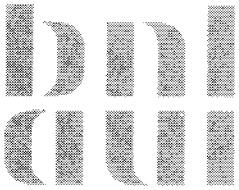
BNL-52207

BROOKHAVEN NATIONAL LABORATORY SITE REPORT FOR CALENDAR YEAR 1988

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



JUNE 1989

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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

UNDER CONTRACT NO. DE-AC02-76CH00016 WITH THE
UNITED STATES DEPARTMENT OF ENERGY

BNL-52207
UC-402
(Environmental Sciences -
DOE/OSTI-4500-R75)

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June 1989

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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: A08; Microfiche Copy: A01

BROOKHAVEN NATIONAL LABORATORY
SITE REPORT FOR CALENDAR YEAR 1988

CONTENTS

FIGURES

APPENDIX D TABLES

APPENDIX D TABLES

APPENDIX D TABLES

APPENDIX D TABLES

APPENDIX D TABLES

ACKNOWLEDGMENTS

The authors would like to thank the following people who offered valuable comments: N. Carter, W. Casey, L. Day, B. Fritz, N. Rohrig and J. Steimers.

There are numerous people in Safety and Environmental Protection and throughout the Laboratory who have, in some form or other, assisted in providing the necessary information. Their cooperation is gratefully acknowledged.

The efforts of the New York State Department of Environmental Conservation, Dr. Frank Panek and his staff, in the collection of biological samples are gratefully acknowledged.

This report was typed by Carrie Sauter and Marie DeAngelis of the Safety and Environmental Protection Division. Their conscientious efforts in typing, editorial work, and overall assistance in completing the report is commended.

1.0 INTRODUCTION

1.1 Site Mission

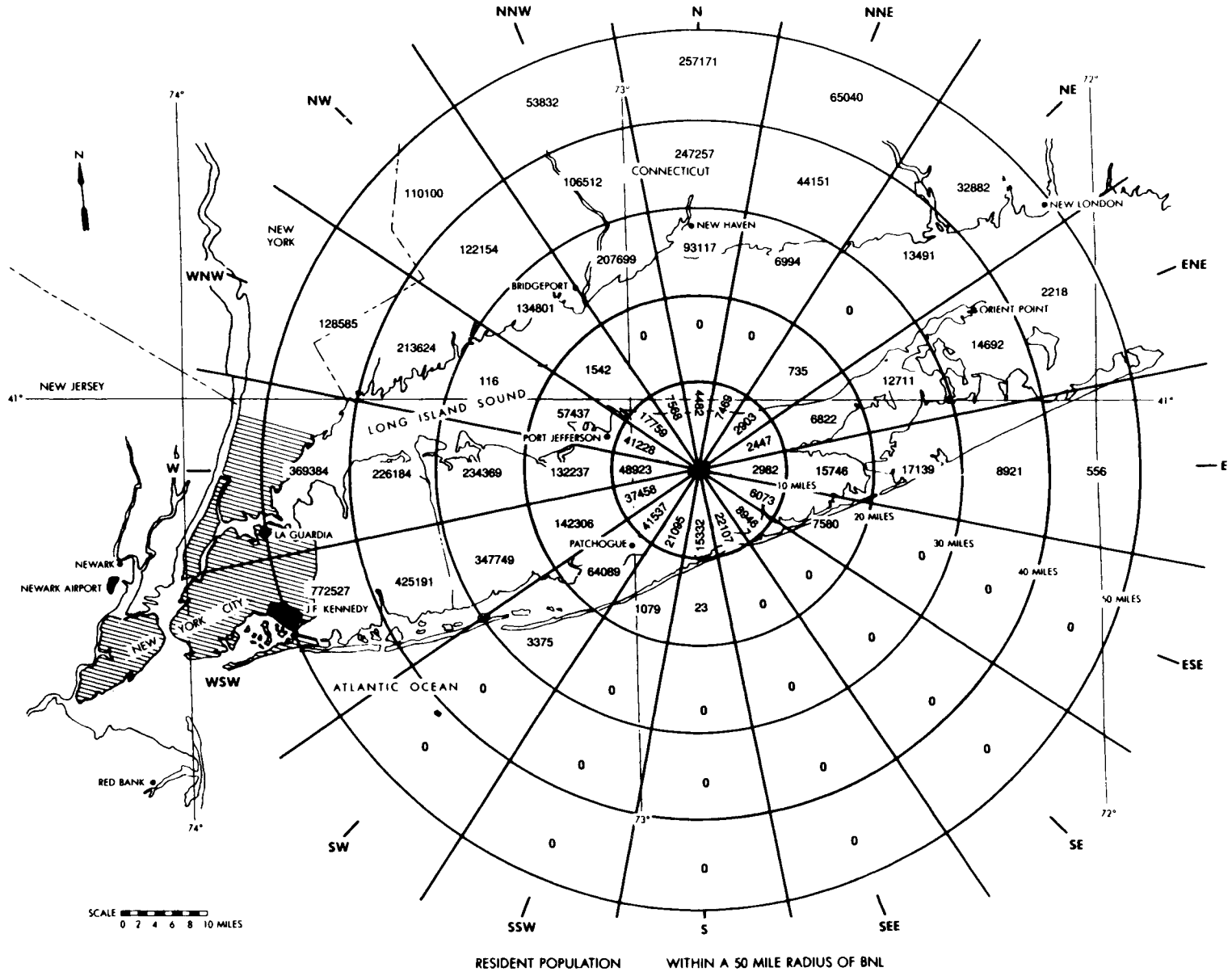
Brookhaven National Laboratory (BNL) is managed by Associated Universities Inc. (AUI), under Department of Energy (DOE) Contract No. DE-AC02-76CH00016. AUI was formed in 1946 by a group of nine universities whose purpose was to create and manage a laboratory in the Northeast in order to advance scientific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

1.2 Site Characteristics

BNL is a multidisciplinary scientific research center located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to the metropolitan area and local communities are shown in Figures 1 and 2 respectively. About 1.36 million persons reside in Suffolk County [1] and about 0.41 million persons reside in Brookhaven Township, within which the Laboratory is situated. Approximately eight thousand persons reside/within a half kilometer of the Laboratory boundary. The distribution of the resident population within 80 km of the BNL site is shown in Figure 1 and Appendix D, Table 1. The population distribution within 0.5 km of the BNL site is shown in Figure 2. Although much of the land area within a 16 km radius remains either forested or cultivated, there has been continuing residential and commercial development near the Laboratory during recent years.

The Laboratory site is shown in Figure 3. It consists of 21.3 square kilometers (2,130 hectares (ha)), most of which is wooded, except for a developed area of about 6.7 square kilometers (670 ha). The site terrain is gently rolling, with elevations varying between 36.6 and 13.3 m above sea level. The land lies on the western rim of the shallow Peconic River water shed. The marshy areas in the north and eastern sections of the site were formerly a principal tributary of the Peconic River. This tributary has been essentially dry since 1984. The absence of this tributary is most likely related to the regional drought, lowering of the water table, and increased residential land use. Liquid effluents from the BNL Sewage Treatment Plant (STP) constitute the principle source of water in the tributary's river bed. The BNL liquid effluents from the STP recharge to ground water prior to leaving the site boundary as is demonstrated by the lack of flow at the BNL site perimeter station, HQ. The Laboratory uses approximately 21 million liters of ground water per day to meet potable water plus heating and cooling requirements. Approximately 54% of the total pumpage was returned to the aquifer through on-site recharge basins and an additional 10% returned to the aquifer through discharges into the Peconic River Bed.



RESIDENT POPULATION WITHIN A 50 MILE RADIUS OF BNL

Figure 1: Resident Population Within an 80 km Radius of BNL (1988)

BROOKHAVEN NATIONAL LABORATORY
LOCAL AND ON-SITE POPULATION DISTRIBUTION

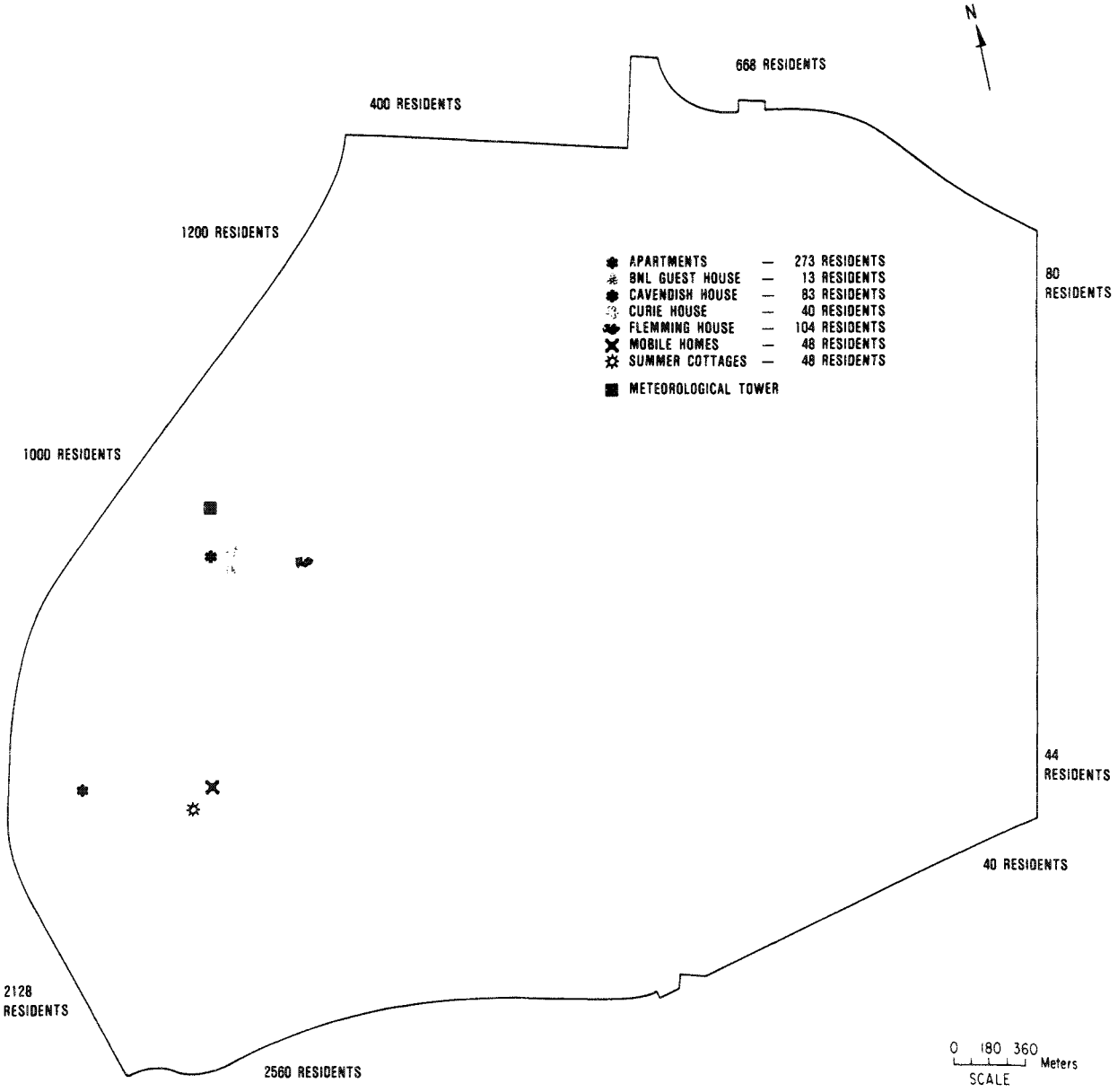


Figure 2: Brookhaven National Laboratory - Local and On-Site Population Distribution

Figure 3: Brookhaven National Laboratory - Major Facilities

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 ten year average wind rose for the BNL site is presented in Figure 4A and the 1988 annual wind rose for BNL is presented in Figure 4B. The average temperature in 1988 was 10°C and the range was -24°C to 35°C. Monthly minimum and average temperature data are presented in Appendix D, Table 2 and shown graphically in Figure 4C.

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 1988 was 109 cm, which is about 10 cm below the 40 year annual average. The historic and 1988 monthly precipitation data are presented in Figure 4D and 4E respectively. On the average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge ground water. The ground water in the vicinity of the Laboratory moves predominantly in a horizontal, southerly direction to the Great South Bay [4-7], while taking a more easterly direction in the Peconic River watershed portions of the site. Ground water velocity is estimated to range from 30 to 45 cm/d [7].

1.3 Existing Facilities

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

1. the fundamental structure and properties of matter,

2. the interactions of radiation, particles, and atoms with other atoms and molecules,

3. the physical, chemical, and biological effects of radiation, and of other materials,

4. the production of special radionuclides and their medical applications,

5. energy and nuclear related technology, and

6. the assessment of energy sources, transmission and uses, including their environmental and health effects.

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

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

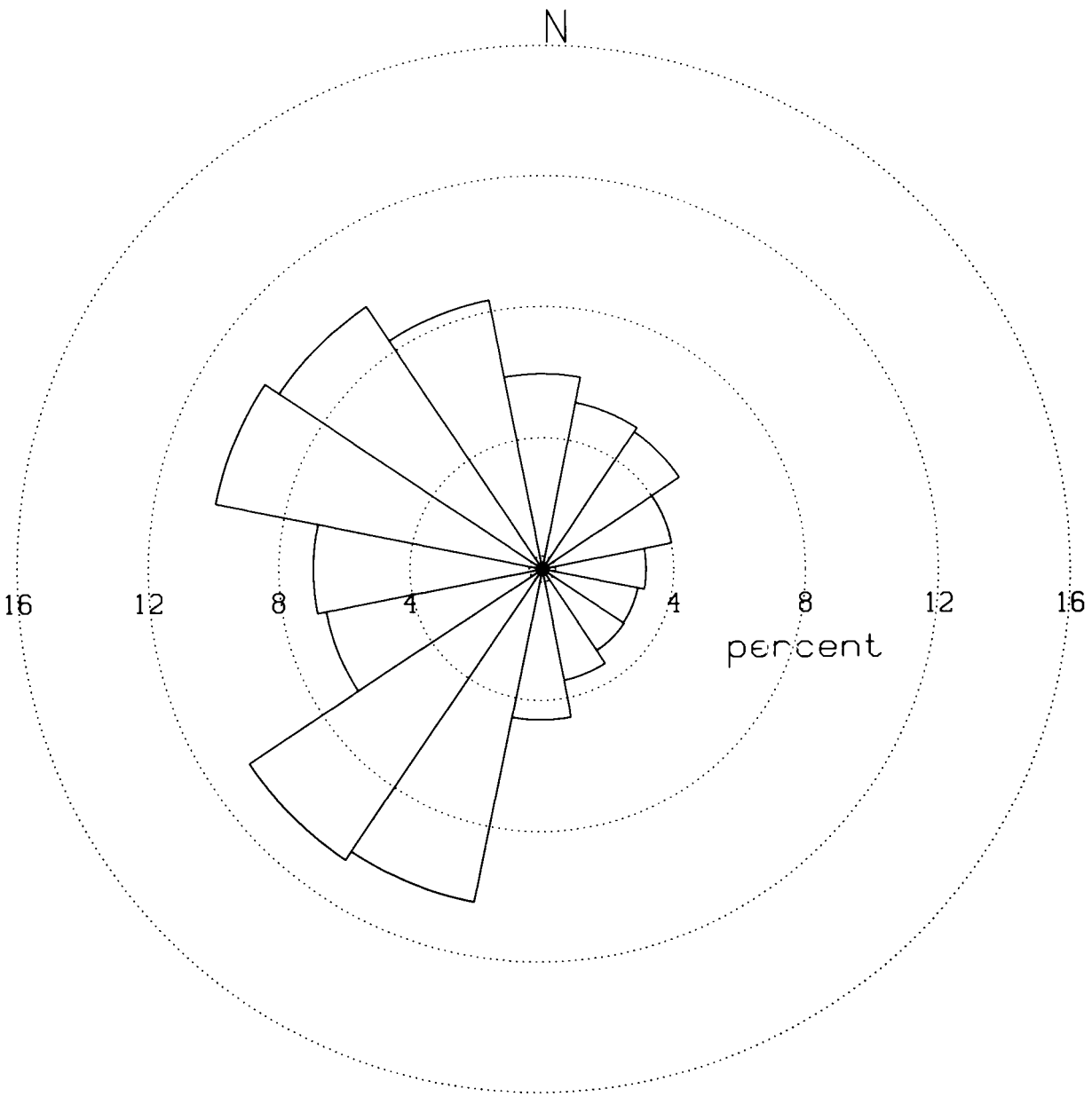


Figure 4A: Brookhaven National Laboratory – Historic Wind Rose

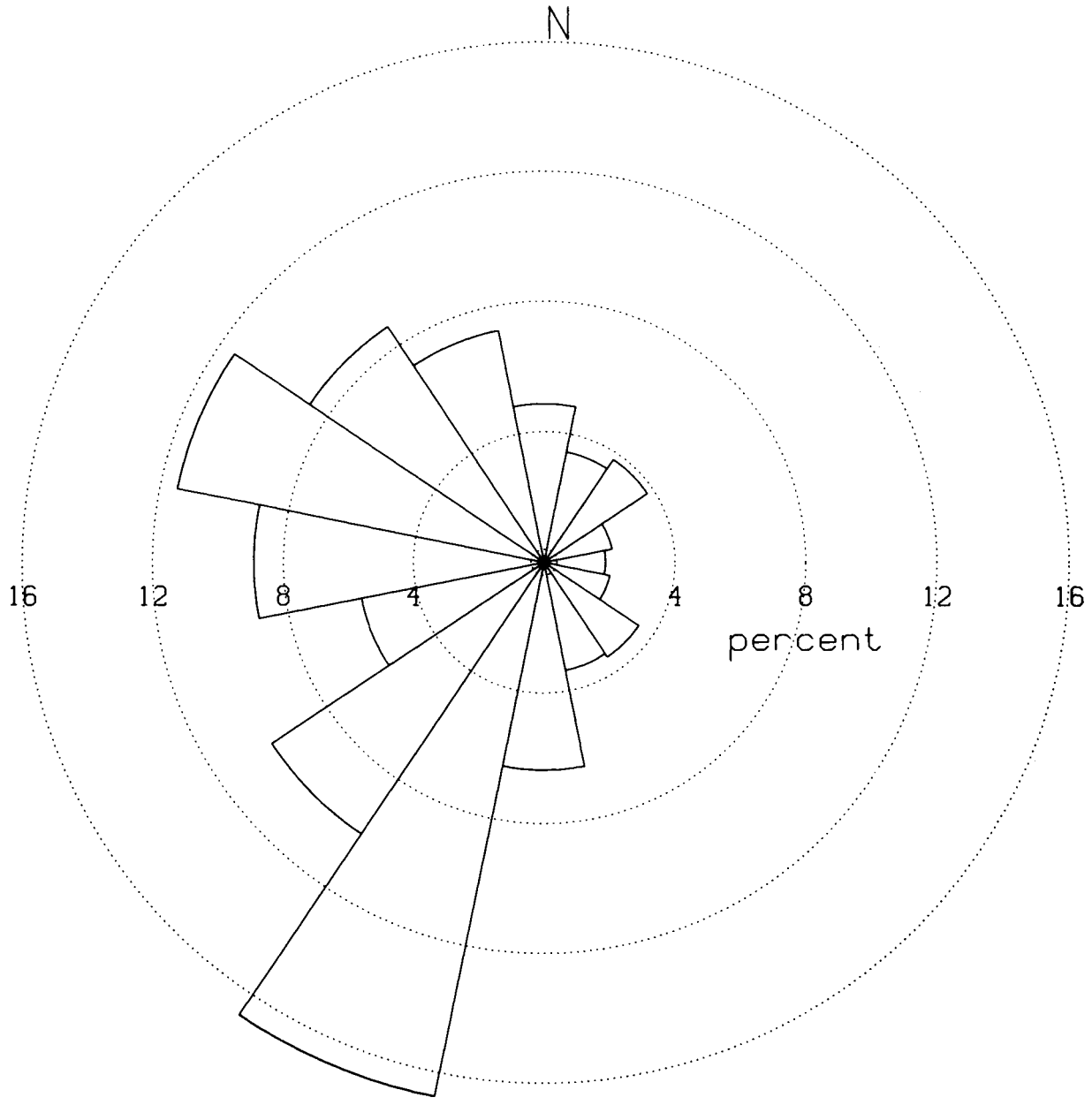


Figure 4B: Brookhaven National Laboratory - Annual Wind Rose (1988)

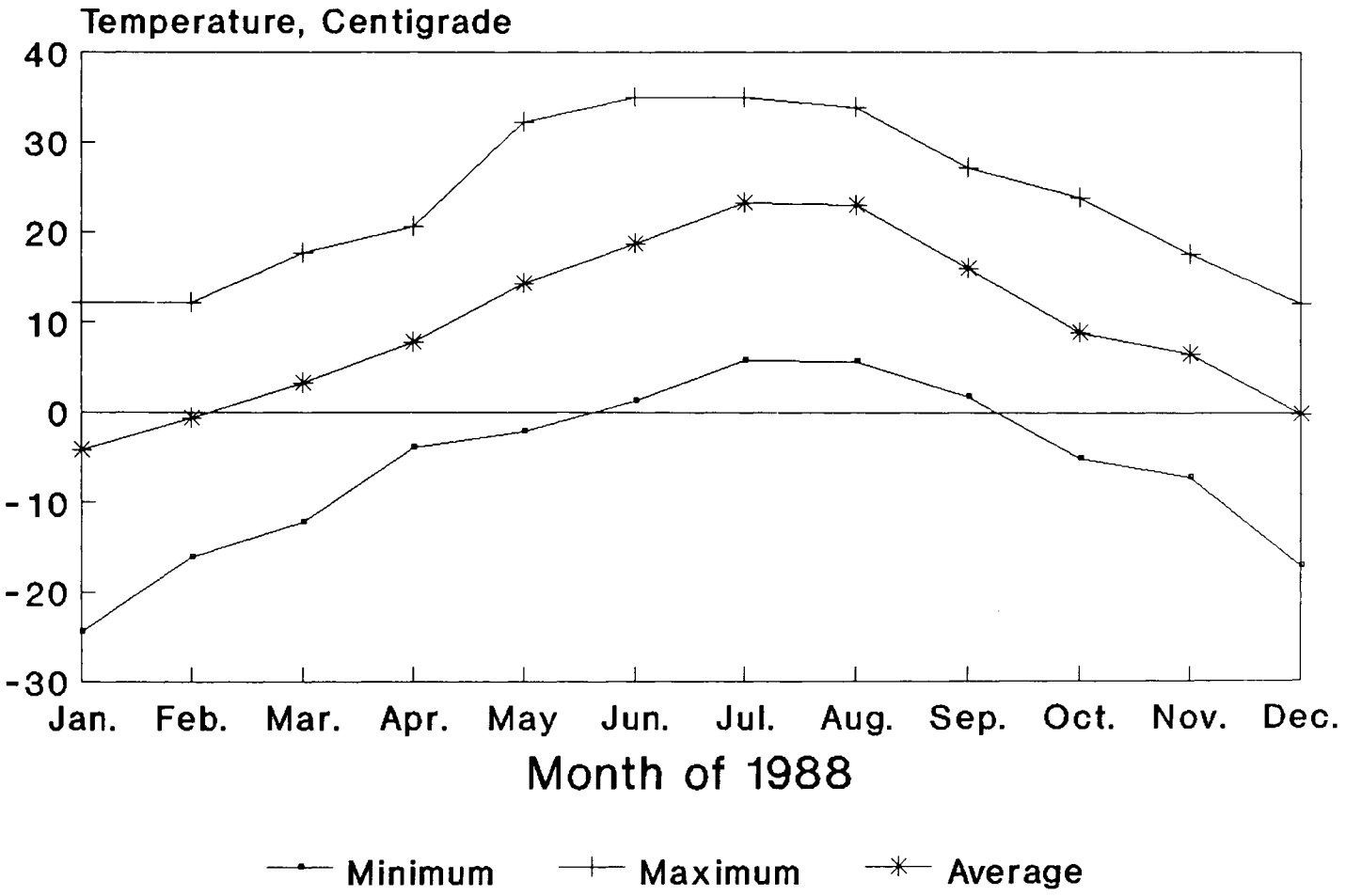


Figure 4C: Brookhaven National Laboratory - Annual Temperature Data (1988)

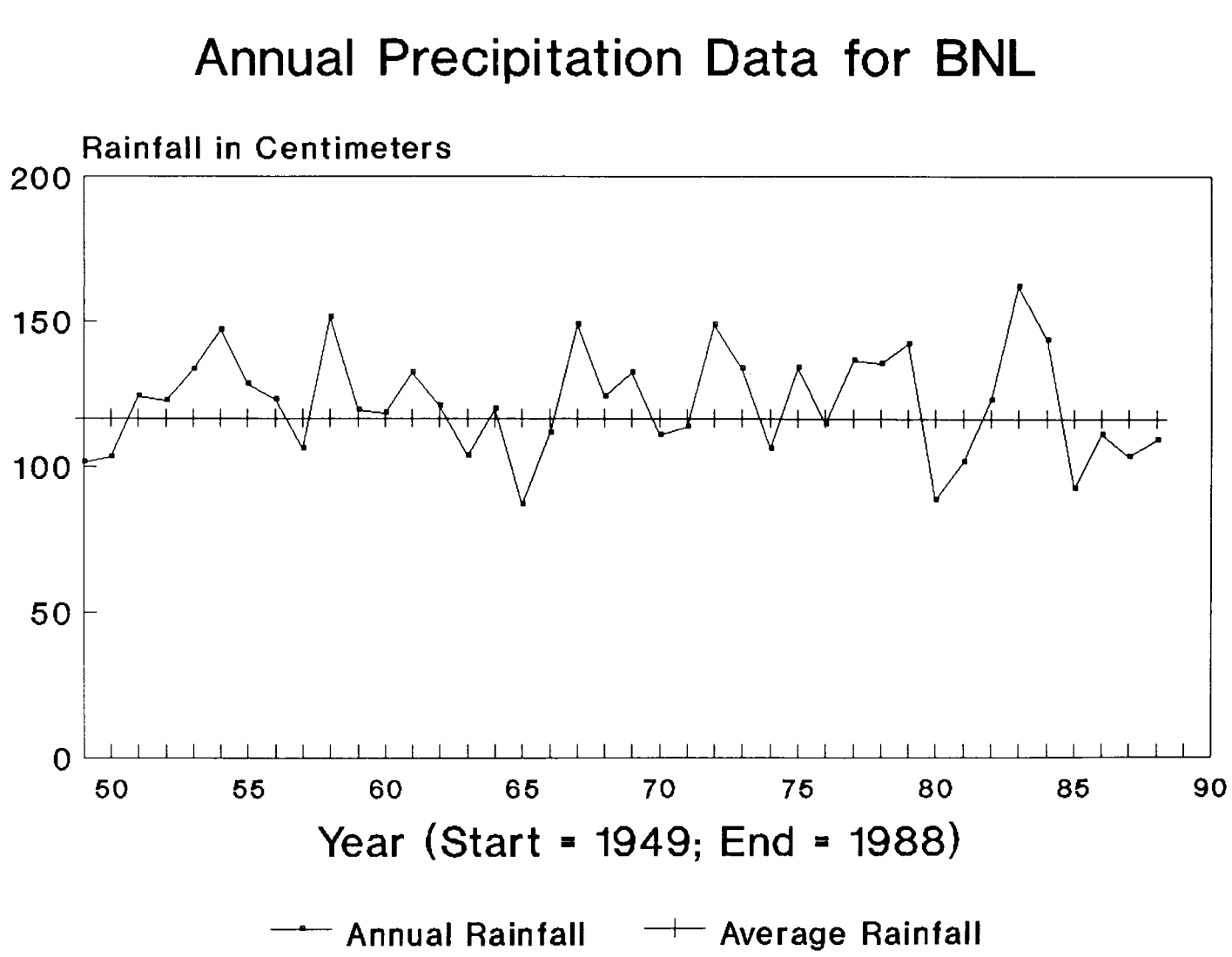


Figure 4D: Brookhaven National Laboratory - Annual Precipitation - 1949 to 1988

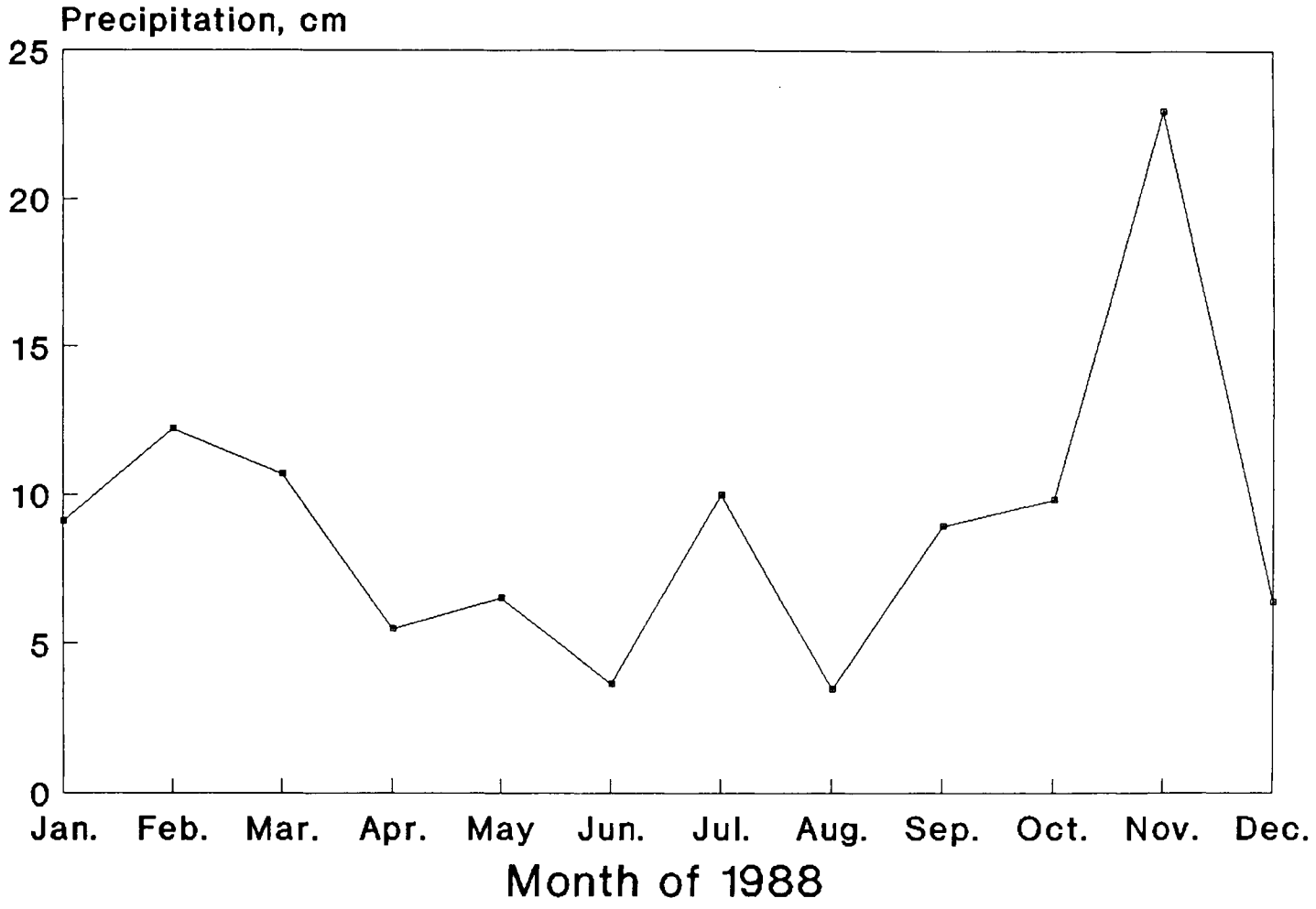


Figure 4E: Brookhaven National Laboratory - Annual Precipitation Data (1988)

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 Graaffs, Vertical Accelerator, Cyclotron, and research Van de Graaff are used in medium energy physics investigations, as well as for special nuclide production. The heavy ions from the Tandem Van de Graaffs are injected into the AGS for use in physics experiments.

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

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

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

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

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

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

2.0 SUMMARY

The environmental monitoring program is conducted to determine whether operation of BNL facilities have met the applicable environmental standards and effluent control requirements. This program includes monitoring for both radiological and nonradiological parameters. This report summarizes the data for the external radiation levels; radioactivity in air, rain, potable water, surface water, ground water, soil, vegetation, and aquatic biota; water quality, metals, organics and petroleum products in ground water, surface water and potable water.

The data were evaluated using the appropriate environmental regulatory criteria. Detailed data for the calendar year 1988 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 1988, 1,628 Ci of argon-41 were released from the MRR stack; 709 Ci of oxygen-15 were released from BLIP; 170 Ci of tritium gas and 268 Ci of tritium in the form of water vapor were released from the 3 MeV Van de Graaff, Chemistry, and HFBR stacks. Much smaller concentrations of airborne radioactive effluents were released from the Hot Laboratory, the Hazardous Waste Management Facility (HWMF), and the Chemistry Building.

2.2 Liquid Effluents

Liquid discharge limits for radiological and nonradiological parameters are subject to conditions listed in the BNL State Pollutant Discharge Elimination System (SPDES) Permit No. NY-000-5835. Radiological release concentrations for gross beta, radium and strontium are also prescribed by the SPDES permit limitations. Other radionuclide discharge concentrations are governed by the U. S. DOE specified Radiation Concentration Guides (RCGs) [8]. Since such liquid discharges have the potential of contaminating the "Sole Source Aquifer" underlying the Laboratory, liquid effluent data are compared not only to the regulatory limits, but also to parameters listed in the Safe Drinking Water Act (SDWA).

Operations at the STP were generally within the limits specified by the SPDES permit. Due to an unplanned discharge of cesium-137 and strontium-90 to the sanitary system, gross beta and nuclide specific concentrations for these radionuclides were higher in 1988 than in 1987. Strontium-90 releases exceeded SPDES permit concentrations in July although the annual average concentration of strontium-90 was only 40 percent of the SPDES permit. On two occasions in August, tritium concentrations at the discharge point to the Peconic River exceeded BNL Administrative guidelines. The elevated tritium concentrations resulted from normal operational releases and sanitary sewerage line-loss testing performed during this period. The annual average tritium concentration at this location was 0.16% of the RCGs [8] and only 23% of the BNL administrative limit.

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. Since recharge basins function as conduits to the underlying aquifer system, the nonradiological water quality parameters used in assessing the discharges were the New York State Drinking Water Standards (NYS DWS). Analysis of the nonradiological water quality parameters indicates that, with the exception of iron and pH, the discharge to the recharge basins met NYS DWS.

2.3 External Radiation Monitoring

Thermoluminescent dosimeters (TLDs) were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1988 was 63.2 $\pm$ 6.0 mrem, while the off-site integrated dose was 58.8 $\pm$ 6.8 mrem. 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, not BNL activities. These values are much lower than ambient exposure rates reported for the New York City area by the Environmental Protection Agency (EPA) for August, 1987 to July, 1988 which predict an annual dose of about 82 mrem [9,10,11,12].

2.4 Atmospheric Radioactivity

Tritium was the predominant radioactive effluent detected in environmental air samples. The maximum annual average tritium concentration at the site boundary was 7.2 pCi/m^3. This concentration would result in a committed effective dose equivalent of 0.006 mrem to the maximally exposed individual residing at the site boundary for the entire year.

2.5 Radioactivity in Precipitation

In rainfall, the following radionuclides were detected: beryllium-7, and strontium-90. The measured concentrations were consistent with typical washout values associated with atmospheric scrubbing [13] and are comparable with the most recently published data by EPA for Yaphank, New York (data on Yaphank is for April, 1987 to March, 1988 [9,10,11,12]).

2.6 Radioactivity in Soil or Vegetation

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

2.7 Peconic River

The concentration of metals and other indices of water quality in the Peconic River were comparable to those in the STP effluent reflecting ambient levels and well within drinking water standards. At the former site boundary (HM), the annual average gross beta concentration was 16.6 pCi/L or 33% of the NYS DWS; the average strontium-90 concentration was 4.7 pCi/L or 59% of the NYS DWS; and the average tritium concentration was 4.4 nCi/L or 22% of the NYS DWS. The STP effluent recharged completely to ground water prior to reaching the site perimeter in 1988.

The Peconic River was sampled in Riverhead, approximately 19.5 km down stream of the site boundary. The average gross alpha concentration was -0.08 pCi/L; the average gross beta concentration was 0.62 pCi/L, and the average tritium concentration was below the analytical detection limit of the system. The Carmans River was sampled as a control location. The average gross alpha concentration was 0.013 pCi/L; the average gross beta value was 0.45 pCi/L and the average tritium value was below the analytical detection limit of the system. The equivalency of the control and Riverhead sample data indicates that BNL operations did not have an impact on radionuclide concentrations in water at the downstream sample location.

2.8 Aquatic Biological Surveillance

Fish samples were collected along the Peconic River at the outfall of the STP (Station EA), the former site boundary (Station HM), Donahue's Pond and Forge Pond. Samples were also collected at Sandy Pond which is a control location. In calendar year 1988, gamma spectroscopy analysis was performed on these samples. The Peconic River fish contained cesium-137 concentrations which ranged from background levels at Forge Pond (100 - 300 pCi/kg-wet) to 25,000 pCi/kg-wet at Station HM. In 1988, the tributary of the Peconic River which has its head waters at the BNL site recharged to ground water during the course of the year. Because fish collected at BNL on-site locations were not capable of migrating off-site, the maximum individual and collective dose from the aquatic biological pathway were calculated based on the cesium-137 concentrations that were observed in samples collected off-site at Donahue's pond. Based on these results, the maximum individual dose was estimated to be 0.15 mrem and the collective dose was estimated to be 39 person-mrem.

2.9 Potable Water Supply

Gross alpha, beta and tritium concentrations in on-site potable well samples were generally at or near the minimum detection limit (MDL). The daily grab sample of potable water collected from a central building on-site exhibited the same results. The highest average tritium concentration in on-site potable well water was 230 pCi/L (the MDL for tritium was typically 300 pCi/L). This concentration if consumed for one year would correspond to a committed effective dose equivalent to the on-site resident of 0.011 mrem. Other nuclides, including beryllium-7, cobalt-60, and sodium-22, were detected in several wells. The committed effective dose equivalent from ingesting these concentrations would be 0.018 mrem and the total dose from all radionuclides would be 0.029 mrem or 0.7% of the dose limit specified in the SDWA. These doses represent an upper limit to the dose actually received because the concentrations used to derive these doses were obtained from analyzing samples from the individual well heads and does not account for mixing that would occur when the water is distributed throughout the site.

Metal analyses performed on potable water samples indicate that silver, cadmium, chromium, copper and zinc were not detected in any sample and that trace quantities of lead (0.002 mg/L), and manganese (0.05 - 0.07 mg/L) were detected in potable well water. All observed values of lead and manganese were substantially below the NYS DWS of 0.025 mg/L and 0.3 mg/L. Iron was detected

in water collected at the well head from Well Nos. 6 and 7. Water from these wells is treated at the BNL Water Treatment Plant prior to use in the domestic water distribution system. Sodium was detected in all potable wells in concentrations ranging from 8.2 to 13.4 mg/L.

2.10 Ground Water Surveillance

Ground water surveillance data are compared to both RCGs and Drinking Water Standards. By comparing ground water data to the RCGs, the Laboratory demonstrates that releases from past practices did not exceed regulatory limits in place at that time. Comparison of surveillance well data to EPA, New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH) Drinking Water Standards, which are technically applicable to community water supplies serving more than twenty-five individuals, demonstrates the Laboratory's commitment to monitor and remediate, where necessary, ground water which does not meet current regulatory criteria.

2.10.1 Radiological Analyses

Elevated gross beta and tritium concentrations have been found on-site adjacent to the STP sand filter beds and the Peconic River. The observed levels are attributed to water losses from the tile collection field underlying the sand filter beds and the recharge of the Peconic River in these areas. In 1988, the maximum gross beta and tritium ground water concentrations for this area were 27% and 34%, respectively, of the applicable New York State Standards [14,15]. Adjacent to the Peconic River at the site boundary, the annual average gross beta concentration was 8% and the annual average tritium concentration was 11% of the applicable New York State Standard. 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 12% of the New York State Standards. Tritium was not detected.

In addition to the BNL off-site surveillance wells, 20 private potable wells 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 two off-site wells. The annual average tritium concentrations at these locations were less than 15% of the EPA DWS [16]. Except for naturally occurring potassium-40, no gamma emitting radionuclides were detected and strontium-90 values ranged between 0.1 and 1.4 pCi/L, which is typical for Long Island.

At the current and former landfill areas, the single highest average gross beta concentration observed was 49% of the applicable guide, the single highest average tritium concentration and strontium-90 concentration observed were 75% and 230% respectively of the EPA DWS. Given the distance to the site boundary, the rate of movement for these radionuclides and radioactive decay, the radionuclide concentrations at the site boundary are anticipated to be substantially below the applicable standards.

The data from the ground water program at the HWMF indicate the presence of tritium, fission, and activation products. The single highest average concentration of cesium-137, cobalt-60, sodium-22, tritium and strontium-90 was

0.0027%, 0.005%, 0.34%, 165% and 578% respectively, of the RCGs or NYS DWS. Concentrations of these radionuclides were below the RCGs or NYS DWS in fifteen out of the twenty wells monitoring this facility.

