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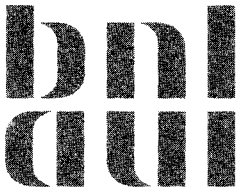
1987 ENVIRONMENTAL MONITORING REPORT

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



April 1988

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

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

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SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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BROOKHAVEN NATIONAL LABORATORY
ANNUAL ENVIRONMENTAL REPORT

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FIGURES

Table 1.2: Potential Impact of Exposure Time Reduction Techniques on Nuclear Power Plant Collective Occupational Exposures

Technique	Short term[2]	Intermediate term[2]	Long term[2]	Remarks
Improved materials	low	medium	medium	significant for component replacement and new plants
Control of BWR piping	medium	medium	low	important for present BWRs
Control of PWR steam generator tube corrosion	low	medium	low	important for present PWRs
Remote tools	low	low	medium	significant for new and standardized plants
Robotics	low	medium	medium	need rugged, reasonably priced devices
Operational and maintenance techniques	medium	medium	very cost-effective for dose reduction	
Advanced reactor designs	low	medium	high	offer new possibilities for remote tools, robotics etc.

[1] Relative to the annual collective dose at the beginning of the appropriate period.
[2] Short (<7 years), intermediate term (7-20 years), long term (>20 years)
[3] Intergranular Stress Corrosion Cracking

Many exposure reduction initiatives are inter-related. Implementation of one initiative can significantly reduce the benefit of another Because of this inter-relation, some initiatives, while providing major benefits, can even cause an increase in exposure. For example, with current chemistry PWR S.G. channel head dose rates might be as high as 20 rad/h. If a major retubing

APPENDIX D TABLES

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1.0 INTRODUCTION

1.1 Background

The primary purpose of Brookhaven National Laboratory's (BNL) environmental monitoring program is to determine whether:

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

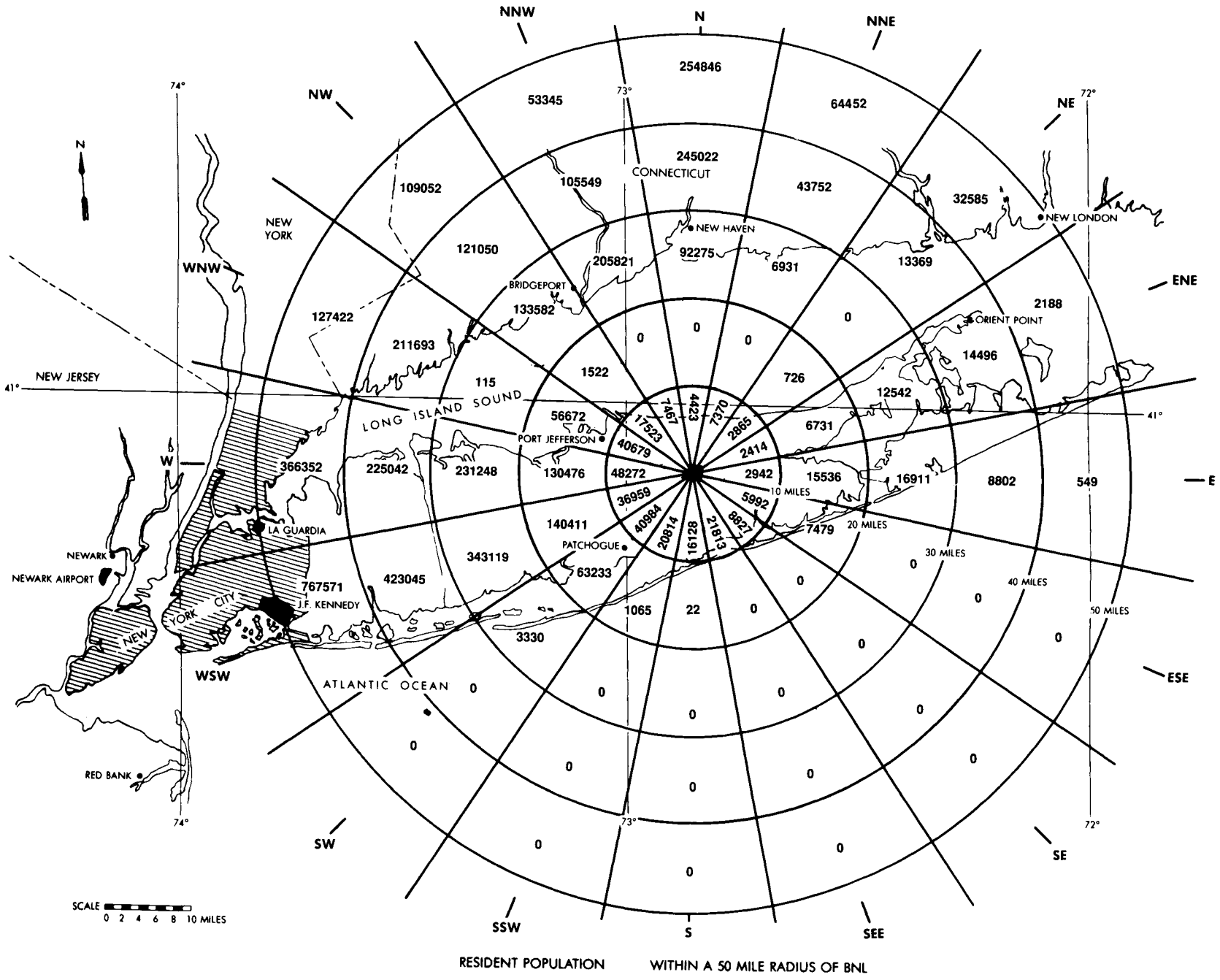
2) the applicable environmental standards and effluent control requirements were met.

This annual report for calendar year 1987 follows the recommendations given in the Department of Energy (DOE) Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements [1], and DOE/EP-0023, "A Guide for Environmental Radiological Surveillance at U.S. DOE Installations" [2], but has been broadened to meet site-specific environmental monitoring needs. This program includes the sampling and analysis for radioactivity, water quality indices, metals, and organic compounds.

1.2 Site Characteristics

Brookhaven National Laboratory is a multidisciplinary scientific research center located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to the metropolitan area and local communities are shown in Figures 1 and 2 respectively. About 1.36 million persons reside in Suffolk County [3] 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 with 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 (2130 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 watershed. 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 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 only of source water in the tributary's river bed. The BNL liquid effluents from the STP recharge to ground water prior to leaving the site boundary. The demise of this tributary is most likely related to the regional drought and increased residential land use.



RESIDENT POPULATION WITHIN A 50 MILE RADIUS OF BNL

Figure 1: Resident Population Within an 80 km Radius of BNL (1987)

BROOKHAVEN NATIONAL LABORATORY
LOCAL AND ON-SITE POPULATION DISTRIBUTION

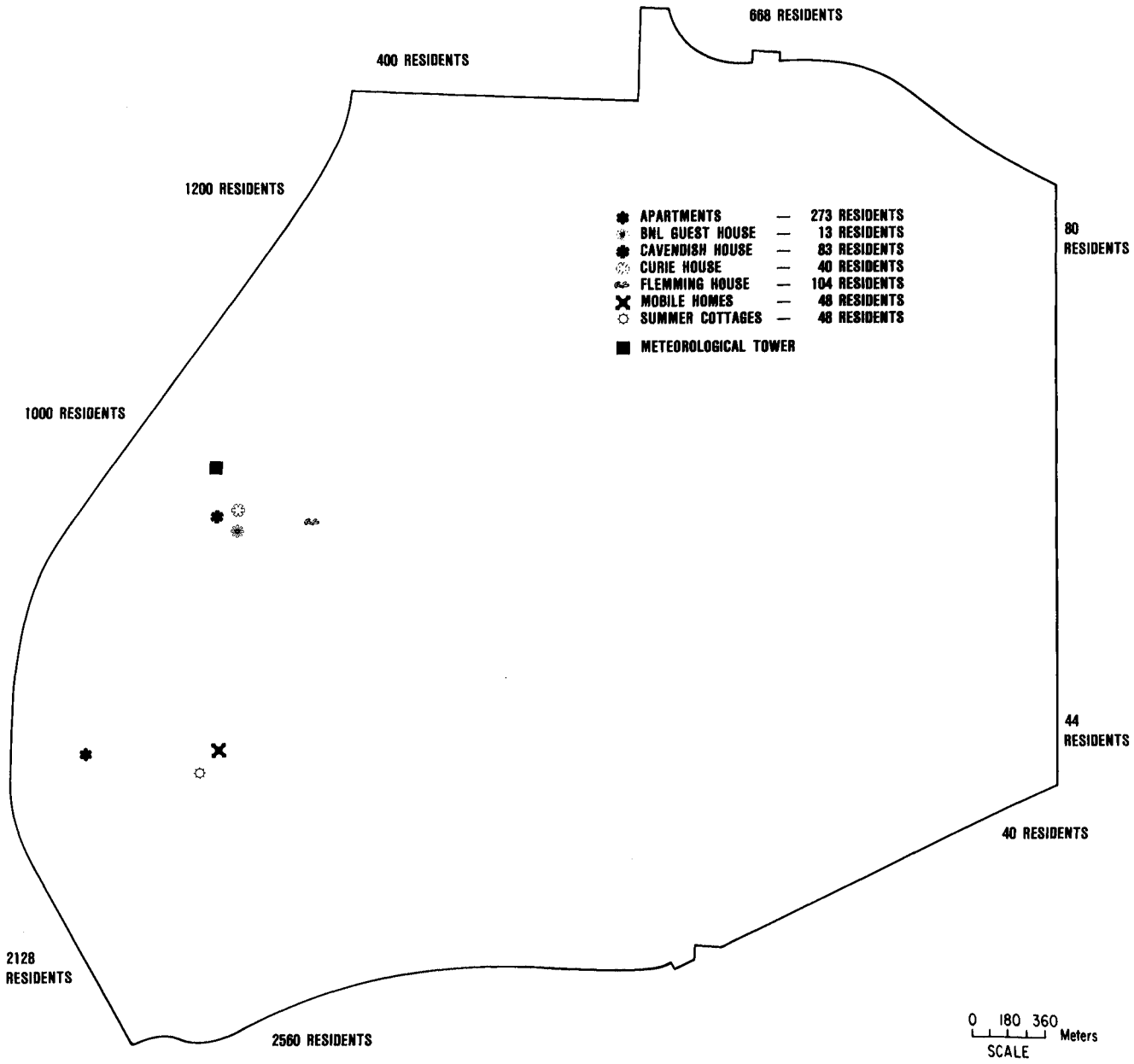


Figure 2: Brookhaven National Laboratory - Local and On-Site Population Distribution

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 [4,5]. The average temperature in 1987 was 10°C and the range was -21°C to 36°C.

Studies of Long Island hydrology and geology [6-9] 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 them readily and there is little direct run-off into surface streams, except during periods of intense precipitation. The total precipitation for 1987 was 104 cm, which is 18 cm below the 39 year annual average. The historic precipitation data are presented in Figure 4. 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 [6-9], taking a more easterly direction in the Peconic River watershed portions of the site. The estimated rate of movement at the ground water surface is about 45 cm/d [9].

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 energy-related environmental pollutants,

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.

