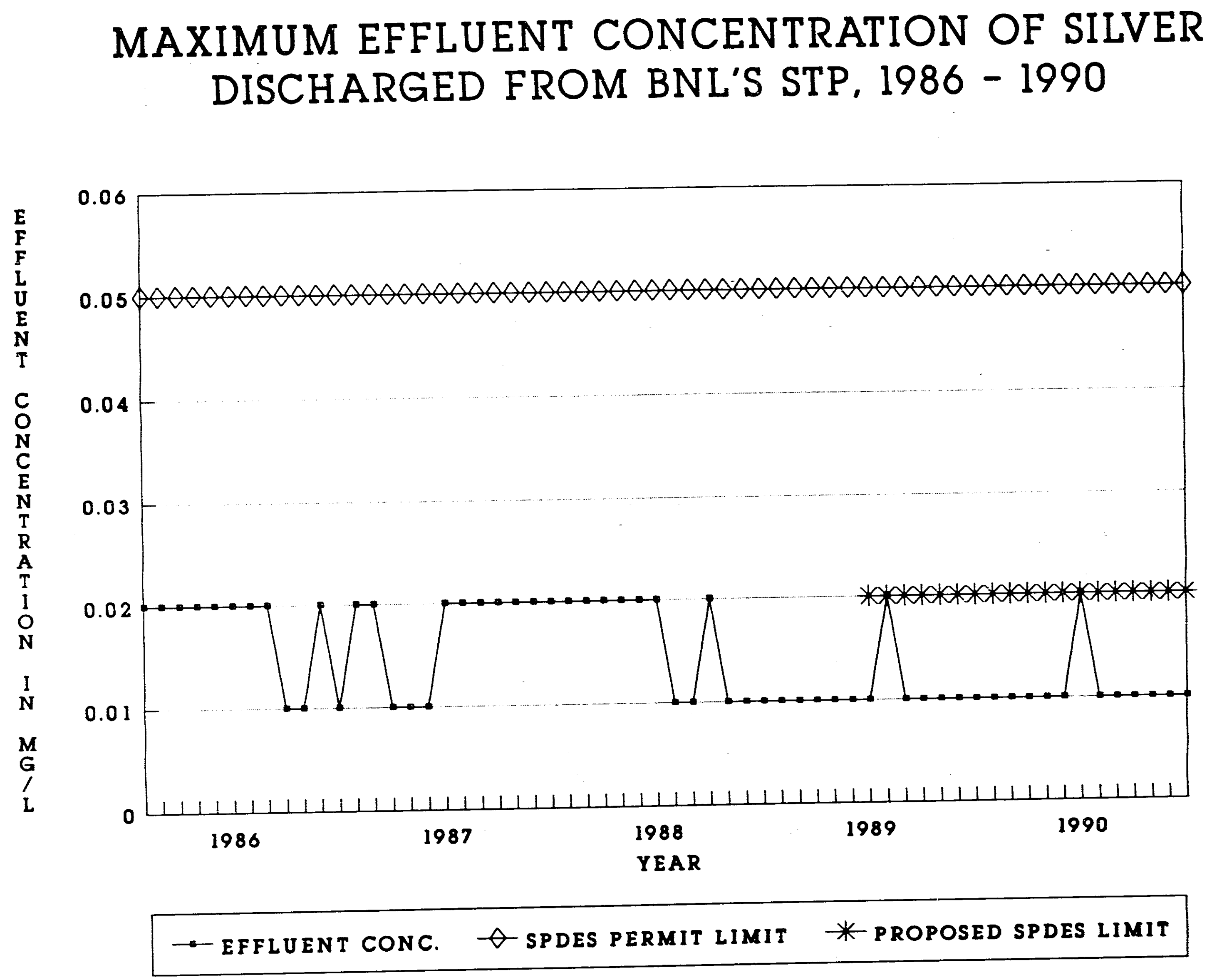


Figure 20: Maximum Effluent Concentration of Silver Discharged from BNL's STP

DAILY AVERAGE LOADING OF SILVER TO BNL'S STP, 1986 - 1990

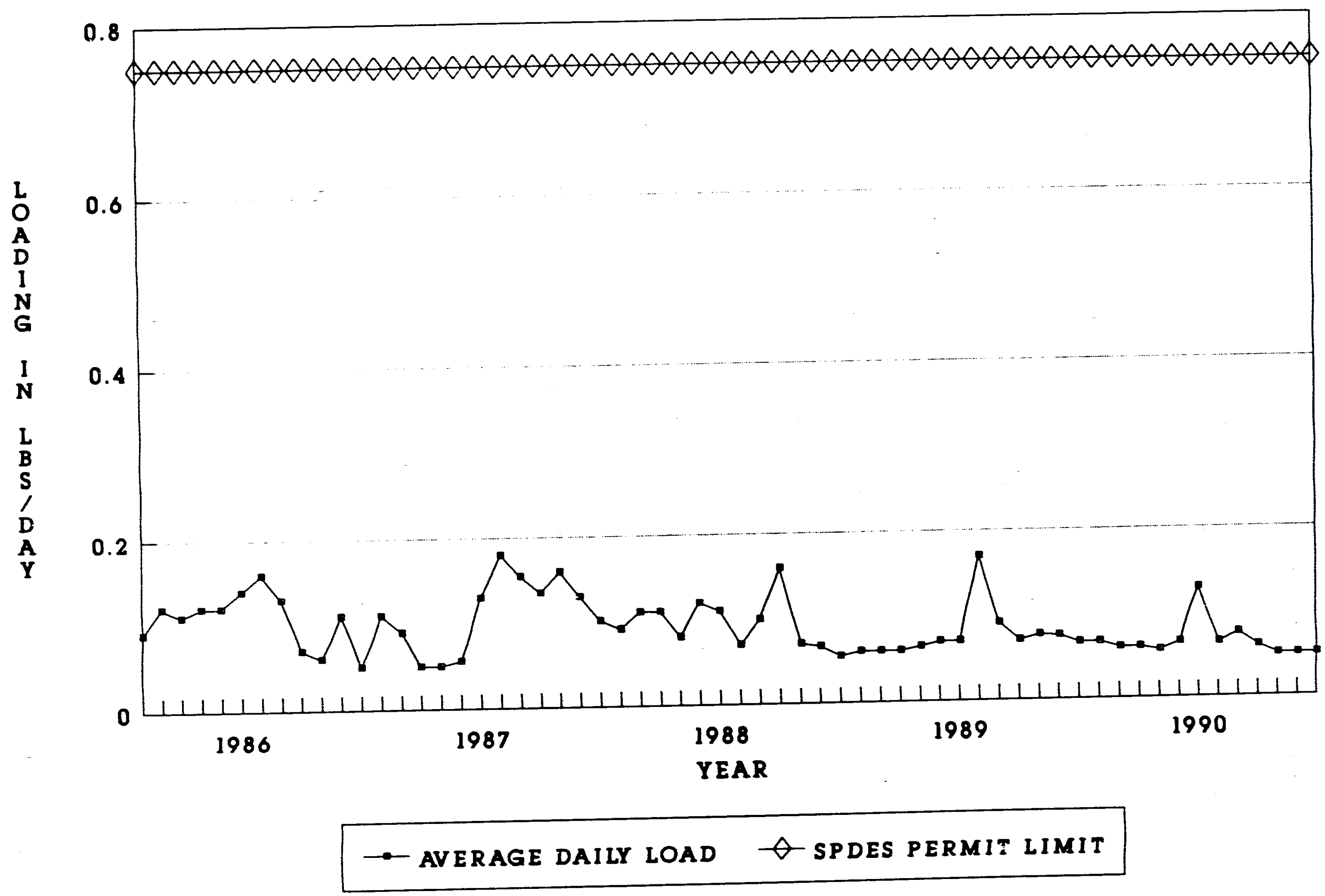


Figure 21: Daily Average Loading of Silver to BNL's STP, 1986 - 1990

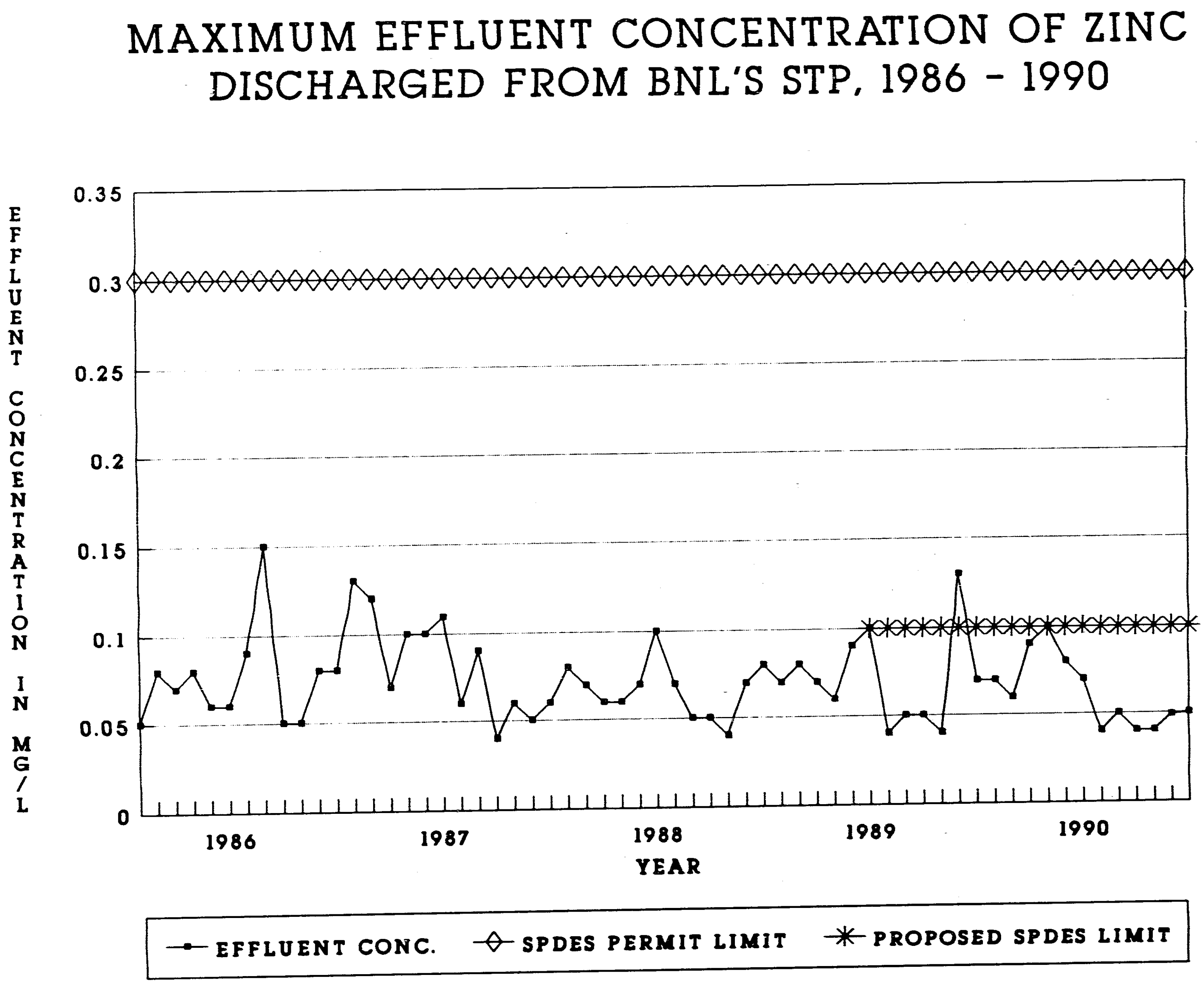


Figure 22: Maximum Effluent Concentration of Zinc Discharged from BNL's STP

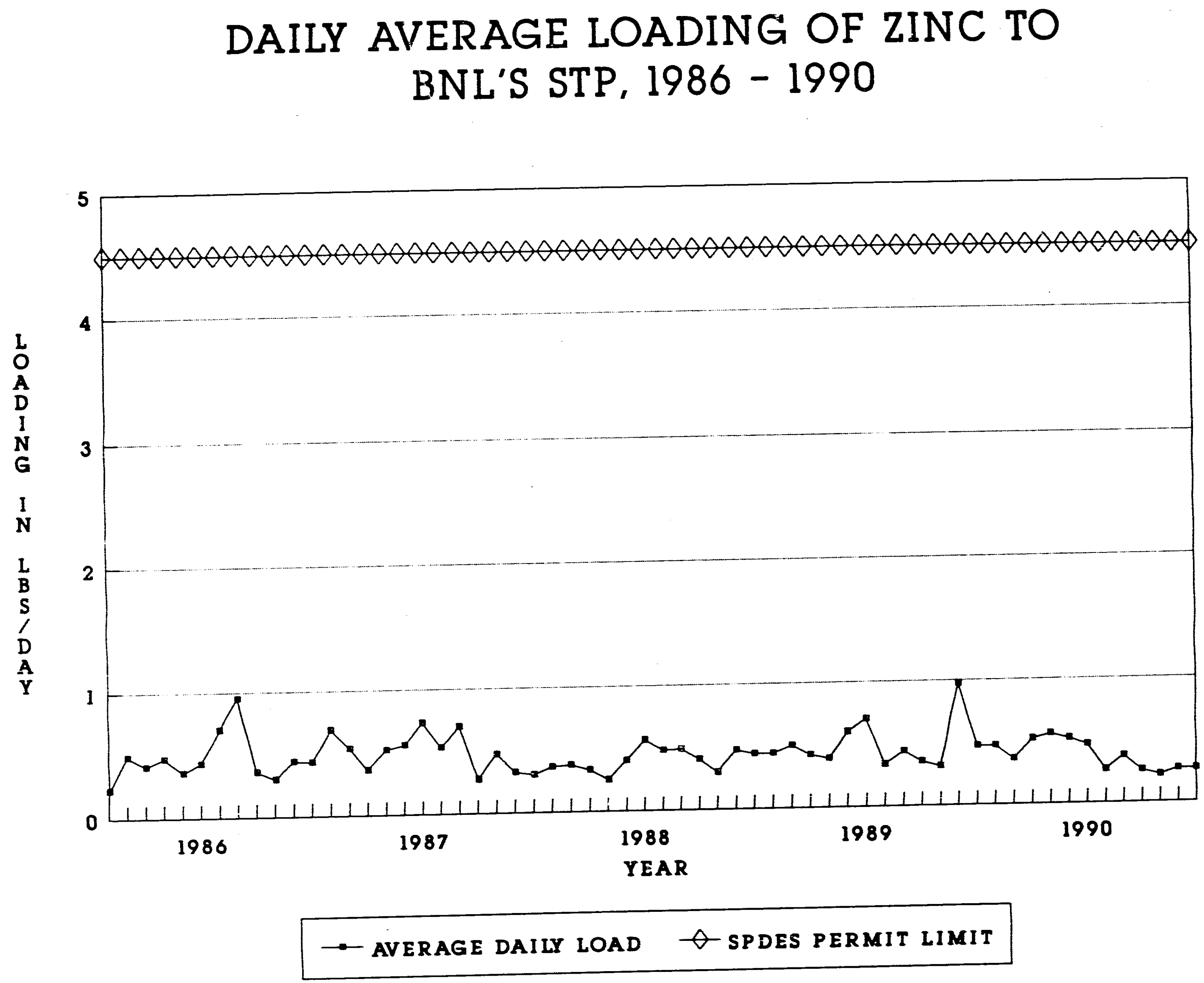


Figure 23: Daily Average Loading of Zinc to BNL's STP, 1986 – 1990

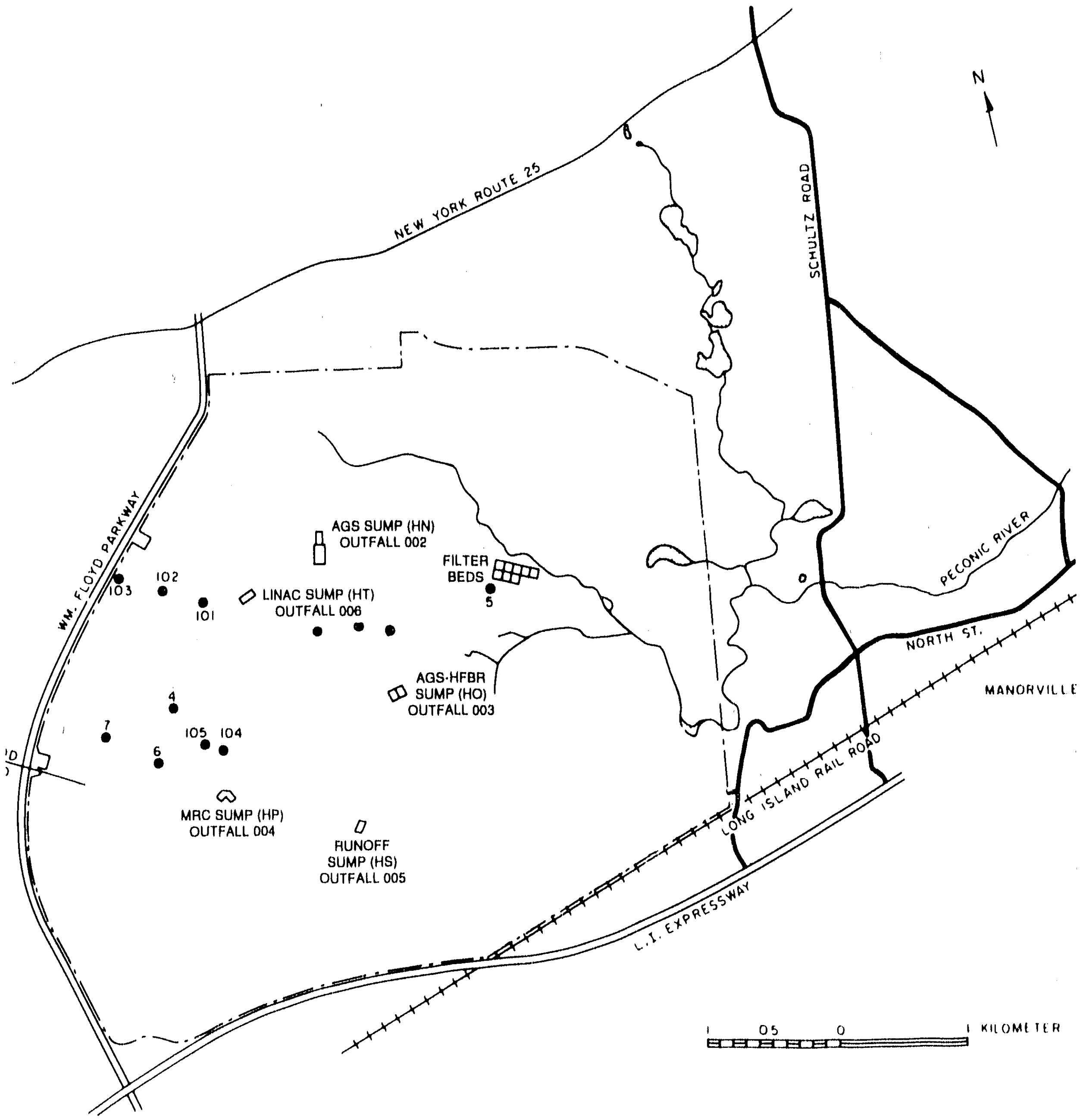


Figure 24: On Site: Potable and Supply Wells and Recharge Sumps

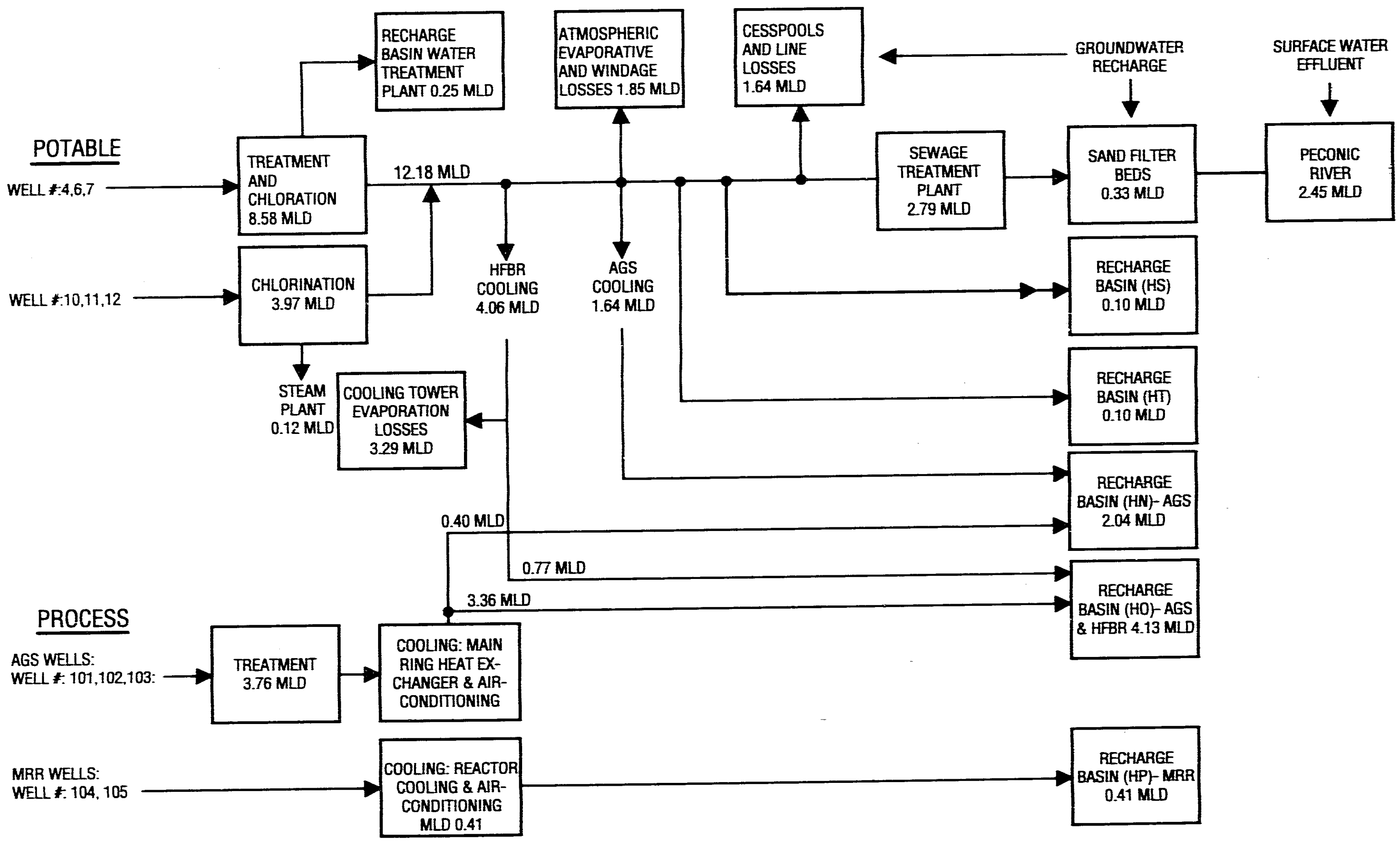


Figure 25: Brookhaven National Laboratory Schematic of Water Use and Flow for 1990

3.2.3.1 Recharge Basins - Radiological Analyses

Radiological results for recharge basin samples are reported in Appendix D, Table 17. The data indicates that trace quantities of activity were discharged to Recharge Basin HN. The activity detected at Recharge Basin HN resulted 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 the remaining radionuclides is most likely due to activation of facility components and subsequent corrosion. No samples contained strontium-90 above ambient levels and for virtually all samples the tritium concentration was at or 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 0.05 mrem (0.0005 mSv).

3.2.3.2 Recharge Basins - Non-radiological Analyses

In 1990, approximately 6.8 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 4.8 and 8.1. These values are outside the discharge limits of 6.5 to 8.5 but consistent with ground water observations throughout the site and observed ranges of pH in precipitation. This last observation is important because most recharge basin samples are collected from the standing water in the basin which can be a mixture of precipitation and process water. The results of selected water quality parameters are presented in Appendix D, Table 18. All values were within the NYS DWS.

Water discharged to recharge basins was also sampled and analyzed for metals. The results of these analyses are presented in Appendix D, Table 19. Although discharges to recharge basins typically met NYS DWS, elevated iron concentrations were observed at Recharge Basins HN (Outfall 002), HO (Outfall 003), and HS (Outfall 005). Recharge Basins HN and HO receive most of their water from AGS pumping wells where no iron removal is performed on ground water. Recharge Basin HS receives predominantly rainwater run-off and a limited amount of processed cooling water.

Collection of grab samples from the recharge basins for VOC analyses was initiated in 1990. Analytical results are presented in Appendix D, Tables 19A and 19B. No VOCs were detected with the exception of chloroform, which was found in concentrations ranging from 2 to 5 μg/L. The NYD DWS standard for this compound is 100 μg/L.

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.[30,31] The locations of the on-site and off-site TLDs are shown in Figures 26 and 27, 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 21. The annual average dose-equivalent rate as indicated by all TLDs was 60.7 mrem/a (0.61 mSv/a). The dose-equivalent rate at the site boundary was 61.2 mrem/a (0.61 mSv/a), while the off-site average rate was 60.3 mrem/a (0.60 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 and not related to BNL operations.[10]

The maximum dose at the site boundary due to argon-41 and oxygen-15 airborne emissions was calculated using CAP88[32] as 0.07 mrem (0.0007 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 January, 1990, a single particulate filter was identified as containing trace quantities of iodine-126. Although iodine-126 was emitted from the Building 801 Hot Laboratory during this period, the release rate was at normal levels. Furthermore, iodine is normally not detected on particulate filters without a significantly larger fraction being adsorbed onto the charcoal filter that is present in the sampling train. Source term information and supplemental environmental data do not support this result as valid. Consequently, the datum is considered as an outlier. It is presented in the tables but not used in the assessment of facility impact.

3.3.2.1 Tritium Analyses

Sampling for tritium vapor was performed at six different on-site stations (as shown in Figure 9). Location 6T had a duplicate sample train all year (identified as 6T1 and 6T2 in Appendix D, Table 22) 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 21. The maximum annual average tritium concentration at the site boundary was observed at Station 16T and was 7.9 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.[33]

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 8.7 pCi/m^3 (0.32 Bq/m^3) and would represent a dose of 0.002 mrem (0.00002 mSv) to the typical BNL employee.

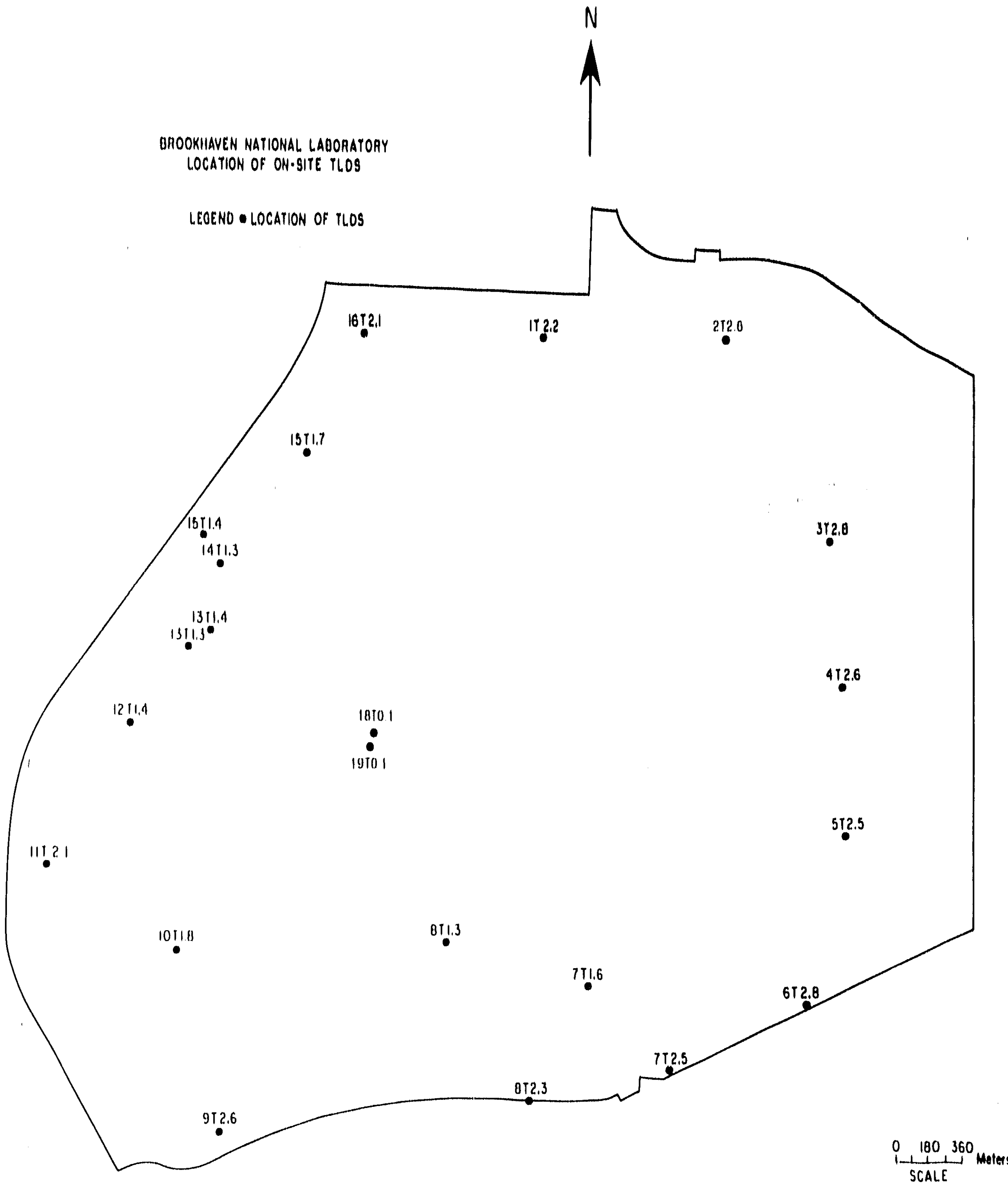


Figure 26: Brookhaven National Laboratory Location of On-Site TLDs

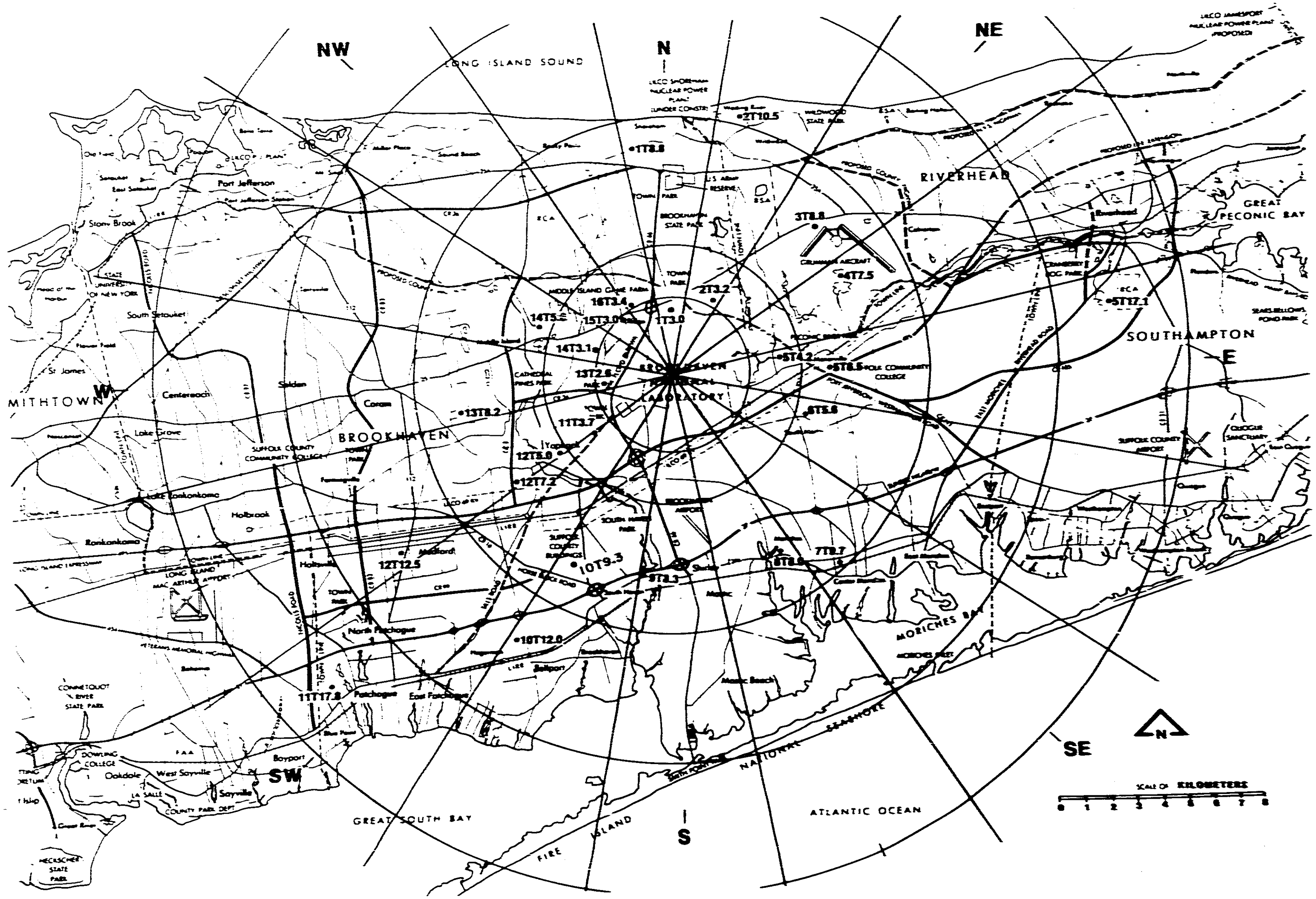


Figure 27: Brookhaven National Laboratory Location of Off-site TLDs

As part of the response to the DOE Tiger Team Audit,[34] the impact of down draft at the 100m stack was incorporated into the tritium source term in an effort to have the modeled data be more comparable to the measured site boundary tritium data. This was performed in 1989 and resulted in good agreement between the data sets. In 1990, the comparison of modeled versus measured data indicates that measured data results in a calculated site boundary dose of about ten times the value calculated by CAP88 using actual meteorological data and measured effluent releases. Having made reasonable correction to the model for tritium sources and knowing that the model accurately predicts gaseous plume concentration and dose, the issue of non-comparable measured versus predicted tritium concentration and dose now centers on the ability to measure tritium at the predicted air concentration considering the low air sample volume required to collect the sample and the present practice of processing environmental and effluent samples in the same work space. The MDL of the sampling system for tritium, assuming a 200 cc/min sample rate, processing in a tritium free environment and counting in an ultra-low background counter, is 0.2 pCi/m^3 (0.008 Bq/m^3) which corresponds to a dose of 0.00015 mrem/yr (0.0000015 mSv/yr). These air concentrations and dose rates are comparable to the CAP88 predicted values. Since the sample flow rate and the method of counting used by BNL are equivalent to those needed for the projected sensitivity, the issue of better model/measured agreement revolves around the processing of environmental tritium air samples in the same area as effluent tritium samples.

The presence of tritium in the sample processing area, as evidenced by air concentration in the Building 535 Counting Room and Analytical Laboratory, is certainly the most obvious reason for the inability to obtain better agreement between modeled and measured tritium data. The resolution of this issue, processing effluent and environmental samples in the same work area, is being addressed as a response item to the Tiger Team findings.

For the foreseeable future, site perimeter monitoring will continue to be used as a method to monitor for potential large releases and provide an upper boundary for both model verification and dose estimates. Compliance verification will be performed using CAP88 and measured source terms plus BNL meteorology.

3.3.2.2 Radioactive Particulate

During 1990, positive displacement air pumps were operated at five on-site monitoring stations (16T2.1, 11T2.1, 6T2.8, 4T2.4, and S6). 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 (except for Location S6 which was changed daily) and counted for gross alpha and beta activity using an anticoincidence proportional counter. Sample Location S6 gross alpha and gross beta data have higher average values than other sample sites because of the difference in sample period. The air particulate gross alpha and beta data are consistent with 1989 BNL data. However, the gross beta concentrations are four times higher than EPA values for Yaphank, New York.[11-14] This is most likely due to differences in methods of sample processing. For 1990, the background subtracted for gross alpha and gross beta analysis by BNL was the empty counter background. Use of an un-used filter paper as the background dramatically changes the result and is responsible for the difference between the EPA and BNL data sets.

In addition, analyses for gamma-emitting nuclides were performed on a weekly composite of the filter papers and on charcoal filter bed samples that had a sample period of one month. The analytical results for air particulate filters are shown in Appendix D, Tables 22 through 26. Gamma-emitting radionuclides detected on charcoal filters are reported in Appendix D, Tables 27 through 31.

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 January, 1990, what is believed to be an anomalous iodine-126 value was reported for an air particulate filter at Location 16T2.1. If that value is real, a resident at that location of the maximum observed concentration would have received a committed effective dose equivalent of 0.006 mrem (0.00006 mSv) as a result of inhaling the measured concentrations. This dose is below both the NCRP[33] and EPA[32] level of "de minimis".

3.3.3 Radioactivity in Precipitation

Pot-type rain collectors are situated at Locations S5 and 11 (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 1990 are reported in Appendix D, Table 32 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. These data are similar to those detected by EPA[11-14] at their Yaphank, New York Monitoring Station.

3.3.4 Radioactivity and Metals in Soil, Grass and Vegetation

The results of soil and grass sampling conducted at three locations in the vicinity of the site are shown in Appendix D, Table 33. 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.

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. A control location (Location HH) located on the Carmans River in North Shirley which is not influenced by BNL liquid effluent was also sampled. The Peconic River sampling stations are identified in Figure 28. Routine grab sampling at both the former site boundary (Location HM) and the current site boundary (Location HQ) was conducted three times per week. The locations are equipped with V-notched weirs to permit flow proportional sampling and volume measurements. Due to heavy vegetation growth down stream of these weirs, which causes no vertical drop across the weir, volume measurements cannot be performed with the existing equipment. Figure 29 provides a twenty 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. As stated earlier, vegetation growth below the weir is now too dense to permit flow measurement using the currently installed equipment. Samples from Locations HA, HB, HC, HR, and HH were collected during the first, third, and fourth quarters of 1990. No samples were collected in the second quarter due to a reprioritization of field sampling team activities associated with presence of the DOE Tiger Team.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 34 and 35. The data indicate that gross beta, tritium, cesium-137, and cobalt-60 are present above ambient levels at Locations HM and HQ. Trace quantities of tritium are present out to Location HR. Strontium-90 and cesium-137 are present at ambient levels in all surface water tested.

3.3.5.2 Non-radiological Analyses

Measurements of selected non-radiological water quality parameters were performed at the former site boundary (Location HM). Analytical results are presented in Appendix D, Table 36. A pH range of 3.1 - 7.2 was observed at this location. The results for metal analyses are presented in Appendix D, Table 37. Metals such as silver, cadmium, and chromium were not detected. Copper, mercury, manganese, and lead were occasionally detected at or near the lower limit of detection which is well below the NYS DWS. Iron was the only metal found in concentrations which exceeded the NYS DWS.

In 1990, surface water samples were also collected along the Peconic and Carmans Rivers. These samples were analyzed for water quality parameters. The analytical results are presented in Appendix D, Table 38.

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 fresh water bodies (Figure 28). In 1990, fish samples from the Peconic River were collected at Locations EA, HM, Donahue's Pond, and Forge Pond. Control samples were collected from Carmans River and Swan Lake. 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,

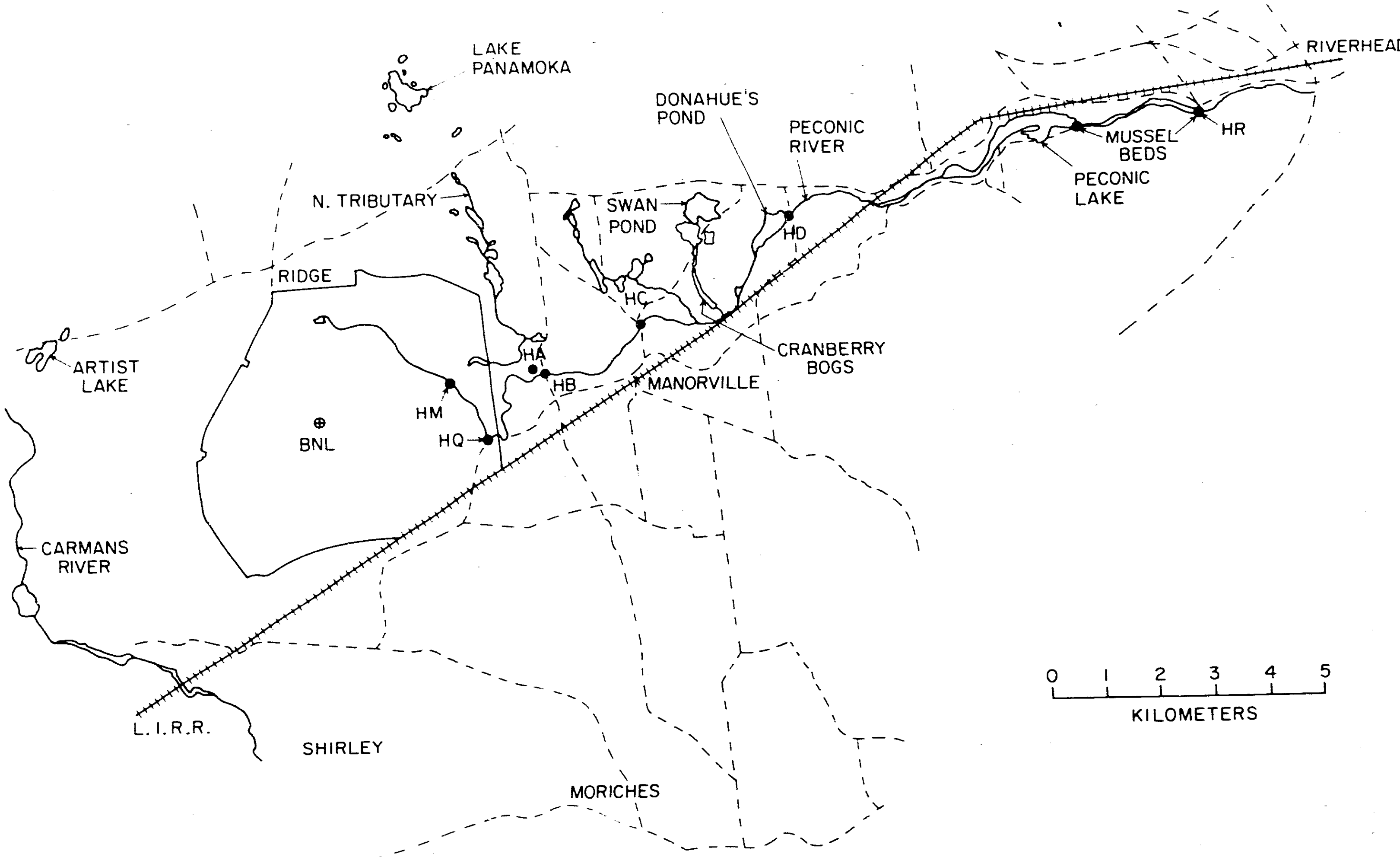


Figure 28: Peconic River Sampling Stations

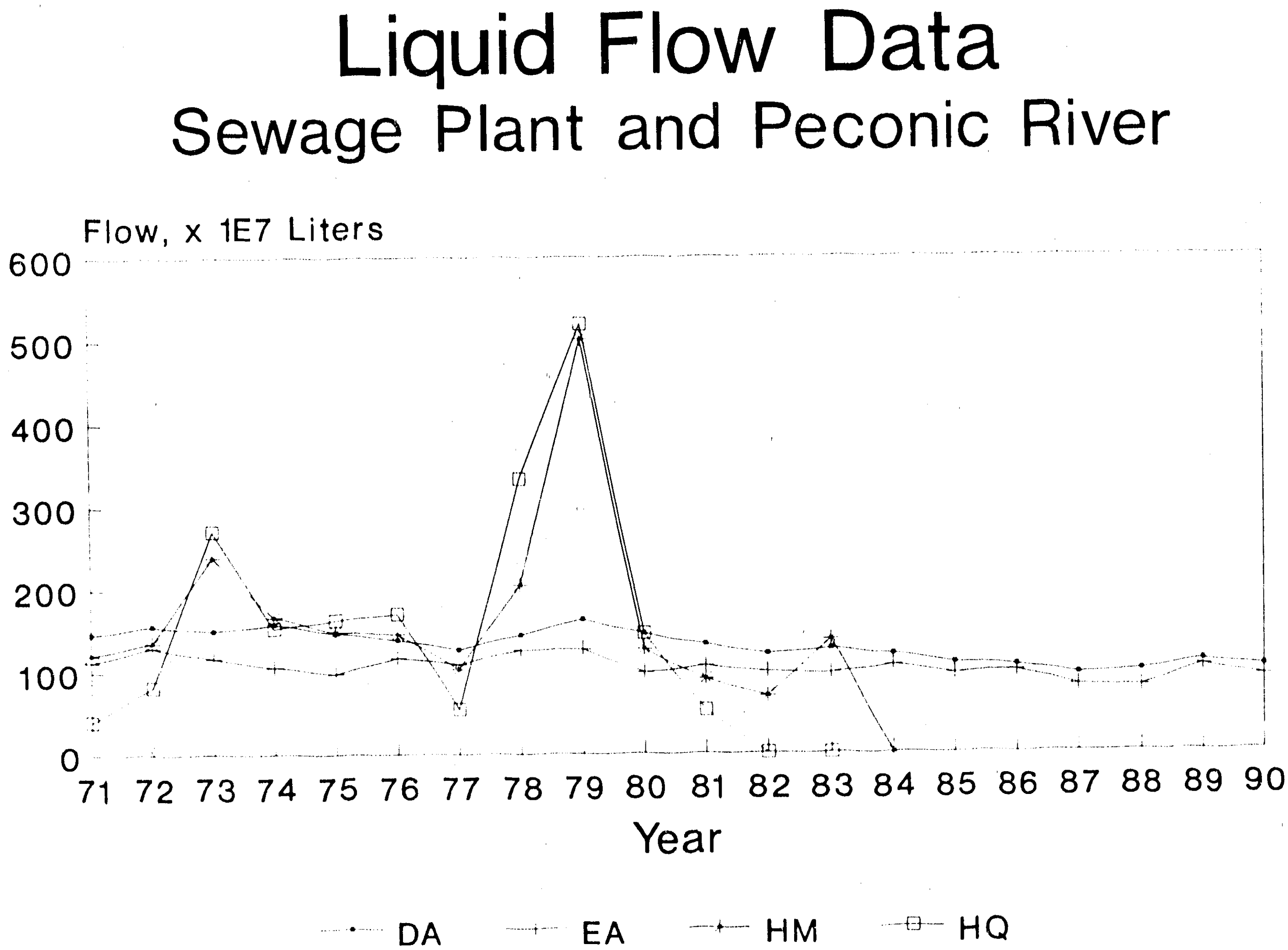


Figure 29: Liquid Flow Data - Sewage Plant and Peconic River 1971 to 1990

Table 39. In CY 1990 only, gamma spectroscopy analysis was performed on these samples. The Peconic River fish contained cesium-137 concentrations which ranged from near background levels at Forge Pond (150 - 300 pCi/kg-wet [5.6 - 11.1 Bq/kg-wet]) to 1,647 pCi/kg-wet (61 Bq/kg-wet) at Location EA. In order to obtain an estimate of the strontium-90 concentrations in fish for 1990, a strontium-90 to cesium-137 ratio was developed from the data reported in 1989. This relationship was then used to estimate the strontium-90 concentration for use in dosimetric assessment.

The Forge Pond and Donahue's Pond analytical data for cesium-137 indicates that this radionuclide is present in net concentration levels which range from 1.4 to 6.5 times control data. The presence of these levels may be indicative of a BNL contribution to the cesium-137 inventory. Cesium-137 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 were calculated based on the measured 1990 cesium-137 concentrations and strontium-90 concentrations predicted by multiplying the 1990 cesium-137 concentrations by the 1989 strontium-90 to cesium-137 ratio. Only samples collected off-site were used for this assessment. Based on the methods and results just described, the maximum individual committed effective dose equivalent was estimated to be 0.75 mrem (0.0075 mSv) and the collective committed effective dose equivalent was estimated to be 0.375 person-rem (0.00375 person-Sv).

3.3.7 Potable Water and Process Supply Wells

Potable Wells 4, 6, 7, and 12 supplied the majority of potable water for use at BNL during 1990. In October, 1990, Potable Well 4 was voluntarily removed from service when TCA was observed at a concentration of 7.5 μg/L. Potable Wells 10 and 11 remained out of service due to the presence of TCA that exceeded the New York State DWS of 5 μg/L. The Laboratory initiated the process to install carbon filtration at Well 11 in 1990 and expects that this well will be available for service during CY 1991. Process Supply Wells 101, 102, and 103 were used periodically during 1990 to provide cooling water to the AGS facility. Process Supply Wells 104 and 105 provided secondary cooling water to the MRR until March, 1990 when both wells were placed out of service due to the presence of TCA in recharge water that exceeded the NYS DWS.

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 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 24, 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 25, about 16.7 MLD were pumped from these wells in 1990. Grab samples were obtained from the potable wells on a quarterly basis and analyzed for radioactivity, water quality indices, metals, chlorocarbon compounds, trihalomethane compounds, and benzene, toluene, and xylene (BTX). Supply Wells 104 and 105 were sampled only once in 1990 for chlorocarbon and BTX compounds. Well 105 had a TCA concentration that exceeded the NYS DWS. Although no organics were detected in the 1990 water sample from Well 104, this well had TCA concentrations in excess of the NYS DWS in 1989. Because discharge of organic compounds in excess of the NYS DWS is not authorized under the SPDES permit, and because there was uncertainty regarding the potential for upper to lower aquifer contamination, BNL placed both wells out of service in March, 1990.

Process Supply Wells 101, 102, and 103 were not sampled in 1990 by 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 cesium-137 in Potable Wells 6 and 12 and beryllium-7 at Potable Well 12 does not appear 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 0.01 mrem (0.0001 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 Non-radiological 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 5.8 - 7.9 and are typical of Long Island.[35,36] The pH of water distributed by the BNL water treatment plant (WTP-EFF) ranged from 6.5 to 9.1 while the pH at Potable Well 12, which introduces water directly into the distribution system, was 6.3 to 7.9.