2.10.2 Nonradiological Analyses

Iron and manganese were found in excess of the New York State Standards in several monitoring wells on-site. Lead concentrations exceed New York State Standards at one on-site monitoring well. However, with the exception of wells which monitor the landfill, this appears to be related to corrosion from the well casings and not to Laboratory effluents. At the landfill, the maximum concentrations of iron, and manganese, were 95 and 2.8 mg/L, respectively.

Chlorocarbons were detected in monitoring wells near the current landfill, control wells, wells which monitor the former landfill, and wells in the vicinity of the HWMF. Concentrations of trihalomethane compounds and benzene, toluene and xylene (BTX) were also detected at many of these locations. The highest concentrations of organic compounds in ground water were observed near the HWMF where the Laboratory initiated an aquifer restoration program in 1985. Because of this program, which operates with a greater than 95% reduction of organic concentrations, samples from wells in this area have significantly reduced organic concentrations compared to 1985, 1986 and 1987 data.

An additional area of concern is near the Central Steam Facility (CSF) where organic compounds were detected in soil during installation of ground water surveillance wells in 1986 to meet the requirements specified for a Major Petroleum Storage Facility. IT Corporation completed a study to delineate the extent of soil and ground water contaminated by the 1977 spill of mineral spirits and No. 6 fuel oil [17]. Based on these observations, IT Corporation evaluated potential remediation options and provided BNL with a draft document which contains their proposed ground water remediation plan [18]. This issue is discussed in more detail in Section 6.1 of this report.

2.11 Off-Site Dose Estimates

For the year 1988, the collective dose-equivalent attributable to Laboratory operations, for the population up to distance of 80 km, was calculated to be 2.46 rem. This can be compared to a collective dose-equivalent to the same population of approximately 300,000 rem due to natural sources.

3.0 EFFLUENT EMISSIONS

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

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

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

This annual report for calendar year 1988 follows the recommendations given in the DOE Order 5400.1, General Environmental Protection Program [19,20].

3.1 Airborne Effluent Emissions

3.1.1 Radioactive Airborne Effluent Emissions

The locations of principal Laboratory facilities from which radioactive airborne effluents are released are shown in Figure 5. The installed on-line effluent monitors, sampling devices and amounts of effluents released during 1988 are presented in Appendix D, Table 3. Tritium was the only radionuclide detected at the site boundary which was attributable to Laboratory operations.

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 [21]. Based on 118 milliampere-hours of operation, 709 Ci of oxygen-15 was produced in the beam tubes at the BLIP facility during 1988 and released via the stack. Due to extended maintenance at the BNL LINAC, BLIP operated during the first six months of 1988. Monthly effluent emissions are listed in Appendix D, Table 4.

Argon-41, which has a 110-minute half-life, is produced at the MRR by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the stack at an estimated rate of 2 Ci $MW^{-1}h^{-1}$. The estimated release for the MRC stack during 1988 was 1,628 Ci of argon-41. Monthly effluent emissions are listed in Appendix D, Table 4.

Of the 267 Ci of tritiated water vapor released from the Laboratory research facilities during 1988, 189 Ci were released from the HFBR, 76 Ci from the Van de Graaff, and the remainder from all other facilities. Appendix D, Tables 5 and 6 present monthly summaries of tritium release data.

The Building 705, 100-meter stack, receives airborne effluents from three separate exhaust systems: the HFBR (Building 750) and the Hot Laboratory (Building 801) acid and non-acid lines. Gamma emitting nuclides released from the 100-meter stack are shown in Appendix D, Table 6. Bromine-82, iodine-131 and iodine-133 are present as a result of operations and experimental activities at the HFBR. The remaining radionuclides are released from the Hot Laboratory complex as the result of processing BLIP targets for the recovery of radioisotopes used by medical health practioners. At the BLIP facility, other radio-

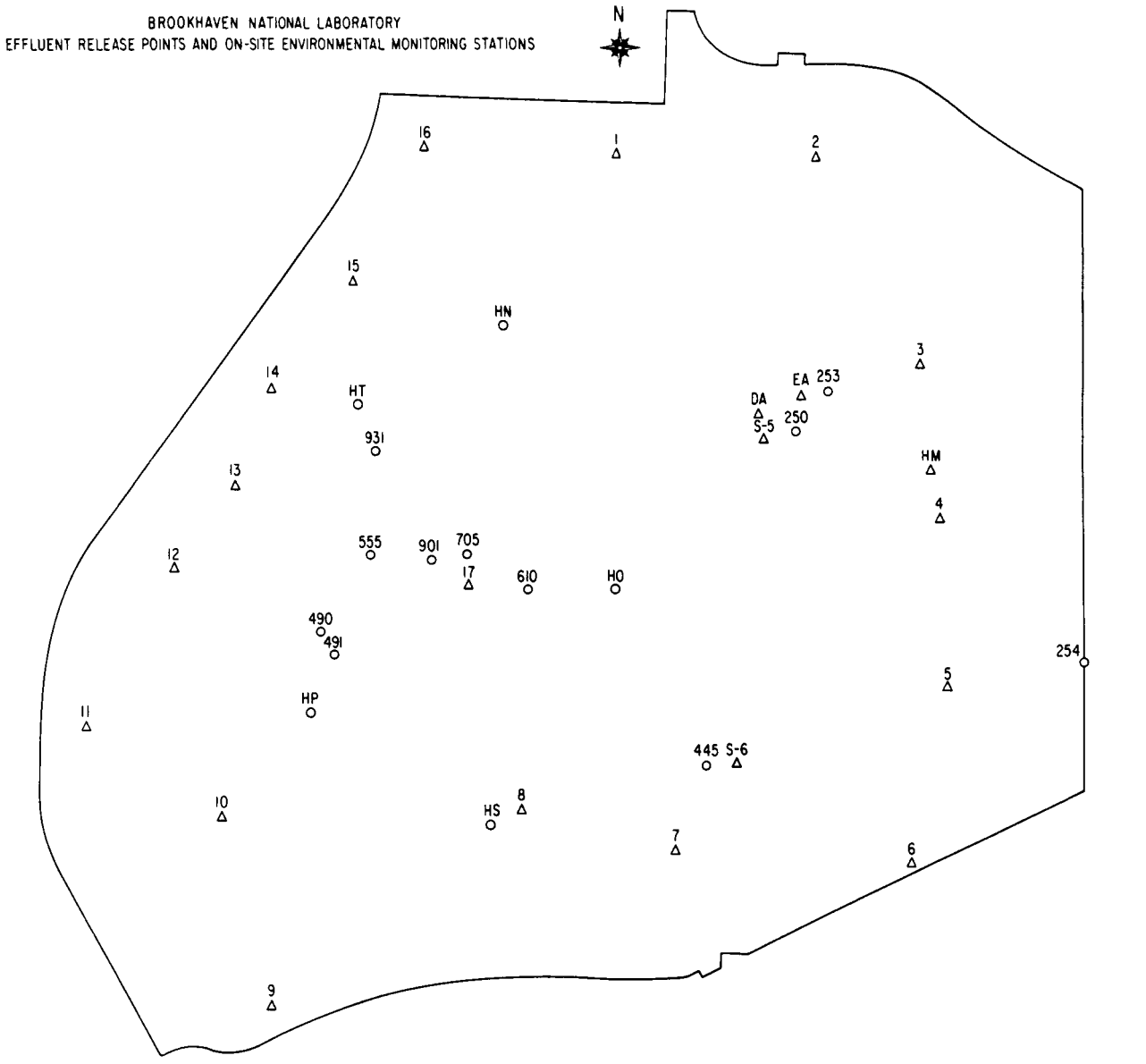


Figure 5: Brookhaven National Laboratory - Effluent Release Points and On-Site Environmental Monitoring Stations

nuclides in addition to oxygen-15 can be produced and are periodically emitted into the environment. Appendix D, Table 7, summarizes the gamma emitting radionuclides released from this facility.

The Laboratory incinerates certain wastes which contain low-level radioactivity at the HWMF incinerator (Figure 5). The total quantities of the individual radionuclides in the incinerated materials during 1988 are shown in Appendix D, Table 8. Tin-113 was the radionuclide released from the incinerator in the largest quantity, 0.0002 Ci. Site meteorological characteristics and administrative limits on the amount of material incinerated ensure that airborne concentrations at the site boundary are small fractions of the applicable standards.

3.1.2 Nonradioactive Airborne Effluent Emissions

The potential sources of elemental and hydrocarbon air pollutants emitted by BNL facilities and all environmental permits issued to the DOE at BNL are listed in Appendix D, Table 9. Under the air permits issued by the NYSDEC, individual stack monitoring is not required since emissions are reduced at the source through the use of pollution control equipment appropriate for the specific process.

The CSF (Building 610) 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 1988, the fraction of light feed stock (LFS) relative to total fuel consumption was approximately 7.2%, a substantial decrease from previous years. These LFS fuels typically have a weighted average sulfur content of 0.5% or less as compared to the NYSDEC regulatory limit of 1% sulfur content in No. 6 oil [22]. NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum [22]. 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 [23,24], thus providing greater combustion efficiency than required by state criteria. Samples of all LFS used are routinely analyzed for polychlorinated biphenyls (PCBs) prior to their use to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations.

BNL is currently proceeding with plans and specifications to upgrade all tanks to conform with requirements 373-2.10(h) and provisions of Suffolk County Sanitary Code Articles 7 and 12. Remediation of ground water in this location is scheduled for implementation in FY91.

3.2 Liquid Effluents

The basic principle 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 [25]. Accordingly,

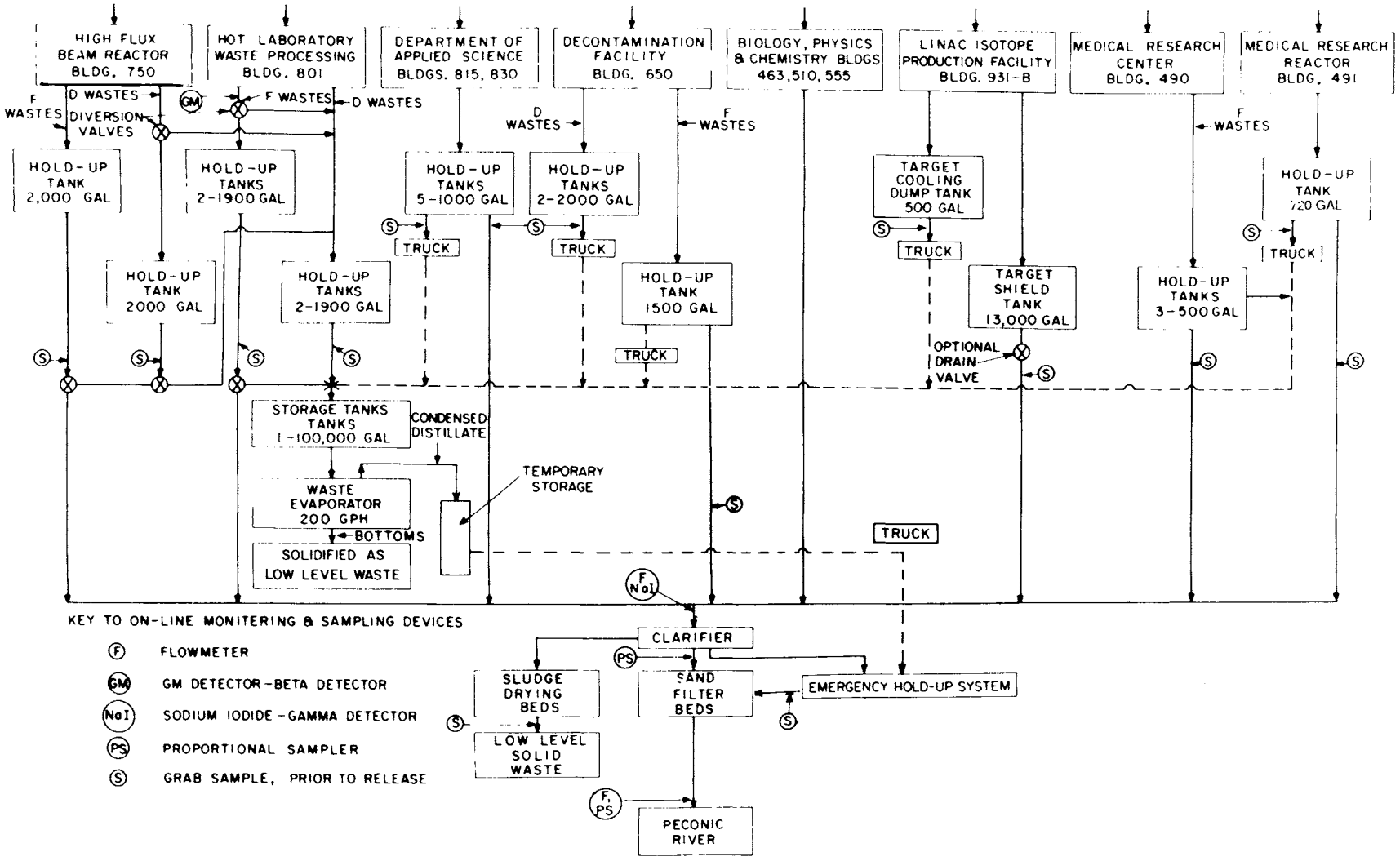


Figure 6: Liquid effluent systems Brookhaven National Laboratory.

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. 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 6, 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 sufficiently low [26] or are transferred to the WCF for processing. In 1988, authorized releases of F-waste to the sanitary system totaled 0.96 million liters with a total gross beta activity of 7.2 mCi and a total tritium activity of 176 mCi. These values do not include the June 14 - 15, 1988 release of liquid from the WCF complex. This release is discussed in Section 3.2.2.1 of the report.

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 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 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 and the goal of 10,000 pCi/L. By comparison, the RCG [8] for tritium is 3,000,000 pCi/L.

3.2.2 Sanitary System Effluents

Primary treatment of the sanitary waste stream to remove suspended solids is provided by a 950,000 liter clarifier. The liquid effluent flows from the clarifier onto sand filter beds, from which about 80% of the water is recovered by an underlying tile field. This recovered water is then released into a small stream that formerly contributed to the headwaters of the Peconic River. In recent years, virtually all water released to this channel has recharged to ground water prior to reaching the site boundary. The balance, about 20%, is assumed to percolate to the ground water under the beds and/or is lost through evaporation. A schematic of the STP and its related sampling arrangements is shown in Figure 7. Volume proportional and grab samples were collected each working day at the STP.

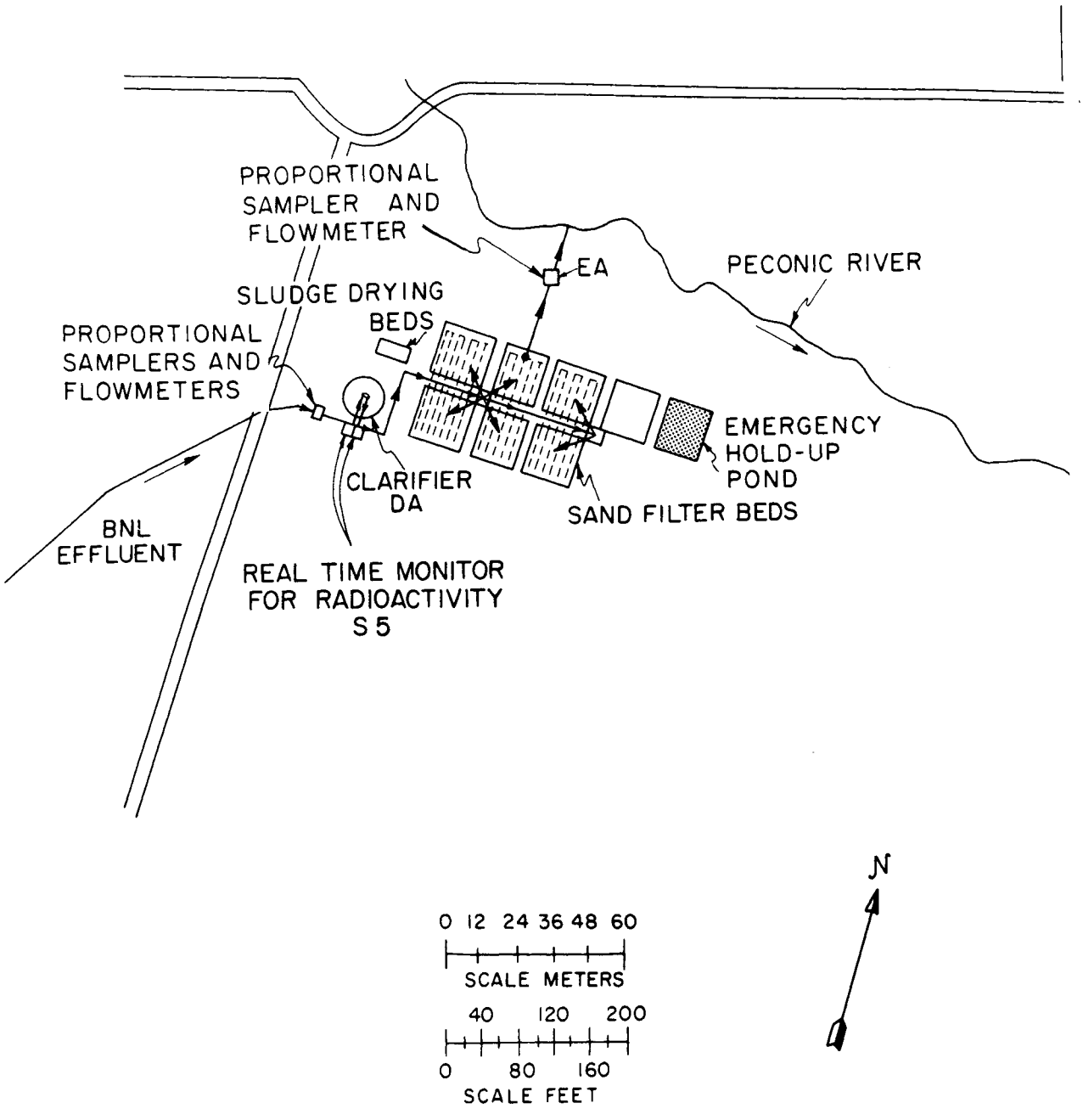


Figure 7: Sewage Treatment Plant
Sampling Stations

3.2.2.1. Radiological Analyses

The proportional samples collected at Station DA, the effluent from the STP clarifier, and Station EA, the STP discharge point into the Peconic River, are analyzed daily for gross alpha, beta and tritium activities. An aliquot is composited for monthly strontium-90 and gamma spectroscopy analyses. The results of these measurements are reported in Appendix D, Tables 10 and 11. Current and historic trend plots of gross beta and tritium concentrations that were released to the Peconic River are presented in Figures 8 and 9.

The gross alpha data at the STP remained virtually constant between 1987 and 1988. The tritium concentrations increased in 1988 on the average by about 40%. The 1988 tritium concentrations were below regulatory standards and were within administrative controls. The reason for the increase stems from fewer heavy water changes at the HFBR and the controlled release of WCF distillate from the STP holding pond. The total tritium activity released into the sanitary system was 4.1 Ci as compared to 2.8 Ci in 1987. The tritium activity discharged from Station EA was 3.6 Ci as compared to 2.8 Ci in 1987. The gamma emitting radionuclides, except for cesium-137 remained essentially constant with prior year's data [27].

The gross beta data for the STP were highly influenced by a contamination event that occurred on June 14 - 15, 1988. Water from the WCF, which was sampled, analyzed and determined to have virtually no activity, became contaminated with cesium-137 and strontium-90 during the discharge process. As a result, about 120 mCi of gross beta activity entered the STP system. Of this activity, approximately 90 mCi was cesium-137 and 15 mCi was strontium-90 in equilibrium with yttrium-90. This single incident was responsible for the elevated annual average gross beta, cesium-137 and strontium-90 concentrations at the clarifier station (DA). If one removes the contribution from this incident, then the average clarifier gross beta concentration becomes 13.5 pCi/L, the cesium-137 concentration becomes 3.6 pCi/L and the strontium-90 concentration is reduced to 1.5 pCi/L. These concentrations are consistent with prior year's results [27].

At Station EA, the chlorine house outfall, the impact of this single incident is reflected by elevated gross beta, cesium-137, and strontium-90 concentrations from June through December. This occurred even with diversion of the clarifier effluent to the STP emergency hold-up pond and removal of sand from the sand filter beds. Residual cesium-137 and strontium-90 have continued to leach from the beds at a slow rate. Most of the residual strontium-90 had been eliminated by the end of September, but the cesium-137 continues to slowly disassociate from the sand. The agreement between the gross beta and cesium-137 concentrations is quite close beginning in September and continuing through the remainder of the year.

As a result of this incident, the strontium-90 concentration exceeded the SPDES permit discharge limit in July. The annual average concentration for all parameters is within the permit conditions.

Gross Beta Concentration Data
Sewage Plant and Peconic River

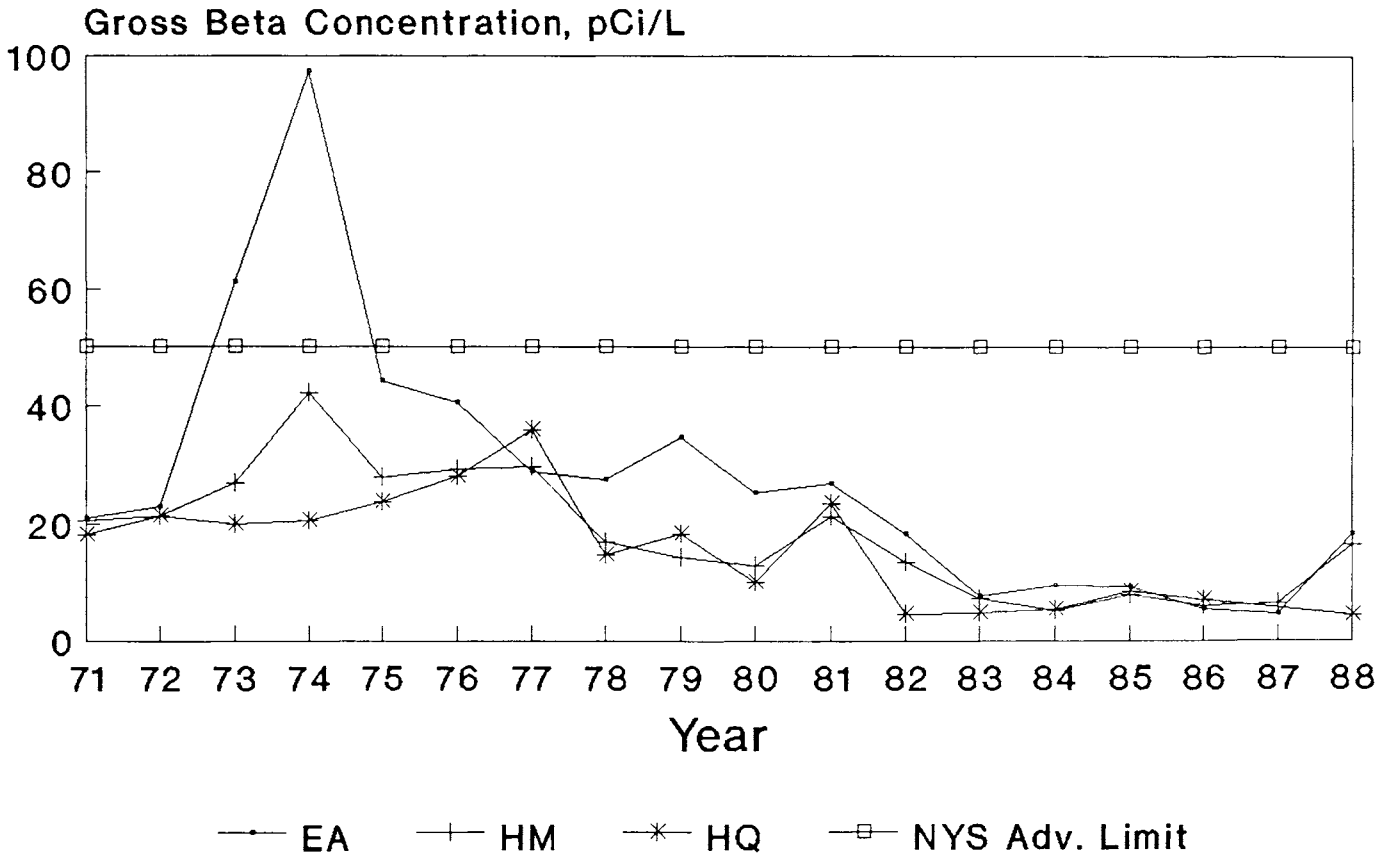


Figure 8: Trend Data - Gross Beta Concentration Data - Sewage Plant and Peconic River 1971 - 1988

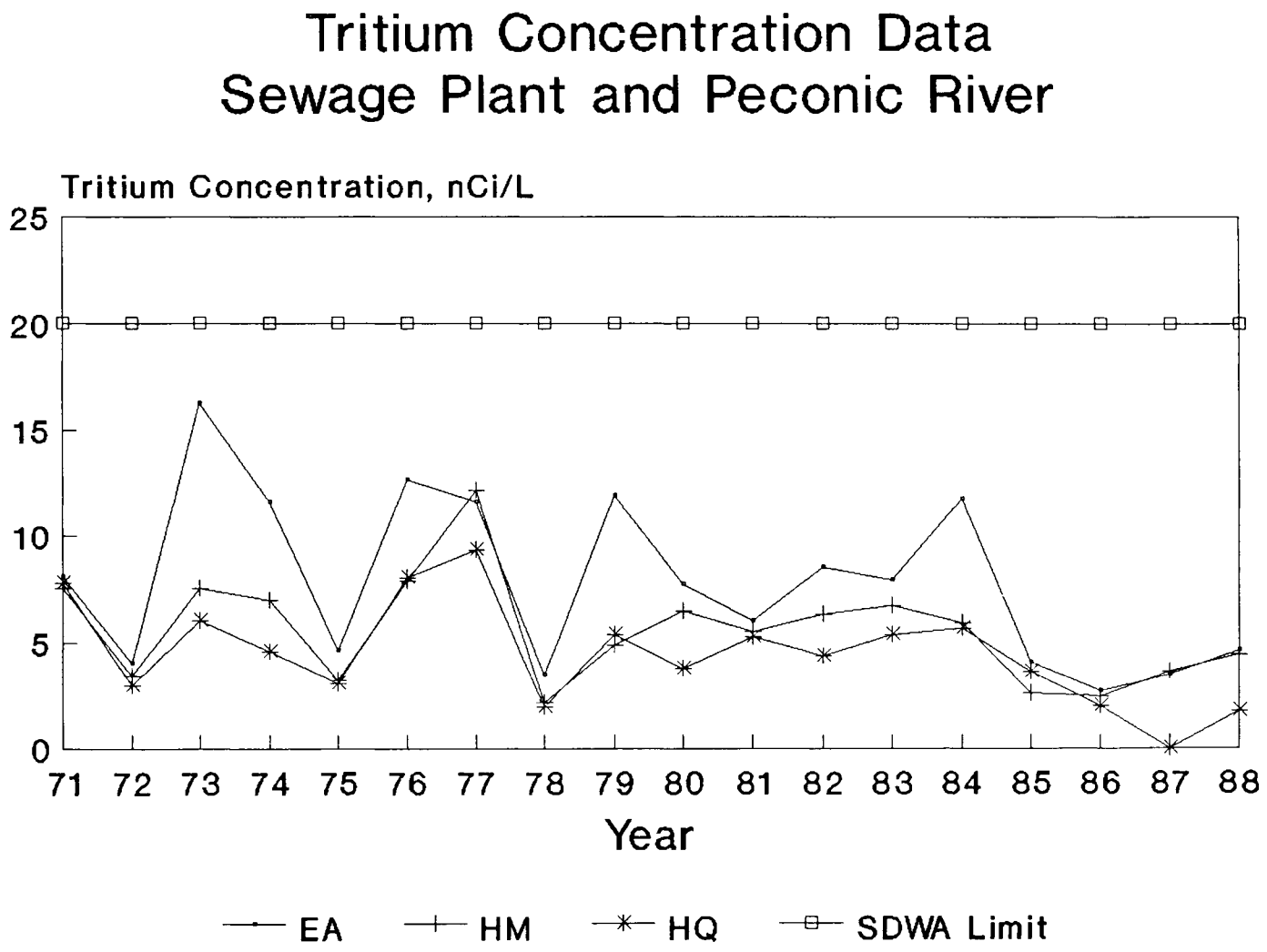


Figure 9: Trend Data - Tritium Concentration Data - Sewage Plant and Peconic River 1971 to 1988

3.2.2.2 Nonradiological Analyses

The effluent from the Laboratory STP (Station EA) is subject to the conditions of the SPDES Permit No. NY-000-5835, authorized by the NYSDEC. Monitoring reports, which include analytical results, are submitted on a monthly basis to the NYSDEC and the SCDHS. A summary of the nonradiological data for 1988 is shown in Appendix D, Table 12. The summary includes data required under the permit and additional analyses which were performed under the Laboratory's broader surveillance program. Operation of the STP resulted in a greater than 99% compliance rate in meeting permit requirements.

3.2.3 Recharge Basins

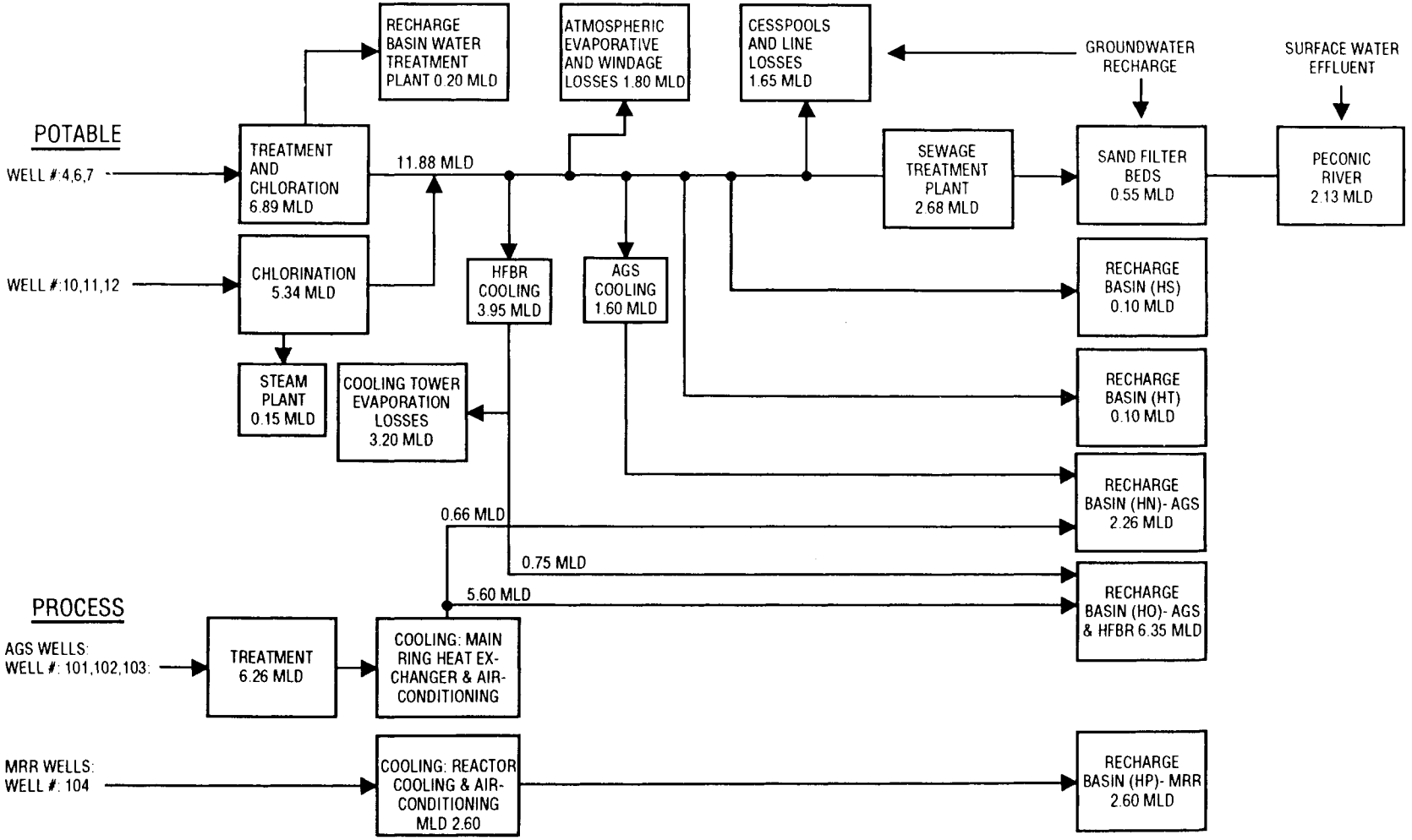
An overall schematic of water use at the Laboratory is shown in Figure 10. After use in "once through" heat exchangers and process cooling, approximately 11.4 MLD of water was returned to the aquifer through on-site recharge basins; 2.3 MLD to basin HN located about 610 m northeast of the AGS; 6.4 MLD to basin HO about 670 m east of the HFBR; and 2.6 MLD to basin HP located 305 m south of the MRR. The locations of the basins on the Laboratory site are shown in Figure 11. A polyelectrolyte and dispersant was added to the AGS cooling and process water supply to keep the ambient iron in solution. Of the total AGS pumpage, approximately 0.66 MLD was discharged to the HN basin, and 5.6 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 (0.75 MLD) was also discharged to the HO basin. The MRR secondary cooling water (2.6 MLD) was adjusted to a neutral pH prior to use and then discharged to the MRC sump shown in Figure 11. Grab samples were collected at all recharge basins for analysis of water quality.

3.2.3.1 Recharge Basins - Radiological Analyses

Radiological results for recharge basin samples are reported in Appendix D, Table 13. The data indicates that trace quantities of activity were discharged to all recharge basins. The activity detected at recharge basin HN results from the discharge of primary magnet rinse water into the recharge basin. The observed concentrations of beryllium-7 and sodium-22 result from high energy particle interactions in the cooling water at both the AGS and LINAC facilities. The presence of cobalt-60 is most likely due to activation of facility components and subsequent corrosion. No samples contained strontium-90 above the detection limit and for virtually all samples the tritium concentration was less than the system MDL. All concentrations detected were small fractions of effluent release limits. If a person ingested water from sump HN as the sole source of drinking water for one year, this would result in a committed effective dose equivalent of less than 0.05 mrem.

3.2.3.2 Recharge Basins - Nonradiological Analyses

In 1988, approximately 11.4 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



Brookhaven National Laboratory
Schematic of Water Use And Flow

Figure 10: Brookhaven National Laboratory: Schematic of Water Use and Flow

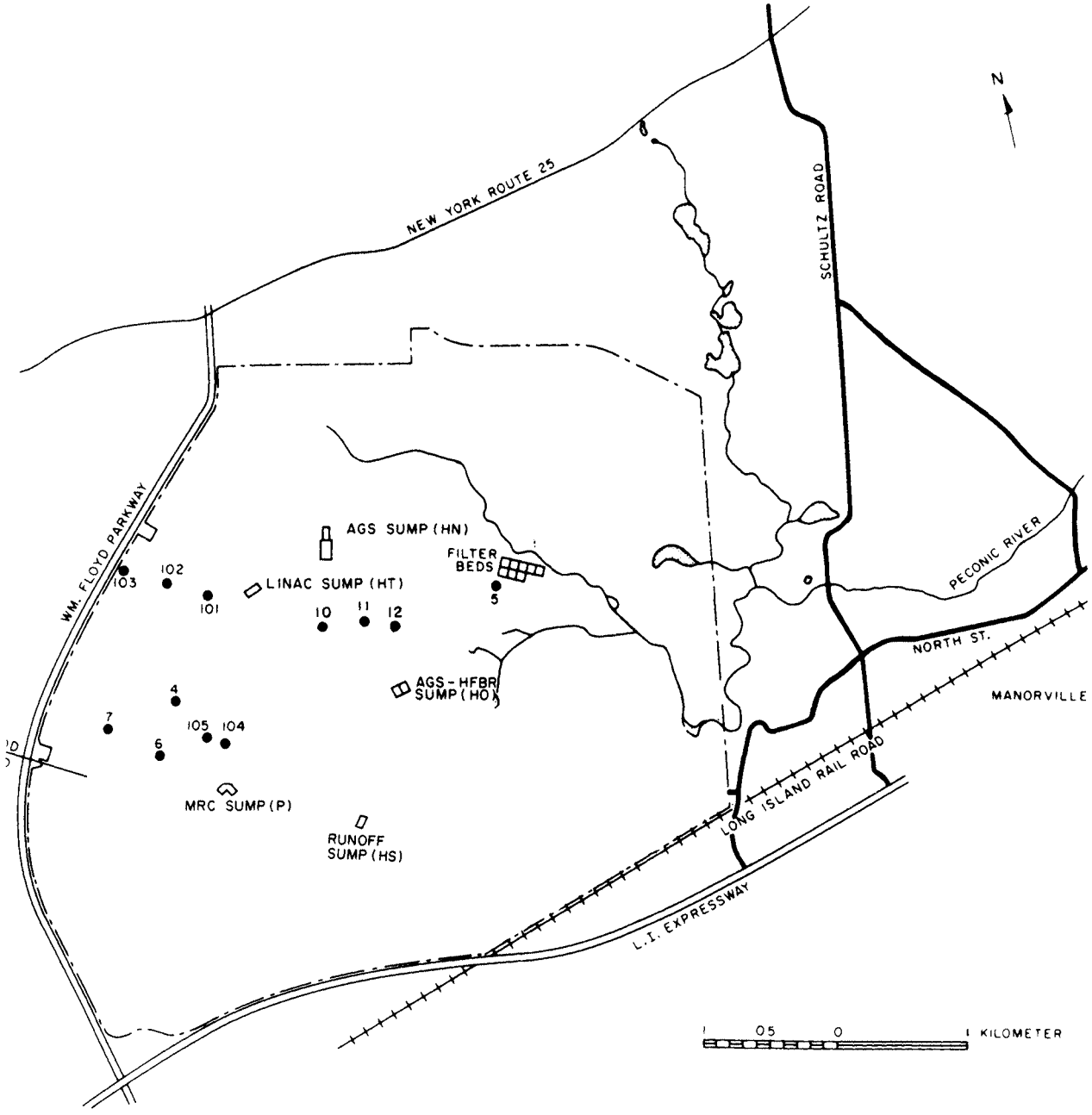


Figure 11: On-Site: Potable and Supply Wells and Recharge Sumps

between 5.5 and 9.8. The results of selected water quality parameters are presented in Appendix D, Table 14. With the exception of iron and pH, the discharge to the basins met both the SPDES permit conditions and NYS DWS for metals and other water quality criteria.

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 [28,29]. The locations of the on-site and off-site TLDs are shown in Figures 12 and 13, 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 15. The annual average dose-equivalent rate as indicated by all TLDs was 60.6 mrem/a. The dose-equivalent rate at the site boundary was 62.1 mrem/a, while the off-site average rate was 58.8 mrem/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 (See Section 7.4.1 for detailed description of data verifying this conclusion).

The maximum dose at the site boundary due to argon-41 and oxygen-15 airborne emissions were calculated using both AIRDOS-EPA [30] and DOE models as 0.1 mrem. 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, Chernobyl fallout and beryllium-7 produced in the atmosphere as a result of cosmic particle interaction in the atmosphere.

3.3.2.1 Tritium Analyses

Sampling for tritium vapor was performed at 17 on-site stations (shown in Figure 5). Water vapor was collected by drawing a stream of air through silica gel cartridges. The data collected from these stations are presented in Appendix D, Table 16. The maximum annual average tritium concentration at the site boundary was observed at Station 2T and was 7.2 pCi/m^3. This air concentration would result in whole body dose from the inhalation and submersion pathways of 0.006 mrem. By comparison, the National Council on Radiation Protection (NCRP) publication 91 recommends that 1 mrem is a dose which is below regulatory concern [46].

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 21.4 pCi/m^3 and would represent a dose of 0.005 mrem to the typical BNL employee.