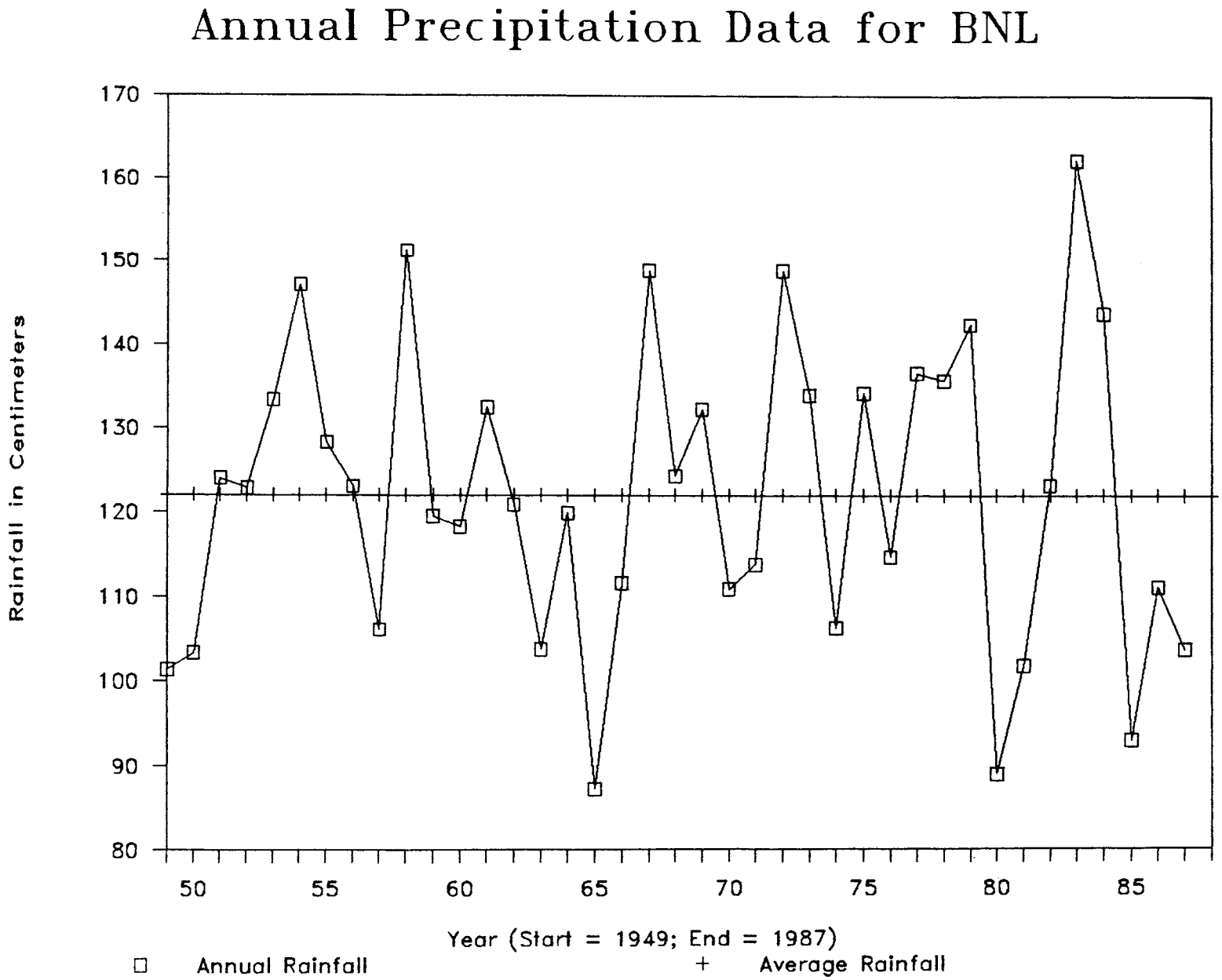


Figure 4: Brookhaven National Laboratory - Annual Precipitation 1949 - 1987

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 oxygen or silicon 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) and in the Chemistry LINAC Irradiation Facility (CLIF).

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 Tandem Van de Graaffs are also used to inject heavy ions 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 receives 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.

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, BLIP, MRR, and the research Van de Graaff, with lesser contributions from the Hot Laboratory, the Hazardous Waste Management Facility (HWMF), the Chemistry Building, and the MRC. The HFBR and BLIP contribute principally to the Laboratory's liquid radioactive wastes. Additional smaller contributions originate from the MRC, the Hot Laboratory complex, as well as from decontamination and laundry operations. Liquid radioactive waste is processed at the BNL Waste Concentration Facility (WCF) to remove dissolved and suspended solids as part of the BNL Waste Minimization Program.

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 monitors the external radiation levels; radioactivity in air, rain, potable water, surface water, ground water, soil, vegetation, aquatic biota and small game, 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 1987 are presented in Appendix D. In 1987, the results of the surveillance program demonstrated that the Laboratory has operated within the applicable environmental standards.

2.1 Airborne Effluents

Argon-41, oxygen-15, and tritium were the predominant radionuclides released from BNL facilities. In 1987, 1,500 Ci of argon-41 were released from the MRR stack; 582 Ci of oxygen-15 were released from BLIP; 12 Ci of tritium gas and 188 Ci of tritium in the form of water vapor were released from the Tandem Van de Graaff, MRC, and HFBR stacks.

2.2 Liquid Effluents

Liquid discharge limits for non-radiological 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 prescribed by the SPDES permit limitations. Other radionuclide discharge concentrations are governed by the Radiation Concentration Guides (RCGs). 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 of the STP resulted in a greater than 99% compliance rate for those parameters that fall within the scope of the SPDES permit requirements. Radioactive concentrations released to the Peconic River have remained virtually constant compared to 1986. Gross beta, tritium, and strontium-90 concentrations were less than 14% of the limits specified in the SDWA. Concentrations of gamma emitting radionuclides which are not listed in the SDWA were less than 17% of the appropriate RCGs.

Approximately 13 million liters per day (MLD) of water, 60% of the total pumpage, were returned to the aquifer through on-site recharge basins. The monitoring data indicates that only trace quantities of radioactivity were discharged to the recharge basins as a result of routine facility operations. These concentrations were all small fractions of the applicable guides or standards. Since recharge basins function as conduits to the underlying aquifer system, the non-radiological water quality parameters used in assessing the discharges were the New York State Drinking Water Standards. Analysis of the nonradiological water quality parameters indicates that, with the exception of iron and pH, the discharge to the recharge basins met New York State Drinking Water Standards.

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 1987 was 64.5 ± 5.4 mrem, while the off-site integrated dose was 59.9 ± 7.4 mrem. The difference between the on-site and off-site integrated exposure is within the uncertainty of the measurement. The difference between the mean exposure rates is most likely related to variations in the terrestrial component of the external dose. These values are much lower than ambient exposure rates reported for the New York City area by EPA for August, 1986 to July, 1987 which predict an annual dose of about 83 mrem [29, 30, 31, 32].

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 5.4 pCi/m^3. This concentration would result in a committed effective dose equivalent of 0.004 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, cesium-137, iodine-131, ruthenium-103, and strontium-90. The measured concentrations were consistent with typical washout values associated with atmospheric scrubbing [10] and compare reasonably well with the most recently published data by EPA for Yaphank, New York (data on Yaphank is for August, 1986 to July, 1987 [29,30,31,32]).

2.6 Radioactivity in Soil or Vegetation

No nuclides attributable to Laboratory operations were detected in soil and vegetation samples collected in the vicinity of the Laboratory.

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 6.4 pCi/L or 13% of the New York State Drinking Water Standards; and the average tritium concentration was 3.6 nCi/L or 18% of the New York State Drinking Water Standards. No samples were collected at the site perimeter since the STP effluent recharges to ground water prior to reaching this point.

The Peconic River was sampled in Riverhead, approximately 19.5 km downstream of the site boundary. The average gross alpha concentration was 0.13 pCi/L; the average gross beta concentration was 1.7 pCi/L, and the average tritium and strontium-90 concentrations were below the analytical detection limit of the system. The Carmen's River was sampled as a control location. The average gross alpha concentration was 0.22 pCi/L; the average gross beta value was 1.1 pCi/L and the average tritium and strontium-90 values were 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 were collected at the outfall from the STP, the former site boundary, Donahue's Pond, Sandy Pond, and at control locations not influenced by the Peconic River. Shellfish in the Raritan Bay were also sampled in 1987. Cesium-137 was the only radionuclide detected at higher concentrations in the Peconic River fish samples than in the control samples. The Peconic River fish contained cesium-137 concentrations between 410 and 1,100 pCi/kg-wet more than the control samples. Based on these results, the maximum individual dose from this pathway was 0.39 mrem and the collective dose was 150 mrem.

2.9 Potable Water Supply

All gross alpha, beta and tritium concentrations in on-site potable well samples were at or near the minimum detection limit. 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 340 pCi/L (the minimum detectable limit [MDL] for tritium is 300 pCi/L). This concentration if consumed for one year would correspond to a committed effective dose equivalent to the on-site resident of 0.016 mrem. Other nuclides, including cobalt-60, cesium-137, and sodium-22, were detected in several wells. The committed effective dose equivalent from ingesting these concentrations would be 0.080 mrem and the total dose from all radionuclides would be 0.096 mrem or 2.4% 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 and mercury were not detected in any sample and that traces quantities of copper (0.02 - 0.03 mg/L), lead (0.002 - 0.004 mg/L), and manganese (0.01 - 0.07 mg/L) were detected in potable well water. All observed values of copper, lead, and manganese were substantially below the New York State Drinking Water Standards of 1.0 mg/L, 0.025 mg/L, and 0.3 mg/L. Iron and sodium were also detected in water collected at the well head. Water with iron concentrations in excess of the drinking water limit is treated at the BNL Water Treatment Plant prior to use in the domestic water distribution system.

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 release from past practices did not exceed regulatory limits in place at that time. Comparison of surveillance well data to EPA, 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 Radionuclide Analysis

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 1987, on-site gross beta and tritium concentrations were 27% and 19%, respectively, of the New York State regulations [13,14]. Adjacent to the Peconic River at the site boundary, the annual average gross beta concentration was 3% and the annual average tritium concentration was 20% of the New York State regulations. At a surveillance well located adjacent to the Peconic River and several hundred meters downstream of the site boundary, the annual average gross beta and tritium concentration were 10% and 7% respectively of the New York State Standards.

In addition to the BNL off-site surveillance wells, 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 Suffolk County Department of Health Services (SCDHS). Detectable quantities of tritium were found in four off-site wells. The annual average tritium concentrations at these locations were less than 4% of the EPA Drinking Water Standard. An elevated gross beta concentration was found in one household water sample. Gamma spectroscopy results of this sample indicate that the source of the radioactivity is natural potassium. This water sample also contained pesticide and fertilizer contamination. The radioactivity detected is most likely due to the presence of agricultural products in the water.

At the current and former sanitary landfill areas, the highest average gross beta concentration was 49% of the applicable guide, the highest average tritium concentration and the highest annual strontium-90 concentration were equal to the EPA Drinking Water Standard. Given the distance to the site

boundary, the rate of movement for these radionuclides and radioactive decay, the radionuclide concentrations at the site boundary should be substantially below the applicable standards.

The data from the ground water program at the HWMF indicate that the tritium, fission, and activation products have entered the ground water system and are migrating from their source. The highest average concentrations of cesium-137, cobalt-60, sodium-22, and tritium were 0.0007%, 0.004%, 6.20%, and 150% respectively, of the RCGs or New York State Drinking Water Standard.

2.10.2 Analysis of Metals, Organics, and Water Quality

Iron, lead, and manganese were found in excess of the New York State Standards in several sampling wells on-site. 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 110 and 5.7 mg/L, respectively.

Trace levels of 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 detected at these locations and in the vicinity of the STP sand filter beds. The highest concentrations of organic compounds in ground water were observed near the HWMF where the Laboratory adopted an agressive plan for aquifer restoration 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 and 1986 data. A second area of interest in 1987 was near the Central Steam Facility (CSF) where organic compounds were detected in soil during installation of ground water surveillance wells to meet the requirements specified for a Major Petroleum Storage Facility. Preliminary sampling and assessment reports received from BNL's contractor indicate that the 1977 spill of mineral spirits and No. 6 fuel oil has remained contained within the soil column with minimal contamination of ground water. A final assessment and remediation plan recommendations are expected in 1988.