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, cadmium, chromium, mercury, and lead were not detected in the Laboratory supply system. Copper, manganese, and zinc were detected at levels below their respective NYS DWS. Iron was not detected in water samples collected at the well head of Potable Well 12 and was detected at 40% of NYS DWS in water from the BNL water treatment plant. Iron was detected at ambient levels in Potable Wells 4, 6, and 7. The water from these latter wells is treated at the WTP which has an iron removal efficiency in excess of 90% and permits distribution of water (WTP-EFF) at concentrations below the 0.3 mg/L NYS DWS. 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, Tables 44 and 45. These data indicate that the potable water from Wells 6, 7, and 12 at BNL met the NYS DWS or NYSDOH advisory limits.[17,18] As indicated previously, TCA was detected in Potable Well 4 in excess of the NYS DWS of 5 μg/L. This compound was also detected at Wells 6 and 12 but at concentrations significantly lower than at Potable Well 4. Trace concentrations of chloroform were also detected at Potable Wells 4 and 6 at concentrations corresponding to 3% of the NYS DWS.

During the second or third month of each quarter, BNL schedules the collection of 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 results of this sampling program are presented in Appendix D, Tables 46 and 47. In 1990, the only organic compound detected in the BNL program for potable wells was chloroform at Well 6 and at the WTP effluent. Observed concentrations were 19% and 5% respectively of the NYS DWS.

In 1989, TCA concentrations of 13 μg/L were observed in water from supply well 104 (FK). In 1990, as a result of the DOE Tiger Team assessment, this well was placed in an out-of-service mode, until a decision is made regarding the need to close this well in an effort to minimize the potential for channelling of upper aquifer contamination to greater depths. In 1990, Supply Well 105 (FL) was found to contain TCA at a concentration of 31 μg/L. Because discharge of water to a recharge basin containing contamination in excess of the NYS DWS was viewed by NYS as a violation of the SPDES permit conditions, this well was taken out of service as a source of cooling water for the MRR. No other chlorocarbon data, as reported in Appendix D, Table 46 were detected.

Water samples were also analyzed for BTX by BNL. These results are shown in Appendix D, Table 47. In all cases, these compounds were not detected in BNL potable or supply water.

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 30. Wells located in specific Sections (grids) of interest are shown in Figures 31, 32, 33, and 36. Appendix D, Table 48 provides a cross reference index which assigns grid coordinates for each well to the historic location identifier. For this report, both the old and the new well identifiers are used. The conversion to the grid numbering system was implemented in order to establish a uniform identification system for the monitoring wells.

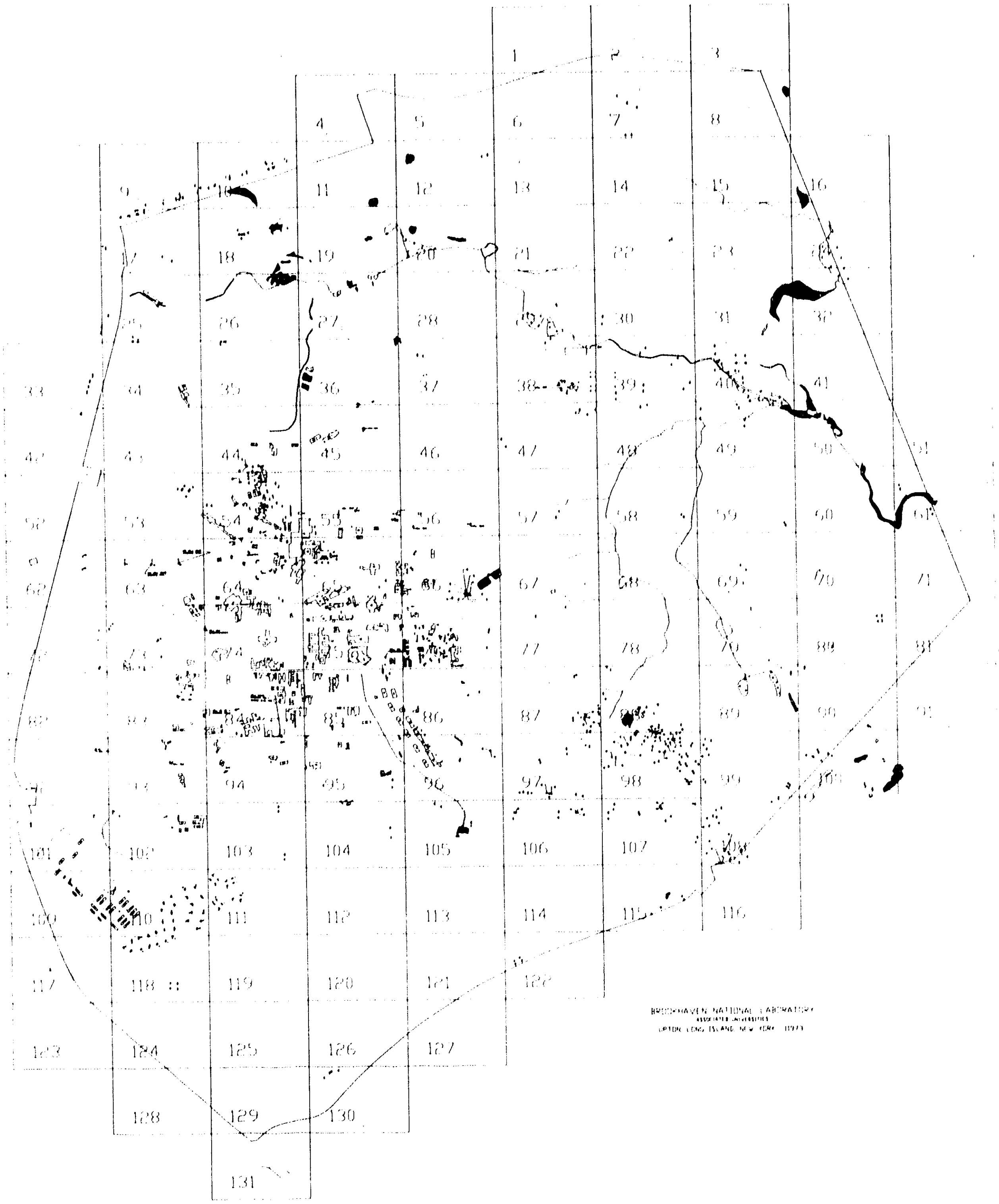


Figure 30: Location of Ground Water Monitoring Wells at Brookhaven National Laboratory

The data presented in subsequent text and tables are compared to DCGs to determine compliance with operational limits and, because the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source",[37] 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 50. The location of these wells is presented in Figures 30 and 31. 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 probably attributable to losses from the tile collection field underlying the sand filter beds and periodic recharge to ground water from the Peconic River in this area. In 1990, on-site gross beta ground water concentrations ranged from 2% to 7% of the NYS DWS. Tritium concentrations ranged from detection limits to 11% of the NYS DWS. Strontium-90 concentrations ranged from nondetectable to 24% of the NYS DWS. Ten of the 15 wells monitoring these sites were abandoned in 1990 and of these, one well (40-04, previously XY) had strontium-90 concentrations exceeding DWS. Replacement of this monitoring well will be considered in the preparation of the BNL Ground Water Monitoring Plan. Gamma-emitting radionuclides were not detected in any of the Peconic River or Meadow Marsh-upland recharge area monitoring wells.

In 1990, the cooperative program between BNL and the SCDHS continued for the collection and analysis of samples from wells serving private homes. As part of this 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 SCDHS. A total of 23 different locations were sampled in 1990. 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 51, indicate that tritium was detected in samples collected from three locations adjacent to the Laboratory. (One location was a sampling point along the Peconic River and two locations were private potable wells.) The private wells in the sampling program are screened at depths ranging from 50 to 200 feet and had annual average tritium concentrations that ranged from below detection limits to 2255 pCi/L (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 DWS[19] for community water supplies. Gamma spectroscopy results from these private potable wells in 1990 indicated the trace presence of naturally occurring potassium-40. The observed concentrations were below the detection limit but above the two sigma counting error. They are reported as trace for trending purposes. The Peconic River sampling location was observed to contain cesium-137. The reported concentration, 1.6 pCi/L (0.06 Bq/L), agrees well with the 1990 annual average cesium-137 concentration at the Peconic River site boundary Sampling Location HQ of 1.78 pCi/L (0.07 Bq/L) strontium-90 results are effectively at or below the analytical detection limits.

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 HWM area are shown in Appendix D, Tables 52 through 55. At the north boundary, Former Army Landfill, AGS, south boundary, and west side site wells, (Appendix D, Table 52) most results were either below the system detection limits or typical of ground water not impacted by laboratory operations. The highest gross beta level observed was along the south boundary at Location 130-02. The value corresponds to a time when the sample water was milky in color and there was a question regarding the dissolution of the bentonite seal. Beryllium-7 was detected once at Well Location 53-04 but not in subsequent samples. Downgradient of the AGS at Building 811, sodium-22 was routinely detected at concentrations up to 1% of the DWS. Strontium-90 was also detected in these and other AGS area wells in concentrations representing less than 14% of the DWS.

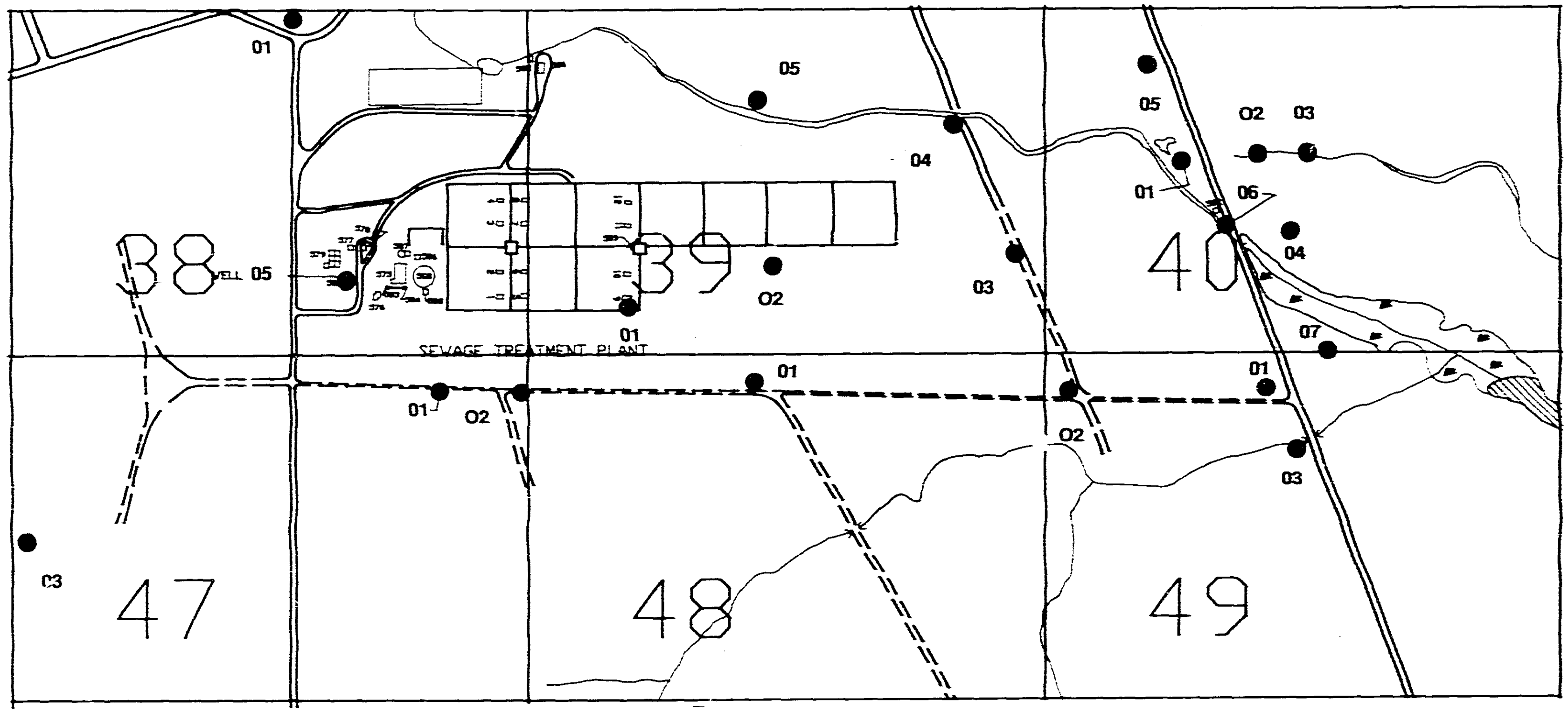


Figure 31: Ground Water Monitoring Wells – Peconic River Area

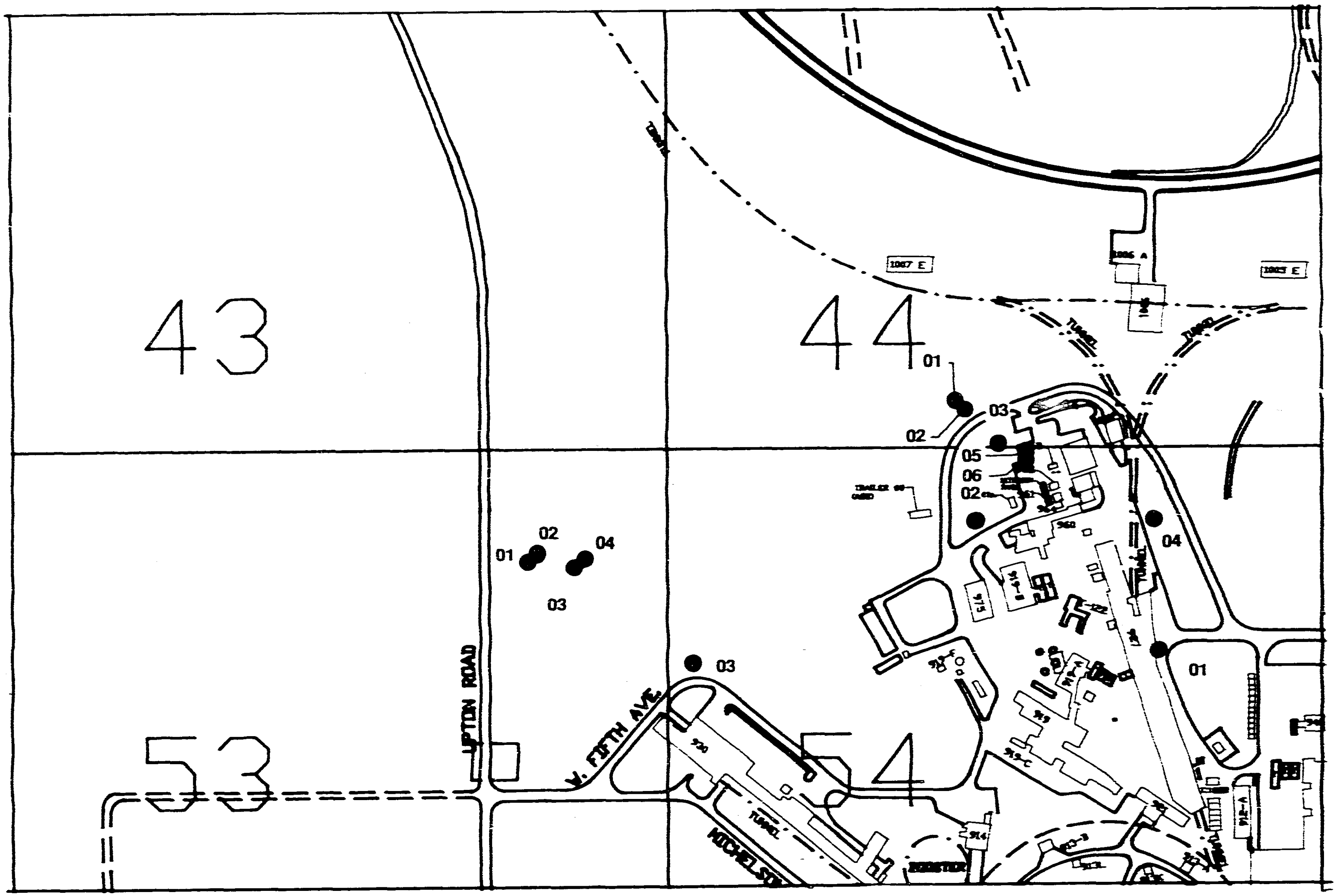


Figure 32: Ground Water Monitoring Wells – AGS Area

The location of wells installed to monitor Building 830, the MPF, CSF, or Photography or Graphic Arts are shown in Figure 33 and the radionuclide concentrations observed in 1990 samples are presented in Appendix D, Table 53. Except for a single elevated gross beta result at Well 76-16, gross beta concentrations were at ambient levels and all observations were well below the NYS DWS.

In the vicinity of Building 830 (Appendix D, Table 53), radiological results for ground water monitoring samples indicated the presence of cobalt-60 in each well sample. The cobalt-60 concentrations are most likely related to operational activities at Building 830 associated with the "d-waste" line leak although AGS storage of activated components outside on nearby soil may play a contributing role. The observed concentrations are less than 1% of the NYS DWS. Well 76-18 in the MPF area showed strontium-90 concentration levels slightly above ambient conditions but well below (13%) the NYS DWS. Ground water samples analyzed from monitoring wells near the Photography and Graphic Arts building indicated no significant concentrations of radio-nuclides.

Radionuclide results for samples collected at the former ashfill and the current and the former landfill areas are presented in Appendix D, Table 54. No activity was observed in the ashfill well sample. At the current landfill, eight downgradient wells consistently show elevated gross beta concentrations; 14 wells exhibit above ambient concentrations of tritium; seven wells (essentially those with elevated gross beta concentrations) have elevated strontium-90 levels; sodium-22 was detected in five wells; and cesium-137 was detected in two wells. The highest annual average gross beta, tritium, strontium-90, sodium-22, and cesium-137 concentrations were 35%, 95%, 53%, 0.2%, and 0.4%, respectively of the NYS DWS. In general, radionuclide concentrations in the downgradient current landfill wells are consistent with inorganic contaminants, specifically iron, observed at the same locations. The presence of radionuclides in ground water samples, collected from the current landfill area, is the result of BNL's past practice of placing low specific activity material in that location. This practice was terminated in 1978.

At the former landfill, the maximum tritium and gross beta concentrations of 1160 pCi/L (43 Bq/L), 14.93 pCi/L (0.55 Bq/L) were observed in Wells 96-04 and 97-03 respectively. Strontium-90 was detected at Well 97-03 at a concentration of 5.1 pCi/L (0.2 Bq/L). In all three instances, these radionuclide concentrations were well below NYS DWS. The presence of radionuclides in ground water samples from the former landfill and chemical hole area is the result of BNL's past practice of placing low specific activity material in that location.

The ground water monitoring program conducted at the HWMF (Figure 36) 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 55. The elevated annual average gross beta concentrations were observed at three wells locations: 88-04, 98-02, and 98-29. The observed concentrations were 81%, 42%, and 26%, respectively of the gross beta NYS DWS. Nineteen well locations exhibit tritium concentrations in excess of ambient levels. The maximum annual average concentration observed in this

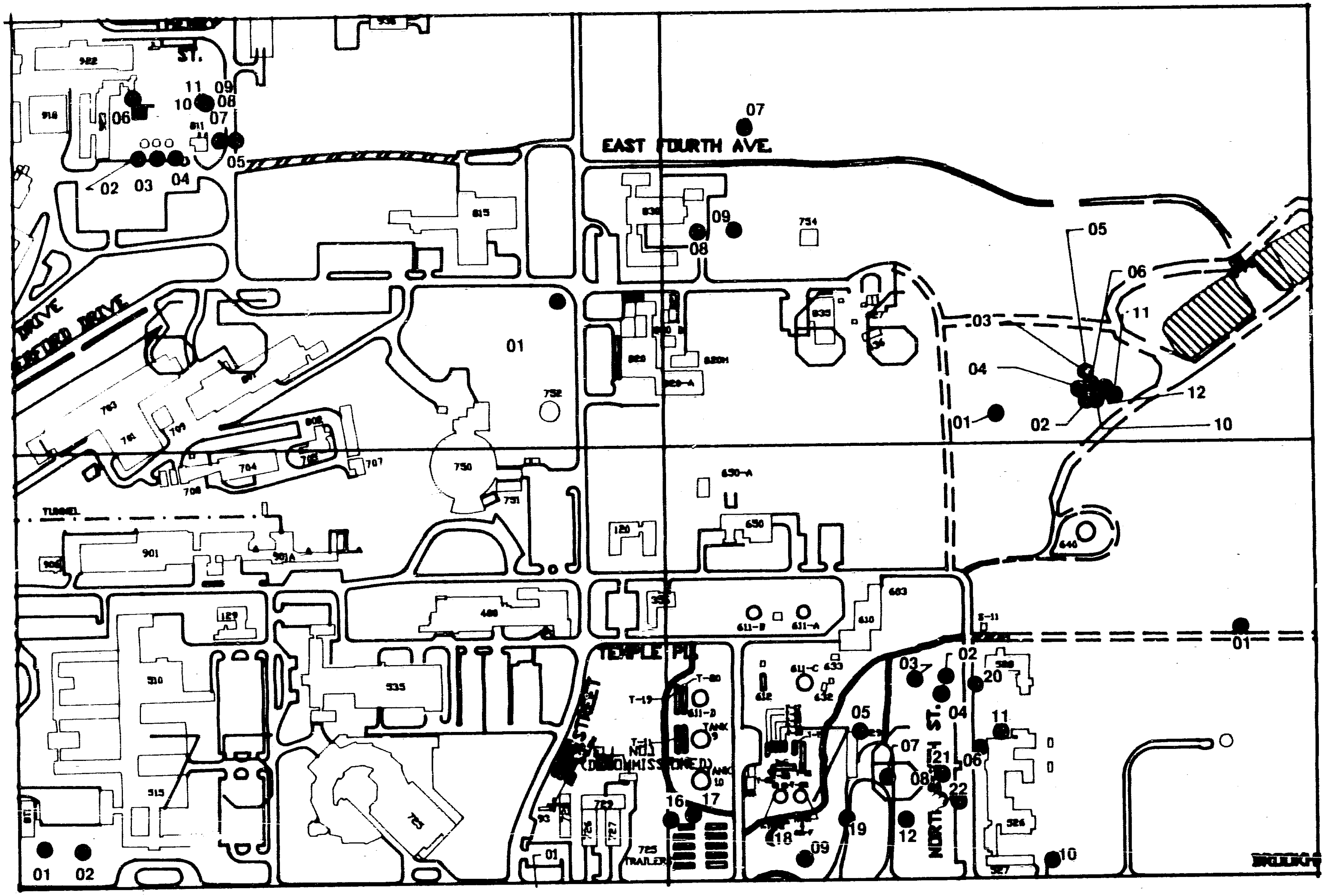


Figure 33: Ground Water Monitoring Wells - Central Portion of the Site

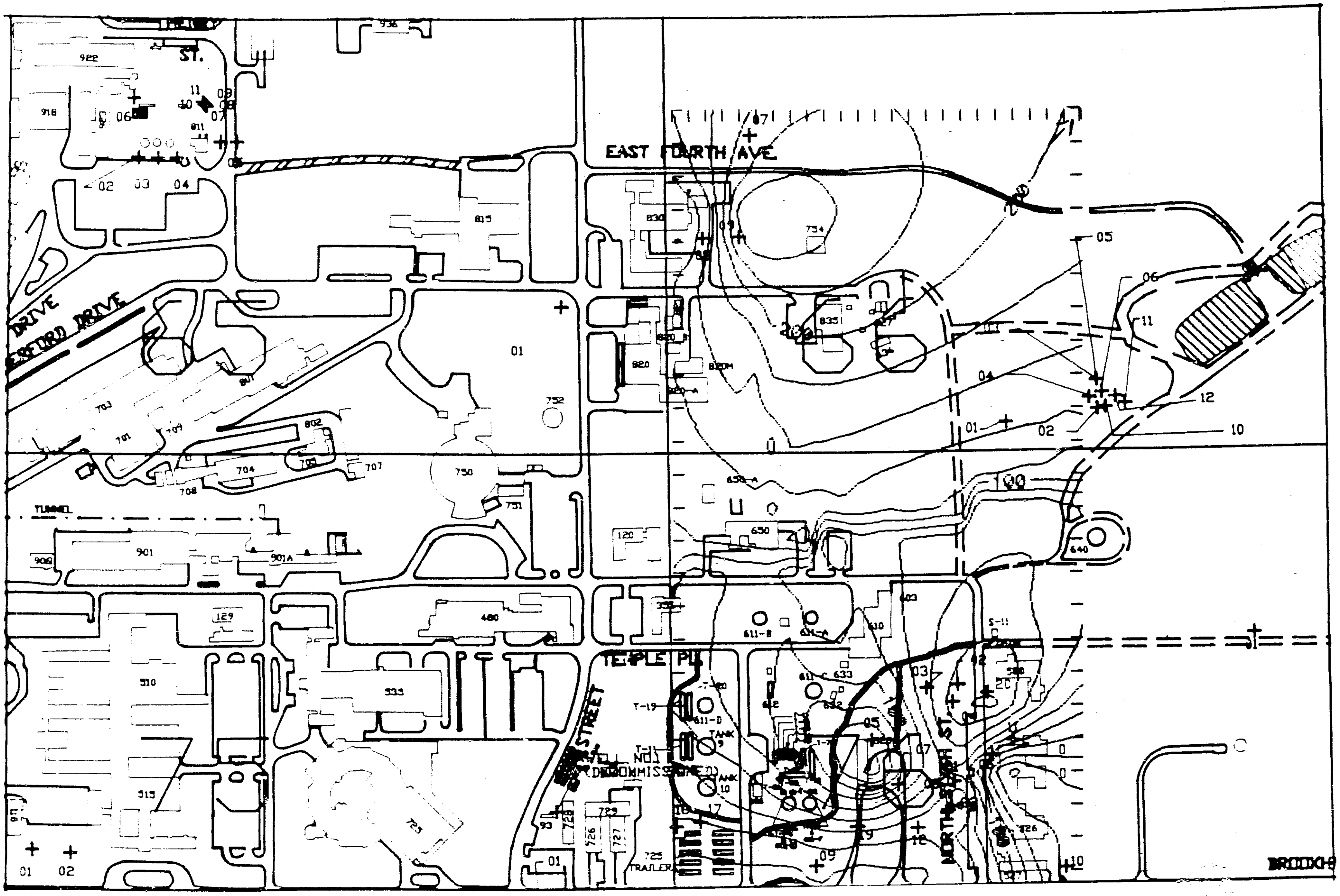


Figure 34: Tritium Concentrations - Central Portion of Site

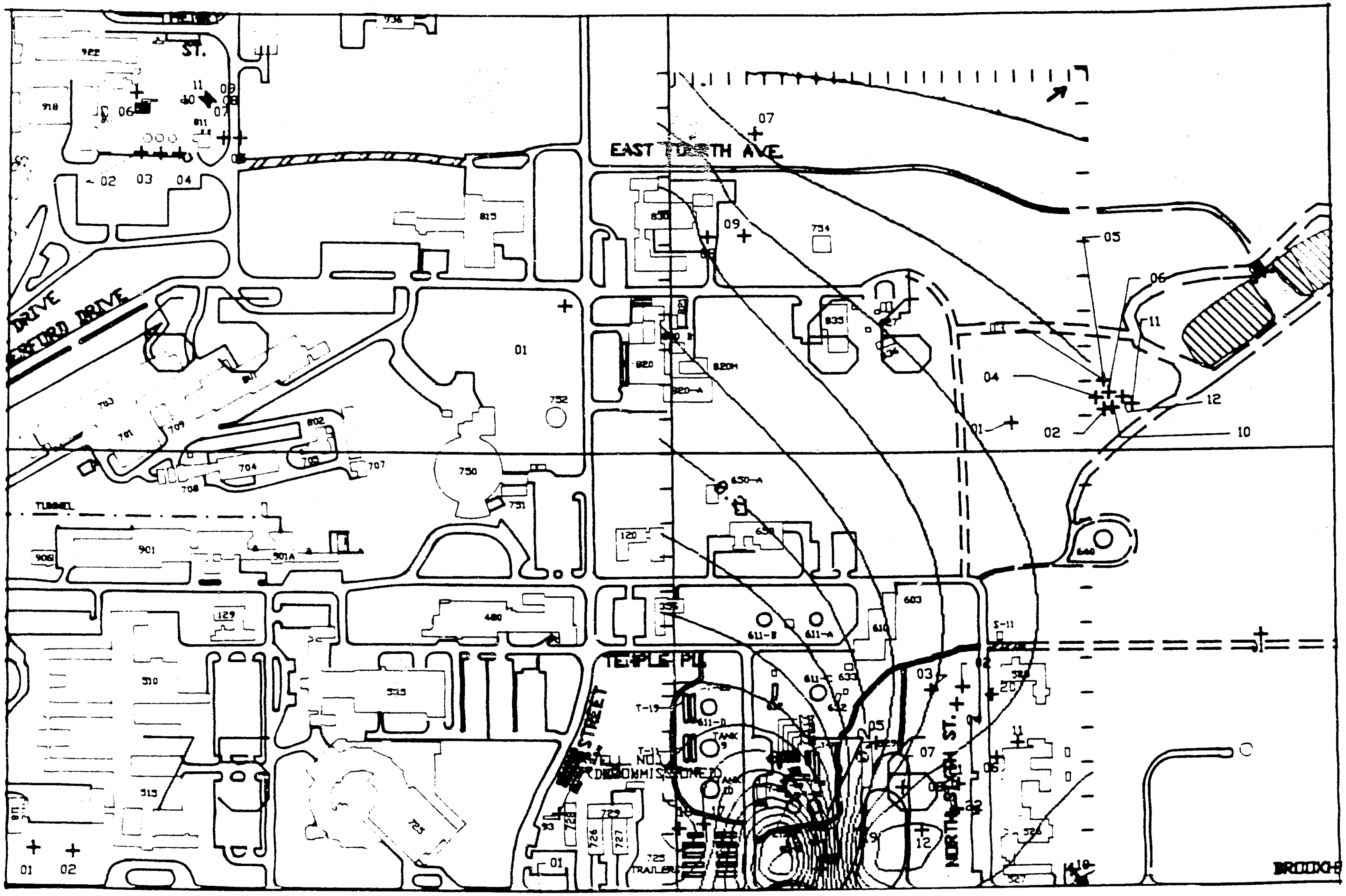


Figure 35: Strontium-90 Concentrations - Central Portion of Site

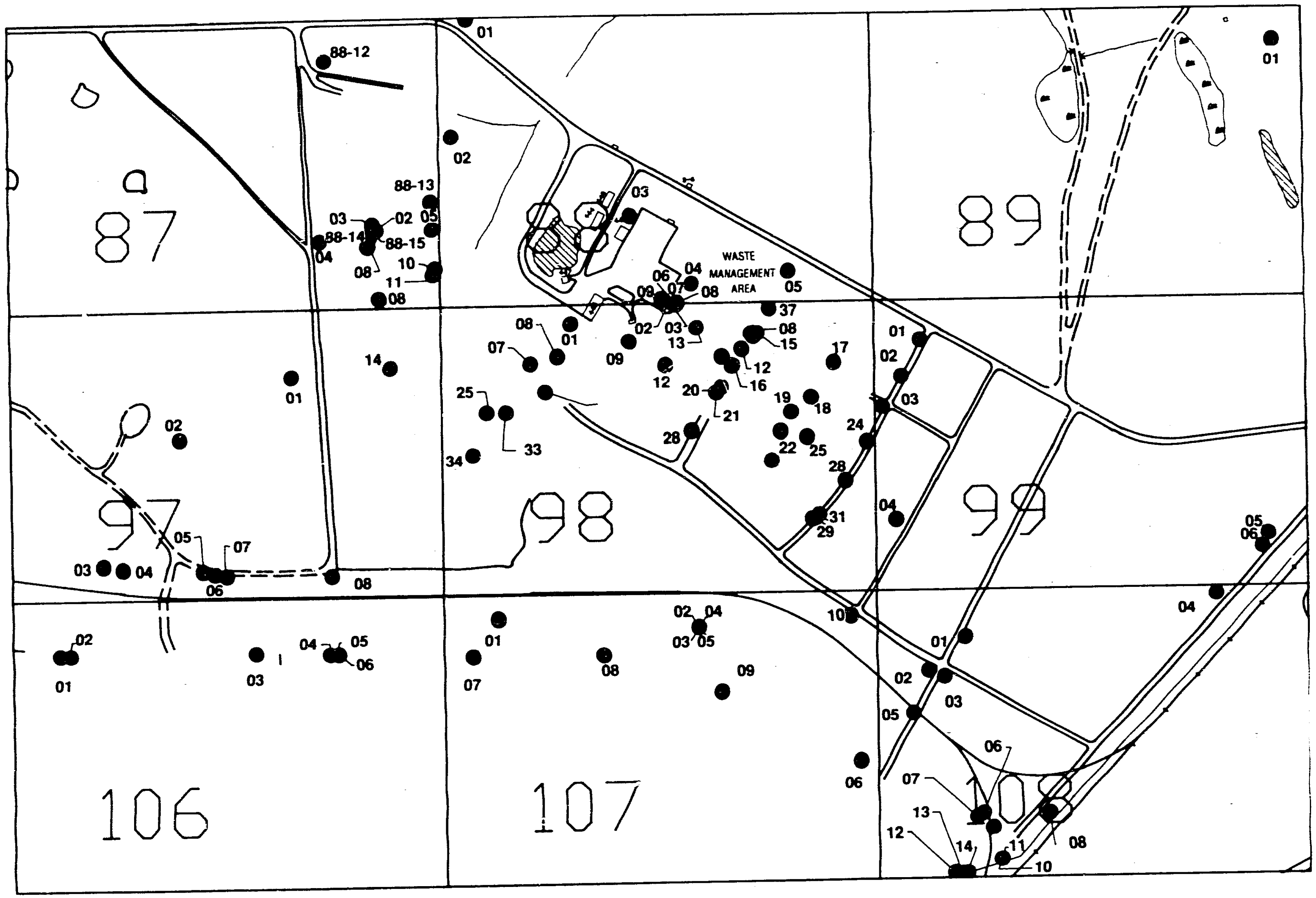


Figure 36: Ground Water Monitoring Wells - Waste Management and Landfill Areas.

area was 27% of the DWS. Sodium-22 and cobalt-60 were detected periodically in samples from this area at concentrations substantially less than 1% of the DWS. Strontium-90 was detected in excess of the DWS at the three wells identified with elevated gross beta concentration. At Well 88-04, the strontium-90 concentration was 61 pCi/L (2.3 Bq/L); at Well 98-02 the strontium-90 concentration was 44 pCi/L; and at Well 98-29, the strontium-90 concentration was 32 pCi/L (1.2 Bq/L). The NYS and EPA strontium-90 DWS is 8 pCi/L (0.3 Bq/L). The locations where these concentrations were observed were well within the site boundary. Ground water concentrations at all site boundary stations were well within regulatory guidelines. Figures 37 and 38 depict the tritium and strontium-90 concentration contours for the HWM area.

In addition to the routine ground water monitoring program, gross alpha, gross beta, and tritium analyses were performed on a monthly basis during the first quarter of 1990 for samples collected from the spray aeration project wells. The approximate location of these wells are indicated in Figure 36. The Pumping Wells 98-05, 98-16, and 98-25 were totally inactive in 1990. Pumping Wells 108-02 and 108-09 ran only from January to March, 1990. The project was suspended at the request of NYSDEC and the DOE Tiger Team who expressed reservations regarding hydraulic containment of the plume. The radiological results from this sampling program are presented in Appendix D, Table 56. These data indicate the presence of low level tritium and periodic sodium-22 concentrations. These concentrations are 7% and 0.4% of the respective DWS. All other radionuclides were either not detected or at ambient levels.

3.3.8.2 Non-radiological Analyses

The data for wells adjacent to the sand filter beds and downstream of the Peconic River on- and off-site (Figures 30 and 31), are shown in Appendix D, Tables 56 - 59. 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 56. Conductivity, chlorides, sulfates, and nitrate-nitrogen were not significantly different than values observed in BNL's control wells. The pH ranged from 4.7 to 7.1 which shows a slightly wider variation in pH than observed in control wells. Copper and zinc (Appendix D, Table 57) were detected in concentrations below NYS DWS.[18] Silver, cadmium, chromium, mercury, and lead concentrations were all less than or equal to the method minimum detectable concentration. One manganese concentration in excess of NYS DWS was observed at Well 47-02, while iron was observed in five monitoring wells in excess of NYS DWS.

Some of these wells were also analyzed for chlorocarbon, trihalomethane, and BTX compounds. As can be seen from the data in Appendix D, Tables 58 and 59, all reported results for TCA, chloroform, and BTX 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 60 through 63. The BNL current landfill ceased operations in 1990 in accordance with the Long Island Landfill Law. Permanent closure of this facility will follow completion of a RI/FS for the area. Radioactivity and metals data from wells monitoring the BNL current landfill are reported quarterly to NYSDEC.

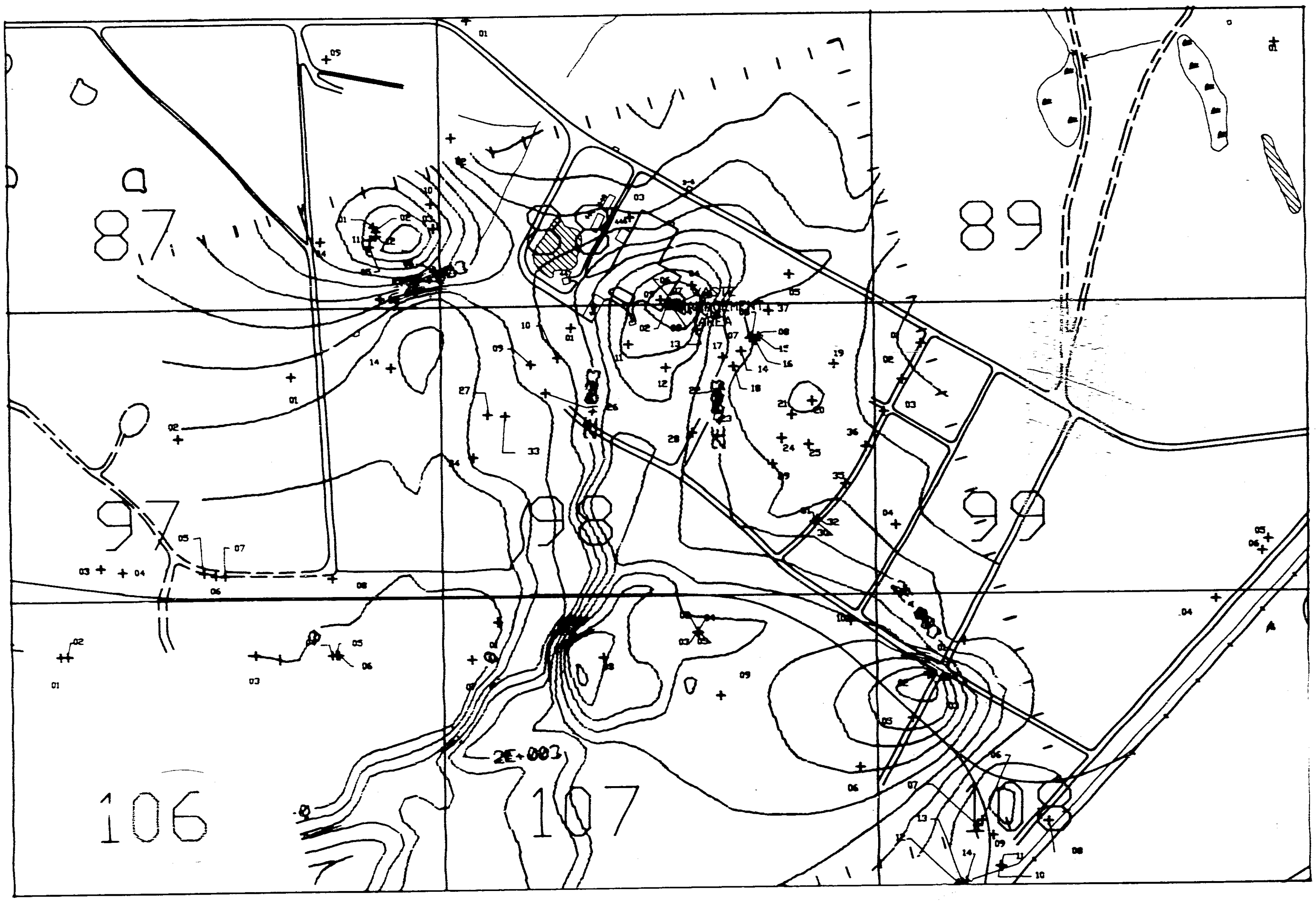


Figure 37: Tritium Concentrations – Waste Management and Landfill Areas

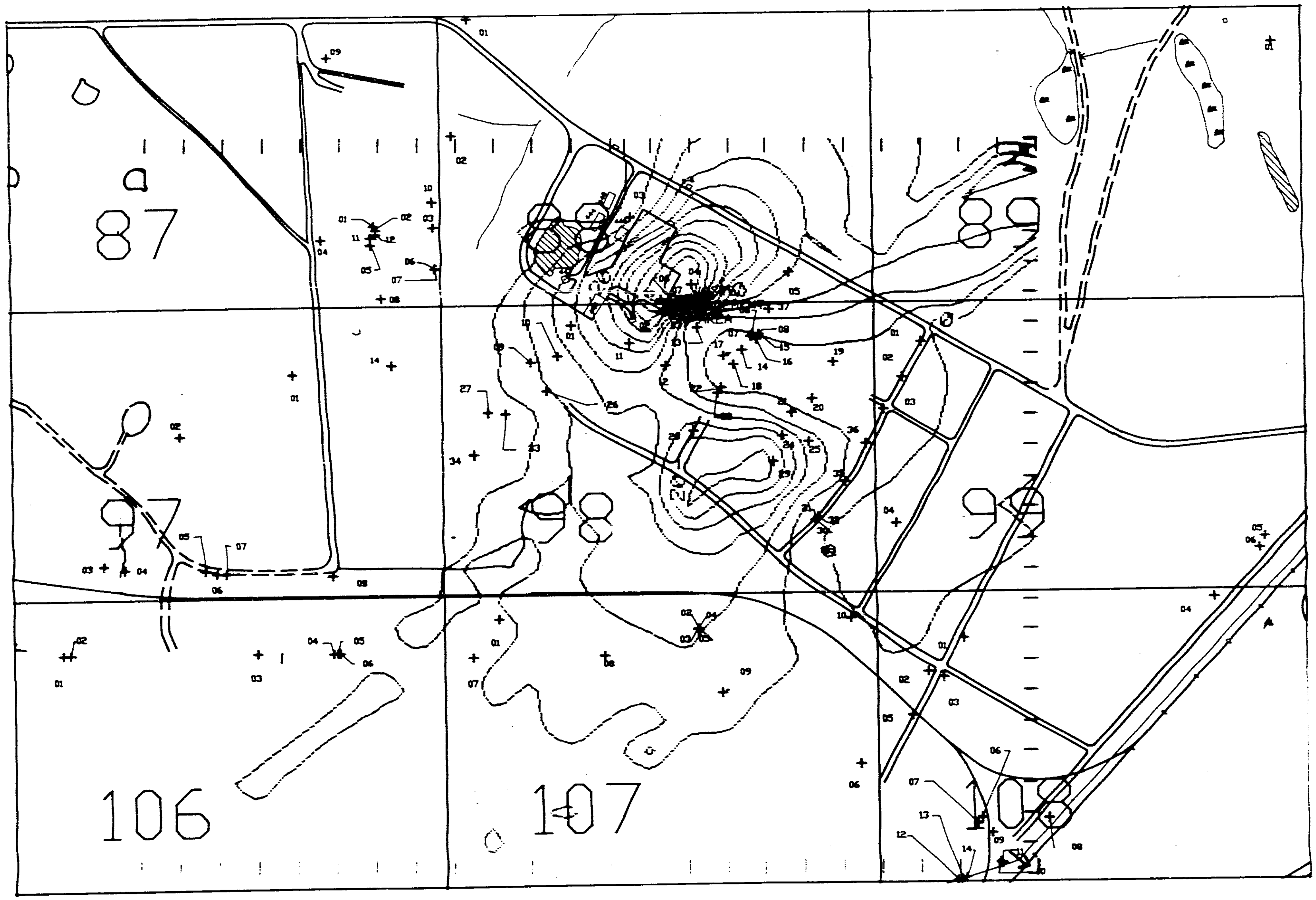


Figure 38: Strontium-90 Concentrations – Waste Management and Landfill Areas

The pH data from the Current Landfill wells ranged from 5.1 to 7.9. In the downgradients wells (87-03, 87-05, 87-08, 87-11, 88-02, and 88-13), chlorides ranged from five to ten times ambient conditions as observed in Well 88-12. Sulfates in Wells 88-02 and 88-13 ranged from two to four times background levels in Well 88-12. Nitrate-nitrogen concentrations were consistent with on-site control well data. Metals data for the current landfill wells indicate that silver, cadmium, chromium, and copper were not detected in these samples. While the lead, mercury, and zinc were sporadically detected, these parameters were well below the NYS DWS. Iron and manganese were detected at many 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 past landfill activities.

At the Former Landfill area, the pH ranged from 4.9 to 7.02 and water quality parameters were consistent with data from control wells. Silver, chromium, copper, zinc, and lead were not detected in water samples from these wells. Cadmium, iron, and mercury were detected at levels below the NYS DWS. Manganese was the only inorganic parameter which exceeded the NYS DWS and this occurred only in Well 97-05.

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. Only one of these concentrations (Location 87-03) exceeded NYS DWS. Toluene was detected in one well (Location 88-13) which exceeded the NYS DWS. The presence of xylene was indicated in one well, but it did not exceed the NYS DWS. Of the other organic compounds which BNL analyzes, TCA and DCA were detected in three and five wells respectively. The DCA was detected in five wells used to monitor the Current Landfill. The maximum values observed in two of these wells exceeded the NYS DWS by a factor of two. At the Former Landfill, of the eight wells sampled for chlorocarbon, trihalomethane, and BTX compounds, none had concentrations exceeding MDLs. In 1990, however, six wells were removed from the Former Landfill monitoring schedule due to their poor condition. Several of these wells which were sampled in 1989 and which indicated chlorocarbon, trihalomethane, and/or BTX impacts to the underlying aquifer system, will be replaced with new monitoring wells as the remedial investigation for this area of concern proceeds in CY 1991 and CY 1992.

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 average water quality and metals data for the HWMF are presented in Appendix D, Tables 64 and 65. Water quality parameters were all within ambient conditions. Metals such as silver, lead, copper, and cadmium were not detected in any of the wells. Trace concentrations of chromium, mercury, and zinc were detected sporadically. Iron and manganese were detected at ambient (trace) levels and were consistently well below NYS DWS. Iron concentrations in ground water at the HWMA are substantially lower (by as much as three orders of magnitude) than the adjacent Current Landfill area located immediately to the west.

The results for organic analyses performed on samples collected from these wells are presented in Appendix D, Tables 66 - 67. The presence of TCA was not detected in thirteen wells but was observed in five surveillance wells at concentrations that exceeded the NYS DWS; these wells included 88-04, 98-02, 108-05, 108-12, and 108-13. Tetrachloroethylene and DCA were detected in Monitoring Wells 88-04 and 98-02, respectively; in each case exceeding the NYS DWS. Chloroform was detected at trace levels in only one well: 108-05 at a concentration that was substantially below the NYS DWS. No BTX compounds were detected in 1990 in the HWMF monitoring wells.

The five pumping wells used in the HWMF spray aeration project were not sampled and analyzed in 1990, following temporary shut down of that operation.

Samples were not collected from spray aeration project pumping wells for VOC analyses during 1990. During the first quarter of 1990, Pumping Wells 108-02 and 108-09 were operating in the winter, but not in a spraying mode. Sampling for organic compounds was not scheduled for winter mode operation, as stated earlier, the project was suspended upon the arrival of the DOE Tiger Team and was not restarted in 1990. Concentrations of VOCs in the surveillance wells used to define the TCA plume recommended and installed by H2M/Roux in their 1985 HWMF study[38] appear to have declined substantially as a result of the spray aeration project. For the most part, the original four VOC compounds identified in the plume in 1985 (TCA, TCE, PCE, and chloroform) were at non-detectable levels with the exception of Monitoring Wells 88-04, 98-02, 108-05, 108-12, and 108-13.

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 68 through 71. The water quality parameters are consistent with ambient levels. Silver, cadmium, copper, and lead were not detected in water sampled from this area. Trace quantities of mercury and zinc were identified at concentrations that were substantially below the NYS DWS. Only iron and manganese were found in concentrations 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 monitoring wells that straddle the surface of the water table (Appendix D, Table 71). Benzene, ethylbenzene, toluene, and xylene or combinations of these compounds were observed in five of the CSF wells at concentrations exceeding NYS DWS ranging from a factor of two to a factor of nearly 50. No BTX compounds were detected in the five MFP monitoring wells, nor was free product (oil floating on top of the ground water) observed at any of these locations. Chlorocarbon compounds were detected in four wells from the MFP and CSF areas. At Well 76-21, the TCA concentration exceeded the DWS by a factor of four; the TCE concentration exceeded the DWS by a factor of seven; the PEC concentration exceeded the DWS by a factor of 26. Other wells where chlorocarbon data exceeded the DWS were 76-19, 76-08, and 76-05.

Monitoring wells at Building 830 and the Photography and Graphic Arts Building (PG&A) were sampled in 1990 and the analytical data for water quality parameters, metals, chlorocarbons, and BTX compounds are reported in Appendix D, Tables 72 - 75. No apparent ground water impacts are evident for any of the parameters analyzed in the vicinity of these specific lab facilities.

Water quality data for the north boundary, Army Landfill, AGS, Building 811, west sector, and south boundary monitoring wells are presented in Appendix D, Tables 76 - 79. Water quality parameters and metals in these areas were either below detection limits or sporadically detected at trace levels. Iron exceeded DWS in wells at the north boundary, AGS, and south boundary but cannot be directly attributed to any lab activities. The BTX compounds were detected only in Wells 18-01 and 53-01 in the form of toluene at concentrations below DWS. The former well has been spray painted once and continually vandalized; the spent paint can indicate toluene as an ingredient. Chlorocarbons in the form of TCA have been detected above DWS in one west sector well and one south boundary well. These are Wells 83-02 and 130-02, respectively. The latter well has been the subject of G.raghty and Miller's off-site contamination report discussed in Section 7.7 of this report.

3.4 Laboratory Quality Assurance

The EM program, which includes surveillance monitoring as well as compliance monitoring, utilizes on-site radiological and analytical chemistry laboratories as well as off-site contractor laboratories. The S&EP Analytical Chemistry Laboratory is certified by NYSDOH for metals and anions under potable water analyses.