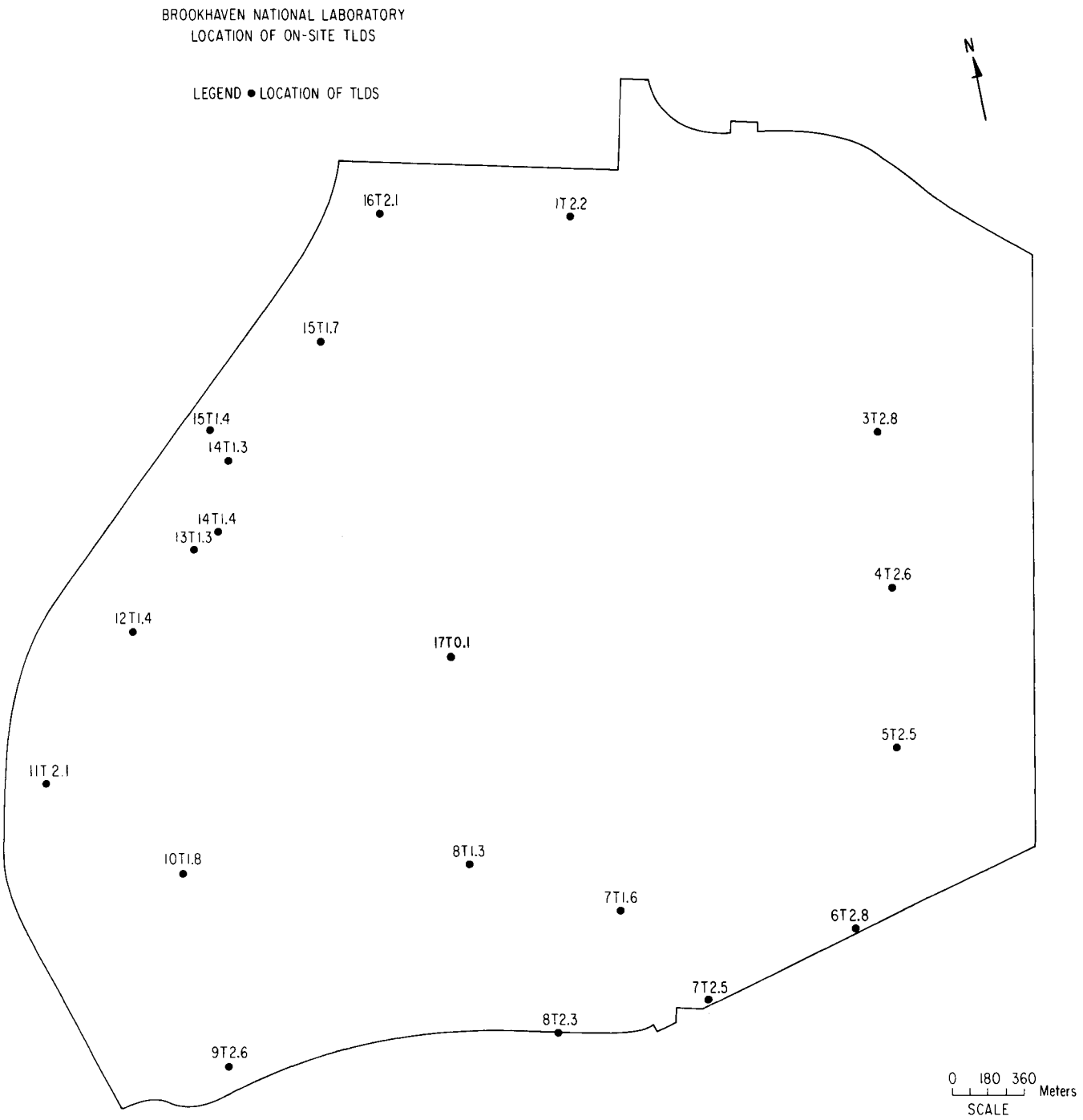


Figure 12: Brookhaven National Laboratory - Location of On-Site TLDs

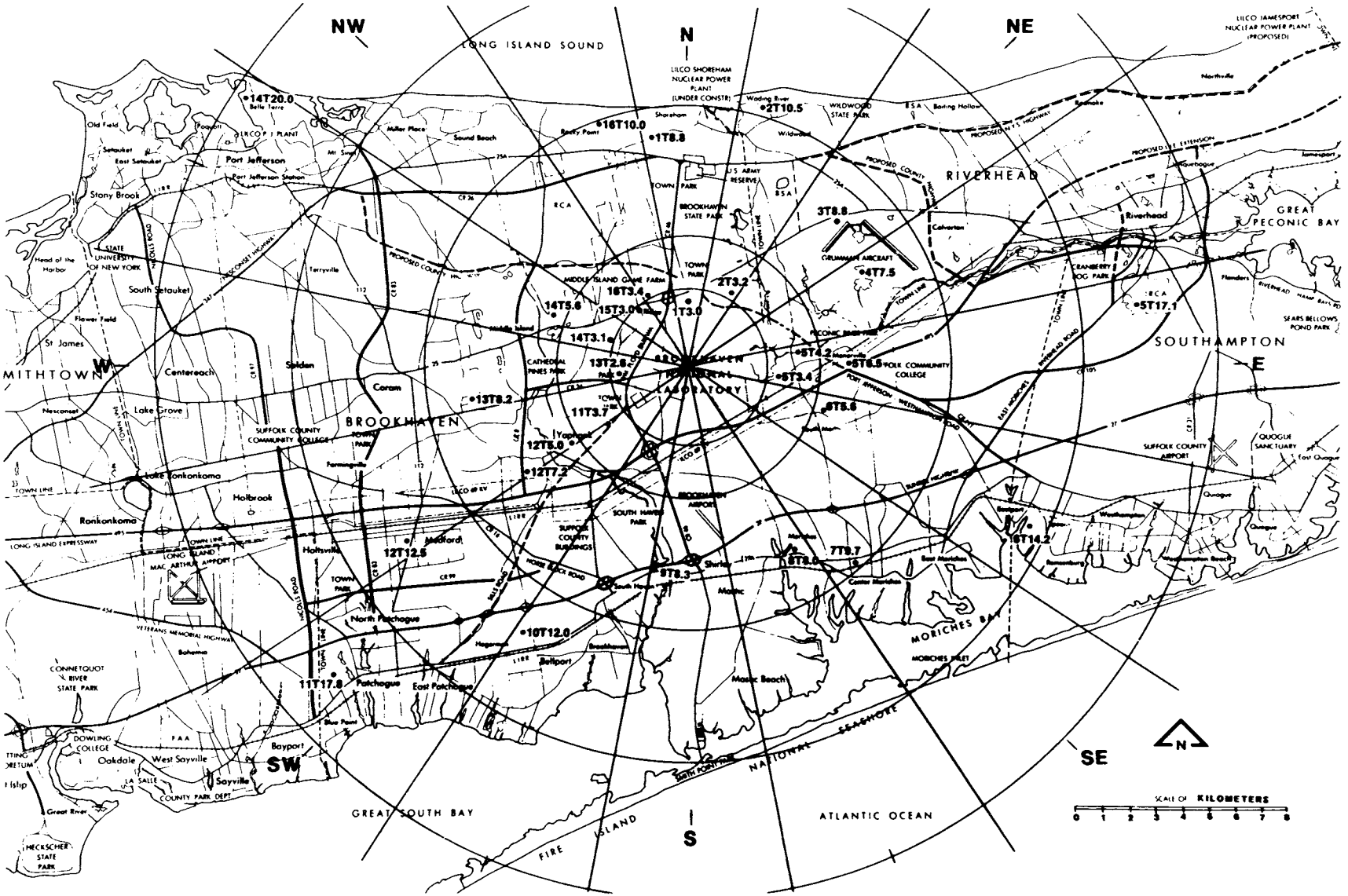


Figure 13: Location of Off-Site TLDs

3.3.2.2 Radioactive Particulate

During 1988, positive displacement air pumps were operated at five on-site monitoring stations (16T2.1, 11T2.1, 6T2.8, 4T2.4, and S-6). The sampling media consisted of a 5-cm diameter air particulate filter followed by a 51.5 cm^3 canister of triethylene diamine-impregnated charcoal for the collection of radiohalogens. The air particulate samples were collected on a weekly basis and counted for gross alpha and beta activity using an anticoincidence proportional counter. In addition, analyses for gamma-emitting nuclides were performed on a monthly composite of the filter papers and on charcoal filter bed samples that had a sample period of one month. The gross alpha and beta analytical results are shown in Appendix D, Tables 17 through 21. Gamma-emitting radionuclides detected on the particulate and charcoal filters are reported in Appendix D, Tables 22 through 27. 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. No activity attributable to BNL operations was detected.

3.3.3 Radioactivity in Precipitation

Pot-type rain collectors are situated at Stations S-5 and 11 (see Figure 5). Collections were made whenever precipitation was observed. Portions of each collection were processed for gross alpha, beta, and tritium analysis. A fraction was composited for quarterly strontium-90 and gamma analysis. The data for 1988 are reported in Appendix D, Table 28 and reflect typical washout values associated with atmospheric scrubbing [13] and the presence of radioactive particulate resulting from cosmogenic production, nuclear weapons fallout and Chernobyl.

3.3.4 Radioactivity in Soil, Grass and Local Vegetation

The results of soil and grass sampling conducted at four locations in the vicinity of the site are shown in Appendix D, Table 29. The results are consistent with data collected in previous years [27]. 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 several 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; HR, located 21 km downstream from the discharge point, and Station HH, a control station located on the Carmans River, which is not influenced by BNL liquid effluent. The Peconic River sampling stations are identified in Figure 14. The sample collected at the site boundary (HQ) was collected as a one time grab sample upstream of the weir. There was no flow leaving the BNL site in 1988. Figure 15 provides an eighteen year review of liquid discharge volumes to the Peconic

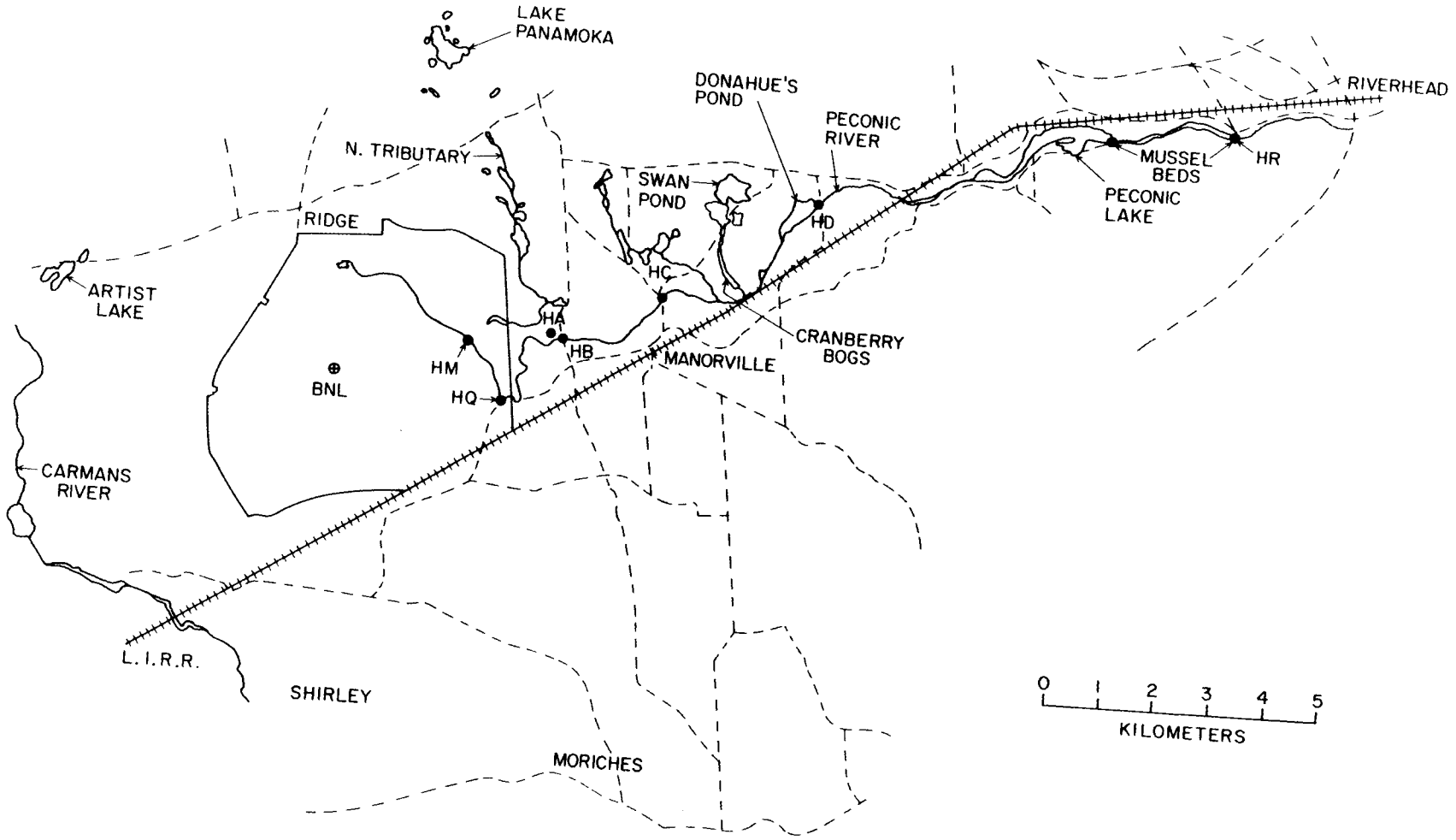


Figure 14: Peconic River
Sampling Stations

Liquid Flow Data
Sewage Plant and Peconic River

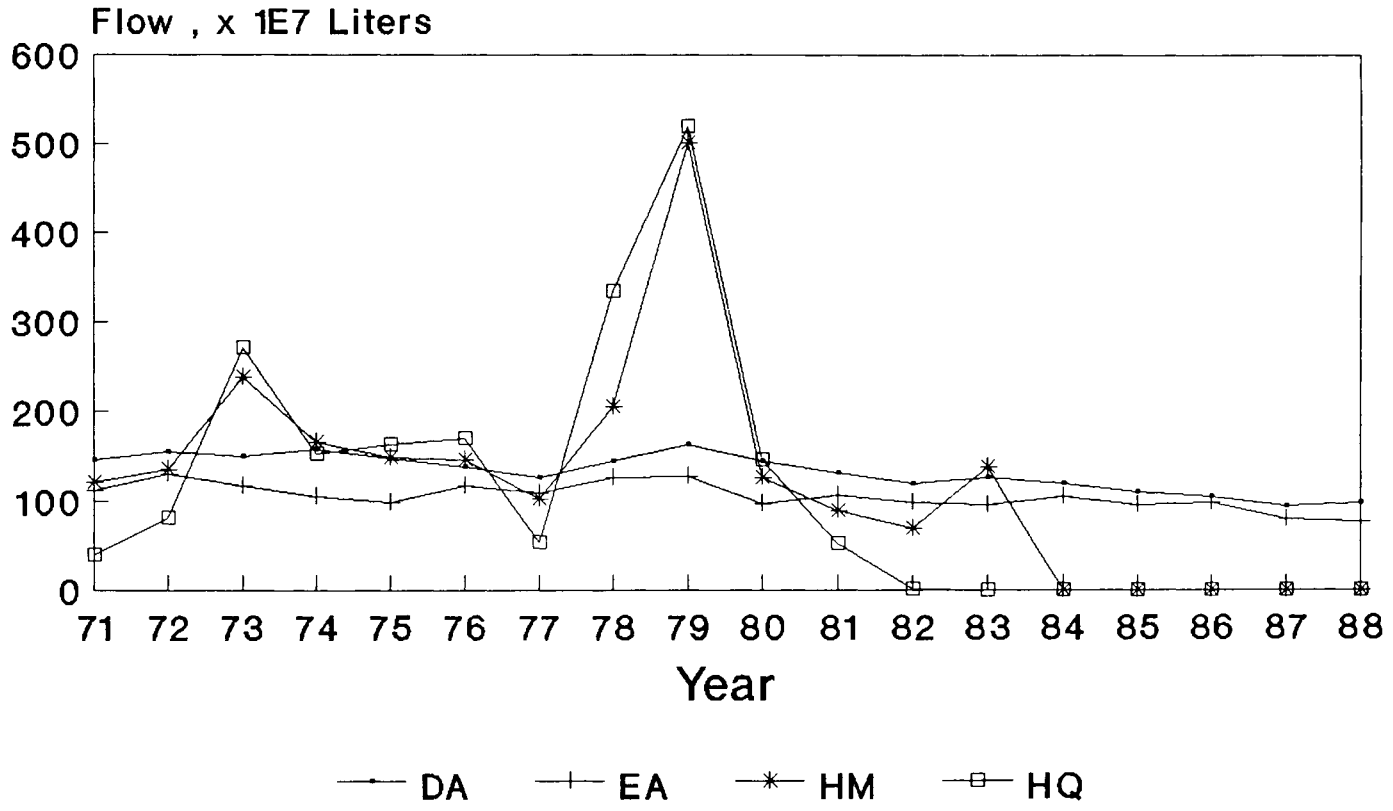


Figure 15: Liquid Flow Data
Sewage Plant and
Peconic River
1971 to 1988

River and flow estimates for the Peconic River on-site. The data indicate that there has been no measurable flow at the site boundary since 1983 and non-quantifiable flow at Station HM since 1984. Since 1985, water levels at Station HQ have been below the conduit which transports water from the BNL site to the weir at Station HQ.

Since 1984, the flow across the measuring weir at Station HM has been too low to obtain an accurate staff gauge measurement. Consequently, only time-proportional samples were collected at Station HM. Samples collected at Stations HR and HH were quarterly grab samples.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 30 and 31. The gross data indicate that gross beta, tritium, cesium-137, and strontium-90 are present above ambient levels in BNL effluent waters at Station HM. Because this water recharges prior to the site boundary, elevated levels do not extend beyond Station HQ. Gamma spectroscopy results indicate that only naturally occurring potassium-40 were detectable at off-site stations.

3.3.5.2 Nonradiological Analyses

Measurements of selected nonradiological water quality parameters were performed at the former site boundary location (HM). The pH range was 4.6 - 6.8. Metals such as chromium, silver, and manganese were not detected. Cadmium, lead and zinc were occasionally detected at the lower limit of detection while concentrations of copper, iron, sodium, chlorides, sulfates, and nitrates were all below the NYS DWS. No metals were found in concentrations which exceeded the NYS DWS.

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 14). Fish samples from the Peconic River were collected at Station EA, Station HM, Donahue's Pond and Forge Pond. Control samples were collected from Swan Pond. Specific information regarding the sampling point, distance from the BNL effluent release point, species of fish collected and analytical results are presented in Appendix D, Table 33. In calendar year 1988, gamma spectroscopy analysis was performed on these samples. The Peconic River fish contained cesium-137 concentrations which ranged from background levels at Forge Pond (100 - 300 pCi/kg-wet) to 25,000 pCi/kg-wet at Station HM.

The Forge Pond analytical data is statistically not different from the control data and is due to weapons test fallout. The Donahue's Pond data indicate the presence of elevated cesium-137 levels. These concentrations are produced by both weapons test fallout and historic BNL releases. The net cesium-137 concentration column listed in Appendix D, Table 33 is the best estimate of the BNL contribution to the activity detected in theses samples. Cesium-137 concentrations detected at Stations EA and HM are clearly related to BNL effluent discharges. The 1988 cesium-137 concentrations are elevated over the concentrations observed in past years [27]. This increase was preceded by

the release of cesium-137 to the STP from Building 811 (see Section 3.2.2.1 of this report for more details).

In 1988, the tributary of the Peconic River which has its headwaters at the BNL site recharged to ground water during the course of the year. Because fish collected at BNL on-site locations were not capable of migrating off-site and were not collected for human consumption, the maximum individual and collective dose from the aquatic biological pathway was calculated based on the cesium-137 concentrations that were observed in samples collected off-site. Based on these results, the maximum individual dose was estimated to be 0.15 mrem and the collective dose was estimated to be 39 person-mrem.

3.3.7 Potable Water and Process Supply Wells

Well Nos. 6, 7, 10, 11, and 12 supplied the majority of potable water for use at BNL during 1988. Well No. 4 was used to supply potable water on a limited basis due to mechanical problems. Well Nos. 101, 102, and 103 were used periodically during 1988 to provide cooling water to the AGS facility. Well No. 104 provided secondary cooling water to the MRR.

The Laboratory's potable water wells and cooling water supply wells are screened from a depth of about 15 m to about 46 m, in the Upper Glacial aquifer, with one exception. Well No. 104 is screened from a depth of 60 to 90 m in the Magothy aquifer. As was shown in Figure 11, most of these wells are located west or to the northeast of the Laboratory's principal facilities and "upgradient" to them in the local ground water flow pattern. As was indicated in Figure 10, about 21.4 MLD were pumped from them in 1988. Grab samples were obtained from the potable wells and supply Well No. 104 on a quarterly basis and analyzed for radioactivity, water quality indices, metals, chlorocarbon compounds, trihalomethane compounds, and BTX.

Well Nos. 101, 102, and 103 were not sampled in 1988 by Safety and Environmental Protection Division (S&EP). Water chemistry analyses were performed by the facility operators as needed to meet their operational requirements.

3.3.7.1 Radiological Analyses

The average radionuclide concentrations are reported in Appendix D, Table 34. The presence of cobalt-60 and sodium-22 in Well Nos. 10, 11, and 12 appear related to Laboratory operations. The presence of beryllium-7 in the June sample from the Water Treatment Plant (WTP) effluent (location F2) is not supported by samples from Well Nos. 6 and 7 that make up the influent to the WTP. The data from sample location F2 is believed to be anomalous, but was included in the dose calculations. 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 0.018 mrem. 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 35 and can be used for comparison against other ground water sample results.

3.3.7.2 Nonradiological Analyses

The water quality and metals data for the Laboratory potable supply wells are shown in Appendix D, Table 36. 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 [14,15]. The pH values in these wells ranged from 5.9 - 6.7 and are typical of Long Island [33].

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 [16] and the New York State Sanitary Code [14].

The majority of metals including silver, cadmium, chromium, copper, and zinc, were not detected in the Laboratory supply system. Lead and manganese were detected at trace levels. Iron was not detected in water samples collected at the well heads of Well Nos. 10, 11, and 12. Iron was detected at ambient levels in Well Nos. 6 and 7. The water from these latter wells is treated at the WTP to remove iron. Water distributed from the WTP had no detectable iron.

Water samples are also 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 comply with SCDHS requirements for a Community Water System and the National Interim Primary Drinking Water Regulations. The results of these compliance samples are presented in Appendix D, Table 37. These data indicate that the potable water at BNL meets the NYS DWS or NYSDOH advisory limits [14,15,16].

During the second or third month of each quarter, BNL collects potable water samples which are analyzed 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 for 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene, (common contaminants detected in Long Island ground water) [31,32,33] are shown in Appendix D, Table 38. 1,1,1-trichloroethane was detected in four potable wells and one supply well on the BNL site. The maximum concentration of 1,1,1-trichloroethane was detected in Well No. 11 at a concentration of 22 ppb, which is approximately 44% of the NYS DWS. Trichloroethylene was detected in one potable well at a concentration below the NYS DWS. Tetrachloroethylene was not detected in any samples from these wells.

Water samples were also analyzed for trihalomethanes and BTX by BNL. These results are shown in Appendix D, Tables 39 and 40 respectively. In most cases, these compounds were either not detected in BNL potable water or detected in trace quantities which were small fractions of the NYS DWS.

3.3.8 Ground Water Surveillance

Samples of ground water were obtained from a network of surveillance wells in the vicinity of several locations where the potential for ground water contamination exists or has been confirmed. These include areas adjacent to the on-site recharge basins, the 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 most of these ground water surveillance wells is shown in Figure 16. Wells located in the southeast corner of the site are shown in Figure 17. The data are compared to RCGs to determine compliance with operational limits and, because the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" [34], the data are also compared to the EPA [16] and NYS DWS [14,15].

As part of the Phase I CSF Remedial Investigation Project [17], existing wells near the CSF and WCF were reviewed to determine the adequacy of data from the sample locations. In this review process, it was discovered that the screens in Wells D8 through D15 had been installed approximately 20 feet below the water table. While these wells are still useful monitoring tools for baseline purposes and investigations concerning center of the site activities, they do not serve their original intended purpose of monitoring operations at these facilities. This information, along with BNL's proposal to meet the ground water monitoring requirements for the Major Petroleum Facility (MPF) license, was discussed with NYSDEC in November 1988. A draft report [18] of the proposed remediation plan for this area was presented at this meeting for their review and comment.

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, and downstream on the Peconic River are summarized in Appendix D, Table 41. Elevated gross beta and tritium concentrations have been found in on-site wells adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to losses from the tile collection field underlying the sand filter beds and from the recharge to ground water from the Peconic River in this area. In 1988, on-site ground water concentration ranges were 0-27% for gross beta and 0-34% for tritium of the applicable limits [14,15,16]. Strontium-90 concentrations ranged between 1% and 20% of the EPA DWS. Gamma-emitting radionuclides, although detectable at Well Nos. XA and XK, were far below applicable standards. Daily ingestion of all water from these wells for one year would result in a committed effective dose equivalent of 0.12 mrem (3% of the EPA DWS).

In 1988, the cooperative program between BNL and the SCDHS continued for the collection and analysis of samples from wells serving private homes. In this sampling program, 16 samples were collected quarterly from private drinking water wells in Suffolk County. Twelve of these sampling stations were from homes near the Laboratory, with the remainder from locations randomly selected by Suffolk County. 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 42, indicate that tritium was detected in private well samples collected from

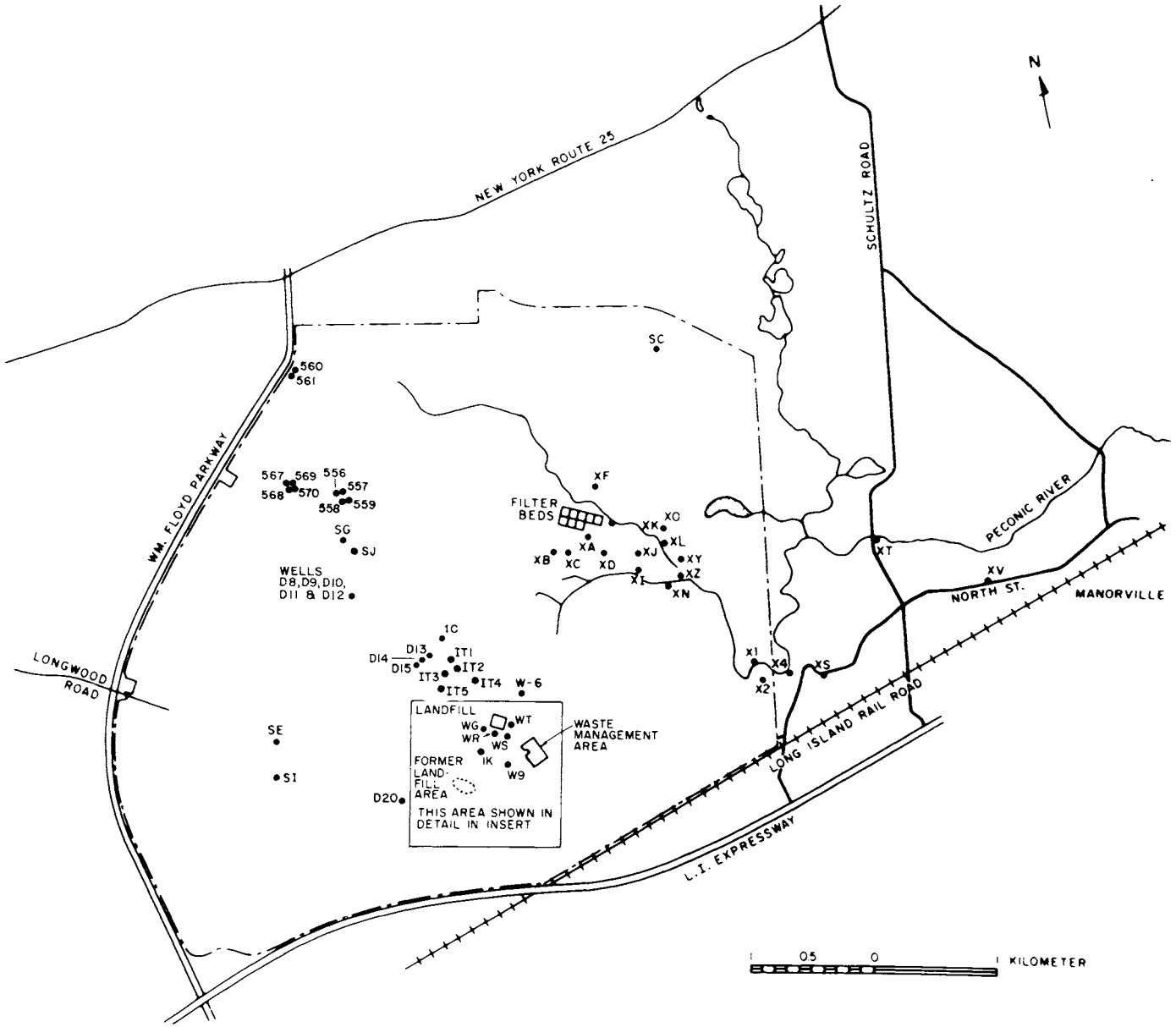


Figure 16: Location of Ground Water Surveillance Wells

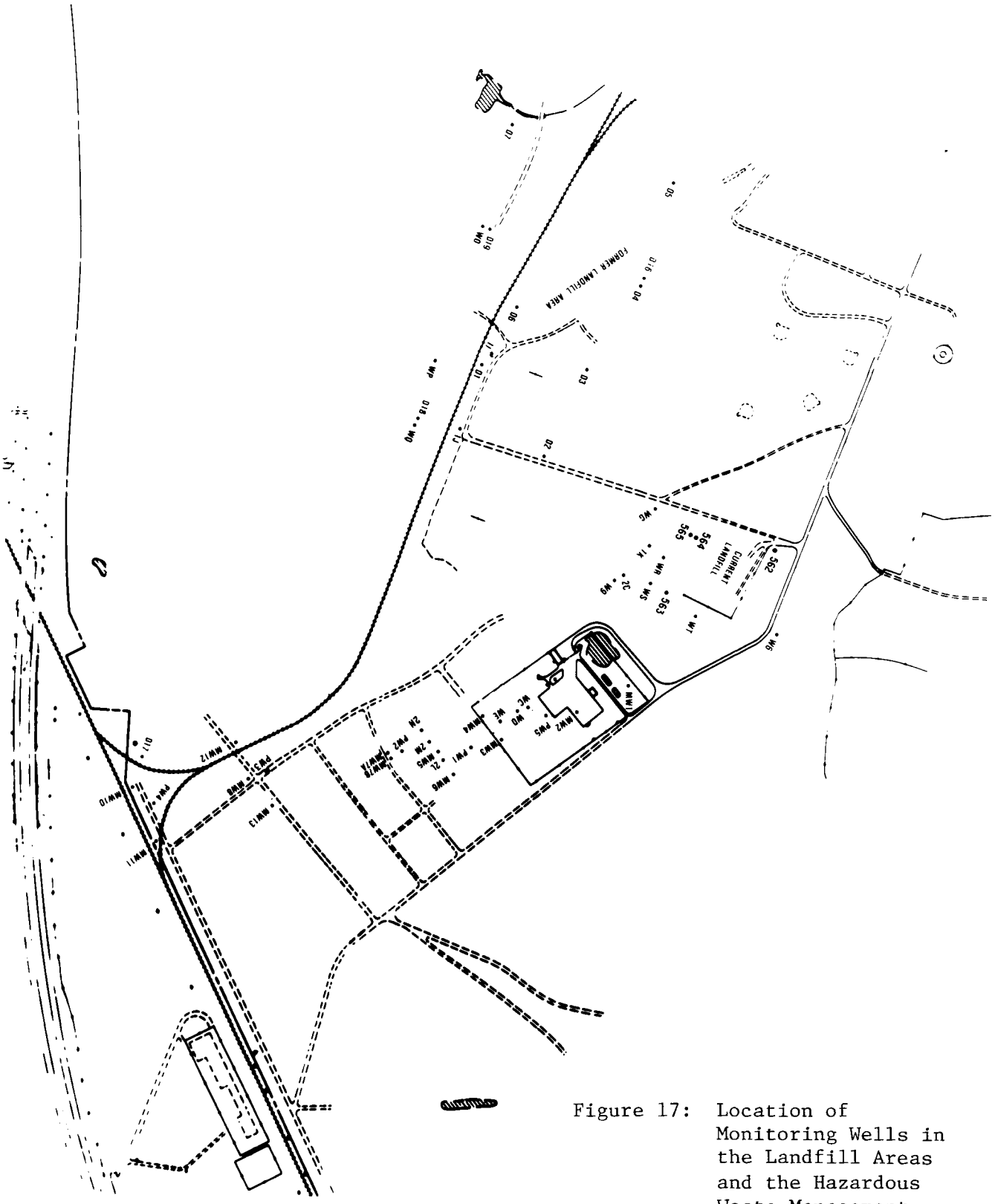


Figure 17: Location of Monitoring Wells in the Landfill Areas and the Hazardous Waste Management Facility

two locations adjacent to the Laboratory. The private wells, screened at depths ranging from 50 to 200 feet, had annual average tritium concentrations that ranged from 580 to 2,610 pCi/L. Although above background, these data were consistent with data collected since 1979, and were less than 13% of concentration limits and 3% of the dose limit specified by the EPA DWS [16] for community water supplies. One gross beta concentration at sample location No. 3 was clearly above normally observed levels. Gamma spectroscopy results from the same location indicated that the contaminant is potassium-40. The SCDHS data indicate that the water from this well also contained pesticide and fertilizer contaminants. The presence of elevated potassium concentrations is consistent with the agricultural product contamination that is also present in the water.

The data for the samples from control wells, wells adjacent to the past and present BNL landfills, ash repository, Building 650 Sump, former Army Landfill ("X-26" site), CSF, and WCF are shown in Appendix D, Table 43. Gross alpha concentrations in all wells did not differ from results observed in the previous years and remained at or below the system detection limits. At the current landfill, elevated gross beta, tritium, fission and activation product concentrations were detected. The presence of these radionuclides in ground water samples is the result of BNL's past practice of placing low specific activity material on the landfill. This practice was discontinued in 1978. In general, all wells immediately downgradient of the current landfill exhibited elevated gross beta, tritium, strontium-90, and sodium-22 concentrations. The annual average concentrations at each monitored location are below the nuclide specific concentration limits identified in the EPA DWS [16]. The committed effective dose equivalent as calculated by using the highest annual average concentration for each radionuclide detected in this area and an ingestion rate of two liters of water per day for one year, would be 1.3 mrem or 33% of the DWS [16]. Wells W6 and 562 are upgradient wells and can be used to infer the impact of the landfill on water quality.

The radionuclide concentrations in ground water near the former landfill are generally much lower than the concentrations detected at the current landfill. Except for Well No. D6, most gross alpha, beta and tritium concentrations are at or below the system MDLs and are consistent with prior years data [27]. Data from Well No. D6 exhibit elevated gross beta and strontium-90 concentrations. The strontium-90 concentration is 2.3 times the value specified in the EPA DWS. Several well water samples from this area also contain trace quantities of fission and activation products. These concentrations are all below levels of regulatory concern. One well, location WO, was sampled twice and on one occasion had a reported strontium-90 value that is above the EPA DWS. This data is believed to be erroneous because it is not supported by either the gross beta data or the data from adjacent Well D19.

At the Building 650 Sump area, only one well was capable of being sampled. The radiological data from this sample indicate the presence of elevated gross beta. The gamma spectroscopy and strontium-90 data confirm the gross assessment and attributes most of the activity to cesium-137 and strontium-90 respectively. The activity, although detected, is substantially below drinking water limits. At the ash repository, former army landfill ("X-26" site), and control wells, all results were either below the system detection limits or typical of ground water not contaminated by laboratory operations.

Ground water monitoring performed in the vicinity of the CSF indicated the presence of cobalt-60. The observed concentrations, if ingested for an entire year, would result in less than 0.3% of the Drinking Water limit dose. In the vicinity of the WCF, radiological results for ground water monitoring samples indicated the presence of sodium-22 in most samples and a slightly elevated strontium-90 concentration at location D8. The sodium-22 concentrations are related to operational activities at the AGS (i.e. storage of activated components outside or soil activation due to beam target interaction). The observed concentrations are below the Drinking Water Limits and would contribute less than 0.2 mrem if consumed annually.

The ground water monitoring program conducted at the HWMF 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 44. The annual average concentration of gross beta or strontium-90 exceeded DWS at three wells in this area. Two wells, locations, MW2 and MW7A, had water concentrations that were 106% and 164% respectively of the gross beta New York State Advisory Limit while at location MW2, MW7A and WC, strontium-90 concentrations were 5.8, 5, and 1.25 times the Drinking Water Limits. The remaining sample locations show concentrations that range from 2% to 50% of the standard. The average tritium concentration at all wells was below the DWS. Gamma emitting radionuclides that were detected at these sampling locations and are not specified in the DWS were compared to RCGs. Ground water concentrations at all site boundary stations were well within regulatory guidelines.

In addition to the routine program, gross alpha, gross beta, and tritium analyses were performed on a monthly to quarterly basis for samples collected from the spray aeration project wells. These wells are labeled PW1 through PW5 and their locations are indicated in Figure 17. The Well Nos. PW1, PW2 and PW5 were turned on in April and were scheduled to operate through December 1988. Pumping Well Nos. PW3 and PW4 ran all year. The radiological results from this sampling program are presented in Appendix D, Table 45. These data indicate that the gross beta activity declines with distance from the HWMF. Tritium concentrations tend to increase with distance from the HWMF until they reach a maximum at Well No. PW3. The activity detected at this well, and the increased activity at Well Nos. MW8 and MW13, indicates that the tritium plume emanating from the HWMF has been intercepted by these wells. In 1988, the tritium concentrations at locations PW3, MW8 and MW13 declined relative to 1987 data thus indicating a termination of the plume observed in the 1987 data. In addition to tritium low concentrations of strontium-90, cobalt-60, cesium-137 and sodium-22 were detected in the spray aeration project wells. All of these radionuclides were observed in concentrations below advisory or Drinking Water limits.

3.3.8.2 Nonradiological Analyses

The data for wells adjacent to the sand filter beds and downstream of the Peconic River on- and off-site, are shown in Appendix D, Tables 46 - 50. In general, the data for samples obtained from these wells were comparable to those observed during previous years [27]. The water quality data for this series of

surveillance wells is reported in Appendix D, Table 46. Conductivity, chlorides, sulfates and nitrate-nitrogen were not significantly different than values observed in BNLs control wells. The pH ranged from 4.3 to 7.3 which shows a slightly wider variation in pH then observed in control wells. Cadmium, chromium, copper and silver concentrations were detected in concentrations significantly below NYS DWS [15]. All lead and zinc concentrations, except for one lead value at Well XA and one zinc value at Well XB, were also below the NYS DWS. Elevated manganese values were observed at three well locations, XC, X2, and XT. Elevated iron concentrations were observed in ten monitoring wells. These metals were not observed in significant concentrations in either the influent or effluent from the STP. The presence of iron, lead, and manganese is believed to reflect a well-casing effect. Iron is typically found in high concentrations in L.I. ground water [33].

These wells were also analyzed for chlorocarbon, trihalomethane and BTX compounds. As can be seen from the data in Appendix D, Table 48, except for a positive value of 1,1,1-trichloroethane at Well XA, all results for chlorocarbon compounds were below the system detection limits. All results for trihalomethane compounds and BTX, Appendix D, Tables 48 and 49 were below the system detection limits.

The surveillance data for the current and former landfills, and control wells are shown in Appendix D, Tables 51 - 54. The BNL landfill is operated in accordance with the permit issued by NYSDEC, Permit No. 10-84-0346. Data from the BNL landfill wells is reported quarterly to NYSDEC in compliance with this permit.

The data from the current landfill wells indicate that the pH, ranged from 4.9 to 7.7, sulfates and nitrate-nitrogen concentrations were consistent with on-site control well data, and the following metals were below detection limits: silver, cadmium, chromium, copper and lead. While the presence of conductivity, chlorides and zinc were detected at concentrations above ambient levels, these parameters were well below the NYS DWS. Iron and manganese were detected at all wells in concentrations which exceeded the NYS DWS. The presence of these five parameters in ground water samples collected from this area is consistent with landfill activities.

At the former landfill area, the pH ranged from 5.1 to 6.4 and water quality parameters were consistent with data from control wells. Silver, chromium, copper and lead were not detected in water samples from these wells. Zinc, manganese and iron were periodically detected at this location. Iron and manganese were observed in three wells at average concentrations above the NYS DWS and are consistent with past landfill activities.

The ground water surveillance wells at the landfill areas and control wells were analyzed for chlorocarbon, trihalomethane and BTX compounds. At the current landfill, benzene was detected at five locations. Four of these concentrations exceeded NYS DWS. Toluene was detected in one well and xylene was detected in two wells at concentrations at or above the MDL. None of the other organic compounds for which BNL analyzes were detected in samples collected near the current landfill. At the former landfill, five wells contained concentrations of 1,1,1-trichloroethane, two wells contained tetrachloroethylene, and chloroform

was detected in one well. Only one well exceeded the NYSDOH advisory guideline for 1,1,1-trichloroethane. All other compounds were well below applicable standards. Trace quantities of toluene were detected in two wells at the former landfill area. Three designated control wells were found to contain 1,1,1-trichloroethane and chloroform at concentrations well below applicable standards. The wells at the landfill areas will continue to be sampled to monitor the impact of past or current BNL operations on the underlying aquifer.

The average water quality and metals data for the HWMF are presented in Appendix D, Tables 55 and 56. Metals such as silver, chromium, and copper were not detected in any of the wells. Trace concentrations of cadmium, manganese and lead were detected sporadically. Iron was below the MDL in nine wells downgradient of the HWMF and was found in concentrations exceeding the NYS DWS in only one of the remaining wells. In general, iron, sodium and zinc concentrations declined slightly compared with 1987 data [27].

At the HWMF, the routine ground water monitoring program consists of a shallow well network located near the facility and a set of deeper wells that extend out from the facility in the direction of ground water flow. The results for organic analyses performed on samples collected from these wells are presented in Appendix D, Tables 57 - 59. The presence of 1,1,1-trichloroethane was observed in five of these surveillance wells. The average annual concentration of 1,1,1-trichloroethane exceeded the NYS DWS at monitoring Well Nos. MW13 and MW8. Trichloroethylene was observed in only two wells (MW13 and MW8) in 1988. These concentrations exceeded the NYS DWS. Although tetrachloroethylene was detected in five of these surveillance wells, it exceeded the NYSDOH advisory guidelines only at Well No. MW2. The average annual concentration of tetrachloroethylene reported for Well No. MW2 in Appendix D, Table 57, is an underestimate of its true value. The concentration in this sample exceeded that of the highest standard used to establish the instrument calibration curve. Since a replicate sample was not available, the value for this sample was reported as the upper limit of the calibration curve.