2.11 Off-Site Dose Estimates

For the year 1987, the collective dose-equivalent attributable to Laboratory sources, for the population up to distance of 80 km, was calculated to be 2.7 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 ENVIRONMENTAL PROGRAM INFORMATION: Facility Effluents, Environmental Measurements and Analyses

3.1 Airborne Effluents

The locations of principal Laboratory facilities from which radioactive effluents are released to the atmosphere are shown in Figure 5. The installed on-line effluent monitors, sampling devices, and the types and amounts of

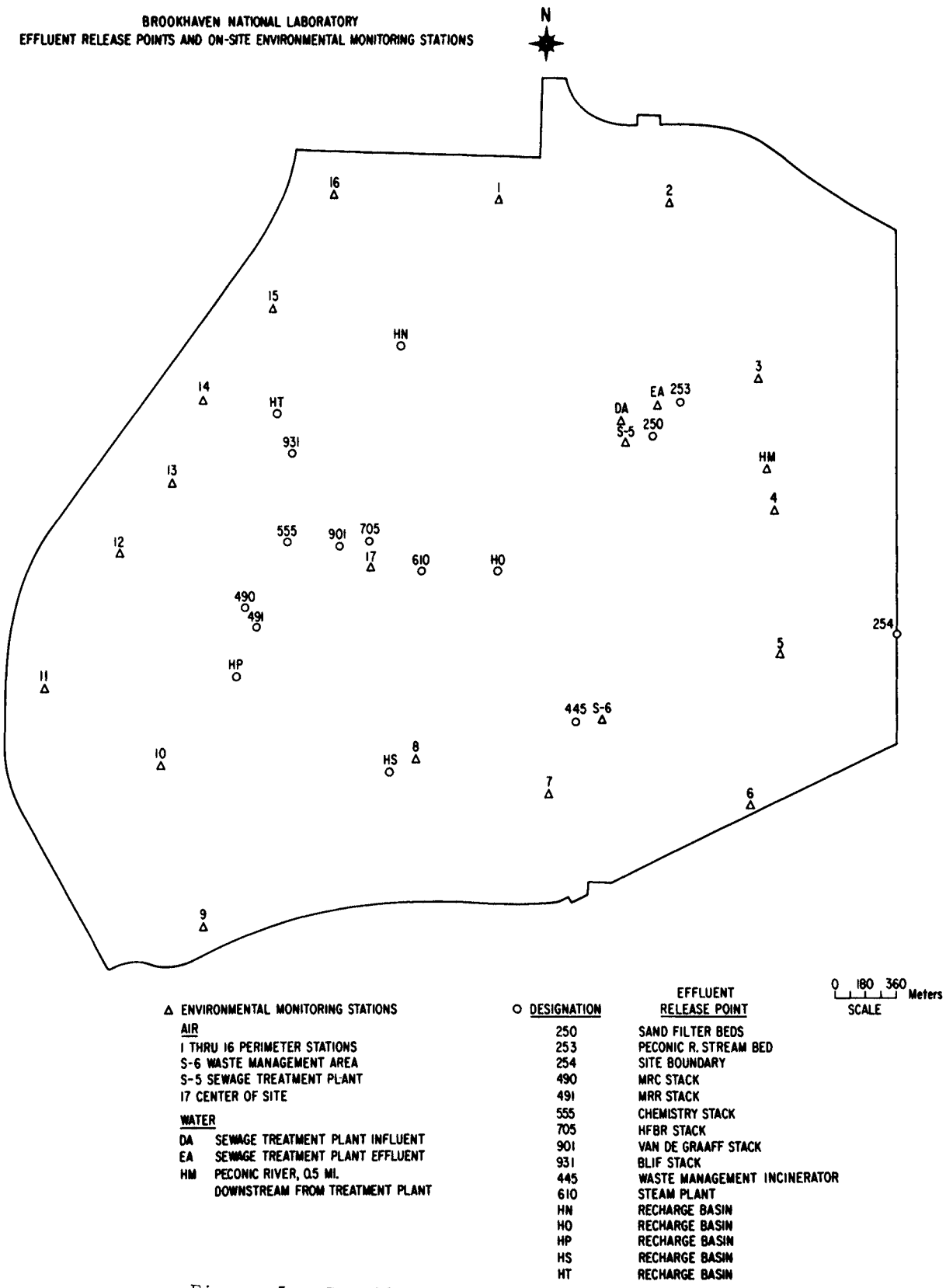


Figure 5: Brookhaven National Laboratory - Effluent Release Points and On-Site Environmental Monitoring Stations

effluents released during 1987 are indicated in Appendix D, Table 2. Tritium was the major radionuclide detected at the site boundary which was attributable to Laboratory operations.

3.1.1 Airborne Radioactive Effluents

At the BLIP facility, oxygen-15, which has a two minute half-life, is produced by the interaction of protons and water in the beam tubes and generated at an estimated rate of 6 mCi per microampere-hour. The oxygen-15 production rate was determined by facility management during a reassessment of BLIP airborne effluent releases [15]. Based on 65 milliampere-hours of operation, 582 Ci of oxygen-15 was produced in the beam tubes at the BLIP facility during 1987 and released via the stack.

At the MRR, argon-41, which has a 110-minute half-life, is produced 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 1987 was 1,500 Ci of argon-41.

Of the 188 Ci of tritiated water vapor released from the Laboratory research facilities during 1987, 169 Ci were released from the HFBR, 14 Ci from the Van de Graaff, 3.9 Ci from the MRC and the remainder from all other facilities.

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 1987 are shown in Appendix D, Table 3. Tritium was the radionuclide released from the incinerator in the largest quantity, 0.16 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.

Gamma-emitting nuclides released from the 100-meter stack at Building 705 are shown in Appendix D, Table 4. Bromine-82, iodine-131, and iodine-133 are present as a result of operations and experimental activities at the HFBR. The remaining radionuclides are generated from operational activities at the Hot Laboratory. Inert gas, tritium and gamma emitting radionuclides released from other stacks on-site are summarized in Appendix D, Table 5. As stated earlier, the argon-41 is the product of air activation at the MRR; the oxygen-15 and the listed gamma emitting radionuclides are produced at BLIP.

3.1.2 Airborne Elemental and Hydrocarbon Effluents

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 6. 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.

Most of the heating and cooling requirements for the principal buildings at the Laboratory are supplied by the CSF (Figure 3). Since 1976, the Laboratory has utilized light feed stock (LFS) materials, such as mineral spirits, alcohol, solvents, jet fuel, and reconstituted fuels in addition to

No. 6 oil. These materials are classified as EPA-regulated hazardous waste due to their ignitability and are blended with No. 6 oil to form Alternate Liquid Fuel (ALF). In 1987, the fraction of LFS relative to total fuel consumption was approximately 13%, a substantial decrease from previous years. The changing economic climate is largely responsible for this reduction in the ALF program. 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 [16]. NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum [16]. 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 [17,18], thus meeting the state criteria.

Samples of all LFS used in the preparation of ALF are routinely analyzed for polychlorinated biphenyls (PCBs) to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations. In October of 1984, it was determined that the Laboratory had 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 ALF with a PCB concentration of approximately 80 ppm. The EPA and NYSDEC were notified and the Laboratory applied for a provisional EPA permit (in accordance with 40 CFR 761) to burn the fuel. A 10% fuel firing rate will ensure that the concentration will be well below the EPA limit of 50 ppm. Formal approval to incinerate the PCB-contaminated fuel in BNL's high-efficiency boilers, designated as Boiler No. 4 and Boiler No. 5, was granted by EPA Region II on January 21, 1986. Since approval from NYSDEC has not yet been received, the material remains in a storage tank awaiting approval for incineration.

3.2 Liquid Effluents

The basic principle of liquid waste management at the Laboratory is to minimize the volume of liquids requiring decontamination prior to on-site release or processing into solid form for off-site burial at a licensed facility [19]. Accordingly, liquid wastes are segregated by the generator at the point of origin on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

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

The Waste Management Group also collects small quantities of liquid radioactive wastes. Depending on the radionuclide and its concentration, these wastes are either solidified at the HWMF or processed at the WCF. Buildings where large volumes (up to several hundred liters) of liquid radioactive waste are generated have dual waste handling systems. These systems are identified as "active" (D) and "inactive" (F). As shown in Figure 6, wastes placed into the D and F systems are collected in holdup tanks. After sampling and analysis, they are either discharged directly to the sanitary waste system if concentrations are sufficiently low [20] or are transferred to the WCF. At this facility, liquid waste is distilled to remove

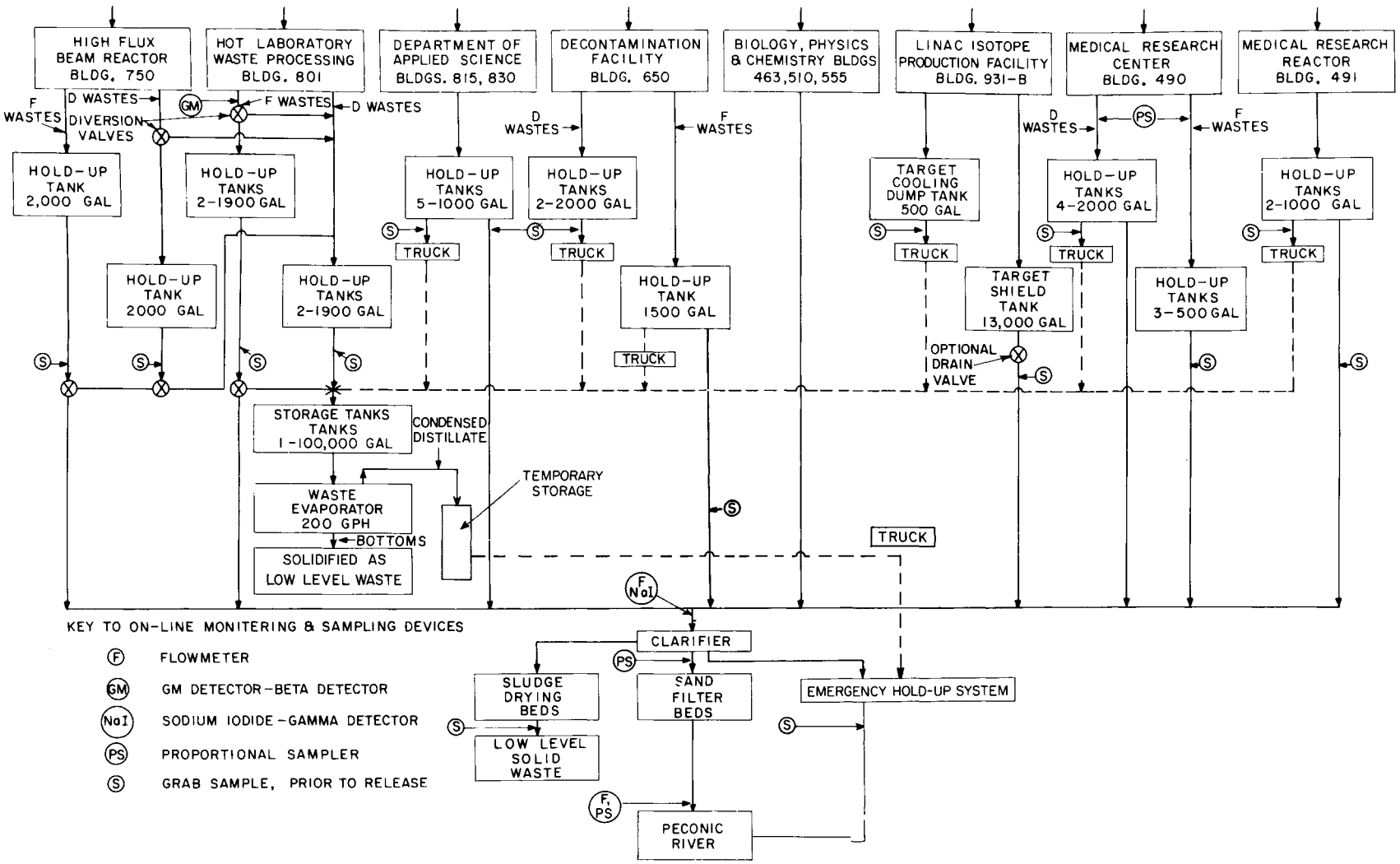


Figure 6: Liquid Effluent Systems
Brookhaven National Laboratory

particulates, 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 a lined hold-up pond at the STP where it is released into the pond and 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.