During CY 1990, certification for purgeable organic compounds analyses was changed and incorporated into the nonpotable chemistry category; this is due to the fact that, under NYSDOH laboratory certification rules, a sub-category under potable chemistry cannot be split for the purpose of certification. Since only some of the analytes of the sub-category are needed for certification, on the advice of the NYSDOH, the category is changed from potable to non potable chemistry under which analytes of interest can be chosen from a sub-category. However, the essential elements of quality control and detection limits achieved for the sample analyses are in line with the potable chemistry.

The S&EP Radiological Laboratory participates in the DOE Environmental Measurements Laboratory QA Program and the EPA Nuclear Radiation Assessment Division (EMSL-LV) Intercomparison Study. The results of these intercomparison studies are summarized in Appendix E.

Most of the data that are generated to comply with environmental regulations are analyzed by off-site contractor laboratories. This information is used for the SPDES discharge monthly monitoring reports, WTP monthly reports, and the CSF semiannual reports. Procedures are established for collection of all samples and analyses of those samples performed on site. Audits of contractor laboratories are performed on a periodic basis and are coordinated by the QA Officer. During CY 1990, three off-site laboratories were reviewed for QA/QC compliance and competence of required methods.

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 80. The highest annual average site boundary concentration of tritium vapor was 7.9 pCi/m^3 (0.29 Bq/L) at Monitoring Location 16 (NNW 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 CAP88 are presented in Appendix D, Table 81. 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 CAP88, are presented in Appendix D, Table 82. The maximum site-boundary dose-equivalent from argon-41 and oxygen-15 was calculated to be 0.066 mrem/a (0.00066 mSv/a). The maximum site boundary dose from all three radionuclides was 0.067 mrem/a (0.00067 mSv/a).

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 radionuclides released from each facility are presented in Appendix D, Table 83. Argon-41 contributed a collective dose equivalent of 1.30 person-rem (0.0130 person-Sv) which is essentially the entire collective dose equivalent for the site. The dose equivalent contributions from tritium and gallium-68 were 0.012 and 0.0081 person-rem (0.00012 and 0.000081 person-Sv), respectively. This is depicted graphically in Figure 39. The fraction of collective dose as a function of facility is presented graphically in Figure 40. The 1990 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 1.33 person-rem (0.0133 person-Sv). This can be compared to the 1990 population collective dose-equivalent due to cosmic and terrestrial natural background of 291,000 person-rem (2,910 person-Sv). The Laboratory airborne releases comprised 0.0005% of the total dose due to natural background.

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 acts as a limited source for sport fishing. In 1990, the collective dose equivalent resulting from the discharge of radioactive materials to the Peconic River has been computed by evaluating private potable water.

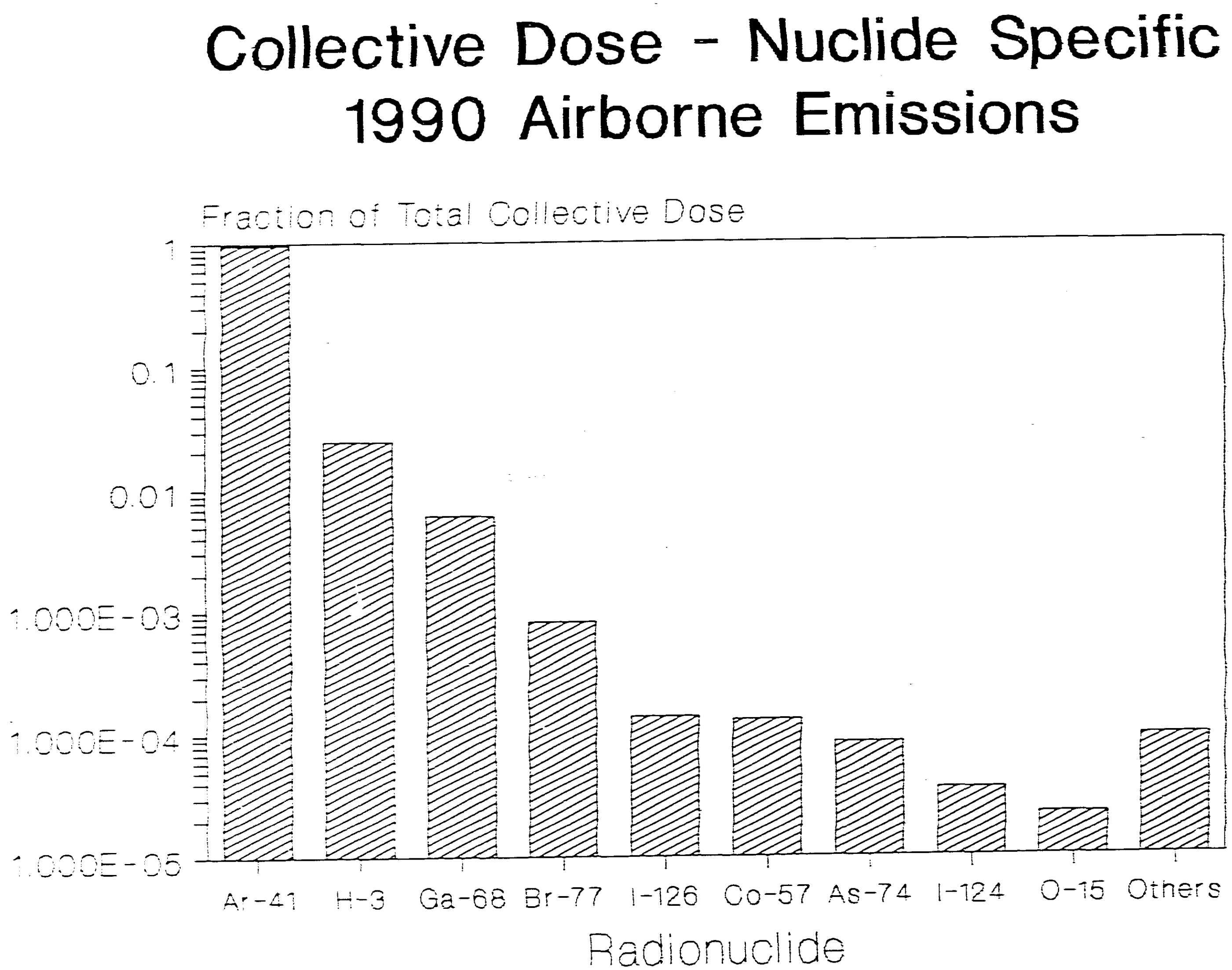


Figure 39: Collective Dose – Nuclide Specific 1990 Airborne Emissions

Fraction of Collective Dose by Facility

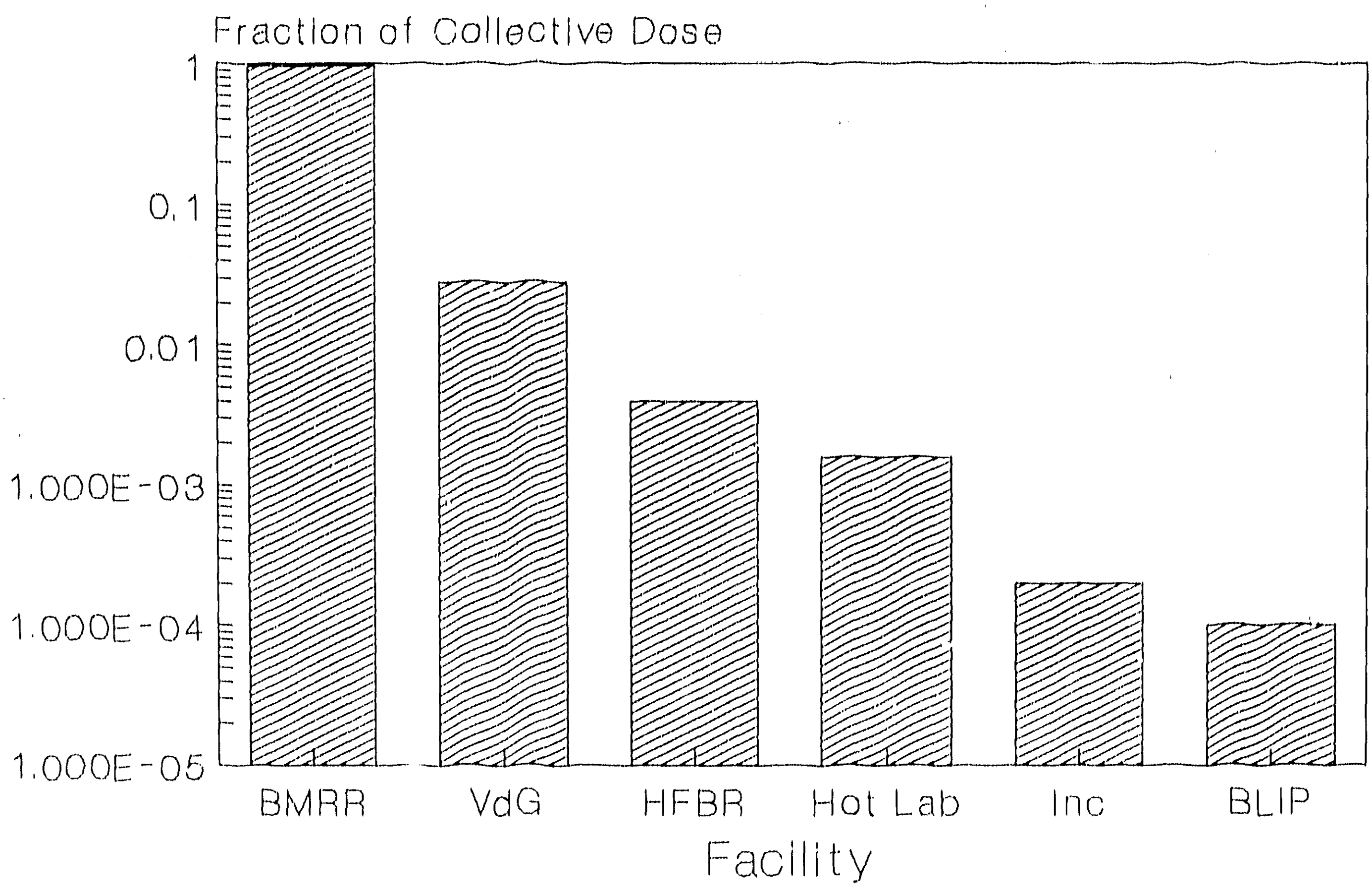


Figure 40: Fraction of Collective Dose by Facility

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 2,255 pCi/L (83 Bq/L). The average concentration for the group of positive tritium concentrations at private potable wells was 2,020 pCi/L (75 Bq/L). This corresponds to a committed effective dose equivalent to the maximum individual of 0.10 mrem (0.001 mSv) and a collective dose equivalent to the population at risk (assumed to be not more than 500 persons) of 0.052 person-rem (0.00052 person-Sv). The data are summarized in Appendix D, Table 84.

The cesium-137 concentrations in fish samples collected from Peconic River and control locations are reported in Appendix D, Table 39. Using the method described in Appendix B, the maximum individual committed collective dose equivalent was calculated to be 0.75 mrem (0.0075 mSv). The population collective dose equivalent was calculated to be 0.427 person-rem (0.00427 person-Sv). The water and fish pathway dosimetric results are summarized in Appendix D, Table 84.

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 1990 was 1.8 person-rem (0.018 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 85.

The collective dose equivalent to the population within an 80-km radius of the Laboratory, due to external radiation from natural background, amounts to about 291,000 person-rem/a (2,910 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 with the County of Suffolk[39] 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 Review of Engineering Design Drawings

Brookhaven National Laboratory agreed to submit plans for construction projects that are regulated by Articles 6, 7, 10, and 12[40-43] to the SCDHS for review for compliance with the environmental requirements of these codes. During 1990, 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 SCDHS.

All comments provided by the SCDHS were reviewed and, where applicable, were incorporated into the final design plans. As part of the BNL engineering design review process, the collaboration with SCDHS on these reviews will continue in CY 1991.

5.1.2 Registration of Toxic Liquid Storage Facilities

The intent and purpose of Suffolk County Sanitary Code Article 12[43] 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 which is used to store toxic or hazardous materials, as defined by the SCDHS, must be registered with the SCDHS.

In accordance with Section 760-1207 of Article 12, BNL submitted Toxic and Hazardous Liquid Storage Registration Forms to the SCDHS in July, 1989. Approximately 200 storage facilities were registered in this submittal. An update to this registration package was submitted to the SCDHS in March, 1990. Additional updates will be submitted to the SCDHS as existing facilities are upgraded or new facilities are proposed.

5.2 SPDES Permit Renewal

Brookhaven National Laboratory 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,[44] 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 to renew the SPDES permit continued during the CY 1990. These efforts included (1) the submittal of information describing best management practices for waste management at BNL and the mechanisms utilized to educate employees at BNL regarding the proper methods of handling and disposal of industrial wastes; and (2) the submittal of results for organic analyses from grab samples collected at recharge basins. In addition, a meeting was held to resolve some of the questions raised by the Tiger Team regarding the inclusion of specific sources into the permit. Additional data requests were made by NYSDEC which required modification to existing processes in order to facilitate collection of samples. These requests will be addressed in 1991.

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 No. 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 13 - 16. Specific instances of noncompliance during 1990 include five occurrences of suspended solids in excess of the SPDES permit limit and one instance where total coliform was measured above the SPDES discharge limit. The increase in suspended solids is believed to be due to the liming process which was initiated to correct the drop in pH as the water passes through the sand filter beds.

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 those samples collected during 1990 have been within limits. The DHS inspections have typically rated the STP as satisfactory.

As part of the SPDES renewal process, BNL collected samples from recharge basins for organic analyses. The results, which were submitted to NYSDEC in February, 1990 observed the presence of TCA in Recharge Basin HP (Outfall 004). As part of their compliance verification process, NYSDEC collected samples from all outfalls at BNL on March 13, 1990. Analytical results for their samples indicated the presence of TCA at Outfall 004 at 20 $\mu g/L$ and iron at the WTP recharge basin (Outfall 007) at 4 mg/L which resulted in the issuance of a NOV issued by NYSDEC on May 17, 1990. The source of TCA at Outfall 004 was identified as ground water obtained from supply wells for the MRR; their use was discontinued immediately. The elevated iron concentration at Outfall 007 is the result of backwash discharged from the WTP. Monitoring requirements for iron will be incorporated into the renewed SPDES permit for Outfall 007. Brookhaven National Laboratory is developing a program to evaluate the impact of this discharge on the ambient ground water in the vicinity of the WTP in accordance with a request from NYSDEC. In addition, TCA was detected at a concentration of 39 in a sample collected by NYSDEC at Outfall 001. As a result, BNL commenced collection of a monthly grab sample for TCA analyses at Outfall 001; the results are included on the monthly discharge monitoring report.

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 monitored for water quality, metals, and radioactivity. The analytical results for samples collected from these basins are presented in Appendix D, Tables 7 - 19. 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. In addition, collection of grab samples from the recharge basins for VOC analyses was initiated in 1990. Analytical results are presented in Appendix D, Tables 19A and 19B. No VOCs were detected in the grab samples with the exception of chloroform, which was found in concentrations ranging from 2 to 5 $\mu g/L$. The NYS DWS for chloroform is 100 $\mu g/L$.

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, the pools at twelve facilities, 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] Brookhaven National Laboratory had a line item project which provided connections to the site sanitary system for these facilities. This project was completed in 1990 and is discussed in more detail in Section 7.1.2 of this report.

5.3.1 Upstream Monitoring of STP Influent and Automated Diversion Capability

As part of corrective actions resulting from a June, 1988 unplanned release of radioactive materials into the sanitary system,[45] a monitoring system was installed upstream of the STP that would provide advanced warning of liquid effluent streams that may have the potential to exceed SPDES permit conditions at the STP. The site selected was Manhole 192 which is 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. In 1989, a V-notched weir, pH and conductivity probes were installed and tested. In 1990, radioactive measurement capability was added to the system. Also, telemetry of data was completed to both the STP and the Chilled Water Facility. The system became fully operational in the first quarter of 1990 with on-line monitoring of pH, conductivity, and gamma activity. If the monitoring instrumentation detects liquid discharges that are outside the range of conditions that are acceptable for release under the SPDES permit, an alarm is actuated both locally and at a constantly manned console at the Chilled Water Facility. This early warning provides about one hour of response time prior to the material reaching the STP. The second action that was completed in 1990 relating to the June, 1988 incident was the installation of automated diversion capability at the STP. Prior to this time, diversion of STP effluent to one of the two lined holding ponds required about 20 minutes of manual labor to initiate the diversion. The installation of automated equipment eliminates the time requirement to initiate diversion once the need is recognized.

5.4 Closure of Landfill

Brookhaven National Laboratory 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 1990, 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 IAG. Because of these difficulties, a revised Consent Order was not received prior to the December, 1990 landfill closure date.

Brookhaven National Laboratory ceased accepting wastes into the on-site landfill on December 18, 1990. Planning for this termination of operations began when discussions were held with Brookhaven Town Officials in April, 1990. In July, 1990, all BNL nonradioactive, nonhazardous solid waste was taken to the Town landfill as a test program to assess manpower and equipment requirements.

In November, 1990, the Laboratory's long-term recycling program for computer paper, waste oil, and metals was expanded to include white office paper and cardboard. Efforts were also initiated to procure receptacles for use in the BNL apartment area to begin metal and glass container recycling. While a temporary vendor has been obtained for recycling of construction/demolition debris, the Laboratory is continuing to explore permanent vendor sources. In addition, asbestos waste will be removed by a licensed disposal firm under existing task order agreements.

Nonradioactive, nonhazardous, nonrecyclable solid waste will be disposed of at the Brookhaven Town Landfill as of December 19, 1990. The Laboratory had obtained a verbal commitment on this agreement from the Solid Waste Commissioner and is pursuing formalization of a five year agreement. Brookhaven National

Laboratory will pay the same tipping fee as Town residents, which is currently $45 per ton. The increased costs of disposal have been factored into Plant Engineering's FY 1991 operating budget.

5.5 National Emission Standards for Hazardous Air Pollutant Authorization Applications

Brookhaven National Laboratory possessed seven NESHAPs authorizations for facilities under construction or that have been built since 1985. In 1990, seven additional facilities were reviewed for NESHAPs compliance as required by 40 CFR 61.94.[32] These facilities were found to contribute site perimeter doses that were substantially less than the 0.1 mrem/yr effective dose equivalent that requires formal authorization to construct or modify from EPA Region II. All other facilities had construction dates which predate 1985. The site boundary dose from all facilities as calculated using CAP88 for CY 1990 was 0.07 mrem (0.0007 mSv). The collective dose over an 80 km radius was 1.33 person-rem (0.013 person-Sv).

During 1990, several activities involving dispersable airborne radionuclides were reviewed for NESHAPs compliance and were found to be exempt from filing requirements. These include the evaporation of STP holding pond water; the aquifer restoration project; sludge drying operation at Building 445; a laboratory fume hood involving tritium in Building 318; Plasma Mass Spectroscopy lab operation; pharmaceutical labeling process in Building 490; and fluorine-18 use at the PETT VI facility. A brief description of the source and documentation that the dose does not exceed 0.1 mrem has been provided in the 1990 annual report to EPA.

The risk assessment program CAP88 was used to evaluate the dosimetric impact of 1990 radioactive airborne effluent releases. Several of the radioisotopes which were released from BNL facilities in 1990 do not appear in the CAP88 nuclide library. Therefore, analogue nuclides whose selection was based on similar radiological and chemical properties were substituted where necessary. The doses resulting from the inclusion of these analogues were then adjusted using the appropriate dose conversion factors of the original missing species. Brookhaven National Laboratory 1990 annual wind rose data and revised 1990 population data were input into the CAP88 program. The agricultural parameters used were those provided by CAP88. Brookhaven National Laboratory did not attempt to use site specific data that were previously provided as part of the 40 CFR 61.07 Application to Modify BNL Building 705.

5.6 Audits and Appraisals

5.6.1 Tiger Team Assessment General

In March and April of 1990, the DOE conducted a comprehensive Environmental, Safety, and Health (ES&H) and waste operations Assessment at BNL. The team, labelled by DOE as a Tiger Team, consisted of about 50 ES&H professionals that had been assembled from a combination of DOE, contractor, and consultant organizations. Compliance with applicable federal, state, and local regulations; applicable DOE Orders; and internal BNL requirements were assessed. In addition, the assessment included an evaluation of the adequacy and effectiveness of the DOE and site contractor, AUI, management, organization, and administration of the ES&H programs at BNL. A complete documentation of the findings of this assessment has been published.[16] In the area of compliance with environmental and waste management concerns, there were 37 findings dealing with the lack of conformance to Federal and State laws and regulations, County codes, DOE Orders, and 27 findings in which best management practices were not attained. The key concerns in the environmental area was the lack of adequate hydrogeological characterization and inadequate control of activated material.

Four activities at BNL were directly affected by the assessment: The Aquifer Restoration Project was halted in response to requests from NYSDEC and the Tiger Team to halt the activity until concerns of NYSDEC were addressed; the installation of 26 additional ground water surveillance wells was terminated until a well construction protocol that would meet DOE, EPA, and NYSDEC concerns was finalized; the MRR was taken off-line because organic contamination in the cooling water supply wells (pre and post use as cooling water) exceeded NYSDEC discharge limits for release to a recharge basin; and the ground water surveillance sampling program was suspended in the areas of the HWM facility, Current Landfill, and Former Landfills because sampling personnel had not completed training required due to BNL's listing on the National Priorities List.

Brookhaven National Laboratory reviewed the findings, responded to the technical accuracy of the findings, and developed an action plan[34] which was submitted to the DOE in October, 1990. This action plan provides the milestones and schedules to address the findings of the Tiger Team. Regarding the immediate impacts of the Tiger Team, a new source of water for the MRR was found that allowed restart of the reactor in the third quarter of 1990. The S&EP field sampling personnel were trained and the program resumed in late June of 1990. The Aquifer Restoration Program has yet to restart. A ground water consultant was hired to evaluate the questions raised by the NYSDEC and the Tiger Team but a final report was not issued in 1990. Finally, a ground water surveillance well installation protocol was finalized. However, the ground water monitoring program upgrades were not restarted because the decision was made to coordinate ground water upgrades with ground water investigation work that would be required under the IAG.

5.6.2 <u>Inspector General</u>

In the first quarter of 1990, the Office of the Inspector General audited the facility for environmental compliance. The objectives of the audit were to determine whether the DOE, Chicago Operations Office, and BNL had established and implemented policies, procedures, and practices for:

- Complying with the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and
- Identifying the need for and obtaining necessary permits and monitoring compliance with the permits.

A draft report was issue to the DOE in November of 1990.[47] The audit identified three areas where improvements were needed:

- Documentation of training provided and needed for job performance;
- Evaluation of RCRA/CERCLA compliance due to sewer line loss issues; and

- Better policies, procedures, and controls to obtain and comply with permits.

The items identified by the Inspector General report are also documented in the Tiger Team Assessment.[16] The action plan developed for the Tiger Team[34] should address the issues raised in this audit.

5.6.3 EPA Region II 40 CFR 61 Subpart H NESHAPS Compliance Inspection

In the third quarter of 1990, EPA Region II conducted an on-site inspection of facilities and records relative to compliance with 40 CFR 61 Subpart H NESHAPs radionuclide air emissions. The inspectors toured the site and visited the four locations which were found not to be in compliance in 1989, verified the documentation for these facilities, discussed issues regarding use of CAP88, and reviewed evaluations that were performed on facilities or operations where radioactive airborne effluents resulted in a dose of less than 0.1 mrem (0.001 mSv) to the maximum exposed individual. No notices of violations were issued as a result of this inspection.

5.7 Oil Spills

During 1990, S&EP responded to a total of 29 environmental releases of oil or chemicals. Twenty three of these incidents involved small quantities of material 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. Six of these releases required EPA, NYSDEC, and SCDHS notification. These spills were cleaned up and the associated contaminated absorbent and affected soil were sent off-site for disposal of in an approved manner.

5.8 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 EP 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 CY 1990, between 25 to 30 of these types of reviews were performed.

5.9 Major Petroleum Facility (MPF)

The NYSDEC is required by Article 12 of the Navigation Law[48] 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. The license is contingent on several conditions. In addition to general ground water monitoring conditions, specific conditions may be included from year to year.

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. Brookhaven National Laboratory operates its MPF under a license (No. 01-1700) which is issued by the NYSDEC and renewed annually.

Five ground water wells, one upgradient and four downgradient, are used for regulatory compliance monitoring of the BNL CSF. The upgradient well is designated as Well ID 66-08 and is located approximately 1100 feet north of CSF Tank 611A. The four downgradient wells were installed by R&L Drillers at the NYSDEC specified locations in the vicinity of the CSF during the week of June 28 through July 6, 1989. These wells are designated as 76-16, 76-17, 76-18, and 76-19. Their approximate locations are shown in Figure 33. The well casings are constructed of polyvinyl chloride (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 30 to 35 feet. The NYSDEC was informed of the drilling schedule and sent a representative to observe the installation process for one of these monitoring wells.

In accordance with conditions of our MPF license, regulatory compliance samples were collected from these wells twice during 1990 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 are summarized in Tables 70 - 71 and discussed in Section 3.3.8.2. The analytical results were transmitted to the NYSDEC. Another condition of the MPF license is that these wells be monitored monthly for floating product. This condition was fulfilled during CY 1990 and no floating product was found in any of these wells. In addition to these compliance samples, these wells are also monitored several times a year as part of the BNL routine environmental monitoring program.

5.10 Safe Drinking Water Act (SDWA)

During 1990, four on-site wells were used to provide potable water at BNL. Routine monitoring frequency of these wells exceeds the minimum requirements prescribed by the SCDHS. The samples are analyzed by a contractor laboratory using standard methods of analysis. This laboratory is a state approved commercial drinking water laboratory. The results are submitted to the SCDHS as required by Chapter I, Part 5 of the NYS Sanitary Code.

One of the SCDHS monitoring requirements includes quarterly analysis of potable well water samples for VOCs. The fourth quarter VOC analyses indicated the presence of TCA in Potable Well 4 at a concentration above the NYS standard of 5 parts per billion. The well was voluntarily removed from service.

Prior to obtaining these results, BNL was concerned with the increasing concentrations of TCA observed in this well during previous quarterly sampling. In an effort to further investigate this, a testing program was developed to evaluate the ability of the existing processes at the BNL WTP to remove organic compounds. To ensure the merit of this testing program, the proposed protocol was discussed with a representative from the SCDHS.

The testing program was conducted in October, 1990. A package was prepared describing the test protocol and analytical results, and submitted to the SCDHS for their review and evaluation. A decision from the SCDHS is anticipated to be issued during the first quarter of 1991.

5.11 NEPA Program

In 1990, the Laboratory showed its strong commitment to full compliance with NEPA and DOE Order 5440.1D through the hire of a dedicated NEPA compliance officer. The BNL NEPA Policy continued to take shape with draft protocols addressing construction, operation, capital improvement, and research projects issued in June and October. To further promote NEPA compliance, Dames and Moore was contracted to prepare an Occupational Health and Safety Guide which would include procedures for NEPA compliance. The first draft of this guide was reviewed in October.

Environmental evaluations were completed for 166 projects in accordance with the NEPA protocol. Of these, 44 were considered minor actions requiring no additional documentation and 122 had Environmental Evaluation Forms completed for submission to DOE.

5.12 Superfund Amendments and Reauthorization Act (SARA) of 1986

The SARA regulations require that BNL compile and submit Tier I reports to the New York State Emergency Response Commissioner, the Suffolk County Local Emergency Response Committee, and the responding fire organization. For BNL, the responding fire organization is the S&EP Fire and Rescue Group. For CY 1990, BNL submitted to these groups the Tier I report. This report contained the maximum and average daily amounts for all chemicals, determined from inventory and purchasing records, which fall into the following categories: physical hazardous, classified by type as fire, sudden release of pressure or reactivity, and health hazards, classified by type as immediate (acute) and delayed (chronic). Brookhaven National Laboratory is not required under the SARA regulations to submit a Tier II report unless requested by an outside agency. In 1991, New York State requested that this report be submitted. Brookhaven National Laboratory complied with this request.

5.13 Interagency Agreement (IAG)

On December 21, 1989, BNL was included as a Superfund Site on the National Priorities List. Subsequently, a draft interagency agreement, also referred to as a Federal Facilities Agreement, was negotiated among the U.S. DOE, the U. S. EPA, and the NYSDEC. The IAG was written to insure compliance with CERCLA, the corrective actions requirements of RCRA, the National Environmental Policy Act

(NEPA), and corresponding NYS regulations. In particular, the IAG is intended to insure that environmental impacts associated with past and present activities at BNL are thoroughly and adequately investigated so that appropriate response actions can be formulated, assessed, and implemented. Although negotiations for this agreement were completed in 1990, all parties have yet to sign the document. Due to deadlines agreed to in the IAG, BNL proceeded with preliminary work as if the document were adopted by each agency. The BNL site currently has 24 Areas of Concern (AOC) that have been grouped into seven operable units as defined in the IAG.

In 1990, the draft Site Baseline Report was issued for review and comment. This report provides a historical review of the information available on these areas of concern. Remedial investigation and feasibility study project plans for the area including the CSF, Building 650 Sump and Sewer System Line-Loss were initiated. Also planning for removal actions began for the decontamination and decommissioning of three 100,000 gallon above-ground radioactive waste storage tanks, sampling and removal of various underground storage tanks, and the sampling plus removal, if necessary, of various industrial cesspools. Finally, EPA and NYSDEC received the following reports for review: Solid Waste Management Unit Classification Report, Historical Site Review Work Plan, Sampling and Analysis Results for the Underground Storage Tank (UST) Project and the Cesspool Sampling and Analysis Plan.

5.14 Resource Conservation Recovery Act (RCRA)

The HWMF is operating in interim status under Part 6 NYCRR373 Permit (40 CFR 270.10). Brookhaven National Laboratory is responding to a Notice of Incomplete Application (NOIA) from the State of New York and will be submitting a revised application in 1991. Fire protection constitutes the major RCRA compliance issue identified as part of the DOE Tiger Team RCRA inspection. There is concern that an insufficient supply of water in the area exists to successfully fight a fire at the facility. The long-term solution is the construction of a new facility which is currently in the design phase. The short-term solutions are being investigated and include: fire protection upgrades to the existing structures, installation of two stationary 5,000 gallon water tank, and the procurement of small waste storage sheds that contain fire suppression systems. The Tiger Team audit also identified containers that were not appropriately dated or labeled and a small amount of uncharacterized waste. These items have been addressed through procedural changes and analytical analysis of the material. In the 90-day accumulation areas, the issue of inadequate labeling and dating of the waste was also observed. Communications to the Departments/Divisions that describes proper labeling and dating practices were issued.

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 1990 work are presented in this report.

The type of species used in the 1990 monitoring effort ranged from sensitive species (brown or rainbow trout) to hardy species (blue gills, large mouth bass, golden shiner, etc.). The latter species are also endemic to Long Island freshwater bodies and are considered as local game fish. 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 1990 paralleled observations made in 1987, 1988 and 1989, 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 except that variations in dissolved oxygen and temperature impacted on uptake characteristics of the trout species (decreased uptake during summer months). Effluent characteristics seemed to promote good growth rate, thus testifying to the viability of the effluent stream.

6.2 Department/Division Safety Assessments

According to BNL policy, periodic safety assessments of all Departments and Divisions are performed by members of the S&EP Division. Applying the most current guidelines, standards and rules, the purpose of these assessments is to detect and assess programmatic deficiencies in the Department's/Division's environmental protection, occupational safety, and health programs. The EP Section's participation in such assessments is part of a multi-disciplinary task force. The following guidelines were used by the EP Section staff in conducting such assessments:

1. Evaluating Supervisor's knowledge of EP requirements, such as applicable regulations, available training, contacts for assistance in compliance issues.

2. Verification of compliance with federal, state, local, and BNL Safety Manual effluent discharge limitations.

3. Identification of effluent sources and location of potential contamination areas.

4. Evaluating effectiveness of effluent treatment and control methods.

5. Evaluating 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 1990:

- Central Shops
- Chemistry
- Department of Applied Science
- Department of Nuclear Energy
- Medical
- National Synchrotron Light Source
- Photography and Graphic Arts
- Physics
- Plant Engineering
- Reactor
- Safeguards and Security
- Staff Services
- Supply and Materiel

The main focal points of this assessment program during 1990 were compliance with Suffolk County Article 12, Toxic and Hazardous Materials Storage and Handling Controls, NYS Air Emissions Standards, and issues that affect the Laboratory's SPDES permit. Each assessment resulted in a report that identified areas of concern that were conveyed to the respective Department/Divisions as observations, which are isolated or infrequent occurrence items, or recommendations, which are based on observations that are serious, repetitive, and therefore considered programmatic in nature.

6.3 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. Several activities were completed during 1990 with regard to the P&GA effluents: State-of-the-art silver recovery units were installed; Arrangements were made with a vendor for off-site disposal of concentrated photographic wastes; and Discharges from photoprocessing equipment in Building 197 were piped to a drum storage area to facilitate collection of these effluents. Similar modifications will be made to the photoprocessing equipment in Building 118 in 1991.

6.4 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 to estimate the material depth to be nearly 53 inches. 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.

The 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 licensed hazardous materials hauler was contracted to pump the contents from the leaching pit to 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 Number Six fuel oil but does contain some hazardous constituents as does virgin Number Six fuel 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.

In February, 1990, DOE-BHO determined based on the analysis of oil samples from the pit that the soil in the pit was contaminated with Number Six fuel oil. The NYSDEC Region I office also concurred with that determination. As a result, NYSDEC had no objections to the disposal of the oil-soaked soil and oil-soaked concrete blocks which were the construction material for the leaching pit at the Town of Brookhaven Landfill. NYSDEC provided expeditious approval of the emergency waste transporter permit necessary for this disposal.

A contract was initiated with Marine Pollution Control to excavate the soil and debris from the leaching pit. The EPA and NYSDEC were provided with ample notification of the proposed subsequent soil and debris removal activities. The excavation was initiated on April 18, 1990. The extent of excavation of soils from the pit was initially based upon visually contaminated soil. A representative from NYSDEC who was present for the excavation also indicated that oil and gas spills are typically remediated based on visual criteria.

After the pit appeared clean based upon visual inspection, samples of soil were collected from the bottom of the pit and tested based on odor criteria to ensure that no discernible petroleum-type odors were present. On April 19, 1990, representatives from BNL, DOE-BHO, and NYSDEC agreed that sufficient soil and debris was excavated from the leaching pit and that the cleanup criteria established was met. The ultimate dimensions of the excavated hole were approximately 20 feet deep by 20 feet in diameter. The total volume of soil and debris excavated from the pit was approximately three hundred cubic yards. Clean sand soil from another part of the Lab was placed into the hole.

Future investigation of the soil and ground water in the vicinity of the leaching pit will be addressed under the Remedial Investigation/Feasibility Study (RI/FS) for the CSF which is anticipated to begin in 1991. It has also been proposed that soils in and around the pit will be analyzed as part of the CSF RI for benzene, toluene, and xylene, since these are typical components of petroleum-based products. The ground water in this area will also be further characterized during the RI/FS.

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

Ultra-pure demineralized water is used as the primary cooling fluid in BNL accelerator facilities. This medium is produced by passing domestic water through ion exchange column resins to remove impurities. Periodically, these resins are regenerated by flushing the columns with an acidic/basic solution which, until 1990, was discharged into the recharge basins that received the normal cooling water outfall. However, in December of 1989, one such discharge reacted under ambient conditions and the metals in solution precipitated out into the bed of the recharge basin. The incident was reported to NYSDEC, EPA, and SCDHS; was reported in Unusual Occurrence Report 89-29[50] and resulted in the collection of regeneration water from all sources within the AGS. A subsequent review of the regeneration process indicated that there were three facilities on-site that used this process: the AGS, the Tandem Van De Graaff, and the NSLS. The Tandem Van De Graaff and NSLS operations were small volume operations that were discharged into the sanitary system and occurred very sporadically over the course of several years. Metals concentrations at the STP appear to be unaffected by these releases. At the AGS, regeneration water was collected in mobil tank trucks that were processed by a waste hauler when the tank capacity was full during the first six months of 1990. Review of this practice led to the conclusion that waste disposal costs could be reduced by replacing fixed ion-bed exchange columns with removable columns that could be regenerated at an appropriate off-site location. Implementation of this solution commenced in the third quarter of 1990. Currently, regeneration water is collected for off-site disposal.

6.6 Building 830 and Fire House Completion Reports

In the middle 1980's, radioactive contaminated soil was removed from the vicinity of the former fire house (located just east of NSLS Building 725) and a leaking D-waste line at Building 830. The work performed and the level of remediation was documented in reports generated during the period of initial remediation. Under the IAG, this work needed to be reviewed for completeness and adequacy and a completion report developed that outlined any additional sampling or activities that needed to be performed in order to close out these issues. A consultant firm was hired to perform this assessment for both former remedial actions. The reports were developed and concluded that additional sampling would be required to determine if further work would be needed. The reports were submitted to BNL's Office of Environmental Restoration (OER), NYSDEC, and EPA. The additional sampling will be performed as part of the RI/FS process.

7.0 **SPECIAL PROJECTS**

7.1 Status of Environmental Upgrades

7.1.1 General Plant Project (GPP) to Upgrade Underground Storage Tanks

Brookhaven National Laboratory 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.[41,43] The funding for this program, which consists of three phases, began in FY 1988. Although the program was anticipated to be completed by the end of FY 1990, additional funding will be required to complete the project.

The first phase of this program focused on 23 underground storage tanks (UST) used to store aqueous radionuclides. Most of these tanks had no future use and had 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 SCDHS. As a result of these actions, fourteen tanks were left in the program.

Two of these tanks were subsequently deleted from this program. These included a 550 gallon tank at Building 927 and a 2800 gallon tank at Building 462. The UST at Building 927 was installed in 1984 and used for temporary storage of cooling water from horn pumps. The water is stored for approximately one to two weeks while waiting for analytical results to determine its final disposal. Frequency of use for this tank is based on research conducted in Building 927. It was last used in 1986 and is reported to have been used only a couple of times since it was installed. This tank was deleted from this program pending a determination of the applicability of Article 12 to emergency hold-up tanks and a determination from the AGS Department regarding its future use. The UST at Building 462 receives rinse water from a sink in which tools used in radioactive areas are washed. Once the tank is filled, the water is tested to determine the appropriate method of disposal. Based on historical analytical data, the contents of this tank are not considered to be radioactive waste. Therefore, this tank was also deleted from this project.

To evaluate the contents of the remaining tanks, a sampling and analysis plan was developed by an engineering consulting firm[51] and was submitted to BNL in July, 1989. This plan was transmitted to both EPA and NYSDEC in April, 1990. During the second quarter of 1990 an engineering consulting firm was contracted to characterize the tank sludges and provide recommendations for the proper removal of the tanks and their contents. The sampling program was conducted in June of 1990. Seven of the twelve tanks contained sludge sufficient for sampling. All tank samples were analyzed for Target Compound List organic compounds, Target Analyte List inorganic compounds, and cyanide using the EPA Contract Laboratory Program (CLP). In addition, all samples were also analyzed for radioactivity. All of the tank sludges were found to contain radioactivity and RCRA hazardous constituents. The sludges may be considered characteristic mixed waste, however, TCLP analysis must be performed on the sludges in their final waste form in order to determine this.

These USTs are included as one of the areas of concern covered under the IAG for BNL. All future activities involving the treatability testing, removal, and disposal of the sludges and the tanks will be coordinated by the BNL OER. In accordance with the requirements of the IAG, EPA, and NYSDEC will also be involved with all future plans involving these USTs.

Additional activities were conducted during 1990 involving the five USTs which were found to contain insufficient sludge for sampling. One of these tanks was a 550 gallon UST located at Building 527. Two of these tanks were under a parking lot at Building 463. The fourth tank was located in a concrete vault at Building 703. The fifth tank had previously been connected to Building 931. It had been removed from the ground in 1988 in the presence of a representative from the SCDHS and was in storage pending characterization of its contents.

Since there is no evidence of leakage from these USTs, and no response actions were anticipated under the IAG, these tanks constitute no-action AOCs. Section 760-1209.d of the Suffolk County Sanitary Code Article 12 states that it is unlawful to use or maintain the existence of an abandoned underground storage facility. In order to achieve compliance with Article 12, the Laboratory notified DOE-BHO that these tanks should be removed. In accordance with the conditions of the IAG, EPA, and NYSDEC were appraised of the proposed removal of these tanks. Both agencies provided concurrence with this proposal in September 1990. The SCDHS was notified of the schedule to remove these tanks in October, 1990. Representatives from the SCDHS witnessed various portions of the removal of these tanks. A soil sample was collected beneath each tank and analyzed for radioactivity, (tritium, gamma scan, and strontium-90) and target compound list organics. The tanks were assumed to be radioactive and handled accordingly. The tanks will be cut up on-site and wipe samples from inside the tanks will be tested for radioactivity to determine the proper method of disposal. A completion report will be prepared in accordance with the IAG once all activities associated with these tanks have been finalized.

The Underground Storage facilities for gasoline and waste oil at Buildings 423 and 630 were replaced with double walled tanks and associated piping as part of the second phase of this program. The engineering design drawings and specifications for this project had been reviewed by the SCDHS during 1989. The tanks were subsequently replaced during the first quarter of 1990. Representatives from the SCDHS witnessed various portions of the installation and testing of the new tanks and piping. In addition, seven underground fuel oil tanks were retrofitted with overfill protection equipment. A separate portion of this program also provided 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). Funding for this phase was received in 1990. Design work is in progress. Additional funding will be sought to upgrade indoor storage facilities.

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[41] and 12[43] due to the sole source ground water aquifer.[37]

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.

Construction for this work began in August, 1989. Connection of all of these facilities to the BNL site STP was completed by the summer of 1990. These cesspools are included on the list of AOCs under the IAG. The plans for sampling and closure of these cesspools were also developed during 1990. In accordance with the requirements of the IAG, these plans were submitted to EPA and NYSDEC for review and comment in November, 1990. Implementation of this effort will be coordinated by the BNL OER.

7.1.3 Ground Water Upgrades - Well Abandonment Program

The ground water upgrades program was designed to permit the installation of new ground water surveillance wells, provide protective casings for existing wells, and abandon wells which were of no further use. In 1990, well abandonment and well-head protection were the components of the program that were initiated. To date, 41 wells have been abandoned according to current regulatory protocols under the IAG Agreement between DOE, EPA, and the NYSDEC. Aquifer Drilling and Testing Inc. and ERM Corp. are scheduled to abandoned an additional 28 on-site wells in 1991. In 1990, 22 wells received protective casings and/or riser pipes as necessary for the installation of the protective casings. Twenty-five wells have also been slated to be retained for continued use as piezometers in BNL's EM program; these will be upgraded via the installation of protective casings and riser pipes as deemed necessary. Brookhaven National Laboratory's S&EP Division will maintain an ongoing program of locating, identifying, and assessing the need to abandon old site wells which are discovered during routine sampling or field operations.

7.1.4 Brookhaven National Laboratory CERCLA IAG and 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.[52] Following the listing of BNL on the NPL as a SUPERFUND site, the S&EP EP Section has been coordinating with the OER group, S&EP HWM 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

Beginning in 1990, members of the EP staff began conducting Environmental Awareness seminars to first-line supervisors and upper level management of the BNL Departments and Divisions. Eight training sessions were conducted. The course provided the attendee with an overview of the most significant federal, state and local environmental regulations (i.e., NEPA, CWA, CAA, SDWA, Wild, Scenic and Recreational Rivers Act, Wetland restrictions, and Suffolk County Articles). The presentation also introduced the revised DOE environmental policy as outlined in the DOE Order 5400 series. Finally, the course presented BNL policy on effluent emissions and proposed changes in the ES&H Standard.

7.3 Summer Student Projects

7.3.1 Determination of Argon-41 Release Rate From the MRR

In terms of overall dose equivalent received at the BNL site boundary, the most significant airborne effluent is argon-41. Argon-41 is an air activation product produced by operation of the MRR, which contributed 96.8% of the off-site collective dose equivalent resulting from BNL activities in 1990. As the major contributor to off-site dose, the calculation of this source term is critical. Such a source term estimate can be calculated from the product of release rate (in Ci/MW-hr) and active operating time. This release rate was calculated during a student project in which argon activity concentrations were measured using Marinelli beaker effluent gas sampling and gamma spectroscopy techniques. The mean of several such measurements along with the knowledge of volumetric airflow rates in the MRR stack allowed for the construction of the appropriate power level-correlated Ar-41 release rate. This rate was found to be approximately 2 Ci/MW-hr and is now used to estimate the yearly argon source term resulting from MRR operation.

7.3.2 Analytical Laboratory Instrument Calibration

An additional student project was conducted in order to determine correction factors for two of the specific counting methods utilized in the BNL S&EP Analytical Laboratory. The correction factors examined and calculated were the self-absorption factors involved in gross alpha counting on the Tennelec LB5100 and quench curve corrections necessary for accurate Liquid Scintillation

Counting (LSC) on the Packard Tri-Carb 2250CA LSC. As a result of the project, self-absorption corrections for a particular sample being analyzed for gross alpha activity can be determined by correlating the sample's mass with a point on a plot of mass versus relative response. Likewise, low-energy beta activity may now be measured more precisely with the quench curves developed for the various scintillation fluid volumes routinely used in LSC analysis.

7.4 Release of Tritiated Water from the STP Emergency Hold-up Pond #2

Low-level radioactive liquid waste undergoes volume reduction at the BNL WCF. This facility reduces volume in excess of 100 to 1. The residue is removed, solidified, and appropriately disposed of as solid low-level radioactive waste. The distillate, which contains tritium, is released into the STP effluent from the clarifier under controlled conditions. Presently, distillate is transported from the WCF to one of the two lined emergency hold-up ponds at the STP. The distillate is released to the hold-up pond where evaporation and precipitation combine to both reduce the liquid effluent discharge and reduce the initial tritium concentration. Pond water is periodically pumped back to the STP and combined with the STP effluent for release at SPDES Outfall 001, the discharge to the Peconic River. The pump rate is determined by measurement of the tritium concentration in the pond and in the incoming STP waste stream. Administrative guidelines require that planned discharges to the Peconic River be smaller than 50% of the NYS DWS. In 1990, 68,100 liters of distillate containing 0.85 Ci (31.6 GBq) of tritium were placed into the STP Emergency Recharge Pond #2. Controlled release of this material commenced in November and continued through early December 1990. Approximately 0.3 Ci (11.1 GBq) was added to the effluent stream during this period. Tritium concentrations entering the Peconic River averaged 5400 pCi/L (200 Bq/L) or 27% of the NYS DWS. Releases during this period met both the NYS DWS and BNL administrative guidelines.

7.5 Multimedia Environmental Pollution Assessment (MEPAS)

As part of the 1987 DOE Environmental Survey, DOE developed and used the "Multimedia Environmental Pollution Assessment" (MEPAS) model to determine the impact of the operations of DOE Facilities on the environment. The model was used to rank the "Findings" or "Units" at each facility and subsequently for ranking the "Findings" on a DOE-wide basis using the MEPAS developed Hazard Potential Index (HPI). Currently, this methodology is being used for developing the priority rationale for the BNL Environmental Restoration Activities on a Fiscal Year (FY) basis. The principal components taken from this model to do the Priority rationale is the June, 1990 MEPAS ranking units and baseline risks as applied to the BNL Environmental Restoration Activities. This ranking is done for each FY and is specific to BNL.

7.6 Off-site Ground Water Contamination

Low-level concentrations of DCA, chloroform, TCE, and TCA, were detected in 1989 at a ground water surveillance well located in the southwest corner of the BNL site and screened at about 78 feet below grade. Brookhaven National Laboratory notified the SCDHS who, upon review of the data, embarked on a ground water surveillance survey of nearby private potable wells in an attempt to determine if the observed concentrations in the BNL surveillance wells were impacting the water quality of nearby residents. The SCDHS investigation identified five potable wells in the North Shirley area that had significant contamination of TCA. Brookhaven National Laboratory retained the services of Geraghty and Miller (G&M)[53] to investigate any possible connection between BNL and the contamination found in the private residences. The result of the SCDHS and G&M studies were that ground water flow in the south west section of the site is primarily in the southern direction and that the source of the private water contamination was due to operations and waste disposal practices within a nearby industrial complex that is located between the BNL boundary and the residences in question.

7.7 Vandalism of Ground Water Surveillance Well 18-01

On October 25, 1990, S&EP field sampling personnel found that Ground Water Surveillance Well 18-01 had been vandalized. The lock on the protective casing had been forcibly opened, the protective casing removed, and the dedicated well pumps located inside the well were found laying on the ground. A grab sample of the standing water indicated the possibility of a brown substance being added to the well. A bailer was used to collect a standing water sample that was analyzed for fecal coliform, metals, volatile organics, and radioactivity. The only contaminant detected was toluene at a concentration of 18 μg/L. These data indicated that a foreign substance was probably not added to the well. Dedicated sampling equipment was next reinserted into the well. The well was purged following the standard protocol and samples were collected for analysis. No organics were detected on the second round of sampling. This incident has been reported to DOE under UOR 90-042.[54]

7.8 Investigation of Blue Substance in Recharge Basin HS (Outfall 005)

On October 8, 1990, Plant Engineering personnel noticed that the water in Recharge Basin HS had an unusual looking material that was blue/green in color and, although gelatinous in standing water, dissolved easily into solution upon mixing. Investigation into the observation revealed that when the recharge basin was sampled in September, there was no gelatinous material or blue/green color to the water. Further review determined that Hydro-Seed, a green colored grass seed/paper/fertilizer mixture, had recently been applied throughout the site and that PYLON Dye, a water tracing dye recommended for use by SCDHS, had recently been used to determine water sources that discharged into Recharge Basin HS. Testing of the recharge basin water, hydro-seed, and PYLON dye produced tentative results that indicated the Pylon dye was responsible for the observation. Because this material is a recommended substance for water tracing activities in Suffolk County and is believed to be environmentally benign, this observation, although extensively investigated, did not constitute an unusual occurrence that required formal reporting to DOE.