The average trihalomethane data from these surveillance wells are presented in Appendix D, Table 58. Chloroform was the only trihalomethane compound detected. It was observed in only three wells and all values were below the NYS DWS. As can be seen from Appendix D, Table 69, BTX was not detected in any of these wells.

In addition to the shallow and deep surveillance well network, monitoring results are available from the five pumping wells used in the spray aeration project. These data are presented in Appendix D, Tables 60 - 63. Water quality parameters at these wells are consistent with control well results. Silver, and chromium were not detected at any of these wells. Cadmium, copper, lead, manganese and zinc were detected at several locations in concentrations that were at or below the system MDL.

The spray aeration project was initiated in 1986 in order to remediate ground water contaminated with volatile organic compounds. Organic compound results are found in Appendix D, Tables 61 to 63. No detectable quantities of BTX, chlorodibromomethane, bromodichloromethane or bromoform were found. Detectable quantities of chloroform, trichloroethylene and tetrachloroethylene

were found in wellhead samples from most of these locations. None of these compounds were detected in residual spray samples. The compound 1,1,1-trichloroethane was detected in all spray aeration project wellhead samples. Only at Well No. PW3 was any residual compound detected in the sprayed water. Using the pre- and post-spray data for this well, the pumping/spraying process is at least 95% efficient in the remediation of the ground water.

The 1,1,1-trichloroethane plume path has followed the pattern displayed by tritium in 1987 and 1988 [27]. The consistency of these data allows us to conclude that the source of both the tritium and organic contamination of ground water in this section of the site is the result of past activities at the HWMF and is not related to operations of either the current or former landfill.

The MPF is the holding area for most fuels used at the CSF. The potential for ground water contamination at this facility is monitored by one upgradient well and eight 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 64 through 67. The water quality parameters are consistent with ambient levels. Metals such as silver, cadmium, chromium and copper were not detected in any of these wells. Trace concentrations of lead and zinc were observed periodically. Manganese was found in six of these wells in concentrations which exceeded NYS DWS. Analyses of samples from this location for petroleum products identified the presence of BTX compounds at concentrations in excess of the NYS DWS in several of the new monitoring wells that straddle the surface of the water table. These wells were installed by IT Corporation during Phase I of the CSF remedial investigation project [17]. A more detailed discussion of this project is presented in Section 6.1 of this report. Free product (oil floating on top of the ground water) was not observed at any of these locations.

The WCF was also monitored using five wells which surround this facility. The analytical results for water quality parameters and metals (presented in Appendix D, Table 68) are typical of ambient levels. Silver, cadmium, chromium, copper, lead, and zinc were not detected in any samples. Iron was observed in one well at this facility and was below NYS DWS. Manganese was detected in a sample from the well upgradient to the WCF in excess of the NYS DWS. In 1988, organic analyses were performed on samples from this area. The average chlorocarbon data are presented in Appendix D, Table 69. 1,1,1-trichloroethane was detected in all samples from these wells. The average value reported for Well Nos. D9 and D10 are underestimates of their true values. In two out of the three samples used to calculate these averages, the concentration exceeded that of the highest standard used to establish the instrument calibration curve. Since replicate samples were not available, the maximum value of the system detection limit for each of these analyses was used in computation of the averages. Trichloroethylene and tetrachloroethylene were not detected in any samples from these wells. As can be seen in Appendix D, Tables 70 and 71, neither trihalomethane compounds nor BTX were detected in these surveillance wells.

4.0 OFF-SITE DOSE ESTIMATES

4.1 Dose Equivalents due to Airborne Effluents

The major radionuclides released from BNL airborne effluent discharge points are tritium, oxygen-15, and argon-41. The measured tritium concentrations and dose equivalents at the site boundary are shown in Appendix D, Table 72. The highest annual average site boundary concentration of tritium vapor was 7.23 pCi/m^3 at Station 2 (NNE Sector) and the committed effective dose equivalent (inhalation and skin absorption) was 0.006 mrem for the hypothetical individual residing at that location. By comparison, the site boundary tritium dose calculated using source term data and both AIRDOS-EPA and AIRDOS dispersion plus DOE dose conversion factors are presented in Appendix D, Table 73. The overall correlation is quite good with the predicted and measured maximum dose occurring in precisely the same sector. The exposure rates due to argon-41 and oxygen-15 were not measured at the site boundary. The dose-equivalent rates for these radio nuclides, calculated using both AIRDOS-EPA and DOE dose conversion factors, are presented in Appendix D, Table 74. The maximum site-boundary dose-equivalent from argon-41 and oxygen-15 was calculated to be 0.107 mrem/a. The maximum site boundary dose from all three radionuclides was 0.113 mrem/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 10 meter, 45 meter and 100 meter release heights are shown in Appendix D, Table 75. Argon-41 contributed essentially the entire collective dose equivalent, 2.23 person-rem. The dose equivalent contributions from tritium and radioiodines were 0.125 and 0.007 person-rem, respectively. The computer models AIRDOS-EPA and DOE dose conversion factors applied to AIRDOS estimated concentrations were both used to determine the collective and maximum individual dose estimates. In the text, only doses computed using DOE dose conversion factors have been reported. The 1988 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 2.35 person-rem. This can be compared to the 1988 population collective dose-equivalent due to cosmic and terrestrial natural background of 300,000 person-rem. The Laboratory airborne releases comprised 0.0007% 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 [35], nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. However, the Peconic River does recharge the aquifer. In 1988, virtually all of the Laboratory's effluent was recharged to ground water.

The collective dose equivalent resulting from the discharge of radioactive materials to the Peconic River has been computed by evaluating private, potable water.

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 2,600 pCi/L. The average concentration for the group of two positive tritium concentrations was 1,600 pCi/L. This corresponds to a committed effective dose equivalent to the maximum individual of 0.000118 rem and a collective dose equivalent to the population at risk (assumed to be not more than 500 persons) of 0.037 rem. The data are summarized in Appendix D, Table 76.

The cesium-137 concentrations in fish samples collected from Peconic River and control locations are reported in Appendix D, Table 33. Using the method in Appendix C, the maximum individual committed collective dose equivalent was calculated to be 0.15 mrem. The population collective dose equivalent was calculated to be 39 person-mrem. The water and fish pathway dosimetric results are summarized in Appendix D, Table 76.

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 1988 was 2.46 person-rem 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 77.

The collective dose equivalent due to external radiation from natural background to the population within an 80-km radius of the Laboratory, amounts to about 300,000 person-rem/a, to which about 97,000 person-rem/a 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 [36] with the County of Suffolk wherein these two organizations in the spirit of comity move to achieve the highest practical level of environmental protection to the citizens and lands of Suffolk County. While it is recognized that the Laboratory operates 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 during calendar year 1988. These activities are discussed in more detail in Sections 5.1.1 and 5.1.2 of this report.

5.1.1 Facility Inspections

As part of this joint agreement, the Laboratory agreed to make their land and facilities available to representatives from the SCDHS to carry out their responsibilities in relation to the environmental requirements of the applicable Sanitary Codes. The objective of the SCDHS personnel in carrying out this responsibility, was to inspect all BNL facilities for compliance with Suffolk County Sanitary Codes Articles 6, 7, 10, and 12 [37,38,39,40]. The major areas to be evaluated during these inspections were storage tanks, drum storage areas, air emission points, and connections to the BNL STP. Inspections of BNL facilities began on March 1, 1988 and were conducted weekly. On three occasions the SCDHS inspectors collected samples, from locations on-site which were identified during the facility inspections, for metals and organic analyses. By December 28, 1988, approximately 85% of all BNL facilities had been inspected. It is anticipated that inspection of the remaining facilities will be completed by the end of the first quarter of 1989.

5.1.2 Review of Engineering Design Drawings

The Laboratory also agreed to submit plans for construction which is regulated by Articles 6, 7, 10, and 12, to the SCDHS for review for compliance with the environmental requirements of these codes. During 1988, several plans were submitted to the SCDHS. These plans include engineering design drawings for the construction or modification of storage tanks, the upgrading of drum storage areas, and for connections to the BNL STP. All comments submitted by the SCDHS were reviewed and, where applicable, were incorporated into the final design plans. This review process will continue in calendar year 1989.

5.2 SPDES Permit Renewal

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

In accordance with the appropriate New York State SPDES permit regulations and procedures, BNL submitted an application package for the renewal of its SPDES permit to the NYSDEC on October 30, 1987. On September 13, 1988, DOE received a draft of the proposed discharge permit conditions issued by the NYSDEC. As a result of the reclassification of the Peconic River from a class "D" water to a class "C" water since the issuance of the previous SPDES permit, the NYSDEC proposed several significant changes to the BNL SPDES limits for the discharge of the STP effluent. These changes included the reduction, by two to three orders of magnitude, of the concentration of copper and lead in the STP effluent. On October 18, 1988, BNL submitted a response to the NYSDEC describing the potentially significant operational problems that would be encountered as a result of their proposed changes. Although the NYSDEC had not yet finalized the SPDES permit for BNL as of the end of the calendar year, it is anticipated that this will be resolved in 1989. The Laboratory has authorization to continue operating with the discharge limits from the previous permit under interim status.

5.3 Compliance with State Pollution Discharge Elimination System Discharge Limitations

Liquid effluent emissions to five recharge basins and the STP discharge to the Peconic River are subject to the conditions of the SPDES Permit Number NY-000-5385, authorized by the NYSDEC. Monthly reports are submitted to both the NYSDEC and the SCDHS which provide detailed analytical results and performance information regarding the operational activities at the STP. These data indicate a general compliance rate of greater than 99% for all parameters monitored. Monitoring data are presented in detail for this discharge point in Appendix D, Tables 10 - 12. Specific instances of noncompliance included one occurrence of strontium-90 concentrations which exceeded the SPDES Permit limits of 10 pCi/L (see Section 3.2.2.1 of this report for a description of the reason for this area of noncompliance); several pH measurements which indicated liquid discharges between 5.6 and the SPDES permit limit of 5.8; and several instances of residual chlorine slightly in excess of the SPDES Permit limits.

At the recharge basins, flow and pH are the parameters that must be monitored. In addition, water discharged to these basins are monitored for water quality and radioactivity. The analytical results for samples collected from these basins are presented in Appendix D Tables 13 and 14. 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.

5.3.1 Elevated Radioactive Concentrations at the Sewage Treatment Plant

On the morning of June 14, 1988, discharge of the liquid contents from tank D-2 at Building 811, approximately 95,000 liters, was initiated at a release rate of 13 liters per minute. Samples collected in December, 1987 and April, 1988 indicated that there was virtually no activity in this water. Because tank D-2 had been physically isolated from other waste tanks by cutting all influent and effluent lines prior to the collection of the April, 1988 sample, the water was believed to be uncontaminated at the time of release. In fact the release proceeded uneventfully for between 10 to 11 hours. However, sometime during the

evening of June 14, 1988 the concentration levels in the discharge water changed. The increase in activity was detected by the STP Station S-5 radiation detectors on both the influent to and effluent from the clarifier. The radiation levels detected by the influent monitor were below the alarm set-point which triggers an alarm at BNL Security and requires a physical call-in of STP operators and S&EP personnel. The effluent radiation levels were sufficient to initiate a local alarm which was observed by BNL personnel performing routine rounds on June 15, 1988.

Once instrument response was verified, diversion of the STP liquid effluent stream to a lined holding pond was completed by 1045 hours. An investigation as to the source of the elevated radioactive concentrations identified the Building 811 tank drainage project as the source of the elevated radioactivity in the STP influent. Isotopic analysis of the water indicated that cesium-137 and strontium-90 were the predominant radionuclides present in the STP influent. Effluent monitoring data presented in Appendix D, Table 11, indicates that approximately 85 mCi of cesium-137 and 14 mCi of strontium-90 were detected at the influent to the STP. STP effluent monitoring data indicates that between June and December, 1988, approximately 7 mCi of cesium-137 and 3 mCi of strontium-90 were released from the Chlorine House. The difference between the influent and effluent releases represents the quantity of material that was either retained in the STP hold-up pond or collected on the sand filter beds. It is estimated that approximately 40 mCi of cesium-137 and 7 mCi of strontium-90 were retained on the sand filter beds while about 45 mCi of cesium-137 and 7 mCi of strontium-90 was diverted to the emergency hold-up pond. Remediation of the sand filter beds was accomplished on June 16, 1988 with about two-thirds of the available activity recovered. Remediation of the water in the hold-up pond will be accomplished in 1989 under contract to IT Corporation. This incident was reported to DOE (Unusual Occurrence Report Number 88-13)[41], NYSDOH, NYSDEC and SCDHS along with the results of the remedial actions.

As a result of this incident, the following modifications were instituted: effluent samples must be collected and analyzed within seven days of the initiation of a release; radiation alarm levels on the clarifier influent and effluent were set to the same sensitivity levels with both detectors enunciating at the BNL Security desk. In addition to modification of operational protocols, the following physical changes to the STP system have been accomplished or are in progress: the creation of a second emergency hold-up pond (project completed January, 1989); upgrading of radiation monitoring equipment (purchased in 1988 with installation to occur in 1989); and creation of a new sewer line monitoring station located approximately one mile from the STP (construction scheduled for 1989). These facility and operational changes will minimize the potential for unplanned releases; provide added flexibility to the management of unplanned releases and provide about one hour of advanced warning should a release occur.

5.4 Landfill Permit Renewal

BNL operates a 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.

It was decided that BNL would provide the NYSDEC with a copy of a Conceptual Design Report for closure of the landfill which was prepared by Burns and Roe, an engineering consulting firm, and a copy of the most recent Environmental Monitoring Report. In addition, BNL arranged for a tour of the landfill, which was conducted on March 3, 1988, for the two new NYSDEC individuals who would be working on this project. NYSDEC agreed to review these reports, as well as the quarterly landfill monitoring well reports submitted by BNL, to determine the proper course of action.

Since iron had been reported in concentrations in excess of the NYS DWS in wells downgradient of the landfill, NYSDEC would have to issue a Consent Order, rather than simply renew the existing permit, for BNL to continue operation of the landfill through the end of 1990. NYSDEC submitted a draft Consent Order to BNL for review in September, 1988. A meeting was held on November 17, 1988 to discuss a variety of differences regarding the wording of the Consent Order. This issue had not been resolved by the end of the calendar year. It is anticipated to be finalized during 1989.

5.5 PCB Consent Order

In October 1984, the Laboratory received off-specification military fuels containing PCBs in excess of 50 ppm. The Laboratory blended this material with other fuel resulting in 280,000 gallons of ALFs having a PCB concentration of approximately 80 ppm. On January 21, 1986, the EPA Region II formally approved BNL's plan to incinerate this material at a 10% firing rate (concentration of 8 ppm) in BNL's high-efficiency boilers, No. 4 and No. 5 [42]. The material has remained in storage since this time awaiting NYSDEC authorization to burn it. In 1988, although DOE has made several requests for a decision on BNL's proposal to incinerate this material, the NYSDEC has not progressed towards resolution of the request.

5.6 National Emission Standards for Hazardous Air Pollution Permit Applications

In 1987, BNL submitted two applications to EPA Region II in compliance with 40 CFR 61 Regulations on National Emission Standards for Hazardous Air Pollutants (NESHAPS) [43]. One application was for the construction of the AGS Booster while the second application was for the modification of the Building 705 stack to receive WCF distillate. Both applications received EPA interim approval in 1988. The application numbers for these projects are BNL-188-01 and BNL-288-01 respectively. In 1988, the application for resumption of construction activities at the Relativistic Heavy Ion Collider (RHIC) was submitted under application No. BNL-389-01. An interim approval was received in February of 1989.

5.7 Department of Energy Environmental Survey

During calendar year 1988, BNL continued to act on the 1987 DOE Environmental Survey findings. Those findings requiring simple solutions were completed and closed out. Other findings required long term solutions. Many programs were developed and initiated in response to these needs. Quarterly reports were issued to provide the status of all DOE findings.

In June of 1988, DOE sent a sampling team to BNL. This team collected samples from surface water, cesspools, and various soil locations. Depending on the actual location of each sample, analyses included metals, organics, and radioactivity. Although the analytical results were scheduled to be provided to BNL by October, 1988, no analytical results had been received by the end of the calendar year.

In addition to this sampling program, DOE had monitoring wells installed in pairs at five locations. Each pair consisted of one shallow and one deeper well. A team returned to BNL in late summer to collect samples from these wells.

5.8 Oil Spills

During 1988, Plant Engineering and S&EP responded to 13 petroleum product spills. Ten of these incidents involved small quantities of petroleum products which were contained on asphalt, concrete or surfaces lined with an oil impervious material. Clean up procedures were instituted and there were no environmental impacts as a result of these occurrences. On four occasions, petroleum spills required EPA, NYSDEC and SCDHS notification. These spills were cleaned up and contaminated absorbent and soil were disposed of in an approved manner. All cleanup operations where approved by NYSDEC and SCDHS. No further remediation was required for any of the above spills.

5.9 Review of Engineering Design Drawings

New construction projects and plans for major modifications to existing structures are required to be under S&EP review prior to construction and final occupancy. As part of the the review team a member of the Environmental Protection staff reviews these proposals and plans for compliance with local, state and federal environmental regulations. In calendar year 1988, approximately 15 of these types of reviews were performed.

6.0 ENVIRONMENTAL ASSESSMENTS

6.1 Central Steam Facility Ground Water Contamination

A subsurface soil and ground water contamination investigation was conducted by IT Corporation near the CSF in October and November, 1987. The final report was issued in June of 1988 [17]. The study was centered on the reported location of the November, 1977 spill of fuel oil and waste solvents and included a soil gas survey; soil sample analysis from five soil borings; installation of five ground water monitoring wells (IT1 to IT5) to determine geological conditions, define the local hydrogeological regime and provide ground water sampling points; and bacterial enumeration measurements.

The study concluded that the depth to water in this area was approximately 35 feet and that ground water presently flows toward the south in the vicinity of the spill area. Soil contamination is limited to the spill area. Ground water samples collected from the five new wells and analyzed for organic contaminants indicated the presence of several compounds that exceeded the NYS DWS. The concentrations in the ppm range were detected in well IT1, located at the source of the spill, and consisted of predominantly benzene, toluene, and xylene. At wells IT4, IT5 and D15 tetrachloroethene was detected in concentrations that ranged from 23 to 45 ppb. The sample from well IT4 also contained trichloroethene at a concentration of 16 ppb.

In summary, shallow ground water contaminated by aromatic hydrocarbons is limited to the spill area. Ground water in close proximity to this spill area contains concentrations of organics which exceed NYS DWS and will require remediation. A plan for remediation of this area is being developed and remediation is expected to commence in fiscal year 1991.

6.2 Building 830 Soil Contamination

In August of 1986, the Building Safety Service Representative for Building 830 (Department of Nuclear Engineering) requested that management evaluate the radioactive waste storage capacity of the building in order to assure that sufficient capacity existed to operate the facility during an extended maintenance program at the WCF. Inspection of the liquid levels in the tanks and the waste inventory records revealed that there was an 825 gallon discrepancy during the period of July, 1984 to August of 1986. Leak tests of the tanks and the under ground piping system, conducted between August, 1986 and April, 1987, revealed that the source of the loss was the transfer line between the building and the underground holding tanks. The NYSDEC was notified of the leak in April of 1987. The waste transfer line was isolated from the building and tanks at this time.

A preliminary characterization of the radioactivity in the soil surrounding the leaking pipe and various remedial action proposals were developed between April and September, 1988. The contaminated soil was removed in September and October, 1988. The S&EP Division provided environmental sampling and analysis of soil samples, waste disposal and the technical guidance regarding the extent of remediation that was required. The BNL Plant Engineering Division provided

the labor required for the project while the Department of Nuclear Energy provided assistance with project coordination.

Nine shallow soil profile (0 - 30 cm) samples and four deep (0 - 120 cm) were collected along the length of the waste line in the summer of 1988. Based on the analytical results of these samples, it was estimated that approximately 120 cm of soil should be removed. Following this remediation, three soil profiles were collected to depths of 210 to 300 cm below the initial level of the pipe were collected in November, 1988. The soil profile results where used as the input to a ground water pathway analysis which indicated that the maximum dose to the non-radiation worker at BNL from the drinking water use of ground water contaminated by the residual activity would be 0.12 to 0.14 microrem per year. The dose to a member of the general public residing 2,900 meters down gradient of the source would be 0.009 to 0.014 microrem per year. These data indicated that the residual soil contamination would result in projected doses that were significantly below levels of regulatory concern. Consequently, no further remediation of the site is expected. The remediation site was backfilled and paved. In 1989, two ground water monitoring wells will be installed as part of the ground water monitoring upgrade project. These wells will permit the continued follow-up and verification of the pathway analysis.

6.3 Tritium and Volatile Organics in the Aquifer Restoration Project Well Water

A review of the volatile organic data obtained from the aquifer restoration wells and from wells in the area of the HWMF for the years 1985 to 1988 indicate that the concentrations of chlorocarbon and trihalomethane compounds in most well water samples continued to decline. Ground water samples from surveillance wells Nos. MW2, MW6, MW8 and MW13 continued to have elevated tetrachloroethylene concentrations. In addition, well Nos. MW8 and MW13 have shown elevated levels of 1,1,1-trichloroethane and chloroform. The spray system has continued to operate at 95 to 100% efficiency.

In 1987, following the noted increase in tritium concentration in well Nos. MW8, MW13, MW10 and D17, the water pumped from the restoration wells Nos. PW3 and PW4 was repiped to the recharge basin adjacent to well No. PW1. This change in recharge location and the fact that the wells Nos. PW3 and PW4 were pumped throughout the year has impacted on the contaminated plume movement. Tritium concentrations in the samples collected from these wells has declined, however, it seems that the direction of the plume has been shifted as wells that were not showing elevated levels are now beginning to show elevated levels of tritium. Strontium-90 levels in well Nos. MW2, MW7A have continued to show elevated levels. It should be noted that the wells at the site boundary have not exceeded drinking water standards for any of the pollutants identified.

6.4 Investigation of Former Army Landfill ("X-26" Dump Site)

In 1986, the Suffolk County contracted with Cornell University to conduct an examination of all available aerial photos of the western portion of Suffolk County from 1947, 1962 and 1970, and determine the location of possible storage tanks, chemical drums or disturbed areas. Six hundred and fifty-six sites were identified in this survey, of which 29 were related to the Laboratory. Twenty-eight of these twenty-nine sites had been previously reported in Laboratory

publications which were available to the public. The remaining one site, located in the northwest corner of the Laboratory, was identified to be a landfill area used by the Army during World War II. In 1988, IT Corporation, an environmental engineering firm, conducted detailed surface geophysical surveys and concluded [44] that no significant metallic objects existed in this area and that no contaminant plume either emanated from or was travelling through this area. Analytical data taken from the four wells (two shallow and two deep) installed in this area indicated that organic, metals and radioactive contaminants, if any, were at or below detection limits.

6.5 Biomonitoring of the STP Liquid Effluent

Biomonitoring studies initiated in the fall of 1987 were continued into 1988. In this process the indicator species, trout, was exposed to effluent conditions that represented at least two seasons, spring and fall. The results of the three separate studies, fall 1987, spring 1988 and fall 1988, showed similarities in that a rapid intake of the principal radionuclide cesium-137 and a good growth rate were observed. The differences were in the uptake and growth rates, which were greater during the fall than that observed during the spring study. The spring study is being repeated in 1989 to corroborate the preliminary findings. The quality of the effluent continued to indicate good growth rate, thus testifying to the viability of the effluent stream. This program will continue and the study will be expanded to include organic pollutant uptake determinations.

6.6 Sewage Treatment Plant Line Loss Study

In response to questions raised in the 1987 DOE Environmental Survey and a request by the HWMG, a study was conducted of the sewer line integrity between various facilities and the STP. An initial review of past effluent releases and activity detected at the STP indicated that between 15 and 30% of the normal effluent could be lost in transit. Due to inherent uncertainties in the historic data, a sewer line loss study was initiated by the S&EP Division. The study was originally designed to test the five major sewer lines that transport liquid waste from BNL facilities to the STP. The project commenced in December of 1987 and proceeded through August of 1988. Three of the major lines were tested before project operations were suspended due to difficulty in interpretation of analytical results, elevated tritium concentrations in the STP effluent and Plant Engineering issuing a contract to Carlson and Sweatt (C&S), consulting engineers, to conduct a video examination of the sewer line system. The data collected indicated that there was about a 13 to 15% line losses between major facilities and the STP. Most of the line loss occurred in 30 inch vitreous clay pipes used between the merger of all sewer lines and the STP. Preliminary data from C&S indicate that line losses in the sewer lines can occur due to breeches in line integrity. An estimate of 10 to 15% line loss is consistent with the observed physical conditions of these lines.

6.7 National Environmental Policy Act Activities

During the year, a major activity was the Implementation Plan for the National Environmental Policy Act (NEPA) on a Laboratory-wide basis. As part

of the NEPA implementation, the following project was subject to an Environmental Assessment and a final report was developed:

1. AGS Accumulator Booster.

In addition, a number of projects were also reviewed in terms of NEPA requirements and Environmental Analysis reports were issued. These are listed below:

1. Target Range - potential for contamination of ground water from spend lead shots.
2. 200 Mev Radiation Effects Facility.
3. CSF Steam Turbine Topping Cycle.
4. Cu-64 Positron Facility.
5. HFBR Plugs.
6. Once-Through Cooling Experimental Chiller.
7. National Atomic Physics Facility
8. Tandem Van De Graaff/Booster HITL.
9. Cryogenic Facility Decommissioning.
10. Relativistic Heavy Ion Collider

6.8 Environmental Assessment for Relativistic Heavy Ion Collider

A RHIC is proposed for construction and operation at BNL. RHIC will be placed at the site previously designated and developed for the Proton-Proton Storage Accelerator Facility (ISABELLE) in the northwest corner of the BNL site. As a result of the Environmental Analysis done by BNL and Dames & Moore (an environmental consulting firm) [45], it has been concluded that the proposed action will not have a significant impact on the environment within the meaning of the NEPA. This conclusion is based on the fact that the conventional construction is 90% complete, that the use of the site is consistent with present land use regulations, that the site does not contain cultural material relevant to historic or prehistoric occupation, that the airborne and liquid releases will have a negligible effect on either onsite non-radiation workers (6 mrem/yr) or offsite residents (0.5 mrem/yr), and that radiation doses to onsite personnel and offsite public will be kept as low as reasonably achievable, and well below DOE guidelines.

6.9 Departmental Appraisals

In May, 1988, the S&EP Division initiated a formal appraisal of each Department/Division's safety program. A total of 25 program reviews were to be conducted between May, 1988 and April, 1989. During calendar year 1988, the Environmental Protection group participated in twelve of the eighteen appraisals that were conducted. The major areas reviewed with respect to Environmental Protection were: verification of compliance with Federal, State, Local and BNL regulations on effluent emissions; definition of potential source terms; evaluation of effluent treatment and control technology; and the identification of outstanding appraisal findings. Each Department/Division received a written report of the findings. Recommended improvements are being tracked for implementation and follow-up in subsequent appraisals.

6.10 Environmental Assessment of Sewage Treatment Plant Sludge

The STP operates an anaerobic digester which generates sludge that periodically, typically once every four to five years, needs to be emptied. In 1978, the digester sludge was dried on the sludge drying beds at the STP and then placed on the BNL landfill. In 1983, the digester sludge was thought to contain elevated levels of metals. In an effort to avoid contamination of the soil and ground water with elevated metal concentrations, the sludge was emptied onto sludge beds that were lined with plastic. Analysis of this sludge indicated that no hazardous levels of metals were present but the sludge contained radioactivity at levels which were considered sufficiently elevated to warrant disposal as low-level radioactive waste.

In October of 1987, the STP digester again required removal of the sludge. Samples of the sludge were collected and analyzed for metals and radioactive constituents. Essentially, no metals were detected and the radioactive content was virtually equivalent to typical environmental levels. A pathway analysis was performed using the radioactive concentrations found in the October, 1987 sludge as the source term in order to determine the dosimetric impact of its disposal at the BNL landfill. Assuming that institutional controls would exist for at least the next 30 years, and, following the institutional control period, the general public would have immediate, unrestricted access to the site, the maximum calculated dose would be on the order of 0.6 to 1.0 millirem. These doses correspond to what NCRP Publication 91 [46] considers as "negligible individual risk". As a result of this analysis, BNL has decided to dispose of the existing sludge as low-level radioactive waste and petition the NYSDEC for an opinion on the disposal of future sludge with radioactive concentrations equivalent to those observed in this assessment at authorized area landfills.

7.0 SPECIAL PROJECTS

7.1 Status of Environmental Upgrades

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

BNL has a three year, 1.1 million dollar program to bring its storage tanks into compliance with the requirements of Suffolk County Sanitary Code, Articles 7 and 12. The funding for this program began in FY88. The program is anticipated to be completed by the end of FY90.

The first year of this program addressed 23 underground tanks used to store aqueous radionuclides. Several of these tanks will be replaced with doubled-walled tanks and associated piping to meet the requirements of Articles 7 and 12 for continued service. The remaining tanks have no future use and will be removed.

Samples were collected from those tanks where possible and analyzed to determine the appropriate method of disposal of the liquid contents. The liquid in several of these tanks had either very low level or no detectable level of radionuclides and was acceptable to be discharged to the STP.

A contract is anticipated to be awarded during the first quarter of 1989 to an outside engineering consulting firm for the development of a sampling and analysis plan to evaluate the sludge in these tanks. The appropriate method of disposal for the sludge will be determined based on the analytical results. The sludge and the tanks are anticipated to be removed during calendar year 1989.

The second year of this program will replace underground gasoline storage tanks with double-walled tanks and associated piping. In addition, seven underground fuel oil tanks will be retrofitted with overfill protection equipment. Several small outdoor aboveground storage tanks will also have secondary containment provided as a part of this program. The funding for this program is already in hand and preliminary design work was initiated during the last quarter of 1988.

The third year of this program will provide the upgrades necessary for any remaining outdoor aboveground storage tanks not completed during the previous year. It will also provide the design work necessary to upgrade indoor storage tanks for compliance with Articles 7 and 12. This program is anticipated to commence in FY90.

7.1.2 Closure of Cesspools

The New York State Department of Health 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 and 12 due to the sole source ground water aquifer [34]. 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 to be included in a cesspool elimination project. Funding for this task was obtained through a line item project.

By the end of this calendar year, the BNL Plant Engineering Division had nearly completed the design work for connection of these buildings to the STP. A contract for this work is expected to go out to bid during the first quarter of 1989. Construction is anticipated to be completed by December, 1989. As the buildings are connected to the STP, the cesspools will be resampled and analyzed to determine the appropriate method of closure. Liquid samples will be analyzed for metals and organics. Sediment samples will be collected and analyzed from those pools found to be dry.

7.1.3 Installation of Ground Water Monitoring Wells

Based on the requirements of the continually evolving ground water monitoring program and the recommendations of the DOE Survey of April, 1987 [47], a site wide geohydrological investigation was done by IT Corporation, an environmental engineering consultant firm. The objectives of this study were to integrate available information, plot water table contours and provide a basis for a site wide ground water monitoring program. A report [48] was submitted to BNL in March 1988, which formed the basis for issuing a contract to a qualified well driller for the installation of 51 wells around the site. The locations of these wells were based on ground water flow and water table contours, areas of potential ground water contamination, and the need for piezometric data. In order to establish a baseline, these wells will be initially sampled and analyzed as per the EPA-CLP program by September, 1989. Following this analysis they will be incorporated in the routine ground water monitoring program.

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

A key component of the RI/FS program, which deals with the closure/remediation of the former and current landfills plus investigation and possible remediation of other areas on-site, is the understanding of the geohydrological conditions underlying these two areas. An investigation was completed to review the patterns of pollutant migration, and to define the influence, if any, of the upgradient developed portion of the site on the landfills. A preliminary analysis of existing data does not suggest any such impact. However, the ground water monitoring program will be enhanced in FY89 in the vicinity of the landfills to confirm this assessment.

7.2 Assessment of Lead in Drinking Water

An extensive sampling effort was conducted to evaluate the quality of drinking water on-site with respect to lead and to recommend corrective actions where appropriate. Analytical results from the previous years study indicated that the quality of the water at the potable supply wellhead and the water leaving the water treatment plant was well within NYS DWS for lead. Based on this study, it was decided to conduct another study to reexamine lead concentra-

tions in building water samples. Water samples were collected from 272 drinking fountains, 137 faucets, and several bottled water coolers. In addition, samples were collected from many of the replacement fountains.

The findings from this study are summarized as follows: (1) supply from BNL wells meet EPA and New York State drinking water requirements; (2) elevated lead levels are possible at point discharge due to equipment design, plumbing practices, and the naturally occurring low pH of supply water; (3) low use lines are more likely to yield elevated lead levels; (4) lead levels decrease as a function of water usage; and (5) hot water is likely to contain higher lead levels than cold water.

On the basis of these studies, a number of drinking water fountains were taken out of service and replaced with bottled water supplies. Further routine monitoring will be conducted.

7.3 Environmental Awareness Training Program

The S&EP Division is responsible for assisting Departments/Divisions in the interpretation of environmental requirements. An integral part of this assistance is the development of an environmental awareness amongst BNL employees. In order to create this awareness, Black and Veatch Engineers and Architects were requested to develop a training manual to discuss issues such as regulatory compliance, materials handling, storage, elimination and minimization of waste discharges to the environment. The training manual would be used by S&EP staff in discussions with BNL first-line supervisors.

In August of 1988, the contractor conducted a limited survey of ten BNL work environments. From the data collected during this survey, a report was developed and submitted to BNL in the first quarter of 1989 which discussed pertinent environmental regulations, provided limited materials minimization/elimination suggestions and a checklist of methods to reduce/eliminate discharges to the environment on a laboratory wide basis. The contractor has received authorization to finalize a manual for general training at BNL. This manual is expected in the second quarter of 1989 and the training is expected to begin following the receipt of the contractor material.

7.4 Summer Student Projects

7.4.1 Thermoluminescent Dosimeter - Terrestrial and Cosmic Component of Brookhaven National Laboratory Thermoluminescent Dosimeter Response

BNL has been conducting exposure rate monitoring at the site boundary since the operation of the Brookhaven Graphite Research Reactor. In those earlier days, exposure rate monitoring was performed using ion chambers and electrometers located at the site perimeter. In 1972, the ion chambers and electrometers were replaced by TLDS. Following the Three Mile Island accident in 1979, the exposure rate monitoring program was gradually expanded to included dosimeters in each sector of the wind rose beginning at the site boundary and at distances of 3 and 8 Km from the center of the BNL site. Dosimeters at distances beyond 8 Km where established near major population centers.

Comparison of exposure rate data between on-site and off-site stations has historically [27] indicated that the on-site dosimeters yielded consistently higher exposure rates (approximately 5 mrem/yr) than the off-site measurements. This trend is apparent in the 1988 data presented earlier in this report. Because the facility had operated for twenty-five years prior to the use of TLDs, there was no mechanism for defining the baseline exposure rate at a sample station prior to operation of the facility. Modeling of effluent releases with measured meteorological parameters only accounts for a fraction of a millirem difference between the two data sets. In past Site Environmental Reports [27], the Laboratory had attributed the difference to fluctuations of terrestrial exposure rates at each monitoring location. In the summer of 1988, soil samples from each TLD location where collected and analyzed for gamma emitting radionuclides. Using the methodology described in NCRP Report No. 50 [49], estimates of the terrestrial component of the external dose were developed based on the identification of gamma emitting radionuclides in the soil. The results of this survey are summarized in Appendix D Table 78. These data clearly indicate that the terrestrial component of the external dose rate measurement exhibits considerable fluctuation between location and is responsible for the differences between external exposure rate measurements at any given station. In summary, the on-site external exposure rate due to terrestrial components is about 25 mrem/yr while off-site results range from 17 to 23 mrem/yr. The cosmic contribution was essentially constant at 40 mrem/yr out to beyond 15 Km from the site. The principle reason for variations in the terrestrial component of the exposure rate was the presence of varying concentrations of the primordial radionuclides potassium-40, radium-226 and daughter products of thorium-232. Fallout produced cesium-137 was the only non-promordial radionuclide detected in the soil samples. The dosimetric contribution from this radionuclide was insignificant relative to the contributions from the primordial series.

7.4.2 DeMinimus - Below Regulatory Concern Soil Concentrations

The Laboratory monitors the site for radioactivity in the soil. Periodically, areas are found where there is detectable concentrations of BNL generated activity in the soil. The remediation required is based on a pathway analysis of the activity detected. In 1988, a study was conducted to determine the important pathways to consider at BNL for soil concentrations that would produce a 1 mrem/yr dose to individuals of the general public who had access to this soil. The choice of the 1 mrem/yr dose was based on the ease of scaling the results to whatever Below Regulatory Concern (BRC) levels that a regulatory agency may promulgate in the future. The typical radionuclides present in surface soil as a result of BNL generate soil contamination include: cesium-137, strontium-90, cobalt-60, zinc-65, sodium-22, beryllium-7, manganese-54 and iron-59. The pathways determined to be most important in order of decreasing priority where: direct exposure, ingestion of food grown on contaminated land, inhalation of resuspended dust and ingestion of ground water. The major products of this study were the validation of the technique, identification of the principle pathways and estimation of target soil concentrations for BRC levels.

7.5 Quality Assurance Program

BNL has implemented DOE Order 5700.6 for Quality Assurance (QA) [50]. The S&EP Division has adopted the BNL QA program [51] and modified it to address the

needs of the Division [52]. A designated quality assurance officer has been appointed to review procedures and activities within the Environmental Protection Section and to assure that environmental and effluent monitoring or upgrade programs comply with the S&EP, BNL and DOE QA Programs. Currently, all environmental programs receive QA Category 2 review. At the field sampling and laboratory level, quality of information is assured by following the established protocols and participation in third party QA programs. The Analytical Chemistry laboratory is certified by New York State for drinking water analysis. The Radiological Laboratory participates in the third party DOE QA program operated by the Environmental Measurements Laboratory. Problems identified through these programs are corrected as directed by the QA officer. Purchases for environmental or effluent monitoring programs are evaluated for the level of quality assurance activity based on the criteria found in the BNL Quality Assurance manual [52].

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

Because BNL is situated on a sole source aquifer, radiological and nonradiological environmental data obtained from the ground water monitoring program are compared to the DWS. The following information lists the locations where ground water monitoring data indicates DWS 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 Wells Nos. 1 and 2 are currently out of service due to organic contamination detected at the wellhead which exceeds the DWS. Potable Wells Nos. 10 and 11 have indicated the presence of organic contamination which may exceed the proposed lower organic concentrations limits. Potable water at receptor points are within the DWS. The Laboratory is evaluating the need to install active filtration systems and alternate sources of drinking water for the site. The evaluation is expected to be completed in 1989.
CSF	Soil and ground water in the vicinity of the CSF are contaminated with organic compounds at concentrations which require remedial action. IT Corporation has evaluated potential remedial options and has proposed a remediation program for this area. Funding and remediation is expected in fiscal year 1991.
HWMA	Remediation for organic contamination detected southeast of the HWMA has been in effect for three years. Several monitoring wells still exceed DWS. The remediation will continue until ground water data are within DWS. Tritium concentrations have been detected in this same area that were above the EPA concentration limits. This issue was addressed by rerouting the sprayed water back to the HWMA for recharge thus providing sufficient decay to occur prior to the water reaching the site boundary. Strontium-90 was detected at two wells within the HWMF and at one well in close proximity to the HWMF at concentrations which exceeded the current DWS concentrations. Due to the distance from the site boundary, rate of ground water movement, half-life of the material, and pollutant migration rate, concentrations of strontium-90 at the site boundary may never exceed those specified in the DWS.

Old Landfill	One ground water well was detected with strontium-90 concentrations that exceed the DWS. Due to the distance from the site boundary, rate of ground water movement, half-life of the material and pollutant migration, rate concentrations of strontium-90 at the site boundary may never exceed those specified in the DWS. One well in this area was detected with elevated organic levels. Because only one sample was collected at this location in 1988, verification of the result through resampling and analysis is planned for 1989.
Current Landfill	Concentrations of benzene that were at or just above the DWS were detected in most of the current landfill monitoring wells. Also iron concentrations in down gradient wells generally exceed the DWS. Monitoring will continue to further assess pollutant migration. In addition, an RI/FS is in the process of being planned for proper closure of this facility in FY90.

8.2 SPDES Permit

There are five recharge basins and one discharge to the Peconic River that are governed by the SPDES permit. In 1988, the following deviations from the permit requirements occurred:

Location	Status/Comments
Recharge Basins	At the recharge basins, low pH and elevated iron concentrations were the only deviations from the permit conditions.
New Recharge Basin	In the 1987/1988 SPDES renewal review, the NYSDEC has requested that the recharge basin used to recharge water from the HWMA ground water remediation be listed on the permit. Once the renewal process has been finalized, a modification to the permit will be submitted.
Peconic	One out of twelve monthly samples exceeded the permit limits for strontium-90. In addition, pH has periodically been recorded below the minimum discharge limit. It should be noted however, that the influent to the STP is typically around 6.6 - 7.2. The pH of the treated water drops approximately one pH unit during the biological treatment process in combination with the low pH of the rain as it passes through the large surface area of the sand filter beds.
Cesspools	A contract to complete this work is expected to go out for bid during the first quarter of 1989. Construction is anticipated to be completed by December, 1989.

8.3 Radioactive Airborne Effluent Emissions Governed by NESHAPS

The Laboratory has submitted and received three NESHAPS authorizations from EPA Region II. In addition to these submissions for facilities in the process of being constructed, several facilities were modified or constructed during the

understanding was issued. The following summarizes the facilities and status of NESHAPS applications.