3.2.1 Sewage Treatment Plant (STP)

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 (secondary treatment), from which about 83% 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 17%, was 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.

3.2.1.1 Radionuclide Analysis

The proportional samples collected at Station DA, the influent to 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 7 and 8.

The gross alpha, beta, and tritium concentrations at both stations were essentially the same as in 1986. Figures 8 and 9 present trend data of gross beta and tritium concentrations over the years 1971 to 1987. The trend data indicate that gross beta and tritium concentrations over the last seventeen years have never exceeded the RCGs under which the facility operates. Furthermore, tritium concentrations have always been below the more restrictive Drinking Water Standards. The concentration of strontium-90 at these stations remained within the range observed over the past eight years (0.21 to 1.23 pCi/L) and was slightly lower than in 1986. Although slight fluctuations were observed, the released quantities and the radiological profile of gamma emitting radionuclides remained constant (0.3 to 1.5 pCi/L) over the past few years. All radioactive releases were substantially below applicable standards or radiation concentration guides.

3.2.1.2 State Pollutant Discharge Elimination System Permit - Metals and Water Quality Analysis

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 these data for 1987

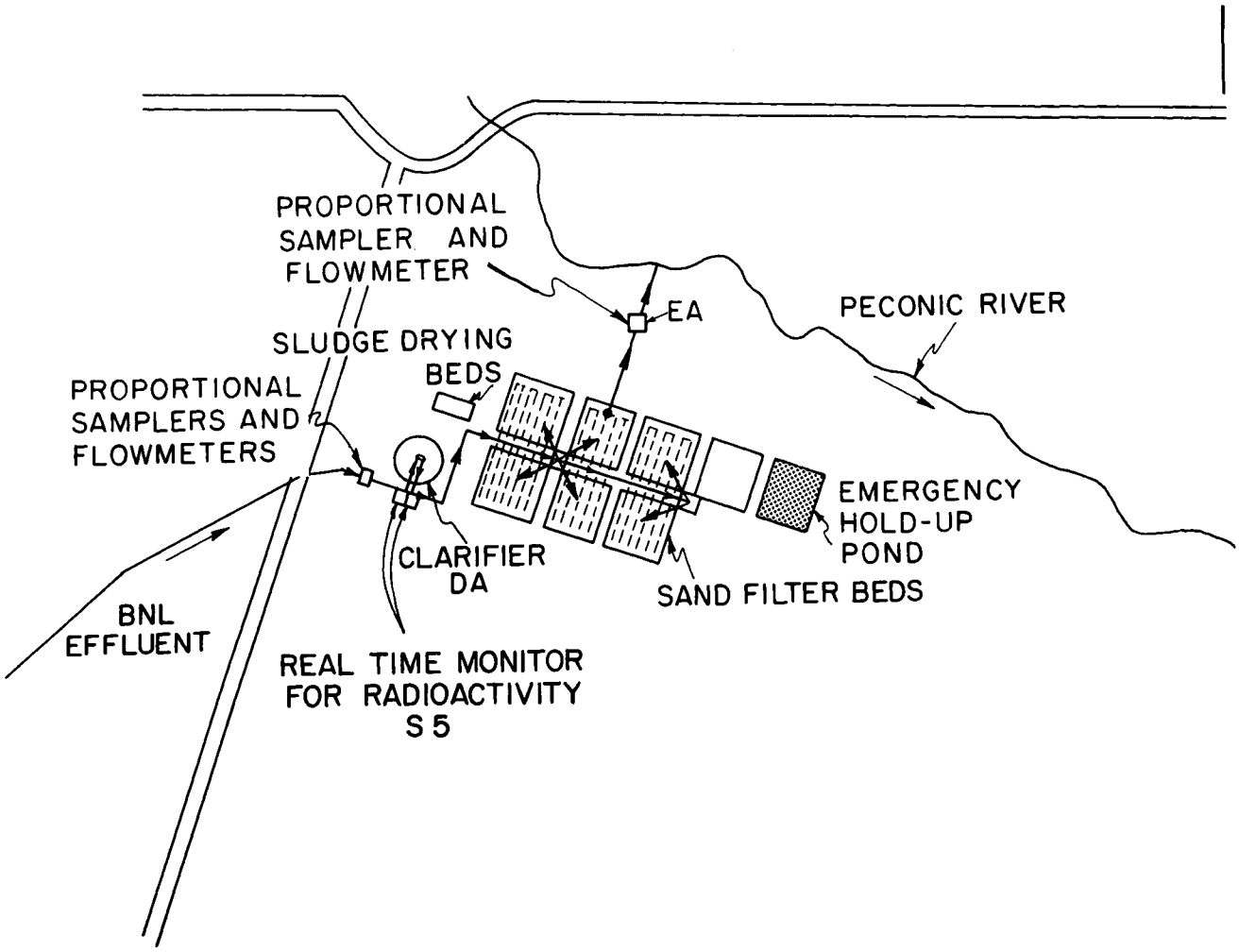


Figure 7: Sewage Treatment Plant - Sampling Stations

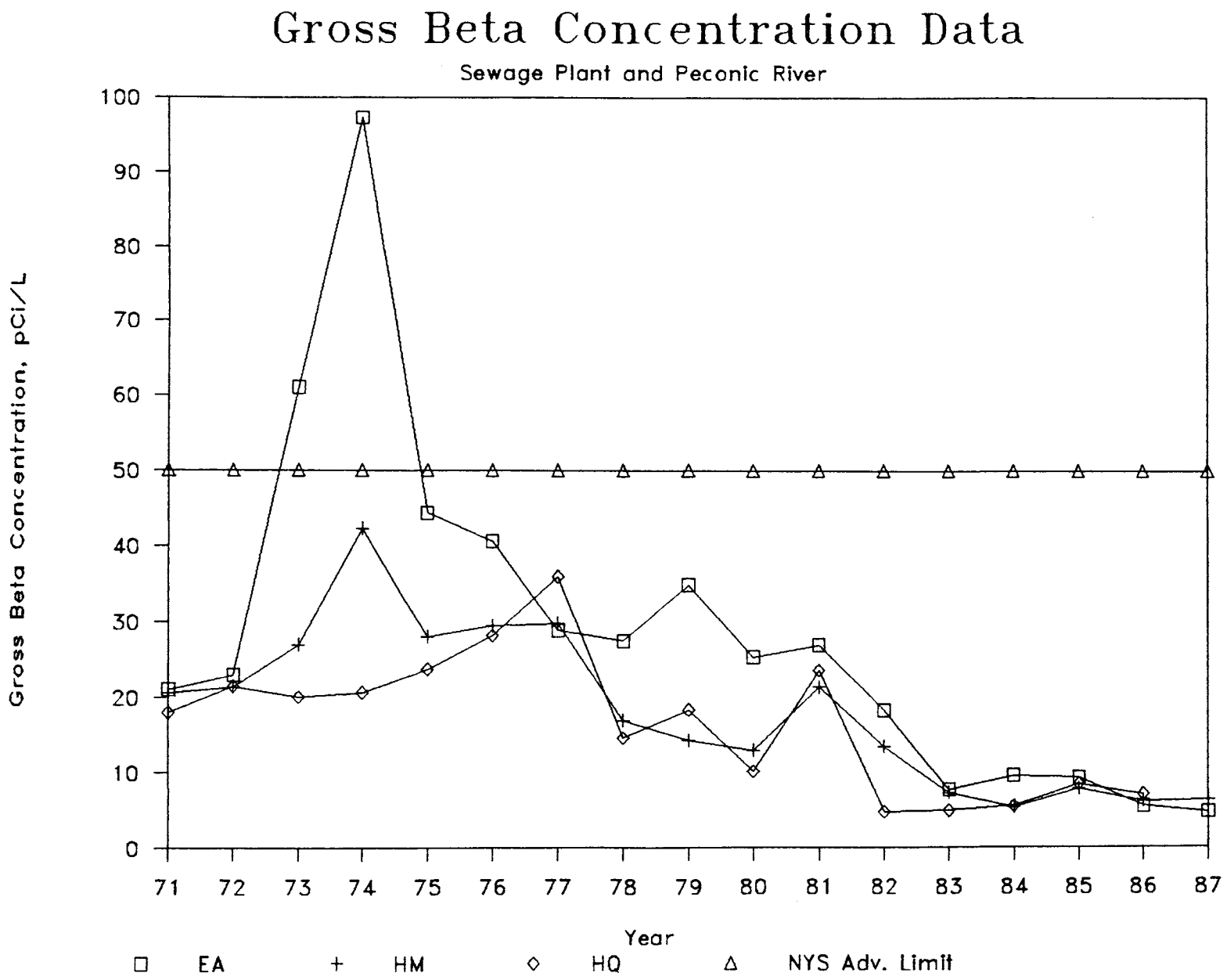


Figure 8: Trend Data - Gross Beta Concentration Data - Sewage Plant and Peconic River 1971 - 1987

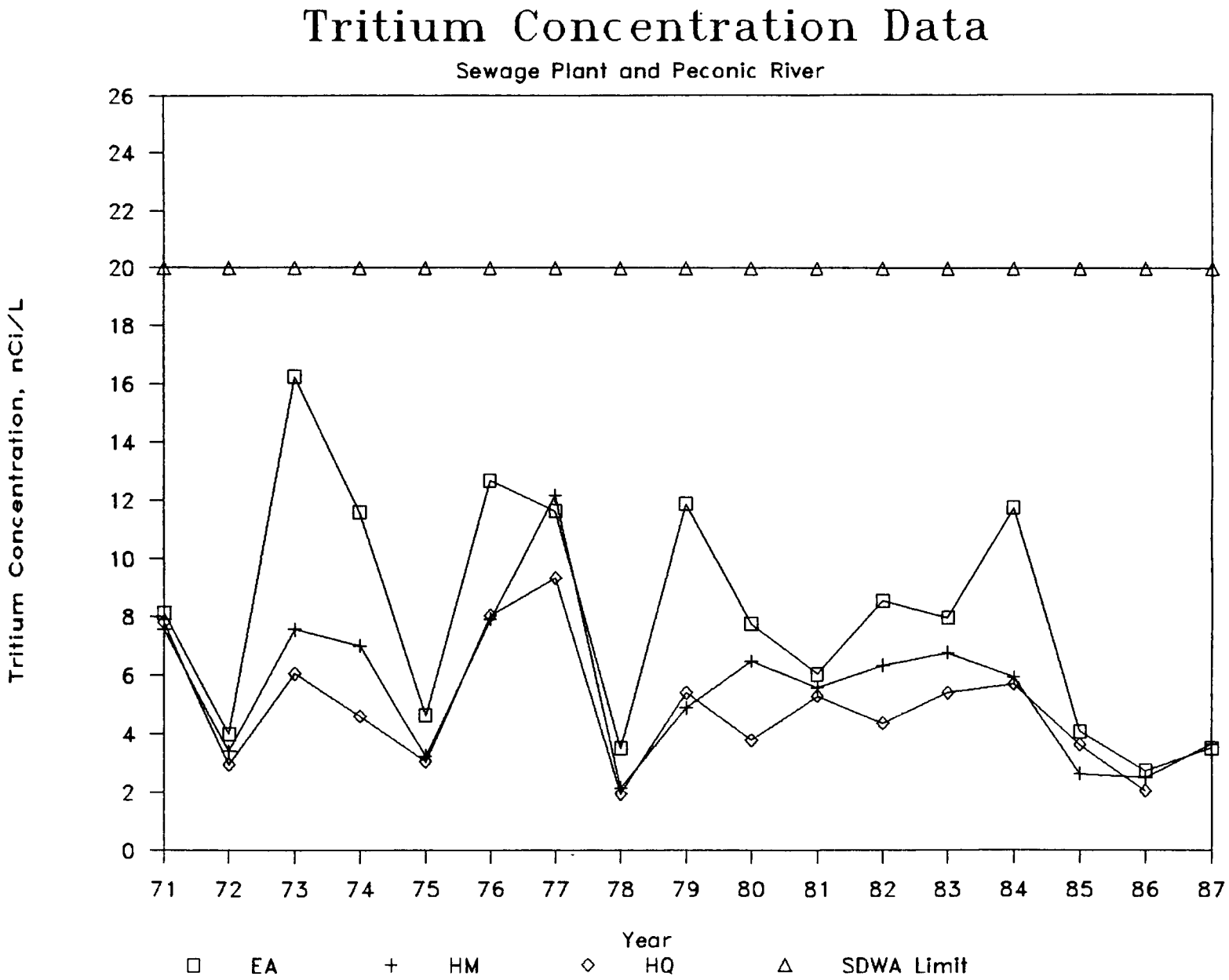


Figure 9: Trend Data - Tritium Concentration Data - Sewage Plant and Peconic River 1971 - 1987

is shown in Appendix D, Table 9. 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. Only one total coliform result did not meet the permit conditions.