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.[18] 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. In 1989, BNL Wells 10 and 11 were found to contain TCA at concentrations that exceeded the NYS DWS of 5 μg/L. Both wells were removed from service. Carbon filtration was procured and installation of the filters commenced in 1990 at Well 11. Similar treatment is planned for Well 10. In October of 1990, TCA concentrations that exceeded the NYS DWS were observed at Well 4. A testing program to verify the fourth quarter TCA concentration and to determine the TCA removal efficiency of the BNL WTP was conducted. Upon verification that Well 4 TCA concentrations exceeded the NYS DWS, it was removed from service. The test data for removal efficiency of TCA during routine processing of potable water at the WTP indicated that sufficient TCA was removed so that processed water from Well 4 had TCA concentrations less than the NYS DWS. These test data were provided to the regulators for a determination on the adequacy of the treatment method. A decision is expected in early 1991.
CSF	Soil and ground water in the vicinity of the CSF are contaminated with organic compounds which may require remedial action as a result of a 1977 spill. Iron concentrations exceeded the NYS DWS at Wells 76-04 and 76-06. In addition, the following organic compounds were observed in samples from ground water surveillance wells in this area: TCA at Well 76-21, TCE at Wells 76-08, and 76-21; PCE at Wells 76-19, 76-05, 76-08, and 76-21; benzene at Well 76-21; ethylbenzene at Wells 76-04 and 76-21; toluene at Wells 76-04, 76-06, and 76-08; and o-xylene at Wells 76-04 and 76-20. This area has been identified for remedial investigation under the RI/FS as Operable Unit 4.

Location	Status/Comments
HWMA	Remediation for organic contamination detected southeast of the HWMA was suspended in 1990 due to concerns raised by NYSDEC and the DOE Tiger Team regarding the adequacy of the plume definition and capture zone of the remediation pumping wells. Surveillance Wells in the area indicated that the following organic compounds were present in segments of the ground water from this area at concentrations in excess of the NYS DWS: TCA at Wells 108-13, 88-04, 98-02, 108-05, and 108-12; PCE at Wells 88-04; and DCE at Well 98-02. In addition, strontium-90 exceeded the NYS DWS at Wells 88-04, 98-02, and 98-29. This area has been identified as requiring further remedial investigation under the RI/FS as Operable Unit 1.
Old Landfill	The only parameter that was detected above NYS DWS was manganese at Well 97-05. All other parameters were below the NYS DWS. The former landfill has been identified for remedial investigation under the RI/FS as Operable Unit 1.
Current Landfill	Iron, manganese, DCA, benzene, ethylbenzene, and toluene are parameters that were observed in excess of the NYS DWS. Wells containing these parameters were: iron at Wells 88-01, 88-12, 87-03, 87-05, 88-02, 88-13, 87-08, 87-11, 87-10, 88-14, and 88-15; manganese at Wells 97-14, 98-33, 98-34, 88-01, 88-12, 87-03, 87-05, 88-13, 87-08, 87-11, 87-10, 88-14, and 88-15; DCA at Wells 107-09, 88-13, and 87-11; benzene at Wells 87-08 and 87-11; ethylbenzene at Well 87-08 and toluene at Well 88-13. The Current Landfill ceased operation in December, 1990 in compliance with the Long Island Landfill Law. This area has been identified for remedial investigation under the RI/FS as Operable Unit 4.
Peconic River/ Meadow March-Upland Recharge Area	Iron concentrations in excess of the NYS DWS were observed at Wells 39-05, 47-02, 40-02, 47-01, and 47-04. Manganese was observed in excess of the NYS DWS at Wells 47-02 and 89-01. The Meadow Marsh-upland recharge and the STP in the area of the Peconic River areas of the site have been identified for remedial investigation under the RI/FS as Operable Units 6 and 5, respectively.
Site Boundary	Trichlorethane was detected at Well 83-02, a west sector well, and at Well 130-02 along the southwest boundary at concentrations exceeding the NYS DWS. Toluene was detected at Well 18-01 in excess of the NYS DWS. The results at Wells 83-02 and 18-01 were sporadic. Normal monitoring will continue in these areas. The area near Well 130-02 has been identified for remedial investigation under the RI/FS as Operable Unit 1.

8.2 SPDES Permit

There are five recharge basins and one discharge to the Peconic River that are governed by the SPDES permit. In 1990, the following deviations from the permit requirements occurred:

Location	Status/Comments
Recharge Basins	Samples collected from three of the five recharge basins had pH values below the MDL of 6.5. These include: one out of four samples collected from Recharge Basin HN (Outfall 002) had pH recorded at 6.0; one of five samples collected from Recharge Basin HS (Outfall 005) had pH measured at 6.0; and one of three samples collected from recharge basin HO (Outfall 003) had pH of 4.75. In addition, iron concentrations in excess of NYS discharge limits to ground water were observed at three of the five recharge basins.
STP Effluent	There were five occurrences where suspended solids exceeded the SPDES permit maximum daily value of 10 mg/L. In addition, there was one instance where total coliform was measured above the SPDES discharge limit.
Cesspools	The line item project which provided connections to the site sanitary system for twelve buildings previously served by cesspools was completed in 1990. Plans for sampling and closure of these cesspools were submitted to EPA and NYSDEC for their review in accordance with the requirements of the IAG.

8.3 Radioactive Airborne Effluent Emissions Governed by NESHAPs

In 1990, BNL emissions complied with 40 CFR 61 regulations regarding radioactive airborne effluent releases. EPA Region II was notified that the Radiation Therapy Facility (BNL-489-01) had commenced operation and that seven operations had NESHAPs evaluations performed with the conclusion that a formal submission was not required. The site boundary dose resulting from BNL airborne emissions as calculated using CAP88 was 0.071 mrem. The radionuclide contributing the largest fraction of both the site boundary (87%) and population dose (96%) was argon-41. The release rate of this radionuclide was about 37% less than in 1989. The reduced source term is the result of lower operation time and power level of the MRR in 1990. This information was transmitted to both DOE and EPA in compliance with reporting requirements specified in 40 CFR 61 subpart 94. Also, BNL received a facility compliance inspection in 1990 with no deficiencies reported.

The only facility that has the potential to release airborne radioactive effluents in concentrations that could result in a site boundary dose in excess of 0.1 mrem per year as a result of normal operations is the MRR release of argon-41. As stated in Section 7.3.1, the argon-41 production rate was measured and verified in 1990. The argon-41 source term for this facility is calculated based on power level and the measured production rate. This methodology represents an alternative method to define source term and as such, requires EPA Region II concurrence. The BNL Reactor division has requested funding to upgrade the air effluent monitoring capability at the MRR to comply with DOE[23] and EPA[32] monitoring requirements.

Other sources at BNL require periodic confirmation. At the major facilities where routine monitoring occurs, the monitoring systems of the source term typically do not meet 40 CFR 61 requirements regarding sampling location and sample transport to the collection media. Most other small sources require identification and verification. The plan to identify these potential sources is outlined in the BNL Tiger Team Assessment Plan of Action.[34]

Brookhaven National Laboratory is in the process of notifying EPA Region II of the methods currently used to calculate and measure source terms used for compliance with 40 CFR 61.[32]

8.4 State Air Laws

During 1990, BNL evaluated a variety of air emission sources for the requirement of Permits to Construct (PCs) and 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
2	Certificates to Operate for two paint spray booths were canceled in April, 1990. These sources are no longer available for use as they were destroyed in a building fire.
2	A request for renewal of two air emission sources at the Inhalation Toxicology Facility was made in September, 1990 and is currently undergoing review by the NYSDEC. The process continues to operate under the provisions of the Uniform Procedures Act.
2	Applications for PCs for two air emissions sources associated with a cleaning room were submitted in October, 1990.
1	A request for cancellation of an existing CO for an incinerator was submitted to NYSDEC in November, 1990. This unit was removed from operation in July, 1990.
11	Applications for COs for general processes, exhaust, and/or ventilation systems were submitted to NYSDEC in December, 1990. These address a commitment made during the environment, safety, and health audit conducted by DOE Tiger Team in April, 1990.

8.5 Suffolk County Sanitary Codes

During 1990, BNL has made progress in bringing a number of storage facilities into compliance with the requirements of SCDHS. The applicable regulations are the Suffolk County Sanitary Code, Articles 7 and 12.[41,43] These storage facilities and their status are described below:

No.	Status/Comments
1	Underground waste oil tank was removed and replaced with a double-walled tank during February, 1990. Plans for the project were reviewed by representatives from the SCDHS.
5	Underground gasoline storage tanks were removed and replaced with double-walled tanks and associated piping during February and March, 1990. Representatives from the SCDHS reviewed the plans and inspected various phases of this project.
7	Existing outdoor underground fuel oil tanks were retrofitted with the addition of overfill alarm systems during March, 1990.
5	Aboveground outdoor tanks were upgraded with secondary containment.
1	Outdoor underground tank used to store fuel oil at Building 423 was removed in March, 1990 and replaced with a double-walled tank and associated piping.
1	Outdoor underground tank used to store fuel oil at Building 321 was removed in June, 1990; the tank and excavation were inspected by a representative of NYSDEC.
12	Further activities were conducted during CY 1990 involving outdoor underground tanks, formerly used to store aqueous r-adionuclides. Sludge samples were collected from seven of these tanks and analyzed by a contractor in order to determine the next phase of the project. The remaining tanks were free of sludge; four of these were removed in the presence of representatives from the SCDHS, one was removed in 1988. Additional details are discussed in Section 7.1.1.
3	Plans to upgrade three aboveground tanks used to store diesel fuel at the site maintenance facility were developed during November, 1990.
2	Overfill protection equipment and alarms were installed on two large aboveground tanks at the CSF.
10 - 12	As part of Phase III of BNL's tank upgrade program, plans were developed to install overfill protection for aboveground fuel oil tanks at the CSF and for an underground tank at the HWMF; replace storage tanks at the CSF and at the WCF. Additional details are discussed in Section 7.1.1.

8.6 Safe Drinking Water Act (SDWA)

The potable water at BNL is obtained from wells on-site. Four potable wells were used during 1990. These wells are routinely monitored; BNL's monitoring of these wells exceeds the minimum requirements prescribed by the SCDHS. The samples are analyzed by a contractor laboratory using standard methods of analysis. This laboratory is a State approved commercial drinking water laboratory. The results are submitted to the SCDHS as required by Chapter I, Part 5 of the NYS Sanitary Code.

One of the SCDHS monitoring requirements includes quarterly analysis of potable well water samples for VOCs. The fourth quarter VOC analyses indicated the presence of TCA in Potable Well 4 at a concentration above the NYS standard of 5 parts per billion. The well was voluntarily removed from service.

Prior to obtaining these results, BNL was concerned with the increasing concentrations of TCA observed in this well during previous quarterly sampling. In an effort to further investigate this, a testing program was developed to evaluate the ability of the existing processes at the BNL WTP to remove organic compounds. To ensure the merit of this testing program, the proposed protocol was discussed with a representative from the SCDHS.

The testing program was conducted in October, 1990. A package was prepared describing the test protocol and analytical results, and submitted to the SCDHS for their review and evaluation. A decision from the SCDHS is anticipated to be issued during the first quarter of 1991.

8.7 Toxic Substance Control Act (TSCA)

8.7.1 TSCA Program at BNL

The Toxic Substance Control Act (TSCA) regulates the use and disposal of specific substances, one of which is PCBs. The TSCA requirements include labeling, inspections, record keeping, immediate notification and cleanup upon discovery of spills, and proper disposal. In February, 1990, S&EP issued the BNL PCB Program Requirements to all Departments and Divisions. This program formally identifies the activities that Departments and Divisions must perform to ensure that their facilities are in compliance with the requirements of TSCA. At this time the Departments/Divisions were requested to review, verify, and update previous inventories of PCB equipment in Buildings under their jurisdiction. S&EP personnel visited the various Departments to verify and inspect their equipment. A database was developed by S&EP to enable tracking of all Department/Division PCB equipment. This will be updated as changes to individual inventories are reported. In addition, the Annual PCB Report for CY 1989 was prepared in accordance with the requirements of TSCA. This report is retained on file at S&EP Division. A copy is also submitted to DOE-BHO.

8.7.2 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 286,000 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, 4 and 5.[46] The material has remained in storage since this time awaiting NYSDEC authorization to burn it.

Several activities occurred during 1990 related to the PCB contaminated fuel in storage at the CSF. In January, 1990, NYSDEC issued a letter to DOE-BHO indicating that they were going to modify the certificates to operate CSF Boilers 4 and 5 to reflect the current fuel usage of Number Six oil and ALF free of PCBs. This modification revoked the special conditions previously agreed to for burning PCB contaminated fuel and became effective February 9, 1990. The NYSDEC also issued a revised Order on Consent for the incineration of PCB contaminated fuel at the CSF in February, 1990. While it addressed many of the previous concerns, there are still legal issues which were not resolved by the end of 1990.

Discussions and negotiations also continued with EPA during 1990. One of the conditions of EPA's formal approval to incinerate the PCB contaminated fuel was that it be initiated and completed within specific time frames. Due to the lengthy period of negotiating a Consent Order with NYSDEC, this time frame expired which necessitated BNL to request an extension. Brookhaven National Laboratory received an extension of time to begin incineration of the fuel from EPA in April, 1990. During the fall of 1990 it was proposed to EPA and NYSDEC that the fuel be disposed of as a removal action under the proposed RCRA/CERCLA IAG. In addition, BNL requested a modification to the January 21, 1986 approval from the EPA to incinerate the PCB contaminated fuel. Brookhaven National Laboratory proposed incineration at a fuel feed rate of 100% as opposed to the 10% rate as set forth in the Federal Facilities Compliance Agreement and Section 761.60 of TSCA. The basis for the request was that the results of stratified fuel samples collected during 1989 indicated that the concentration of PCBs remaining in the fuel ranged from 10 to 32 ppm which is less than the 50 ppm concentration specified in Section 761.60.

8.8 Resource Conservation Recovery Act (RCRA)

8.8.1 Tiger Team Assessment

The HWMF has one major compliance concern, which was noted on the Tiger Team Assessment. There is an insufficient volume of water to fight a fire as required under RCRA (40 CFR 265.32(d)). This problem is being addressed by investigating the possibility of installing two 5,000 gallon tanks that will hold water for fire fighting. These tanks will be on an automatic feed, which will insure a constant supply of water. Additionally, the HWMF has purchased hazardous waste storage sheds that are protected with a fire detection/ suppression system.

The HWMF did have some minor compliance concerns. During the Tiger Team Assessment and on other audits, containers were found without labels and dates [40 CFR 262.34(a)]. This problem has been eliminated by the issuance of a new standard operating procedure, "Inspection Plan Procedure for the Hazardous Waste Management Facility" (HWM-001). This procedure instructs the inspector to check each container once a week to insure that the containers comply with the labeling requirements. The HWMF also had a small quantity of waste that was uncharacterized (40 CFR 262.11). This waste has been analyzed, and it was determined that the waste was only radioactive and not a RCRA waste.

8.8.2 90-Day Accumulation Areas

The 90-Day Accumulation Areas were inspected during the Tiger Team Assessment and during Tier II inspections. The same type of compliance deficiency was found. Some generators of hazardous waste place waste in their 90-Day Accumulation Area without the words "Hazardous Waste", and without the date it was placed into the 90-Day areas [40 CFR 262.34(a)]. Guidance has been provided on numerous occasions from the Directors Office on this subject.

8.8.3 RCRA Permits

The Part 6 NYCRR373 Permit (40 CFR 270.10) is still in interim status. Brookhaven National Laboratory has received a NOIA from the State of New York. The permit is currently being revised to answer the concerns of the NOIA. The Permit Application should be ready for resubmission by July 1, 1991.

8.9 Comprehensive Environmental Response, Compensation Liability Act (CERCLA)

On December 21, 1989, BNL was included as a Superfund Site on the NPL. Subsequently, a draft IAG, also referred to as a Federal Facilities Agreement, was negotiated among the U.S. DOE, the U.S. EPA, and the NYSDEC. The IAG was written to insure compliance with the CERCLA, the corrective action requirements of the RCRA, the NEPA, and corresponding NYS regulations. In particular, the IAG is intended to insure that environmental impacts associated with past and present activities at BNL are thoroughly and adequately investigated so that appropriate response actions can be formulated, assessed, and implemented.

There are currently twenty-four AOCs (some of which include sub-areas) at the BNL site to be addressed through the IAG. The AOC's consist of both active facilities (STP, HWMF, ...) and inactive facilities (former landfills, cesspools, radioactive storage tanks, ...). The AOCs are currently being grouped and prioritized into more workable "operable units" and removal actions.

As a result of a near-term work schedule agreed to by DOE, EPA, and DEC during 1990, the preparation of RI/FS project plans at one operable unit (CSF, Building 650 Sump, leaking sewer lines) has been initiated, as well as planning activities at three removal actions (decontamination and decommissioning of three large above-ground radioactive waste storage tanks; sampling and removal of various underground storage tanks; and sampling, and removal if necessary, of various industrial cesspools). During 1990, the following reports have also been prepared and submitted to EPA and DEC for their review; Solid Waste Management Unit Classification Report, Historical Site Review Work Plan, Underground Storage Tank Sampling Results, and Conceptual Treatment Plan, and Cesspool Sampling and Analysis Plan.

8.10 Superfund Amendments and Reauthorization Act (SARA) of 1986

The SARA regulations require that BNL compile and submit Tier I reports to the New York State Emergency Response Commissioner, the Suffolk County Local Emergency Response Committee and the responding fire organization. For BNL, the responding fire organization is the S&EP Fire and Rescue Group. For CY 1990, BNL submitted to these groups the Tier I report. This report contained the maximum and average daily amounts for all chemicals, determined from inventory and purchasing records, which fall into the following categories: physical hazards, classified by type as fire, sudden release of pressure or reactivity, and health hazards, classified by type as immediate (acute) and delayed (chronic). The quantities reported are listed as follows:

Hazard Type	Maximum, tons	Average, tons	Location
Fire	5,000 to 25,000	50 to 500	Buildings 630, 326 and 610
Sudden Release of Pressure	5,000 to 25,000	50 to 500	Buildings 158 and 901
Reactivity	50 to 500	5 to 50	Buildings 158, 555 and 197
Immediate (acute)	5,000 to 25,000	50 to 500	Buildings 158, 555, 197 and 610
Delayed (chronic)	5,000 to 25,000	50 to 500	Buildings 158, 610, 197 and 555

Brookhaven National Laboratory is not required under the SARA regulations to submit a Tier II report that provides detail regarding the chemicals and quantities within each hazard type unless requested by an outside agency. In 1991, New York State requested that this report be submitted. Brookhaven National Laboratory complied with this request.

8.11 National Environmental Policy Act (NEPA)

In 1990, the Laboratory showed its strong commitment to full compliance with NEPA and DOE Order 5440.1D[49] through the hire of a dedicated NEPA compliance officer. The BNL NEPA Policy continued to take shape with draft protocols addressing construction, operation, capital improvement, and research projects issued in June and October. To further promote NEPA compliance, Dames and Moore was contracted to prepare an Occupational Health and Safety Guide which would include procedures for NEPA compliance. The first draft of this guide was reviewed in October.

Environmental evaluations were completed for 166 projects in accordance with the NEPA protocol. Of these, 44 were considered minor actions requiring no additional documentation and 122 had Environmental Evaluation Forms completed for submission to DOE. These forms are the basis used to determine if additional documentation is required or if a project falls under one of the Categorical Exclusions to NEPA approved for the DOE. The second level of documentation, a Memorandum-To-File (MTF), was completed and approved for additions to BNL's

Central Shops and Computing and Communications buildings, and the installation of a new boiler at the CSF. Environmental Assessments (EAs) were prepared for the proposed Science Education Center and Child Development Facility buildings. After review by DOE-HQ, it was determined that the appropriate level of documentation for these projects should have been MTFs. An MTF was subsequently prepared and approved for each project. Draft EAs were also prepared for the construction of a Laser Laboratory in Building 535B and the construction and operation of the Relativistic Heavy Ion Collider (RHIC).

Potential cultural resource impacts were coordinated through the New York State Historic Preservation Officer (SHPO). Representatives of the SHPO toured BNL on June 27th to augment their reviews. The same was done with representatives of the NYSDEC on August 14th for projects with the potential to impact fresh water wetlands within their jurisdiction.

8.11.1 Environmental Assessment for the RHIC

Dames and Moore completed a draft EA for the RHIC project in March, 1990. After internal modifications, this document was formally transmitted to DOE for comment in June, 1990. Revisions to the document were completed in August and December, 1990. It is anticipated that the document will be released for public review in 1991.

8.12 Federal Insecticide, Fungicide, and Rodenticide Act

Brookhaven National Laboratory has two programs where insecticides and pesticides are used. As per the regulatory requirements, both users, the Biology Department and Plant Engineering Division (Grounds Section) maintain a log of applications made and a log on the inventory at each facility. In addition, key personnel are trained and the training updated annually on the handling and application of these chemicals. Formal reporting is not required, however, the log books are available for inspection and verification to auditing agencies.

8.13 Endangered Species Act

Brookhaven National Laboratory has received notification from the U.S. Fish and Wild Life Service and the NYSDEC that there are no endangered species resident on the site.

8.14 National Historic Preservation Act

The BNL site contains two standing structures, the Graphite Reactor Building (Bldg. 701) and the Old Cyclotron enclosure (Bldg. 902), along with the World War I era trencher that are of interest to the NYS Office of Parks, Recreation, and Historic Preservation. Brookhaven National Laboratory must consult with this agency only on projects that have any potential impact on these resources. In all other projects, there is no effect upon cultural resources that would require inclusion in the National Register of Historic Places. Implementation of the NEPA process ensures compliance with this Act.

8.15 Flood Plain Management

There was no construction in flood plain areas during CY 1990.

8.16 Protection of Wetlands

In August of 1990, a representative from NYSDEC conducted a preapplication consultation at the BNL site. This visit was made in anticipation of BNL applications to construct environmental monitoring enclosures and install flow monitoring devices as part of an S&EP environmental program upgrade project plus an application to improve the RHIC ring road. During the visit, wetland areas were identified.

8.17 Compliance Issues During First and Second Quarter of 1991

This section provides a brief overview of the major compliance issues encountered at BNL during the first two quarters of CY 1991. These issues will be discussed in detail in the Site Environmental Report for CY 1991.

8.17.1 SPDES Compliance Issues

During the first two quarters of 1991, there were two instances of non-compliance with the existing SPDES permit. In March, a split sample collected from Location EA by the EPA was analyzed by BNL for volatile organics. The compound TCA was detected in excess of the NYS DWS. Organic compounds are not on the list of allowable discharges to the sanitary system. However in a prior sample, NYSDEC had identified TCA in the effluent and was proposing to include the compound in the revised SPDES permit. In April, BNL initiated a daily sampling program to determine the range of detectable organic concentrations that were present in STP influent, effluent, and in surface water prior to leaving the BNL site. This investigation identified the presence of several facilities that discharged organic compounds, noticeably TCA, to the sanitary sewer system. Review of these operations identified various alternatives to discharge of this material into the environment. Consequently, TCA concentrations are typically below the NYS DWS. Other compounds detected in this investigation were methylene chloride, toluene, and acetone. Although present in STP influent, these compounds were rarely detectable in liquid discharges to the Peconic River and never detected in the surface water leaving the site. This incident is being reported in an Unusual Occurrence Report.

The second non-compliance occurred with the discharge of lubricating oil from an elevator to Recharge Basin HT (Outfall 006). A piston elevator located in Building 930 developed a leak in a seal that permitted the discharge of about 1 to 2 gallons of lubricating oil. The oil was removed from the water by adsorption on to adsorbent pads. The elevator seal was repaired prior to continued use of the elevator. This incident is reported in a Unusual Occurrence Report.

8.17.2 NESHAPs Compliance for Radioactive Airborne Emissions

Experiments, construction of new facilities, and modification to airborne effluent sources that have the potential to generate an NESHAPs evaluation. No potential sources required formal application to EPA Region II.

8.17.3 Compliance with NYS Air Laws

Efforts continued during the first two quarters of 1991 to bring air emission sources into compliance with NYS Air Laws. Applications for COs for three existing sources were submitted to NYSDEC in January, 1991. A request to cancel an existing CO for a source at Building 452, which is no longer in service, was submitted to NYSDEC in February, 1991. Renewals for four COs were also submitted to NYSDEC in February, 1991. The NYSDEC issued PCs for two new sources at Building 197 in March, 1991. A request was submitted to NYSDEC for a determination of PSD nonapplicability for the proposed CSF Boiler No. 7 in April, 1991. Preparation of the PC for proposed CSF Boiler No. 7 was also initiated during the second quarter of 1991. Efforts continued during the first two quarters of 1991 for the installation, debugging, and testing of the continuous emission monitors required at CSF Boiler No. 6.

8.17.4 SDWA Compliance Issues with SDWA

The SCDHS reviewed the report describing the testing of the BNL WTP for VOC removal. After consultation with individuals at the NYSDOH, SCDHS found it to be a satisfactory demonstration that the existing aeration stage of the WTP constitutes adequate treatment such that Potable Well No. 4 could be returned to service. This approval is subject to the following conditions: (1) that the levels of synthetic organic compounds (SOCs) do not change substantially from the ranges encountered thus far; (2) that SOCs are not encountered in other wells feeding the WTP; (3) that quarterly SOC analytical samples be taken from the treated water from the WTP; and (4) that all other routine monitoring of the wells continue at the current frequencies required. Samples will continue to be collected at Potable Well No. 4 in order to evaluate the VOC removal efficiency and to isolate the well-source if a significant increase in SOCs is encountered. Based on this approval, Potable Well No. 4 was returned to service in February, 1991.

8.17.5 TSCA Compliance Issues

Departments and Divisions were requested to review and update their inventory of equipment containing PCBs in May, 1991. This information was provided to the S&EP Division and incorporated into the PCB inventory database. The BNL annual PCB report for CY 1990 was prepared in accordance with Section 761.180 of TSCA during the second quarter of 1991.

8.17.6 RCRA Compliance Issues

In response to both Tiger Team findings[32] and observations of the EPA multi-media inspection, the HWMF is undergoing two immediate facility upgrades. First, outdoor modular storage units with automatic dry chemical fire suppression systems were installed and more have been ordered. Second, additional fire protection capability is being addressed through the installation of a water storage tank near Building 483, the Drum Storage Facility. In addition to upgrades to existing facilities, the HWM group received revised conceptual design reports for new facilities that will satisfy all code requirements. These reports were forwarded to DOE-CH and EM with EM staff performing an Independent Cost Review in February, 1990.

8.17.7 SARA Compliance Issues

In 1991, New York State requested that a SARA Tier II report be provided for CY 1990. This report was prepared and submitted to NYS in August of 1991.

8.17.8 NEPA Compliance

Review of projects, research, and construction activities continued in an effort to comply with the provisions of DOE Order 5440.1D. The major accomplishment during this period was the completion of the RHIC Environmental Assessment and receipt of concurrence from DOE Head Quarters. The document is now ready for transmittal to other interested regulatory parties.

8.17.9 Status of IAG Activities

In accordance with the proposed IAG milestones, a Work Plan for historical site review was submitted to EPA and NYSDEC for review in October, 1990, with the Plan being approved in January, 1991. A draft Site Baseline Report, which presents past monitoring data and other background information for the twenty-four AOCs at BNL, and a draft soil sampling and analysis plan for the "D" low-level radioactive waste storage tank removal action were prepared and submitted to EPA and NYSDEC for review in February, 1991. A site-wide Community Relations Plan, which describes the community relation activities to be conducted during the environmental restoration work at BNL, was prepared and submitted to EPA and NYSDEC for review in April. The first OU that is being addressed under the IAG is OU 4, the Central Steam Facility, and Building 650 Sump areas. A draft RI/FS work plan for this area was prepared and submitted to EPA and NYSDEC for their review in April. Following regulatory approval of this plan, remedial investigation field activities are expected to commence in the spring of 1992.

8.17.10 EPA Multi-media Inspection

In order to initiate more comprehensive and integrated environmental protection and compliance activities, EPA Region II in 1991 began sending inspection teams to major facilities that have the potential to impact a variety of environmental media. A team consisting of approximately 15 inspectors with expertise in CAA, SDWA, NPDES, SPCC RCRA, TSCA, USTs, and NESHAPs regulatory programs performed an inspection of BNL during the week of March 4, 1991. The inspection consisted of interviews with BNL personnel, inspection of facilities, review of data reports and compliance documentation, and periodic sampling to confirm effluent releases. A close-out meeting was held at the conclusion of the inspection to discuss significant findings.

Subsequent to the close-out meeting, BNL has received written comments from EPA regarding the findings and recommendations of their inspectors. In late March, 1991, correspondence was received concerning compliance with the SDWA stating that the BNL potable water system is currently in compliance with all SDWA requirements. The inspectors did make several recommendations which BNL is evaluating. In April, 1991, comments were received regarding Class V wells that are regulated under the Underground Injection Control section of the SDWA requesting additional information. This information was supplied to EPA. In July, 1991, DOE/BHO and BNL received a response to the information sent. Brookhaven National Laboratory and DOE-BHO are evaluating and preparing a response to EPA.

The EPA issued a Deficiency Notice to BNL for issues regarding compliance with NPDES in April, 1991. The AOCs included measurement of Total Suspended Solids, Biochemical Oxygen Demand, quality control documentation regarding the recording of temperature on the incubator and refrigerator used for BOD_5, and parameters such as pH, dissolved oxygen, moisture content of ovens, and use of chemicals that had exceeded shelf expiration dates and issues regarding the verification of procedures at the contractor laboratory where analyses are performed for fecal and total coliform. Brookhaven National Laboratory responded to this notice in May with corrective actions on all issues except for procedural changes at the contractor laboratory. This last issue was resolved in June.

The EPA requested additional information regarding BNL implementation and compliance with the CA in June 1991. Information regarding combustion units at the CSF was compiled and transmitted to EPA in July. Information relating "coating line" at Building 458 was transmitted in August of this year. Further correspondence is expected upon completion of the data review by EPA.

In early July, EPA issued NOVs to BNL on RCRA and TSCA issues. The EPA identified eight RCRA and ten TSCA violations. The BNL technical staff and legal counsel plus DOE-BHO are reviewing the NOVs and are preparing a response that is scheduled for submission to EPA in August, 1991.

APPENDIX A

A.1 Glossary of Terms

ADM	- Action Description Memorandum
AGS	- Alternating Gradient Synchrotron
ALF	- Alternate Liquid Fuels
AOC	- Area of Concern
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
CERCLA	- Comprehensive Environmental Response, Compensation & Liability Act
CLP	- Contractor Laboratory Program
COs	- Certificates to Operate
CSF	- Central Steam Facility
CY	- Calendar Year
DAS	- Department of Applied Science
DCA	- Dichloroethane
DCE	- Dichloroethylene
DCG	- Derived Concentration Guide
DOE	- Department of Energy
DOT	- Department of Transportation
DWS	- Drinking Water Standard
EA	- Environmental Assessment
ECL	- Environmental Conservation Law
EM	- Environmental Monitoring
EP	- Environmental Protection
EPA	- Environmental Protection Agency
ES&H	- Environmental, Safety, and Health
HFBR	- High Flux Beam Reactor
HPI	- Hazard Potential Index
HWMF	- Hazardous Waste Management Facility
HWMG	- Hazardous Waste Management Group
IAG	- Interagency Agreement
LFS	- Light Feed Stocks
LSC	- Liquid Scintillation Counting
LINAC	- Linear Accelerator
MDC	- Minimum Detection Concentration
MEPAS	- Multimedia Environmental Pollution Assessment
MDL	- Minimum Detection Limit
MLD	- Million Liters per Day
MPF	- Major Petroleum Facility
MRC	- Medical Research Center
MRR	- Medical Research Reactor
MTF	- Memorandum to File
NA	- Not Analyzed
NBTF	- Neutral Beam Test Facility
NCRP	- National Council on Radiation Protection

A.1 Glossary of Terms (cont.)

ND	- Not Detected
NEPA	- National Environmental Policy Act
NESHAPS	- National Emission Standards for Hazardous Air Pollutants
NOIA	- Notice of Incomplete Application
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
OSHA	- Occupational, Safety, and Health Administration
PCB	- Polychlorinated biphenyls
PCE	- Tetrachloroethylene
PCs	- Permits to Construct
P&GA	- Photography and Graphic Arts
PNA	- Polynuclear Aromatics
PVC	- Polyvinyl Chloride
QA	- Quality Assurance
RCG	- Radiation Concentration Guide
RCRA	- Resource Conservation Recovery Act
RI/FS	- Remedial Investigation/Feasibility Study
REF	- Radiation Effects Facility
RHIC	- Relativistic Heavy Ion Collider
SARA	- Superfund Amendments and Reauthorization Act
SCDHS	- Suffolk County Department of Health Services
SDWA	- Safe Drinking Water Act
S&EP	- Safety and Environmental Protection
SHPO	- State Historic Preservation Office
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
TCA	- 1,1,1-Trichloroethane
TCE	- Trichloroethylene
TLD	- Thermoluminescent Dosimeters
TSCA	- Toxic Substance Control Act
UST	- Underground Storage Tank
VOC	- Volatile Organic Compound
VUV	- Vacuum Ultraviolet
WCF	- Waste Concentration Facility
WTP	- Water Treatment Plant

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 was calculated for release elevations as listed in Appendix D, Table 4, at each of the 16 directional sectors, and for 6 distance increments (site boundary, 1.6-16 km, 16-32 km, 32-48 km, 48-64 km, and 64-80 km) from the center of the site using CAP88. The 1990 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 determine the annual emission rate for each radionuclide. The site boundary and collective were obtained from the CAP88 computer code printout. The CAP88 calculates the total dose due to contributions from the submersion, ingestion, shoreline, and recreational pathways as a result of an atmospheric release. In 1990, two percent of the tritium atmospheric relase from the 100 m stack was added to the 10 meter tritium source term in an effort to account for down-draft at the 100 meter stack.

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. <u>Methodology for Dose-Equivalent Calculations - Fish Ingestion Pathway</u>

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.[55]

c. Committed Dose Equivalent Tables [56] 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.

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	(All concentration values in mg/L except where noted)
Ag	0.025
Cd	0.0005
Cr	0.005
Cu	0.05
Fe	0.075
Hg	0.0002
Mn	0.05
Na	1.0
Pb	0.005
Zn	0.02
Ammonia-N	0.02
Nitrite-N	0.01
Nitrate-N	1.5
Specific Conductance	10 umhos/cm
Chlorides	6.0
Sulfates	6.0
1,1,1-trichloroethane	0.002
trichloroethylene	0.002
tetrachloroethylene	0.002
chloroform	0.003
chlorodibromomethane	0.002
bromodichloromethane	0.002
bromoform	0.002
benzene	0.002
toluene	0.002
xylene	0.002

APPENDIX C
INSTRUMENTATION AND ANALYTICAL METHODS

The analytical laboratory of S&EP Division is divided into 1) radiological, and 2) non-radiological sections to facilitate analysis of specific parameters in each category. The following analytes are analyzed in each category.

1) Radiological: Gross alpha, gross beta, gamma, tritium and Sr^{90}.

2) Non-radiological: Purgeable aromatics, Purgeable halocarbons, PCBs, anions and metals.

A brief description of methods and instrumentation for each category is given below. Only validated and regulatory referenced methods are used during the analysis. All samples are collected and preserved by trained technicians according to appropriate referenced methods. Well qualified and trained analysts are involved in performing different analysis. The analytical laboratory is certified by NY State Department of Health (NYDOH) for all non-radiological parameters, except for PCBs. The radiological laboratory participates in:

1a) Gross Alpha and Gross Beta Analysis - Water Matrix:

Water samples are collected in one liter polyethylene containers. No preservatives are added prior to sample collection. If the samples are effluent or surface stream samples from locations DA, EA, HM, or HQ or Building 535B daily process samples then 100 ml are extracted for analysis. Ground water samples are typically analyzed using a 500 ml aliquot. Due to high iron content, 100 ml aliquots of ground water samples from the landfill areas may be used in this analysis. The aliquot is evaporated to near dryness in a glass beaker. The beaker is rinsed to remove the solids and the combined solids and rinsate are transferred to a 5 cm diameter planchet. The planchettes are evaporated to dryness, allowed to cool and then are counted in a gas flow proportional counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. System performance is checked daily with an americium-241 and chlorine-36 source.

1b) Gross Alpha and Gross Beta Analysis - Air Particulate Matrix:

Air particulate samples are collected on 50 mm filters at a nominal flow rate of 15 liters per minute. At the end of the collection period, particulate filters are returned to the analytical laboratory for assay. Filter papers are counted twice in a gas flow proportional counter for 50 minutes. The first count occurs immediately upon receipt in the analytical laboratory. This count is used to screen the samples for unusual levels of air particulate activity. The filters are then recounted approximately one week later. The week delay permits decay of the short-lived radon/thoron daughters. The second analysis is used for environmental assessments. The first sample of each batch is a an empty chamber (no filter paper) background that is subtracted from the raw data prior to computation of net concentration. System performance is checked daily with an americium-241 and chlorine-36 source.

1c) Tritium Analysis - Water Matrix:

Water samples are collected in one liter polyethylene containers. No preservatives are added prior to sample collection. If the samples are effluent or surface stream samples from locations DA, EA, HM, or HQ or building 535B daily process samples then 1 ml is extracted for analysis. Ground water and potable water samples are typically analyzed using a 7 ml aliquot. Liquid scintillation cocktail is then added to the sample aliquot so that the final volume in the liquid scintillation counting vial is 15 ml. Samples are then counted in a low background liquid scintillation counter for 100 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. The second sample in each batch is a standard that is used to compute system performance and efficiency. Each sample is also checked for quenching. Corrections for background, quenching and current system efficiency for the sample matrix and size are factored into the final net concentrations for each sample.

1d) Tritium Analysis - Air Matrix:

Ambient and facility tritium air concentrations are measured by drawing the air at a rate of approximately 200 cc/m through a desiccant. At the end of each collection period, typically one week, the desiccant is brought to the analytical laboratory for processing. The desiccant is dried in a glass manifold system. Effluent samples have dedicated glassware as do environmental samples. The off gas containing moisture from the sampled air is collected by means of a liquid nitrogen trap. This water is then assayed for tritium content. A 7 ml aliquot is used for analysis. Liquid scintillation cocktail is then added to the sample aliquot so that the final volume in the liquid scintillation counting vial is 15 ml. Samples are then counted in a low background liquid scintillation counter for 100 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. The second sample in each batch is a standard that is used to compute system performance and efficiency. Each sample is also checked for quenching. Corrections for background, water recovery, air sample volume, quenching and current system efficiency for the sample matrix and size are factored into the final net concentrations for each sample.

1e) Strontium-90 Analysis:

Strontium-90 analyses are currently performed on water, soil, and aquatic biota samples. Typically, at least four liters of liquid and one kilogram of solid sample is shipped to the contractor laboratory. The analysis proceeds by using the HASL-300 procedure which utilizes wet chemistry techniques to isolate strontium-90 from the sample. Samples are counted twice to verify strontium-90 and yttrium-90 ingrowth. Chemical recoveries are determined by a combination of gravimetric and strontium-85 standard addition techniques. Samples are typically process in a batch. Backgrounds and system performance are verified with each batch. Chemical recoveries for both strontium-90 and yttrium-90 are determined for each sample.

1f) Gamma Spectroscopy Analysis:

Surface, potable and ground water surveillance samples are typically 12 liter samples that are placed in polyethylene bottles without preservatives. Samples are then passed through a mixed bed ion exchange column at a rate of 20 cc/m until all 12 liters have passed through the column. The column is then removed, placed in a teflon coated aluminum can and counted for 50,000 seconds. Where effluent sampling is performed in a flow proportional manner, 10 cc aliquots are passed through the mixed bed column on an as needed basis. Typically samples sizes for this type of sample tend to approach the 50 to 100 liter size. Air particulate filter papers are counted directly on the detector for 10,000 seconds. Charcoal filter canisters are also counted directly on the detector with a count time or 50,000 seconds. Soil, vegetation and aquatic biota are all processed following collection. Typically, 50g, 100g, or 300 g aliquots are taken, placed in a teflon lined canister and directly counted. For gamma spectroscopy analyses, backgrounds are collected once per week and system performance is verified daily. Analytical results reflect net activity that has been corrected for background and system response of the detection medium

2a) Purgeable aromatics and purgeable halocarbons:

Water samples are collected in 40 ml glass vials with removable teflon-lined caps without any headspace and stored at 4° C and analyzed within 14 days.

Ten (10) purgeable compounds (benzene, toluene, ethyl benzene, total xylenes, chloroform, 1,1-dichloroethane, 1,1-dichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene) are analyzed under this category following EPA method 624 protocols using gas chromatography/mass spectrometry (GCMS). These ten compounds were chosen as the target compounds since they are known or suspected to be present in the monitoring wells based on the DOE survey of the sight in 1988[57] and a comprehensive analysis of 51 new monitoring wells using EPA's Contract Laboratory Program (CLP)[58,59] procedures in 1989. There are currently two Hewlett-Packard GCMS instruments. One instrument is exclusively used for the analysis of purgeable compounds and the other for screening extractables and other extraneous compounds in non-routine samples. Since ground water under BNL is classified as a sole source aquifer, the detection limits reported for the compounds are close to drinking water standards.

The method involves purging a 25 ml aliquot of the sample with ultra pure helium in a specially designed sparger using Purge and Trap technique. Each sample is spiked with known concentration of internal standards and surrogates before purging to facilitate identification, quantitation and determination of the extraction efficiency of analytes from the matrix. The purged analytes are trapped on to a specially designed trap and thermally desorbed on to the DB-624 megabore capillary chromatographic column by back flushing the trap with helium. The compounds are separated into individual compounds with a temperature program of the GC and enter the mass spectrometer where they undergo fragmentation to give characteristic mass spectra. The unknown compounds are identified comparing their mass spectra and retention times with reference compounds, and quantitated by internal standard method. The quantitation data is supported by extensive amount of QA/QC such as tuning mass spectrometer to meet bromofluorobenzene (BFB) criteria, initial and continuing calibrations verifying daily response factors, method blanks, surrogate recoveries, duplicate analysis, matrix spike and matrix spike duplicate analysis and performing reference standard analysis to verify the daily working standard.

2b) PCB analysis:

Samples are collected in 50-100 ml glass containers with teflon-lined lid and stored at 4° C and analyzed within 14 days.

Transformer oil, waste oil and spill wipe samples are analyzed for PCBs using gas chromatography- electron capture detector (GC-ECD) method. This method is similar to EPA method 608 and is targeted to identify and quantitate seven different mixtures of PCB congeners in the samples.

The method consists of diluting a known weight of the sample with isooctane and removing the interfering compounds with one or more aliquots of concentrated sulfuric acid till the acid layer is almost colorless. All the oil matrix along with other interfering polar compounds are selectively removed from the sample, leaving PCBs in isooctane solvent.

There are two GC-ECD instruments for the analysis of PCBs. Each GC-ECD instrument is calibrated with different concentrations of each PCB mixture to establish linearity. PCBs found in the samples are identified and quantitated by comparing the retention times and chromatographic patterns with the standards. Methods blanks, duplicates, spikes and reference standards are run as part of QA/QC.

2c) Anions:

Chloride, nitrate-N and sulfate are analyzed using Dionex Ion-chromatography (IC) with ion suppression and conductivity detection technique.

Monitoring well samples are collected in 500-1000 ml polypropylene bottles, cooled to 4° C and analyzed within 28 days. For nitrate analysis in drinking water analysis, samples are supposed to be analyzed within 48 hrs. However, even though holding times were exceeded for nitrate analysis of monitoring well samples, it is expected that the depletion of nitrate will be negligible.

The anions are passed through a anion-exchange polymer column and eluted with carbonate/bicarbonate solution. Then the eluent passes through a ion-suppressing column where the background contribution from the eluent is suppressed, leaving the target anions to be detected by conductivity meter.

Initially, the IC system is calibrated with standards to define the working range of the system. The target anions in the samples are identified and quantitated by comparing the retention times and areas with the standards. Method blanks, duplicates, replicates, spikes and reference standards are routinely analyzed as a part of QA/QC.

2d) <u>Metals</u>:

Samples are collected in 1000 ml polypropylene bottles and stabilized with ultra-pure nitric acid to a pH of <2. The samples are analyzed within 6 months, except for mercury, in which case the samples are analyzed within 28 days.

Cadmium, chromium, lead (furnace), copper, iron, manganese, silver, sodium, zinc (flame) and mercury (manual cold vapor) are analyzed with Perkin-Elmer atomic absorption spectrometer. Using the flame technique, the sample containing the target element is nebulized and atomized in an oxy-acetylene flame. At the same time, a beam of light from a element-specific hollow cathode lamp corresponding to the absorption frequency of target element is passed through the flame. The atomized element absorbs the energy specific to that element from the cathode lamp and the intensity of absorption is proportional to the concentration of the element in the sample. Calibration curves are run to establish the linearity of the system and samples are quantitated by comparing with standards.

Using the furnace technique, chemical interference is eliminated in two stages: first by heating the sample at 105-110° C to remove moisture and then at 600-900° C to burn out any organic matrix. Final atomization is achieved by heating the furnace to 2400-2700° C. The rest of the technique is similar to the flame method mentioned above. Using this furnace technique, sub-ppb detection limits are possible for water samples.

Using cold vapor technique for mercury, a 100 ml aliquot of the sample is digested with potassium permanganate/persulfate oxidizing solution at 95° C for 2 hours to oxidize any organically-bound and/or monovalent mercury to mercury (II) ion state. Excess oxidizing agent is destroyed with hydroxylamine hydrochloride. The mercuric ion later is reduced to elemental mercury with excess stannous chloride which is purged with helium into the absorption cell. The absorption is directly proportional to the concentration of mercury in the sample.

All the above mentioned atomic absorption techniques involve initial calibrations to define the calibration range, continuing calibrations, method blanks, duplicates, replicates, matrix spikes and reference standard analysis as a part of QA/QC.

APPENDIX D

TABULATED ANALYTICAL RESULTS

Table 1
BNL Site Environmental Report for Calendar Year 1990
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
N	4556	0	94083	249823	259840	608302	Between 16 km and 32 km - Long Island Sound; Beyond 32 km - Connecticut
NNE	7592	0	7066	44607	65715	124980	Between 16 km and 32 km - Long Island Sound; Beyond 32 km - Connecticut
NE	2951	748	0	13631	33223	50553	Between 32 km and 48 km - Long Island Sound; Beyond 48 km - Connecticut
ENE	2488	6935	12920	14935	2256	39534	North Fork of Long Island
E	3033	16007	17420	9068	565	46093	South Fork of Long Island and Atlantic Ocean
ESE	6176	7706	0	0	0	13882	Long Island; Beyond 32 km - Atlantic Ocean
SE	9094	0	0	0	0	9094	Beyond 16 km - Atlantic Ocean
SSE	22472	0	0	0	0	22472	Beyond 16 km - Atlantic Ocean
S	15585	24	0	0	0	15609	Beyond 32 km - Atlantic Ocean
SSW	21444	1098	0	0	0	22542	Beyond 32 km - Atlantic Ocean
SW	21894	65146	3431	0	0	90471	Beyond 48 km - Atlantic Ocean
WSW	38077	144660	353503	427339	775758	1739337	Beyond 80 km - Part of New York City
W	49732	134425	238530	227326	371491	1021504	Beyond 80 km - New York City
WNW	41910	58723	118	215840	129920	446511	Between 32 km and 48 km - Long Island Sound; Beyond 48 km - Connecticut and New York
NW	18053	1568	136199	123421	110860	390101	Between 32 km and 48 km - Long Island Sound; Beyond 48 km - Connecticut and New York
NNW	7693	0	209855	107617	54390	379555	Between 16 km and 32 km - Long Island Sound; Beyond 32 km - Connecticut
TOTAL	272750	437040	1073125	1433607	1804018	5020540	

Table 2
BNL Site Environmental Report for Calendar Year 1990
Wind Rose
Joint Frequency Distribution
Percentages by Year

	YEAR											
	1980-1989	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
<u>Wind Speed, mps</u>												
LE 1	1,01	0,82	1,02	1,43	1,03	0,91	0,53	0,59	1,25	1,26	1,18	0,89
GT 1 LE 3	9,72	7,68	8,28	9,77	9,88	9,98	8,13	10,11	10,78	10,42	12,05	11,70
GT 3 LE 5	23,84	18,94	18,71	21,60	22,59	23,86	23,88	29,49	26,63	24,87	27,86	26,16
GT 5 LE 7	32,13	30,14	28,42	29,45	33,42	34,40	33,55	31,53	34,15	33,45	32,90	32,52
GT 7 LE 9	21,51	24,45	23,97	24,07	20,51	21,03	23,22	19,90	18,97	21,86	17,21	19,73
GT 9 LE 12	9,36	13,30	14,21	10,61	10,21	8,34	8,89	6,81	6,69	7,22	7,26	7,78
GT 12 LE 16	2,20	4,18	4,53	2,74	2,27	1,30	1,65	1,50	1,41	0,90	1,47	1,19
GT 16	0,23	0,48	0,83	0,31	0,10	0,18	0,13	0,12	0,10	0,00	0,08	0,00
<u>Gustiness</u>												
Very Unstable	11,47	7,58	13,49	15,61	11,19	13,64	12,29	12,84	7,28	8,75	12,08	13,77
Unstable	43,32	42,79	38,26	44,95	40,57	43,15	44,78	39,69	49,69	45,17	44,12	45,37
Neutral	12,50	14,61	16,75	6,65	15,01	9,67	11,25	16,14	9,57	12,55	12,86	14,05
Stable	32,71	35,00	31,48	32,77	33,24	33,54	31,67	31,37	33,44	33,51	30,94	26,79
<u>Direction</u>												
N	6,06	5,78	4,39	7,83	6,81	7.55	4,89	4,88	7,83	4,85	5,69	5,62
NNE	5,06	4,77	3,98	5,86	5,20	6.43	6,17	5.14	5,55	3,44	4,14	3,83
NE	5,05	4,91	4,86	5,66	5,70	5.15	5,88	4,78	5,20	3,78	4,66	5,55
ENE	4,01	2,97	4,37	3,84	4,60	4,07	5,15	4,87	4,02	2,11	4,20	3,28
E	3,23	2,79	3,03	3,30	3,71	3,58	3,87	3,56	3,43	1,87	3,24	2,41
ESE	3,02	2,18	3,49	3,03	3,74	3,26	3,37	2,65	3,39	2,04	3,09	2,46
SE	3,01	2,64	3,53	2,56	2,75	2,89	1,90	2,82	3,53	3,47	3,88	3,60
SSE	3,33	3,66	3,67	3,70	3,02	2,35	2,28	4,10	3,11	3,36	3,99	3,67
S	4,57	3,27	4,35	4,22	4,73	3,89	2,59	5,42	5,10	6,31	5,64	6,55
SSW	10,40	8,47	9,42	7,92	9,72	7,77	8,16	13,34	9,78	16,74	12,56	16,73
SW	10,65	11,66	8,67	13,74	9,01	13,43	13,94	7,95	8,61	10,02	9,66	9,75
WSW	6,56	7,20	5,20	7,11	6,71	8,13	8,71	5,58	6,05	5,69	5,38	6,26
W	7,21	6,15	6,50	6,53	7,99	6,24	7,20	7,58	7,31	8,90	7,73	6,91
WNW	10,30	10,13	13,71	8,57	9,48	8,38	10,30	10,43	9,37	11,46	11,18	8,87
NW	9,36	12,17	10,83	8,74	9,99	8,61	8,15	8,40	10,12	8,66	7,80	7,39
NNW	8,17	11,24	9,98	7,37	6,85	8,28	7,41	8,52	7,58	7,23	7,17	7,12

LE: Less than or equal to.
GT: Greather than.