Building	Facility	Status/Comments
938	REF	This facility was first operational in 1986. The air emission source terms were defined in December 1988. Although radiation releases are very minor, a formal NESHAPS application will be submitted to EPA Region II in 1989.

8.4 State Air Laws

BNL currently has a variety of air emission sources which need to be evaluated for the requirement of a Certificate to Operate 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, Parts 200 through 230, New York State Air Pollution Control Regulations. The approximate number of sources and their status is described below:

No.	Status/Comments
4-5	Applications for Certificates to Operate will be submitted to the NYSDEC by June 30, 1989. This will satisfy a commitment date made during the environmental appraisal conducted by DOE-Chicago in May, 1988.
15 - 20	Applications for Certificates to Operate will be submitted to NYSDEC by September 30, 1989.
40 - 45	Sources will be evaluated; however, it is believed that these sources do not require permits. The justification needed to document this belief will be compiled and submitted to NYSDEC.

8.5 Suffolk County Sanitary Codes

BNL currently has a number of storage facilities which are not in complete compliance with the requirements of SCDHS. The applicable regulations are the Suffolk County Sanitary Code, Articles 7 and 12. The approximate number of storage facilities and their status is described below:

No.	Status/Comments
5	Underground tanks currently used to store aqueous radionuclides; will be replaced by double-walled tanks and associated piping during FY89-90.
7	Underground tanks formerly designed for storing aqueous radionuclides; will be removed from the ground during FY89-90.

2	Underground tanks will be evaluated for replacement requirements.
6 - 8	Underground petroleum storage tanks will be equipped with overfill protection by December 30, 1989.
10 - 15	Outdoor aboveground tanks will be equipped with overfill protection by December 30, 1989.
6 - 7	Outdoor aboveground storage tanks will be upgraded to comply with requirements for overfill protection and secondary containment by December 30, 1990.
	Indoor storage facilities, including tanks and drum storage areas, will be evaluated for compliance requirements.

APPENDIX A

A.1 Glossary of Terms

AGS	- Alternating Gradient Synchrotron
ALF	- Alternate Liquid Fuels
AUI	- Associated Universities Inc.
BHO	- Brookhaven Area Office
BLIP	- Brookhaven LINAC Isotope Production Facility
BNL	- Brookhaven National Laboratory
BTX	- Benzene Toluene Xylene
CSF	- Central Steam Facility
DAS	- Department of Applied Science
DOE	- Department of Energy
DOT	- Department of Transporation
DWS	- Drinking Water Standard
EPA	- Environmental Protection Agency
HFBR	- High Flux Beam Reactor
HWMF	- Hazardous Waste Management Facility
HWMG	- Hazardous Waste Management Group
ICRP	- International Commission on Radiation Protection
LFS	- Light Feed Stocks
LINAC	- Linear Accelerator
MDC	- Minimum Detection Concentration
MDL	- Minimum Detection Limit
MLD	- Million liters per day
MPF	- Major Petroleum Facility
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NA	- Not Analyzed
NBTF	- Neutral Beam Test Facility
NCRP	- National Council on Radiation Protection
ND	- Not Detected
NEPA	- National Environmental Policy Act
NESHAPS	- National Emission Standards for Hazardous Air Pollutants
NR	- Not Reported
NS	- Not Sampled
NSLS	- National Synchrotron Light Source
NYS	- New York State
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
PCB	- Polychlorinated biphenyls
RCG	- Radiation Concentration Guide
REF	- Radiation Effects Facility
RHIC	- Relativistic Heavy Ion Collider
SCDHS	- Suffolk County Department of Health Services
SDWA	- Safe Drinking Water Act
S&EP	- Safety and Environmental Protection
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
TLD	- Thermoluminescent Dosimeters
VUV	- Vacuum Ultraviolet

A.2 Glossary of Units

USGS	- United States Geologic Survey
WCF	- Waste Concentration Facility
a	- Annum
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
$CiMW^{-1}h^{-1}$	- Curie per megawatt hour
cm	- Centimeter
cm/d	- Centimeters per day
d	- Day
gal	- Gallon
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
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
rem	- Unit of radiation dose equivalent
uCi	- Microcuries
uCi/L	- Microcuries per liter
ug/L	- Micrograms per liter

APPENDIX B

METHODOLOGIES

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

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

2. Method for Tritium Dose-Equivalent Calculations - Potable Water Ingestion Pathway

The method used to calculate the maximum individual committed effective dose equivalent and the collective dose equivalent are present along with the basic assumptions used in the calculation. For the maximum individual, the highest annual average tritium concentration, as measured from a single potable well was used to calculate the total quantity of tritium ingested via the drinking water pathway. For the collective dose equivalent calculation, the annual average tritium concentration was obtained by averaging all positive results from potable wells which were in the demographic region adjacent to the Laboratory. The annual intake of tritium via the drinking water pathway was calculated from the following equation:

$$AI = 1 \times 10^{-6} \, C \cdot IR \cdot T$$

where: AI = Activity Intake, μCi

C = annual average water concentration, pCi/L

IR = Ingestion Rate (2) L/d

T = Time, 365 d

The committed effective dose equivalent was calculated from the following equation:

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

where: H = committed effective dose equivalent, rem

AI = Activity Intake, μCi

DCF = Dose Conversion Factor, Rem/μCi (6.3E-5 rem/μCi)

P = Population at risk

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

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

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

a. Radionuclide data for fish samples were all converted to pCi/kg wet weight, as this is the form in which the fish is used.

b. The average fish consumption for an individual who does recreational fishing in the Peconic River was based on a study done by the NYSDEC which suggests that the consumption rate is 7 kg/yr [53].

c. Committed Dose Equivalent Tables [54] were used to get the 50 year Committed Dose Equivalent Factor - rem/μCi intake.

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

^{3}H: 6.3E-05 rem/μCi intake

^{90}Sr: 1.3E-01 rem/μCi intake

^{137}Cs: 5.0E-02 rem/μCi intake

d. Calculation:

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

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

4. Data Processing

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

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

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

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

APPENDIX C

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

Nuclide	Matrix	Aliquot (ml)	MDC (μCi/ml)	MDL (μCi)
Gross alpha	water	1	3E-7	3E-7
		100	3E-9	
		500	6E-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	2.0E-7	

Nuclide	300g MDL μCi/g	300ml MDL μCi/ml	12000ml MDL μCi/ml	Charcoal MDC μCi
^{7}Be	1.9E-7	2.2E-7	3.8E-9	2.1E-5
^{22}Na	2.1E-8	2.4E-8	4.2E-10	2.7E-6
^{40}K	2.6E-7	3.0E-7	5.2E-9	3.3E-5
^{48}Sc	2.2E-8	2.6E-8	4.5E-10	2.9E-6
^{51}Cr	2.1E-7	2.1E-7	3.8E-9	2.1E-5
^{54}Mn	2.1E-8	2.5E-8	4.3E-10	2.6E-6
^{56}Mn	5.1E-7	5.7E-7	9.8E-9	5.9E-5
^{57}Co	1.8E-8	2.1E-8	3.5E-10	1.7E-6
^{58}Co	2.3E-8	2.7E-8	4.6E-10	2.8E-6
^{60}Co	2.7E-8	3.2E-8	5.5E-10	3.5E-6
^{65}Zn	4.7E-8	5.3E-8	9.0E-10	5.6E-6
^{134}Cs	2.6E-8	3.0E-8	5.2E-10	3.1E-6
^{137}Cs	2.3E-8	2.8E-8	4.7E-10	2.7E-6
^{226}Ra	5.1E-8	6.0E-8	1.0E-9	5.8E-6
^{228}Th	4.7E-8	5.0E-8	8.3E-10	4.5E-6
^{82}Br	3.4E-8	3.9E-8	6.6E-10	3.8E-6
^{113}Sn	3.0E-8	3.1E-8	6.1E-10	3.2E-6
^{124}I	4.3E-8	5.1E-8	8.6E-10	4.9E-6
^{126}I	5.7E-8	5.8E-8	1.2E-9	5.9E-6
^{131}I	2.4E-8	2.4E-8	4.6E-10	2.4E-6
^{133}I	3.1E-8	3.6E-8	6.1E-10	3.5E-6
^{123}Xe	1.2E-6	1.4E-6	2.4E-8	1.2E-4
^{125}Xe	4.8E-8	5.4E-8	8.9E-10	4.7E-6
^{127}Xe	2.5E-6	2.8E-8	4.6E-10	2.4E-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	0.005
trichloroethylene	0.005
tetrachloroethylene	0.005
chloroform	0.005
chlorodibromomethane	0.005
bromodichloromethane	0.005
bromoform	0.005
benzene	0.005
toluene	0.005
xylene	0.005

APPENDIX D

TABULATED ANALYTICAL RESULTS

Table 1
BNL Site Report for Calendar Year 1988
Resident Population Distribution Within 80 km of BNL

Sector	0-16 Km	16-32 Km	32-48 Km	48-64 Km	64-80 Km	Total	Remarks
SSW	21,095	1,079	0	0	0	22,174	Beyond 32 Km - Atlantic Ocean
SW	21,537	64,086	3,375	0	0	108,998	Beyond 48 Km - Atlantic Ocean
WSW	37,458	142,306	347,749	425,191	772,527	1,725,231	Beyond 80 Km - Part of New York City
W	48,923	132,237	234,369	226,184	369,384	1,011,097	Beyond 80 Km - New York City
WNW	41,228	57,437	116	213,624	128,585	440,990	Between 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut and New York
NW	17,759	1,542	134,801	122,154	110,100	386,356	Same as WNW
NNW	7,568	0	207,699	106,512	53,832	375,611	Between 16 Km and 32 Km - Long Island Sound; Beyond 32 Km - Connecticut
N	4,482	0	93,117	247,257	257,171	602,027	Same as NNW
NNE	7,469	0	6,994	44,151	65,040	123,654	Same as NNW
NE	2,903	735	0	13,491	32,882	50,011	Between 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut
ENE	2,447	6,822	12,711	14,692	2,218	38,890	North Fork of Long Island
E	2,982	15,746	17,139	8,921	556	45,344	South Fork of Long Island and Atlantic Ocean
ESE	6,073	7,580	0	0	0	13,653	Long Island; Beyond 32 Km - Atlantic Ocean
SE	8,946	0	0	0	0	8,946	Beyond 16 Km - Atlantic Ocean
SSE	22,107	0	0	0	0	22,107	Same as SE
S	15,332	23	0	0	0	15,355	Beyond 32 Km - Atlantic Ocean
TOTAL	288,309	429,593	1,058,070	1,422,177	1,792,295	4,990,444	

Note: Population distribution obtained from LILCO estimate.

Table 2
BNL Site Report for Calendar 1988
Summary of Climatology Data at BNL for 1988

Month	Temperature, °C			Precipitation
	Minimum	Maximum	Average	cm
January	-24.4	12.2	-4.2	9.12
February	-16.1	12.2	-0.7	12.22
March	-12.2	17.8	3.2	10.72
April	-3.9	20.6	7.8	5.51
May	-2.2	32.2	14.3	6.55
June	1.2	35.0	18.8	3.63
July	5.8	35.0	23.3	9.98
August	5.6	33.9	23.0	3.45
September	1.7	27.2	16.1	8.94
October	-5.0	23.9	8.9	9.83
November	-7.2	17.8	6.5	22.99
December	-17.2	12.2	-0.2	6.40
Annual	-24.4	35.0	9.7	109.34

Table 3
BNL Site Report for Calendar Year 1988
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 1988 (Ci)
491	Medical Research Reactor Stack[c]	45.7	^{41}Ar	Moving tape for radioparticulates	Charcoal for radioiodines	1,630
555	Chemistry Roof Stack	16	Tritium	None	Dessicant for tritium vapor	0.99
705	High Flux Beam Reactor	97.5	Tritium ^{82}Br ^{133}I ^{131}I	None	Dessicant for tritium vapor, particulate filter for gross beta analysis, and charcoal filter for radioiodines	189 0.003 0.0003 0.00006
705	Hot Laboratory	97.5	^{77}Br ^{124}I ^{68}Ga ^{127}Xe ^{143}Ce ^{82}Br	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	0.0062 0.00012 0.00098 0.00058 0.00022 0.00018
901	Van de Graff Accelerator	21	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	170 (gas) 76 (vapor)
931	Linac Isotope[d] Facility	20	^{15}O Tritium ^{7}Be ^{69}Ge	G-M Detector for radioactive gases	Dessicant for tritium vapor, particulate filter for gross beta, and charcoal filter for radionuclides	709 0.130 0.00041 0.00006
445	Incinerator	8.7	See Table 8	None	None	See Table 8

(a) Locations shown in Figure 2.
(b) Above ground level.
(c) Calculated from reported operating time and "one-time" measured emission rate at 3MW power level.
(d) Calculated from reported operating and estimated production rate at 180 uamp full beam current.

Table 4
BNL Site Report for Calendar Year 1988
Noble Gas Releases from the Medical Research Reactor (MRR)
and the Brookhaven Linear Isotope Production Facility (BLIP)

Month	MRR Building 491 Ar-41 <---------- Ci ---------->	BLIP* Building 931 O-15 <---------- Ci ---------->
January	131.5	47.0
February	219.4	153.0
March	127.5	166.0
April	154.8	128.0
May	111.2	161.0
June	81.7	54.0
July	39.9	0.0
August	136.3	0.0
September	241.3	0.0
October	174.1	0.0
November	60.4	0.0
December	149.7	0.0
Total	1,627.8	709.0

* The BLIP Facility did not operate in the second half of 1988 due to extended maintenance at the AGS and Linac.

Table 5
BNL Site Report for Calendar Year 1988
Tritium Releases from 10-m Stacks

Month	Bldg 931 BLIP	Bldg 555 Chem	Bldg 444 HWM Comp.	Bldg 445 HWM Inc.	Bldg 901A Van de Graaff Vapor	Bldg 901A Van de Graaff Gas	Total Tritium Releases
	<---------- mCi ---------->						
January	1.4	NS	<MDL	<MDL	740.0	4,042.0	769.7
February	1.7	70.2	<MDL	<MDL	8,400.0	400.0	8,474.7
March	7.6	71.9	1.3	<MDL	13,220.0	38,880.0	13,572.9
April	16.5	43.9	0.4	<MDL	22,270.0	1,9730.0	22,469.0
May	66.3	87.0	<MDL	<MDL	23,130.0	44,270.0	23,593.2
June	2.8	220.0	<MDL	<MDL	1,250.0	20,410.0	1,615.6
July	5.6	8.0	0.8	<MDL	1,730.0	14,600.0	1,846.6
August	2.8	144.0	0.3	<MDL	2,750.0	7,040.0	2,946.4
September	6.3	103.0	<MDL	0.0	1,164.0	6,100.0	1,316.0
October	18.3	85.8	<MDL	<MDL	1,113.0	2,780.0	1,236.6
November	0.4	151.0	<MDL	0.1	218.0	8,580.0	429.5
December	0.5	0.4	<MDL	<MDL	7.0	2,880.0	28.0
Total	130.2	985.2	2.8	0.1	75,992.0	169,712.0	78,298.1

NS = Not Sampled

MDL = Minimum Detection Limit

Table 6
BNL Site Report for Calendar Year 1988
Airborne Effluent Releases via Building 705 100-m Stack

	Facility:	HFBR					Hot Lab								
Month	Flow m^3	H-3	Br-82	I-131	I-133	Flow m^3	Xe-127	Ce-143	Br-77	I-124	I-126	Ga-68	Se-75	Br-82	Xe-122*
		<---------- mCi ---------->					<---------- mCi ----------								
January	1.16E+07	8.23E+03	1.39E-01	4.74E-03	8.57E-03	2.44E+07	3.79E-03	9.56E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
February	1.26E+07	8.03E+03	2.57E-01	1.50E-03	0.00E+00	2.46E+07	0.00E+00	9.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
March	1.26E+07	1.21E+04	1.79E-01	1.65E-03	1.76E-02	2.76E+07	2.94E-02	0.00E+00	5.41E+00	1.24E+00	0.00E+00	5.27E-02	0.00E+00	1.66E-01	0.00E+00
April	1.18E+07	2.92E+04	3.15E-01	5.27E-03	4.63E-02	2.38E+07	1.79E-02	0.00E+00	0.00E+00	0.00E+00	3.56E-03	7.81E-03	0.00E+00	0.00E+00	0.00E+00
May	1.31E+07	1.10E+04	1.85E-01	1.09E-02	5.56E-02	2.62E+07	2.81E-01	2.30E-02	7.03E-01	3.95E-03	9.62E-03	0.00E+00	4.20E-03	1.12E-02	0.00E+00
June	1.22E+07	1.62E+04	3.09E-01	9.54E-03	3.92E-03	3.11E+07	8.22E-02	0.00E+00	4.32E-02	0.00E+00	2.70E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
July	9.01E+06	2.13E+04	2.15E-01	2.74E-03	3.37E-02	2.19E+07	9.82E-03	0.00E+00	2.30E-02	0.00E+00	1.51E-02	7.96E-01	0.00E+00	0.00E+00	0.00E+00
August	1.35E+07	1.84E+04	1.77E-01	5.36E-03	2.05E-02	3.50E+07	1.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-01	0.00E+00	0.00E+00	0.00E+00
September	1.22E+07	4.20E+04	2.74E-01	7.81E-03	4.58E-02	3.06E+07	1.84E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
October	1.24E+07	7.89E+03	9.95E-02	6.88E-03	2.56E-02	2.67E+07	2.16E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
November	1.22E+07	4.26E+03	2.89E-01	0.00E+00	0.00E+00	2.84E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-03	0.00E+00	2.28E-02	0.00E+00	4.30E-02
December	1.22E+07	9.88E+03	8.72E-02	9.70E-04	0.00E+00	2.99E+07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.66E-03	0.00E+00	0.00E+00
Total	1.45E+08	1.89E+05	2.53E+00	5.73E-02	2.57E-01	3.30E+08	5.79E-01	2.18E-01	6.17E+00	1.24E+00	3.38E-02	9.80E-01	3.26E-02	1.77E-01	4.30E-02
Average Conc. pCi/m^3		1.30E+06	1.74E+01	3.94E-01	1.77E+00		1.76E+00	6.62E-01	1.87E+01	3.76E+00	1.02E-01	2.97E+00	9.89E-02	5.37E-01	1.30E+00

* Radionuclide emitted from the Hot Lab Acid vent line with a total flow that is ten times smaller that the flow quoted here which is the flow for the non-acid line.

Table 7
BNL Site Report for Calendar Year 1988
Airborne Effluent Releases via Building 931 10-m Stack

Month	Flow m^3	Facility: Be-7	Ge-69	BLIP Zn-65	I-126
		<---------- mCi ---------->			
January	6.60E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
February	6.83E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
March	8.56E+05	6.60E-04	0.00E+00	0.00E+00	3.90E-04
April	8.08E+05	9.56E-03	6.44E-02	0.00E+00	0.00E+00
May	7.09E+05	1.15E-01	0.00E+00	0.00E+00	0.00E+00
June	6.81E+05	6.71E-02	0.00E+00	1.15E-03	0.00E+00
July	8.89E+05	1.14E-01	0.00E+00	1.28E-03	0.00E+00
August	8.23E+05	4.66E-02	0.00E+00	0.00E+00	0.00E+00
September	6.17E+05	1.76E-03	0.00E+00	0.00E+00	0.00E+00
October	6.20E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
November	6.80E+05	9.98E-03	0.00E+00	1.90E-04	0.00E+00
December	8.14E+05	4.54E-02	0.00E+00	6.40E-04	0.00E+00
Total	8.84E+06	4.10E-01	6.44E-02	3.26E-03	3.90E-04
Average Conc. pCi/m^3		4.63E+01	7.28E+00	3.69E-01	4.41E-02

Table 8
BNL Site Report for Calendar Year 1988
Estimated Radioactivity in Incinerated Material

Month in 1988	Tc-99	I-131	C-14	Sn-113	I-125	Cr-51	H-3
	<---------- uCi ---------->						
January							
February	0.005	10	3	230	RNI	RNI	RNI
March							
April							
May							
June							
July							
August							
September	RNI	RNI	RNI	RNI	11.5	RNI	1
October							
November	RNI	RNI	RNI	RNI	8.0	0.5	55
December							
Total	0.005	10	3	230	19.5	0.5	56

Incinerator operated only in February, September and November.

RNI = Radionuclide not incinerated during the operational period.

Table 9
BNL Site Report for Calendar Year 1988
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
208	lead melting	NYSDEC-Air Quality	472200 3491 20801	11-29-91
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802	11-29-91
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803	11-29-91
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804	11-29-91
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202	11-29-91
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203	11-29-91
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42204	11-29-91
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205	11-29-91
423	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 42304	11-29-91
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	11-29-91
452	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45204	11-29-91
457	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45704	11-29-91
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
479	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 47904	11-29-91
493	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 49304	11-29-91
493	incinerator	NYSDEC-Air Quality	472200 3491 493AO	11-29-91
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	11-29-91
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending	
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 - ALF	NYSDEC-Air Quality	472200 3491 61006	11-29-91
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
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301	11-29-91
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101	11-29-91
T30	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 T3004	11-29-91
AGS Booster	accelerator	U.S. EPA - NESHAPS	BNL-188-01	None
RHIC	accelerator	U.S. EPA - NESHAPS	BNL-389-01	None
BNL Site	major petroleum facility	NYSDEC-Water Quality	1-1700	3-31-89
STP(a) & RCB(b)	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005385	under review for renewal;I.O.S.
CLF(c)	current landfill	NYSDEC-Solid Waste	52-S-20	under review for renewal;I.O.S.
HWMF(d)	waste management	NYSDEC	NYS ID No. 789 005 385	I.O.S.

(a) Sewage Treatment Plant.
(b) Recharge basins.
(c) Current landfill.
(d) Hazardous Waste Management Facility.
I.O.S. = Interim Operating Status.

Table 10
BNL Site Report for Calendar Year 1988
Sewage Treatment Plant Influent and Effluent Gross Alpha, Gross Beta and Tritium Concentrations

Month	Flow Liters	Gross Alpha Concentration Average	Minimum	Maximum	Gross Beta Concentration Average	Minimum	Maximum	Tritium Concentration Average	Minimum	Maximum
		pCi/L			pCi/L			pCi/L		
Location - DA										
January	5.85E+07	0.57	-1.28	1.54	9.32	4.16	28.90	1,256.10	-1,340.00	4,200.00
February	6.79E+07	0.30	-2.05	3.58	11.94	4.72	28.50	1,025.45	-681.00	3,460.00
March	7.20E+07	0.33	-1.54	1.54	9.96	0.57	25.30	867.12	-668.00	4,390.00
April	6.11E+07	0.10	-0.77	2.05	10.53	2.46	24.00	926.15	-782.00	1,550.00
May	8.15E+07	0.27	-0.77	1.79	10.66	3.59	55.70	2,462.91	-388.00	13,700.00
June	9.30E+07	0.57	-0.77	2.30	1,287.20	4.91	16,700.00	2,741.78	96.00	13,100.00
July	1.00E+08	0.15	-1.79	2.56	32.76	8.12	59.50	8,137.00	202.00	12,900.00
August	1.13E+08	0.32	-1.28	1.79	16.65	9.82	31.90	10,584.70	1,210.00	24,100.00
September	8.83E+07	0.57	-1.25	1.28	10.94	3.59	20.60	8,939.13	408.00	17,100.00
October	8.69E+07	0.63	-1.02	1.79	10.38	1.21	33.60	4,568.42	-404.00	14,500.00
November	7.93E+07	0.51	-1.54	2.30	8.05	0.00	21.00	1,200.63	-297.00	6,400.00
December	8.07E+07	0.44	-1.28	1.79	7.71	1.51	12.80	1,182.30	-718.00	7,040.00
Avg. Conc.		0.40			133.96			4178.86		
Total Release (L or mCi)	9.82E+08	0.39			131.58			4,104.56		
Location - EA										
January	4.90E+07	0.95	-0.51	3.07	8.22	2.46	15.50	1,404.00	-1,550.00	6,640.00
February	5.70E+07	0.21	-1.79	2.56	8.68	2.64	20.40	3,107.80	-394.00	8,500.00
March	6.44E+07	0.65	-1.28	1.54	7.79	1.89	14.00	4,090.71	2,810.00	7,440.00
April	5.96E+07	0.40	-2.30	3.33	10.34	3.59	36.50	3,447.29	1,270.00	8,310.00
May	6.81E+07	0.52	-0.51	1.54	8.14	3.21	21.50	4,377.82	2,450.00	14,100.00
June	6.75E+07	0.61	-1.54	2.56	26.77	3.97	84.00	1,862.93	-294.00	9,640.00
July	7.07E+07	0.46	-1.28	2.30	37.34	10.80	81.80	8,032.52	2,420.00	12,280.00
August	8.53E+07	0.90	-0.77	2.56	32.43	17.80	49.30	10,233.50	1,710.00	22,600.00
September	6.46E+07	0.32	-1.02	1.79	25.76	17.00	41.70	8,757.27	1,840.00	15,200.00
October	7.06E+07	0.79	-0.77	2.05	16.26	1.72	28.10	4,093.21	304.00	13,700.00
November	5.95E+07	0.54	-2.05	1.79	13.38	5.67	30.20	1,559.53	-981.00	5,260.00
December	6.36E+07	0.59	-1.28	4.10	14.84	6.23	27.20	1,569.00	-501.00	7,860.00
Avg. Conc.		0.59			18.38			4,650.36		
Total Release (L or mCi)	7.80E+08	0.46			14.34			3,626.82		
SPDES Limits		3.0 (Ra-226)			1000.0			Not Listed		
New York State Drinking Water Standard		15.0			50.0			20,000.0		
Typical Minimum Detectable Concentrations		2.7			5.7			1,200.0		

Table 11
BNL Site Report for Calendar Year 1988
Sewage Treatment Plant Influent and Effluent Gamma Spectroscopy and Strontium-90 Concentrations

Month	Flow L	Co-60	Zn-65	Cs-137	K-40	Ra-226	Na-22	Mn-54	Co-58	Ce-141	Co-57	Rb-84	Be-7	Sb-124	Cs-134	Sr-90
		<----------						pCi/L								---------->
Sample Location DA																
January	5.85E+07	0.13	0.14	0.61	3.30	0.83	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.29
February	6.79E+07	0.11	0.11	0.56	2.41	<MDL	0.11	0.04	0.06	0.08	<MDL	<MDL	<MDL	<MDL	<MDL	0.44
March	7.20E+07	0.19	<MDL	0.11	2.23	<MDL	0.15	<MDL	<MDL	0.13	<MDL	<MDL	<MDL	<MDL	<MDL	0.07
April	6.11E+07	0.14	0.11	0.12	2.90	<MDL	0.06	<MDL	<MDL	0.07	0.02	0.10	0.68	<MDL	<MDL	0.14
May	1.76E+08	0.57	0.73	484.90	<MDL	<MDL	<MDL	0.48	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	73.95
June																
July	1.00E+08	0.18	0.15	16.40	1.87	<MDL	0.04	0.10	<MDL	<MDL	<MDL	<MDL	<MDL	0.10	0.07	7.83
August	1.13E+08	0.12	<MDL	5.02	2.11	<MDL	0.08	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	2.14
September	8.83E+07	0.17	<MDL	3.15	2.49	<MDL	0.16	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.70
October	8.69E+07	0.15	<MDL	1.80	2.67	<MDL	0.27	0.05	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.49
November	7.93E+07	0.13	<MDL	1.76	2.44	0.43	0.39	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.53
December	8.07E+07	0.11	0.18	1.37	2.14	<MDL	0.14	0.03	<MDL	<MDL	0.06	<MDL	1.31	<MDL	<MDL	0.18
Avg. Conc.		0.22	0.18	89.38	1.97	0.08	0.12	0.11	0.004	0.02	0.006	0.006	0.15	0.01	0.01	14.45
Total Release (L or mCi)	9.82E+08	0.22	0.18	87.83	1.94	0.08	0.11	0.10	0.004	0.02	0.006	0.006	0.15	0.01	0.01	14.19
Sample Location EA																
January	4.90E+07	<MDL	<MDL	2.11	5.05	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.52
February	5.70E+07	0.11	0.20	1.43	3.11	<MDL	0.12	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.30
March	6.44E+07	0.49	<MDL	1.74	6.54	<MDL	0.67	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.55
April	5.96E+07	0.17	0.13	1.11	3.34	<MDL	0.11	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.18
May	6.81E+07	0.26	0.11	1.53	3.32	<MDL	0.13	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.05	
June	6.75E+07	0.36	0.22	8.44	3.59	<MDL	0.11	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.08	1.62
July	7.07E+07	0.21	<MDL	12.60	3.33	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	18.60
August	8.53E+07	0.06	0.17	13.00	3.33	<MDL	0.95	0.03	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.05	9.30
September	6.46E+07	0.16	<MDL	21.00	5.53	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	3.51
October	7.06E+07	0.09	<MDL	13.00	3.01	<MDL	0.55	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	3.63
November	5.95E+07	<MDL	<MDL	5.86	<MDL	<MDL	0.39	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	1.85
December	6.36E+07	0.14	<MDL	14.70	3.72	<MDL	0.37	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.48
Avg. Conc.		0.17	0.07	8.46	3.64	<MDL	0.31	0.003	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.02	3.89
Total Release (L or mCi)	7.80E+08	0.14	0.06	6.59	2.84	<MDL	0.24	0.003	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.01	3.04
SPDES		--	--	--	--	--	--	--	--	--	--	--	--	--	--	10
NYS Drinking Water Standards		--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.0
Radiation Concentration Guides		30,000	100,000	20,000			30,000	100,000	90,000	40,000	400,000	20,000	2,000,000	20,000	9,000	--

MDL = Minimum Detection Limit

Table 12
BNL Site Report for Calendar Year 1988
Sewage Treatment Plant[a]
Average Water Quality and Metals Data

	Sewage Treatment Plant Influent (DA)	Sewage Treatment Plant Effluent (EA)	SPDES Effluent Limitation
pH (SU)	2.5-12.0	5.6-6.7	5.8-9.0
Conductivity (umhos/cm)	(b)	260	(c)
Temperature maximum (°C)	25	28	32
Total coliform (per 100 ml)	NA	1,880	10,000
Fecal coliform (per 100 ml)	NA	380	2,000
Results in mg/L			
Dissolved Oxygen	NA	7.8	(c)
Chlorides	NA	48.4	(c)
Settleable Solids	0.7	0.0	0.1
Suspended Solids - max	138.0	0.0	10.0
- avg	33.2	0.0	5.0
BOD5 - max	38.4	8.4	20.0
- avg	25.2	2.9	10.0
Ammonia-Nitrogen	NA	0.05	2.0
Nitrate-Nitrogen	NA	4.4	(c)
Total Phosphorous	0.42	0.38	(c)
Sulfates	NA	17.7	(c)
Ag	<0.025	<0.02	0.05
Cd	0.0003	0.0010	(c)
Cr	0.001	<0.005	(c)
Cu	0.05	0.06	0.40
Fe	0.55	0.16	0.60
Mn	<0.05	<0.05	(c)
Na	25.6	25.3	(c)
Pb	0.010	0.002	0.067
Zn	0.07	0.07	0.30

NA: Not Analyzed.
(a) Locations shown in Figure 5.
(b) Metered.
(c) Effluent limitation not specified.

Table 13
BNL Site Report for Calendar Year 1988
Radioactivity Detected in On-Site Recharge Basin Water

Sample Location	Quarter	Gross Alpha	Gross Beta	Tritium	Co-60	Be-7	Na-22	Co-57	Co-58	Mn-54	Zn-65	Cs-137	K-40	Sr-90
		<---------- pCi/L ---------->												
HN	1	-0.205	1.930	55.500	1.330	ND	ND	ND	ND	ND	ND	ND	14.10	<0.1
	2	0.000	40.600	580.000	0.361	293.000	1.190	1.11	2.29	1.13	ND	ND	4.20	NA
	3	0.205	6.950	-166.000	0.303	56.800	3.560	0.40	1.07	0.49	0.41	1.79	2.93	NA
	4	0.358	0.831	-227.000	ND	ND	0.378	ND	ND	0.17	ND	ND	ND	NA
	Average Conc.	0.090	12.578	60.625	0.499	87.450	1.282	0.378	0.840	0.448	0.103	0.448	5.308	<0.1
HO	1	-0.102	2.000	-111.000	0.277	ND	ND	ND	ND	ND	ND	ND	2.55	<0.1
	2	0.051	1.780	82.900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3	0.205	0.982	-54.300	ND	ND	ND	ND	ND	ND	ND	ND	2.72	NA
	Average Conc.	0.051	1.587	-27.467	0.092	ND	ND	ND	ND	ND	ND	ND	1.757	<0.1
HP	1	-0.102	1.280	-83.200	ND	ND	ND	ND	ND	ND	ND	ND	1.35	0.1
	2	0.154	1.020	359.000	ND	ND	ND	ND	ND	ND	ND	ND	1.04	NA
	3	0.051	5.330	-194.000	ND	ND	ND	ND	ND	ND	ND	ND	7.39	NA
	4	0.205	5.700	-199.000	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
	Average Conc.	0.077	3.333	-29.300	ND	ND	ND	ND	ND	ND	ND	ND	2.445	0.1
HS	1	0.051	2.640	884.000	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
	2	0.461	3.020	-108.000	ND	ND	ND	ND	ND	ND	ND	ND	1.22	NA
	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	4	-0.154	2.150	-28.400	ND	ND	ND	ND	ND	ND	ND	ND	0.10	NA
	Average Conc.	0.119	2.603	249.200	ND	ND	ND	ND	ND	ND	ND	ND	0.441	NA
HT	1	0.000	2.190	-277.000	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.1
	2	0.154	0.491	221.000	ND	33.100	ND	ND	ND	ND	ND	ND	ND	NA
	3	-0.051	1.130	0.000	ND	ND	0.583	ND	ND	ND	ND	ND	ND	NA
	4	0.000	1.060	-398.000	ND	ND	0.897	ND	ND	ND	ND	ND	ND	NA
	Average Conc.	0.026	1.218	-113.500	ND	8.275	0.370	ND	ND	ND	ND	ND	ND	<0.1
SPDES	(Ra-226) 3.0	1,000.0	Not Listed	-	-	-	-	-	-	-	-	-	10	
NYS Drinking Water Standard		15	50	20,000										8
Radiation Concentration Guides					30,000	2,000,000	30,000	400,000	90,000	90,000	100,000	20,000		-
Typical MDL		0.53	1.17	300	0.24	2.0	0.25	0.19	0.23	0.23	0.54	0.25		0.1

NA = Not Analyzed.
ND = Not Detected.
NS = Not Sampled.

Table 14
BNL Site Report for Calendar Year 1988
Average Water Quality and Metals Data
in On-Site Recharge Basins

Parameter	Location[a] HN	HO	HP	HT	HS	NYS Drinking Water Standards
No. of Samples	4	3	3	4	3	
pH (SU)	6.6-9.8	6.5-6.7	5.5-7.6	6.5-7.7	6.0-7.2	6.5-8.5
Specific Conductance (umhos/cm)	162	155	201	141	127	(b)
Temperature (°C)	15	18	17	20	16	(b)
Results in mg/L						
Nitrate-N	<1.5	<1.5	<1.5	<1.5	<1.5	10.0
Chlorides	24.5	24.9	24.8	19.8	10.9	250.0
Sulfates	13.6	15.6	15.0	12.1	8.2	250.0
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	0.08	0.06	<0.05	<0.05	<0.05	1.0
Fe	0.59	1.25	0.20	<0.075	0.24	0.3
Hg	NA	NA	NA	NA	NA	0.002
Mn	0.02	0.19	0.04	<0.05	<0.05	0.3
Na	13.6	15.1	23.3	15.1	8.3	(b)
Pb	0.005	<0.005	<0.005	<0.005	0.006	0.025
Zn	0.03	0.01	<0.02	0.02	0.05	5.0

(a) Locations of recharge basins are shown in Figure 11.
(b) No standard specified.
NA: Not Analyzed.