3.2.2 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 13 MLD of water was returned to the aquifer through on-site recharge basins; 2.1 MLD to basin HN located about 610 m northeast of the AGS; 6.0 MLD to basin HO about 670 m east of the HFBR; and 4.4 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 0.62 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 (0.39 MLD) was also discharged to the HO basin. The MRR secondary cooling water (4.4 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.

3.2.2.1 Recharge Basins - Radionuclide Analysis

Radiological results for recharge basin samples are reported in Appendix D, Table 10. 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 and for virtually all samples the tritium concentration was less than the system minimum detection limits. 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 0.03 mrem.

3.2.2.2 Recharge Basins - Metals and Water Quality Analysis

In 1987, approximately 13 MLD of water were discharged to the recharge basins. The BNL SPDES permit requires that records be maintained of the pH and the quantity of water discharged to these basins. The pH of this water ranged between 5.0 and 9.5. The results of selected water quality parameters are presented in Appendix D, Table 11. With the exception of iron and pH, the discharge to the basins met both the SPDES permit conditions and New York State Drinking Water Standards for metals and other water quality criteria.

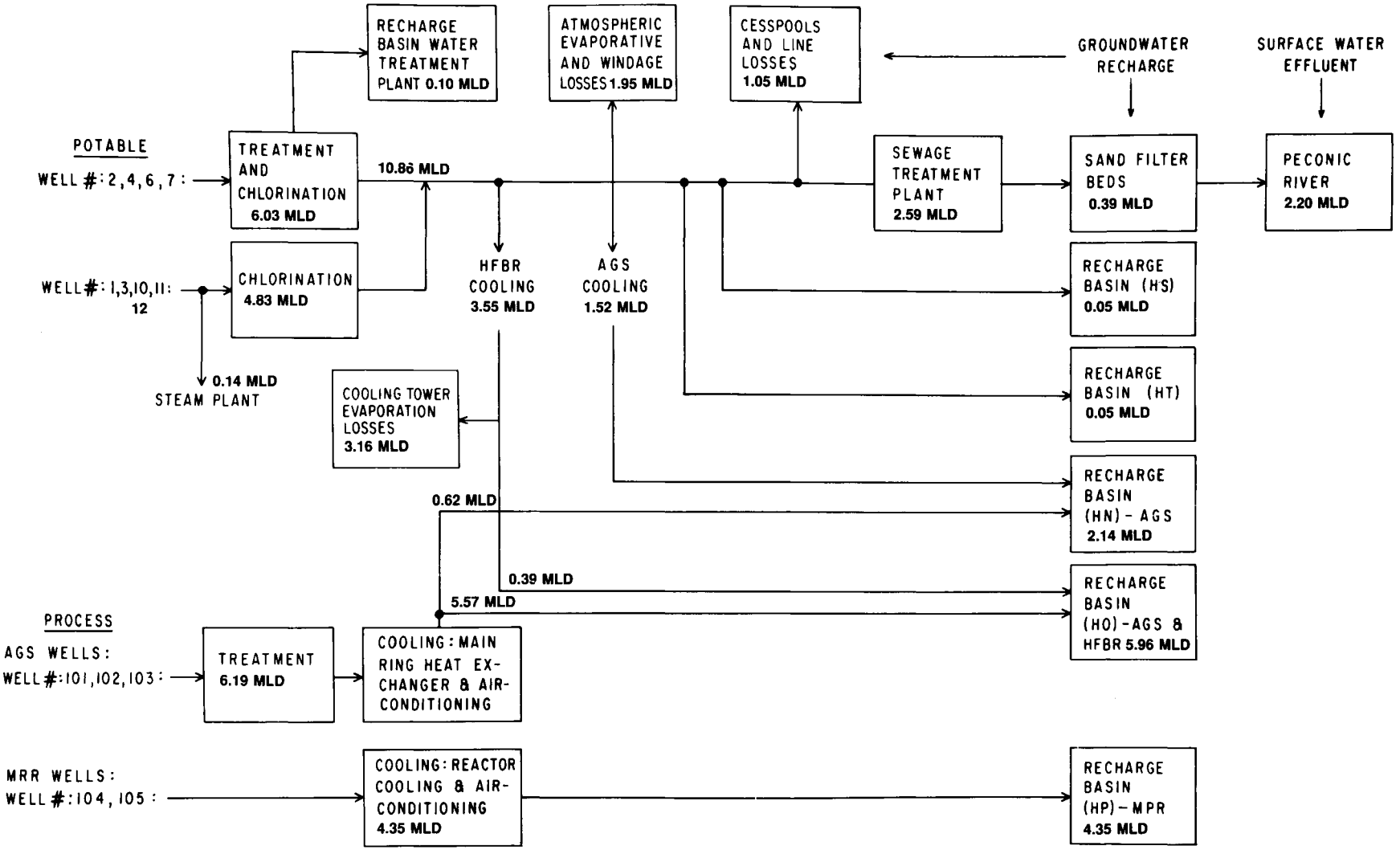


Figure 10: Brookhaven National Laboratory: Schematic of Water Use and Flow

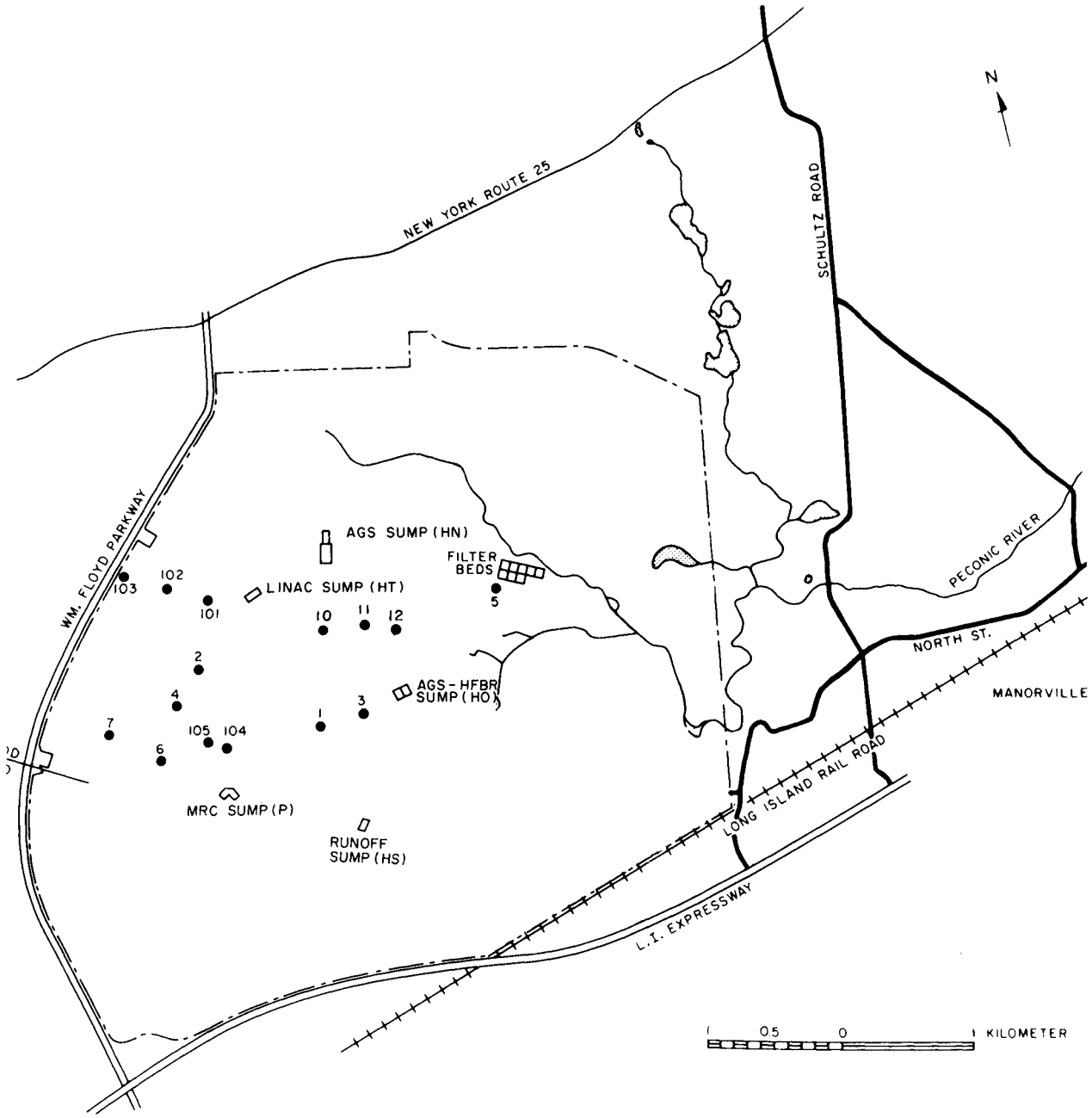


Figure 11: On-Site: Potable and Supply Wells and Recharge Sumps

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 [21]. The locations of the on-site and off-site TLDs are shown in Figures 12 and 13, respectively. The standard 16 sectors with sector No. 1 centering on true North have been used to locate the TLDs. The dose-equivalent rates observed are given in Appendix D, Table 12. The annual average dose-equivalent rate as indicated by all TLDs was 61.6 mrem/a. The dose-equivalent rate at the site boundary was 64.5 mrem/a, while the off-site average rate was 59.9 mrem/a. Differences between the on-site and off-site TLD measurements data reflects environmental differences between TLD locations.

The maximum site boundary dose due to argon-41 and oxygen-15 airborne emissions was calculated using AIRDOS-EPA as 0.059 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 berylium-7 produced in the atmosphere as a result of cosmic and galactic particle interaction in the atmosphere.

3.3.2.1 Tritium Analyses

Sampling for tritium vapor was performed at 18 on-site stations (shown in Figure 5) and one off-site control air sampling station located 17 km southwest of the Laboratory. Water vapor was collected by drawing a stream of air through silica gel cartridges. The data collected from the site perimeter, analytical laboratory, and control monitoring stations are presented in Appendix D, Table 13. The maximum annual average tritium concentration at the site boundary was observed at Station 3 and was 5.4 pCi/m^3. This air concentration, adjusted for background and inhaled continuously for one year, would result in whole body dose from the inhalation and submersion pathways of 0.004 mrem.

The airborne tritium concentrations measured in the Safety and Environmental Protection Division analytical laboratory (location 17T) and outside Building 535 (location 20T) reflect ambient air concentrations in the analytical laboratory and in the central part of the Laboratory site respectively. The elevated laboratory air concentrations are the result of processing building effluent tritium samples in this lab. Because building effluent and ambient air samples are processed on different days using different hardware, the elevated laboratory air concentration should not influence the environmental results.