The height of the wind vane was changed from 355 ft. to 290 ft. in May 1981.

Table 3
BNL Site Environmental Report for Calendar Year 1990
Summary of Daily Mean Climatology Data at BNL for 1990

Month	Temperature, °C Min	Max	Avg	Precipitation cm
January	-8.3	15.2	2.9	13.31
February	-17.6	14.9	1.8	7.42
March	-15.2	27.8	4.4	5.44
April	-11.7	31.8	8.7	12.60
May	-0.3	25.8	13.2	16.56
June	5.2	29.1	19.3	10.03
July	9.7	33.3	22.5	6.71
August	12.2	31.1	22.3	17.15
September	1.7	29.2	17.0	7.72
October	-2.8	26.7	14.1	18.21
November	-4.6	25.0	7.6	4.52
December	-8.0	15.2	4.1	14.99
Annual	-17.6	33.3	11.5	134.65
40 Year Average			9.8	123.01

Note: Minimum and maximum temperatures listed for each month represent the lowest and highest temperature observed during the month.

Table 4
BNL Site Environmental Report for Calendar Year 1990
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 1990 (Ci)
491	Medical Research Reactor Stack[c]	45.7	Ar-41	Moving tape for radioparticulates	Charcoal for radioiodines	1,046.
555	Chemistry Roof Stack	16	Tritium	None	Dessicant for tritium vapor	0.010
705	High Flux Beam Reactor	97.5	Tritium Cs-137	None	Dessicant for tritium vapor, particulate filter for gross beta analysis, and charcoal filter for radioiodines	24.3 0.000003
705	Hot Laboratory	97.5	Br-77 I-124 Ga-68 I-126 Br-82 As-74 Ge-69	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	0.163 0.000570 0.0267 0.000977 0.00344 0.00331 0.00297
901	Van de Graff Accelerator	21	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	0 (gas) 4.4 (vapor)
931	Linac Isotope[d] Facility	20	O-15 Tritium Be-7	G-M Detector for radioactive gases	Dessicant for tritium vapor, particulate filter for gross beta, and charcoal filter for radionuclides	700. 3.04 0.000374
445	Incinerator	8.7	See Table 11	None	None	See Table 11

(a) Locations shown in Figure 9.
(b) Above ground level.
(c) Calculated from reported operating time and "one-time" measured emission rate at 1MW power level.
(d) Calculated from reported operating and estimated production rate at 180 uamp full beam current.

Table 5
BNL Site Environmental Report for Calendar Year 1990
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	207.7	87.8
February	281.6	141.9
March	151.2	202.3
April	0.0	211.0
May	0.0	57.5
June	0.0	0.0
July	0.0	0.0
August	41.6	0.0
September	70.1	0.0
October	135.0	0.0
November	42.7	0.0
December	115.7	0.0
Total	1045.6	700.4

Notes:

1. The MRR did not operate from April through July while a new source of secondary cooling water was provided.

2. The BLIP Facility did not operate from May 13, 1990 to the end of the calendar year due to lack of beam from the Linac.

Table 6
BNL Site Environmental Report for Calendar Year 1990
Tritium Releases from 10-m Stacks

Month	Bldg. 931 BLIP	Bldg. 555 Chem.	Bldg. 444 HWM Comp.	Bldg. 445 HWM Inc.	Bldg. 901A VDG Vapor	Bldg. 901A VDG Gas	Total Tritium Releases
	<-----------			mCi			----------->
January	ND	ND	0.0001	NR	1340	NR	1340.00
February	0.753	0.160	0.0056	NR	140	NR	140.92
March	2.594	0.657	0.0002	NR	2170	NR	2173.25
April	4.710	1.070	ND	0.005	ND	NR	5.79
May	0.487	5.970	0.0002	NR	619	NR	625.46
June	ND	0.103	0.0001	NR	34.6	NR	34.70
July	2968.000	1.120	0.0002	NR	90.4	NR	3059.52
August	21.705	0.323	ND	1.513	ND	NR	23.54
September	35.700	0.228	0.0046	NR	28.2	NR	64.13
October	3.190	0.086	0.0005	NR	ND	NR	3.28
November	2.732	0.027	ND	NR	3.52	NR	6.28
December	2.553	0.109	ND	0.087	ND	NR	2.75
Total	3042.42	9.85	0.01	1.60	4425.72	0.00	7479.61

ND: Not detected.
NR: No release. Facility did not operate in 1990.

Table 7
BNL Site Environmental Report for Calendar Year 1990
Airborne Effluent Emissions from Building 750 via the Building 705 Stack

Month	Total Stack Flow cc	Total Activity H-3	Be-7	Cs-137	Sc-46	Average Air Concentration H-3	Be-7	Cs-137	Sc-46
		<--------		uCi	------>	<--------		pCi/m³	-------->
January	1.431E+13	840030	0.22	0.10	0.00	58713	0.015	0.007	ND
February	2.280E+13	672930	0.00	0.32	0.08	47034	ND	0.023	0.006
March	2.130E+13	730430	0.00	0.09	0.00	51053	ND	0.006	ND
April	2.758E+13	960710	0.12	0.33	0.00	67148	0.008	0.023	ND
May	2.212E+13	1137700	0.00	0.13	0.00	79518	ND	0.009	ND
June	2.017E+13	1458000	0.00	0.10	0.00	101905	ND	0.007	ND
July	2.873E+13	6960100	0.00	0.14	0.00	486469	ND	0.010	ND
August	2.036E+13	4018000	0.00	0.18	0.00	280834	ND	0.013	ND
September	2.280E+13	998000	0.00	0.14	0.00	69754	ND	0.010	ND
October	2.723E+13	2229800	0.00	0.34	0.00	155849	ND	0.024	ND
November	1.978E+13	1437600	0.28	0.48	0.00	100479	0.019	0.034	ND
December	2.351E+13	2824100	0.00	0.30	0.00	197387	ND	0.021	ND
Total	2.707E+14	24267400	0.61	2.66	0.08				
Annual Avg.						8.96E+04	0.002	0.010	0.0003
DOE Order 5400.5 Derived Concentration Guides						1.00E+05	40000	400	600

ND: Not Detected.

Table 8
BNL Site Environmental Report for Calendar Year 1990
Airborne Effluent Releases from Building 801 Acid Off-Gas Stack

Month	Total Stack Flow	Total Activity						Average Air Concentration					
		Cs-137	Xe-127	Br-77	Ga-68	Se-75	Co-60	Cs-137	Xe-127	Br-77	Ga-68	Se-75	Co-60
	cc	uCi						pCi/m³					
January[a]	1.717E+12	0.35	0.11	0.00	0.00	0.00	0.00	0.20	0.06	ND	ND	ND	ND
February[a]	---------	----	----	----	----	----	----	----	----	----	---	----	----
March	2.442E+12	0.50	0.00	37.84	0.00	0.00	0.00	0.20	ND	15.49	ND	ND	ND
April	4.018E+12	0.19	0.00	22.02	0.00	0.00	0.00	0.05	ND	5.48	ND	ND	ND
May	2.008E+12	0.29	1.85	25.02	91.91	0.30	0.00	0.14	0.92	12.46	45.76	0.15	ND
June	2.518E+12	0.44	0.00	0.00	8.37	0.39	0.00	0.17	ND	ND	3.32	0.16	ND
July	2.131E+12	0.29	0.00	0.00	0.00	0.00	0.00	0.14	ND	ND	ND	ND	ND
August	1.384E+12	0.00	0.00	0.00	0.00	0.00	0.40	ND	ND	ND	ND	ND	0.29
September	4.382E+12	0.11	0.00	0.00	0.00	0.00	0.00	0.03	ND	ND	ND	ND	ND
October	2.143E+12	0.13	0.00	0.00	0.00	0.00	0.00	0.06	ND	ND	ND	ND	ND
November	3.251E+12	0.51	0.00	0.00	0.00	0.00	0.00	0.16	ND	ND	ND	ND	ND
December	3.321E+12	0.32	0.00	0.00	0.00	0.00	0.00	0.10	ND	ND	ND	ND	ND
Total	2.932E+13	3.12	1.96	84.87	100.28	0.69	0.40						
Annual Avg.								0.11	0.07	2.90	3.42	0.02	0.01
DOE Order 5400.5 Derived Concentration Guides								400	(b)	50000	100000	1000	80

ND: Not detected.
(a) January and February measurements composited and reported together.
(b) No standard specified.

Table 9
BNL Site Environmental Report for Calendar Year 1990
Radioactive Airborne Effluent Emissions from the Non-Acid Stack at Building 801

	Sample Stack Flow cc	Mn-54	Zn-65	Ga-68	Ge-69	As-74	Se-75	Br-77	Br-82	Sb-124	I-124	I-126	Xe-127	Cs-137	Eu-155	Hg-203
		Total Activity														
		<---- µCi ---->														
January[a]	5.456E+13	1.25	0.00	0.00	0.00	69.07	30.55	0.00	0.00	3.70	0.00	41.93	113.05	2.20	0.00	44.81
February[a]	---------	----	----	----	----	-----	-----	----	----	----	----	----	----	----	----	----
March	2.386E+13	0.00	0.00	0.00	0.00	0.00	109.18	82447.68	1607.37	0.00	570.39	608.05	0.00	0.00	0.00	0.00
April	3.930E+13	1.00	1.94	0.00	0.00	52.58	139.56	27480.74	0.00	0.00	0.00	126.95	0.00	0.00	0.00	46.61
May	1.953E+13	0.00	0.00	25646.36	2973.47	3187.47	53.18	53427.55	1835.89	0.00	0.00	11.91	585.38	1.10	6.04	0.00
June	2.389E+13	0.00	0.00	740.02	0.00	0.00	15.77	0.00	0.00	0.00	0.00	188.62	0.00	0.96	0.00	6.45
July	2.075E+13	0.00	0.00	93.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	0.00	0.00
August	1.334E+13	0.00	0.00	114.89	0.00	0.00	1.49	0.00	0.00	0.00	0.00	0.00	0.00	1.45	0.00	1.57
September	4.227E+13	0.00	0.00	22.91	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.00	0.00
October	2.064E+13	0.00	0.00	8.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.73	0.00	0.00
November	3.148E+13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00
December	2.842E+13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.180E+14	2.25	1.94	26626.41	2973.47	3309.11	351.84	163355.9	3443.26	3.70	570.39	977.46	698.44	14.42	6.04	99.44

Month	Sample Stack Flow cc	Mn-54	Zn-65	Ga-68	Ge-69	As-74	Se-75	Br-77	Br-82	Sb-124	I-124	I-126	Xe-127	Cs-137	Eu-155	Hg-203
		Average Air Concentrations														
		<---- pCi/m^3 ---->														
January[a]	5.456E+13	2.30E-02	ND	ND	ND	1.27E+00	5.60E-01	ND	ND	6.79E-02	ND	7.69E-01	2.07E+00	4.04E-02	ND	8.21E-01
February[a]	---------	-------	--	--	--	--------	--------	--	--	--------	--	--------	--------	--------	--	--------
March	2.386E+13	ND	ND	ND	ND	ND	4.58E+00	3.46E+03	6.74E+01	ND	2.39E+01	2.55E+01	ND	ND	ND	ND
April	3.930E+13	2.53E-02	4.94E-02	ND	ND	1.34E+00	3.55E+00	6.99E+02	ND	ND	ND	3.23E+00	ND	ND	ND	1.19E+00
May	1.953E+13	ND	ND	1.31E+03	1.52E+02	1.63E+02	2.72E+00	2.74E+03	9.40E+01	ND	ND	6.10E-01	3.00E+01	5.62E-02	3.09E-01	ND
June	2.389E+13	ND	ND	3.10E+01	ND	ND	6.60E-01	ND	ND	ND	ND	7.89E+00	ND	4.01E-02	ND	2.70E-01
July	2.075E+13	ND	ND	4.50E+00	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.92E-01	ND	ND
August	1.334E+13	ND	ND	8.61E+00	ND	ND	1.12E-01	ND	ND	ND	ND	ND	ND	1.09E-01	ND	1.18E-01
September	4.227E+13	ND	ND	5.42E-01	ND	ND	5.00E-02	ND	ND	ND	ND	ND	ND	4.13E-02	ND	ND
October	2.064E+13	ND	ND	4.29E-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.37E-02	ND	ND
November	3.148E+13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.94E-02	ND	ND
December	2.842E+13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Annual Avg.		7.07E-03	6.11E-03	8.40E+01	9.35E+00	1.04E+01	1.11E+00	5.14E+02	1.08E+01	1.16E-02	1.79E+00	3.07E+00	2.20E+00	4.53E-02	1.90E-02	3.13E-01
DOE Order 5400.5 Derived Concentration Guide		2000	600	100000	20000	2000	1000	50000	9000	600	600	300	(b)	400	300	2000

ND: Not detected.
(a) January and February measurements composited and reported together.
(b) No standard listed.

Table 10
BNL Site Environmental Report for Calendar Year 1990
Radioactive Effluent Emissions from Building 931

Month	Stack Flow	Average Air Concentration							Total Activity						
		Be-7	Na-24	Mn-54	As-72	As-74	Xe-125	Cs-137	Be-7	Na-24	Mn-54	As-72	As-74	Xe-125	Cs-137
	cc	<-------------------------			pCi/m³			------------------------->	<-------------------------			uCi			------------------------->
January	6.672E+11	4.04E+01	ND	ND	ND	ND	ND	2.02E+00	26.96	0.00	0.00	0.00	0.00	0.00	1.35
February	4.989E+11	2.01E+02	ND	ND	5.53E+01	3.99E+01	ND	1.02E+00	100.37	0.00	0.00	27.57	19.89	0.00	0.51
March	5.855E+11	1.62E+01	1.73E+01	ND	ND	ND	5.11E+01	1.17E+00	9.47	10.10	0.00	0.00	0.00	29.92	0.68
April	8.766E+11	1.93E+02	ND	ND	ND	ND	ND	1.12E+00	168.98	0.00	0.00	0.00	0.00	0.00	0.98
May	7.082E+11	3.59E+01	ND	ND	ND	ND	ND	2.22E-01	25.43	0.00	0.00	0.00	0.00	0.00	0.16
June[a]	---------	--------	--	--	--	--	--	--------	----	----	----	----	----	----	----
July[a]	1.577E+12	1.97E+01	ND	ND	ND	ND	ND	3.81E-01	31.04	0.00	0.00	0.00	0.00	0.00	0.60
August	9.638E+11	7.53E+00	ND	3.89E-01	ND	ND	ND	ND	7.26	0.00	0.37	0.00	0.00	0.00	0.00
September	5.706E+11	7.10E+00	ND	ND	ND	ND	ND	5.85E-01	4.05	0.00	0.00	0.00	0.00	0.00	0.33
October	7.349E+11	1.43E+00	ND	ND	ND	ND	ND	1.44E+00	1.05	0.00	0.00	0.00	0.00	0.00	1.06
November	7.231E+11	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
December	7.518E+11	ND	ND	ND	ND	ND	ND	5.24E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Total								374.62	10.10	0.37	27.57	19.89	29.92	6.06	
Annual Avg.	7.215E+11	4.30E+01	1.17E+00	4.33E-02	3.18E+00	2.30E+00	3.46E+00	7.00E-01							
DOE Order 5400.5 Derived Concentration Guides		40000	10000	2000	3000	2000	(b)	400							

ND: Not detected.
(a) June and July measurements composited and reported together.
(b) No standard listed.

Table 11
BNL Site Environmental Report for Calendar Year 1990
Estimated Radioactivity in Incinerated Material

Month	H-3	I-125	C-14	Tl-201	Sn-113m	Cr-51	Sn-117m	Co-57
	<------			mCi				------>
January	RNI	0.005	0.100	RNI	RNI	0.001	RNI	RNI
February	---	---	---	---	---	---	---	---
March	---	---	---	---	---	---	---	---
April	0.005	0.005	0.005	0.005	RNI	RNI	RNI	0.002
May	---	---	---	---	---	---	---	---
June	---	---	---	---	---	---	---	---
July	---	---	---	---	---	---	---	---
August	1.513	0.032	0.030	RNI	RNI	RNI	RNI	RNI
September	---	---	---	---	---	---	---	---
October	RNI	0.005	RNI	RNI	RNI	RNI	RNI	RNI
November	---	---	---	---	---	---	---	---
December	0.087	RNI	RNI	RNI	0.200	RNI	0.003	0.200
Total	1.604	0.047	0.135	0.005	0.200	0.001	0.003	0.202

Note: The incinerator operated only in January, April, August, October, and December.

RNI: Radionuclide not incinerated.

Table 12
BNL Site Environmental Report for Calendar Year 1990
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	472200 3491 19702	3-22-91
197	acid metal cleaning	NYSDEC-Air Quality	472200 3491 19703	3-22-91
197	welding shop	NYSDEC-Air Quality	472200 3491 19704	4-1-95
197	fiche duplicator	NYSDEC-Air Quality	submitted 12-90, status pending	
197	cleaning room hoods	NYSDEC-Air Quality	submitted 10-90, status pending	
197	cleaning room hoods	NYSDEC-Air Quality	submitted 10-90, status pending	
206	cyclone G-10	NYSDEC-Air Quality	472200 3491 20601	4-1-95
207	belt sander	NYSDEC-Air Quality	472200 3491 20701	4-1-95
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
348	paint hood exhaust	NYSDEC-Air Quality	submitted 12-90, status pending	
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	Canceled 4-90
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205	Canceled 4-90
423	stage II vapor recovery	NYSDEC-Air Quality	472200 D365 WG	9-27-95
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	11-29-91
452	parts cleaner tank	NYSDEC-Air Quality	472200 3491 45201	3-22-91
457	sulfite dispensing	NYSDEC-Air Quality	472200 3491 45705	4-1-95
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	472200 3491 47301	3-22-91
479	cyclone G-10	NYSDEC-Air Quality	472200 3491 47905	4-1-95
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*
490	lead alloy melting	NYSDEC-Air Quality	submitted 12-90, status pending	
490	milling machine/block cutter	NYSDEC-Air Quality	submitted 12-90, status pending	
493	incinerator	NYSDEC-Air Quality	472200 3491 493A0	11-29-91
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	11-29-91
510	metal cutting exhaust	NYSDEC-Air Quality	submitted 12-90, status pending	
510	calorimeter enclosure	U.S.EPA - NESHAPS	BNL-689-01	None
526	polymer mix booth	NYSDEC-Air Quality	472200 3491 52601	4-1-95
526	polymer weighing	NYSDEC-Air Quality	472200 3491 52602	4-1-95
535B	plating tank	NYSDEC-Air Quality	472200 3491 53501	4-1-95
535B	etching machine	NYSDEC-Air Quality	472200 3491 53502	4-1-95
535B	PC board process	NYSDEC-Air Quality	472200 3491 53503	4-1-95
535B	welding hood	NYSDEC-Air Quality	submitted 12-90, status pending	

Table 12 (Continued)
BNL Site Environmental Report for Calendar Year 1990
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
555	scrubber (1)	NYSDEC-Air Quality	472200 3491 55501	4-1-95
555	scrubber (2)	NYSDEC-Air Quality	472200 3491 55502	4-1-95
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	472200 3491 61006	3-21-91
630	stage II vapor recovery	NYSDEC-Air Quality	472200 D366 WG	9-27-95
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	472200 3491 72501	4-1-95
815	welding hood	NYSDEC-Air Quality	submitted 12-90, status pending	
820	accelerator test facility	U.S.EPA - NESHAPS	BNL-589-01	None
901	tin lead solder	NYSDEC-Air Quality	472200 3491 90101	4-1-95
902	spray booth exhaust	NYSDEC-Air Quality	submitted 12-90, status pending	
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301	11-29-91
903	cyclone G-10	NYSDEC-Air Quality	472200 3491 90302	4-1-95
903	brazing process exhaust	NYSDEC-Air Quality	submitted 12-90, status pending	
905	vapor degreaser	NYSDEC-Air Quality	472200 3491 90501	3-22-91
905	belt sander	NYSDEC-Air Quality	472200 3491 90502	6-18-95
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101	11-29-91
911	paint spray hood	NYSDEC-Air Quality	submitted 12-90, status pending	
922	cyclone exhaust	NYSDEC-Air Quality	472200 3491 92201	4-1-95
924	spray booth exhaust	NYSDEC-Air Quality	submitted 12-90, status pending	
	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
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	closed, 12-18-90
HWMF(d)	waste management	NYSDEC-Hazardous Waste	NYS ID No. 789 005 385	I.O.S.
CSF(e)	major petroleum facility	NYSDEC-Water Quality	1-1700	3-31-91
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

*<u>Note</u>: Renewal application submitted 9-20-90; process can continue to operate under provisions of the NYS Uniform Procedures Act.

Table 13
BNL Site Environmental Report for Calendar Year 1990
Sewage Treatment Plant Effluent Gross Alpha, Gross Beta, and Tritium Concentrations

Month	Flow, Liters	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	------	------	------	------>
Sample Location Station DA - Clarifier Effluent										
January	8.82E+07	0.05	-1.28	1.28	3.17	-6.42	15.90	555.21	-408.00	6420.00
February	7.07E+07	0.64	-1.02	2.05	5.60	-0.38	9.63	226.59	-586.00	1240.00
March	7.85E+07	0.36	-1.02	2.30	4.65	-1.51	10.60	-53.92	-1160.00	1230.00
April	8.12E+07	0.35	-1.02	2.56	6.01	1.32	10.20	-195.36	-1890.00	1270.00
May	9.30E+07	0.30	-0.77	2.30	4.11	-2.08	9.44	658.48	-2440.00	5590.00
June	9.36E+07	0.05	-1.28	1.54	5.07	0.00	14.90	750.54	-69.50	3710.00
July	1.01E+08	0.37	-1.02	1.79	3.99	-0.94	8.50	3408.04	-173.00	11700.00
August	1.26E+08	0.16	-1.28	2.30	5.04	-1.13	9.25	3242.70	1410.00	20900.00
September	6.93E+07	0.03	-1.28	1.54	3.84	1.13	9.25	1916.00	470.00	3720.00
October	8.57E+07	0.46	-1.54	2.05	9.26	-1.70	92.00	1596.74	-103.00	4940.00
November	6.67E+07	0.12	-1.54	2.05	4.18	0.94	14.20	1259.10	13.30	4850.00
December	6.49E+07	0.22	-0.51	1.54	3.83	0.00	10.80	563.66	-196.00	1350.00
Avg. Conc.		0.26			4.92			1295.41		
Total Release (L or mCi)	1.02E+09	0.26			5.01			1319.94		
Sample Location Station EA - Chlorine House Effluent										
January	7.96E+07	0.77	-1.28	3.07	12.89	-0.19	21.00	102.78	-885.00	1070.00
February	7.10E+07	0.98	-1.78	2.56	10.72	2.46	17.00	284.23	-303.00	895.00
March	7.37E+07	0.81	-0.26	2.56	9.58	2.46	16.80	71.60	-1160.00	1420.00
April	7.86E+07	0.66	-1.79	2.30	8.02	3.40	13.80	-61.38	-1700.00	1810.00
May	8.89E+07	0.44	-0.77	2.30	7.24	3.21	12.30	379.84	-2410.00	4070.00
June	8.70E+07	0.06	-1.79	2.05	6.66	1.13	13.40	835.73	-168.00	4560.00
July	8.89E+07	0.14	-1.79	2.05	6.68	3.97	10.60	3200.06	509.00	8870.00
August	8.72E+07	0.18	-1.79	2.30	7.33	2.83	14.80	3433.04	966.00	14300.00
September	6.80E+07	0.38	-1.54	1.79	5.20	2.27	9.07	1747.72	246.00	3580.00
October	7.12E+07	0.20	-1.28	1.28	5.98	1.32	10.40	1608.48	-380.00	3940.00
November	5.42E+07	0.21	-1.02	2.30	5.12	-1.13	10.60	6072.84	3970.00	8670.00
December	5.24E+07	0.31	-0.51	2.30	7.53	2.64	15.50	1773.65	-216.00	5090.00
Avg. Conc.		0.43			7.81			1526.52		
Total Release (L or mCi)	9.01E+08	0.38			7.03			1374.87		
SPDES Limits		3.0(Ra-226)			1000			Not Listed		
NYS Drinking Water Standard		15			50			20000		
Typical MDL		2.3			6			1000		

MDL: Minimum detection limit.

Table 14
BNL Site Environmental Report for Calendar Year 1990
Sewage Treatment Plant Effluent Gamma Spectroscopy and Strontium-90 Concentrations

Month	Flow, Liters	Be-7	Co-60	Cs-137	K-40	Ce-139	Co-58	Zn-65	I-131	Sr-90	Co-57	Na-22
		<------					pCi/L					------>
Sample Location Station DA - Clarifier Effluent												
January	8.82E+07	0.32	0.05	0.28	2.54	ND	ND	ND	ND	0.12	ND	ND
February	7.07E+07	ND	0.09	0.42	3.80	0.03	ND	ND	ND	0.68	ND	ND
March	7.85E+07	ND	0.09	0.24	2.74	ND	0.09	ND	ND	-0.09	ND	ND
April	8.12E+07	0.54	0.06	0.20	2.89	ND	ND	ND	ND	0.01	ND	ND
May	9.30E+07	0.37	0.02	0.23	2.51	0.04	ND	ND	ND	-0.10	ND	ND
June	9.36E+07	ND	0.10	0.18	1.85	ND	ND	ND	ND	0.05	ND	ND
July	1.01E+08	ND	0.03	0.21	3.86	ND	ND	ND	ND	-0.12	ND	ND
August	1.26E+08	ND	ND	0.14	1.64	ND	ND	ND	ND	0.00	ND	ND
September	6.93E+07	ND	ND	0.30	2.70	ND	ND	ND	ND	NR	ND	ND
October	8.57E+07	ND	0.06	0.14	1.84	ND	ND	0.05	6.95	NR	ND	ND
November	6.67E+07	ND	0.10	ND	4.15	ND	ND	ND	ND	NR	ND	ND
December	6.49E+07	ND	0.12	0.08	ND	ND	ND	ND	ND	NR	ND	ND
Avg. Conc.	8.49E+07	0.10	0.06	0.20	2.52	0.01	0.01	0.00	0.58	0.05	ND	ND
Total Release (L or mCi)	1.02E+09	0.11	0.06	0.20	2.57	0.01	0.01	0.00	0.60	0.04	0.00	0.00
Sample Location Station EA - Chlorine House Effluent												
January	7.96E+07	ND	0.11	5.53	1.27	ND	ND	ND	ND	0.50	ND	ND
February	7.10E+07	ND	0.05	5.09	2.40	ND	ND	ND	ND	0.44	ND	ND
March	7.37E+07	ND	ND	4.45	1.92	ND	ND	ND	ND	-0.14	ND	ND
April	7.86E+07	ND	0.04	5.02	2.87	ND	ND	ND	ND	-0.08	ND	ND
May	8.89E+07	ND	0.03	4.64	2.50	ND	ND	ND	ND	-0.21	0.0151	ND
June	8.70E+07	ND	0.04	4.69	2.22	ND	ND	ND	ND	-0.34	0.0233	ND
July	8.89E+07	ND	0.06	4.38	2.03	ND	ND	ND	ND	0.20	ND	0.404
August	8.72E+07	ND	0.27	9.70	6.05	ND	ND	ND	ND	0.27	ND	0.294
September	6.80E+07	ND	ND	5.27	4.62	ND	ND	ND	4.47	0.36	ND	ND
October	7.12E+07	ND	ND	6.72	4.91	ND	ND	ND	4.08	NR	ND	ND
November	5.42E+07	ND	ND	ND	2.46	ND	ND	ND	ND	NR	ND	ND
December	5.24E+07	ND	ND	ND	ND	ND	ND	ND	ND	NR	ND	ND
Avg. Conc.	7.51E+07	ND	0.06	4.90	2.84	ND	ND	0.00	0.66	0.08	0.004	0.07
Total Release (L or mCi)	9.01E+08	0.00	0.05	4.42	2.56	0.00	0.00	0.00	0.59	0.07	0.003	0.06
DOE Order 5400.5 Derived Concentration Guides		1000000	5000	3000	7000	100000	40000	9000	3000	1000	100000	10000
Concentration Required to Produce SDWA Annual Dose		40000	200	120	280	4000	1600	360	120	40	4000	400
SPDES Limit		(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	10	(a)	(a)
NYS DWS		(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	8	(a)	(a)
Typical MDL		1.6	0.23	0.2	3.9	0.14	0.18	0.45	0.21	0.1	0.14	0.2

NR: Not detected.
ND: Result not reported by Contractor Laboratory.
MDL: Minimum detection limit.
(a) No standard specified.

Table 15
BNL Site Environmental Report for Calendar Year 1990
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)	4.1 - 10.2	5.9 - 7.2	5.8 - 9.0
Conductivity (umhos/cm)	(b)	216	(c)
Temperature maximum (°C)	25	27	32
Total coliform (per 100 ml)	NA	2,665	10,000
Fecal coliform (per 100 ml)	NA	153	2,000
<u>Results in mg/L</u>			
Dissolved Oxygen	NA	9.2	(c)
Chlorides	NA	52.1	(c)
Settleable Solids	0.6	0.0	0.1
Suspended Solids - max	109.0	30.0	10.0
- avg	19.3	2.7	5.0
BOD_5 - max	26.4	6.6	20.0
- avg	13.1	2.0	10.0
Ammonia-Nitrogen	NA	0.16	2.0
Nitrate-Nitrogen	NA	5.0	(c)
Total Phosphorous	0.24	0.32	(c)
Sulfates	NA	15.8	(c)
Chlorine Residual	0.00	0.00	(c)
Ag	<0.025	0.01	0.05
Cd	<0.0005	0.0006	(c)
Cr	0.0055	<0.0005	(c)
Cu	0.053	0.06	0.40
Fe	0.34	0.16	0.60
Mn	<0.05	0.06	(c)
Na	24.0	22.8	(c)
Pb	0.007	0.006	0.067
Zn	0.06	0.05	0.30

NA: Not Analyzed.
(a) Locations shown in Figure 11.
(b) Metered.
(c) Effluent limitation not specified.

Table 16
BNL Site Environmental Report for Calendar Year 1990
SPDES Compliance for Sewage Treatment Plant Effluent (Outfall 001)

Parameter	Permitted Frequency of Sample/Yr	Actual Frequency of Sample/Yr	No. of Exceedances (per yr)
Temperature	250	250	0
Gross β	250	250	0
BOD_5	12	28	0
pH (Min)	365	365	0
pH (Max)	365	365	0
Suspended Solids	12	54	5
Settleable Solids	250	250	0
Ammonia-Nitrogen	12	12	0
Cu (concentration)	12	12	0
Cu (loading)	12	12	0
Fe (concentration)	12	12	0
Pb (concentration)	12	12	0
Pb (loading)	12	12	0
Ag (concentration)	12	12	0
Ag (loading)	12	12	0
Zn (concentration)	12	12	0
Zn (loading)	12	12	0
Gross α	250	250	0
Strontium-90	12	12	0[a]
Flow	365	365	0
Chlorine (residual)	250	250	0
Fecal Coliform	12	39	0
Total Coliform	12	34	1
Tritium	250	250	0
1,1,1-trichloro-ethane	6	6	0
Total	2781	2888	6

(a) Contractor Laboratory has reported only nine months of data. No exceedances were observed in the data received.

Table 17

BNL Site Environmental Report for Calendar Year 1990
Radioactivity Detected in On-Site Recharge Basin Water and Run-Off Ponds
at the Hazardous Waste Management Area

Location	Sample Date	Gross Alpha	Gross Beta	Tritium	Cs-137	K-40	Be-7	Na-22	V-48	Cr-51	Mn-52	Mn-54	Co-57	Co-58	Co-60	Zn-65	Sr-90
		<----								pCi/L							---->
HN	12-Feb-90	0.307	134.000	421	MDL	MDL	299.00	0.76	4.61	6.70	14.70	5.29	1.26	3.78	0.59	0.645	0.04
	16-Mar-90	0.205	7.030	89	MDL	MDL	26.90	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.81
	05-Sep-90	0.973	2.910	-136	0.13	MDL	MDL	MDL	MDL	MDL	MDL	0.28	MDL	MDL	MDL	MDL	-0.15
	19-Nov-90	-0.051	1.660	154	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	-0.28
	Avg. Conc.	0.359	36.400	132	0.03	0.00	81.48	0.19	1.15	1.68	3.68	1.39	0.32	0.95	0.15	0.16	-0.10
HO	12-Feb-90	0.614	-0.150	315	0.81	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.15
	16-May-90	0.307	1.400	-157	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	-0.08
	20-Nov-90	0.102	0.038	-74	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.341	0.429	28	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.02
HP	12-Feb-90	0.256	3.100	31	MDL	7.54	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.1
	Avg. Conc.	0.256	3.100	31	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.1
HS	12-Feb-90	0.512	0.680	155	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.26
	16-May-90	0.102	1.280	-45	MDL	MDL	2.65	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	-0.18
	05-Sep-90	0.154	1.210	0	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	-0.01
	19-Nov-90	0.205	3.140	-12	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.243	1.578	24	MDL	MDL	0.66	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.02
HT	23-Feb-90	0.102	4.380	99	0.34	6.79	MDL	MDL	MDL	MDL	MDL	1.15	MDL	MDL	MDL	MDL	0.07
	16-May-90	0.205	0.557	34	MDL	MDL	MDL	MDL	MDL	MDL	MDL	1.10	MDL	MDL	MDL	MDL	NA
	05-Sep-90	0.205	-0.260	57	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	-0.34
	19-Nov-90	-0.100	0.227	-92	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	NA
	Avg. Conc.	0.103	1.228	24	0.09	1.70	MDL	MDL	MDL	MDL	MDL	0.56	MDL	MDL	MDL	MDL	-0.07
Ponded Water HWM Side of Road	16-Feb-90	0.205	8.570	142	3.87	5.7	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	2.9
Ponded Water Landfill Side of Road	16-Feb-90	0.051	2.080	13	MDL	MDL	6.49	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	MDL	0.24
Typical MDL		0.460	1.200	300	0.2	3.9	1.6	0.2	0.23	1.6	0.2	0.2	0.14	0.18	0.23	0.45	0.1
DOE Order 5400.5 Derived Concentration Guide				2000000	3000	7000	1000000	10000	20000	1000000	20000	50000	100000	40000	5000	9000	1000
Concentration Required to Produce SDWA Annual Dose				80000	120	280	40000	400	800	40000	800	2000	4000	1600	200	360	40

MDL: Minimum detection limit.

Table 18
BNL Site Environmental Report for Calendar Year 1990
Water Quality Data in On-Site Recharge Basins

Location[a]	No. of Samples[b]	pH (SU)	Temperature Avg.	Temperature Min.	Temperature Max.	Conductivity Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen[c] Avg.	Nitrate-Nitrogen[c] Min.	Nitrate-Nitrogen[c] Max.
			°C			(umhos/cm)			mg/L								
HN	4 (4)	6.0 - 7.4	15	8	25	145	132	157	17.5	14.4	21.7	11.0	10.3	11.6	<1.0	<1.0	<1.0
HO	3 (3)	4.8 - 8.0	15	12	18	111	78	133	19.1	17.5	20.5	10.3	9.8	10.6	<1.0	<1.0	<1.0
HP	1 (1)	6.5	18	—	—	256	—	—	28.3	—	—	18.3	—	—	1.0	—	—
HT	4 (4)	6.5 - 7.2	19	16	23	137	120	159	21.2	17.1	25.3	10.6	9.9	12.0	<1.0	<1.0	<1.0
HS	4 (5)	6.0 - 8.1	18	7	32	80	50	117	6.2	<4.0	14.9	5.8	5.2	6.7	<1.0	<1.0	<1.0
NYS Drinking Water Standards		6.5 - 8.5	(d)			(d)			250.0			250.0			10.0		
Typical MDL		—	—			10			4.0			4.0			1.0		

MDL: Minimum detection limit.
(a) Locations of recharge basins are shown in Figure 24.
(b) Number outside parenthesis represents number of samples for anions; number inside paranthesis represents number of samples for pH, temperature, and conductivity.
(c) Holding time expired.
(d) No standard specified.

Table 19
BNL Site Environmental Report for Calendar Year 1990
Average Metals Data in On-Site Recharge Basins

Parameter	Location[a] HN	HO	HP	HT	HS	NYS Drinking Water Stds
	<-----------	----------	mg/L	----------	----------->	
No. of Samples[b]	4 (2)	3 (1)	1 (0)	4 (2)	4 (2)	
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	0.0001	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	0.04	<0.05	<0.05	0.03	<0.05	1.0
Fe	0.58	0.38	0.24	0.14	0.40	0.3
Hg	<0.0002	<0.0002	NA	<0.0002	<0.0002	0.002
Mn	0.05	<0.05	<0.05	<0.05	0.04	0.3
Na	12.9	11.6	18.7	11.5	7.2	(c)
Pb	0.002	<0.005	<0.005	0.001	0.001	0.05
Zn	0.04	0.01	<0.02	0.02	0.02	5.0

NA: Not analyzed.
(a) Locations of recharge basins are shown in Figure 24.
(b) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(c) No standard specified.

Table 19A
BNL Site Environmental Report for Calendar Year 1990
Chlorocarbon Data in On-site Recharge Basins

Location[a]	No. of amples		TCA	TCE	PCE	DCA	DCE	Chloroform
			<------	------	------	μg/L	------	------>
HN	3	Avg:	ND	ND	ND	ND	ND	ND
		Min:	ND	ND	ND	ND	ND	ND
		Max:	ND	ND	ND	ND	ND	ND
HO	2	Avg:	ND	ND	ND	ND	ND	2.
		Min:	ND	ND	ND	ND	ND	ND
		Max:	ND	ND	ND	ND	ND	4.
HP	0	Avg:	NA	NA	NA	NA	NA	NA
		Min:	--	--	--	--	--	--
		Max:	--	--	--	--	--	--
HT	4	Avg:	ND	ND	ND	ND	ND	3.
		Min:	ND	ND	ND	ND	ND	ND
		Max:	ND	ND	ND	ND	ND	5.
HS	3	Avg:	ND	ND	ND	ND	ND	1.
		Min:	ND	ND	ND	ND	ND	ND
		Max:	ND	ND	ND	ND	ND	4.
NYS Drinking Water Standards			5.	5.	5.	5.	5.	100.
Typical MDL			2.	2.	2.	2.	2.	2.

ND: Not detected.
NA: Not analyzed.
NA: Not analyzed.
MDL: Minimum detection limit.

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene

(a) Locations of recharge basins are shown in Figure 24.

Table 19B
BNL Site Environmental Report for Calendar Year 1990
BTX Data in On-site Recharge Basins

Location[a]	No. of Samples		benzene	ethyl-benzene	toluene	o-xylene
			<----------------	µg/L	----------------	---->
HN	3	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	ND
		Max:	ND	ND	ND	ND
HO	2	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	ND
		Max:	ND	ND	ND	ND
HP	0	Avg:	NA	NA	NA	NA
		Min:	--	--	--	--
		Max:	--	--	--	--
HT	4	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	ND
		Max:	ND	ND	ND	ND
HS	3	Avg:	ND	ND	1.	ND
		Min:	ND	ND	ND	ND
		Max:	ND	ND	3.	ND
NYS Drinking Water Standards			5.	5.	5.	5.
Typical MDL			2.	2.	2.	2.

ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.
(a) Locations of recharge basins are shown in Figure 24.

Table 21
BNL Site Environmental Report for 1990
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	17CR	17L	20T
	<------									pCi/m³		------							------>
10-Jan-90	-1.4	-5.5	-2.6	0.6	-1.3	-0.2	0.7	-1.3	4.4	-0.1	0.2	-1.5	-1.3	0.8	-0.6	-0.3	4.8	0.8	1.7
18-Jan-90	OFSR	-1.9	-0.2	TWS	-0.7	-0.3	-1.5	0.0	-0.6	-0.3	0.1	0.3	OFSR	-0.2	0.1	0.6	4.6	5.8	1.2
25-Jan-90	TWS	TWS	TWS	TWS	0.9	1.3	TWS	TWS	-0.8	-0.4	0.4	-0.2	-0.7	TWS	0.1	0.6	4.2	6.0	1.4
31-Jan-90	0.9	0.7	-2.5	-0.8	-0.3	0.0	-2.0	2.6	3.4	-1.1	-0.3	0.1	-0.0	1.6	-2.1	2.6	3.8	6.1	27.3
08-Feb-90	1.0	DLA	-1.4	0.9	0.3	-1.7	0.5	NS	-0.5	0.0	0.2	3.2	-2.3	1.1	0.8	-0.8	3.0	6.7	TWS
15-Feb-90	1.3	1.6	-12.8	1.6	0.7	0.4	0.0	-1.3	0.6	0.8	-0.2	0.8	0.4	1.4	1.8	1.6	3.6	5.1	0.7
22-Feb-90	1.6	-2.6	NS	2.9	1.7	2.3	8.1	1.3	OFSR	-0.0	1.3	14.7	-0.9	1.1	0.1	-0.2	3.6	5.6	3.6
28-Feb-90	1.0	0.7	OFSR	0.8	0.3	3.6	1.7	2.4	OFSR	2.5	1.9	2.6	1.0	2.3	3.4	1.8	5.8	5.3	-0.1
08-Mar-90	-1.3	-0.3	0.8	-1.6	0.3	-1.4	0.6	0.6	0.2	-0.2	-0.5	OFSR	-1.5	0.7	0.5	-1.7	5.6	3.6	1.8
15-Mar-90	1.2	-1.2	0.0	-0.8	0.3	-0.4	-0.4	-0.9	-0.3	OFSR	0.8	OFSR	1.0	-0.2	0.5	0.2	3.4	2.2	-0.6
22-Mar-90	0.3	1.8	-0.3	0.9	0.8	2.0	-0.9	OFSR	-0.2	1.1	2.8	1.7	-0.3	OFSR	OFSR	-0.7	0.6	3.1	3.8
30-Mar-90	0.6	-1.9	TWS	-0.3	1.9	-0.3	1.4	OFSR	-0.7	0.5	-0.9	1.7	0.2	OFSR	OFSR	0.7	2.5	7.4	TWS
06-Apr-90	TWS	FWS	-0.5	NS	0.4	0.8	-0.6	13.3	-0.4	0.3	17.1	0.2	0.4	-0.1	-0.2	0.4	1.6	OFSR	-0.6
12-Apr-90	TWS	FWS	-1.3	0.0	0.7	1.0	FWS	TWS	TWS	TWS	-0.3	TWS	TWS	OFSR	TWS	0.1	2.6	OFSR	OFSB
19-Apr-90	0.6	FWS	0.3	1.1	0.2	0.4	FWS	1.7	0.2	0.4	1.3	0.7	2.7	OFSR	1.3	NS	0.2	OFSR	OFSR
30-Apr-90	-0.1	1.1	-1.1	0.0	-0.4	-3.8	-0.8	-2.5	0.4	14.0	50.2	0.0	OFSB	0.1	0.6	2.1	0.4	11.1	OFSR
10-May-90	OFSR	NS	3.6	6.0	0.3	-0.2	0.6	0.4	OFSB	1.2	NS	1.8	2.2	NS	OFSB	0.3	4.6	5.0	1.4
18-May-90	-0.2	-0.1	-22.4	OFSB	-0.8	-0.7	TWS	-0.6	1.1	0.9	0.7	-2.9	OFSB	-0.4	-0.3	NS	1.7	0.3	TWS
24-May-90	2.7	-0.6	3.1	1.9	0.8	4.4	3.4	1.0	0.8	-1.0	-0.7	-1.3	-1.7	-2.7	6.8	NS	12.9	2.4	11.3
31-May-90	2.7	NS	OFSR	1.7	0.7	-1.2	1.4	OFSR	3.8	-2.2	1.3	-40.8	-0.1	2.0	0.6	3.3	17.9	28.1	20.8
08-Jun-90	2.5	0.2	1.4	2.5	2.8	2.3	2.0	2.0	2.0	0.8	0.2	OFSR	2.1	0.8	1.2	0.6	21.1	OFSR	6.5
15-Jun-90	1.3	1.7	TWS	3.6	0.9	2.3	0.5	2.0	1.9	-0.1	2.2	1.2	OFSR	2.4	5.4	4.5	17.7	7.9	3.9
22-Jun-90	-0.1	0.8	TWS	0.1	12.1	0.7	-1.9	1.0	-3.5	-1.1	3.4	-0.9	OFSR	-0.8	-2.9	NS	4.1	3.2	0.4
29-Jun-90	-1.2	-0.4	-1.9	1.3	-3.7	2.2	-1.6	-1.9	-2.1	-2.9	0.8	-2.8	OFSR	0.7	-3.1	-2.1	-0.9	-0.9	0.3
05-Jul-90	1.7	4.7	TWS	4.6	2.7	1.8	2.5	3.2	6.5	4.8	4.1	3.9	4.8	-1.5	10.9	0.8	TWS	TWS	3.5
12-Jul-90	7.6	6.6	2.0	25.7	136.5	6.7	2.7	OFSR	2.5	1.6	-0.1	3.0	1.8	4.9	1.7	1.8	3.1	9.9	2.0
19-Jul-90	17.6	4.0	58.7	3.0	20.0	3.3	2.7	OFSR	211.2	56.2	9.1	75.3	0.6	5.4	15.4	187.5	1.6	1.8	OFSR
25-Jul-90	11.8	1.8	4.9	OFSR	0.5	3.3	4.2	16.4	2.1	17.0	4.1	3.2	3.4	16.5	5.0	8.8	36.4	65.9	247.2
31-Jul-90	0.2	11.9	-2.2	OFSR	0.2	7.9	0.0	7.6	0.0	2.9	0.2	-9.9	5.9	1.3	1.6	0.1	41.2	28.7	-6.2
07-Aug-90	-3.7	2.5	0.2	OFSR	-2.9	-2.4	0.2	-3.3	-1.7	-2.1	4.9	28.1	1.2	9.5	3.1	-1.3	7.5	20.0	4.7
14-Aug-90	6.0	6.4	0.3	103.6	2.7	3.6	2.8	0.0	3.9	3.8	6.3	-2.1	-1.8	OFSR	-2.1	6.4	OFSR	12.7	9.7
22-Aug-90	-0.7	15.0	3.8	OFSR	2.8	1.6	0.3	-0.0	3.1	0.3	-0.5	0.7	23.6	-2.4	2.8	0.4	17.6	12.2	1.5
30-Aug-90	15.4	51.4	50.4	2.6	5.6	38.9	OFSR	79.0	OFSR	13.7	25.8	17.3	32.2	39.6	72.1	49.3	14.5	20.4	61.9
07-Sep-90	6.3	2.0	3.5	4.1	20.1	6.2	TWS	6.5	OFSR	0.7	-2.5	2.1	6.6	1.0	-1.1	-0.2	6.2	12.5	10.6
20-Sep-90	-0.1	-0.3	0.1	-0.9	1.7	0.4	0.0	0.0	-0.6	20.9	0.7	-3.4	-0.3	-0.8	1.4	-0.9	5.9	4.1	2.9
28-Sep-90	1.2	-1.0	-2.4	3.0	1.3	-0.1	NS	NS	-0.3	-2.1	-1.5	-0.9	0.0	-1.7	OFSR	-0.7	3.2	13.7	OFSR
04-Oct-90	0.4	-1.8	1.1	-0.2	-1.2	0.2	-0.1	0.5	1.0	13.1	0.6	10.7	-0.2	0.1	-0.4	0.8	TWS	TWS	2.8
11-Oct-90	-0.6	-0.2	NS	0.3	-2.0	-0.5	-3.8	-3.8	-1.3	1.3	2.2	-2.0	-1.7	-3.0	-1.7	TWS	8.2	12.6	0.1
18-Oct-90	-2.3	6.0	8.4	12.3	-2.6	-0.1	-1.5	0.1	5.5	-3.4	-2.2	0.3	-0.5	10.3	-2.3	56.2	OFSR	8.9	17.9
25-Oct-90	-2.7	3.6	2.5	9.1	-4.8	35.7	1.4	4.2	-1.7	-1.8	-2.0	-8.7	-5.0	-0.4	5.6	14.3	3.5	7.9	32.1
31-Oct-90	-0.7	-1.0	0.5	0.2	0.8	-0.1	0.3	0.5	-0.4	-0.3	0.4	0.5	-0.3	0.7	4.9	0.0	17.9	19.1	-0.4
08-Nov-90	-0.8	-8.5	-4.2	0.1	0.3	-9.9	-3.1	1.6	-4.9	-0.6	-2.8	0.4	0.2	-4.7	-2.9	NS	4.8	2.6	5.9
15-Nov-90	-1.1	-0.4	0.2	-3.6	NS	-4.1	-2.4	-0.3	-3.5	-8.2	-1.2	-2.1	-2.4	-2.6	-2.4	2.9	1.7	2.6	-0.1
21-Nov-90	-1.0	1.9	1.2	0.2	1.2	-0.1	-0.2	2.8	-0.2	-1.0	1.3	2.1	0.4	-0.9	-0.3	-0.1	5.0	4.7	0.3
30-Nov-90	0.3	NS	0.3	-0.5	0.2	0.5	1.9	1.9	0.0	-0.7	0.0	0.0	0.0	1.2	-0.3	0.0	TWS	TWS	1.2
06-Dec-90	5.4	-10.5	0.2	1.0	1.8	0.1	0.9	0.9	-0.2	1.1	0.2	-0.1	-0.4	-0.3	0.7	-1.2	10.0	26.7	-1.2
13-Dec-90	0.0	NS	0.3	1.1	-0.6	-0.2	0.6	NS	0.2	0.4	0.2	-1.0	4.7	-0.8	-0.5	-0.6	12.0	1.1	4.1
20-Dec-90	62.4	-10.0	0.0	NSV	4.7	3.9	1.3	-4.0	0.9	2.0	DLA	1.6	1.8	2.0	2.1	2.7	8.9	15.8	9.2
31-Dec-90	0.0	NS	0.4	NSV	-0.3	0.5	0.0	0.0	-2.1	-0.2	1.3	0.6	-1.5	1.4	-0.8	1.1	4.4	12.8	1.0
Min. Conc.	-3.7	-10.5	-22.4	-3.6	-4.8	-9.9	-3.8	-4.0	-4.9	-8.2	-2.8	-40.8	-5.0	-4.7	-3.1	-2.1	-0.9	-0.9	-6.2
Max. Conc.	62.4	51.4	58.7	103.6	136.5	38.9	8.1	79.0	211.2	56.2	50.2	75.3	32.2	39.6	72.1	187.5	41.2	65.9	247.2
Avg. Conc.	3.2	1.9	2.3	4.7	4.2	2.3	0.5	3.4	5.3	2.8	2.7	2.2	1.8	2.0	2.9	7.4	7.8	10.3	12.1
FWAVG Conc.	2.5	2.8	3.5	3.2	3.0	2.1	0.5	[illegible]	5.1	3.3	3.1	2.6	1.8	2.0	2.0	7.9	7.3	9.8	8.7

NS: No Sample Collected or Received.
TWS: *Two to Three Week Sample.*
FWS: Four to Five Week Sample.
OFSR: Out of Service for Repairs.
OFSB: Out of Service due to Batteries.
NSV: No Sample Collected - System Vandalized.
FWAVG: Flow Weighted Average.