Table 15
BNL Site Report for Calendar Year 1988
External Dose-Equivalent Rates for All TLD Locations

Location	Dose Rates 1st Quarter mrem	2nd Quarter mrem	3rd Quarter mrem	4th Quarter mrem	Total Normalized Measured Dose mrem	Annual Dose mrem/yr
1T2.2	lost	16.04	lost	12.71	28.75	57.35
1T3.0	13.17	12.92	16.33	17.90	60.32	56.89
1T8.8	11.68	12.33	lost	14.07	38.09	47.61
2T2.6	lost	lost	lost	lost	0.00	
2T3.2	15.16	15.15	lost	19.27	49.59	62.63
3T2.8	12.33	13.74	17.13	lost	43.20	57.76
3T8.8	14.04	13.42	16.60	16.83	60.89	57.73
4T2.4	11.39	lost	16.33	lost	27.72	54.99
4T2.6	13.42	12.92	15.93	18.66	60.93	57.47
4T7.5	14.29	11.93	16.60	14.84	57.66	54.66
5T2.5	14.09	16.90	20.48	16.56	68.03	67.66
5T4.2	12.80	10.45	14.99	14.38	52.62	49.63
5T6.5	14.42	11.70	17.40	14.84	58.35	55.32
5T17.1	11.68	12.92	14.16	15.45	54.21	51.00
6T2.8	12.69	15.56	18.20	14.73	61.18	61.01
6T5.6	13.30	11.98	15.39	16.37	57.04	53.79
6T14.2	10.40	11.63	12.32	13.92	48.27	45.41
7T1.6	15.62	19.57	25.16	17.97	78.33	77.90
7T2.5	17.03	15.60	20.34	lost	52.97	70.82
7T9.7	16.05	13.98	12.98	14.68	57.69	54.27
8T1.3	13.62	16.65	20.88	15.41	66.56	66.20
8T2.3	13.67	11.93	16.46	15.45	57.51	54.53
8T8.0	14.54	13.98	16.60	19.12	64.23	60.58
9T8.3	19.26	15.27	20.34	19.27	74.15	69.93
10T1.8	13.86	16.41	21.68	12.45	64.40	64.05
10T3.7	18.39	15.60	21.01	lost	55.01	73.55
10T9.3	18.39	lost	19.54	lost	37.93	73.25
10T12.0	13.22	15.39	16.00	lost	44.60	58.99
11T2.1	12.80	13.74	18.34	13.61	58.48	58.16
11T3.7	lost	13.54	17.40	lost	30.94	62.04
12T1.4	14.45	17.87	21.41	16.30	70.03	69.65
12T5.0	13.42	13.39	17.94	18.97	63.71	60.09
12T7.2	14.17	13.08	16.73	18.20	62.18	58.95
12T12.5	13.35	14.45	16.13	17.90	61.82	58.16
13T1.3	14.33	18.11	19.01	16.56	68.01	67.64
13T1.4	14.76	13.86	18.09	17.28	64.00	60.21
13T2.6	15.29	13.54	17.94	lost	46.76	62.52
13T8.2	12.55	11.63	16.20	15.60	55.98	52.79
14T1.3	14.33	17.14	20.88	16.18	68.52	68.15
14T5.6	16.05	lost	18.88	20.04	54.97	66.43
15T1.4	15.92	15.03	18.36	18.20	67.51	63.51
15T1.7	lost	15.92	lost	lost	15.92	65.30
15T3.0	13.30	13.16	16.20	15.76	58.40	55.08
15T14.7	15.29	lost	lost	lost	15.29	61.31
16T2.1	12.33	14.22	16.86	13.35	56.77	56.46
16T3.4	14.54	13.54	17.53	lost	45.61	60.98
16T10.0	lost	lost	lost	16.30	16.30	63.31
BKGD-A	3.85	3.64	4.02	5.40	16.91	15.95
BKGD-B	3.76	4.38	4.42	4.49	17.04	16.95
BKGD-C	4.11	4.23	4.20	4.89	17.43	16.39
BKGD-D	4.23	3.90	4.28	5.20	17.61	16.70

Average Dose Equivalent Rate - All Stations : 60.56 +/- 6.90
Number of Stations: 46.00

Average Dose Equivalent Rate - On-Site Stations : 63.18 +/- 6.04
Number of Stations: 19.00

Average Dose Equivalent Rate - On-Site Stations: 62.14 +/- 5.14
Number of Stations: 17.00
(Stations 7T1.6 and 8T1.3 not included due to HWMA influence)

Average Dose Equivalent Rate - Off-Site Stations : 58.77 +/- 6.84
Number of Stations: 27.00

Table 16
BNL Site Report for Calendar Year 1988
Ambient Air Tritium Concentrations at Perimeter and Control Locations

Collect Date	Stations 1T	2T	3T	4T	5T	6T1	6T2	7T	8T	9T	10T	11T	12T	13T	14T	15T	16T	20T	Maximum Monthly Conc. Perimeter Stations
	<---------- pCi/m^3 ----------																		
01/07/88	4.56	0.12	2.76	-0.27	-4.05	60.70	60.80	NS	-0.48	3.06	-3.66	-2.82	-1.34	-0.30	-0.67	0.24	-0.25	8.88	
01/14/88	NS	0.12	6.56	0.34	2.36	3.26	3.04	NS	0.87	6.37	4.45	2.46	-0.30	1.38	1.55	-0.87	0.96	NS	
01/21/88	1.71	4.01	NS	2.33	1.56	1.55	0.42	NS	1.51	1.61	1.73	-0.17	3.21	2.18	3.33	1.66	3.12	NS	
01/28/88	0.39	0.00	NS	4.30	0.77	1.16	0.58	NS	0.35	1.27	1.04	-0.80	-1.02	0.78	1.93	0.40	0.28	19.90	
ave.	2.22	1.06	4.66	1.67	0.16	16.67	16.21	NS	0.56	3.08	0.89	-0.33	0.14	1.01	1.54	0.36	1.03	14.39	18.21
02/04/88	NS	NS	1.60	NS	NS	NS	NS	0.56	NS	0.79	-2.68	-0.99	-1.16	NS	1.21	NS	-0.49	NS	
02/10/88	2.91	NS	2.35	4.13	NS	0.63	23.00	2.87	NS	NS	NS	NS	NS	NS	0.73	0.00	NS	NS	
02/17/88	0.48	1.55	3.13	2.86	3.29	4.24	0.72	2.83	8.61	1.61	1.39	2.00	3.35	NS	4.35	0.50	2.26	NS	
02/24/88	5.78	48.00	6.22	0.57	1.17	1.19	0.00	11.80	5.74	2.80	86.30	2.81	1.69	1.51	7.41	-0.38	-0.52	NS	
02/29/88	3.89	NS	4.82	0.70	5.44	2.80	4.74	5.99	NS	4.96	6.02	0.80	5.11	1.77	NS	8.08	3.96	NS	
ave.	3.27	24.78	3.62	2.06	3.30	2.22	7.12	4.81	7.18	2.54	22.76	1.16	2.25	1.64	3.42	2.05	1.30	NS	24.78
03/08/88	NS	5.74	14.00	4.60	2.93	1.04	2.33	0.44	10.10	4.41	NS	2.48	1.67	4.53	2.66	NS	1.17	NS	
03/15/88	NS	12.30	-0.95	2.91	-2.72	-2.18	-2.26	1.64	0.00	2.31	1.65	0.74	8.20	2.35	1.53	2.60	-1.02	NS	
03/23/88	NS	2.15	7.59	1.53	3.34	10.50	3.37	3.60	0.39	2.71	NS	1.45	4.62	0.54	5.19	-1.17	1.82	NS	
03/31/88	NS	3.47	2.65	7.55	3.11	3.24	3.84	18.40	2.87	5.74	NS	-0.20	4.86	5.08	4.71	2.48	2.39	NS	
ave.	NS	5.92	5.82	4.15	1.67	3.15	1.82	6.02	3.34	3.79	1.65	1.12	4.84	3.12	3.52	1.30	1.09	NS	6.02
04/07/88	NS	4.57	5.81	1.01	1.40	NS	NS	4.61	6.04	4.22	4.80	2.99	3.64	5.52	4.90	10.50	1.69	47.60	
04/14/88	NS	11.60	NS	6.48	4.86	3.53	2.13	5.82	6.52	7.11	11.00	6.00	3.75	8.82	8.21	11.60	2.20	47.60	
04/21/88	NS	11.00	NS	8.93	7.46	2.90	4.52	10.80	10.10	7.60	5.90	2.39	5.01	NS	5.41	0.63	5.18	NS	
04/28/88	NS	5.42	24.10	4.79	5.81	5.52	7.54	8.42	13.10	11.40	19.10	8.86	118.00	6.51	14.90	11.60	4.02	220.00	
ave.	NS	8.15	14.96	5.30	4.88	3.98	4.73	7.41	8.94	7.58	10.20	5.06	32.60	6.95	8.36	8.58	3.27	90.70	32.60
05/05/88	NS	11.70	NS	7.35	6.81	134.00	34.20	4.91	58.10	16.00	5.57	2.16	27.90	14.50	15.10	0.82	1.14	157.00	
05/12/88	NS	138.00	96.00	8.30	6.13	15.10	8.54	5.76	5.06	95.80	28.60	3.66	1.38	33.90	26.90	270.00	134.00	43.90	
05/19/88	NS	177.00	33.30	76.80	40.30	4.95	49.60	44.10	7.69	7.00	27.10	7.73	27.70	4.73	11.30	121.00	22.50	61.50	
05/25/88	NS	55.90	NS	-1.81	0.00	10.10	12.00	11.50	-1.96	6.75	153.00	1.26	27.50	7.05	9.28	3.10	3.46	25.60	
05/31/88	NS	18.00	NS	7.81	2.72	-0.99	12.80	9.81	5.06	1.50	3.00	1.78	25.30	-0.90	2.00	7.57	2.20	25.60	
ave.	NS	80.32	64.65	19.69	11.19	32.63	23.43	15.22	14.99	31.41	43.65	3.32	21.96	11.86	12.92	80.50	32.66	62.72	80.50
06/07/88	NS	-1.31	1.87	1.91	0.58	2.23	0.99	1.52	51.30	6.03	1.52	-2.16	0.71	6.22	6.63	1.92	-0.41	25.00	
06/15/88	NS	0.38	2.79	1.41	0.35	-1.21	-2.05	-0.84	-0.68	1.88	0.00	1.13	20.70	-0.25	5.51	NS	0.89	1.43	
06/23/88	NS	2.96	-6.13	-4.75	-2.65	-1.46	0.39	1.38	0.00	-1.96	-3.68	-4.57	0.49	-4.92	-4.34	-0.31	-0.38	21.30	
06/30/88	NS	-2.87	NS	4.61	-1.42	-0.73	-1.33	-1.24	-3.25	-3.56	-1.99	-1.64	-1.20	-2.27	-0.34	-2.39	-0.81	12.80	
ave.	NS	-0.21	-0.49	0.80	-0.79	-0.29	-0.50	0.20	11.84	0.60	-1.04	-1.81	5.18	-0.30	1.86	-0.26	-0.18	15.13	11.84
07/07/88	NS	-1.70	-1.52	-4.35	-1.36	0.00	-0.37	-1.58	-1.37	-1.78	-1.35	-1.68	-1.65	-6.17	-1.81	-0.78	1.20	38.10	
07/14/88	NS	-2.19	-8.01	-1.91	-10.90	-4.17	-6.37	-4.76	-1.08	-8.52	-14.60	-10.80	-10.10	-5.29	-6.63	-6.57	-3.42	3.58	
07/21/88	NS	NS	-6.24	-1.54	-1.08	-0.96	-2.30	-4.60	-6.10	-3.34	-4.00	22.10	-1.14	0.00	-4.59	-3.49	-1.46	NS	
07/28/88	NS	1.92	4.85	-8.03	1.33	-3.72	-3.40	1.13	-1.51	-2.34	-1.88	-5.83	-3.30	-1.23	-1.75	-4.16	-1.17	NS	
ave.	NS	-0.66	-2.73	-3.96	-3.00	-2.21	-3.11	-2.45	-2.52	-4.00	-5.46	0.95	-4.05	-3.17	-3.70	-3.75	-1.21	20.84	0.95
08/04/88	NS	0.00	-0.40	3.43	-5.69	-3.87	-2.00	7.33	-8.83	-1.51	-4.18	-2.12	-0.65	-3.57	2.06	-3.39	-1.21	6.71	
08/11/88	NS	-0.58	-0.88	-2.38	-3.96	0.00	0.30	-3.46	-2.39	-5.67	0.23	-1.03	0.38	-5.54	-1.67	-3.75	-1.69	0.75	
08/18/88	NS	1.13	-1.32	NS	-1.39	4.30	6.95	5.05	4.41	NS	-1.09	1.59	-6.04	-3.95	-1.87	-2.36	1.62	6.44	
08/25/88	NS	3.84	2.72	1.32	NS	1.63	NS	-1.71	2.41	2.07	2.98	1.20	-3.01	1.01	0.84	2.17	1.66	6.44	
08/31/88	NS	NS	3.98	-1.14	1.65	0.00	0.00	0.00	-5.40	0.99	-2.32	2.85	-4.59	1.86	NS	-1.80	0.00	NS	
ave.	NS	1.10	0.82	0.31	-2.35	0.41	1.31	1.44	-1.96	-1.03	-0.88	0.50	-2.78	-2.04	-0.16	-1.83	0.08	5.09	1.44
09/08/88	NS	2.42	-1.44	-0.12	-1.93	1.76	0.00	-1.57	-3.27	-1.04	-0.26	-0.28	1.93	-3.37	-1.96	0.00	0.00	3.30	
09/15/88	NS	-1.44	-2.50	-4.42	-4.42	-3.28	-2.80	-1.60	-1.39	-3.10	-7.18	-4.37	-2.01	0.80	-3.70	-7.05	-3.22	-5.28	
09/22/88	NS	-1.35	-1.75	1.60	-1.31	-3.93	-3.15	-7.89	1.28	-1.91	-1.65	-2.36	-5.84	-2.26	-8.57	-1.06	NS	1.61	
09/30/88	NS	-6.46	-1.07	-2.59	-1.23	-3.14	-2.09	-5.30	-2.64	-3.44	-3.54	-3.03	NS	-1.83	-3.68	-5.05	NS	7.61	
ave.	NS	-2.92	-1.69	-1.38	-2.22	-2.15	-2.01	-4.09	-1.51	-2.37	-3.16	-2.51	-1.97	-1.67	-4.48	-3.29	-1.61	1.81	-1.38
10/06/88	NS	NS	-5.16	-3.13	-3.78	7.60	8.41	-1.67	-7.40	-1.86	-1.36	-7.79	-3.59	-2.56	-4.54	-8.32	NS	-2.24	
10/14/88	NS	0.50	0.61	0.23	-0.97	-1.63	-5.05	-0.97	-2.09	12.60	1.83	-1.94	-3.85	-2.33	-2.51	-2.69	NS	24.90	
10/21/88	NS	-6.45	-3.91	1.87	-1.13	3.19	-3.69	0.37	0.33	-0.76	-5.37	-4.18	NS	0.75	-0.51	4.05	NS	3.11	
10/31/88	NS	8.56	-0.55	-0.13	-0.31	1.01	-1.26	2.92	-2.41	7.75	-0.34	-0.49	-0.20	0.57	-1.33	0.26	NS	3.40	
ave.	NS	0.87	-2.25	-0.29	-1.55	2.54	-0.40	0.16	-2.89	4.43	-1.31	-3.60	-2.55	-0.89	-2.22	-1.68	NS	7.29	4.43
11/08/88	NS	6.43	1.69	2.24	-2.18	0.60	NS	NS	-2.04	-1.38	-1.61	-2.11	1.83	-1.07	1.20	1.28	NS	-0.29	
11/15/88	NS	0.23	0.25	1.84	0.18	1.43	0.00	0.73	1.52	-0.73	1.07	1.82	0.30	0.84	1.43	0.77	NS	1.38	
11/22/88	NS	-0.56	1.81	1.02	1.81	-0.95	5.77	5.94	0.70	3.88	1.46	0.44	1.45	2.39	3.14	3.50	NS	6.70	
11/29/88	NS	1.52	NS	1.66	7.21	1.07	0.00	-0.94	-1.42	-2.57	0.56	1.55	0.09	-1.02	-1.54	-1.22	NS	0.00	
ave.	NS	1.90	1.25	1.69	1.76	0.54	1.92	1.91	-0.31	-0.20	0.37	0.43	0.92	0.29	1.06	1.08	NS	1.95	1.92
12/07/88	NS	0.57	-0.02	0.39	1.02	-1.63	0.00	NS	0.39	0.14	-0.39	2.35	3.83	0.62	-0.17	0.00	NS	3.00	
12/15/88	NS	-0.70	1.51	-1.59	1.05	-0.73	-0.42	0.00	1.03	0.12	-3.77	0.52	3.15	-0.84	-1.03	-0.42	NS	0.19	
12/22/88	NS	-0.25	0.66	-0.51	-0.78	1.99	1.04	1.66	0.92	-1.23	0.09	3.42	0.91	-1.12	-0.47	2.62	NS	1.60	
12/30/88	NS	1.00	0.24	-2.48	1.45	-0.53	1.32	0.97	2.06	1.15	0.52	2.37	-0.51	4.13	0.82	3.94	NS	0.48	
ave.	NS	0.15	0.60	-1.05	0.68	-0.22	0.49	0.88	1.10	0.04	-0.89	2.17	1.85	0.70	-0.21	1.54	NS	1.32	2.17
Annual Average	2.32	7.23	2.97	2.03	1.38	4.69	4.58	3.67	2.99	3.39	5.02	5.42	5.78	1.34	1.83	7.09	0.54	21.40	15.29

NS = Not sampled.

Table 17
BNL Site Report for Calendar Year 1988
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location 16T2.1

Month	Aliquot m^3	Gross Alpha Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Average	Gross Beta Minimum	Gross Beta Maximum
		<-------- pCi/m^3 -------->			<-------- pCi/m^3 -------->		
January	628.3	0.00126	-0.00020	0.00177	0.03270	0.02850	0.04040
February	662.5	0.00232	0.00061	0.00348	0.03577	0.02850	0.04300
March	606.9	0.00198	0.00015	0.00418	0.02619	0.02090	0.03570
April	400.0	0.00051	-0.00079	0.00135	0.03334	0.02570	0.03700
May	448.9	0.00069	-0.00054	0.00247	0.03420	0.02740	0.04200
June	415.2	0.00210	0.00106	0.00264	0.03830	0.03200	0.04350
July	396.8	0.00084	-0.00134	0.00252	0.04079	0.03500	0.04840
August	365.8	0.00140	0.00090	0.00179	0.04460	0.03060	0.06170
September	266.6	0.00202	0.00089	0.00313	0.03440	0.03090	0.03640
October	0.0	NS			NS		
November*	109.0	0.00258			0.03820		
December	352.1	0.00283	0.00163	0.00768	0.05040	0.03890	0.10700
Total	4,652.1						
Average Conc. pCi/m^3		0.00163			0.03618		
Typical MDL		0.003			0.011		

MDL = Minimum Detection Limit.

NS = Not sampled due to lack of power (site maintenance).

* Only one sample collected in November.

Table 18
BNL Site Report for Calendar Year 1988
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location 11T2.1

Month	Aliquot m^3	Gross Alpha			Gross Beta		
		Average	Minimum	Maximum	Average	Minimum	Maximum
		<-------- pCi/m^3 -------->			<-------- pCi/m^3 -------->		
January	476.90	0.00279	0.00233	0.00355	0.03690	0.02740	0.04820
February	502.17	0.00255	0.00139	0.00376	0.04680	0.03360	0.07840
March	353.99	0.00246	0.00135	0.00304	0.04228	0.02420	0.06170
April	419.17	0.00197	0.00025	0.00331	0.02861	0.01580	0.04550
May	465.03	0.00209	0.00116	0.00440	0.03830	0.03160	0.04480
June	439.77	0.00227	0.00151	0.00305	0.03455	0.02610	0.04160
July	426.00	0.00180	0.00050	0.00367	0.04220	0.03120	0.04860
August	485.81	0.00179	0.00026	0.00248	0.04017	0.03170	0.05580
September	437.00	0.00258	0.00205	0.00330	0.03886	0.03520	0.04300
October	449.00	0.00352	0.00227	0.00441	0.03280	0.03190	0.04050
November	433.00	0.00239	0.00175	0.00379	0.04169	0.03970	0.04460
December	414.90	0.00271	0.00209	0.00311	0.04725	0.04010	0.05930
Total	5,302.74						
Average Conc. pCi/m^3		0.00241			0.03921		
Typical MDL		0.003			0.009		

MDL = Minimum Detection Limit.

Table 19
BNL Site Report for Calendar Year 1988
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location 6T2.8

Month	Aliquot m^3	Gross Alpha Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Average	Gross Beta Minimum	Gross Beta Maximum
		<-------- pCi/m^3 -------->			<-------- pCi/m^3 -------->		
January	626.40	0.00217	0.00085	0.00372	0.02846	0.02320	0.03230
February	660.30	0.00225	0.00135	0.00395	0.03621	0.02700	0.04930
March	537.15	0.00143	-0.00040	0.00321	0.02974	0.02530	0.03450
April	402.83	0.00196	0.00115	0.00260	0.03605	0.03200	0.04270
May	455.49	0.00084	0.00026	0.00149	0.03587	0.02970	0.04200
June	424.67	0.00205	0.00114	0.00286	0.03886	0.03530	0.04220
July	414.70	0.00080	-0.00067	0.00308	0.04208	0.03463	0.04980
August	472.87	0.00244	0.00027	0.00382	0.04238	0.02410	0.05980
September	380.80	0.00222	0.00139	0.00298	0.04218	0.03430	0.05220
October	431.60	0.00207	0.00079	0.00294	0.04044	0.03720	0.04330
November	413.60	0.00296	0.00232	0.00367	0.03891	0.03330	0.04730
December	407.50	0.00244	0.00116	0.00304	0.04039	0.03190	0.04640
Total	5,627.91						
Average Conc. pCi/m^3		0.00197			0.03707		
Typical MDL		0.003			0.009		

MDL = Minimum Detection Limit.

Table 20
BNL Site Report for Calendar Year 1988
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location 4T2.4

Month	Aliquot m^3	Gross Alpha Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Average	Gross Beta Minimum	Gross Beta Maximum
		<-------- pCi/m^3 -------->			<-------- pCi/m^3 -------->		
January	627.30	0.00188	-0.00033	0.00422	0.03204	0.02770	0.03910
February	673.97	0.00182	0.00119	0.00259	0.03548	0.02880	0.04390
March	530.08	0.00154	-0.00081	0.00343	0.03599	0.03280	0.03800
April	405.57	0.00133	0.00023	0.00273	0.03611	0.02930	0.04970
May	451.39	0.00113	0.00000	0.00257	0.03580	0.03150	0.04040
June	425.18	0.00204	0.00181	0.00258	0.03862	0.02840	0.04650
July	413.10	0.00122	-0.00022	0.00223	0.04328	0.03900	0.05090
August	468.89	0.00235	0.00151	0.00328	0.04046	0.03320	0.05540
September	421.50	0.00145	0.00000	0.00228	0.03647	0.02930	0.04400
October	435.60	0.00323	0.00200	0.00472	0.03943	0.03580	0.04290
November	420.00	0.00189	0.00105	0.00253	0.04081	0.03840	0.04560
December	416.80	0.00270	0.00184	0.00368	0.04299	0.03730	0.04770
Total	5,689.38						
Average Conc. pCi/m^3		0.00188			0.03775		
Typical MDL		0.003			0.009		

MDL = Minimum Detection Limit.

Table 21
BNL Site Report for Calendar Year 1988
Gross Alpha and Beta Concentrations on Air Particulate Filters from Location S-6

Month	Aliquot m^3	Gross Alpha			Gross Beta		
		Average	Minimum	Maximum	Average	Minimum	Maximum
		<-------- pCi/m^3 -------->			<-------- pCi/m^3 -------->		
January	626.45	0.00180	-0.00588	0.01430	0.02983	0.00293	0.07300
February	634.53	0.00194	-0.00358	0.00930	0.03151	0.00434	0.15300
March	539.22	0.00740	-0.01000	0.01740	0.11760	0.05320	0.25700
April	369.85	0.11210	0.00371	0.03500	0.15170	0.06690	0.27100
May	391.46	0.00773	-0.00188	0.02340	0.12750	0.03770	0.24600
June	406.04	0.00751	0.00063	0.02520	0.14800	0.07550	0.23000
July	391.71	0.00746	-0.01130	0.02090	0.14090	0.03960	0.71500
August	442.94	0.00849	-0.00933	0.02870	0.15160	0.06750	0.27000
September	399.00	0.00674	0.00000	0.02330	0.12730	0.05210	0.22900
October	412.90	0.00564	-0.00783	0.02150	0.12780	0.05810	0.22500
November	361.00	0.00844	0.00064	0.03240	0.11760	0.00490	0.21700
December	386.67	0.00609	-0.00935	0.02980	0.13100	0.05230	0.22800
Total	5,361.76						
Average Conc. pCi/m^3		0.01324			0.10952		
Typical MDL		0.020			0.064		

MDL = Minimum Detection Limit.

Table 22
BNL Site Report for Calendar Year 1988
Composite Air Particulate Filter Radionuclide Data

Month	Flow cc	Be-7 <----------	K-40 pCi/m^3	Cs-137 ---------->
January	4.32E+09	2.91E-02	3.63E-02	3.07E-03
February	4.27E+09	6.53E-02	2.16E-02	2.67E-03
March	3.83E+09	6.13E-02	1.54E-02	1.41E-03
April	3.30E+09	1.00E-01	2.59E-02	1.08E-03
May	2.21E+09	5.99E-02	2.92E-02	<MDL
June	3.33E+09	7.10E-02	3.39E-02	2.53E-03
July	3.24E+09	4.47E-02	2.18E-02	2.38E-03
August	3.71E+09	4.68E-02	1.84E-02	1.08E-03
September	3.18E+09	3.95E-02	1.76E-02	1.20E-03
October	2.97E+09	4.42E-02	4.89E-02	3.34E-03
November	3.07E+09	4.00E-02	2.02E-02	1.45E-03
December	3.22E+09	6.92E-02	2.65E-02	6.39E-03
Average	3.39E+09	5.56E-02	2.60E-02	2.28E-03
Typical MDL		2.7E-03	5.3E-03	3.4E-04

MDL = Minimum Detection Limit.

Table 23
BNL Site Report for Calendar Year 1988
BNL Charcoal Filter Data for Station 16T2.1

Month	Flow m^3	Cs-137 <---------- pCi/m^3	K-40	Ra-226 ---------->
January	6.29E+02	0.00231	0.456	<MDL
February	6.67E+02	0.0013	0.348	<MDL
March	6.69E+02	<MDL	0.384	<MDL
April	4.00E+02	<MDL	0.586	<MDL
May	4.45E+02	<MDL	0.588	0.0253
June	4.13E+02	0.00346	0.623	<MDL
July	3.98E+02	<MDL	0.429	<MDL
August	4.67E+02	0.00369	0.532	<MDL
September	2.67E+02	<MDL	0.83	<MDL
October	*	*	*	*
November	2.05E+02	<MDL	1.02	<MDL
December	3.12E+02	<MDL	0.522	0.00587
Annual	4.43E+02	0.00112	0.522	0.0027
Typical MDL		0.006	0.07	0.012

* Station out of service from mid September to mid November.

MDL = Minimum Detection Limit.

Table 24
BNL Site Report for Calendar Year 1988
Radionuclides Detected on Charcoal Filter Samples for Station 11T2.1

Month	Flow m^3	Cs-137 <---------- pCi/m^3	K-40 ---------->
January	6.29E+02	<MDL	0.513
February	4.91E+02	0.0028	0.494
March	2.37E+02	0.0056	1.05
April	3.05E+02	0.0049	0.769
May	4.67E+02	<MDL	0.564
June	4.38E+02	0.00857	0.042
July	4.28E+02	0.00336	0.608
August	4.86E+02	0.00156	0.539
September	4.37E+02	<MDL	0.309
October	3.46E+02	<MDL	0.654
November	4.32E+02	0.00292	0.524
December	3.30E+02	0.00314	0.665
Average	4.19E+02	0.0025	0.529
Typical MDL		0.006	0.08

MDL = Minimum Detection Limit.

Table 25
BNL Site Report for Calendar Year 1988
Radionuclides Detected on Charcoal Filter
Samples for Station 6T2.8

Month	Flow m^3	Cs-137 <----------	K-40 pCi/m^3 ----------	Ra-226 ---------->
January	6.26E+02	0.020	0.615	<MDL
February	6.69E+02	0.002	0.380	<MDL
March	6.52E+02	<MDL	0.439	<MDL
April	4.05E+02	<MDL	0.616	0.042
May	4.58E+02	0.002	0.521	0.014
June	4.22E+02	<MDL	0.464	<MDL
July	4.16E+02	0.019	0.461	<MDL
August	4.73E+02	<MDL	0.499	<MDL
September	3.81E+02	<MDL	0.631	<MDL
October	4.32E+02	0.004	0.574	0.117
November	4.15E+02	<MDL	0.500	<MDL
December	3.15E+02	<MDL	0.371	<MDL
Average	4.72E+02	0.004	0.503	0.013
Typical MDL		0.006	0.07	0.012

MDL = Minimum Detection Limit.

Table 26
BNL Site Report for Calendar Year 1988
Radionuclides Detected on Charcoal Filter
Samples for Station 4T2.4

Month	Flow m^3	Cs-137	K-40	Ra-226	Be-7
		<----------	pCi/m^3	----------	----->
January	6.27E+02	<MDL	0.469	<MDL	<MDL
February	6.92E+02	0.00194	0.40	<MDL	<MDL
March	4.69E+02	<MDL	0.553	0.087	<MDL
April	4.06E+02	0.00218	0.55	<MDL	<MDL
May	4.54E+02	<MDL	0.578	<MDL	<MDL
June	4.23E+02	0.00343	0.55	<MDL	0.0788
July	4.14E+02	0.00308	0.69	<MDL	<MDL
August	4.69E+02	0.00407	0.54	<MDL	<MDL
September	4.15E+02	0.00492	0.55	<MDL	<MDL
October	4.36E+02	<MDL	0.252	<MDL	<MDL
November	4.20E+02	0.0036	0.547	<MDL	<MDL
December	3.06E+02	<MDL	0.863	<MDL	<MDL
Average	4.61E+02	0.0019	0.530	0.0074	0.0060
Typical MDL		0.006	0.07	0.012	0.05

MDL = Minimum Detection Limit.

Table 27
BNL Site Report for Calendar Year 1988
Radionuclides Detected on Charcoal Filter Samples for Station S-6

Month	Flow m^3	Cs-137 <---------- pCi/m^3	K-40	Ra-226 ---------->
January	6.26E+02	0.00353	0.408	<MDL
February	6.47E+02	<MDL	0.38	0.013
March	6.52E+02	<MDL	0.356	0.0193
April	3.69E+02	<MDL	0.593	0.0276
May	3.94E+02	0.00255	0.663	0.0485
June	4.04E+02	<MDL	0.677	<MDL
July	3.93E+02	<MDL	0.457	<MDL
August	4.56E+02	<MDL	0.271	<MDL
September	3.99E+02	0.00241	0.543	<MDL
October	4.15E+02	<MDL	0.583	0.053
November	3.74E+02	0.00297	0.596	0.0199
December	4.00E+02	<MDL	0.514	0.0127
Average	4.61E+02	0.00096	0.484	0.0153
Typical MDL		0.006	0.07	0.012

MDL = Minimum Detection Limit.

Table 28
BNL Site Report for Calendar Year 1988
Radionuclide Concentrations in Precipitation at Station 4T2.4 and 11T2.1

Quarter	Precipitation cm	Gross Alpha Concentration Average	Gross Beta Concentration Average	Tritium Average	^{7}Be	^{40}K	^{90}Sr
		<---------- nCi/m^2 ---------->					
Station 4T2.4							
1	32.06	NA	NA	NA	16.7	2.6	0.03
2	15.69	0.030	0.309	69.2	7.6	0.4	<0.02
3	22.37	0.000	0.025	-13.9	ND	3.6	<0.02
4	39.22	-0.014	0.136	39.9	14.8	1.1	<0.03
Total	109.34	0.016	0.470	95.20	39.1	7.1	<0.03
Typical MDL		0.136	0.30	77.0	0.16	0.32	0.03
Station 11T2.1							
1	32.06	0.027	0.599	22.1	12.5	1.9	<0.05
2	15.69	0.046	0.492	12.9	12.6	0.9	0.02
3	22.37	0.047	0.096	-56.1	ND	4.5	<0.03
4	39.22	0.099	0.346	-93.5	11.6	0.3	<0.03
Total	109.34	0.219	1.534	-114.6	36.7	7.6	0.02
Typical MDL		0.136	0.30	77.0	0.16	0.32	0.03

NA = Not Analyzed.

ND = Not Detected. Radionuclide less than system MDL.

Rain collector area at each station is 0.0656 m^2.

Table 29
BNL Site Report for Calendar Year 1988
Radionuclide Concentrations in
Vegetation and Soil in the Vicinity of BNL

Location	Matrix	Sample Date	Cs-137	K-40	Ra-226	Th-228	Be-7
			<---------- pCi/g ---------->				
Cow Neck Farm	Soil	06/22/88	0.303	4.210	0.318	0.669	<MDL
		10/26/88	0.139	2.520	0.243	0.364	<MDL
		avg.	0.221	3.365	0.281	0.517	<MDL
S.C. Honor Farm	Soil	06/22/88	0.104	4.230	0.606	0.777	0.907
		10/26/88	0.106	4.220	0.395	0.498	<MDL
		avg.	0.105	4.225	0.501	0.638	0.453
NYS Game Farm	Soil	06/22/88	0.336	3.740	0.241	0.159	<MDL
		10/26/88	0.614	3.910	0.531	0.540	<MDL
		avg.	0.475	3.825	0.386	0.350	<MDL
Berenzy Farm	Soil	06/22/88	0.108	4.180	0.402	0.502	0.403
		10/26/88	0.534	3.480	0.377	0.579	<MDL
		avg.	0.321	3.830	0.390	0.541	0.202
Cow Neck Farm	Grass	06/22/88	0.029	3.790	<MDL	<MDL	0.589
		10/26/88	<MDL	2.120	0.469	<MDL	1.640
		avg.	0.029	2.955	0.469	<MDL	1.115
S.C. Honor Farm	Grass	06/22/88	0.015	2.720	<MDL	<MDL	0.558
		10/26/88	<MDL	3.750	0.470	<MDL	0.963
		avg.	0.015	3.235	0.470	<MDL	0.761
NYS Game Farm	Grass	06/22/88	0.052	2.810	<MDL	<MDL	0.506
		10/26/88	<MDL	0.500	<MDL	<MDL	1.600
		avg.	0.052	1.655	<MDL	<MDL	1.053
Berenzy Farm	Grass	06/22/88	<MDL	<MDL	<MDL	<MDL	<MDL
		10/26/88	<MDL	3.690	0.378	<MDL	2.470
		avg.	<MDL	3.690	0.378	<MDL	2.470
Berenzy Farm	Straw-berries	06/22/88	0.093	1.520	<MDL	<MDL	<MDL
Typical MDL			0.023	0.26	0.051	0.048	0.19

MDL = Minimum Detection Limit.

Table 30
BNL Site Report for Calendar Year 1988
Gross Alpha, Beta and Tritium Concentrations in
Peconic and Carmen's River Surface Water Samples

Sample Location	Month	Number of Samples	Gross Alpha			Gross Beta			Tritium		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
			<-------- pCi/L --------->			<--------- pCi/L -------->			<--------- pCi/L --------->		
HM	January	11	1.768	0.768	3.070	10.100	5.670	18.700	1,229	-1,420	3,770
	February	12	0.063	-1.280	1.020	8.235	2.270	16.100	5,925	197	19,500
	March	13	0.710	-0.512	1.540	6.089	0.567	10.400	3,448	379	8,890
	April	13	0.119	-1.020	1.280	6.796	2.830	26.600	2,948	1,360	6,250
	May	13	0.649	-0.512	2.300	5.872	-1.130	15.500	3,628	206	10,500
	June	13	0.335	-0.768	1.540	17.849	3.780	46.300	2,150	384	7,630
	July	12	0.491	-1.020	2.050	36.050	21.000	44.000	7,243	1,010	12,380
	August	13	0.591	-1.020	2.300	33.215	14.900	49.700	10,739	4,320	20,100
	September	13	0.433	-1.540	1.790	26.039	17.600	61.200	8,770	2,600	17,500
	October	13	0.650	-1.020	2.560	19.331	9.630	26.600	3,871	101	16,300
	November	11	0.163	-1.540	2.050	13.712	4.720	19.800	1,302	-392	3,820
	December	12	0.704	-0.512	2.050	15.139	2.460	23.200	826	-616	3,700
	Total	149									
	Average		0.548	-1.540	3.070	16.594	-1.130	61.200	4,416	-1,420	20,100
	Typical MDL		2.7			5.7			1,200		
HQ	April	1	0.205			4.340			1,760		
	Total	1									
	Average		0.205			4.340			1,760		
HR	January	1	0.000			0.113			-277		
	March	1	-0.102			1.400			-646		
	June	1	0.000			0.718			-110		
	October	1	-0.205			0.227			-313		
	Total	4									
	Average		-0.077			0.615			-336		
HH	January	1	0.000			0.076			-277		
	March	1	-0.102			0.755			-534		
	June	1	0.307			0.944			-138		
	October	1	-0.154			0.038			-284		
	Total	4									
	Average		0.013			0.453			-308		
	Typical MDL		0.53			1.17			300		

MDL = Minimum Detection Limit.

Table 31
BNL Site Report for Calendar Year 1988
Nuclide Specific Concentrations in Peconic and Carmens River Surface Water Samples

Month	Aliquot, Liters	Na-22	Co-60	Zn-65	Cs-137	K-40	Be-7	Sr-90
		<---------- pCi/L ---------->						
Station HM								
January	9.60E+00	<MDL	<MDL	<MDL	1.36E+00	3.30E+00	<MDL	6.50E-01
February	1.50E+01	<MDL	<MDL	<MDL	1.32E+00	4.30E+00	1.27E+00	6.50E-01
March	1.50E+01	3.10E-01	5.95E-01	<MDL	1.73E+00	4.80E+00	<MDL	6.50E-01
April	6.11E+01	6.01E-02	1.15E-01	1.69E-01	1.23E+00	3.33E+00	<MDL	1.87E+00
May	6.30E+01	7.81E-02	1.43E-01	<MDL	5.97E-01	8.94E-01	<MDL	1.87E+00
June	1.09E+02	1.44E-02	4.53E-02	<MDL	6.83E-01	1.18E+00	<MDL	1.87E+00
July	1.27E+02	1.64E-02	4.67E-02	5.06E-02	2.86E+00	1.03E+00	<MDL	1.21E+01
August	4.01E+01	1.29E-01	8.07E-02	<MDL	3.10E-01	3.13E+00	<MDL	1.21E+01
September	3.17E+01	1.99E-01	<MDL	<MDL	1.90E+01	5.38E+00	<MDL	1.21E+01
October	3.36E+01	1.64E+00	1.58E-01	<MDL	2.95E+01	9.46E+00	<MDL	2.01E-01
November	9.68E+01	1.65E-01	3.21E-02	<MDL	3.53E+00	<MDL	<MDL	2.01E-01
December	9.50E+00	<MDL	<MDL	<MDL	1.37E+01	1.71E+01	<MDL	2.01E-01
Average	5.10E+01	1.63E-01	7.76E-02	2.74E-02	4.39E+00	2.39E+00	3.11E-02	4.74E+00
Station HH								
1st Qtr.	1.20E+01	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	NA
2nd Qtr.	1.20E+01	<MDL	<MDL	<MDL	<MDL	1.33E+00	<MDL	NA
3rd Qtr.	1.20E+01	<MDL	<MDL	<MDL	<MDL	1.28E+00	<MDL	NA
4th Qtr.	1.20E+01	<MDL	<MDL	<MDL	<MDL	1.41E+00	<MDL	NA
Average	1.20E+01	<MDL	<MDL	<MDL	<MDL	1.01E+00	<MDL	NA

MDL = Minimum Detection Limit.

NA = Not Analyzed.

Table 32
BNL Site Report for Calendar Year 1988
Peconic River Water Quality and Metals Data

Location	Sample Period	pH (SU)	Conductivity (umhos/cm)	Sulfates	Nitrate-Nitrogen	Chlorides	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
				<----------						mg/L						---------->
HM	January	6.1-6.6	239	17.5	3.3	32.4	<0.025	0.0016	<0.005	0.10	0.25	NA	<0.05	25.0	0.009	0.08
	February	5.3-6.8	243	17.7	4.0	30.8	<0.025	0.0010	<0.005	0.07	0.25	NA	<0.05	23.1	0.011	0.05
	March	5.0-6.8	260	18.2	4.4	28.0	<0.025	0.0008	<0.005	0.06	0.17	NA	<0.05	24.9	<0.005	0.05
	April	5.9-6.6	228	18.1	5.0	30.4	<0.025	0.0009	<0.005	0.36	0.10	NA	<0.05	24.0	<0.005	0.05
	May	5.6-6.6	230	17.2	4.3	34.6	<0.025	0.0010	<0.005	0.37	<0.075	NA	<0.05	25.1	<0.005	0.05
	June	5.7-6.2	236	17.0	4.5	31.4	<0.025	0.0009	<0.005	<0.05	<0.075	NA	<0.05	23.1	<0.005	0.05
	July	5.5-6.4	208	18.0	4.3	41.7	<0.025	0.0009	<0.005	0.29	0.10	NA	<0.05	24.0	<0.005	0.06
	August	4.8-6.3	207	15.6	3.7	42.5	<0.025	0.0009	<0.005	0.14	0.24	NA	<0.05	23.7	0.001	0.05
	September	5.4-6.6	318	NA	NA	NA	<0.025	0.0007	<0.005	0.23	0.09	NA	<0.05	24.3	<0.005	0.04
	October	5.8-6.5	NA	18.4	NA	44.0	<0.025	0.0009	<0.005	0.17	0.12	NA	<0.05	31.2	<0.005	0.06
	November	5.2-6.1	311	15.2	NA	39.0	<0.025	0.0010	<0.005	0.32	0.12	NA	<0.05	22.7	<0.005	0.08
	December	4.6-6.0	410	16.3	NA	33.1	<0.025	0.0007	<0.005	0.07	0.26	NA	<0.05	23.6	<0.005	0.07
NYS Drinking Water Standards		6.5-8.5	(a)	250.0	10.0	250.0	0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

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

Table 33
BNL Site Report for Calendar Year 1988
Radionuclide Concentrations in Fish

Sample Location	Distance from BNL, Discharge, km	Species	Cs-137 Conc., pCi/kg wet	Net Cs-137 Conc. pCi/kg-wet	Maximum Ind. Dose mrem	Collective Dose person-mrem
Swan Pond	Control	Blue Gill	ND	NA		
		Catfish	300	NA		
		Catfish	300	NA		
		Catfish	100	NA		
		Pumpkin Seed	200	NA		
		ave.	180			
		one stnd.	117			
Forge Pond, Peconic River Riverhead	20	Large Mouth Bass	100	-80		
		Blue Gill	200	20		
		Blue Gill	200	20		
		Blue Gill	300	120		
		Blue Gill	300	120		
		Blue Gill	100	-80		
		ave.	200	20	0.007	3.50
		one STND.	82			
Donahue's Pond, Peconic River	10	Pumpkin Seed	600	420		
		Pumpkin Seed	500	320		
		Pumpkin Seed	500	320		
		Pumpkin Seed	600	420		
		Blue Gill	700	520		
		Blue Gill	400	220		
		Catfish	700	520		
		Catfish	700	520		
		Catfish	500	320		
		Catfish	500	320		
		Catfish	1000	820		
		ave.	609	429	0.150	75.09
		one stnd.	156			
Station HM, Peconic River BNL Site	0.8	Pumpkin Seed	9000	8820		
		Pumpkin Seed	25000	24820		
		ave.	17000	16820	5.89	NA
		one stnd.	8000			
Station EA, Peconic River BNL Site	0	Pumpkin Seed	9000	8820		
		Pumpkin Seed	10000	9820		
		Brown Bullhead	8000	7820		
		Brown Bullhead	8000	7820		
		Large Mouth Bass	8000	7820		
		ave.	8600	8420	2.95	NA
		one stnd.	800			

ND = Not Detected; radionuclide concentration less than the system MDL.
NA = Not Applicable.