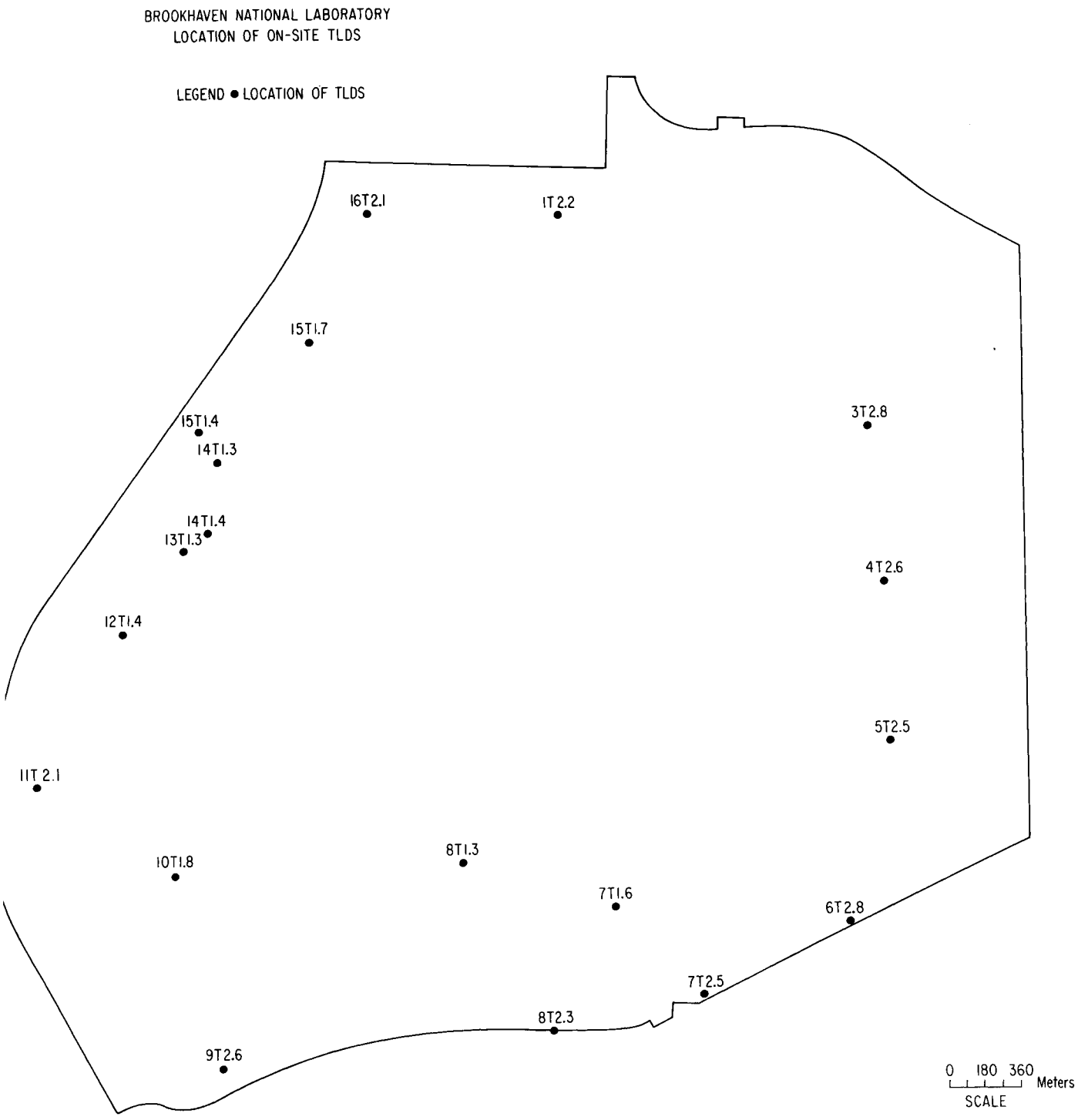


Figure 12: Brookhaven National Laboratory - Location of On-Site TLDs

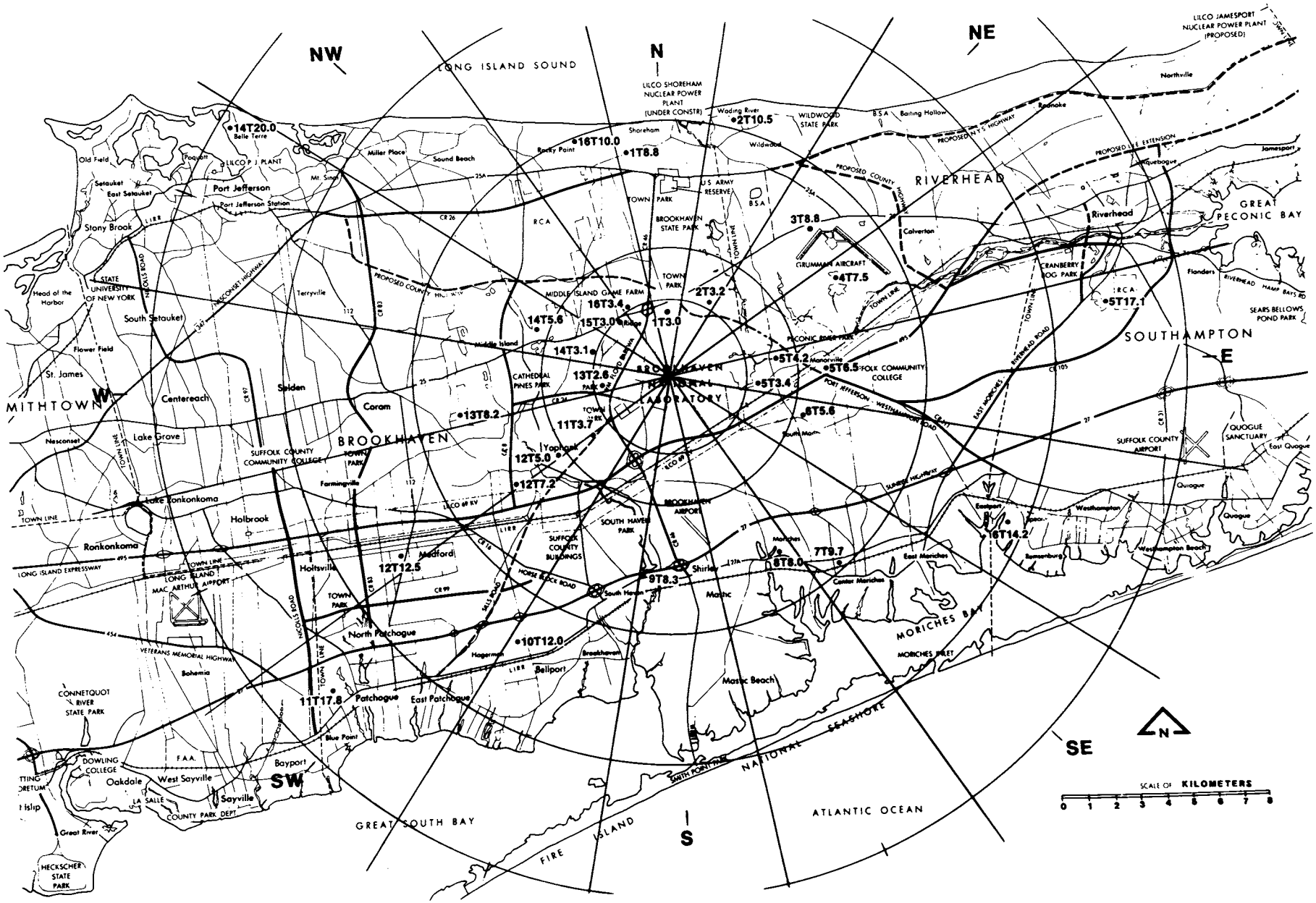


Figure 13: Location of Off-Site TLDs

In 1987, the Laboratory continued to use the STP emergency hold-up pond as an interim storage area for WCF distillate. The water in the pond was periodically pumped back to the STP for controlled discharge. Ambient air tritium monitoring was not conducted at this area because the 1985 and 1986 monitoring data indicated that the above practice did not contribute to the levels detected at the site boundary nor did they contribute a significant dose to the operators of the STP.

3.3.2.2 Radioactive Particulates

During 1987, 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 filters followed by a 62.5 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 anti-coincidence 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 14 through 18. Gamma-emitting radionuclides detected on the particulate and charcoal filters are reported in Appendix D, Tables 19 through 24. 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

A pot-type rain collector is situated adjacent to the STP (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 1987 are reported in Appendix D, Table 25 and reflect typical wash-out values associated with atmospheric scrubbing [10] and the presence of radioactive particulates 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 26. The results are consistent with data collected in previous years [22]. 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 Peconic River - Radionuclide Analysis

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 225 meters downstream of the discharge

point; HC, located approximately 11 km downstream from the discharge point; HW, located approximately 18 km downstream from the discharge point; HT, located approximately 10 km downstream from the discharge point; HR, located 21 km downstream from the discharge point, and Station HH, a control station located on the Carmens River, which is not influenced by BNL liquid effluent. No samples were collected at the site boundary weir because there was no flow leaving the BNL site. Figure 14 provides a seventeen year review of liquid discharge volumes to the Peconic River and flow estimates for the Peconic River on-site. The data indicates that there has been no measurable flow at the site boundary since 1983 and no measurable flow (volume too small) 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. The Peconic River sampling stations are identified in Figure 15.

Time-proportional samples were collected at Stations HM and HR. No estimate of total flow was made at these stations during the sample period. Sample collections at all other stations along the Peconic River consisted of grab samples that were collected in conjunction with the aquatic biota sampling program. Weather permitting, grab samples were collected at the control station on a monthly basis.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 27 and 28. The gross alpha, beta, tritium, and strontium-90 data indicate that only gross beta, tritium, and strontium-90 are present above ambient levels in BNL effluent waters at Station HM. Elevated levels do not extend beyond Station HQ. Gamma spectroscopy results indicate that cesium-137, due to weapon test fallout, and naturally occurring potassium-40 were detectable at off-site stations. As stated earlier, in 1987 almost all of the STP effluent either evaporated or was recharged to the ground water prior to leaving the site. The surface water gamma-spectroscopy, gross beta, and tritium analyses support this observation.

3.3.5.2 Peconic River - Metals and Water Quality Analysis

Measurements of selected non-radiological water quality parameters were performed at the former site boundary location (HM). The pH range was 5.0 - 6.9. Heavy metals such as chromium, cadmium, silver, and mercury were not detected. Lead and copper were occasionally detected at the lower limit of detection while concentrations of zinc, sodium, chlorides, sulfates, and nitrates were all below the Drinking Water Standards. Iron and manganese were the only metals that exceeded the Drinking Water Standards.

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 15). Fish samples were collected at Stations EA, HM, HC, HW and HT. Control samples were obtained from off-site fresh water bodies which are not influenced by the Peconic River.