Table 22
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Gamma Emitting Radionuclide Concentrations on Air Particulate Filters from Location 16T2.1

		Gross Alpha			Gross Beta			Be-7			I-126		
Month	Flow m^3	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<---	---	---	---	---	pCi/m^3	---	---	---	---	---	--->
January	462	0.0018	0.0008	0.0028	0.0480	0.0312	0.0636	0.0000	0.0000	0.0000	0.0348	0.1480	0.1480
February	392	0.0016	0.0003	0.0031	0.0426	0.0322	0.0491	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
March	422	0.0014	-0.0003	0.0026	0.0426	0.0349	0.0502	0.1227	0.4730	0.4730	0.0000	0.0000	0.0000
April	438	0.0019	0.0005	0.0036	0.0347	0.0262	0.0432	0.0867	0.2420	0.2420	0.0000	0.0000	0.0000
May	442	0.0006	0.0000	0.0013	0.0214	0.0164	0.0307	0.2609	0.4100	0.5670	0.0000	0.0000	0.0000
June	316	0.0015	0.0008	0.0025	0.0343	0.0307	0.0401	0.2198	0.2330	0.4230	0.0000	0.0000	0.0000
July	464	0.0010	0.0003	0.0020	0.0357	0.0293	0.0451	0.1336	0.2620	0.3570	0.0000	0.0000	0.0000
August	436	0.0540	0.0008	0.2280	0.0326	0.0252	0.0389	0.0869	0.3750	0.3750	0.0000	0.0000	0.0000
September	415	0.0013	0.0007	0.0025	0.0299	0.0243	0.0400	0.0751	0.2720	0.2720	0.0000	0.0000	0.0000
October	472	0.0019	0.0012	0.0023	0.0347	0.0266	0.0412	0.2963	0.2070	0.7090	0.0000	0.0000	0.0000
November	403	0.0024	0.0009	0.0052	0.0456	0.0424	0.0494	0.1298	0.0713	0.2170	0.0000	0.0000	0.0000
December	427	0.0020	0.0013	0.0028	0.0396	0.0309	0.0492	0.1354	0.1570	0.2820	0.0000	0.0000	0.0000
Annual Average	424	0.0061	-0.0003	0.2280	0.0368	0.0164	0.0636	0.1288	0.0000	0.7090	0.0032	0.0000	0.1480
Typical MDL		0.002			0.006			0.213			0.064		
DOE Order 5400.5 DAC		NA			NA			40,000			300		

MDL: Minimum detection limit.
DAC: Derived air concentration.
NA: Not applicable.

Table 23
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Gamma Emitting Radionuclide Concentrations on Air Particulate Filters from Location 11T2.1

Month	Flow	Gross Alpha			Gross Beta			Be-7		
	m^3	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
		<----------				pCi/m^3				---------->
January	472	0.0017	0.0012	0.0020	0.0342	0.0220	0.0418	0.0000	0.0000	0.0000
February	404	0.0012	0.0000	0.0026	0.0406	0.0365	0.0495	0.0564	0.1980	0.1980
March	429	0.0009	-0.0002	0.0025	0.0418	0.0344	0.0488	0.2484	0.2500	0.7110
April	445	0.0023	0.0000	0.0037	0.0336	0.0294	0.0426	0.0539	0.2790	0.2790
May	447	0.0013	0.0005	0.0021	0.0254	0.0140	0.0339	0.1291	0.1900	0.2950
June	420	0.0012	0.0008	0.0018	0.0340	0.0283	0.0395	0.1292	0.4700	0.4700
July	467	0.0014	0.0000	0.0026	0.0363	0.0335	0.0397	0.0784	0.1740	0.2210
August	440	0.0017	0.0011	0.0024	0.0326	0.0275	0.0356	0.0000	0.0000	0.0000
September	420	0.0011	0.0004	0.0018	0.0277	0.0218	0.0362	0.1093	0.1110	0.2160
October	481	0.0015	0.0005	0.0023	0.0378	0.0323	0.0467	0.1169	0.2900	0.3020
November	430	0.0019	-0.0003	0.0032	0.0471	0.0362	0.0592	0.0281	0.1200	0.1200
December	445	0.0020	0.0012	0.0033	0.0398	0.0287	0.0545	0.0000	0.0000	0.0000
Annual Average	442	0.0015	-0.0003	0.0037	0.0359	0.0140	0.0592	0.0785	0.0000	0.7110
Typical MDL		0.002			0.006			0.204		
DOE Order 5400.5 DAC		NA			NA			40,000		

MDL: Minimum detection limit.
DAC: Derived air concentration.
NA: Not applicable.

Table 24
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Gamma Emitting Radionuclide Concentrations on Air Particulate Filters from Location 6T2.8

Month	Flow	Gross Alpha			Gross Beta			Be-7		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
	m^3	<----				pCi/m^3				---->
January	458	0.0018	0.0003	0.0031	0.0390	0.0328	0.0456	0.0000	0.0000	0.0000
February	388	0.0014	-0.0013	0.0042	0.0384	0.0314	0.0447	0.1603	0.1830	0.3110
March	411	0.0029	0.0016	0.0040	0.0405	0.0340	0.0446	0.2043	0.1680	0.2290
April	415	0.0022	0.0003	0.0038	0.0393	0.0286	0.0500	0.0454	0.1280	0.1280
May	414	0.0017	0.0014	0.0021	0.0297	0.0274	0.0325	0.0481	0.2170	0.2170
June	381	0.0015	0.0011	0.0020	0.0361	0.0322	0.0438	0.0845	0.1260	0.1960
July	385	0.0013	-0.0010	0.0046	0.0453	0.0357	0.0633	0.0000	0.0000	0.0000
August	395	0.0023	0.0007	0.0038	0.0360	0.0326	0.0416	0.1021	0.1550	0.2780
September	373	0.0020	0.0012	0.0027	0.0421	0.0326	0.0533	0.1266	0.2830	0.2830
October	460	0.0024	0.0015	0.0033	0.0442	0.0357	0.0546	0.0939	0.2010	0.2310
November	424	0.0031	0.0015	0.0041	0.0454	0.0385	0.0522	0.2246	0.1930	0.3720
December	436	0.0029	0.0007	0.0057	0.0402	0.0289	0.0489	0.2142	0.1610	0.3630
Annual Average	412	0.0022	-0.0013	0.0057	0.0397	0.0274	0.0633	0.1086	0.0000	0.3720
Typical MDL		0.002			0.006			0.219		
DOE Order 5400.5 DAC		NA			NA			40,000		

MDL: Minimum detection limit.
DAC: Derived air concentration.
NA: Not applicable.

Table 25
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Gamma Emitting Radionuclide Concentrations on Air Particulate Filters from Location 4T2.4

Month	Flow	Gross Alpha			Gross Beta			Be-7		
		Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
	m^3	<----------				pCi/m^3				---------->
January	460	0.0014	-0.0003	0.0040	0.0317	0.0208	0.0408	0.0000	0.0000	0.0000
February	391	0.0014	0.0003	0.0024	0.0424	0.0375	0.0478	0.0505	0.2350	0.2350
March	419	0.0013	-0.0003	0.0030	0.0418	0.0360	0.0471	0.1459	0.1620	0.4020
April	434	0.0018	0.0000	0.0034	0.0344	0.0270	0.0453	0.0231	0.1020	0.1020
May	433	0.0014	0.0005	0.0023	0.0267	0.0228	0.0319	0.0000	0.0000	0.0000
June	407	0.0014	0.0008	0.0023	0.0335	0.0301	0.0363	0.0000	0.0000	0.0000
July	452	0.0017	-0.0012	0.0033	0.0364	0.0319	0.0407	0.0000	0.0000	0.0000
August	426	0.0010	0.0003	0.0020	0.0463	0.0297	0.0837	0.0000	0.0000	0.0000
September	407	0.0026	0.0018	0.0031	0.0291	0.0252	0.0330	0.0651	0.1450	0.1450
October	466	0.0014	0.0008	0.0021	0.0378	0.0331	0.0434	0.0000	0.0000	0.0000
November	422	0.0021	0.0015	0.0029	0.0454	0.0368	0.0534	0.0000	0.0000	0.0000
December	418	0.0017	0.0015	0.0020	0.0392	0.0286	0.0511	0.0000	0.0000	0.0000
Annual Average	428	0.0016	-0.0012	0.0040	0.0370	0.0208	0.0837	0.0229	0.0000	0.4020
Typical MDL		0.002			0.006			0.211		
DOE Order 5400.5 DAC		NA			NA			40,000		

MDL: Minimum detection limit.
DAC: Derived air concentration.
NA: Not applicable.

Table 26
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Gamma Emitting Radionuclide 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.	Be-7 Avg.	Be-7 Min.	Be-7 Max.
		<--------				pCi/m^3				-------->
January	453	0.0056	-0.0038	0.0208	0.1353	0.0498	0.2710	0.0000	0.0000	0.0000
February	388	0.0067	-0.0036	0.0226	0.1345	0.0443	0.3430	0.0975	0.3900	0.3900
March	401	0.0074	0.0006	0.0240	0.1392	0.0573	0.2400	0.0728	0.3470	0.3470
April	431	0.0052	-0.0059	0.0199	0.1250	0.0602	0.2070	0.0955	0.4280	0.4280
May	432	0.0042	-0.0074	0.0173	0.1235	0.0450	0.2240	0.0476	0.2100	0.2100
June	407	0.0039	-0.0135	0.0151	0.1266	0.0455	0.2120	1.8827	0.1127	7.7300
July	445	0.0056	-0.0075	0.0219	0.1164	0.0635	0.3270	0.0314	0.1410	0.1410
August	426	0.0055	-0.0076	0.0235	0.1270	0.0566	0.2120	0.0000	0.0000	0.0000
September	391	0.0033	-0.0019	0.0123	0.1345	0.0484	0.3420	0.0000	0.0000	0.0000
October	421	0.0062	0.0018	0.0234	0.1371	0.0558	0.2580	0.0821	0.1580	0.1930
November	419	0.0091	-0.0039	0.0288	0.1297	0.0430	0.2200	0.0000	0.0000	0.0000
December	423	0.0063	-0.0018	0.0257	0.1150	0.0555	0.2240	0.0509	0.2770	0.2770
Annual Average	420	0.0057	-0.0135	0.0288	0.1285	0.0430	0.3430	0.1917	0.0000	7.7300
Typical MDL		0.002			0.006			0.215		
DOE Order 5400.5 DAC		NA			NA			40,000		

MDL: Minimum detection limit.
DAC: Derived air concentration.
NA: Not applicable.

Table 27
BNL Site Environmental Report for Calendar Year 1990
Charcoal Filter Data for Station 16T2.1

Month	Flow m^3	Cs-137	Radionuclide K-40 pCi/m^3	Ra-226
January	462	0.0037	0.536	ND
February	392	0.0065	0.524	0.065
March	422	ND	0.766	ND
April	438	0.0039	0.469	0.045
May	442	0.0052	0.508	0.049
June	316	ND	0.672	ND
July	464	0.0021	0.471	0.062
August	436	0.0037	0.473	0.055
September	415	0.0094	0.542	ND
October	472	ND	0.536	ND
November	20	0.1210	11.300	ND
December	427	0.0084	0.518	ND
Annual Average	392	0.0044	0.589	0.025
Typical MDL		0.0033	0.069	0.007
DOE Order 5400.5 DAC		400	900	1.0

ND: Not detected.
MDL: Minimum detection limit.
DAC: Derived air concentration.

Note: November sample collected for only one week. Results indicate activity in charcoal filter.

Table 28
BNL Site Environmental Report for Calendar Year 1990
Charcoal Filter Data for Station 11T2.1

Month	Flow m^3	Cs-137	K-40	Ra-226	Be-7
		<-----------	Radionuclide pCi/m^3		----------->
January	473	ND	0.435	0.182	ND
February	404	0.0069	0.536	ND	ND
March	429	0.0043	0.525	ND	ND
April	445	ND	2.490	ND	ND
May	447	ND	0.422	ND	ND
June	420	0.0038	0.602	ND	ND
July	467	0.0052	0.535	ND	ND
August	440	ND	0.553	ND	ND
September	420	0.0122	0.702	ND	ND
October	481	0.0048	0.487	ND	ND
November	430	0.0082	0.416	ND	ND
December	445	0.0041	0.457	ND	0.0482
Annual Average	442	0.0040	0.679	0.016	0.004
Typical MDL		0.0029	0.061	0.007	0.021
DOE Order 5400.5 DAC		400	900	1.0	40,000

ND: Not detected.
MDL: Minimum detection limit.
DAC: Derived air concentration.

Table 29
BNL Site Environmental Report for Calendar Year 1990
Charcoal Filter Data for Station 6T2.8

Month	Flow m^3	Cs-137	K-40	Ra-226	Th-228
		<------------	pCi/m^3		---------->
January	458	0.0038	0.411	ND	ND
February	388	ND	0.688	0.012	ND
March	411	0.0159	0.583	ND	ND
April	415	0.0043	0.617	ND	0.0049
May	408	0.0044	0.591	ND	ND
June	381	0.0046	0.514	ND	ND
July	385	0.0040	0.540	ND	ND
August	395	0.0047	0.578	ND	ND
September	373	0.0045	0.545	ND	ND
October	460	0.0039	0.489	ND	ND
November	424	0.0052	0.585	ND	ND
December	436	0.0052	0.568	ND	ND
Annual Average	411	0.0051	0.557	0.001	0.0004
Typical MDL		0.0032	0.066	0.007	0.006
DOE Order 5400.5 DAC		400	900	1.0	0.04

Radionuclide columns: Cs-137, K-40, Ra-226, Th-228.

ND: Not detected.
MDL: Minimum detection limit.
DAC: Derived air concentration.

Table 30
BNL Site Environmental Report for Calendar Year 1990
Charcoal Filter Data for Station 4T2.4

Month	Flow m^3	Cs-137	K-40	Ra-226
			Radionuclide	
		<-------------	pCi/m^3	----------->
January	460	0.0032	0.433	0.043
February	391	0.0045	0.584	ND
March	419	0.0065	0.536	ND
April	434	0.0049	0.560	ND
May	433	0.0028	0.513	0.015
June	407	0.0049	0.598	ND
July	453	0.0036	0.484	ND
August	426	0.0050	0.558	ND
September	407	0.0049	0.530	ND
October	466	0.0055	0.436	ND
November	422	ND	0.845	ND
December	279	ND	1.150	ND
Annual Average	416	0.0039	0.583	0.005
Typical MDL		0.0031	0.065	0.007
DOE Order 5400.5 DAC		400	900	1.0

ND: Not detected.
MDL: Minimum detection limit.
DAC: Derived air concentration.

Table 31
BNL Site Environmental Report for Calendar Year 1990
Charcoal Filter Data for Station S6

Month	Flow m^3	Radionuclide Cs-137	K-40
		<------ pCi/m^3 ------>	
January	453	ND	0.595
February	388	0.0096	0.459
March	401	0.0042	0.552
April	431	0.0045	0.536
May	432	0.0044	0.496
June	408	ND	0.515
July	445	ND	0.470
August	426	ND	0.503
September	391	0.0127	0.596
October	421	0.0042	0.559
November	419	0.0121	0.530
December	491	0.0093	0.394
Annual Average	426	0.0050	0.515
Typical MDL		0.0031	0.063
DOE Order 5400.5 DAC		400	900

ND: Not detected.
MDL: Minimum detection limit.
DAC: Derived air concentration.

Table 32
BNL Site Environmental Report for Calendar Year 1990
Radionuclide Concentrations in Precipitation (Wet and Dry) at Stations 4T and 11T

Location	Sample Type	Month	Precipitation Collected cm	Gross Alpha	Gross Beta	Tritium	Be-7	K-40	Ra-226	Cs-137	Ce-141	Sr-90
				<------				nCi/m²				------>
4T	Dry	January	0	0.001	0.017	-1.907						
		February	0	-0.003	0.005	1.552						
		March	0	0.001	0.018	5.213	MDL	MDL	MDL	MDL	MDL	NA
		April	0	0.004	0.002	0.396						
		May	0	0.014	0.010	-2.537						
		June	0	0.000	0.047	0.159	MDL	MDL	MDL	MDL	MDL	NA
		July	0	-0.002	0.005	3.628						
		August	0	0.011	-0.012	17.393						
		September	0	-0.002	-0.018	6.616	MDL	MDL	MDL	MDL	MDL	NA
		October	0	0.002	0.015	29.665						
		November	0	0.003	0.033	-0.402						
		December	0	-0.016	0.012	0.000	NA	NA	NA	NA	NA	NA
		Total		0.014	0.131	59.776	MDL	MDL	MDL	MDL	MDL	NA
4T	Wet	January	10640	0.058	0.313	-6.017						
		February	5700	0.027	0.161	2.815						
		March	5960	0.019	0.203	4.252	9.496	MDL	MDL	MDL	MDL	NR
		April	4740	0.026	0.227	-55.565						
		May	22710	0.053	0.485	7.201						
		June	5020	0.016	0.023	8.341	5.835	MDL	MDL	MDL	MDL	NR
		July	7040	-0.011	0.114	4.980						
		August	8820	0.041	0.152	-13.714						
		September	3930	0.006	0.111	-3.960	2.894	MDL	MDL	MDL	MDL	0.027
		October	10200	0.032	0.229	-16.793						
		November	2420	0.008	0.329	9.075						
		December	8120	0.032	0.337	0.829	13.247	MDL	MDL	MDL	MDL	NR
		Total	95300	0.306	2.682	-58.556	31.473	MDL	MDL	MDL	MDL	0.027
11T	Dry	January	0	0.000	0.032	-9.604						
		February	0	-0.002	0.070	3.659						
		March	0	-0.006	0.003	0.555	MDL	MDL	MDL	MDL	MDL	NA
		April	0	0.000	0.000	0.000						
		May	0	0.002	-0.003	-1.784						
		June	0	0.002	-0.012	-5.777	MDL	MDL	MDL	MDL	MDL	NA
		July	0	0.008	-0.015	1.256						
		August	0	0.004	0.012	-4.451						
		September	0	-0.005	-0.001	-12.835	MDL	MDL	MDL	MDL	MDL	NA
		October	0	0.003	0.010	36.280						
		November	0	0.003	-0.010	0.000						
		December	0	IM	IM	IM	IM	IM	IM	IM	IM	IM
		Total		0.009	0.056	7.299	MDL	MDL	MDL	MDL	MDL	NA
11T	Wet	January	10500	0.041	0.303	22.248						
		February	5270	0.000	0.067	18.638						
		March	1400	-0.001	0.046	-0.666	7.329	MDL	MDL	MDL	MDL	NR
		April	4560	0.011	-0.024	-26.345						
		May	22710	0.071	0.627	-27.003						
		June	3500	0.005	0.086	-2.220	12.134	MDL	MDL	MDL	MDL	0.012
		July	2480	0.014	0.114	1.365						
		August	9500	0.015	0.104	22.736						
		September	4600	-0.011	0.005	13.463	3.817	MDL	MDL	MDL	MDL	-0.001
		October	9180	0.000	0.280	191.716						
		November	2130	0.008	0.201	8.572						
		December	7600	0.095	0.266	-13.902	13.018	MDL	MDL	MDL	MDL	NR
		Total	83430	0.248	2.075	228.603	36.299	MDL	MDL	MDL	MDL	0.011
Typical MDL				0.004	0.009	0.032	0.30	0.71	0.09	0.04	0.01	0.006

MDL Minimum detection limit
NA Not applicable
NR Not reported
IM Instrument malfunction

Notes
1 Gamma Spectroscopy and strontium-90 analysis performed on quarterly composite samples
2 The dry deposition collector at Station 11T was frozen in place for December
3 Rain Collector area at each station is 0.0656 m²

Table 33
BNL Site Environmental Report for Calendar Year 1990
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	------------	------------>
Yaphank Honor Farm	Soil	07/20/90	0.12	0.11	5.27	0.44	0.58
NYS Game Farm (Ridge)	Soil	07/20/90	ND	0.52	1.83	0.12	0.18
Berenzey Farm	Soil	07/20/90	ND	0.10	4.72	0.47	0.62
Yaphank Honor Farm	Grass	07/20/90	0.89	ND	2.79	ND	ND
NYS Game Farm (Ridge)	Grass	07/20/90	ND	0.36	13.90	ND	ND
Berenzey Farm	Grass	07/20/90	0.48	ND	3.78	ND	ND
Typical MDL			0.07	0.01	0.18	0.03	0.02

ND: Not detected. Radionuclide Concentration less than the system MDL.
MDL: Minimum detection limit.

Table 34
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross Beta, and Tritium Concentrations in
Peconic River and Carmans River

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				------------------>
Sample Location Station HM										
January	14	0.27	-0.77	2.05	3.76	-4.16	9.44	-123.34	-546.00	245.00
February	11	0.18	-1.79	2.30	2.44	-1.70	8.50	-162.51	-860.00	361.00
March	13	0.18	-0.77	2.05	5.71	1.32	11.00	-239.60	-1760.00	438.00
April	13	0.43	-1.28	1.54	4.07	-1.32	8.69	-446.43	-1880.00	747.00
May	13	0.26	-1.02	2.82	5.28	0.94	13.60	18.63	-628.00	732.00
June	12	0.21	-1.54	2.56	4.14	-3.78	6.61	87.73	-904.00	653.00
July	12	-0.02	-1.02	1.54	5.21	1.70	10.00	1980.42	-159.00	9110.00
August	13	-0.10	-2.56	1.02	6.09	2.27	10.80	1683.54	434.00	4340.00
September	11	0.53	-0.77	2.05	4.96	1.13	9.44	986.09	-282.00	2690.00
October	14	0.62	-0.51	1.54	5.61	-0.19	10.00	1001.10	-564.00	3120.00
November	11	0.28	-1.28	1.79	5.42	2.83	9.07	4543.64	3110.00	6750.00
December	12	0.21	-0.77	1.02	6.89	1.70	14.90	1106.87	-341.00	5170.00
Annual	**149**	**0.26**	**-2.56**	**2.82**	**4.98**	**-4.16**	**14.90**	**823.07**	**-1880.00**	**9110.00**
Sample Location Station HQ										
January	10	0.21	-2.05	1.54	3.40	-2.27	5.67	234.08	-136.00	776.00
February	6	0.47	-0.26	1.54	2.55	-1.70	8.88	619.17	437.00	792.00
March	10	0.13	-1.28	1.28	4.37	-2.08	10.80	138.91	-1230.00	1670.00
April	12	0.51	-1.54	1.54	2.96	-0.94	7.93	-55.91	-1620.00	804.00
May	10	0.66	-1.54	2.30	4.70	-0.38	11.10	63.90	-2130.00	564.00
June	11	0.23	-1.28	1.79	4.76	-0.38	7.18	290.73	-268.00	777.00
July	12	0.06	-1.79	1.28	4.08	0.00	9.25	1290.26	-130.00	3350.00
August	12	0.17	-1.02	1.54	4.69	1.51	8.69	2169.42	283.00	6130.00
September	10	0.49	-0.77	1.79	4.12	1.13	7.18	1142.00	215.00	2160.00
October	13	0.47	-1.28	1.28	7.63	3.97	13.20	747.74	-27.20	2050.00
November	11	0.30	-0.51	1.02	4.10	1.13	6.42	4082.73	1880.00	5550.00
December	12	0.21	-0.77	1.54	6.54	-0.19	21.70	1219.11	-108.00	3190.00
Annual	**129**	**0.32**	**-2.05**	**2.30**	**4.63**	**-2.27**	**21.70**	**1029.51**	**-2130.00**	**6130.00**
Sample Location Station HA - Peconic River Off Site										
February	1	0.15	----	----	1.33	----	----	128.00	------	------
September	1	0.00	----	----	2.12	----	----	882.00	------	------
November	1	0.26	----	----	1.47	----	----	443.00	------	------
Annual	**3**	**0.14**	**0.00**	**0.26**	**1.64**	**1.33**	**2.12**	**484.00**	**128.00**	**882.00**
Sample Location Station HB - Peconic River Off Site										
February	1	0.00	----	----	0.76	----	----	70.90	-----	------
September	1	0.00	----	----	1.93	----	----	882.00	-----	------
November	1	0.05	----	----	1.89	----	----	252.00	-----	------
Annual	**3**	**0.02**	**0.00**	**0.05**	**1.53**	**0.76**	**1.93**	**402.00**	**71.00**	**882.00**
Sample Location Station HC - Peconic River Off Site										
February	1	0.10	----	----	1.32	----	----	-100.00	-----	------
September	1	0.15	----	----	1.17	----	----	765.00	-----	------
November	1	-0.10	----	----	2.23	----	----	295.00	-----	------
Annual	**3**	**0.05**	**-0.10**	**0.15**	**1.57**	**1.17**	**2.23**	**319.00**	**-102.00**	**765.00**
Sample Location Station HR - Peconic River Off Site										
February	1	0.31	----	----	0.57	----	----	22.20	----	------
September	1	0.26	----	----	1.66	----	----	473.00	----	------
November	1	0.21	----	----	3.40	----	----	351.00	----	------
Annual	**3**	**0.26**	**0.21**	**0.31**	**1.88**	**0.57**	**3.40**	**282.00**	**22.00**	**473.00**
Sample Location Station HH - Carmans River										
February	1	0.00	----	----	0.15	----	----	66.50	------	------
September	1	0.15	----	----	1.02	----	----	409.00	------	------
November	1	0.05	----	----	1.93	----	----	-130.00	------	------
Annual	**3**	**0.07**	**0.00**	**0.15**	**1.03**	**0.15**	**1.93**	**116.00**	**-129.00**	**409.00**
Typical MDL for HM and HQ	2.3			6				1000		
Typical MDL All Others	0.46			1.2				300		

MDL: Minimum detection limit.

Table 35
BNL Site Environmental Report for Calendar Year 1990
Nuclide Specific Concentrations in Peconic River, Carmans River and Small Surface Water Ponds

Month	Aliquot, Liters	Co-60	Cs-137	K-40	Sr-90	Be-7	Mn-54
		<----------	----------	pCi/L	----------	----------	---------->
<u>Sample Location Station HM - Peconic River On Site</u>							
January	14	0.18	3.85	2.24	-0.02	ND	ND
February	12	ND	2.02	20.20	-0.02	ND	ND
March	15	ND	2.35	ND	-0.02	ND	ND
April	15	0.87	2.01	ND	0.24	ND	ND
May	16	ND	1.09	ND	0.24	ND	ND
June	14	ND	2.19	ND	0.24	ND	ND
July	16	ND	2.11	ND	NA	ND	ND
August	16	ND	2.65	ND	NA	ND	ND
September	15	ND	1.94	ND	NA	ND	ND
October	16	ND	4.16	ND	NA	ND	ND
November	14	ND	ND	ND	NA	ND	ND
December	15	ND	ND	30.90	NA	ND	ND
Annual	**176**	**0.09**	**2.04**	**4.20**	**0.06**	**ND**	**ND**
<u>Sample Location Station HQ - Peconic River On Site</u>							
June	9	ND	1.64	ND	NA	ND	ND
July	16	ND	2.13	ND	NA	ND	ND
August	16	ND	3.59	ND	NA	ND	ND
September	15	ND	2.17	ND	NA	ND	ND
October	17	ND	2.32	4.25	NA	ND	ND
November	15	ND	0.38	ND	NA	ND	ND
December	15	0.29	ND	ND	NA	ND	ND
Annual	**101**	**0.04**	**1.78**	**0.70**	**NA**	**ND**	**ND**
<u>Sample Location Station HA - Peconic River Off Site</u>							
1st Qtr.	12	ND	0.56	6.20	0.28	ND	ND
3rd Qtr.	12	ND	ND	ND	0.24	ND	ND
Annual	**24**	**ND**	**0.28**	**3.10**	**0.26**	**ND**	**ND**
<u>Sample Location Station HB - Peconic River Off Site</u>							
1st Qtr.	12	ND	0.87	ND	0.27	ND	ND
3rd Qtr.	12	ND	ND	ND	-0.03	ND	ND
4th Qtr.	12	ND	0.92	ND	NA	ND	ND
Annual	**36**	**ND**	**0.60**	**ND**	**0.12**	**ND**	**ND**
<u>Sample Location Station HC - Peconic River Off Site</u>							
1st Qtr.	12	ND	ND	ND	0.24	ND	ND
3rd Qtr.	12	ND	ND	ND	0.30	ND	ND
4th Qtr.	12	ND	ND	ND	NA	ND	ND
Annual	**36**	**ND**	**ND**	**ND**	**0.27**	**ND**	**ND**
<u>Sample Location Station HR - Peconic River Off Site</u>							
1st Qtr.	12	ND	0.51	2.62	0.54	2.65	0.14
3rd Qtr.	12	ND	ND	ND	0.54	ND	ND
4th Qtr.	12	ND	ND	ND	NA	ND	ND
Annual	**36**	**ND**	**0.17**	**0.87**	**0.54**	**0.88**	**0.05**
<u>Sample Location Station HH - Carmans River</u>							
1st Qtr.	12	ND	ND	ND	0.24	ND	ND
3rd Qtr.	12	ND	ND	ND	0.12	ND	ND
4th Qtr.	12	ND	ND	ND	NA	ND	ND
Annual	**36**	**ND**	**ND**	**ND**	**0.18**	**ND**	**ND**
<u>Sample Location - Peconic River at BNL North Gate</u>							
1st Qtr.	12	ND	ND	ND	NA	ND	ND
Annual	**12**	**ND**	**ND**	**ND**	**NA**	**ND**	**ND**
<u>Sample Location - Half Moon Pond</u>							
4th Qtr.	12	ND	ND	ND	NA	ND	ND
Annual	**12**	**ND**	**ND**	**ND**	**NA**	**ND**	**ND**
Typical MDL		0.23	0.20	3.90	0.10	1.60	0.18
DOE Order 5400.5 Derived Concentration Guide		5000	3000	7000	1000	1000000	50000
Concentration Required to Produce SDWA Annual Dose		200	120	280	40	40000	2000

NA: Not analyzed.
ND: Not detected.
MDL: Minimum detection limit.

Table 36
BNL Site Environmental Repc t for Calendar Year 1990
Peconic River Wa er Quality Data

Location	Sample Period	No. of Samples[a]	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	14 (5)	3.1 - 6.8	175	45	348	48.6	40.0	54.9	11.4	10.2	12.0	1.3	1.0	1.6
	February	11 (4)	5.3 - 6.4	102	56	168	23.3	18.9	30.0	9.5	8.0	10.2	0.9	<1.0	1.3
	March	13 (4)	5.1 - 6.5	118	97	138	37.3	25.2	45.2	10.3	9.9	10.8	1.7	1.4	1.8
	April	14 (5)	5.2 - 6.0	100	81	137	19.1	16.3	23.5	9.0	8.3	10.4	1.5	1.2	2.2
	May	13 (4)	4.5 - 5.9	104	80	142	18.0	14.4	22.6	8.8	7.9	9.5	1.5	1.3	1.9
	June	12 (4)	5.0 - 5.9	116	93	143	16.1	12.3	18.9	8.4	7.1	9.0	1.5	1.1	1.8
	July	12 (4)	5.1 - 6.3	135	100	165	25.6	19.7	32.3	10.4	9.6	11.3	2.1	1.7	2.8
	August	12 (4)	4.9 - 6.3	138	63	181	21.1	17.4	25.0	10.7	9.9	12.0	2.7	2.3	2.9
	September	11 (4)	5.6 - 7.2	170	126	223	21.9	21.0	22.9	11.7	11.2	12.1	2.9	2.6	3.2
	October	14 (5)	5.3 - 6.3	127	64	273	25.6	18.1	33.0	14.9	8.0	26.6	2.6	1.6	3.8
	November	11 (4)	5.6 - 7.1	185	117	241	27.7	22.8	34.3	12.7	11.0	14.1	3.0	2.5	3.7
	December	11 (5)	5.9 - 6.6	162	117	200	25.9	21.9	33.8	11.6	8.5	14.1	2.6	1.4	3.8
NYS Drinking Water Standards			6.5 - 8.5	(b)			250.0			250.0			10.0		
Typical MDL			--	10			4.0			4.0			1.0		

MDL: Minimum detection limit.
(a) 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.
(b) No standard specified.

Table 37
BNL Site Environmental Report for Calendar Year 1990
Peconic River Metals Data

Location	Sample Period	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<------------	------------	------------	------------	------------	mg/L	------------	------------	------------	------------>
HM	January	<0.025	<0.0005	<0.005	<0.05	0.56	NA	0.07	19.0	<0.005	0.03
	February	<0.025	<0.0005	<0.005	<0.05	0.55	NA	0.07	12.8	<0.005	<0.02
	March	<0.025	<0.0005	<0.005	<0.05	0.69	NA	0.06	16.8	<0.005	0.03
	April	<0.025	<0.0005	<0.005	<0.05	0.90	NA	0.07	13.4	<0.005	0.02
	May	<0.025	<0.0005	<0.005	<0.05	1.55	NA	0.07	12.6	<0.005	0.02
	June	<0.025	<0.0005	<0.005	<0.05	0.62	0.0005	<0.05	13.0	<0.005	<0.02
	July	<0.025	<0.0005	<0.005	<0.05	0.27	0.0002	<0.05	15.0	<0.005	<0.02
	August	<0.025	<0.0005	<0.005	<0.05	0.28	<0.0002	<0.05	15.6	<0.005	<0.02
	September	<0.025	<0.0005	<0.005	<0.05	0.56	<0.0002	<0.05	17.8	<0.005	<0.02
	October	<0.025	<0.0005	<0.005	<0.05	1.21	0.0002	0.06	15.4	0.006	0.03
	November	<0.025	<0.0005	<0.005	0.05	0.66	<0.0002	<0.05	20.4	<0.005	0.05
	December	<0.025	<0.0005	<0.005	<0.05	0.50	<0.0002	0.05	15.3	<0.005	0.03
NYS Drinking Water Standard		0.05	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.050	5.0
Typical MDL		0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) No standard specified.

Table 38
BNL Site Environmental Report for Calendar Year 1990
Water Quality Parameters for Surface Water Samples
Collected Along the Peconic and Carmans River

River	Sample Location	Number of Samples	pH (SU)	Conductivity Avg.	Conductivity Min.	Conductivity Max.	Temperature Avg.	Temperature Min.	Temperature Max.	Dissolved Oxygen Avg.	Dissolved Oxygen Min.	Dissolved Oxygen Max.
				<------ umhos/cm ---->			<-------- °C ----->			<-------- mg/L -------->		
Peconic	HA	3	5.8 - 6.9	65.7	47	77	11.8	6	22	10.5	5.6	11.8
	HB	3	5.5 - 6.6	84.7	43	148	14.9	7	29	8.4	4.3	12.4
	HC	3	6.0 - 6.9	97.3	51	156	14.9	6	32	11.7	8.1	13.9
	HR	3	6.8 - 7.2	77.0	60	94	16.0	8	28	10.9	8.1	13.7
Carmans	HH	3	6.7 - 7.1	151.7	130	171	14.3	8	25	10.2	8.7	11.6
NYS Drinking Water Standards			6.5 - 8.5	(a)			(a)			(a)		

(a) No standard specified.

Note: The Peconic River and Carmens River sample locations are shown in Figure 28.

Table 39
BNL Site Environmental Report for Calendar Year 1990
Radionuclide Concentrations in Fish

Sample Location	Sample Date	ID #	Remarks	Distance from BNL Discharge, km	Species	Dry/Wet Ratio pCi/kg	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
Carmans River	08/23/90	1-90	Control	--	Pirateferch[a]	0.19	ND	ND	NA	8084	1536
	08/23/90	2-90	Control	--	Darter Sp.	0.22	254	56	NA	1286	283
	08/23/90	3-90	Control	--	American Eel[b]	0.30	783	235	NA	560	168
	08/23/90	4-90	Control	--	Redfin Pickerel	0.29	166	48	NA	18266	5297
Swan Pond, Peconic River, Upstream Calverton	08/22/90	14-90	Control	--	Blue Gill	0.23	265	61	NA	13456	3095
	08/22/90	18-90	Control	--	Yellow Perch[c]	0.27	674	182	NA	9089	2454
	08/21/90	21-90	Control	--	Blue Gill	0.23	365	84	NA	13696	3150
Station EA	08/23/90	6-90	Peconic River	0	Chain Pickerel	0.20	8235	1647	1585	14280	2964
Station HM	08/22/90	7-90	Peconic River	0.8	Brown Bullhead	0.18	2856	514	452	5172	931
Donahue's Pond	08/23/90	10-90	Peconic	10.0	Yellow Perch	0.29	728	211	149	5345	1550
	08/22/90	11-90	Peconic	10.0	Golden Shiner	0.25	716	179	117	8848	2212
	08/21/90	17-90	Peconic	10.0	Chain Pickerel	0.25	1848	462	400	8752	2188
Forge Pond	08/23/90	8-90	Peconic	20.0	Brown Bullhead	0.21	933	196	134	10433	2191
	08/21/90	12-90	Peconic	20.0	Black Crappie	0.25	824	206	144	7900	1975
	08/21/90	13-90	Peconic	20.0	Blue Gill	0.24	1258	302	240	5333	1280
	08/21/90	26-90	Peconic	20.0	Golden Shiner	0.27	552	149	87	8296	2240
	08/21/90	26-90	Peconic	20.0	Golden Shiner	0.24	733	176	114	14479	2755
	11/08/90	24-90	Peconic	20.0	Fresh Water Clams[d]	0.17	300	51	NA	1870	318
	11/08/90	25-90	Peconic	20.0	Fresh Water Clams[d]	0.21	324	68	NA	1448	304

ND: Not detected.
NA: Not applicable.
(a) Introduced into Carmans River from upstate hatchery - not endemic.
(b) Excluded from determining net activity as the American Eel is not endemic to Long Island. It is a transatlantic migratory fish, which means that it has picked up radionuclides from the Atlantic Ocean.
(c) Migratory fish - Peconic River to Swan Pond.
(d) Filter feeders - No biomagnification seen for ^{137}Cs.

Note: Background concentration values based on radionuclide activity in endemic and nonmigratory fish.

Table 40
BNL Site Environmental Report for Calendar Year 1990
On-site Potable and Cooling Water Radionuclide Concentration Data

Sample Location	Sample Date	Gross Alpha	Gross Beta	Tritium	Be-7	Cs-137	K-40	Ra-226	Na-22	Co-60	Sr-90
		<----------				pCi/L					---------->
F1 (WTP-IN)	20-Feb-90	0.51	0.79	-84	ND	ND	ND	ND	ND	ND	0.10
	23-Aug-90	0.31	0.49	-115	ND	ND	ND	ND	ND	ND	-0.17
	27-Nov-90	0.10	0.42	25	ND	ND	ND	ND	ND	ND	0.08
	Avg. Conc.	0.31	0.57	-58	ND	ND	ND	ND	ND	ND	0.00
F2 (WTP-OUT)	21-Feb-90	0.26	0.42	-160	ND	ND	ND	ND	ND	ND	0.12
F2	23-Aug-90	-0.05	0.08	26	ND	ND	ND	ND	ND	ND	-0.02
F2	27-Nov-90	0.05	0.42	-62	ND	ND	ND	ND	ND	ND	0.30
	Avg. Conc.	0.09	0.30	-65	ND	ND	ND	ND	ND	ND	0.13
FD	21-Feb-90	0.21	0.72	-222	ND	ND	ND	ND	ND	ND	-0.04
FD	23-Aug-90	0.05	0.15	-63	ND	ND	ND	ND	ND	ND	NR
	Avg. Conc.	0.13	0.43	-142	ND	ND	ND	ND	ND	ND	-0.02
FE	21-Feb-90	0.10	0.68	-18	ND	ND	ND	ND	ND	ND	-0.04
FF	21-Feb-90	0.77	1.10	-93	ND	ND	ND	ND	ND	ND	0.08
FF	23-Aug-90	-0.05	1.06	-84	ND	0.38	ND	ND	ND	ND	-0.05
FF	27-Nov-90	0.31	0.60	-12	ND	ND	ND	ND	ND	ND	NR
	Avg. Conc.	0.34	0.92	-63	ND	0.13	ND	ND	ND	ND	0.01
FG	21-Feb-90	0.56	0.34	-204	ND	ND	ND	ND	ND	ND	0.08
FG	23-Aug-90	0.15	0.15	-251	ND	ND	ND	ND	ND	ND	0.03
FG	27-Nov-90	1.48	-0.34	12	ND	ND	ND	ND	ND	ND	NR
	Avg. Conc.	0.73	0.05	-148	ND	ND	ND	ND	ND	ND	0.04
FQ	21-Feb-90	0.21	0.57	-244	33.5	0.10	ND	ND	ND	ND	0.04
FQ	23-Aug-90	0.00	0.23	-198	ND	ND	ND	ND	ND	ND	-0.06
FQ	27-Nov-90	0.26	-0.23	172	ND	ND	ND	ND	ND	ND	NR
	Avg. Conc.	0.15	0.19	-90	11.17	0.03	ND	ND	ND	ND	-0.01
NYS Drinking Water Standard		15	50	20000	(a)	(a)	(a)	5	(a)	(a)	8
DOE Order 5400.5, Drinking Water Guide		(a)	(a)	80000	40000	120	280	4	400	200	40
Typical MDL		0.53	1.2	300	-----	0.20	3.90	0.50	0.20	0.23	0.1

WTP-IN: Water Treatment Plant influent.
WTP-OUT: Water Treatment Plant effluent.
ND: Not detected.
NR: Result not reported from off-site Contractor Laboratory
MDL: Minimum detection limit
(a) No standard specified.
Note: DOE Order 5400.5 drinking water guide concentrations obtained by dividing DCGs by 25.

Table 41
BNL Site Environmental Report for Calendar Year 1990
Gross Alpha, Gross 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	21	0.414	-1.280	2.050	2.24	-8.31	8.50	-55	-987	689
(Bldg.	February	20	0.115	-1.280	1.540	1.87	-3.78	5.29	-115	-523	485
535B	March	23	0.466	-1.540	3.070	2.42	-0.57	5.67	-458	-2100	596
Potable	April	22	0.326	-1.790	1.540	1.62	-1.13	4.72	-242	-2020	3360
Water)	May	23	0.289	-1.020	2.300	4.21	-3.02	28.70	-158	-2630	868
	June	22	-0.082	-2.050	1.280	1.88	-3.02	5.10	-54	-560	598
	July	21	0.391	-1.540	1.790	2.99	-0.94	6.80	96	-888	1290
	August	22	-0.012	-1.280	1.540	2.25	-1.51	5.48	82	-701	1750
	September	19	0.633	-0.510	2.820	1.11	-2.64	4.72	-25	-643	530
	October	23	0.089	-1.020	2.560	1.98	-1.51	13.20	-138	-1190	693
	November	19	0.312	-1.280	2.050	2.33	0.00	7.37	576	-711	10800
	December	19	0.363	-1.280	1.790	2.86	-2.83	5.67	-183	-1150	555
	Avg. Conc. (254 Measurements)		0.270	-2.050	3.070	2.33	-8.31	28.70	-65	-2630	10800
ZB	January	21	0.341	-1.790	2.300	0.78	-7.93	5.85	-224	-1240	357
(Dist.	February	20	-0.320	-2.560	1.020	-0.51	-4.72	2.83	-219	-908	414
Water)	March	22	0.023	-1.020	1.020	0.70	-4.53	5.29	-434	-2030	1150
	April	21	0.206	-1.540	1.790	0.56	-3.21	5.10	-327	-2190	1720
	May	22	0.186	-1.020	1.280	2.88	-4.53	31.70	-195	-2290	683
	June	21	-0.074	-2.050	1.020	0.80	-5.67	3.59	-124	-620	594
	July	21	0.134	-2.050	2.050	0.76	-4.34	6.80	16	-579	533
	August	22	-0.233	-1.790	0.768	0.45	-3.40	5.10	189	-589	4660
	September	19	0.121	-0.770	0.768	0.60	-5.10	3.78	4	-662	805
	October	23	0.178	-1.020	1.790	0.60	-4.16	6.04	-32	-1150	706
	November	19	0.066	-1.280	1.790	0.93	-2.08	5.29	74	-656	2140
	December	19	0.175	-1.280	1.790	0.78	-2.64	3.02	-95	-663	1590
	Avg. Conc. (250 Measurements)		0.067	-2.560	2.300	0.79	-7.93	31.70	-113	-2290	4660
Typical MDL			2			5.70			1300		

MDL: Minimum detection limit.

Table 42
BNL Site Environmental Report for Calendar Year 1990
Potable Water and Process Supply Wells
Water Quality Data

Well ID	No. of Samples	pH (SU)	Conductivity Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
			(umhos/cm)			<--- mg/L								--->
WTP-IN	3	5.7 - 8.5	98	88	104	18.0	13.7	22.8	9.7	8.9	10.2	<1.0	<1.0	<1.0
WTP-EFF	3	6.5 - 9.1	117	115	119	18.3	14.6	21.8	9.7	9.2	10.0	<1.0	<1.0	<1.0
4 (FD)	2	5.9 - 6.3	100	93	106	15.2	13.5	16.9	10.4	10.3	10.5	<1.0	<1.0	<1.0
6 (FF)	3	5.8 - 7.2	114	91	134	19.0	18.0	20.2	11.4	10.5	12.1	<1.0	<1.0	<1.0
7 (FG)	3	6.1 - 7.7	90	84	102	13.6	12.5	14.7	9.0	8.8	9.3	<1.0	<1.0	<1.0
12 (FQ)	3	6.3 - 7.9	115	112	121	15.0	13.5	16.7	11.4	10.8	12.4	<1.0	<1.0	<1.0
5 (FE)	1	5.8	39	---	---	6.6	---	---	7.9	---	---	<1.0	---	---
NYS Drinking Water Standards		6.5 - 8.5	(a)			250.0			250.0			10.0		
Typical MDL		---	10			4.0			4.0			1.0		

MDL: Minimum detection limit.
(a) No standard specified.

Table 43
BNL Site Environmental Report for Calendar Year 1990
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. 12 (FQ)	Well No. 105 (FL)	NYS Drinking Water Standard	Typical MDL
	mg/L									
No. of Samples[a]	3 (1)	3 (2)	2 (1)	1 (0)	3 (2)	3 (2)	3 (2)	1 (1)		
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.001	0.05	0.025
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	0.01	0.0005
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	0.005
Cu	<0.05	<0.05	<0.05	<0.05	0.02	<0.05	<0.05	0.09	1.0	0.05
Fe	1.89	0.13	2.07	0.13	2.88	1.80	<0.075	0.24	0.3	0.075
Hg	<0.0002	<0.0002	<0.0002	NA	<0.0002	<0.0002	<0.0002	<0.00025	0.002	0.0002
Mn	0.09	<0.05	0.14	<0.05	0.06	0.07	<0.05	0.02	0.3	0.05
Na	10.3	9.9	10.0	3.3	11.6	9.1	12.6	13.0	(b)	1.0
Pb	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.050	0.005
Zn	<0.02	<0.02	<0.02	0.11	<0.02	<0.02	0.01	0.06	5.0	0.02

WTP-IN: Water Treatment Plant influent.
WTP-EFF: Water Treatment Plant effluent.
MDL: Minimum detection limit.
NA: Not analyzed.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 44
BNL Site Environmental Report for Calendar Year 1990
Potable Water Wells
Average Halogenated Organic Compound Data

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 12 (FQ)	Typical MDL	NYS Drinking Water Standard
	<-------		µg/L			------->
Dichlorodifluoromethane	ND	0.5	0.2	ND	0.5	5.
Chloromethane	ND	ND	ND	ND	0.5	5.
Vinyl Chloride	ND	ND	ND	ND	0.5	2.
Bromomethane	ND	ND	ND	ND	0.5	5.
Chloroethane	ND	ND	ND	ND	0.5	5.
Fluorotrichloromethane	ND	ND	ND	ND	0.5	5.
1,1-dichloroethene	1.0	ND	ND	ND	0.5	5.
Dichloromethane	ND	ND	ND	ND	0.5	5.
trans-1,2-dichloroethene	ND	ND	ND	ND	0.5	5.
1,1-dichloroethane	ND	ND	ND	ND	0.5	5.
cis-1,2-dichloroethene	ND	ND	ND	ND	0.5	5.
2,2-dichloropropane	ND	ND	ND	ND	0.5	5.
Bromochloromethane	ND	ND	ND	ND	0.5	5.
Chloroform	2.4	3.0	ND	ND	0.5	100.
1,1,1-trichloroethane	4.8	1.4	ND	1.1	0.5	5.
Carbon Tetrachloride	ND	ND	ND	ND	0.5	5.
1,1-dichloropropene	ND	ND	ND	ND	0.5	5.
1,2-dichloroethane	ND	ND	ND	ND	0.5	5.
1,1,2-trichloroethene	ND	0.8	ND	ND	0.5	5.
1,2-dichloropropane	ND	ND	ND	ND	0.5	5.
Dibromomethane	ND	ND	ND	ND	0.5	5.
trans-1,3-dichloropropene	ND	ND	ND	ND	0.5	5.
cis-1,3-dichloropropene	ND	ND	ND	ND	0.5	5.
1,1,2-trichloroethane	ND	ND	ND	ND	0.5	5.