Table 34
BNL Site Report for Calendar Year 1988
On-Site Potable and Cooling Water Radionuclide Concentration Data

Sample Location	Sample Date	Gross Alpha	Gross Beta	Tritium	Be-7	K-40	Co-60	Na-22	Sr-90
		<---------- pCi/L ---------->							
F1 (WTP-IN)	02/23/88	-0.768	0.567	-195.00	ND	ND	ND	ND	<0.1
	06/01/88	-0.256	0.189	-219.00	ND	ND	ND	ND	<0.1
	08/16/88	-0.102	0.907	-261.00	ND	ND	ND	ND	<0.1
	12/13/88	0.102	-0.340	-543.00	ND	ND	ND	ND	<0.1
	Average Conc.	-0.256	0.331	-304.50	ND	ND	ND	ND	<0.1
F2 (WTP-EFF)	02/23/88	0.205	1.320	29.10	ND	ND	ND	ND	<0.1
	06/01/88	-0.410	0.453	246.00	3.59	ND	ND	ND	<0.1
	08/16/88	-0.102	0.397	-203.00	ND	ND	ND	ND	<0.1
	Average Conc.	-0.102	0.723	24.03	1.20	ND	ND	ND	<0.1
FA (1)	12/23/88	0.205	5.700	-199.00	NA	NA	NA	NA	NA
	Average Conc.	0.205	5.700	-199.00					
FB (2)	10/10/88	0.358	0.076	-845.00	NA	NA	NA	NA	NA
	11/03/88	0.154	0.302	-197.00	NA	NA	NA	NA	NA
	12/13/88	0.102	0.151	195.00	NA	NA	NA	NA	NA
	Average Conc.	0.205	0.176	-282.33					
FE (5)	02/23/88	0.205	2.230	175.00	ND	ND	ND	ND	0.20
	06/01/88	-0.205	0.604	-167.00	ND	ND	ND	ND	<0.1
	12/13/88	0.563	1.590	-400.00	ND	ND	ND	ND	<0.3
	Average Conc.	0.188	1.475	-130.67	ND	ND	ND	ND	0.17
FF (6)	02/23/88	0.768	0.000	782.00	ND	ND	ND	ND	<0.1
	06/01/88	0.256	2.040	-356.00	ND	ND	ND	ND	<0.1
	08/16/88	-0.102	0.831	-261.00	ND	ND	ND	ND	<0.1
	12/13/88	0.461	2.040	-315.00	ND	ND	ND	ND	<0.2
	Average Conc.	0.346	1.228	-37.50	ND	ND	ND	ND	<0.1
FG (7)	02/23/88	-0.256	0.944	-97.70	ND	ND	ND	ND	<0.1
	06/01/88	-0.410	0.453	-356.00	ND	ND	ND	ND	<0.1
	08/16/88	0.051	0.831	-57.70	ND	ND	ND	ND	<0.1
	12/13/88	0.307	0.567	-429.00	ND	ND	ND	ND	<0.2
	Average Conc.	-0.077	0.699	-235.10	ND	ND	ND	ND	<0.1
FK (104)	02/23/88	0.102	1.100	204.00	ND	4.50	ND	ND	<0.1
	Average Conc.	0.102	1.100	204.00	ND	4.50	ND	ND	<0.1
FO (10)	02/23/88	0.512	1.170	408.00	ND	ND	ND	1.43	<0.1
	06/01/88	-0.307	0.718	-246.00	ND	ND	ND	1.09	<0.1
	08/16/88	-0.102	1.470	-87.00	ND	ND	ND	ND	<0.1
	12/13/88	0.307	0.529	-407.00	ND	ND	ND	ND	<0.2
	Average Conc.	0.103	0.972	-83.00	ND	ND	ND	0.63	0.05
FP (11)	02/23/88	0.256	0.642	495.00	ND	ND	0.74	ND	0.10
	06/01/88	-0.154	2.080	110.00	ND	ND	1.17	ND	<0.1
	08/16/88	0.154	1.550	445.00	ND	ND	ND	ND	<0.1
	12/13/88	0.307	0.642	-143.00	ND	ND	0.72	ND	<0.1
	Average Conc.	0.141	1.229	226.75	ND	ND	0.66	ND	<0.1
FQ (12)	02/23/88	0.154	1.550	262.00	ND	ND	ND	ND	<0.1
	06/01/88	-0.461	0.529	-137.00	ND	ND	0.21	ND	<0.1
	08/16/88	0.307	1.700	208.00	ND	ND	0.29	ND	<0.1
	12/13/88	0.205	0.869	-315.00	ND	ND	0.29	ND	<0.1
	Average Conc.	0.051	1.162	4.50	ND	ND	0.20	ND	<0.1
NYS Drinking Water Standard		15.0	50.0	20,000					8.0
Radiation Conc. Guide					2,000,000		30,000	30,000	
Typical MDL		0.53	1.17	300			0.24	0.25	0.1

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

Table 35
BNL Site Report for Calendar Year 1988
Gross Alpha, Beta and Tritium Concentrations in
Potable Water and Distilled Water from Building 535B

Sample Location	Month	Number of Samples	Gross Alpha			Gross Beta			Tritium		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
			<--- pCi/L --->			<--- pCi/L --->			<--- pCi/L --->		
FN (Bldg. 535B Potable Water)	January	19	0.511	-1.280	2.300	1.968	-0.944	6.040	113.63	-723.00	1,070.00
	February	18	0.170	-1.790	3.070	1.101	-2.270	5.100	586.61	-778.00	7,010.00
	March	23	0.568	-1.280	2.560	1.043	-2.270	5.100	80.47	-876.00	1,170.00
	April	20	0.294	-1.790	1.790	1.171	-2.460	4.720	33.56	-684.00	1,260.00
	May	20	0.716	-0.256	1.790	1.377	-5.850	12.800	226.20	-582.00	3,880.00
	June	21	0.232	-1.790	1.540	2.014	-4.160	8.500	-165.69	-603.00	866.00
	July	19	0.081	-1.790	1.540	2.637	-1.320	11.000	-358.68	-899.00	196.00
	August	21	0.634	-1.280	2.560	5.197	-0.944	20.400	305.33	-972.00	7,060.00
	September	20	0.218	-1.540	2.050	7.543	0.567	47.400	-185.66	-1,120.00	510.00
	October	20	-0.014	-2.050	1.790	1.076	-2.270	8.120	191.00	-606.00	1,820.00
	November	19	0.000	-2.050	1.540	2.337	-2.080	27.400	60.47	-788.00	1,200.00
	December	21	0.122	-1.540	1.540	5.743	-2.080	35.500	-37.52	-1,130.00	1,530.00
	Avg. Conc.		0.300			2.785			67.84		
ZB (Dist. Water)	January	19	0.485	-1.540	2.820	1.480	-5.850	9.440	61.80	-1,620.00	1,630.00
	February	18	-0.099	-2.300	1.540	0.839	-3.970	10.000	125.63	-952.00	2,000.00
	March	23	0.389	-1.280	2.300	0.994	-3.970	5.290	123.55	-782.00	1,370.00
	April	20	0.384	-1.540	1.540	0.718	-3.970	5.100	198.06	-967.00	1,270.00
	May	21	0.756	-0.256	2.820	0.468	-6.800	7.180	-103.50	-1,940.00	582.00
	June	21	0.402	-1.790	2.560	2.130	-3.400	20.800	-239.46	-866.00	289.00
	July	19	-0.041	-1.790	1.280	1.371	-2.460	7.550	-390.22	-1,710.00	99.70
	August	21	0.305	-1.020	2.050	3.418	-2.640	9.250	63.14	-988.00	1,210.00
	September	21	-0.354	-2.050	0.768	6.817	-2.270	43.400	-357.12	-1,210.00	300.00
	October	20	0.192	-0.768	1.790	2.098	-5.100	26.100	257.45	-812.00	3,230.00
	November	19	0.135	-1.540	2.050	0.080	-3.210	4.160	1.83	-1,270.00	696.00
	December	21	0.207	-1.540	1.280	2.177	-2.640	18.900	-56.71	-1,330.00	2,300.00
	Avg. Conc.		0.236			1.914			-26.99		
Typical MDL			2.7			5.7			1,200.0		

MDL = Minimum Detection Limit.

Table 36
BNL Site Report for Calendar Year 1988
Potable Supply Wells, Average Water Quality and Metals Data

	WTP-IN (F1)	WTP-EFF (F2)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
Number of samples	4	4	4	4	4	4	4	
pH (SU)	5.4-7.8	5.3-7.9	6.0-6.5	5.9-6.5	6.1-6.7	6.1-6.2	6.0-6.5	6.5-8.5
Specific conductance (umhos/cm)	104	164	148	100	133	125	123	(a)
Total coliforms[b]	NA	NA	ND	ND	ND	ND	ND	4/100 ml
Results in mg/L								
Ammonia-N	NA	NA	0.03	0.04	0.02	0.03	0.02	(a)
Nitrate-N	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	10.0
Nitrite-N	NA	NA	<0.1	<0.1	<0.1	<0.1	<0.1	(a)
Total solids	NA	NA	100.0	75.0	80.0	85.0	85.0	(a)
Chlorides	18.5	17.1	20.8	14.1	12.8	15.7	16.6	250.0
Sulfates	9.8	9.9	12.2	9.1	11.5	13.5	13.3	250.0
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	0.0004	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0
Fe	0.29	<0.075	4.09	1.80	<0.075	<0.075	<0.075	0.3
Hg	NA	NA	NA	NA	NA	NA	NA	0.002
Mn	0.01	<0.05	0.07	0.05	<0.05	<0.05	<0.05	0.3
Na	9.8	9.7	13.1	8.2	11.5	11.1	13.4	(a)
Pb	<0.005	<0.005	0.002	0.002	<0.005	<0.005	<0.005	0.025
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	5.0

NA: Not Analyzed.
ND: Not Detected.
(a) No standard specified.
(b) Sampled monthly.
WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.

Table 37
BNL Site Report for Calendar Year 1988
Potable Water Supply Wells,
Organic Compound Data

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	Typical MDL	NYS Drinking Water Standards
	<---------- mg/L ---------->							
Benzene	ND	ND	ND	ND	ND	ND	0.001	0.005
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	0.001	0.005
Chloroform	0.017	0.0003	0.0003	0.0003	0.001	0.001	0.001	0.100
1,1-dichloroethane	ND	0.0003	ND	0.001	0.001	0.0003	0.001	
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	0.001	0.005
1,1-dichloroethylene	ND	0.0003	ND	0.001	0.001	ND	0.001	0.007
o-dichlorobenzene	ND	ND	ND	ND	ND	ND	0.001	
p-dichlorobenzene	ND	ND	ND	ND	ND	ND	0.001	
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	0.001	
Methylene Chloride	ND	0.0005	0.0005	0.0003	0.0003	0.0003	0.001	
1,1,1-trichloroethane	ND	0.0025	ND	0.003	0.009	0.002	0.001	
trichloroethylene	ND	0.001	ND	ND	ND	ND	0.001	0.005
Toluene	ND	ND	ND	ND	ND	ND	0.001	
Tetrachloroethylene	ND	ND	ND	ND	ND	ND	0.001	
Vinyl Chloride	ND	ND	ND	ND	ND	ND	0.001	0.002
m-xylene	ND	ND	ND	ND	ND	ND	0.001	
o-xylene	ND	ND	ND	ND	ND	ND	0.001	
p-xylene	ND	ND	ND	ND	ND	ND	0.001	

ND: Not detected.
MDL: Minimum Detection Limit.
Note: Analysis was performed once for Well No. 4 (FD); all other potable wells were analyzed quarterly during the year by a NYS certified contract Laboratory.

Table 38
BNL Site Report for Calendar Year 1988
Potable Water and Supply Wells,
Average Volatile Organic Compound Data

Well ID	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<---------- mg/L ---------->		
WTP-IN	2	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.001		
WTP-EFF	2	Avg:	ND	ND	ND
		Min:			
		Max:			
6 (FF)	3	Avg:	0.003	0.001	ND
		Min:	ND	ND	
		Max:	0.006	0.003	
7 (FG)	3	Avg:	ND	ND	ND
		Min:			
		Max:			
10 (FO)	3	Avg:	0.007	ND	ND
		Min:	0.002		
		Max:	0.013		
11 (FP)	3	Avg:	0.013	ND	ND
		Min:	0.005		
		Max:	0.022		
12 (FQ)	3	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.001		
5 (FE)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
104 (FK)	1	Avg:	0.016	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.050[a]	0.005	0.050[a]
Typical MDL			0.005	0.005	0.005

ND: Not detected.
MDL: Minimum Detection Limit.
[a] NYSDOH advisory guidelines.
WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.

Table 39
BNL Site Report for Calendar Year 1988
Potable Water and Supply Wells,
Average Trihalomethane Data

Well ID	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<---------- mg/L ---------->			
WTP-IN	2	Avg:	0.002	ND	ND	ND
		Min:				
		Max:				
WTP-EFF	2	Avg:	0.010	0.002	0.007	ND
		Min:	0.008	ND	0.004	
		Max:	0.012	0.004	0.010	
6 (FF)	3	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
7 (FG)	3	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
10 (FO)	3	Avg:	ND	0.002	0.001	ND
		Min:		ND	ND	
		Max:		0.005	0.002	
11 (FP)	3	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
12 (FQ)	3	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
5 (FE)	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
104 (FK)	1	Avg:	NA	ND	ND	ND
		Min:				
		Max:				
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.005	0.005	0.005	0.005

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

Table 40
BNL Site Report for Calendar Year 1988
Potable Water and Supply Wells,
Average BTX Data

Well ID	No. of Samples*		benzene	toluene	xylene
			<----------	mg/L ----------	---------->
WTP-IN	2 (2)	Avg:	ND	ND	ND
		Min:			
		Max:			
WTP-EFF	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max			
6 (FF)	3 (2)	Avg:	ND	ND	ND
		Min:			
		Max:			
7 (FG)	3 (2)	Avg:	ND	0.001	ND
		Min:		ND	
		Max:		0.002	
10 (FO)	3 (2)	Avg:	ND	0.001	ND
		Min:		ND	
		Max:		0.002	
11 (FP)	3 (2)	Avg:	ND	ND	ND
		Min:			
		Max:			
12 (FQ)	3 (2)	Avg:	ND	ND	ND
		Min:			
		Max:			
5 (FE)	2 (2)	Avg:	ND	ND	ND
		Min:			
		Max:			
104 (FK)	1 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.005	(a)	(a)
Typical MDL			0.005	0.004	0.005

MDL: Minimum Detection Limit.
ND: Not detected.
* Number inside parenthesis indicates number of xylene samples analyzed.
(a) No standard specified.
WTP-IN: Water Treatment Plant Influent.
WTP-EFF: Water Treatment Plant Effluent.

Table 41
BNL Site Report for Calendar Year 1988
Ground Water Surveillance Wells, Average Radionuclide Concentrations
for Sand Filter Bed and Peconic River

Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			Sr-90			Co-60	Cs-137	Na-22
		avg.	min.	max.	avg.	min.	max.	avg.	min.	max.	avg.	min.	max.			
		<---------- pCi/L ---------->														
On-Site																
XA	4	0.154	-0.102	0.410	4.233	3.780	4.650	4,914.750	529.000	9,410.000	0.93	0.8	1.0	0.190	ND	0.153
XB	4	0.218	0.102	0.410	3.330	2.300	6.190	-84.000	-343.000	462.000	0.35	0.2	0.400	ND	ND	ND
XC	4	0.602	0.461	0.819	2.353	1.700	2.800	-48.000	-34.000	543.000	0.78	0.2	1.100	ND	ND	ND
XD	4	0.038	-0.205	0.307	0.859	0.038	1.780	-55.850	-310.000	114.000	0.15	<0.1	0.200	ND	ND	ND
XE	4	0.064	-0.154	0.154	0.936	0.680	1.440	-302.350	-559.000	-37.400	0.35	0.3	0.4	ND	ND	ND
XI	1	0.461			0.076			-343.000			0.9			ND	ND	ND
XJ	1	0.256			-0.907			-429.000			0.6			ND	ND	ND
XK	1	0.256			4.230			6,750.000			0.95	0.3	1.6	ND	0.260	0.274
XL	1	0.410			13.600			2,380.000			NA			ND	ND	ND
XN	1	1.180			4.340			-862.000			0.5			ND	ND	ND
XO	1	0.921			3.360			-345.000			1.4			ND	ND	ND
XX	1	0.410			4.230			57.500			1.6			ND	ND	ND
XY	1	0.000			2.000			660.000			1.0			ND	ND	ND
XZ	1	0.102			1.440			1,210.000			NA			ND	ND	ND
X3	1	0.154			1.850			-402.000			0.9			ND	ND	ND
Off-Site																
X1	4	0.333	0.000	0.819	0.984	0.755	1.060	-207.100	-400.000	-27.400	0.625	0.600	0.700	ND	ND	ND
X2	4	0.128	-0.051	0.410	1.237	0.227	1.810	2,107.500	1,760.000	2,740.000	0.025	<0.1	0.100	ND	ND	ND
X4	4	0.320	0.051	0.717	3.920	3.480	4.610	734.000	-192.000	2,150.000	1.28	0.800	1.800	ND	ND	ND
XS	3	1.008	0.614	1.280	6.057	5.290	6.650	-340.670	-776.000	0.000	0.567	0.200	0.800	ND	ND	ND
XT	4	-0.026	-0.154	0.102	0.746	0.378	1.170	-361.500	-515.000	-219.000	0.025	<0.1	0.100	ND	ND	ND
NYS Drinking Water Standard		15.0			50.0			20,000			8.0					
Radiation Concentration Guide														30,000	20,000	30,000
Typical MDL		0.53			1.17			300			0.1			0.24	0.25	0.25

ND = not detected.
NA = not analyzed.
MDL = minimum detection limit.

Table 42
BNL Site Report for Calendar Year 1988
Off-Site Potable Water Radionuclide Concentration

Location	Number of Samples	Gross Alpha avg.	Gross Alpha min.	Gross Alpha max.	Gross Beta avg.	Gross Beta min.	Gross Beta max.	Tritium avg.	Tritium min.	Tritium max	Sr-90	K-40
		<---------- pCi/L ---------->										
1	4	0.05	-0.10	0.31	0.92	0.08	1.62	-282	-486	0	<0.4	8.2
2	4	0.01	-0.05	0.10	2.09	1.55	3.06	12	-458	1,120	<0.1	3.5
*3	1	0.10			16.00			187			NS	17.4
4	2	0.00	-0.20	0.21	0.62	-0.26	1.49	-182	-391	27	0.3	<MDL
5	3	-0.03	-0.31	0.21	1.05	0.57	1.74	-177	-458	107	0.15	<MDL
6	4	0.01	-0.26	0.41	1.33	0.26	2.76	-189	-391	27	0.25	2.7
7	4	0.17	0.00	0.31	1.49	0.26	3.30	-271	-572	27	0.1	0.2
8	4	-0.07	-0.21	0.20	1.40	0.23	2.12	576	301	988	<0.3	2.5
9	4	-0.02	-0.26	0.20	0.28	-0.42	1.10	2,606	854	3,910	<0.2	2.2
10	4	-0.02	-0.26	0.15	0.12	-0.49	0.87	-90	-361	257	<0.1	1.3
11	4	0.05	-0.26	0.36	0.22	-0.38	0.64	-120	-315	30	<0.2	<MDL
12	3	0.12	0.05	0.26	0.57	0.15	0.87	-123	-315	0	<0.2	NS
13	3	-0.05	-0.36	0.15	1.84	1.13	2.38	-138	-301	80	1.4	3.5
14	4	0.12	-0.15	0.46	1.80	1.25	2.38	-330	-515	-27	0.3	1.2
15	3	-0.02	-0.15	0.15	2.64	1.85	3.89	-398	-572	-223	<0.1	NS
16	3	0.34	0.26	0.51	0.30	0.11	0.49	-85	-200	0	<0.1	NS
17	3	-0.17	-0.26	0.00	0.43	-0.34	1.51	-364	-400	-331	<0.2	6.5
18	3	-0.03	-0.15	0.10	0.52	0.04	0.91	-387	-511	-315	0.1	<MDL
19	2	-0.03	-0.05	0.00	0.89	0.68	1.10	-339	-421	-257	<0.1	<MDL
20	1	0.05			1.10			0			<0.1	1.3
NYS Drinking Water Standard		15.0			50.0			20,000			8.0	
Typical MDL		0.5			1.3			300			0.1	4.0

* Elevated gross beta result for location number 3 is due to potassium-40 in the water.
MDL = Minimum Detection Limit.
NA = Not Analyzed.
NS = Not Sampled.

Table 43
BNL Site Report for Calendar Year 1988
Ground Water Surveillance Wells, Average Radionuclide Concentrations for the Landfills, 650 Sump, Ash Repository, Waste Concentration Facility Central Steam Facility, Miscellaneous Wells and Army Landfill

Location	Number of Samples	Gross Alpha avg.	Gross Alpha min.	Gross Alpha max.	Gross Beta avg.	Gross Beta min.	Gross Beta max.	Tritium avg.	Tritium min.	Tritium max.	Sr-90 ave.	Sr-90 min.	Sr-90 max.	Co-60	Cs-137	Na-22
		<---------- pCi/L ---------->														
Current Landfill																
W6	4	0.090	-0.102	0.205	0.500	-0.718	1.320	-28.5	-400.0	434.0	0.25	<0.1	0.400	ND	ND	ND
562	1	0.000			0.453			-257.0			<0.2			ND	ND	ND
WT	4	0.448	0.000	0.819	1.614	0.604	2.000	137.6	-143.0	379.0	0.05	<0.1	0.200	ND	ND	0.073
WR	4	-0.154	-1.280	0.410	8.508	3.250	13.600	305.8	-172.0	1290.0	2.33	1.0	3.200	ND	0.363	0.133
WS	4	0.552	0.205	1.540	18.788	4.650	28.000	868.5	-747.0	2250.0	2.43	0.4	3.600	ND	ND	0.625
563	1	0.205			21.900			1290.0			1.0			ND	ND	1.230
1K	4	-0.409	-1.020	0.154	14.725	11.600	17.900	1918.0	-326.0	4540.0	2.43	0.7	4.0	ND	ND	0.461
2C	4	0.064	-1.020	1.020	20.150	16.200	23.000	13092.5	1670.0	19800.0	6.38	2.9	10.9	ND	ND	0.249
W9	4	0.743	-0.768	2.560	17.950	15.300	22.900	14965.0	2360.0	26800.0	3.56	2.7	6.100	ND	ND	0.293
564-S	1	0.717			13.000			5320.0			<0.1			ND	0.386	ND
565-D	1	0.358			2.380			85.8			<0.4			ND	ND	ND
Former Landfill																
D1	2	-0.025	-0.102	0.051	2.155	1.590	2.720	-43.8	-87.6	0.0	<0.1	<0.1	<0.1	ND	ND	ND
D2	4	0.013	-0.102	0.102	0.746	-0.529	1.660	-58.5	-166.0	162.0	0.05	<0.1	0.100	ND	0.041	ND
D3	2	0.128	0.051	0.205	0.756	0.642	0.869	-0.8	-29.2	27.6	0.200			ND	ND	ND
D4	2	0.410	0.256	0.563	0.963	0.944	0.982	-25.5	-189.0	138.0	0.35	0.3	0.4	ND	ND	ND
D5	3	0.017	-0.154	0.154	0.025	-0.529	0.340	-138.7	-346.0	193.0	0.1	<0.2	0.2	ND	ND	ND
D6	3	0.188	0.051	0.256	24.500	13.200	41.600	-163.8	-377.0	-56.0	18.35	7.2	29.5	ND	ND	ND
D7	3	0.102	0.000	0.307	1.448	0.944	2.120	105.0	62.9	135.0	0.200			ND	ND	ND
1I	2	-0.154	-0.205	-0.102	0.397	0.264	0.529	-251.0	-269.0	-233.0	<0.1			ND	ND	ND
1J	4	-0.051	-0.307	0.205	0.312	0.000	1.020	-242.3	-377.0	-138.0	0.067	<0.1	0.200	ND	ND	ND
WO	2	0.384	0.358	0.410	0.453	-0.038	0.944	-155.5	-172.0	-139.0	4.97	<0.1	14.900	ND	0.055	0.147
WP	2	0.128	0.051	0.205	0.302	0.264	0.340	169.0	108.0	230.0	0.15	0.1	0.2	ND	ND	ND
WQ	2	0.000	0.000	0.000	0.567	0.378	0.755	-87.1	-201.0	26.9	<0.1	<0.1	<0.1	ND	ND	ND
D16	2	0.179	0.000	0.358	0.605	0.000	1.210	-96.5	-220.0	27.9	<0.25			0.393	ND	ND
D18	2	0.000	-0.051	0.051	0.849	0.378	1.320	-344.0	-373.0	-314.0	0.4	<0.1	0.8	ND	ND	ND
D19	2	-0.103	-0.205	0.000	0.700	0.340	1.060	-319.5	-189.0	-450.0	<0.1			ND	ND	ND
650 Sump																
1C	1	0.205			2.490			-55.2			0.5			ND	1.420	ND
Ash Repository																
D20	2	0.230	0.102	0.358	1.929	0.718	3.140	-57.5	-115.0	0.0	<0.1			ND	ND	ND
Central Steam Facility																
D13	1	0.000			4.910			119.0						ND	ND	ND
D14	1	0.102			1.280			89.0			<0.1			0.286	ND	ND
D15	1	0.358			1.740			297.0			0.200			0.581	ND	ND
IT1	2	0.205	0.154	0.256	2.245	2.150	2.340	-142.0	-201.0	-82.9	0.23	<0.1	0.400	0.218	ND	ND
IT2	2	-0.128	-0.205	-0.051	1.985	1.780	2.190	171.0	115.0	227.0	0.900			0.132	ND	ND
IT3	1	0.205			1.660			272.0			NA			0.229	ND	ND
IT4	2	0.154	0.102	0.205	2.704	0.907	4.500	96.4	29.7	163.0	0.300			0.087	ND	0.074
IT5	2	0.154	0.102	0.205	2.040	1.170	2.910	143.5	109.0	178.0	0.200			0.092	ND	ND
Waste Concentration Facility																
D8	1	-0.051			4.570			445.0			1.700			ND	ND	ND
D9	2	0.102	0.102	0.102	3.420	2.720	4.120	117.4	-85.3	320.0	0.2	<0.2	0.4	ND	ND	1.190
D10	2	-0.051	-0.154	0.051	3.270	3.250	3.290	71.0	0.0	142.0	0.17	<0.1	0.3	ND	ND	2.070
D11	2	0.052	-0.102	0.205	3.175	1.780	4.570	-339.0	-853.0	175.0	0.25	0.1	0.4	ND	ND	2.270
D12	2	0.000	-0.205	0.205	2.285	1.930	2.640	17.0	-199.0	233.0	<0.1	<0.1	<0.1	ND	ND	1.424
Army Landfill																
IT1S	1	NR			NR			-316.0			<0.1			ND	ND	ND
IT1D	1	0.102			0.718			-287			<0.1			ND	0.235	ND
IT2S	1	0.205			1.960			-115.0			0.400			ND	ND	ND
IT2D	1	0.307			1.020			-86.2			<0.1			ND	ND	ND
Miscellaneous Wells																
SI	2	0.179	0.051	0.307	1.001	0.642	1.360	175.9	54.8	297.0	<0.1	<0.1	<0.1			
SE	2	-0.026	-0.154	0.102	1.453	0.755	2.150	-3.0	-116.0	110.0	<0.1	<0.1	<0.1			
SG	2	-0.102	-0.102	-0.102	1.019	0.907	1.130	8.0	-203.0	219.0	0.200	0.200	0.200			
NYS Drinking Water Standard		15.0			50.0			20,000			8.0					
Radiation Conc. Guide														30,000	20,000	30,000
Typical MDL		0.53			1.17			300			0.1			0.24	0.25	0.25

NA = Not Analyzed.
ND = Not Detected.
NR = Not Reported. Sample lost in laboratory analysis.

Table 44
BNL Site Report for Calendar Year 1988
Ground Water Surveillance Wells, Average Radionuclide Concentrations for the Waste Management Area

Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			Sr-90			Co-60	Cs-137	Na-22
		avg.	min.	max.	avg.	min.	max.	avg.	min.	max.	avg.	min.	max.			
		<---------- pCi/L ---------->														
MW1	4	0.01275	-0.205	0.256	2.53	1.36	4.34	1,469.5	388.0	2,230.0	0.9	0.1	1.2	ND	ND	0.0693
MW2	4	0.256	0.102	0.410	52.800	38.900	60.300	8,255.0	1,270.0	35,600.0	46.27	28.2	56.3	1.379	0.523	10.200
WC	1	-0.051			10.900			757.0			10.000	9.9	10.1	ND	ND	0.835
WD	1	0.410			24.000			473.0			NA			NA		
WE	NS															
MW3	3	-0.120	-0.154	-0.051	0.277	-0.076	0.944	1,054.0	255.0	2,380.0	0.125	<0.1	0.5	ND	0.043	0.182
MW4	4	0.141	0.051	0.256	6.365	3.480	7.630	3,367.5	1,320.0	7,220.0	3.55	<0.1	6.1	ND	ND	0.044
MW6	4	0.090	0.000	0.205	2.446	0.604	4.120	895.8	587.0	1,300.0	<0.1	<0.1	<0.2	ND	ND	2.158
2L	1	0.051			3.170			683.0			2.300			ND	ND	0.383
MW5	4	0.243	-0.154	0.358	3.615	3.170	3.850	2,637.8	693.0	4,470.0	1.425	0.8	2.2	ND	ND	ND
2M	2	1.048	0.205	1.890	3.645	1.170	6.120	1,952.0	124.0	3,780.0	0.05	<0.1	0.1	ND	ND	0.077
2N	2	0.128	0.000	0.256	2.400	1.020	3.780	4,880.0	1,200.0	8,560.0	0.55	0.2	0.9	ND	ND	0.224
MW7A	4	0.294	-0.051	0.563	82.225	39.800	118.000	1,709.8	499.0	3,640.0	39.8	10.0	81.3	ND	ND	0.300
MW7B	4	0.089	-0.051	0.307	1.785	0.567	4.500	2,198.3	263.0	5,450.0	0.05	<0.1	0.2	ND	ND	0.199
MW13	7	0.256	0.051	0.461	5.280	3.100	7.140	329.5	-57.5	606.0	<0.1	<0.1	<0.1	0.057	ND	ND
MW8	9	0.218	0.154	0.256	4.147	0.907	6.650	9,090.8	115.0	32,400.0	<0.1	<0.1	<0.1	ND	ND	ND
MW12	8	0.307	0.000	0.614	3.423	1.440	5.144	1,006.2	86.2	3,640.0	<0.2	<0.1	<0.3	ND	ND	0.054
MW11	9	0.166	0.051	0.461	4.910	2.420	7.550	-42.0	-431.0	349.0	<0.1	<0.1	<0.2	ND	ND	0.055
MW10	9	-0.043	-0.102	0.000	2.783	0.944	4.680	3,215.9	-287.0	10,600.0	<0.1	<0.1	<0.2	ND	ND	ND
D17	4	0.077	0.000	0.154	0.661	0.453	0.869	1,547.8	911.0	2,670.0	0.05	<0.1	0.1	ND	ND	ND
NYS Drinking Water Standards		15.0			50.0			20,000			8.0					
Radiation Concentration Guides														30,000	20,000	30,000
Typical MDL		0.53			1.17			300			0.1			0.24	0.25	0.25

MDL = Minimum Detection Limit.
NA = Not Analyzed.
NS = Not Sampled.
ND = Not Detected.

Table 45
BNL Site Report for Calendar Year 1988
Ground Water Surveillance Wells, Average Radionuclide Concentrations in Recovery Well Water

Location	Number of Samples	Gross Alpha			Gross Beta			Tritium			Sr-90	Co-60	Cs-137	Na-22
		avg.	min.	max.	avg.	min.	max.	avg.	min.	max.				
		<---------- pCi/L ---------->												
PW1	5	0.051	-0.154	0.307	4.494	2.680	8.500	1,019.0	142.0	1,490.0	1.80	ND	ND	0.294
PW2	5	0.082	-0.256	0.358	4.228	2.640	5.060	3,225.4	2,130.0	4,820.0	1.60	ND	ND	0.1265
PW3	10	0.103	-0.102	0.256	1.835	0.907	2.460	13,112.1	1,920.0	64,200.0	<0.1	ND	ND	ND
PW4	11	0.128	-0.154	0.358	1.558	0.416	2.870	930.0	0.0	1,960.0	0.05	0.123	0.132	ND
PW5	5	0.020	-0.154	0.358	5.804	4.500	6.570	434.0	190.0	718.0	3.2	ND	ND	0.142
Typical MDL		0.53			1.17			300			0.1	0.24	0.25	0.25

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

Table 46
BNL Site Report for Calendar Year 1988
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	pH (SU)	Conductivity (umhos/cm)	Chlorides <---------- mg/L ---------->	Sulfates	Nitrate-Nitrogen
On-Site						
XA	3	6.2 - 6.8	270	29.8	18.8	5.4
XB	3	4.3 - 7.3	117	8.2	3.8	<1.5
XC	3	4.9 - 6.1	59	6.3	8.2	<1.5
XD	2	5.8 - 6.1	90	9.2	2.1	<1.5
XE	2	4.9 - 5.4	58	45.2	5.2	1.4
XK	1	6.3	NA	NA	NA	NA
XI	1	5.5	NA	NA	NA	NA
XJ	1	5.2	NA	NA	NA	NA
XY	1	4.8	NA	NA	NA	NA
XZ	1	6.8	NA	NA	NA	NA
XO	1	4.7	NA	NA	NA	NA
XN	1	4.9	NA	NA	NA	NA
XL	1	6.3	NA	NA	NA	NA
X3	1	4.7	NA	NA	NA	NA
Off-Site						
X1	3	4.8 - 5.0	83	13.6	10.7	<1.5
X2	3	4.9 - 6.1	136	18.5	17.8	<1.5
X4	3	5.9 - 6.2	111	25.7	15.8	0.8
XS	2	5.5 - 5.8	94	3.4	<6.0	<1.5
XT	3	5.8 - 6.6	110	<6.0	8.6	<1.5
NYS Drinking Water Standards		6.5 - 8.5	(a)	250.0	250.0	10.0

NA: Not Analyzed.

(a) No standard specified.

Table 47
BNL Site Report for Calendar Year 1988
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<---------- mg/L ---------->									
On-Site											
XA	4	<0.025	0.0030	<0.005	<0.05	0.62	NA	<0.05	25.8	0.045	0.45
XB	4	<0.025	0.0039	<0.005	<0.05	0.25	NA	0.04	4.0	0.007	10.1
XC	4	<0.025	0.0003	<0.005	<0.05	1.32	NA	0.55	4.0	0.010	0.42
XD	3	<0.025	0.0004	<0.005	<0.05	<0.075	NA	<0.05	5.1	0.005	0.40
XE	2	<0.025	0.0021	<0.005	<0.05	0.40	NA	<0.05	2.8	0.009	0.54
XK	1	<0.025	<0.0005	<0.005	<0.05	3.50	NA	0.12	25.0	<0.005	0.04
XI	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	3.8	<0.005	0.10
XJ	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.07	4.2	0.006	0.21
XX	1	<0.025	<0.0005	<0.005	<0.05	4.4	NA	0.15	8.0	<0.005	0.16
XY	1	<0.025	<0.0005	<0.005	<0.05	0.18	NA	0.13	6.1	<0.005	0.79
XZ	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.13	13.4	<0.005	0.49
XO	1	<0.025	<0.0005	<0.005	<0.05	0.16	NA	0.22	6.5	0.005	0.43
XN	1	<0.025	<0.0005	<0.005	<0.05	8.60	NA	<0.05	2.8	<0.005	0.26
XL	1	<0.025	<0.0005	<0.005	<0.05	1.98	NA	0.09	23.3	<0.005	0.06
X3	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.12	2.9	0.006	0.05
Off-Site											
X1	4	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.02	5.5	0.005	0.54
X2	4	<0.025	<0.0005	<0.005	<0.05	0.04	NA	1.50	20.6	<0.005	0.73
X4	4	<0.025	<0.0005	<0.005	<0.05	0.46	NA	<0.05	12.0	<0.005	0.10
XS	3	0.010	<0.0005	<0.005	<0.05	5.46	NA	0.20	2.8	0.002	0.16
XT	4	<0.025	<0.0005	<0.005	<0.05	1.78	NA	0.33	3.6	<0.005	0.30
NYS Drinking Water Standards		0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

NA: Not Analyzed.

(a) No standard specified.

Table 48
BNL Site Report for Calendar Year 1988
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
		<---------- mg/L ---------->		
On-Site				
XA	1	0.006	ND	ND
XC	1	ND	ND	ND
XD	1	ND	ND	ND
XE	1	ND	ND	ND
XK	1	ND	ND	ND
XI	1	ND	ND	ND
XJ	1	ND	ND	ND
XX	1	ND	ND	ND
XY	1	ND	ND	ND
XZ	1	ND	ND	ND
XO	1	ND	ND	ND
XN	1	ND	ND	ND
XL	1	ND	ND	ND
X3	1	ND	ND	ND
Off-Site				
X1	1	ND	ND	ND
X2	1	ND	ND	ND
X4	1	ND	ND	ND
XT	1	ND	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]
Typical MDL		0.005	0.005	0.005

MDL: Minimum Detection Limit.

ND: Not Detected.

[a] NYSDOH advisory guidelines.

Table 49
BNL Site Report for Calendar Year 1988
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Trihalomethane Data

Well ID	No. of Samples	chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
		<---------- mg/L ---------->			
On-Site					
XA	1	ND	ND	ND	ND
XC	1	NA	ND	ND	ND
XD	1	ND	ND	ND	ND
XE	1	ND	ND	ND	ND
XK	1	ND	ND	ND	ND
XI	1	ND	ND	ND	ND
XJ	1	ND	ND	ND	ND
XX	1	ND	ND	ND	ND
XY	1	ND	ND	ND	ND
XZ	1	ND	ND	ND	ND
XO	1	ND	ND	ND	ND
XN	1	ND	ND	ND	ND
XL	1	ND	ND	ND	ND
X3	1	ND	ND	ND	ND
Off-Site					
X1	1	ND	ND	ND	NA
X2	1	ND	ND	ND	NA
X4	1	ND	ND	ND	NA
XT	1	ND	NA	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100
Typical MDL		0.005	0.005	0.005	0.005

MDL: Minimum Detection Limit.

NA: Not Analyzed.

ND: Not Detected.

Table 50
BNL Site Report for Calendar Year 1988
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average BTX Data

Well ID	No. of Samples	benzene	toluene	xylene
		<----------	mg/L ----------	---------->
On-Site				
XA	1	ND	ND	NA
XC	1	ND	ND	ND
XD	1	ND	ND	NA
XE	1	ND	ND	NA
XK	1	ND	ND	NA
XI	1	ND	ND	NA
XJ	1	ND	ND	NA
XX	1	ND	ND	NA
XY	1	ND	ND	NA
XZ	1	ND	ND	NA
XO	1	ND	ND	NA
XN	1	ND	ND	NA
XL	1	ND	ND	NA
X3	1	ND	ND	NA
Off-Site				
X1	1	ND	ND	ND
X2	1	ND	ND	ND
X4	1	ND	ND	ND
XT	1	ND	ND	NA
NYS Drinking Water Standards		0.005	(a)	(a)
Typical MDL		0.005	0.005	0.005

MDL: Minimum Detection Limit.

NA: Not Analyzed.

ND: Not Detected.

(a) No standard specified.

Table 51
BNL Site Report for Calendar Year 1988
Landfill Areas and On-Site Control Wells
Ground Water Surveillance Wells, Average Water Quality and Metals Data

Well ID	No. of Samples	pH (SU)	Conductivity (umhos/cm)	Chlorides	Sulfates	Nitrate-Nitrogen	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
				<---------- mg/L ---------->												
Current Landfill																
W6	4	6.4-7.7	447	30.0	17.1	<1.5	<0.025	<0.0005	<0.005	<0.05	0.04	NA	<0.05	17.0	0.006	1.13
WR	4	6.1-6.4	950	38.3	<6.0	<1.5	<0.025	<0.0005	<0.005	<0.05	85.5	NA	2.80	36.1	<0.005	0.17
WS	4	6.2-6.4	1,152	73.2	5.3	<1.5	<0.025	<0.0005	<0.005	<0.05	95.2	NA	1.70	39.1	<0.005	0.08
WT	4	4.9-5.2	229	39.7	26.1	<1.5	<0.025	<0.0005	<0.005	<0.05	0.93	NA	0.44	17.9	<0.005	0.84
1K	4	6.1-6.5	835	36.0	8.1	<1.5	<0.025	<0.0005	<0.005	<0.05	74.6	NA	2.28	27.2	<0.005	0.25
2C	4	6.0-6.5	1,057	40.7	10.8	<1.5	<0.025	<0.0005	<0.005	<0.05	63.6	NA	1.93	31.3	<0.005	<0.02
W9	4	6.2-6.5	961	43.0	10.1	<1.5	<0.025	<0.0005	<0.005	<0.05	65.6	NA	1.89	35.8	<0.005	0.15
Former Landfill Area																
D1	3	5.2-5.6	105	8.6	18.8	0.9	<0.025	0.0005	<0.005	<0.05	<0.075	NA	0.48	4.0	0.004	0.06
D2	3	5.4-6.0	65	9.8	8.1	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	5.1	<0.005	0.01
D3	2	5.1-6.0	64	7.9	7.5	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	4.0	<0.005	0.02
D4	2	5.6	111	8.4	11.5	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.03	4.6	<0.005	<0.02
D5	3	5.6-6.0	120	13.7	14.2	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	12.3	<0.005	0.03
D6	3	6.0-6.3	302	12.4	59.4	0.8	<0.025	0.0002	<0.005	<0.05	<0.075	NA	<0.05	9.7	<0.005	0.03
1I	1	5.3	88	10.0	3.5	<1.5	<0.025	0.0003	<0.005	<0.05	1.21	NA	<0.05	4.5	<0.005	0.03
1J	2	5.4-6.2	62	9.6	7.6	<1.5	<0.025	<0.0005	<0.005	<0.05	0.21	NA	0.02	4.3	<0.005	<0.02
D18	1	5.8	NA	NA	NA	NA	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	3.8	<0.005	<0.02
WQ	2	5.8-6.0	NA	10.5	7.0	<1.5	<0.025	<0.0005	<0.005	<0.05	2.7	NA	0.24	4.7	<0.005	<0.02
WP	2	5.7-5.9	NA	6.6	<6.0	<1.5	<0.025	<0.0005	<0.005	<0.05	6.6	NA	0.25	3.9	<0.005	<0.02
WO	2	5.3-6.2	NA	7.6	8.0	<1.5	<0.025	<0.0005	<0.005	<0.05	0.26	NA	0.07	4.8	<0.005	<0.02
D19	2	5.6-5.7	105	8.6	17.6	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	4.0	<0.005	<0.02
D16	2	5.6-5.9	139	9.3	22.8	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	4.0	<0.005	<0.02
D20	3	6.0-6.2	140	17.3	8.7	<1.5	<0.025	0.0003	<0.005	<0.05	<0.075	NA	<0.05	12.4	<0.005	<0.02
D7	3	6.3-6.4	189	22.4	14.5	<1.5	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	19.2	<0.005	0.02
On-Site Control Wells																
SE	2	6.4-6.7	192	21.6	16.3	<1.5	<0.025	<0.0005	<0.005	<0.05	0.16	NA	<0.05	23.2	<0.005	<0.02
SI	2	6.2-6.3	193	32.8	13.5	<1.5	<0.025	<0.0005	<0.005	<0.05	0.15	NA	<0.05	23.8	<0.005	0.01
SG	2	6.5-6.6	157	17.1	12.7	<1.5	0.025	<0.0005	<0.005	<0.05	0.28	NA	<0.05	14.2	<0.005	0.03
NYS Drinking Water Standards		6.5-8.5	(a)	250.0	250.0	10.0	0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

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

Table 52
BNL Site Report for Calendar Year 1988
Landfill Areas
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
		<---------- mg/L ---------->		
Current Landfill				
W6	3	ND	ND	ND
WR	4	ND	ND	ND
WS	3	ND	ND	ND
WT	4	ND	ND	ND
1K	3	ND	ND	ND
2C	4	ND	ND	ND
W9	3	ND	ND	ND
Former Landfill				
D1	1	ND	ND	ND
D3	1	0.007	ND	0.009
D4	2	ND	ND	ND
D5	2	ND	ND	ND
D6	2	0.001	ND	ND
1J	2	ND	ND	ND
D18	2	ND	ND	ND
WQ	1	0.024	ND	ND
WP	1	0.150	ND	0.015
WO	2	ND	ND	ND
D19	1	ND	ND	ND
D16	1	0.003	ND	ND
D20	2	ND	ND	ND
D7	1	ND	ND	ND
On-Site Control Wells				
SE	2	0.020	ND	ND
SI	1	0.014	ND	ND
SG	1	0.014	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]
Typical MDL		0.005	0.005	0.005

MDL: Minimum Detection Limit.
NA: Not Analyzed
ND: Not Detected.
(a) NYSDOH advisory guidelines.