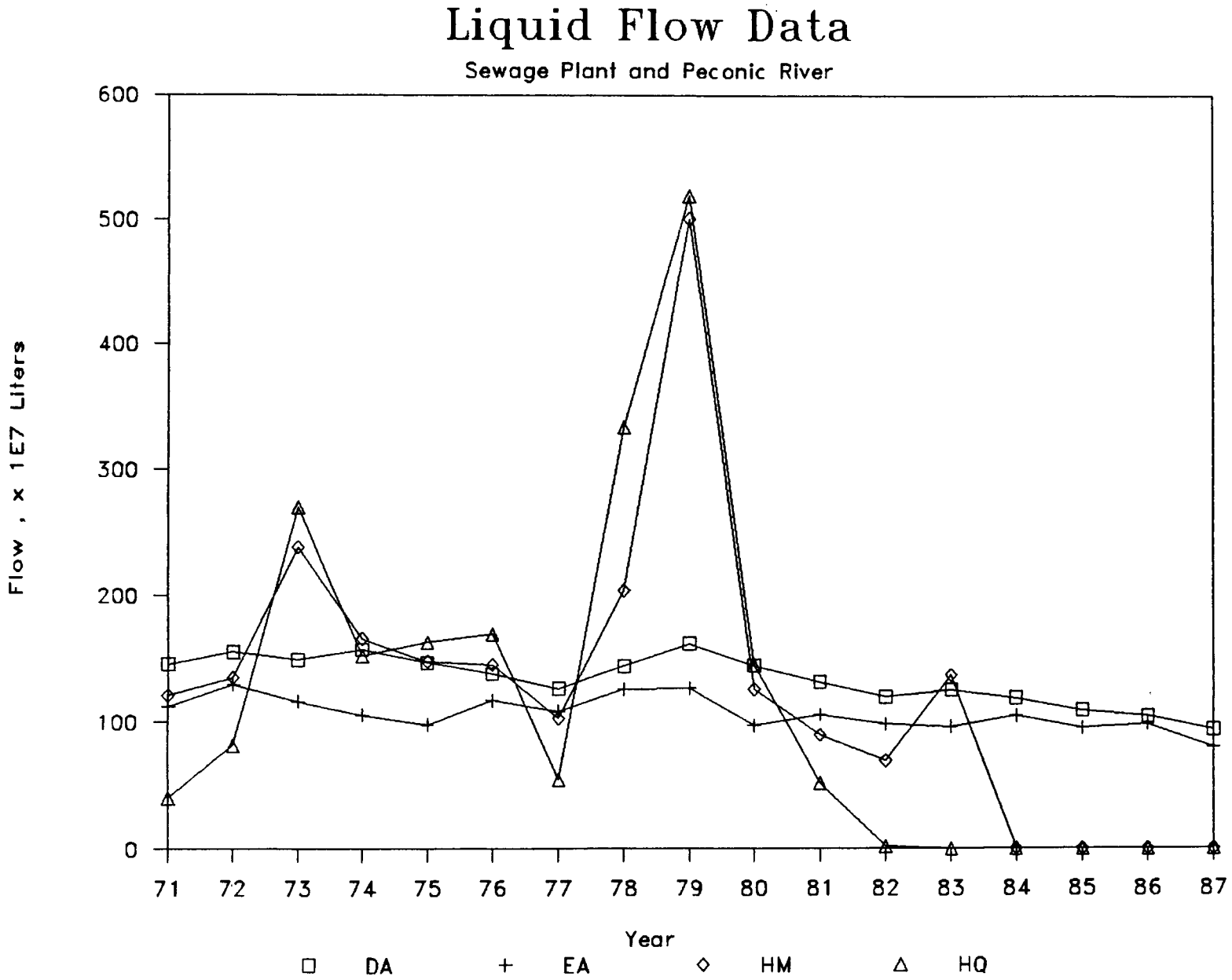


Figure 14: Liquid Flow Data Sewage Plant and Peconic River 1971 - 1987

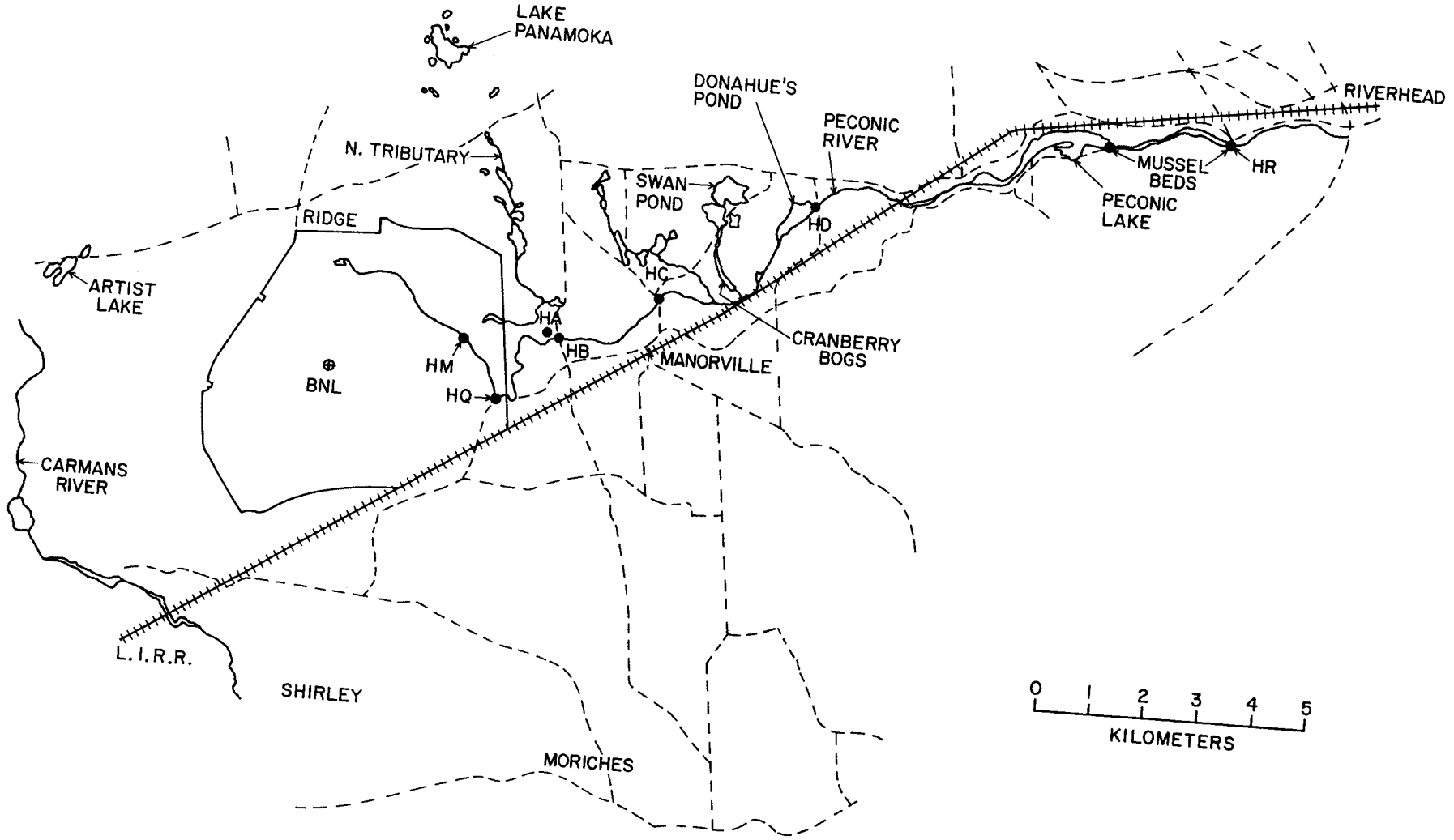


Figure 15: Peconic River Sampling Stations

The data from completed analyses are shown in Appendix D, Table 30. Elevated cesium-137 concentrations were detected in samples collected downstream of the BNL STP. The observed difference between these samples and controls ranged from 400 to 1,100 pCi/kg-wet weight. The presence of cesium-137 at the observed concentrations in on-site samples is due to both current and past releases; at downstream off-site stations due to past releases and at control locations due to weapons fallout.

3.3.7 Potable Water and Process Supply Wells

Well Nos. 4, 6, 7, 10, 11, and 12 supplied water for potable use during 1987. Well Nos. 101, 102, and 103 were used periodically during 1987 to provide cooling water to the AGS facility. Well Nos. 104 and 105 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 MLD were pumped from them in 1987. Grab samples were obtained from these wells on a quarterly basis and analyzed for radioactivity, water quality indices, metals, and chlorocarbon compounds. In the summer of 1987, the analytical laboratory expanded its analysis capabilities for ground water samples to include three additional trihalomethane compounds and BTX.

Well Nos. 101, 102 and 103 were not sampled in 1987 because these wells were not in use when the quarterly samples were collected. The current sampling protocol requires that a well must be in operation for at least several hours prior to sample collection.

3.3.7.1 Radionuclide Analysis

The average radionuclide concentrations are reported in Appendix D, Table 31. The presence of tritium, cobalt-60, cesium-137 and sodium-22 in Well Nos. 7, 10, 11, 12 and 105 appear related to Laboratory operations. Radionuclide concentrations in potable water are all 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 0.096 mrem. 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 32 and can be used for comparison against other ground water sample results.

3.3.7.2 Metals, Water Quality, and Organic Compound Analyses

The water quality and metals data for the Laboratory potable supply wells are shown in Appendix D, Table 33. With the exception of pH, indices of water quality such as nitrates, sulfates, and chlorides were all well within the limits established in the New York State Drinking Water Standards [13,14]. The lower pH values represent values typical of Long Island. The water supplies

were analyzed monthly for residual chlorine and the presence of coliform bacteria and monthly reports were 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 [23] and the New York State Sanitary Code [13].

The majority of metals including silver, cadmium, chromium, and mercury, were not detected in the Laboratory supply system. Copper, lead and zinc were detected at trace levels while iron, manganese, and sodium were present at ambient levels which were well within the New York State Standards.

Water samples from potable wells were also analyzed for volatile organic compounds. The results are shown in Appendix D, Tables 34 - 37. The results for 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene, (common contaminants detected in Long Island wells) [24] are shown in Appendix D, Table 34. Trichloroethylene and 1,1,1-trichloroethane were detected in one potable well and one supply well on the BNL site. The maximum concentration of trichloroethylene detected in Well No. 11, equaled the Drinking Water Limit for this compound. The elevated concentration appeared in only one sample during 1987. Subsequent analysis in 1988 will determine if the observed concentration was a transient occurrence or indicative of organic compound contamination at this well. Potable water samples were analyzed for a wide range of organic compounds that are reported in Appendix D, Table 35. These analyses are performed annually on the BNL well water by an outside contractor. These data indicate that BNL water meets the New York State Drinking Water Standards or advisory limits [13,14,23]. Additional water samples from potable wells were analyzed for trihalomethanes and BTX by BNL. These results are shown in Appendix D, Tables 36 and 37 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 Drinking Water Limits.

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, and the current landfill. The locations of most of these ground water surveillance wells are shown in Figure 16. Wells installed at the landfill and near the HWMF 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" [12]. The data are also compared to the EPA [23] and New York State Drinking Water Standards [13,14] to specify the quality of water in these surveillance wells.