Table 44 (Continued)
BNL Site Environmental Report for Calendar Year 1990
Potable Water Wells
Average Halogenated Organic Compound Data

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 12 (FQ)	Typical MDL	NYS Drinking Water Standard
	<-------------		µg/L			------------->
1,1,2,2-tetrachloroethene	ND	ND	ND	ND	0.5	5.
1,3-dichloropropane	ND	ND	ND	ND	0.5	5.
Chlorobenzene	ND	ND	ND	ND	0.5	5.
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	0.5	5.
Bromobenzene	ND	ND	ND	ND	0.5	5.
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	0.5	5.
1,2,3-trichloropropane	ND	ND	ND	ND	0.5	5.
2-chlorotoluene	ND	ND	ND	ND	0.5	5.
4-chlorotoluene	ND	ND	ND	ND	0.5	5.
1,3-dichlorobenzene	ND	ND	ND	ND	0.5	5.
1,4-dichlorobenzene	ND	ND	ND	ND	0.5	5.
1,2-dichlorobenzene	ND	ND	ND	ND	0.5	5.
1,2,4-trichlorobenzene	ND	ND	ND	ND	0.5	5.
Hexachlorobutadiene	ND	ND	ND	ND	0.5	5.
1,2,3-trichlorobenzene	ND	ND	ND	ND	0.5	5.

ND: Not detected.
MDL: Minimum detection limit.
Note: All potable wells were analyzed quarterly during the year by a NYS certified contract Laboratory.

Table 45
BNL Site Environmental Report for Calendar Year 1990
Potable Water Wells
Average Non-Halogenated Organic Compound Data

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 12 (FQ)	Typical MDL	NYS Drinking Water Standards
	<------------	------------	------------	μg/L	------------	------------>
Benzene	ND	ND	ND	ND	0.5	5.
Toluene	ND	ND	ND	ND	0.5	5.
Ethylbenzene	ND	ND	ND	ND	0.5	5.
m-xylene	ND	ND	ND	ND	0.5	5.
p-xylene	ND	ND	ND	ND	0.5	5.
o-xylene	ND	ND	ND	ND	0.5	5.
Styrene	ND	ND	ND	ND	0.5	5.
Isopropylbenezene	ND	ND	ND	ND	0.5	5.
n-propylbenzene	ND	ND	ND	ND	0.5	5.
1,3,5-trimethylbenzene	ND	ND	ND	ND	0.5	5.
tert-butylbenzene	ND	ND	ND	ND	0.5	5.
1,2,4-trimethylbenzene	ND	ND	ND	ND	0.5	5.
sec-butylbenzene	ND	ND	ND	ND	0.5	5.
p-isopropyltoluene	ND	ND	ND	ND	0.5	5.
n-butylbenzene	ND	ND	ND	ND	0.5	5.

ND: Not detected.
MDL: Minimum detection limit.
Note: All potable wells were analyzed quarterly during the year by a NYS certified contract Laboratory.

Table 46
BNL Site Environmental Report for Calendar Year 1990
Potable Water and Supply Wells
Chlorocarbon Data

Well ID	No. of Samples[a]		TCA	TCE	PCE	DCA	DCE	Chloroform
			<-----	-----	-----	μg/L	-----	----->
WTP-IN	2(1)	Avg:	ND	ND	ND	ND	ND	ND
		Min:	--	ND	ND	ND	ND	ND
		Max:	--	ND	ND	ND	ND	ND
WTP-EFF	2(1)	Avg:	ND	ND	ND	ND	ND	5.
		Min:	--	ND	ND	ND	ND	4.
		Max:	--	ND	ND	ND	ND	6.
4 (FD)	1(0)	Avg:	NA	ND	ND	ND	ND	3.
		Min:	--	--	--	--	--	--
		Max:	--	--	--	--	--	--
6 (FF)	2(1)	Avg:	ND	ND	ND	ND	ND	19.
		Min:	--	ND	ND	ND	ND	ND
		Max:	--	ND	ND	ND	ND	37.
7 (FG)	2(1)	Avg:	ND	ND	ND	ND	ND	ND
		Min:	--	ND	ND	ND	ND	ND
		Max:	--	ND	ND	ND	ND	ND
12 (FC)	2(1)	Avg:	ND	ND	ND	ND	ND	ND
		Min:	--	ND	ND	ND	ND	ND
		Max:	--	ND	ND	ND	ND	ND
5 (FE)	1(0)	Avg:	NA	ND	ND	ND	ND	ND
		Min:	--	--	--	--	--	--
		Max:	--	--	--	--	--	--
104 (FK)	1(1)	Avg:	ND	ND	ND	ND	ND	ND
		Min:	--	--	--	--	--	--
		Max:	--	--	--	--	--	--
105 (FL)	1(1)	Avg:	31.	0.5	ND	1.	7.	2.
		Min:	--	---	--	--	--	--
		Max:	--	---	--	--	--	--
NYS Drinking Water Standards			5.	5.	5.	5.	5.	100.
Typical MDL			2.	2.	2.	2.	2.	2.

WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.
ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene

(a) Number inside parenthesis represents the number of TCA samples analyzed; number outside parenthesis represents the number of samples analyzed for all other parameters.

Table 47
BNL Site Environmental Report for Calendar Year 1990
Potable Water and Supply Wells,
BTX Data

Well ID	No. of Samples[a]		benzene	ethyl-benzene	toluene	o-xylene
			<----------------	µg/L	----------------	---->
WTP-IN	2(1)	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	--
		Max:	ND	ND	ND	--
WTP-EFF	2(1)	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	--
		Max:	ND	ND	ND	--
4 (FD)	1(0)	Avg:	ND	ND	ND	NA
		Min:	--	--	--	--
		Max:	--	--	--	--
6 (FF)	2(1)	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	--
		Max:	ND	ND	ND	--
7 (FG)	2(1)	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	--
		Max:	ND	ND	ND	--
12 (FQ)	2(1)	Avg:	ND	ND	ND	ND
		Min:	ND	ND	ND	--
		Max:	ND	ND	ND	--
5 (FE)	1(0)	Avg:	ND	ND	ND	NA
		Min:	--	--	--	--
		Max:	--	--	--	--
104 (FK)	1(1)	Avg:	ND	ND	ND	ND
		Min:	--	--	--	--
		Max:	--	--	--	--
105 (FL)	1(0)	Avg:	ND	ND	ND	NA
		Min:	--	--	--	--
		Max:	--	--	--	--
NYS Drinking Water Standards			5.	5.	5.	5.
Typical MDL			2.	2.	2.	2.

WTP-IN: Water Treatment Plant influent.
WTP-EFF: Water Treatment Plant effluent.
ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents the number of o-xylene samples analyzed; number outside parenthesis represents the number of samples analyzed for all other parameters.

Table 48
BNL Site Environmental Report for Calendar Year 1990
Monitoring Well Identification Cross Reference

Area Loc.	Old Well ID	New Well ID	Reg. Compl. *if yes	Scheduled Sampling Frequency per Year
CSF AREA				
MPF LIC.	66-08	66-08	*	12
	76-16	76-16	*	12
	76-17	76-17	*	12
	76-18	76-18	*	12
	76-19	76-19	*	12
1977	D13	76-02		2
SPILL	D14	76-07		2
	D15	76-09		2
	IT1	76-04		2
	IT2	76-06		2
	IT3	76-10		2
	IT4	76-08		2
	IT5	76-05		2
	76-20	76-20		2
	76-21	76-21		2
	76-22	76-22		2
BLDG. 830				
	66-07	66-07		3
	66-08	66-08	*	12
	66-09	66-09		3
OLD LF & CHEM DUMPS				
	D1	97-05		3
	D2	97-01		3
	D3	97-02		3
	D4	96-04		3
	D5	96-02		3
	D6	97-03		3
	D7	105-01		3
	D16	96-03		3
	D18	106-04		3
	D19	106-02		3
	D20	104-01		3
	2A	107-01		3
	115-01	115-01		3
	115-02	115-02		3
	115-03	115-03		3
MEADOW MARSH				
	SD	100-02		3
	69-02	69-02		3
	70-01	70-01		3
	89-01	89-01		3
	90-01	90-01		3
	100-03	100-03		3
650 SUMP				
	2Z	77-01		3
PGA & NSLS				
	75-01	75-01		3
	75-02	75-02		3
	75-03	75-03		3
	75-04	75-04		3
WEST SITE				
	72-01	72-01		3
	83-01	83-01		3
	83-02	83-02		3
	84-01	84-01		3
	101-01	101-01		3
	102-04	102-04		3
	102-05	102-05		3
LINAC				
	2G	54-03		1
CURRENT LF				
	WR	87-03	*	4
	WS	87-05	*	4
	WT	88-02	*	4
	W6	88-01	*	4
	W9	87-10	*	4
	1K	87-08	*	4
	2B	98-25		4
	2C	87-11	*	4
	2D	87-12		4
	2H	98-07		4
	2K	98-01		4
	562	88-12		4
	563	88-13		4
	564	88-14		4
	565	88-15		4
	77-02	77-02		4
	77-03	77-03		4
	77-04	77-04		4
	97-14	97-14		4
	98-33	98-33		4
	98-34	98-34		4
	107-07	107-07		4
	107-08	107-08		4
	107-09	107-09		4
PR OFFSITE				
	X2	61-02		4
	X4	NO ID		4
	80-02	80-02		4
	80-03	80-03		4
HWMA				
	MW1	88-03		3
	MW2	88-04		3
	MW3	98-05		3
	MW4	98-20		3
	MW5	98-19		3
	MW6	98-17		3
	MW7A	98-29		3
	MW7B	98-31		3
	MW8	108-03		3
	MW10	108-12		3
	MW11	108-08		3
	MW12	108-05		3
	MW13	108-01		3
	W1	98-16		2
	W2	98-04		2
	W3	99-01		2
	W7	99-02		2
	W8	98-24		2
	WC	98-02		2
	WI	98-09		2
	WK	98-21		2
	WL	98-12		2
	WN	88-05		2
	2L	98-18		2
	2M	98-22		2
	2N	98-27		2
	D17	108-07		3
	99-04	99-04		3
	99-05	99-05		3
	99-06	99-06		3
	107-10	107-10		3
	108-13	108-13		3
	108-14	108-14		3
AGS & WCF				
	556	54-05		3
	557	54-06		3
	558	44-04		3
	559	44-05		3
	63-01	63-01		3
	64-01	64-01		3
	65-01	65-01		3
	65-07	65-07		3
	D8	65-01		3
	D9	65-02		3
	D10	65-03		3
	D11	65-04		3
	D12	65-05		3
CONTROLS				
	SA	57-01		3
NORTH GATE & RHIC				
	560	25-01		3
	561	25-02		3
	IT1S	NO ID		3
	IT1D	NO ID		3
	IT2S	NO ID		3
	IT2D	NO ID		3
	12-01	12-01		3
	18-01	18-01		3
	18-02	18-02		3
	18-03	18-03		3
	37-01	37-01		3
SOUTH BOUNDARY				
	118-01	118-01		3
	118-02	118-02		3
	122-01	122-01		3
	122-02	122-02		3
	130-01	130-01		3
	130-02	130-02		3
PR ONSITE AND NE SITE				
	XB	47-01		3
	XC	47-02		3
	XE	39-03		3
	XF	30-01		3
	XJ	39-04		3
	XL	40-06		3
	XO	31-01		3
	XP	NO ID		3
	XQ	NO ID		3
	XX	40-02		3
	XY	40-04		3
	X3	40-03		3
	22-01	22-01		3
	38-01	38-01		3
	39-05	39-05		3
	40-08	40-08		3
	40-09	40-09		3
	47-03	47-03		3
	49-04	49-04		3
	58-01	58-01		3
	60-01	60-01		3
	60-02	60-02		3
	61-03	61-03		3
	61-04	61-04		3
	61-05	61-05		3

Table 49
BNL Site Environmental Report for Calendar Year 1990
Radionuclide Concentrations in Field Blank Samples

Month	Gross Alpha	Gross Beta	Tritium	K-40	Ra-226	Th-228	Cs-137	Sr-90
	<------	------	------	pCi/L	------	------	------	------>
January	0.10	0.15	49	ND	ND	ND	ND	0.19
February	-0.10	-0.42	408	ND	ND	ND	ND	-0.11
March	-0.10	0.08	135	ND	ND	ND	ND	-0.08
April	0.10	0.83	16	ND	0.93	ND	ND	-0.30
May	0.10	-0.07	-155	NA	NA	NA	NA	-0.12
June	-0.20	-0.87	55	ND	ND	ND	ND	-0.17
July	0.15	-0.60	16	ND	ND	ND	ND	0.14
August	-0.15	0.19	54	38.5	ND	ND	ND	0.07
September	0.15	-0.11	308	ND	ND	ND	ND	-0.02
October	0.00	0.30	126	ND	ND	ND	ND	NR
November	NA	NA	NA	2.8	ND	ND	ND	NR
December	0.00	0.64	149	NA	NA	NA	NA	NR
Average	0.01	0.01	97	3.4	0.1	0.0	0.0	-0.03
Minimum	-0.20	-0.87	-155	2.8	0.0	0.0	0.0	-0.30
Maximum	0.15	0.83	408	38.5	0.9	0.0	0.0	0.19
Typical MDL	0.53	1.20	300	3.9	0.5	0.43	0.2	0.1

ND: Not detected.
NA. Not analyzed.
NR: Not reported.
MDL: Minimum detection limit.

Table 50
BNL Site Environmental Report for Calendar Year 1990
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

All concentrations in pCi/L.

Area	Sample New ID.	Location Old ID.	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.	Be-7 Avg.	Be-7 Min.	Be-7 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.	K-40 Avg.	K-40 Min.	K-40 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
Meadow Marsh Upland Recharge	89-01	89-01	2	-0.05	-0.10	0.00	0.98	0.83	1.13	204.00	169.00	239.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17	-0.07	0.41
	90-01	90-01	2	0.10	0.05	0.15	2.10	1.74	2.46	265.70	90.40	441.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.08	-0.08	-0.08
Peconic River On-Site	38-01	38-01	2	0.31	0.10	0.51	1.45	0.94	1.96	-58.50	-280.00	163.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.60	0.60	0.60
	39-05	39-05	1	0.15	----	----	3.06	----	----	273.00	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	----	----
	40-02	XX	1	0.05	----	----	3.70	----	----	-6.81	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	----	----
	47-01	XB	1	-0.05	----	----	2.61	----	----	-68.10	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	----	----
	47-02	XC	1	0.05	----	----	1.74	----	----	2160.00	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	----	----
Peconic River Off-Site	X4	X4	1	0.05	----	----	5.63	----	----	1770.00	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	1.94	----	----
NYS Drinking Water Standard				15			50			20000			(a)			(a)			(a)			(a)			(a)			8		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water				(a)			(a)			80000			40000			400			200			120			280			40		
Typical MDL				0.53			1.2			300			1.6			0.2			0.23			0.2			3.9			0.1		

ND: Not detected.
NR: Not reported.
MDL: Minimum detection limit.
(a) Standard not specified.

Table 51
BNL Site Environmental Report for Calendar Year 1990
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.	Cs-137 Avg.	K-40 Avg.	Sr-90 Avg.
		<------						pCi/L					------>
1	1	0.00	----	----	0.19	----	----	195	---	---	NA	NA	NA
2	4	0.15	-0.15	0.51	0.35	0.26	0.45	-5	-162	87	ND	ND	3.1[a]
3	3	0.10	-0.15	0.41	0.29	0.04	0.42	41	-37	161	ND	ND	-0.2
4	1	0.15	----	----	0.53	----	----	-37	---	---	NA	NA	NA
5	3	-0 08	-0.31	0.26	0.23	-0.53	0.64	-30	-147	137	NA	NA	0.2
6	3	-0.14	-0.26	-0.05	0.63	0.38	0.82	9	-121	100	NA	NA	0.0
7	4	0.41	0.05	0.97	1.78	1.06	2.91	1778	1150	2140	ND	ND	-0.3
8	1	-0.10	----	----	1.55	----	----	-205	---	---	NA	NA	NA
9	1	0.26	----	----	0.42	----	----	146	---	---	NA	NA	NA
10	1	0.10	----	----	0.91	----	----	-105	---	---	NA	NA	NA
11	4	-0.05	-0.20	0.10	1.26	0.19	2.80	-18	-121	161	ND	ND	0.1
12	2	0.23	0.10	0.36	1.49	0.98	2.00	29	19	40	ND	ND	-0.1
13	4	0.02	-0.31	0.21	0.30	-0.30	0.76	-78	-184	130	ND	1.4	0.0
14 (PR)	4	0.22	0.15	0.31	1.97	1.78	2.12	156	56	291	ND	ND	0.3
15 (PR)	4	0.01	-0.26	0.15	1.13	0.34	2.83	-28	-142	124	ND	ND	0.1
16 (PR)	4	0.10	-0.05	0.36	3.69	2.15	5.97	1034	416	2380	1.6	1.2	0.6
17	2	0.38	0.31	0.46	2.38	2.19	2.57	30	-58	118	ND	ND	NA
18	4	0.10	0.00	0.26	0.66	-0.42	1.59	17	-13	53	ND	2.9	-0.2
19	4	0.18	-0.05	0.72	0.74	0.04	1.47	-108	-226	-35	ND	ND	0.0
20	3	0.14	0.05	0.26	2.87	1.70	4.31	-63	-226	143	ND	ND	0.1
21	2	0.23	0.00	0.46	1.30	0.57	2.04	105	-70	279	ND	ND	NA
22	3	0.17	0.00	0.36	1.46	-0.11	2.27	-63	-177	13	ND	1.9	NA
23	4	0.12	-0.15	0.31	4.62	1.17	13.40	2255	1380	3300	ND	2.2	-0.2
NYS Drinking Water Standard		15.			50.			20000			(b)	(b)	8.
Typical MDL		0.53			1.2			300			0.2	3.9	0.1

PR: Peconic River sampling point.
NA: Not analyzed.
ND: Not detected.
MDL: Minimum detection limit.
(a) Sr-90 result is elevated due to poor chemical recovery. This result has an error of 3.8 pCi/L and is less than MDL.
(b) Standard not specified.

Table 52

BNL Site Environmental Report for Calendar Year 1990

Radionuclide Concentrations in Ground Water - Northeast Sector, West Sector, and South Boundary of the BNL Site

Area	Sample New ID.	Location Old ID.	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								
North Boundary	18-01	18-01	3	0.22	0.05	0.41	1.59	1.02	2.34	58.77	0.00	146.00
	18-02	18-02	3	0.07	-0.26	0.45	0.57	0.30	1.10	117.53	18.20	298.00
	18-03	18-03	3	0.29	0.00	0.66	1.03	0.68	1.36	109.51	-6.08	280.00
	25-01	560	3	0.22	0.00	0.46	0.15	-0.45	0.45	92.10	60.60	133.00
	25-02	561	3	0.07	-0.15	0.31	0.72	-0.19	1.32	275.00	152.00	407.00
Army Landfill	53-01	IT1S	3	-0.09	-0.26	0.05	1.05	0.53	1.55	39.53	-36.40	141.00
	53-02	IT1D	1	-0.05	----	----	1.21	----	----	84.20	------	------
	53-03	IT2S	3	-0.07	-0.15	0.00	0.84	0.11	1.32	103.11	-4.67	192.00
	53-04	IT2D	3	0.15	0.05	0.31	0.79	0.38	1.21	51.30	-149.00	292.00
AGS	44-04	558	2	0.18	0.05	0.31	0.68	0.53	0.83	-74.50	-364.00	215.00
	44-05	559	2	0.23	-0.10	0.56	2.45	2.19	2.72	25.00	-262.00	312.00
	54-05	556	1	0.05	----	----	2.46	----	----	-196.00	------	------
	54-06	557	1	0.00	----	----	1.02	----	----	51.40	------	------
Building 811	65-02	D9	1	-0.31	-0.31	-0.31	4.61	4.61	4.61	472.00	472.00	472.00
	65-03	D10	1	0.00	0.00	0.00	2.12	2.12	2.12	327.00	327.00	327.00
	65-04	D11	1	-0.21	-0.21	-0.21	1.44	1.44	1.44	472.00	472.00	472.00
West Side of Site	83-02	83-02	1	0.82	----	----	0.68	----	----	-36.80	------	------
	101-01	101-01	2	0.26	0.10	0.41	0.90	0.68	1.13	61.53	6.06	117.00
South Boundary	130-01	130-01	3	0.09	0.00	0.15	0.64	0.60	0.68	16.53	-102.00	127.00
	130-02	130-02	4	1.19	0.00	2.76	5.13	0.53	11.70	10.35	-159.00	158.00
NYS Drinking Water Standard				15			50			20000		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water				(a)			(a)			80000		
Typical MDL				0.53			1.2			300		

Area	Sample New ID.	Be-7 Avg.	Be-7 Min.	Be-7 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.	K-40 Avg.	K-40 Min.	K-40 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
		pCi/L →																	
North Boundary	18-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	0.00	0.14	0.00	0.00	0.00	0.14	-0.19	0.47
	18-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	4.73	0.00	11.50	-0.01	-0.02	-0.01
	18-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	5.03	0.00	15.10	-0.10	-0.20	0.01
	25-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.05	-0.07	0.17
	25-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.06	0.02
Army Landfill	53-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.00	-0.03	0.02
	53-02	ND	--	--	ND	--	--	ND	--	--	ND	--	--	14.90	--	--	-0.09	----	----
	53-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.18	ND	0.54	ND	ND	ND	-0.07	-0.20	0.06
	53-04	0.77	ND	2.30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.20	0.16	0.24
AGS	44-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.09	0.00	0.18
	44-05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.13	ND	0.26	ND	ND	ND	0.43	0.12	0.75
	54-05	ND	--	--	ND	--	--	ND	--	--	ND	--	--	3.47	--	--	0.99	----	----
	54-06	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	0.06	----	----
Building 811	65-02	[illegible]	ND	ND	5.43	5.43	5.43	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.15	1.15	1.15
	65-03	[illegible]	ND	ND	1.86	1.86	1.86	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.85	0.85	0.85
	65-04	ND	ND	ND	0.68	0.68	0.68	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17	0.17	0.17
West Side of Site	83-02	ND	--	--	ND	--	--	ND	--	--	ND	--	--	40.50	--	--	-0.03	----	----
	101-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.03	-0.03	-0.03
South Boundary	130-01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.03	-0.10	0.05
	130-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.11	-0.17	-0.04
NYS Drinking Water Standard		(a)			(a)			(a)			(a)			(a)			8		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water		40000			400			200			120			280			40		
Typical MDL		1.6			0.2			0.23			0.2			3.9			0.1		

ND: Not detected.
MDL: Minimum detection limit.
(a) Standard not specified.

Table 53
BNL Site Environmental Report for Calendar Year 1990
Radionuclide Concentrations in Ground Water within the Central Part of the BNL Site

Area	Sample New ID.	Location Old ID.	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								
Building 830	66-07	66-07	2	0.13	0.05	0.21	0.83	0.83	0.83	180.30	45.60	315.00
	66-08	66-08	3	-0.08	-0.15	0.00	0.87	-0.04	1.47	30.00	-165.00	129.00
	66-09	66-09	2	0.05	0.00	0.10	1.15	0.68	1.62	210.50	205.00	216.00
Major Petro. Facility	76-16	76-16	2	1.31	-0.10	2.71	6.03	1.36	10.70	-45.30	-62.70	-27.90
	76-17	76-17	2	-0.15	-0.20	-0.10	1.77	1.21	2.34	-150.00	-177.00	-123.00
	76-18	76-18	2	0.10	0.05	0.15	2.76	1.44	4.08	-2.15	-72.70	68.40
	76-19	76-19	2	-0.15	-0.20	-0.10	0.79	0.38	1.21	4.75	-35.20	44.70
Central Steam Facility	76-02	D13	1	-0.05	----	----	0.98	----	----	-58.70	-----	-----
	76-04	IT1	1	0.15	----	----	1.10	----	----	-188.00	-----	-----
	76-05	IT5	1	0.10	----	----	2.15	----	----	188.00	-----	-----
	76-06	IT2	1	0.41	----	----	2.12	----	----	207.00	-----	-----
	76-07	D14	1	-0.05	----	----	0.87	----	----	48.60	-----	-----
	76-08	IT4	1	0.31	----	----	1.17	----	----	-29.30	-----	-----
	76-09	D15	1	0.00	----	----	1.74	----	----	-34.20	-----	-----
	76-10	IT3	1	-0.15	----	----	1.85	----	----	176.00	-----	-----
	76-20	76-20	2	0.03	-0.10	0.15	1.30	1.17	1.44	-8.80	-17.60	0.00
	76-21	76-21	2	-0.05	-0.10	0.00	1.13	0.26	2.00	-44.35	-118.00	29.30
	76-22	76-22	2	0.10	0.10	0.10	1.06	0.83	1.28	101.10	35.20	167.00
Photo. & Graph. Arts	75-03	75-03	2	0.08	0.00	0.15	0.93	0.87	0.98	11.40	10.50	12.30
	75-04	75-04	3	0.36	0.21	0.56	0.31	-0.42	0.91	7.23	-153.00	187.00
NYS Drinking Water Standard				15			50			20000		
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(a)			(a)			80000		
Typical MDL				0.53			1.2			300		

Sample New ID.	Be-7 Avg.	Be-7 Min.	Be-7 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.	K-40 Avg.	K-40 Min.	K-40 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
	pCi/L ---->																	
66-07	ND	ND	ND	ND	ND	ND	0.18	ND	0.36	ND	ND	ND	ND	ND	ND	-0.23	-0.23	-0.23
66-08	ND	ND	ND	ND	ND	ND	0.08	ND	0.25	ND	ND	ND	ND	ND	ND	0.02	-0.13	0.17
66-09	ND	ND	ND	ND	ND	ND	0.17	ND	0.33	ND	ND	ND	ND	ND	ND	0.07	0.07	0.07
76-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.23	ND	6.45	0.38	0.38	0.38
76-17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.31	0.31	0.31
76-18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.02	1.02	1.02
76-19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-1.39	-1.39	-1.39
76-02	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
76-04	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
76-05	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
76-06	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NR	--	--
76-07	ND	--	--	ND	--	--	0.15	--	--	ND	--	--	ND	--	--	NR	--	--
76-08	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
76-09	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
76-10	ND	--	--	ND	--	--	ND	--	--	ND	--	--	3.70	--	--	0.18	--	--
76-20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NR	NR	NR
76-21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR
76-22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR
75-03	ND	ND	ND	ND	ND	ND	0.14	ND	0.28	ND	ND	ND	ND	ND	ND	-0.18	-0.18	-0.18
75-04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.04	ND	0.11	ND	ND	ND	-0.13	-0.21	-0.05
NYS Drinking Water Standard	(a)			(a)			(a)			(a)			(a)			8		
DOE Order 5400.5 Derived Concentration Guide for Drinking Water	40000			400			200			120			280			40		
Typical MDL	1.6			0.2			0.23			0.2			3.9			0.1		

NA: Not analyzed.
ND: Not detected.
NR: Not reported.
MDL: Minimum detection limit.
(a) Standard not specified.

Table 54
BNL Site Environmental Report for Calendar Year 1990
Radionuclide Concentrations in Ground Water in the Vicinity of the Ashfill, Current Landfill, and Former Landfill

Area	Sample New ID.	Location Old ID.	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.	Be-7 Avg.	Be-7 Min.	Be-7 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.	K-40 Avg.	K-40 Min.	K-40 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
				<----	----	----	----	----	----	----	----	----	----	----	----	----	pCi/L	----	----	----	----	----	----	----	----	----	----	----	----	--->
Ashfill	104-01	D20	1	0.05	----	----	0.38	----	----	-190.00	------	------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
Old Landfill	96-02	D5	2	0.18	0.10	0.26	0.13	-0.38	0.64	12.00	-120.00	144.00	ND	ND	ND	ND	ND	ND	0.37	ND	0.74	ND	ND	ND	ND	ND	ND	0.06	0.06	0.06
	96-03	D16	2	0.23	-0.05	0.51	1.48	1.40	1.55	70.50	36.00	105.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.60	ND	3.20	-0.07	-0.07	-0.07
	96-04	D4	2	-0.03	-0.05	0.00	0.97	0.49	1.44	1160.50	211.00	2110.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.44	0.44	0.44
	97-01	D2	1	0.00	----	----	-0.15	----	----	13.60	-----	-----	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NR	--	--
	97-03	D6	2	-0.08	-0.10	-0.05	14.93	8.76	21.10	100.53	-9.93	211.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.13	5.13	5.13
	97-05	D1	2	0.03	-0.10	0.15	2.19	1.81	2.57	-14.05	-74.50	46.40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.00	ND	4.00	-0.03	-0.03	-0.03
	105-01	D7	2	0.08	0.05	0.10	1.15	0.83	1.47	154.00	124.00	184.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.25	0.25	0.25
	106-04	D18	2	0.08	0.05	0.10	0.72	0.49	0.94	-8.75	-51.50	34.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.06	-0.06	-0.06
	115-03	115-03	2	0.05	0.00	0.10	0.85	0.64	1.06	134.65	68.30	201.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.02	0.02	0.02
Current Landfill	87-03	WR	1	0.56	----	----	12.20	-----	-----	2490.00	-------	-------	ND	--	--	0.28	----	----	ND	--	--	0.42	----	----	13.70	----	----	1.94	----	----
	87-05	WS	1	0.05	----	----	17.30	-----	-----	1070.00	-------	-------	ND	--	--	0.62	----	----	ND	--	--	ND	----	----	17.60	----	----	3.04	----	----
	87-08	1K	3	0.55	0.31	0.77	14.40	10.80	17.10	18970.00	8810.00	33600.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.79	ND	8.38	2.79	2.09	3.49
	87-10	W9	3	0.58	0.41	0.66	10.49	8.76	11.70	6476.33	929.00	9810.00	ND	ND	ND	0.11	0.00	0.33	ND	ND	ND	ND	ND	ND	7.30	ND	11.80	2.06	1.82	2.29
	87-11	2C	3	0.34	0.10	0.61	17.13	14.80	18.40	6010.00	4870.00	7750.00	ND	ND	ND	0.06	0.00	0.18	ND	ND	ND	ND	ND	ND	12.27	ND	20.20	4.20	3.51	4.88
	88-01	W6	3	0.10	0.00	0.26	1.42	0.87	1.70	26.77	-75.20	92.80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.40	0.27	0.53
	88-02	WT	3	0.63	0.46	0.72	1.81	1.51	2.30	290.33	234.00	385.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.02	-0.07	0.03
	88-12	562	3	0.10	-0.10	0.26	0.68	0.57	0.83	6.57	-109.00	111.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.02	-0.10	0.07
	88-13	563	3	0.61	0.46	0.77	8.80	7.37	9.93	1177.33	712.00	1450.00	ND	ND	ND	0.30	0.00	0.90	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.63	0.17	1.09
	88-14	564	3	0.48	0.36	0.66	14.70	11.60	17.40	2784.00	12.00	5360.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.14	ND	0.41	5.97	ND	17.90	2.07	1.92	2.22
	88-15	565	3	0.15	0.05	0.26	1.50	0.91	2.34	870.67	656.00	1020.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.26	0.18	0.34
	97-14	97-14	1	0.56	----	----	2.68	----	----	-5.15	-----	-----	ND	--	--	ND	--	--	ND	--	--	ND	--	--	4.69	----	----	-0.05	----	----
	98-07	2H	1	-0.10	----	----	-0.34	----	----	1460.00	-----	-----	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	----	NR	----	----
	98-33	98-33	2	0.20	0.10	0.31	2.29	1.74	2.83	762.00	565.00	959.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.89	ND	9.57	0.16	0.16	0.16
	98-34	98-34	2	0.41	0.31	0.51	6.57	6.53	6.61	4550.00	4390.00	4710.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.45	ND	12.90	2.79	2.79	2.79
	107-07	107-07	2	0.46	0.15	0.77	2.99	2.83	3.14	1305.00	1260.00	1350.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00	-0.12	0.13
	107-08	107-08	1	0.26	----	----	1.25	----	----	2420.00	-------	-------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	3.40	--	----	-0.04	----	----
	107-09	107-09	1	0.10	----	----	0.30	----	----	1630.00	-------	-------	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	----	-0.19	----	----
NYS Drinking Water Standard				15			50			20000			(a)			(a)			(a)			(a)			(a)			8		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water				(a)			(a)			80000			40000			400			200			120			280			40		
Typical MDL				0.53			1.2			300			1.6			0.2			0.23			0.2			3.9			0.1		

NA: Not analyzed.
ND: Not detected.
NR: Not reported.
MDL: Minimum detection limit.
(a) Standard not specified.

Table 55

BNL Site Environmental Report for Calendar Year 1990

Radionuclide Concentrations in Ground Water in the Vicinity of the Hazardous Waste Management Area

Area	Sample New ID.	Location Old ID.	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								
Haz.	88-03	MW1	2	0.16	-0.15	0.46	2.40	1.93	2.87	1145.00	1090.00	1200.00
Waste	88-04	MW2	2	0.08	-0.10	0.26	40.35	36.90	43.80	3180.00	2320.00	4040.00
Manag.	98-02	WC	1	-0.10	----	----	20.90	-----	-----	4770.00	-------	-------
Area	98-05	MW3	1	0.36	----	----	1.40	-----	-----	1520.00	-------	-------
	98-17	MW6	2	-0.00	-0.26	0.26	0.66	0.53	0.79	1850.00	1740.00	1960.00
	98-19	MW5	1	0.21	----	----	4.95	-----	-----	1350.00	-------	-------
	98-20	MW4	1	0.00	----	----	3.29	-----	-----	1260.00	-------	-------
	98-21	WK	1	-0.05	----	----	4.23	-----	-----	1120.00	-------	-------
	98-22	ZM	1	-0.20	----	----	1.06	-----	-----	1250.00	-------	-------
	98-29	MW7A	2	0.28	0.26	0.31	12.84	0.68	25.00	1450.00	1220.00	1680.00
	98-31	MW7B	2	0.26	0.26	0.26	0.08	0.08	0.08	1610.00	1610.00	1610.00
	107-10	107-10	2	0.08	-0.05	0.21	-0.40	-0.42	-0.38	2440.00	1340.00	3540.00
	108-01	MW13	2	0.28	0.10	0.46	1.76	0.72	2.80	1504.00	668.00	2340.00
	108-03	MW8	2	0.18	-0.05	0.41	1.26	1.25	1.28	1715.00	1020.00	2410.00
	108-05	MW12	2	0.41	0.31	0.51	1.85	0.19	3.51	5380.00	2870.00	7890.00
	108-07	D17	2	-0.02	-0.10	0.05	0.19	-0.45	0.83	380.00	151.00	609.00
	108-08	MW11	2	0.10	-0.05	0.26	2.43	1.89	2.98	797.34	4.67	1590.00
	108-12	MW10	2	0.03	-0.15	0.21	3.25	3.06	3.44	875.00	620.00	1130.00
	108-13	108-13	2	0.08	0.00	0.15	2.66	2.64	2.68	653.50	644.00	663.00
	108-14	108-14	2	0.21	0.21	0.21	1.36	0.64	2.08	70.75	56.00	85.50
Spray Project Wells	108-02	PW3	3	0.24	0.15	0.41	1.26	0.42	2.08	1480.00	1290.00	1580.00
	108-09	PW4	3	0.08	-0.21	0.26	0.53	0.34	0.68	1038.33	915.00	1180.00
NYS Drinking Water Standard				15			50			20000		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water				(a)			(a)			80000		
Typical MDL				0.53			1.2			300		

Area	Sample New ID.	Be-7 Avg.	Be-7 Min.	Be-7 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.	K-40 Avg.	K-40 Min.	K-40 Max.	Sr-90 Avg.	Sr-90 Min.	Sr-90 Max.
		pCi/L ---->																	
Haz.	88-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NC	ND	ND	ND	1.11	1.06	1.16
Waste	88-04	ND	ND	ND	0.15	ND	0.29	0.55	0.48	0.63	ND	ND	ND	2.02	ND	4.84	60.61	45.13	76.10
Manag.	98-02	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	43.57	-----	-----
Area	98-05	ND	--	--	0.15	--	--	ND	--	--	ND	--	--	8.00	--	--	0.12	-----	-----
	98-17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.18	-0.30	-0.05
	98-19	ND	--	--	ND	--	--	ND	--	--	ND	--	--	3.41	--	--	3.77	-----	-----
	98-20	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	1.55	-----	-----
	98-21	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	2.85	-----	-----
	98-22	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	0.56	-----	-----
	98-29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	31.69	29.97	33.42
	98-31	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.84	ND	3.67	0.03	-0.08	0.14
	107-10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08	-0.01	0.17
	108-01	ND	ND	ND	0.13	ND	0.27	ND	ND	ND	ND	ND	ND	1.19	ND	2.38	0.10	-0.08	0.27
	108-03	ND	ND	ND	ND	NC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.10	-0.19	-0.02
	108-05	ND	ND	ND	0.13	ND	0.27	ND	ND	ND	ND	ND	ND	2.29	ND	4.57	-0.08	-0.18	0.02
	108-07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.43	ND	2.85	0.18	0.05	0.30
	108-08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.15	ND	4.29	-0.17	-0.17	-0.17
	108-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-0.10	-0.23	0.04
	108-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.00	ND	4.00	0.08	0.04	0.12
	108-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.03	0.01	0.05
Spray Project Wells	108-02	ND	ND	ND	0.15	0.15	0.15	ND	ND	ND	ND	ND	ND	7.26	7.26	7.26	0.12	0.12	0.12
	108-09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.08	0.08	0.08
NYS Drinking Water Standard		(a)			(a)			(a)			(a)			(a)			8		
DOE Order 5400.5 Derived Concentration Guide For Drinking Water		40000			400			200			120			280			40		
Typical MDL		1.6			0.2			0.23			0.2			3.9			0.1		

NA: Not analyzed.
ND: Not detected.
MDL: Minimum detection limit.
(a) Standard not specified.

Table 56
BNL Site Environmental Report for Calendar Year 1990
Peconic River Areas and Upland Recharge Meadow Marsh Area
Ground Water Surveillance Wells, Water Quality Data

Sample New ID	Location Old ID	No. of Samples[a]	pH (SU)	Conductivity (umhos/cm) Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen[b] Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
							<----				mg/L				---->
Peconic River On-site															
38-01	38-01	2 (2)	4.7 - 7.1	61	58	64	<4.0	<4.0	<4.0	10.2	10.0	10.4	0.5	<1.0	1.0
39-05	39-05	1 (1)	6.3	92	--	--	7.3	---	---	9.0	----	----	1.2	----	---
47-01	XB	1 (1)	7.0	97	--	--	6.9	---	---	5.4	----	----	<1.0	----	---
47-02	XC	1 (1)	6.2	75	--	--	6.7	---	---	5.9	----	----	<1.0	----	---
40-02	XX	1 (1)	6.2	123	--	--	6.3	---	---	17.3	----	----	<1.0	----	---
Peconic River - Off-site															
X4	X4	1 (0)	6.1	166	--	--	20.2	---	---	19.7	----	----	<1.0	----	---
Meadow Marsh															
89-01	89-01	2 (1)	5.4	60	--	--	2.6	<4.0	5.1[b]	11.8	10.7	12.9[b]	1.4	1.1	1.6
90-01	90-01	2 (0)	NA	NA	--	--	3.6	<4.0	7.1[b]	9.6	9.2[b]	10.0	2.7	2.6	2.7
NYS Drinking Water Standards			6.5 - 8.5	(c)			250.0			250.0			10.0		
Typical MDL			---	10			4.0			4.0			1.0		

MDL: Minimum detection limit.
NA: Not analyzed.
(a) Number outside parenthesis represents number of samples analyzed for anions; number inside parenthesis represents number of samples for pH and conductivity.
(b) Holding time expired.
(c) No standard specified.

Table 57
BNL Site Environmental Report for Calendar Year 1990
Peconic River Areas and Upland Recharge Meadow Marsh Area
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<------			------mg/L	------					------>
Peconic River On-site												
38-01	38-01	2 (2)	<0.025	<0.0005	<0.005	<0.05	0.2	<0.0002	0.18	2.7	<0.005	<0.02
39-05	39-05	1 (1)	<0.025	<0.0005	<0.005	<0.05	1.75	<0.0002	0.13	4.8	<0.005	<0.02
47-01	XB	1 (1)	<0.025	<0.0005	<0.005	<0.05	0.57	<0.0002	0.07	5.2	<0.005	3.1
47-02	XC	1 (1)	<0.025	<0.0005	<0.005	0.003	2.43	<0.0002	0.43	4.3	<0.005	0.17
40-02	XX	1 (1)	<0.025	<0.0005	<0.005	<0.05	2.21	<0.0002	0.18	5.9	<0.005	<0.02
Peconic River Off-site												
X4	X4	1 (0)	<0.025	<0.0005	<0.005	<0.05	0.87	NA	0.07	21.1	<0.005	0.22
Meadow Marsh												
89-01	89-01	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.30	3.1	<0.005	<0.02
90-01	90-01	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	2.4	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.30	0.002	0.3	(b)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 58
BNL Site Environmental Report for Calendar Year 1990
Peconic River Areas and Upland Recharge Meadow Marsh Area
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location New ID	Old ID	No. of Samples	TCA Avg.	TCA Min.	TCA Max.	TCE Avg.	TCE Min.	TCE Max.	PCE Avg.	PCE Min.	PCE Max.	DCA Avg.	DCA Min.	DCA Max.	DCE Avg.	DCE Min.	DCE Max.	Chloroform Avg.	Chloroform Min.	Chloroform Max.
			<----									ug/L								---->
Peconic River On-site																				
38-01	38-01	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
39-05	39-05	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--
47-01	XB	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--
47-02	XC	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--
40-02	XX	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--
Peconic River Off-site																				
X4	X4	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--	NA	--	--
Meadow Marsh																				
89-01	89-01	2	ND(a)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND(a)	ND	ND	ND	ND	ND
90-01	90-01	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
NYS Drinking Water Standards			5.			5.			5.			5.			5.			100.		
Typical MDL			2.			2.			2.			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene
ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.
(a) Only one sample analyzed.

Table 59
BNL Site Environmental Report for Calendar Year 1990
Peconic River Areas and Upland Recharge Meadow Marsh Area
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<------					μg/L						------>
Peconic River On-site														
38-01	38-01	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
39-05	39-05	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--
47-01	XB	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--
47-02	XC	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--
40-02	XX	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--
Peconic River Off-site														
X4	X4	1	NA	--	--	NA	--	--	NA	--	--	NA	--	--
Meadow Marsh														
89-01	89-01	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND[a]	ND	ND
90-01	90-01	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.
(a) Only one sample analyzed.

Table 60
BNL Site Environmental Report for Calendar Year 1990
Landfill Areas and Ash Repository
Ground Water Surveillance Wells, Water Quality Data

Sample Location New ID	Old ID	No. of Samples[a]	pH (SU)	Conductivity (umhos/cm) Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen[b] Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
							<------------				mg/L				------------>
Current Landfill															
107-07	107-07	2,2,2	6.3 - 6.5	353	339	367	46.3	45.9	46.7	17.8	17.6	17.9	<1.0	<1.0	<1.0
107-08	107-08	1,1,1	7.6	256	---	---	24.1	----	----	13.8	----	----	<1.0	---	---
107-09	107-09	1,1,1	7.9	94	---	---	13.0	----	----	11.0	----	----	<1.0	---	---
97-14	97-14	1,1,1	6.4	76	---	---	17.9	----	----	10.8	----	----	<1.0	---	---
98-33	98-33	2,2,2	6.1 - 6.7	181	158	203	24.5	22.5	26.5	13.7	13.3	14.0	<1.0	<1.0	<1.0
98-34	98-34	2,2,2	6.4 - 6.6	327	320	334	28.0	25.6	30.4	13.6	13.3	13.8	<1.0	<1.0	<1.0
88-01	W6	3,3,2	6.8 - 7.2	270	240	299	27.6	11.8	38.9	7.6	6.7	9.0	<1.0	<1.0	<1.0
88-12	562	3,3,1	5.1 - 6.1	107	---	---	11.8	9.1	15.3	13.3	11.7	15.4	<1.0	<1.0	<1.0
87-03	WR	1,1,1	6.3	1018	---	---	88.8	---	----	7.1	----	----	<1.0	---	---
87-05	WS	1,1,1	6.3	1044	---	---	66.4	---	----	10.8	----	----	<1.0	---	---
88-02	WT	3,2,2	5.1 - 5.2	224	185	262	57.8	43.0	68.2	24.7	23.3	27.3	<1.0	<1.0	<1.0
88-13	563	3,3,3	6.0 - 6.2	901	643	1056	105.9	77.5	160.0	49.1	43.4	59.4	<1.0	<1.0	<1.0
87-08	1K	3,3,3	6.2 - 6.8	1050	939	1195	108.7	84.0	141.0	5.4	<4.0	11.5	<1.0	<1.0	<1.0
87-11	2C	3,3,3	6.3 - 6.8	922	811	1100	57.2	54.9	61.9	<4.0	----	----	<1.0	---	---
87-10	W9	3,3,3	6.0 - 6.7	687	581	744	31.2	24.1	35.7	9.1	4.0	17.3	<1.0	<1.0	<1.0
88-14	564	3,3,2	6.3 - 6.5	875	817	932	44.8	44.3	45.0	<4.0	----	----	<1.0	---	---
88-15	565	3,3,2	6.3 - 7.0	189	176	201	20.0	14.9	29.1	13.4	12.7	14.5	<1.0	<1.0	<1.0
98-07	2H	1,1,1	6.7	89	---	---	10.2	---	----	11.0	----	----	<1.0	---	---
Former Landfill															
115-03	115-03	2,2,2	5.0 - 5.9	82	69	94	6.5	5.8	7.1	8.5	8.5	8.5	<1.0	<1.0	<1.0
97-05	D1	2,2,2	4.9 - 5.8	113	92	134	7.3	6.7	7.9	13.3	12.0	14.5	<1.0	<1.0	<1.0
97-01	D2	1,1,1	7.0	73	---	---	5.5	---	---	11.3	---	---	<1.0	---	---
96-04	D4	2,2,2	5.9 - 6.8	91	76	105	6.5	6.4	6.5	11.5	9.4	13.3	<1.0	<1.0	<1.0
96-02	D5	2,2,2	6.2 - 6.9	102	99	104	13.3	9.9	16.7	13.5	11.9	15.0	<1.0	<1.0	<1.0
97-03	D6	2,2,2	6.1 - 6.7	466	361	570	10.3	9.8	10.8	65.0	46.4	83.5	2.5	1.9	3.0
106-04	D18	2,2,2	6.0 - 7.0	54	38	69	8.2	7.3	9.0	7.7	7.6	7.8	<1.0	<1.0	<1.0
96-03	D16	2,2,2	5.8 - 6.4	123	114	132	10.6	10.4	10.7	20.3	19.5	21.1	1.1	1.0	1.2
105-01	D7	2,2,2	6.2 - 6.4	94	76	111	8.6	4.8	12.4	7.3	5.8	8.8	<1.0	<1.0	<1.0
Ash Repository															
104-01	D20	1,1,1	6.4	213			11.3			13.9			<1.0		
NYS Drinking Water Standards			6.5 - 8.5	(c)			250.0			250.0			10.0		
Typical MDL			--	10			4.0			4.0			1.0		

MDL: Minimum detection limit.
(a) Number of anion, pH, conductivity samples analyzed.
(b) Holding time expired.
(c) No standard specified.

Table 61
BNL Site Environmental Report for Calendar Year 1990
Landfill Areas and Ash Repository
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<------				mg/L					------>
Current Landfill												
107-07	107-07	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0004	0.27	45.3	<0.005	<0.02
107-08	107-08	1 (1)	<0.025	<0.0005	<0.005	<0.05	0.25	0.0003	0.13	23.2	<0.005	<0.02
107-09	107-09	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0004	0.12	8.3	<0.005	<0.02
97-14	97-14	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	1.47	13.4	<0.005	<0.02
98-33	98-33	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.3	20.3	<0.005	<0.02
98-34	98-34	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.3	25.9	<0.005	<0.02
88-01	W6	3 (2)	<0.025	<0.0005	<0.005	<0.05	5.2	<0.0002	0.38	12.3	0.004	1.04
88-12	562	3 (2)	<0.025	<0.0005	<0.005	<0.05	3.8	0.0004	0.70	9.2	<0.005	0.01
87-03	WR	1 (0)	<0.025	<0.0005	<0.005	<0.05	61.0	NA	1.81	56.0	<0.005	0.12
87-05	WS	1 (0)	<0.025	<0.0005	<0.005	<0.05	78.0	NA	1.96	51.1	<0.005	0.1
88-02	WT	3 (2)	<0.025	<0.0005	<0.005	<0.05	1.8	0.0002	0.27	18.6	<0.005	2.0
88-13	563	3 (2)	<0.025	<0.0005	<0.005	<0.05	55.8	<0.0002	18.8	54.5	<0.005	<0.02
87-08	1K	3 (2)	<0.025	<0.0005	<0.005	<0.05	76.9	0.0002	2.8	55.9	<0.005	0.16
87-11	2C	3 (2)	<0.025	<0.0005	<0.005	<0.05	63.3	0.0003	1.82	38.8	<0.005	<0.02
87-10	W9	3 (2)	<0.025	<0.0005	<0.005	<0.05	63.4	0.0002	2.03	27.3	<0.005	0.17
88-14	564	3 (2)	<0.025	<0.0005	<0.005	<0.05	91.1	<0.0002	2.7	30.0	<0.005	<0.02
88-15	565	3 (2)	<0.025	<0.0005	<0.005	<0.05	30.1	0.0002	9.6	17.7	<0.005	<0.02
98-07	2H	1 (1)	<0.025	<0.0005	<0.005	<0.05	0.08	<0.0002	0.09	6.8	<0.005	<0.02
Former Landfill												
115-03	115-03	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0003	0.08	5.4	<0.005	<0.02
97-05	D1	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.83	4.7	<0.005	<0.02
97-C1	D2	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	4.3	<0.005	<0.02
96-04	D4	2 (2)	<0.025	<0.0005	<0.005	<0.05	0.14	<0.0002	<0.05	5.1	<0.005	<0.02
96-02	D5	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	15.6	<0.005	<0.02
97-03	D6	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	12.2	<0.005	<0.02
106-04	D18	2 (2)	<0.025	0.0007	<0.005	<0.05	<0.075	<0.0002	<0.05	4.9	<0.005	<0.02
96-03	D16	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0001	<0.05	6.7	<0.005	<0.02
105-01	D7	2 (2)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0002	<0.05	5.9	<0.005	<0.02
Ash Repository												
104-01	D20	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.9	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.3	0.002	0.3	(b)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 62
BNL Site Environmental Report for Calendar Year 1990
Landfill Areas
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location New ID	Old ID	No. of Samples	TCA Avg.	TCA Min.	TCA Max.	TCE Avg.	TCE Min.	TCE Max.	PCE Avg.	PCE Min.	PCE Max.	DCA Avg.	DCA Min.	DCA Max.	DCE Avg.	DCE Min.	DCE Max.	Chloroform Avg.	Chloroform Min.	Chloroform Max.
			<----									ug/L								---->
Current Landfill																				
107-07	107-07	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
107-08	107-08	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
107-09	107-09	1	2.	--	--	ND	--	--	ND	--	--	6.	--	--	ND	--	--	ND	--	--
97-14	97-14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-33	98-33	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-34	98-34	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.	ND	8.	ND	ND	ND	ND	ND	ND
88-01	W6	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-12	562	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-02	WT	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-13	563	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.	ND	12.	ND	ND	ND	ND	ND	ND
87-08	1K	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
87-11	2C	2	4.	ND	8.	ND	ND	ND	ND	ND	ND	11.	9.	12.	ND	ND	ND	ND	ND	ND
87-10	W9	2	4.	ND	8.	ND	ND	ND	ND	ND	ND	3.	ND	6.	ND	ND	ND	ND	ND	ND
88-14	564	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-15	565	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-07	2H	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
Former Landfill																				
115-03	115-03	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
97-05	D1	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-04	D4	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-02	D5	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
97-03	D6	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
106-04	D18	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-03	D16	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
105-01	D7	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
NYS Drinking Water Standards			5.			5.			5.			5.			5.			100.		
Typical MDL			2.			2.			2.			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene
ND: Not detected.
MDL: Minimum detection limit.