Table 53
BNL Site Report for Calendar Year 1988
Landfill Areas
Ground Water Surveillance Wells, Average Trihalomethane Data

Well ID	No. of Samples	chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
		<---------- mg/L ---------->			
Current Landfill					
W6	3	ND	ND	ND	ND
WR	4	ND	ND	ND	ND
WS	3	ND	ND	ND	ND
WT	4	ND	ND	ND	ND
1K	3	ND	ND	ND	ND
2C	4	ND	ND	ND	ND
W9	3	ND	ND	ND	ND
Former Landfill					
D1	1	ND	ND	ND	ND
D3	1	ND	ND	ND	ND
D4	2	ND	ND	ND	ND
D5	2	ND	ND	ND	ND
D6	2	ND	ND	ND	ND
1J	2	ND	ND	ND	ND
D18	2	ND	ND	ND	ND
WQ	1	ND	ND	ND	ND
WP	1	0.027	ND	ND	ND
WO	2	ND	ND	ND	ND
D19	1	ND	ND	ND	ND
D16	1	ND	ND	NA	ND
D20	2	ND	ND	ND	ND
D7	1	ND	ND	ND	ND
On-Site Control Wells					
SE	2	0.004	ND	ND	ND
SI	1	0.006	ND	ND	ND
SG	1	0.009	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100
Typical MDL		0.005	0.005	0.005	0.005

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

Table 54
BNL Site Report for Calendar Year 1988
Landfill Areas
Ground Water Surveillance Wells, Average BTX Data

Well ID	No. of Samples*	benzene	toluene	xylene
		<---------- mg/L ---------->		
Current Landfill				
W6	3 (2)	ND	ND	ND
WR	4 (2)	0.007	0.001	0.006
WS	3 (1)	0.002	ND	ND
WT	4 (2)	ND	ND	ND
1K	3 (1)	0.005	ND	ND
2C	4 (2)	0.006	ND	0.007
W9	3 (1)	0.008	ND	ND
Former Landfill				
D1	1 (1)	ND	ND	NA
D3	1 (1)	ND	ND	ND
D4	2 (1)	ND	ND	ND
D5	2 (1)	ND	0.002	ND
D6	2 (1)	ND	0.002	ND
1J	2 (1)	ND	ND	ND
D18	2 (1)	ND	ND	ND
WQ	1 (1)	ND	ND	NA
WP	1 (1)	ND	ND	NA
WO	2 (1)	ND	ND	ND
D19	1 (1)	ND	ND	ND
D16	1 (1)	ND	ND	ND
D20	2 (1)	ND	ND	ND
D7	1 (1)	ND	ND	NA
On-Site Control Wells				
SE	2 (1)	ND	ND	ND
SI	1 (1)	ND	ND	NA
SG	1 (1)	ND	ND	NA
NYS Drinking Water Standards		0.005	(a)	(a)
Typical MDL		0.005	0.005	0.005

MDL: Minimum Detection Limit.
NA: Not Analyzed.
ND: Not Detected.
(a) No standard specified.
* Number inside parenthesis represents number of xylene samples; number outside parenthesis represents number of benzene and toluene samples.

Table 55
BNL Site Report for Calendar Year 1988
Waste Management Area
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples*	pH (SU)	Conductivity (umhos/cm)	Chlorides mg/L	Sulfates mg/L	Nitrate-Nitrogen mg/L
MW1	5 (4)	5.5 - 7.0	101	9.0	10.3	<1.5
MW2	3 (3)	5.4 - 6.1	151	7.8	33.2	1.2
WC	1 (1)	5.5	52	6.0	10.6	<1.5
WD	1 (1)	6.1	98	14.7	12.6	<1.5
MW3	4 (3)	5.8 - 6.3	101	12.7	13.8	<1.5
MW4	4 (4)	5.3 - 6.7	92	15.4	12.5	<1.5
MW6	4 (3)	5.5 - 5.9	96	13.3	14.8	<1.5
2L	1 (1)	5.3	66	13.8	13.8	<1.5
MW5	4 (4)	5.4 - 6.1	109	11.5	12.9	<1.5
2M	2 (2)	5.1 - 5.5	65	13.4	13.6	<1.5
2N	2 (2)	5.0 - 5.5	65	11.7	14.7	<1.5
MW7A	4 (4)	5.1 - 5.7	95	13.4	15.6	<1.5
MW7B	4 (4)	5.2 - 5.7	86	12.1	15.1	<1.5
MW13	3 (4)	5.4 - 5.9	153	10.1	14.2	<1.5
MW8	2 (2)	5.2 - 5.6	NA	10.6	13.6	<1.5
MW12	3 (2)	5.5 - 5.9	126	10.4	14.3	<1.5
MW11	3 (3)	5.6 - 6.1	98	4.3	13.8	<1.5
MW10	3 (3)	5.5 - 6.1	109	7.4	14.9	<1.5
D17	2 (2)	5.5 - 5.6	134	9.6	12.9	<1.5
NYS Drinking Water Standards		6.5 - 8.5	(a)	250.0	250.0	10.0

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

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

Table 56
BNL Site Report for Calendar Year 1988
Waste Management Area
Ground Water Surveillance Wells Average Metals Data

Well ID	No. of Samples	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		<---------- mg/L ---------->									
MW1	4	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	0.09	7.9	<0.005	<0.02
MW2	2	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	5.0	<0.005	<0.02
WC	1	<0.025	<0.0005	<0.005	<0.05	0.15	NA	<0.05	5.3	<0.005	0.17
WD	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	8.6	<0.005	0.37
MW3	4	<0.025	<0.0005	<0.005	<0.05	0.02	NA	<0.05	9.2	<0.005	<0.02
MW4	3	<0.025	<0.0005	<0.005	<0.05	0.03	NA	<0.05	7.3	<0.005	<0.02
MW6	4	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	7.7	<0.005	<0.02
2L	1	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	9.6	<0.005	<0.02
MW5	4	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	7.4	<0.005	<0.02
2M	2	<0.025	0.0003	<0.005	<0.05	<0.075	NA	<0.05	8.0	<0.005	<0.02
2N	2	<0.025	0.0004	<0.005	<0.05	<0.075	NA	<0.05	8.0	<0.005	<0.02
MW7A	4	<0.025	<0.0005	<0.005	<0.05	0.08	NA	<0.05	7.8	0.002	<0.02
MW7B	4	<0.025	<0.0005	<0.005	<0.05	0.03	NA	<0.05	7.8	<0.005	<0.02
MW13	3	<0.025	<0.0005	<0.005	<0.05	0.13	NA	<0.05	8.6	0.002	<0.02
MW8	2	<0.025	<0.0005	<0.005	<0.05	0.48	NA	0.03	8.3	0.003	<0.02
MW12	3	<0.025	<0.0005	<0.005	<0.05	0.16	NA	<0.05	6.3	<0.005	<0.02
MW11	3	<0.025	<0.0005	<0.005	<0.05	0.15	NA	<0.05	4.0	0.004	<0.02
MW10	3	<0.025	<0.0005	<0.005	<0.05	0.08	NA	<0.05	5.3	<0.005	<0.02
D17	2	<0.025	<0.0005	<0.005	<0.05	<0.075	NA	<0.05	6.5	<0.005	<0.02
NYS Drinking Water Standards		0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

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

Table 57
BNL Site Report for Calendar Year 1988
Waste Management Area
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
		<---------- mg/L ---------->		
MW1	2	ND	ND	ND
MW2	1	0.046	ND	0.126*
WC	1	ND	ND	ND
WD	1	ND	ND	ND
MW3	2	ND	ND	ND
MW4	1	ND	ND	ND
MW6	3	ND	ND	0.006
2L	1	ND	ND	ND
MW5	2	0.005	ND	ND
2M	1	ND	ND	ND
2N	2	0.012	ND	ND
MW7A	2	ND	ND	ND
MW7B	1	ND	ND	ND
MW13	5	0.269	0.032	0.020
MW8	5	0.260	0.117	0.024
MW12	3	ND	ND	ND
MW11	4	ND	ND	ND
MW10	5	ND	ND	0.006
D17	3	ND	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]
Typical MDL		0.005	0.005	0.005

MDL: Minimum Detection Limit.

ND: Not Detected.

* Value reported is underestimated, see Section 3.3.8.2 in text for discussion.

[a] NYSDOH advisory guidelines.

Table 58
BNL Site Report for Calendar Year 1988
Waste Management Area
Ground Water Surveillance Wells, Average Trihalomethane Data

Well ID	No. of Samples	chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
		<---------- mg/L ---------->			
MW1	2	ND	ND	ND	ND
MW2	2	ND	ND	ND	ND
WC	1	NA	ND	ND	ND
WD	1	NA	ND	ND	ND
MW3	2	ND	ND	ND	ND
MW4	1	ND	ND	ND	ND
MW6	3	ND	ND	ND	ND
2L	1	NA	ND	ND	ND
MW5	2	0.005	ND	ND	ND
2M	1	ND	ND	ND	ND
2N	2	ND	ND	ND	ND
MW7A	2	ND	ND	ND	ND
MW7B	1	NA	ND	ND	ND
MW13	5	0.028	ND	ND	ND
MW8	5	0.036	ND	ND	ND
MW12	3	ND	ND	ND	ND
MW11	4	ND	ND	ND	ND
MW10	5	ND	ND	ND	ND
D17	3	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100
Typical MDL		0.005	0.005	0.005	0.005

MDL: Minimum Detection Limit.

ND: Not Detected.

NA: Not Analyzed.

Table 59
BNL Site Report for Calendar Year 1988
Waste Management Area
Ground Water Surveillance Wells, Average BTX Data

Well ID	No. of Samples*	benzene	toluene	xylene
		<---------- mg/L ---------->		
MW1	2 (2)	ND	ND	ND
MW2	2 (2)	ND	ND	ND
WC	1 (1)	ND	ND	ND
WD	1 (1)	ND	ND	ND
MW3	2 (2)	ND	ND	ND
MW4	1 (1)	ND	ND	ND
MW6	3 (2)	ND	ND	ND
2L	1 (1)	ND	ND	ND
MW5	2 (2)	ND	ND	ND
2M	1 (1)	ND	ND	NA
2N	2 (1)	ND	ND	ND
MW7A	2 (2)	ND	ND	ND
MW7B	1 (1)	ND	ND	ND
MW13	5 (1)	ND	ND	ND
MW8	5 (1)	ND	ND	ND
MW12	3 (3)	ND	ND	NA
MW11	4 (1)	ND	ND	ND
MW10	5 (1)	ND	ND	ND
D17	3 (1)	ND	ND	ND
NYS Drinking Water Standards		0.005	(a)	(a)
Typical MDL		0.005	0.005	0.005

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

(a) No standard specified.

* Number inside parenthesis represents number of xylene samples; number outside parenthesis represents number of benzene and number of toluene samples.

Table 60
BNL Site Report for Calendar Year 1988
Ground Water Restoration Project at Waste Management Area
Average Water Quality and Metals Data

	Well ID					NYS Drinking Water Standard
	PW1	PW2	PW3	PW4	PW5	
Number of samples*	1 (2)	1 (2)	1 (2)	1 (2)	1 (2)	
pH (SU)	5.6	6.0	5.6	5.6	6.0	6.5-8.5
Specific conductance (umhos/cm)	107	96	93	70	124	(a)
Results in mg/L						
Nitrate-Nitrogen	<1.5	<1.5	<1.5	<1.5	<1.5	10.0
Chlorides	14.1	12.6	11.3	8.5	15.8	250.0
Sulfates	13.5	14.3	10.8	10.1	13.2	250.0
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.0005	<0.0005	<0.0005	0.0004	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	<0.05	<0.05	<0.05	<0.05	0.03	1.0
Fe	1.14	<0.075	<0.075	<0.075	<0.075	0.3
Hg	NA	NA	NA	NA	NA	0.002
Mn	0.04	<0.05	<0.05	<0.05	<0.05	0.3
Na	8.0	7.3	6.4	5.3	9.4	(a)
Pb	0.004	<0.005	<0.005	<0.005	0.004	0.025
Zn	0.03	<0.02	<0.02	<0.02	0.03	5.0

NA: Not Analyzed.

(a) No standard specified.

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

Table 61
BNL Site Report for Calendar Year 1988
Ground Water Restoration Project at Waste Management Area
Average Chlorocarbon Data

Well ID*	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<---------- mg/L ---------->		
PW1-A	4	Avg:	0.001	ND	ND
		Min:	ND		
		Max:	0.005		
PW1-B	5	Avg:	ND	ND	ND
		Min:			
		Max:			
PW2-A	4	Avg:	0.004	0.007	0.020
		Min:	ND	ND	ND
		Max:	0.020	0.029	0.078
PW2-B	5	Avg:	ND	ND	ND
		Min:			
		Max:			
PW3-A	6	Avg:	0.079**	0.031	0.024
		Min:	ND	ND	ND
		Max:	0.148	0.085	0.058
PW3-B	5	Avg:	0.005	ND	ND
		Min:	ND		
		Max:	0.009		
PW4-A	8	Avg:	0.009	0.001	0.004
		Min:	ND	ND	ND
		Max:	0.024	0.007	0.010
PW4-B	3	Avg:	ND	ND	ND
		Min:			
		Max:			
PW5-A	5	Avg:	0.020	0.004	0.021
		Min:	ND	ND	ND
		Max:	0.039	0.020	0.074
PW5-B	4	Avg:	ND	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.050[a]	0.005	0.050[a]
Typical MDL			0.005	0.005	0.005

* A represents sample collected at the well head and B represents sample collected from the residual spray.
** Value reported is underestimated; see discussion in Section 3.3.8.2 of text.
MDL: Minimum Detection Limit.
ND: Not Detected.
[a] NYSDOH advisory guidelines.

Table 62
BNL Site Report for Calendar Year 1988
Ground Water Restoration Project at Waste Management Area
Average Trihalomethane Data

Well ID*	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<---------- mg/L ---------->			
PW1-A	4	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.005			
PW1-B	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW2-A	4	Avg:	0.002	ND	ND	ND
		Min:	ND			
		Max:	0.007			
PW2-B	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW3-A	6	Avg:	0.001	ND	ND	ND
		Min:	ND			
		Max:	0.006			
PW3-B	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW4-A	8	Avg:	0.006	ND	ND	ND
		Min:	ND			
		Max:	0.014			
PW4-B	4	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW5-A	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
PW5-B	4	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.005	0.005	0.005	0.005

MDL: Minimum Detection Limit.
ND: Not Detected.
* A represents sample collected at the well head and B represents sample collected from the residual spray.

Table 63
BNL Site Report for Calendar Year 1988
Ground Water Restoration Project at Waste Management Area
Average BTX Data

Well ID*	No. of Samples**	benzene	toluene	xylene
		<----------	mg/L ----------	---------->
PW1-A	4 (1)	ND	ND	ND
PW1-B	5 (1)	ND	ND	ND
PW2-A	4 (1)	ND	ND	ND
PW2-B	5 (1)	ND	ND	ND
PW3-A	6 (2)	ND	ND	ND
PW3-B	5 (1)	ND	ND	ND
PW4-A	8 (4)	ND	ND	ND
PW4-B	4 (1)	ND	ND	ND
PW5-A	5 (1)	ND	ND	ND
PW5-B	4 (1)	ND	ND	ND
NYS Drinking Water Standards		0.005	(a)	(a)
Typical MDL		0.005	0.005	0.008

MDL: Minimum Detection Limit

ND: Not Detected.

* A represents sample collected at the well head and B represents sample collected from the residual spray.

** Number in parenthesis indicates number of xylene samples.

(a) No standard specified.

Table 64
BNL Site Report for Calendar Year 1988
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Average Water Quality and Metals Data

	Well ID									NYS Drinking Water Standard
	D8	D13	IT1	IT2	IT5	D14	IT4	D15	IT3	
Number of Samples*	2 (1)	3 (1)	3 (2)	3 (2)	2 (2)	3 (1)	3 (2)	2 (1)	1 (1)	
pH (SU)	6.4-7.0	6.2-7.0	6.3-7.0	6.1-7.0	6.0-6.1	6.2-7.0	6.0-7.0	5.1-7.0	6.2	6.5-8.5
Conductivity (umhos/cm)	70	147	245.5	189.5	169.5	176	175.0	NA	173	(a)
Chlorides (mg/L)	NA	NA	19.6	15.0	17.7	NA	21.2	NA	27.2	250.0
Sulfates (mg/L)	NA	NA	21.1	24.4	19.4	NA	19.4	NA	32.4	250.0
Nitrates (mg/L)	NA	NA	1.6	1.6	2.0	NA	<1.5	NA	3.7	10.0
Results in mg/L										
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0
Fe	<0.075	<0.075	6.4	3.1	1.3	1.01	0.10	<0.075	<0.075	0.3
Hg	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.002
Mn	3.2	<0.05	1.5	0.08	0.69	<0.05	0.44	3.8	0.9	0.3
Na	15.8	14.3	17.2	17.0	11.1	18.5	10.3	11.0	10.0	(a)
Pb	<0.005	<0.005	<0.005	<0.005	0.004	<0.005	<0.005	<0.005	<0.005	0.025
Zn	<0.02	<0.02	<0.02	0.01	0.01	<0.02	<0.02	<0.02	<0.02	5.0

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

Table 65
BNL Site Report for Calendar Year 1988
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples		1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			<---------- mg/L ---------->		
D13	1	Avg:	ND	ND	ND
		Min:			
		Max:			
IT1	2	Avg:	0.060	0.032	0.033
		Min:	0.051	0.017	0.027
		Max:	0.069	0.046	0.039
IT2	2	Avg:	0.002	ND	ND
		Min:	ND		
		Max:	0.004		
IT5	2	Avg:	0.006	0.005	0.028
		Min:	0.003	0.003	0.012
		Max:	0.009	0.006	0.043
D14	1	Avg:	ND	ND	ND
		Min:			
		Max:			
IT4	2	Avg:	0.021	0.011	0.045
		Min:	0.019	0.007	0.039
		Max:	0.022	0.014	0.051
D15	1	Avg:	ND	ND	ND
		Min:			
		Max:			
IT3	1	Avg:	0.036	ND	0.003
		Min:			
		Max:			
NYS Drinking Water Standards			0.050[a]	0.005	0.050[a]
Typical MDL			0.005	0.005	0.005

MDL: Minimum Detection Limit.
ND: Not Detected.
[a] NYSDOH advisory guidelines.

Table 66
BNL Site Report for Calendar Year 1988
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Average Trihalomethane Data

Well ID*	No. of Samples		chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
			<---------- mg/L ---------->			
D13	1	avg:	ND	ND	ND	ND
		min:				
		max:				
IT1	2	avg:	0.004	ND	ND	ND
		min:	ND			
		max:	0.007			
IT2	2	avg.	ND	ND	ND	ND
		min:				
		max:				
IT5	2	avg:	ND	ND	ND	ND
		min:				
		max:				
D14	1	avg:	ND	ND	ND	ND
		min:				
		max:				
IT4	2	avg:	ND	ND	0.004	ND
		min:			ND	
		max:			0.008	
D15	1	avg:	ND	ND	ND	ND
		min:				
		max:				
IT3	1	avg:	ND	ND	ND	ND
		min:				
		max:				
NYS Drinking Water Standards			0.100	0.100	0.100	0.100
Typical MDL			0.005	0.005	0.005	0.005

MDL: Minimum Detection Limit.
ND: Not Detected.

Table 67
BNL Site Report for Calendar Year 1988
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Petroleum Product Data

Well ID	No. of Samples*		benzene	toluene	xylene	free product
			<---------- mg/L ---------->			
D8	2 (6)	avg:	ND	ND	ND	ND
		min:				
		max:				
D13	3 (7)	avg:	ND	ND	ND	ND
		min:				
		max:				
IT1	4 (11)	avg:	0.299	7.64	4.65	ND
		min:	0.050	0.43	2.30	
		max:	0.760	19.00	7.00	
IT2	3 (8)	avg.	ND	0.002	0.003	ND
		min:		ND	ND	
		max:		0.005	0.006	
IT5	3 (5)	avg:	ND	ND	0.008	ND
		min:			ND	
		max:			0.016	
D14	3 (7)	avg:	ND	0.002	ND	ND
		min:		ND		
		max:		0.004		
IT4	3 (2)	avg:	ND	0.001	0.080	ND
		min:		ND	0.007	
		max:		0.004	0.153	
D15	2 (7)	avg:	ND	ND	ND	ND
		min:				
		max:				
IT3	1 (1)	avg:	0.004	0.060	0.028	ND
		min:				
		max:				
NYS Drinking Water Standards			0.005	(a)	(a)	
Typical MDL			0.005	0.005	0.005	

MDL: Minimum Detection Limit.
ND: Not Detected.
* Number inside parenthesis represents number of samples analyzed for free product; number outside parenthesis represents number of benzene, toluene, and xylene samples.
(a) No standard specified.
Note: As required by the MPF license, all testing of benzene, toluene and xylene is conducted by a NYSDEC approved technically acceptable laboratory. All testing for free product is performed by BNL.

Table 68
BNL Site Report for Calendar Year 1988
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Average Water Quality and Metals Data

	Well ID					NYS Drinking Water Standards
	D8	D9	D10	D11	D12	
Number of Samples*	1 (1)	1 (2)	1 (2)	1 (2)	1 (2)	
pH (SU)	6.4-7.0	6.0-6.2	6.0-6.1	6.0-6.1	6.0-6.4	6.5-8.5
Conductivity (umhos/cm)	70	148	144	149	134	(a)
Chlorides (mg/L)	NA	18.7	19.0	19.6	16.1	250.0
Sulfates (mg/L)	NA	18.7	18.1	18.9	20.5	250.0
Nitrates (mg/L)	NA	<1.5	<1.5	<1.5	<1.5	10.0
Results in mg/L						
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Cr	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Cu	<0.05	<0.05	<0.05	<0.05	<0.05	1.0
Fe	<0.075	<0.075	0.13	<0.075	<0.075	0.3
Hg	NA	NA	NA	NA	NA	0.002
Mn	3.2	<0.05	<0.05	<0.05	<0.05	0.3
Na	15.8	12.8	18.0	13.3	14.3	(a)
Pb	<0.005	<0.005	<0.005	<0.005	<0.005	0.025
Zn	<0.02	<0.02	<0.02	<0.02	<0.02	5.0

NA: Not Analyzed.

* Number outside parenthesis represents number of samples analyzed for conductivity, chlorides, sulfates, and nitrates; number inside parenthesis represents number of samples analyzed for pH and metals.

(a) No standard specified.

Table 69
BNL Site Report for Calendar Year 1988
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
		<---------- mg/L ---------->		
D8	1	0.014	ND	ND
D9	1	0.103*	ND	ND
D10	2	0.061*	ND	ND
D11	1	0.130	ND	ND
D12	1	0.091	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]
Typical MDL		0.005	0.005	0.005

MDL = Minimim Detection Limit.

ND: Not Detected.

* Value reported is underestimated, see discussion in Section 3.3.8.2 of the report.

[a] NYSDOH advisory guidelines.

Table 70
BNL Site Report for Calendar Year 1988
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Average Trihalomethane Data

Well ID	No. of Samples	chloroform	chlorodibromo-methane	bromodichloro-methane	bromoform
		<---------- mg/L ---------->			
D8	1	ND	ND	ND	ND
D9	1	NA	ND	ND	ND
D10	2	ND	ND	ND	ND
D11	1	ND	ND	ND	ND
D12	1	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100
Typical MDL		0.005	0.005	0.005	0.005

MDL: Minimum Detection Limit

NA: Not Analyzed.

ND: Not Detected.

Table 71
BNL Site Report for Calendar Year 1988
Waste Concentration Facility (WCF)
Ground Water Surveillance Wells, Average BTX Data

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

MDL: Minimum Detection Limit.

NA: Not Analyzed.

ND: Not Detected.

(a) No standard specified.

Table 72
BNL Site Report for Calendar Year 1988
Tritium Committed Effective Dose Equivalent
at the Site Boundary Monitoring Stations

Location ID	Sector ID	Annual Average Air Conc. pCi/m^3	Committed Effective Dose Equivalent* mrem
1T	N	2.32	0.001840
2T	NNE	7.23	0.005735
3T	NE	2.97	0.002356
4T	ENE	2.03	0.001610
5T	E	1.38	0.001094
6T1	ESE	4.69	0.003720
6T2	ESE	4.58	0.003633
7T	SE	3.67	0.002911
8T	SSE	2.99	0.002372
9T	S	3.39	0.002689
10T	SSW	5.02	0.003982
11T	SW	5.42	0.004299
12T	WSW	5.78	0.004585
13T	W	1.34	0.001063
14T	WNW	1.83	0.001451
15T	NW	7.09	0.005624
16T	NNW	0.54	0.000428
20T	Central Site	21.4	0.016977

Maximum Site Perimeter Dose is: 0.005735

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

Table 73
BNL Site Report for Calendar Year 1988
Site Boundary Tritium Committed Effective Dose Equivalent
Calculated and Measured Values

Direction	AIRDOS Calculations All Sources mrem	DOE Dose Conversion Factors AIRDOS Meteorology mrem	Measured Dose mrem
N	0.00282	0.00143	0.00184
NNW	0.00225	0.00114	0.00043
NW	0.00284	0.00144	0.00562
WNW	0.00167	0.00085	0.00145
W	0.00284	0.00144	0.00106
WSW	0.00230	0.00117	0.00459
SW	0.00390	0.0020	0.00430
SSW	0.00171	0.00087	0.00398
S	0.00211	0.00107	0.00269
SSE	0.00272	0.00138	0.00237
SE	0.00313	0.00159	0.00291
ESE	0.00388	0.00197	0.00372
E	0.00242	0.00123	0.00109
ENE	0.00264	0.00134	0.00161
NE	0.00382	0.00194	0.00236
NNE	0.00443	0.00225	0.00574

Table 74
BNL Site Report for Calendar Year 1988
External Exposure Rates at the Site Boundary
from Argon-41 and Oxygen-15

Direction	DOE ^{41}Ar* mrem	DOE ^{15}O* mrem	DOE Total* mrem	AIRDOS ^{41}Ar** mrem	AIRDOS ^{15}O** mrem	AIRDOS Total** mrem
N	0.036	0.008	0.044	0.032	0.007	0.039
NNW	0.021	0.005	0.026	0.019	0.004	0.023
NW	0.024	0.005	0.029	0.022	0.004	0.026
WNW	0.012	0.002	0.014	0.011	0.002	0.013
W	0.014	0.005	0.019	0.013	0.004	0.017
WSW	0.017	0.008	0.025	0.015	0.007	0.022
SW	0.028	0.016	0.044	0.025	0.014	0.039
SSW	0.020	0.006	0.026	0.018	0.005	0.023
S	0.033	0.007	0.040	0.030	0.006	0.036
SSE	0.038	0.011	0.049	0.034	0.010	0.044
SE	0.043	0.015	0.058	0.039	0.013	0.052
ESE	0.061	0.019	0.080	0.055	0.017	0.072
E	0.046	0.012	0.058	0.041	0.011	0.052
ENE	0.030	0.012	0.042	0.027	0.011	0.038
NE	0.054	0.020	0.074	0.049	0.018	0.067
NNE	0.087	0.020	0.107	0.078	0.018	0.096

* Ar-41 and O-15 dose calculated using AIRDOS Dispersion Model and DOE Dose Conversion Factors.

** Ar-41 and O-15 dose calculated using AIRDOS Computer Codes.

Table 75
BNL Site Report for Calendar Year 1988
Collective Dose Summary

Nuclide	January	February	March	April	May	June	July	August	September	October	November	December	CEDE Whole Body Total	Thyroid Total	AIRDOS Total Body	AIRDOS Thyroid Total
	<---------- person-rem ---------->															
Ar-41	1.48E-01	2.36E-01	1.43E-01	3.08E-01	2.66E-01	9.11E-02	3.92E-02	1.50E-01	3.50E-01	2.26E-01	6.26E-02	2.05E-01	2.23E+00	-	2.01E+0	-
Br-82	2.19E-06	5.03E-06	5.44E-06	1.10E-05	9.09E-06	6.09E-06	4.15E-06	3.40E-06	5.61E-06	1.58E-06	4.28E-06	1.39E-06	5.92E-05	-	7.58E-5	-
Ce-143	2.51E-07	3.28E-07	-	-	1.74E-07	-	-	-	-	-	-	-	7.53E-07	-	1.22E-6	-
H-3	1.09E-03	5.14E-03	8.79E-03	1.98E-02	3.62E-02	2.14E-03	2.24E-03	2.50E-03	3.88E-03	6.69E-04	4.87E-04	4.26E-04	8.34E-02	-	1.64E-1	-
I-131	4.91E-07	2.10E-06	1.71E-07	5.76E-07	1.59E-06	9.55E-07	2.57E-07	4.72E-07	7.27E-07	5.64E-07	-	9.20E-08	8.00E-06	-	2.69E-5	-
I-131;th	6.34E-06	3.82E-05	2.21E-06	8.75E-06	2.47E-05	1.28E-05	3.43E-06	6.37E-06	9.98E-06	7.49E-06	-	1.21E-06	-	1.21E-04	-	1.21E-4
I-133	4.26E-08	-	8.75E-08	4.81E-07	7.62E-07	2.36E-08	1.95E-07	1.17E-07	2.84E-07	1.25E-07	-	-	2.12E-06	-	7.40E-6	-
I-133;th	8.48E-07	-	1.74E-06	9.17E-06	1.47E-05	4.57E-07	3.72E-06	2.22E-06	5.47E-06	2.42E-06	-	-	-	4.07E-05	-	4.07E-5
O-15	2.77E-05	1.34E-04	9.76E-05	5.59E-05	1.31E-04	2.35E-05	-	-	-	-	-	-	4.70E-04	-	4.16E-4	-
C-14	-	7.21E-08	-	-	-	-	-	-	-	-	-	-	7.21E-08	-	7.21E-10	-
Sn-113	-	9.78E-06	-	-	-	-	-	-	-	-	-	-	9.78E-06	-	2.72E-5	-
Tc-99	-	2.11E-09	-	-	-	-	-	-	-	-	-	-	2.11E-09	-	6.14E-9	-
Be-7	-	-	5.52E-09	1.55E-07	3.02E-06	6.34E-07	9.35E-07	4.13E-07	1.91E-08	-	7.17E-08	4.04E-07	5.66E-06	-	1.34E-5	-
Br-77	-	-	6.49E-06	-	2.51E-06	6.24E-08	3.20E-08	-	-	-	-	-	9.09E-06	-	5.80E-5	-
I-124	-	-	3.38E-05	-	1.71E-07	-	-	-	-	-	-	-	3.39E-05	-	3.39E-5	-
I-124;th	-	-	6.58E-04	-	4.54E-06	-	-	-	-	-	-	-	-	6.63E-04	-	6.63E-4
I-126	-	-	1.65E-07	4.99E-07	1.78E-06	4.27E-07	2.22E-06	-	-	-	3.98E-07	-	5.49E-06	-	5.49E-6	-
I-126;th	-	-	2.65E-06	8.46E-06	3.09E-05	5.84E-06	3.04E-05	-	-	-	5.39E-06	-	-	8.36E-05	-	8.36E-5
Zn-65	-	-	-	-	-	6.26E-07	6.11E-07	-	-	-	7.89E-08	3.27E-07	1.64E-06	-	3.26E-6	-
I-125	-	-	-	-	-	-	-	-	6.68E-06	-	4.39E-06	-	1.11E-05	-	3.65E-5	-
I-125;th	-	-	-	-	-	-	-	-	9.49E-05	-	5.73E-05	-	-	1.52E-04	-	1.52E-4
Cr-51	-	-	-	-	-	-	-	-	-	-	3.89E-09	-	3.89E-09	-	1.15E-8	-
Se-75	-	-	-	-	1.10E-06	-	-	-	-	-	1.69E-06	4.64E-07	3.25E-06	-	2.15E-6	-
Total-WB	1.35E-01	2.18E-01	1.38E-01	2.97E-01	2.76E-01	8.42E-02	3.75E-02	1.37E-01	3.19E-01	2.05E-01	5.69E-02	1.85E-01	2.31E+00	-	2.17E+0	-
Ar-41	1.33E-01	2.13E-01	1.29E-01	2.77E-01	2.40E-01	8.21E-02	3.53E-02	1.35E-01	3.15E-01	2.04E-01	5.64E-02	1.85E-01	2.23E+00	-	2.01E+0	-
H-3	1.09E-03	5.14E-03	8.79E-03	1.98E-02	3.62E-02	2.14E-03	2.24E-03	2.50E-03	3.88E-03	6.69E-04	4.87E-04	4.26E-04	8.34E-02	-	1.64E-1	-
H-3;tot	1.63E-03	7.71E-03	1.32E-02	2.97E-02	5.43E-02	3.21E-03	3.36E-03	3.76E-03	5.82E-03	1.00E-03	7.30E-04	6.39E-04	1.25E-01	-	2.46E-1	-
Total-Th	7.19E-06	3.82E-05	6.65E-04	2.64E-05	7.48E-05	1.91E-05	3.75E-05	8.59E-06	1.10E-04	9.91E-06	6.27E-05	1.21E-06	-	1.06E-3	-	1.06E-3

NOTE: Tritium dose was multiplied by 1.5 to obtain total inhalation plus skin absorption dose in total column.

Table 76
BNL Site Report for Calendar Year 1988
Collective and Maximum Individual Committed Effective Dose Equivalent (CEDE) from the Water Pathway

Pathway	Nuclide	Maximum Individual CEDE mrem	Collective CEDE person-mrem
Water	^{3}H	0.12	37.0
Fish	^{137}Cs	0.15	75.1

Table 77
BNL Site Report for Calendar Year 1988
Collective Dose from All Pathways

Pathway	Committed Plus Effective Collective Dose person-mrem	AIRDOS Collective Dose person-mrem	Thyroid person-mrem
Air	2.35E3	2.26	1.1
Water	3.7E1	-	-
Fish	7.5E1	-	-
Total	2.46E3	-	1.1

Table 78
BNL Site Report for Calendar Year 1988
Terrestrial and Cosmic Component of BNL TLD Response

Location	1987 Exposure Rate	Terr. Comp.	Cosmic Comp.	Soil Concentrations at TLD Locations: Cs-137	K-40	Ra-226	Ac-228
	<----------	mrem/yr	---------->	<----------	pCi/g	----------	---------->
TLDS Located On the BNL Site							
3T2.8	61.4	18.3	43.1	0.6412	2.9890	0.4618	0.6109
4T2.4	56.7	19.0	37.7	0.3812	4.6340	0.3760	0.5597
4T2.6	57.4	19.4	38.0	0.4296	3.829	0.4297	0.6333
5T2.5	72.8	26.2	46.6	0.1283	5.8610	0.4190	1.0020
6T2.8	65.3	25.7	39.6	0.3821	5.7800	0.4363	0.9447
7T1.6	77.7	30.4	47.3	0.2402	6.2930	0.6547	0.9864
7T2.5	74.8	33.2	41.6	1.8190	7.0170	0.7608	0.9766
8T1.3	71.6	19.2	52.4	0.3443	3.9340	0.4979	0.5036
8T2.3	59.1	22.3	36.8	0.2620	4.6230	0.4488	0.7686
10T1.8	66.5	21.8	44.7	0.2049	4.4280	0.5106	0.6590
11T2.1	57.1	27.6	29.5	0.4263	4.6540	0.6052	1.0410
12T1.4	68.4	29.9	38.5	0.2673	6.0080	0.6795	0.9378
13T1.3	69.1	29.0	40.1	0.2518	5.5590	0.7388	0.8331
13T1.4	62.6	30.5	32.1	0.7022	6.6110	0.6588	0.9360
14T1.3	67.5	27.2	40.3	0.3814	6.3450	0.5832	0.7745
15T1.4	66.3	27.2	39.1	0.3814	6.3450	0.5832	0.7745
15T1.7	64.4	24.6	39.8	0.9466	5.3440	0.5204	0.7701
16T2.1	61.9	21.4	40.5	0.3373	4.8200	0.4767	0.6073
avg.	65.6	25.2	40.4	0.474	5.281	0.547	0.800
+/- 1std	6.0	4.5	5.1	0.378	1.07	0.113	0.166
TLDS Located Off-Site but less than 3.0 km from BNL							
13T2.6	64.4	19.1	45.3	0.1383	3.8740	0.4536	0.5667
15T3.0	51.2	15.0	36.2	0.1543	3.5650	0.3393	0.3868
avg.	57.8	17.0	40.8	0.1463	3.7195	0.3966	0.477
+/- 1std	6.6	2.1	4.5	0.008	0.1545	0.0570	0.090
TLDS located 3.0 to 5.0 km from BNL							
1T3.0	55.1	23.7	31.4	0.1075	4.2930	0.6692	0.6154
2T3.2	59.9	26.3	33.5	0.2415	5.2410	0.5533	0.9042
5T4.2	50.5	14.6	35.9	0.3716	2.9090	0.2963	0.5204
10T3.7	78.2	29.9	48.3	0.3056	5.8540	0.6987	0.9317
16T3.4	65.3	18.1	47.2	0.1383	3.8740	0.3916	0.5684
avg.	61.8	22.5	39.3	0.2329	4.4342	0.5218	0.7080
+/- 1std	10.5	5.6	6.6	0.0993	1.032	0.156	0.174
TLDS Located 5.0 to 10 km from BNL							
1T8.8	50.1	16.9	33.2	0.5473	3.9530	0.3707	0.4666
3T8.8	63.8	22.1	41.7	0.4330	3.5760	0.5461	0.7620
4T7.5	59.0	14.4	44.6	0.1215	2.3050	0.3815	0.4580
5T6.5	60.3	14.2	46.1	0.3668	2.9820	0.4041	0.3063
6T5.6	62.1	18.9	33.2	0.5757	2.8370	0.4345	0.7285
7T9.7	59.5	14.9	44.6	0.3657	2.0370	0.3640	0.5746
8T8.0	59.5	27.4	32.1	0.4125	4.3840	0.6977	0.9205
9T8.3	63.2	26.8	36.4	0.4792	6.7210	0.5428	0.7421
12T5.0	57.1	10.5	46.6	0.1347	1.7970	0.3616	0.1953
12T7.2	62.6	12.6	50.0	0.2863	2.7850	0.2790	0.3674
13T8.2	51.2	13.9	37.3	0.4939	1.5460	0.4060	0.4878
14T5.6	73.0	35.6	37.4	0.7259	6.2290	0.8741	1.1640
16T10.0	67.2	15.8	51.4	0.1059	3.1310	0.3773	0.4728
avg.	59.9	18.8	41.1	0.3885	3.406	0.4646	0.5881
+/- 1std	6.2	7.0	6.3	0.1804	1.528	0.157	0.256
TLDS Located 11 to 15 km from BNL							
6T14.2	49.0	14.0	35.0	0.5993	3.0440	0.2250	0.5459
12T12.5	66.3	24.1	42.2	1.0670	3.9960	0.7269	0.6138
15T14.7	66.5	24.4	42.1	0.7223	4.7850	0.5421	0.8056
avg.	60.6	20.8	39.8	0.7962	3.942	0.498	0.655
+/- 1std	8.2	4.8	3.4	0.1980	0.718	0.207	0.110
TLDS Located 15 km or greater from BNL							
5T17.1	54.8	24.3	30.5	1.1660	6.0810	0.5223	0.6310
11T17.8	51.3	8.6	42.7	0.2760	2.3860	0.1259	0.2787
avg.	53.1	16.5	36.6	0.721	4.2335	0.3241	0.4585
+/- 1std	1.8	7.9	6.1	0.445	1.8475	0.1982	0.1615

TLD Study Summary

Location	Total Exposure mrem/yr	+/- 1std	Terrestrial mrem/yr	+/- 1std	Cosmic mrem/yr	+/- 1std
On-Site	65.6	6.0	25.2	4.5	40.4	5.1
<3 km	57.8	6.6	17.0	2.1	40.8	4.5
3 to 5 km	61.8	10.5	22.5	5.6	39.3	6.6
5 to 10 km	59.9	6.2	18.8	7.0	41.1	6.3
10 to 15 km	60.6	8.2	20.8	4.8	39.8	3.4
>15 km	53.1	1.8	16.5	7.9	36.6	6.1
Grand Ave.	62.1	7.5	21.8	6.4	40.3	5.8

Average Soil Concentration at All Locations

Nuclide	Result pCi/g ± 1STD
Cs-137	0.439 ± 0.325
K-40	4.401 ± 1.472
Ra-226	0.498 ± 0.154
Ac-228	0.682 ± 0.224

APPENDIX E

QUALITY CONTROL AND QUALITY ASSURANCE

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

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

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