Table 63
BNL Site Environmental Report for Calendar Year 1990
Landfill Areas
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<------					μg/L						------>
Current Landfill														
107-07	107-07	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
107-08	107-08	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
107-09	107-09	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
97-14	97-14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-33	98-33	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-34	98-34	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-01	W6	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-12	562	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-02	WT	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-13	563	2	ND	ND	ND	2.	ND	3.	12.	ND	24.	2.	ND	4.
87-08	1K	2	9.	5.	12.	8.	5.	10.	ND	ND	ND	ND	ND	ND
87-11	2C	2	5.	4.	6.	ND	ND	ND	ND	ND	ND	ND	ND	ND
87-10	W9	2	4.	ND	7.	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-14	564	2	2.	ND	4.	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-15	565	2	2.	ND	3.	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-07	2H	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
Former Landfill														
115-03	115-03	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
97-05	D1	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-04	D4	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-02	D5	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
97-03	D6	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
106-04	D18	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
96-03	D16	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
105-01	D7	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
MDL: Minimum detection limit.

Table 64
BNL Site Environmental Report for Calendar Year 1990
Hazardous Waste Management (HWM) Area and Spray Aeration Project
Ground Water Surveillance Wells, Water Quality Data

Sample Location New ID	Old ID	No. of Samples[a]	pH (SU)	Conductivity (umhos/cm) Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min.	Sulfates Max.	Nitrate-Nitrogen[b] Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
							<------	------	------	mg/L	------	------	------	------	------>
HWM Area															
107-10	107-10	2 (2)	6.3 - 7.0	83	82	84	12.5	11.8	13.2	12.8	12.5	13.0	<1.0	<1.0	<1.0
108-13	108-13	2 (2)	5.8 - 5.9	98	85	110	8.7	8.1	9.3	15.8	15.4	16.1	<1.0	<1.0	<1.0
108-14	108-14	2 (2)	6.0 - 6.2	88	85	91	13.3	12.2	14.3	9.1	9.5	8.6	<1.0	<1.0	<1.0
88-03	MW1	1 (2)	5.6	51	--	--	<4.0	<4.0	<4.0	12.0	12.0	12.0	1.2	1.0	1.3
88-04	MW2	2 (2)	5.6 - 6.1	53	128	177	3.5	<4.0	7.0	36.2	29.7	42.6	1.2	1.0	1.3
98-02	WC	0 (1)	NA	NA			6.4	---	---	59.7	---	---	2.8	---	---
98-05	MW3	1 (1)	5.6	65	--	--	13.3	---	---	12.7	---	---	<1.0	---	---
98-20	MW4	1 (1)	5.6	59	--	--	10.7	---	---	10.7	---	---	<1.0	---	---
98-21	WK	1 (1)	6.4	86	--	--	9.2	---	---	12.6	---	---	<1.0	---	---
98-17	MW6	1 (2)	6.0	69	--	--	10.0	9.8	10.2	12.3	11.9	12.6	<1.0	<1.0	<1.0
98-22	2M	1 (1)	7.1	86	--	--	9.6	---	---	11.2	---	---	<1.0	---	---
98-19	MW5	1 (1)	5.5	64	--	--	10.9	---	---	12.7	---	---	<1.0	---	---
98-29	MW7A	2 (2)	5.4 - 5.8	71	67	74	10.5	9.2	11.8	12.9	12.6	13.2	<1.0	<1.0	<1.0
98-31	MW7B	2 (2)	5.5 - 5.6	70	69	71	11.1	10.3	11.8	12.4	11.8	12.9	<1.0	<1.0	<1.0
108-01	MW13	2 (2)	6.0 - 7.0	68	63	72	12.1	11.0	13.1	12.5	12.0	13.0	<1.0	<1.0	<1.0
108-03	MW8	2 (2)	5.8 - 6.0	71	62	80	11.4	9.9	12.8	13.3	11.2	15.5	<1.0	<1.0	<1.0
108-05	MW12	2 (2)	5.8 - 6.4	76	73	78	11.0	9.8	12.2	15.4	14.1	16.6	<1.0	<1.0	<1.0
108-08	MW11	2 (2)	5.7 - 6.2	75	66	84	7.3	6.8	7.8	12.5	12.0	12.9	<1.0	<1.0	<1.0
108-12	MW10	2 (2)	5.6 - 5.8	98	96	100	9.9	9.6	10.1	18.3	16.6	20.0	<1.0	<1.0	<1.0
108-07	D17	2 (2)	5.7 - 6.1	77	75	78	12.9	11.0	14.7	10.4	9.9	10.9	<1.0	<1.0	<1.0
Spray Aeration															
108-02	PW3	2 (1)	5.6 - 6.1	67	64	69	11.7	---	---	11.4	---	---	<1.0	---	---
108-09	PW4	2 (1)	5.4 - 5.8	60	58	62	9.4	---	---	10.6	---	---	<1.0	---	---
NYS Drinking Water Standards			6.5 - 8.5	(c)			250.0			250.0			10.0		
Typical MDL			--	10			4.0			4.0			1.0		

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of anions; number outside parenthesis represents number of samples analyzed for pH and conductivity;
(b) Holding time expired.
(c) No standard specified.

Table 65
BNL Site Environmental Report for Calendar Year 1990
Hazardous Waste Management (HWM) Area and Spray Aeration Project
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<------	------	------	------	mg/L	------	------	------	------	------>
HWM Area												
107-10	107-10	2 (1)	<0.025	<0.0005	<0.005	<0.05	0.09	<0.0002	0.09	9.7	<0.005	<0.02
108-13	108-13	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	6.7	<0.005	<0.02
108-14	108-14	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.08	8.3	<0.005	<0.02
88-03	MW1	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0002	<0.05	6.5	<0.005	<0.02
88-04	MW2	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	6.5	<0.005	<0.02
98-02	WC	1 (1)	<0.025	<0.0005	0.011	<0.05	0.18	<0.0002	<0.05	5.3	<0.005	0.31
98-05	MW3	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	8.4	<0.005	<0.02
98-20	MW4	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	6.8	<0.005	<0.02
98-21	WK	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	6.6	<0.005	<0.02
98-17	MW6	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0002	<0.05	7.5	<0.005	<0.02
98-22	2M	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.3	<0.005	<0.02
98-19	MW5	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	6.7	<0.005	<0.02
98-29	MW7A	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.3	<0.005	<0.02
98-31	MW7B	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.5	<0.005	<0.02
108-01	MW13	2 (1)	<0.025	<0.0005	<0.005	<0.05	0.05	<0.0002	<0.05	7.8	<0.005	<0.02
108-03	MW8	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.5	<0.005	0.01
108-05	MW12	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.2	<0.005	<0.02
108-08	MW11	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	5.2	<0.005	<0.02
108-12	MW10	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	8.2	<0.005	<0.02
108-07	D17	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	7.7	<0.005	<0.02
Spray Aeration												
108-02	PW3	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	7.5	<0.005	<0.02
108-09	PW4	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	6.0	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.30	0.002	0.3	(b)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 66
BNL Site Environmental Report for Calendar Year 1990
Hazardous Waste Management (HWM) Area and Spray Aeration Project
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location New ID	Old ID	No. of Samples	TCA Avg.	TCA Min.	TCA Max.	TCE Avg.	TCE Min.	TCE Max.	PCE Avg.	PCE Min.	PCE Max.	DCA Avg.	DCA Min.	DCA Max.	DCE Avg.	DCE Min.	DCE Max.	Chloroform Avg.	Chloroform Min.	Chloroform Max.
			<--								µg/L									-->
HWM Area																				
107-10	107-10	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-13	108-13	1	23.	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-14	108-14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
88-03	MW1	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-04	MW2	2	85.	78.	91.	ND	ND	ND	>150.[a]	>150.	>150.	ND	ND	ND	3.	ND	5.	ND	ND	ND
98-02	WC	1	1000.	--	--	ND	--	--	ND	--	--	ND	--	--	52.	--	--	ND	--	--
98-05	MW3	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-20	MW4	1	NA	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-21	WK	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-17	MW6	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-22	2M	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-19	MW5	1	NA	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-29	MW7A	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
98-31	MW7B	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-01	MW13	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-03	MW8	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-05	MW12	1	8.	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	2.	--	--
108-08	MW11	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-12	MW10	1	30.	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
108-07	D17	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
Spray Aeration																				
108-02	PW3	1	NA			NA			NA			NA			NA			NA		
108-09	PW4	1	NA			NA			NA			NA			NA			NA		
NYS Drinking Water Standards			5.			5.			5.			5.			5.			100.		
Typical MDL			2.			2.			2.			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene
ND: Not detected.
MDL: Minimum detection limit.
NA: Not analyzed.
(a) Value reported is underestimated, see Section 3.3.8.2 in text for discussion.

Table 67
BNL Site Environmental Report for Calendar Year 1990
Hazardous Waste Management (HWM) Area and Spray Aeration Project
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<------------					µg/L						------------>
HWM Area														
107-10	107-10	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-13	108-13	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-14	108-14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
88-03	MW1	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88-04	MW2	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-02	WC	1	ND	--	--	ND	--	--	ND	--	-	ND	--	--
98-05	MW3	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-20	MW4	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-21	WK	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-17	MW6	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98-22	2M	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-19	MW5	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-29	MW7A	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
98-31	MW7B	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-01	MW13	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-03	MW8	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-05	MW12	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-08	MW11	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-12	MW10	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
108-07	D17	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
Spray Aeration														
108-02	PW3	1	NA			NA			NA			NA		
108-09	PW4	1	NA			NA			NA			NA		
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.

Table 68
BNL Site Environmental Report for Calendar Year 1990
Major Petroleum Facility and Central Steam Facility
Ground Water Surveillance Wells, Water Quality Data

Sample Location New ID	Old ID	No. of Samples[a]	pH (SU)	Conductivity (umhos/cm) Avg.	Conductivity Min.	Conductivity Max.	Chlorides Avg.	Chlorides Min.	Chlorides Max.	Sulfates Avg.	Sulfates Min. (mg/L)	Sulfates Max.	Nitrate-Nitrogen[b] Avg.	Nitrate-Nitrogen Min.	Nitrate-Nitrogen Max.
Major Petroleum Facility															
66-08[c]	66-08	3 (2)	5.8 - 6.2	95	88	101	10.7	8.8	12.8	16.5	15.9	17.0	0.5	<1.0	1.4
76-16	76-16	2 (1)	3.0 - 5.6	118	--	---	13.0	11.0	15.0	23.0	19.8	26.1	4.1	3.2	5.0
76-17	76-17	2 (1)	5.2 - 5.4	105	--	---	10.8	10.1	11.5	14.4	11.0	17.7	3.4	1.9	4.8
76-18	76-18	2 (1)	5.5 - 5.8	128	--	---	5.2	4.8	5.6	23.6	21.3	25.9	4.8	4.6	4.9
76-19	76-19	2 (1)	5.9 - 6.0	126	--	---	6.2	5.5	6.9	25.6	15.3	35.9	<1.0	<1.0	<1.0
Central Steam Facility															
76-02	D13	1 (1)	6.6	117	--	---	19.0	---	---	12.5	---	---	<1.0	---	---
76-07	D14	1 (1)	6.5	118	--	---	18.9	---	---	16.2	---	---	<1.0	---	---
76-09	D15	1 (0)	6.0	NA	--	---	20.8	---	---	14.4	---	---	<1.0	---	---
76-04	IT1	2 (2)	6.7 - 6.8	101	94	108	13.1	11.6	14.6	12.5	12.3	12.7	0.9	<1.0	1.7
76-06	IT2	1 (1)	6.8	323	--	---	41.6	---	---	38.5	---	---	1.4	---	---
76-08	IT4	1 (1)	6.7	112	--	---	9.5	---	---	16.4	---	---	<1.0	---	---
76-05	IT5	1 (1)	6.2	338	--	---	45.4	---	---	32.0	---	---	2.9	---	---
76-20	76-20	1 (0)	6.3	NA	--	---	15.9	---	---	22.7	---	---	2.1	---	---
76-21	76-21	1 (1)	5.6	102	--	---	8.2	---	---	16.2	---	---	<1.0	---	---
76-22	76-22	1 (1)	6.7	73	--	---	17.2	---	---	13.8	---	---	<1.0	---	---
76-10	IT3	1 (1)	6.0	127	--	---	13.7	---	---	18.9	---	---	1.6	---	---
NYS Drinking Water Standards			6.5 - 8.5	(d)			250.0			250.0			10.0		
Typical MDL			---	10			4.0			4.0			1.0		

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for conductivity; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) Holding time expired.
(c) Upgradient well.
(d) No standard specified.

Table 69
BNL Site Environmental Report for Calendar Year 1990
Major Petroleum Facility and Central Steam Facility
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<------			mg/L						------>
Major Petroleum Facility												
66-08[b]	66-08	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0003	<0.05	8.2	<0.005	<0.02
76-16	76-16	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13.4	<0.005	<0.02
76-17	76-17	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	3.9	<0.005	<0.02
76-18	76-18	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.07	19.3	<0.005	<0.02
76-19	76-19	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.06	5.4	<0.005	<0.02
Central Steam Facility												
76-02	D13	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0 075	<0.0002	<0.05	15.5	<0.005	<0.02
76-07	D14	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	15.9	<0.005	<0.02
76-09	D15	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	19.3	<0.005	0.04
76-04	IT1	2 (2)	<0.025	<0.0005	<0.005	<0.05	3.10	<0.0002	0.39	10.7	<0.005	0.02
76-06	IT2	1 (1)	<0.025	<0.0005	<0.005	<0.05	0.88	<0.0002	0.12	31.1	<0.005	<0.02
76-10	IT3	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	11.8	<0.005	<0.02
76-08	IT4	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	1.71	8.7	<0.005	<0.02
76-05	IT5	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.08	35.7	<0.005	<0.02
76-20	76-20	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0002	<0.05	16.2	<0.005	<0.02
76-21	76-21	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.96	6.2	<0.005	<0.02
76-22	76-22	1 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	14.1	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.30	0.002	0.3	(c)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) Upgradient well.
(c) No standard specified.

Table 70
BNL Site Environmental Report for Calendar Year 1990
Major Petroleum Facility and Central Steam Facility
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location New ID	Old ID	No. of Samples	TCA			TCE			PCE			DCA			DCE			Chloroform		
			Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
			<---								ug/L									--->
Major Petroleum Facility																				
66-08[a]	66-08	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND[b]	ND	ND	ND	ND	ND
76-16	76-16	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-17	76-17	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-18	76-18	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-19	76-19	2	ND	ND	ND	ND	ND	ND	7.	ND	14.	ND	ND	ND	ND	ND	ND	ND	ND	ND
Central Steam Facility																				
76-02	D13	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-07	D14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-09	D15	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-04	IT1	2	3.	ND	5.	4.	ND	7.	4.	ND	8.	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-06	IT2	1	ND	--	--	ND	--	--	3.	--	--	ND	--	--	ND	--	--	ND	--	--
76-08	IT4	1	3.	--	--	7.	--	--	28.	--	--	ND	--	--	ND	--	--	ND	--	--
76-05	IT5	1	ND	--	--	ND	--	--	22.	--	--	ND	--	--	ND	--	--	ND	--	--
76-20	76-20	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-21	76-21	1	22.	--	--	33.	--	--	130.	--	--	5.	--	--	ND	--	--	2.	--	--
76-22	76-22	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NYS Drinking Water Standards			5.			5.			5.			5.			5.			100.		
Typical MDL			2.			2.			2.			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene

ND: Not detected.
MDL: Minimum detection limit.
(a) Upgradient well.
(b) Only two samples analyzed.

Table 71
BNL Site Environmental Report for Calendar Year 1990
Major Petroleum Facility and Central Steam Facility
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<----------						µg/L					---------->
Major Petroleum Facility[a]														
66-08[b]	66-08	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-16	76-16	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-17	76-17	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-18	76-18	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76-19	76-19	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Central Steam Facility														
76-02	D13	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-07	D14	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-09	D15	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-04	IT1	2	ND	ND	ND	45.	ND	89.	240.	ND	480.	60.	ND	120.
76-06	IT2	1	ND	--	--	3.	--	--	26.	--	--	4.	--	--
76-08	IT4	1	ND	--	--	ND	--	--	480.	--	--	ND	--	--
76-05	IT5	1	ND	--	--	ND	--	--	10.	--	--	ND	--	--
76-20	76-20	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
76-21	76-21	1	12.	--	--	100.	--	--	ND	--	--	160.	--	--
76-22	76-22	1	ND	--	--	ND	--	--	ND	--	--	ND	--	--
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
MDL: Minimum detection limit.
(a) As required by the MFP License, these wells were monitored by BNL monthly for free product. No free product was observed.
(b) Upgradient well.

Table 72
BNL Site Environmental Report for Calendar Year 1990
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Water Quality Data

Sample Location New ID	Old ID	No. of Samples	pH (SU)	Conductivity (umhos/cm) Avg.	Min.	Max.	Chlorides Avg.	Min.	Max.	Sulfates Avg.	Min.	Max.	Nitrate-Nitrogen[a] Avg.	Min.	Max.
							<----				mg/L				---->
Building 830															
66-07	66-07	2	7.0	100	97	103	16.5	15.4	17.6	13.1	12.7	13.5	<1.0	----	---
66-08	66-08	3	5.8 - 6.2	95[b]	88	101	10.7	8.8	12.8	16.5	15.9	17.0	0.5	<1.0	1.4
66-09	66-09	2	6.4 - 7.0	119	118	120	20.6	19.4	21.8	13.9	13.8	13.9	<1.0	----	---
P&GA															
75-03	75-03	2	4.5 - 6.5	112	102	121	18.1	17.2	18.9	14.3	13.8	14.8	<1.0	----	---
75-04	75-04	3	5.0 - 6.8	88	79	98	10.1	9.1	11.6	8.8	5.9	14.0	<1.0	----	---
NYS Drinking Water Standards			6.5 - 8.5	[c]			250.0			250.0			10.0		
Typical MDL			---	10			4.0			4.0			1.0		

MDL: Minimum detection limit.
NA: Not analyzed.
(a) Holding time expired.
(b) Only two of three samples analyzed.
(c) No standard specified.

Table 73
BNL Site Environmental Report for Calendar Year 1990
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<---			mg/L						--->
Building 830												
66-07	66-07	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	16.1	<0.005	<0.02
66-08	66-08	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	0.0003	<0.05	8.2	<0.005	<0.02
66-09	66-09	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	15.8	<0.005	<0.02
PG&A												
75-03	75-03	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.9	<0.005	<0.02
75-04	75-04	3 (1)	<0.025	<0.0005	<0.005	<0.05	0.23	<0.0002	0.07	8.5	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.30	0.002	0.3	(b)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 74
BNL Site Environmental Report for Calendar Year 1990
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location New ID	Old ID	No. of Samples	TCA Avg.	TCA Min.	TCA Max.	TCE Avg.	TCE Min.	TCE Max.	PCE Avg.	PCE Min.	PCE Max.
			ug/L								
Building 830											
66-07	66-07	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
66-08	66-08	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
66-09	66-09	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
PG&A											
75-03	75-03	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
75-04	75-04	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
NYS Drinking Water Standards			5.			5.			5.		
Typical MDL			2.			2.			2.		

Sample Location New ID	Old ID	No. of Samples	DCA Avg.	DCA Min.	DCA Max.	DCE Avg.	DCE Min.	DCE Max.	Chloroform Avg.	Chloroform Min.	Chloroform Max.
			ug/L								
Building 830											
66-07	66-07	2	ND	ND	ND	ND[a]	ND	ND	ND	ND	ND
66-08	66-08	3	ND	ND	ND	ND[b]	ND	ND	ND	ND	ND
66-09	66-09	2	ND	ND	ND	ND[a]	ND	ND	ND	ND	ND
PG&A											
75-03	75-03	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
75-04	75-04	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
NYS Drinking Water Standards			5.			5.			100.		
Typical MDL			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene
ND: Not detected.
MDL: Minimum detection limit.
(a) Only one sample analyzed.
(b) Only two samples analyzed.

Table 75
BNL Site Environmental Report for Calendar Year 1990
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<------	------	------	------	------	------	µg/L	------	------	------	------	------>
Building 830														
66-07	66-07	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
66-08	66-08	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
66-09	66-09	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PG&A														
75-03	75-03	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
75-04	75-04	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
MDL: Minimum detection limit.

Table 76
BNL Site Environmental Report for Calendar Year 1990
Northeast Sector, West Sector, and South Boundary Areas
Ground Water Surveillance Wells, Water Quality Data

Sample Location New ID	Old ID	No. of Samples[a]	pH (SU)	Conductivity Avg.	Conductivity Min. (umhos/cm)	Conductivity Max.	Chlorides[b] Avg.	Chlorides[b] Min.	Chlorides[b] Max.	Sulfates[b] Avg.	Sulfates[b] Min. (mg/L)	Sulfates[b] Max.	Nitrate-Nitrogen[c] Avg.	Nitrate-Nitrogen[c] Min.	Nitrate-Nitrogen[c] Max.
North Boundary															
18-01	18-01	3 (3)	5.3 - 6.1	45	28	73	3.5	<4.0	5.4	8.1	6.4	9.2	<1.0	<1.0	<1.0
18-02	18-02	3 (3)	5.8 - 6.3	46	31	62	6.0	5.7	6.4	7.4	6.6	8.0	<1.0	<1.0	<1.0
18-03	18-03	2 (3)	6.3 - 6.8	93	14	172	11.1	10.3	12.5	11.3	10.9	11.6	0.8	<1.0	1.3
25-01	560	3 (3)	5.6 - 6.5	117	112	122	20.1	15.6	24.4	13.1	12.7	13.8	<1.0	<1.0	<1.0
25-02	561	3 (3)	5.8 - 6.5	55	45	69	6.0	5.6	6.4	10.7	9.2	12.7	<1.0	<1.0	<1.0
Army Landfill															
53-02	IT1D	1 (1)	5.5	52	--	--	6.5	---	---	7.2	---	----	<1.0	---	---
53-01	IT1S	3 (3)	5.6 - 6.4	59	54	70	8.2	7.8	8.7	10.2	9.7	10.5	<1.0	<1.0	<1.0
53-03	IT2D	3 (3)	5.6 - 5.7	87	74	107	9.4	8.1	11.0	8.2	8.0	8.4	0.7	<1.0	1.1
53-04	IT2S	3 (3)	5.3 - 5.9	61	48	82	7.7	7.1	8.6	10.1	9.8	10.2	<1.0	<1.0	<1.0
AGS															
54-05	556	1 (1)	5.9	234	--	--	9.5	---	---	36.2	---	---	1.8	---	---
54-06	557	1 (1)	5.5	58	--	--	<4.0	---	---	10.7	---	---	1.1	---	---
44-04	558	2 (2)	5.7 - 6.3	53	46	60	2.8	<4.0	5.5	9.0	8.8	9.2	1.4	1.1	1.7
44-05	559	2 (2)	5.1 - 5.6	52	33	71	7.1	6.7	7.5	20.3	18.5	22.1	<1.0	<1.0	<1.0
Bldg. 811															
65-03	D10	1 (1)	6.2	181	--	--	20.5	---	---	19.7	---	---	1.9	---	---
65-04	D11	1 (1)	6.4	172	--	--	24.6	---	---	18.2	---	---	<1.0	---	---
65-02	D9	1 (1)	5.7	192	--	--	22.5	---	---	17.2	---	---	2.8	---	---
West Sector															
101-01	101-01	2 (3)	6.9 - 7.0	151	91	210	51.0	34.5	61.1	20.6	16.1	24.4	<1.0	<1.0	<1.0
83-02	83-02	1 (1)	7.2	106	--	--	12.6	---	---	9.9	---	---	<1.0	---	---
South Boundary															
130-01	130-01	3 (3)	6.3 - 8.4	66	43	78	9.5	8.5	11.3	9.8	9.7	9.8	<1.0	<1.0	<1.0
130-02	130-02	5 (4)	5.9 - 7.1	153	116	180	24.5	22.4	25.1	17.6	17.2	18.0	1.1	1.0	1.3
NYS Drinking Water Standards			--	(d)			250.0			250.0			10.0		
Typical MDL			--	10			4.0			4.0			1.0		

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number outside parenthesis represents number of samples analyzed for anions; number inside parenthesis represents number of samples for pH and conductivity.
(b) Samples collected between 3/1/90 - 3/14/90 holding time expired before analysis.
(c) Holding time expired.
(d) No standard specified.

Table 77
BNL Site Environmental Report for Calendar Year 1990
Northeast Sector, West Sector, and South Boundary Areas
Ground Water Surveillance Wells, Average Metals Data

Sample Location New ID	Old ID	No. of Samples[a]	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			<----			----mg/L	----					---->
North Boundary												
18-01	18-01	5 (3)	<0.025	0.0001	<0.005	<0.05	1.78	<0.0002	0.45	3.1	<0.005	<0.02
18-02	18-02	3 (1)	<0.025	<0.0005	<0.005	<0.05	0.12	<0.0002	<0.05	3.5	<0.005	<0.02
18-03	18-03	3 (1)	<0.025	<0.0005	<0.005	<0.05	0.93	<0.0002	0.07	7.0	<0.005	<0.02
25-01	560	3 (1)	<0.025	0.0003	0.003	<0.05	0.03	<0.0002	<0.05	18.7	<0.005	<0.02
25-02	561	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	5.4	<0.005	<0.02
Army Landfill												
53-02	IT1D	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	5.4	<0.005	<0.02
53-01	IT1S	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	5.5	<0.005	<0.02
53-04	IT2D	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	5.6	<0.005	<0.02
53-03	IT2S	3 (1)	<0.025	0.0002	<0.005	<0.05	<0.075	<0.0002	<0.05	6.8	<0.005	<0.02
AGS												
54-05	556	1 (0)	<0.025	<0.0005	<0.005	<0.05	0.18	NA	<0.05	7.7	<0.005	<0.02
54-06	557	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	3.6	<0.005	<0.02
44-04	558	2 (0)	<0.025	<0.0005	<0.005	<0.05	0.46	NA	0.03	3.0	<0.005	<0.02
44-05	559	2 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.03	5.4	<0.005	<0.02
Bldg. 811												
65-03	D10	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	18.4	<0.005	<0.02
65-04	D11	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.16	19.1	<0.005	<0.02
65-02	D9	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	14.6	<0.005	<0.02
West Sector												
101-01	101-01	2 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	31.5	<0.005	<0.02
83-02	83-02	1 (0)	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.42	11.9	<0.005	<0.02
South Boundary												
130-01	130-01	3 (1)	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	6.7	<0.005	<0.02
130-02	130-02	3 (1)	<0.025	<0.0005	<0.005	<0.05	0.497	<0.0002	0.16	18.9	<0.005	<0.02
NYS Drinking Water Standards			0.05	0.01	0.05	1.0	0.30	0.002	0.3	(b)	0.050	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1.0	0.005	0.02

NA: Not analyzed.
MDL: Minimum detection limit.
(a) Number inside parenthesis represents number of samples analyzed for Hg; number outside parenthesis represents number of samples analyzed for all other parameters.
(b) No standard specified.

Table 78
BNL Site Environmental Report for Calendar Year 1990
Northeast Sector, West Sector, and South Boundary Areas
Ground Water Surveillance Wells, Chlorocarbon Data

Sample Location		No. of	TCA			TCE			PCE			DCA			DCE			Chloroform		
New ID	Old ID	Samples[a]	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
			<----------									μg/L								--------->
North Boundary																				
18-01	18-01	2 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
18-02	18-02	2 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
18-03	18-03	2 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
25-01	560	3 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-02	561	3 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Army Landfill																				
53-02	IT1D	1 (0)	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
53-01	IT1S	3 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
53-04	IT2D	3 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
53-03	IT2S	3 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
AGS																				
54-05	556	1 (0)	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
54-06	557	1 (0)	ND	--	--	ND	--	--	ND	--	--	ND	--	--	NA	--	--	ND	--	--
44-04	558	2 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
44-05	559	2 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
Bldg. 811																				
65-04	D11	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
65-02	D9	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
West Sector																				
101-01	101-01	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
83-02	83-02	1 (1)	9.	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--	ND	--	--
South Boundary																				
130-01	130-01	3 (1)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND
130-02	130-02	4 (1)	9.	ND	16.	3.	ND	4.	ND	ND	ND	ND	ND	ND	4.	--	--	ND	ND	ND
NYS Drinking Water Standards			5.			5.			5.			5.			5.			100.		
Typical MDL			2.			2.			2.			2.			2.			2.		

TCA: 1,1,1-trichloroethane
TCE: trichloroethylene
PCE: tetrachloroethylene
DCA: dichloroethane
DCE: dichloroethylene
(a) Number inside parenthesis represents number of samples analyzed for DCE; number outside parenthesis represents number of samples analyzed for all other parameters.

ND: Not detected.
NA: Not analyzed.
MDL: Minimum detection limit.

Table 79
BNL Site Environmental Report for Calendar Year 1990
Northeast Sector, West Sector, and South Boundary Areas
Ground Water Surveillance Wells, BTX Data

Sample Location New ID	Old ID	No. of Samples[a]	benzene Avg.	benzene Min.	benzene Max.	ethylbenzene Avg.	ethylbenzene Min.	ethylbenzene Max.	toluene Avg.	toluene Min.	toluene Max.	o-xylene Avg.	o-xylene Min.	o-xylene Max.
			<---					μg/L						--->
North Boundary														
18-01	18-01	3 (3)	ND	ND	ND	ND	ND	ND	6.	ND	18.	1.	ND	3.
18-02	18-02	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-03	18-03	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-01	560	3 (3)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-02	561	3 (3)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Army Landfill														
53-02	ID1D	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
53-01	IT1S	3 (3)	ND	ND	ND	ND	ND	ND	1.	ND	4.	ND	ND	ND
53-04	IT2D	3 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
53-03	IT2S	3 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AGS														
54-05	556	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
54-06	557	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
44-04	558	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
44-05	559	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bldg. 811														
65-04	D11	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
65-02	D9	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
West Sector														
101-01	101-01	2 (2)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
83-02	83-02	1 (1)	ND	--	--	ND	--	--	ND	--	--	ND	--	--
South Boundary														
130-01	130-01	3 (3)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
130-02	130-02	4 (4)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NYS Drinking Water Standards			5.			5.			5.			5.		
Typical MDL			2.			2.			2.			2.		

ND: Not detected.
MDL: Minimum detection limit.
(a) Number outside parenthesis represents number of samples analyzed for benzene and toluene; number inside parenthesis represents number of samples analyzed for ethylbenzene and o-xylene.

Table 80
BNL Site Environmental Report For Calendar Year 1990
Tritium Committed Effective Dose Equivalent
at the Site Boundary Monitoring Stations

Location ID	Sector ID	Annual Average Air Conc. (pCi/m3)	Committed Effective Dose Equivalent (mrem)[a]
1T	N	NM	NM
2T	NNE	2.5	0.0020
3T	NE	2.8	0.0022
4T	ENE	3.5	0.0028
5T	E	3.2	0.0025
6T	ESE	3.0	0.0024
7T	SE	0.5	0.0004
8T	SSE	4.3	0.0034
9T	S	5.1	0.0040
10T	SSW	3.3	0.0026
11T	SW	3.1	0.0024
12T	WSW	2.6	0.0020
13T	W	1.8	0.0014
14T	WNW	2.0	0.0016
15T	NW	2.0	0.0016
16T	NNW	7.9	0.0062
20T	Central Site	8.7	0.0068

(a) Committed Effective Dose Equivalent includes the contribution from the inhalation and submersion pathways. ICRP Publication No. 30 dose conversion factors used.
NM: Not measured due to vandalism
Maximum Site Perimeter Dose is: 0.0068 mrem

Table 81
BNL Site Environmental Report for Calendar Year 1990
Site Boundary Tritium Committed Effective Dose Equivalent
Calculated and Measured Values

Direction	CAP88 Calculations All Sources mrem	Measured Committed Effective Dose Equivalent mrem[a]
N	0.0004	NM
NNE	0.0004	0.0020
NE	0.0004	0.0022
ENE	0.0004	0.0028
E	0.0005	0.0025
ESE	0.0006	0.0024
SE	0.0007	0.0004
SSE	0.0005	0.0034
S	0.0004	0.0040
SSW	0.0002	0.0026
SW	0.0002	0.0024
WSW	0.0002	0.0020
W	0.0001	0.0014
WNW	0.0001	0.0016
NW	0.0002	0.0016
NNW	0.0003	0.0062

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

NM: Not measured due to vanadalism.

Table 82
BNL Site Environmental Report for Calendar Year 1990
External Exposure Rates at the Site from Argon-41 and Oxygen

Direction	Ar-41 mrem	O-15 mrem	Total mrem
N	0.026	0.002	0.028
NNE	0.062	0.004	0.066
NE	0.033	0.002	0.035
ENE	0.017	0.001	0.017
E	0.020	0.001	0.021
ESE	0.025	0.003	0.029
SE	0.023	0.002	0.025
SSE	0.023	0.001	0.024
S	0.021	0.001	0.022
SSW	0.015	0.000	0.015
SW	0.024	0.000	0.024
WSW	0.013	0.001	0.014
W	0.013	0.001	0.013
WNW	0.011	0.001	0.012
NW	0.015	0.003	0.018
NNW	0.015	0.001	0.016

Table 83
BNL Site Environmental Report For Calendar Year 1990
Collective Dose - BNL 1990 Airborne Emissions

Nuclide	Major Facility	Dept.	CAP88 Total Body Dose person-rem
Ar-41	BMRR	Reactor	1.30E+00
H-3	BLIP	Medical	1.17E-02
Ga-68	Hot Lab	Medical	8.10E-03
H-3	HFBR	Reactor	4.11E-03
H-3	VdG	DAS	2.43E-03
Br-77	Hot Lab	Medical	1.10E-03
I-126	Hot Lab	Medical	1.86E-04
Co-57	HWM	S&EP	1.77E-04
Se-75	Hot Lab	Medical	1.32E-04
Br-82	Hot Lab	Medical	1.16E-04
As-74	Hot Lab	Medical	1.13E-04
I-124	Hot Lab	Medical	4.82E-05
O-15	BLIP	Medical	2.96E-05
Sn-113m	HWM	S&EP	2.69E-05
Be-7	BLIP	Medical	2.20E-05
I-125	HWM	S&EP	1.33E-05
Co-60	Hot Lab	Medical	1.33E-05
Hg-203	Hot Lab	Medical	1.14E-05
Ge-69	Hot Lab	Medical	6.16E-06
Eu-155	Hot Lab	Medical	6.00E-06
H-3	Chemistry	Chemistry	5.43E-06
Cs-137	Hot Lab	Medical	5.32E-06
Cs-137	HFBR	Reactor	5.32E-06
Cs-137	Hot Lab	Medical	5.32E-06
Mn-54	Hot Lab	Medical	5.04E-06
Cs-137	BLIP	Medical	4.50E-06
H-3	HWM	S&EP	3.63E-06
Sb-124	Hot Lab	Medical	3.57E-06
C-14	HWM	S&EP	2.96E-06
Zn-65	Hot Lab	Medical	2.43E-06
As-74	BLIP	Medical	2.20E-06
Mn-54	BLIP	Medical	1.97E-06
As-72	BLIP	Medical	1.64E-06
Na-24	BLIP	Medical	5.71E-07
Sn-117m	HWM	S&EP	2.17E-07
Xe-127	Hot Lab	Medical	1.16E-07
Sc-46	HFBR	Reactor	1.16E-07
Xe-127	Hot Lab	Medical	1.16E-07
Xe-125	BLIP	Medical	7.13E-08
Cr-51	HWM	S&EP	2.31E-08
Be-7	HFBR	Reactor	1.48E-08
Tl-201	HWM	S&EP	1.12E-08
Total			1.33E+00

Table 84
BNL Site Environmental Report for Calendar Year 1990
Collective and Maximum Individual Committed Effective Dose Equivalent (CEDE) from the Water Pathway

Pathway	Nuclide	Maximum Individual CEDE (mrem)	Collective CEDE (person-mrem)
Drinking Water	H-3	0.104	52
Fish	Cs-137	0.080	40
	Sr-90[(a)]	0.670	335
All Ingestion Pathways		0.854	427

(a) Sr-90 CEDE estimated from 1990 Cs data and a ratio of 1989 Sr:Cs values.

Table 85
BNL Site Environmental Report for Calendar Year 1990
Collective Dose from All Pathways

Pathway	Maximum Individual CEDE (mrem)	Annual Background Dose Equiv. (mrem)	Maximum Individual Annual Dose Limit (mrem)	Collective CEDE (person-mrem)	Collective Background Dose Equiv. (person-mrem)
Air[a]	0.067	58	10	1330	2.91E+08
Water	0.104	ND	4	52	ND
Fish	0.750	0.206	NA	375	103
All Pathways	0.921	58	100	1757	2.91E+08

ND: Not detected.
NA: Not applicable.
(a) Direct exposure from plume passage included in air component.

APPENDIX E

Table 1
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Isotope	Matrix	Units	Date	Conc. Level	BNL/EML Ratio
H^3	Water	$Bq \bullet \ell^{-1}$	?/90	1960	.87
			9/90	3900	.93
Mn^{54}	Water		3/90	103	1.03
			9/90	301	1.09
Co^{57}	Water		3/90	198	1.02
			9/90	1300	.40[a]
Co^{60}	Water		3/90	206	.93
			9/90	491	1.13
Cs^{134}	Water		3/90	462	.94
			9/90	355	1.16
Cs^{137}	Water		3/90	198	1.01
			9/90	390	1.16
Ce^{144}	Water		3/90	403	1.16
			9/90	923	1.06
Mn^{54}	Air	Bq/ Filter	3/90	9.6	1.03
			9/90	33.3	1.15
Co^{57}	Air		3/90	6.5	.89
			9/90	11.4	1.08
Co^{60}	Air		3/90	9.4	.95
			9/90	25.4	.98
Cs^{134}	Air		3/90	18.2	.83
			9/90	16.3	.97
Cs^{137}	Air		3/90	20.4	.94
			9/90	15.7	1.01
Ce^{144}	Air		3/90	31.2	.91
			9/90	16.5	1.03
Be^7	Air		3/90	51.4	1.03
Cs^{137}	Veg	$Bq \bullet kg^{-1}$	3/90	28.5	.81
			9/90	18.2	.79
K^{40}	Veg		3/90	323	.69
			9/90	1030	.81
Cs^{137}	Soil	$Bq \bullet kg^{-1}$	3/90	17500	.70
			9/90	196	.81
K^{40}	Soil		3/90	608	.74
			9/90	513	.84

[a] Outside acceptance limits, >50%

Table 2
BNL Intercomparison Study Results
Environmental Monitoring Systems Laboratory

Isotope	Matrix	Units	Date	Conc. Level	BNL/EMSL Ratio
Gross Alpha	Water	pCi•ℓ$^{-1}$	1/90	12	.41
			9/90	10	.50
			10/90	62	.81
Gross Beta	Water		1/90	12	.86
			9/90	10	.80
			10/90	53	.94
H^3	Water		2/90	4976	.95
			6/90	2933	1.11
Co^{60}	Water		6/90	24	1.40[a]
Cs^{134}	Water		4/90	15	1.18
CS^{137}	Water		4/90	15	1.29
			6/90	25	1.29
			10/90	5	3.40[b]
Zn^{65}	Water		6/90	148	1.27[a]
Ba^{133}	Water		6/90	99	1.00
Alpha	Air	pCi/ Filter	3/90	5	1.20
Beta			3/90	31	1.09
I^{131}	Milk	pCi•ℓ$^{-1}$	4/90	99	1.12
Cs^{137}			4/90	24	1.36
K		mg/ℓ	4/90	1550	1.16

[a] Above control limits, ± 3 σ.
[b] Determined to be an outlier; ≤ BNL MDL.

Table 3
BNL Non-potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	Conc. Level ($\mu g \bullet \ell^{-1}$)	BNL/ELAP Ratio
Benzene	7/90	19.0	.94
		37.4	.96
Ethyl-benzene	7/90	12.1	.79
		20.3	.82
Toluene	7/90	26.5	.91
		35.2	.95
Chloroform	7/90	45.1	.97
		22.5	1.02

Table 4
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	Conc. Level ($\mu g \bullet \ell^{-1}$)	BNL/ELAP Ratio
Cloride	4/90	35.3	1.03
		101.0	1.00
	10/90	70.2	.95
		40.1	.99
Nitrate (asN)	4/90	1.35	1.01
		4.92	1.01
	10/90	2.00	.95
		0.51	.97
Sulfate	4/90	99.3	.98
		49.9	.98
	10/90	84.0	.96
		29.8	.98
Barium	4/90	251	.95
		549	.96
	10/90	300	1.00
		655	1.01
Cadmium	4/90	2.60	1.01
		7.21	.93
	10/90	3.17	1.05
		8.16	1.08
Copper	4/90	203	1.03
		406	1.01
	10/90	101	1.07
		664	1.07
Lead	4/90	10.2	1.03
		39.8	1.08
	10/90	15.5	.97
		38.6	1.01
Manganese	4/90	10.2	1.01
		30.2	.99
	10/90	19.9	.96
		39.9	.97
Silver	4/90	20.2	1.07
		45.6	1.04
	10/90	15.2	1.04
		40.6	1.07
Zinc	4/90	603	.95
		1000	.95
	10/90	202	1.07
		753	1.05
Chromium	4/90	25.4	1.09
		40.8	.99
	10/90	15.6	.97
		35.6	.98
Iron	4/90	153	.97
		243	.95
	10/90	81.4	.99
		284	1.02
Sodium	4/90	766	.99
		1510	.97
	10/90	324	.93
		2220	.99

APPENDIX F

REFERENCES

1. Long Island Lighting Company Population Estimates, 1990.

2. Nagle, C. M., Climatology of Brookhaven National Laboratory: 1949-1973, BNL Report No. 50466, November, 1975.

3. Nagle, C. M., "Climatology of Brookhaven National Laboratory: 1974 through 1977." BNL-50857, May, 1978.

4. Warren, M. A., W. de Laguna, and N. J. Lusczynski, "Hydrology of Brookhaven National Laboratory and Vicinity," Geological Survey Bulletin 1156-C, 1968.

5. Cohen, P. H. et al., Atlas of Long Island Water Resources, New York State Resources Bulletin No. 62, 1969.

6. Clearlock, D. B. and A. F. Reisenauer, "Sitewide Ground Water Flow Studies for Brookhaven National Laboratory," BNL Informal Report, December, 1971.

7. H2M, Holzmacher, McLendon, and P. C. Murrel, in Association with Roux Associates, Aquifer Evaluation and Program Design for Restoration. Submitted to BNL, June, 1985.

8. Koppelman, L. Long Island Waste Treatment Management Plan, Vol. I and II, July, 1978.

9. U. S. Department of Energy, "Radiation Protection of the Public and the Environment", DOE Order 5400.5, February, 1990.

10. BNL Environmental Monitoring Reports - 1971-1987, Safety and Environmental Protection Division, BNL Report Nos. 17874, 18625, 19977, 21320, 22627, 50813, 51031, 51252, 51417, 51697, 51827, 51884, 51993, 52088, 52152, 52207, 52264.

11. U. S. Environmental Protection Agency, Environmental Radiation Data Report 59, July - September, 1989, EPA 520/5-90-003, March, 1990.

12. U. S. Environmental Protection Agency, Environmental Radiation Data Report 60, October - December, 1989, EPA 520/5-90-018, June, 1990.

13. U. S. Environmental Protection Agency, Environmental Radiation Data Report 61, January - March, 1990 EPA 520/5-90-031, September, 1990.

14. U. S. Environmental Protection Agency, Environmental Radiation Data Report 62, April - June, 1990, EPA 520/5-91-044, December, 1990.

15. Eisenbud, M., Environmental Radioactivity, Academic Press, Inc., New York, 1987.

16. "Tiger Team Assessment of the Brookhaven National Laboratory", U.S. Department of Energy, DOE/EH-0140, June, 1990.

17. Chapter 1 State Sanitary Code NYSDOH Part 5, Drinking Water Supplies Subpart 5-1 (Revised and adopted January 9, 1989).

18. New York State Department of Environmental Conservation, Classification and Standards Governing the Quality and Purity of Waters of New York State, Parts 700-703, 1978.

19. U. S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 1975, Amended February 19, 1988.

20. U. S. Department of Energy, "Quality Assurance," Order No. 5700.6B, September, 1986.

21. Brookhaven National Laboratory, "Quality Assurance Manual," Revised March, 1989.

22. Brookhaven National Laboratory, "Safety and Environmental Protection Quality Assurance Program Document", Revised May, 1989.

23. U.S. Department of Energy, "General Environmental Protection Program", Order 5400.1, November, 1988.

24. Personal Communications, L. Mausner, Medical Department, BNL, 1986.

25. New York State Department of Environmental Conservation, Fuel Composition and Use, Part 225, Amended November, 1984.

26. Reliance Energy Services, "Stack Monitoring Program for Brookhaven National Laboratory Central Steam Facility", March, 1983.

27. Murphy, E. T., "Combustion of Alternate Liquid Fuels in High Efficiency Boilers", Air Pollution Control Association Annual Meeting and Exhibition, June, 1983.

28. Energy Research and Development Administration, Brookhaven National Laboratory, Final Environmental Impact Statement, July, 1977.

29. Brookhaven National Laboratory, "Safety Manual", OSHA Guide 6.1.0, 1984.

30. Denham, D. M., et al., "A CaF2:Dy Thermoluminescent Dosimeter for Environmental Monitoring", BNWL-SA-4191, 1972.

31. Budnitz, R. J., A. V Nero, D. J. Murphy, and R. Graven, "Instrumentation for Environmental Monitoring," Volume 1, Radiation, Second Edition, Lawrence Berkeley Laboratory, 1983.

32. U.S. Environmental Protection Agency Regulations on National Emission Standards for Hazardous Air Pollutants, 40 CFR 61 - Revised - Federal Register Vol. 54, No. 240, December 1989.

33. National Council on Radiation Protection and Measurements, Recommendations on Limits for Exposure to Ionizing Radiation, NCRP Report No. 91, 1987.

34. Action Plan for the Tiger Team Assessment Report, Brookhaven National Laboratory, BNL 52258, Revision 3, October 15, 1990.

35. Krulikas, R. K., "Hydrologic Appraisal of the Pine Barrans, Suffolk County, New York", Volume 1, January, 1987.

36. Dvirka and Bartilucci, "Suffolk County Comprehensive Water Resources Management Plan", Volume 1, January, 1987.

37. "Safe Drinking Water Act", New York State-Section 1414 (e): Aquifer Underlying Nassau and Suffolk Counties (NYS) designated as a sole source [U.S. EPA 42 USCA Section 3004-3 (e)].

38. Waste Management Area Aquifer Evaluation and Program Design for Restoration, Holzmacher, McLendon, and Murrell, P.C. in Association with Roux Associates, June, 1985.

39. Agreement Between Brookhaven National Laboratory and County of Suffolk, September, 1987.

40. Suffolk County Sanitary Code, Article 6, "Realty Subdivisions, Developments, and Other Construction Projects", Amended April, 1986.

41. Suffolk County Sanitary Code, Article 7, "Water Pollution Control", Amended April, 1986.

42. Suffolk County Sanitary Code, Article 10, "Air Pollution Control", Amended February, 1979.

43. Suffolk County Sanitary Code, Article 12, "Toxic and Hazardous Materials Storage and Handling Controls", Amended January, 1987.

44. New York State Environmental Conservation Law, Article 70 Part 621, Uniform Procedures Act.

45. Brookhaven National Laboratory, Unusual Occurrence Report, UOR 88-13, Accidental Release of Radioactivity from WCF Tank D-2, June 28, 1988.

46. Letter from C. J. Daggett (U. S. Environmental Protection Agency Region II) to D. Schweller (U. S. Department of Energy Brookhaven Area Office), Reference: PCB-Contaminated Fuel; Subject: U. S. Environmental Protection Agency Final Approval, January 21, 1986.

47. Environmental Compliance at Brookhaven National Laboratory, Office of the Inspector General, IG-36 (A90PR027), November 30, 1990.

48. New York Oil Spill, Control and Compensation Act, New York Navigation Law Article 12.

49. U.S. Department of Energy, "National Environmental Policy Act", Draft DOE Order 5440.1D, 1990.

50. Brookhaven National Laboratory, Unusual Occurrence Report, UOR 89-29, "Unauthorized Release of Material to Building 930 Recharge Basin", December, 1989.

51. IT Corporation, "Brookhaven National Laboratory Underground Storage Tank Investigation Sampling and Analysis Plan", July, 1989.

52. U.S. Environmental Protection Agency, "National Priorities List" Federal Register, November 21, 1989.

53. Evaluation of Ground Water Flow and Quality, Southern Boundary of BNL, Upton, NY, Geraghty and Miller, September, 1990.

54. "Appraisal of BNL Environmental Monitoring Program", Dames and Moore, December, 1989.

55. New York State Department of Environmental Conservation, Personal Communication, Dr. F. Panek, 1985.

56. U. S. Department of Energy, "Internal Dose Conversion Factors for Calculation of Dose to the Public", July, 1988.

57. U. S. Department of Energy, "Environmental Survey Preliminary Report", June, 1988.

58. "Compendium of Superfund Field Operations Methods", December, 1987, U.S. Environmental Protection Agency, Washington, D.C.

59. "USEPA contract Laboratory Program", Statement of Work for Organic Analysis; Multi-media/Multi-concentration, February, 1988.

END

DATE FILMED

6/24/92