3.3.8.1 Radionuclide Analysis

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 38. Elevated gross beta and tritium concentrations have been found in on-site wells adjacent to the sand

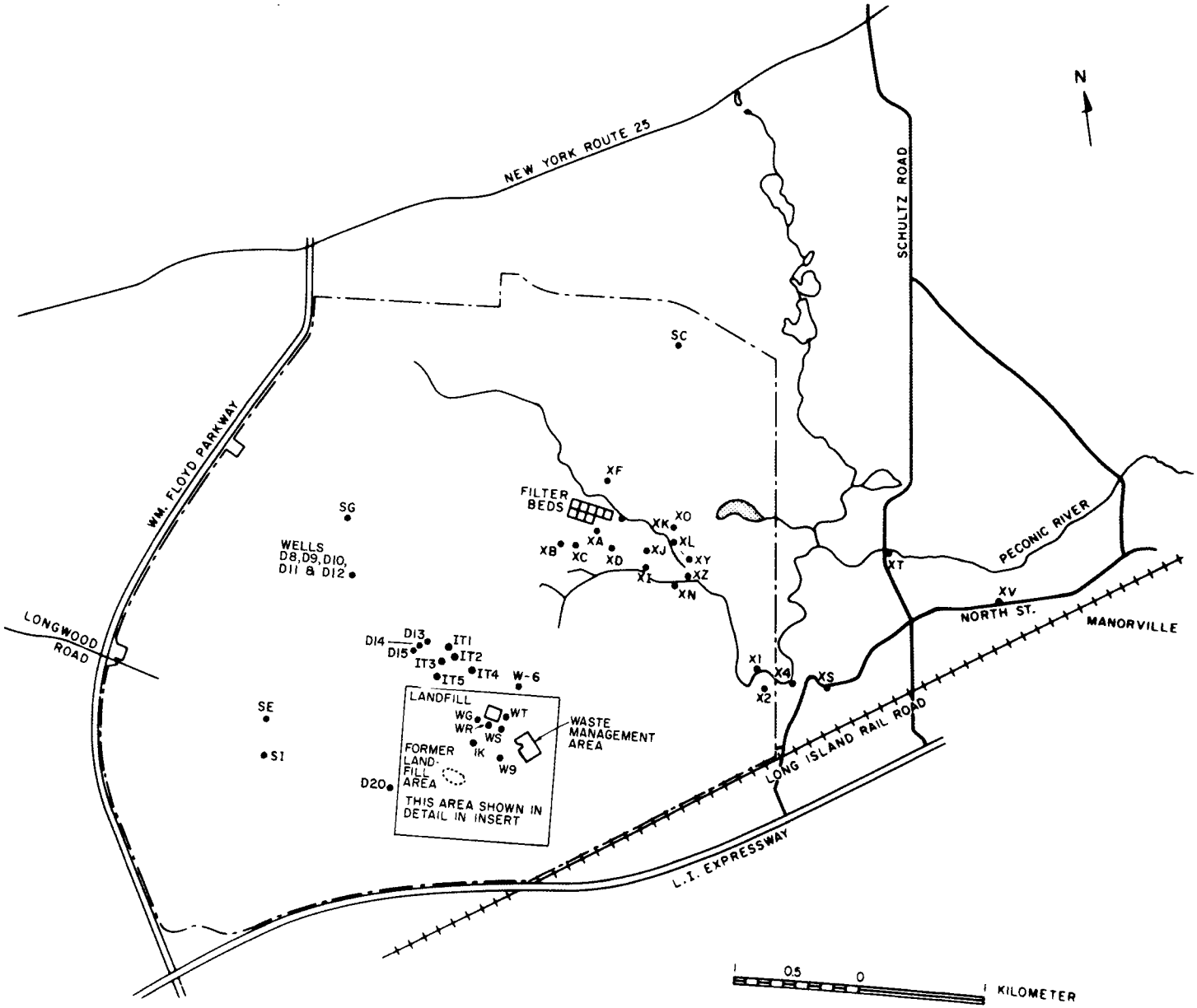


Figure 16: Location of Ground Water Surveillance Wells

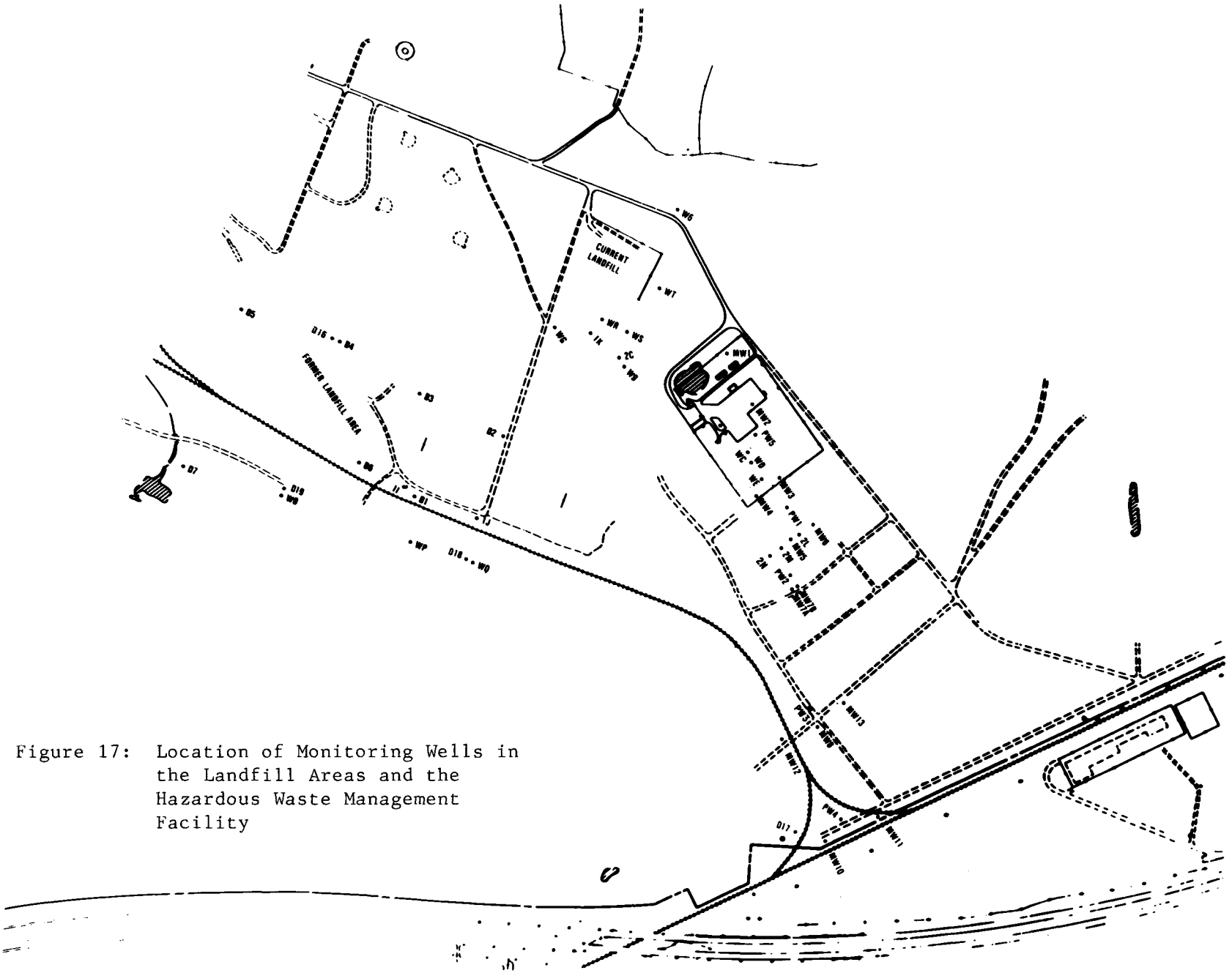


Figure 17: Location of Monitoring Wells in the Landfill Areas and the Hazardous Waste Management Facility

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 1987, on-site ground water concentration ranges were 0-21% for gross beta and 0-20% for tritium of the applicable limits [13,14,23]. Strontium-90 concentrations ranged between 1% and 70% of the EPA Drinking Water Standard. Gamma-emitting radionuclides, although detectable at well Nos. XA and XL, were far below applicable standards. Daily ingestion of all water from these wells for one year would result in a committed effective dose equivalent which would be 4% of the Drinking Water Standard.

In 1987, a cooperative program between BNL and the SCDHS for the collection and analysis of samples from wells serving private homes continued. In this sampling program, 16 samples are collected on a quarterly basis 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 the program, presented in Appendix D, Table 39, indicate that tritium was detected in private well samples collected from four locations adjacent to the Laboratory. The private wells, screened at depths ranging from 50 to 200 feet, had annual average tritium concentrations that ranged from 380 to 1,500 pCi/L. Although above background, these data were consistent with data collected since 1979, and were less than 7% of the EPA Drinking Water Standard [23] for community water supplies. One gross beta concentration at sample location number 3 was clearly above normally observed levels. Gamma spectroscopy results from the same location indicate that the contaminant is potassium-40. The SCDHS data indicate that the water from this well contains 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, CSF and WCF are shown in Appendix D, Table 40. 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 may be the result of BNL's past practice of placing low specific activity material on the landfill. This means of disposal was discontinued in 1978. In general, all wells immediately down gradient of the current landfill exhibited elevated gross beta, tritium, strontium-90, and sodium-22 concentrations. The annual average concentrations at each monitored location are below the nuclide specific concentration limits identified in the EPA Drinking Water Standard [23] and the committed effective dose equivalent from ingesting 2 liters of water per day for one year from this water would be 1.7 mrem or 42% of the Drinking Water Standard [23].

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. Data from Well No. D6 exhibit elevated gross beta and strontium-90

concentrations. The strontium-90 concentration is 80% of the value specified in the Drinking Water Standard. Several well water samples from this area also contain trace quantities of fission and activation products. The concentrations are all below levels of regulatory concern.

No detectable activity was found at the monitoring well at the ash repository, and miscellaneous control wells. Elevated gross beta, strontium-90, fission and activation products were detected in water samples collected in the vicinity of the CSF and WCF. The average concentrations were all below values of regulatory concern.

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 41. The annual average concentration of gross beta and strontium-90 exceeded Drinking Water Standards at several wells in this area. Two wells exceed the gross beta value, while the remaining sample locations show concentrations that range from 2% to 73% of the standard. The average strontium-90 concentrations at four wells exceed the Drinking Water Standard. The remaining sample locations show concentrations that range from less than 1% to 24% of the standard. The average tritium concentration at all wells, except Well No. MW8, was below the Drinking Water Standard. The annual average tritium concentration at Well No. MW8 was 1.5 times the 20,000 pCi/L value specified in the standard. Gamma emitting radionuclides that were detected at these sampling locations and are not specifically quoted in the Drinking Water Standard were compared to RCGs. Ground water concentration 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 biweekly to monthly basis for samples collected from the Spray Aeration Project wells. These wells are labeled PW1 through PW5 and their location is described in Figure 17. The wells were turned on in April and were scheduled to operate through December 1987. Pumping Well Nos. PW1, PW2, and PW5 did operate in this manner. Pumping Well Nos. PW3 and PW4 were run from April to June and then October through December. These latter wells were not in operation during the summer months so that a new piping system could be installed which would channel the pumped water back to the HWMF for spraying and recharge. The change in operation was made to minimize the tritium concentrations that were approaching the site boundary. The radiological results from this sampling program are presented in Appendix D, Table 42. The sample location column of this table uses the suffix "A" to indicate that a sample was collected prior to spraying and the suffix "B" to indicate that a sample was collected post spraying. Only Sr-90 and organic samples were collected and analyzed pre and post spraying. For Sr-90, there is no marked change in the concentration as a result of spraying. The remaining radiological data indicate that the gross beta activity declines as one gets further from the HWMF. Tritium concentrations tend to increase until they reach their 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 and landfill areas has been intercepted by these wells. The increased tritium concentrations at Well Nos. D17 and

MW10 are also indicative of the plume movement toward the site boundary. Finally, small concentrations of sodium-22 were detected in the near vicinity of the HWMF.

3.3.8.2 Metals, Water Quality and Organic Analysis

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 43 - 47. In general, the data for samples obtained from these wells were comparable to those observed during previous years [22]. All analyzed water quality parameters were within New York State Water Quality Standards [14], with some exceptions for iron, manganese, and one lead value. These species were not observed in significant concentrations in either the influent or effluent from the STP. The presence of iron, lead, and mangenese is believed to reflect a well-casing effect. The low pH levels appear to reflect ambient levels of pH in ground water, since pH levels in the potable wells ranged from 5.6 to 6.7 (refer to Appendix D, Table 43).

These wells were also analyzed for chlorocarbon, trihalomethane and BTX compounds. All results for chlorocarbon compounds were below the system detection limits. The sample from Well No. XA had a positive chloroform concentration that was just above the detection limit. All other trihalomethane concentrations were less than the system detection limits. While a sample from Well No. XK contained a trace quantity of toluene, all other BTX concentrations were below the detection limits for these compounds.

The surveillance data for the current and former landfills, and control wells are shown in Appendix D, Tables 48 - 51. The BNL landfill is operated in accordance with the permit issued by NYSDEC, Permit No. 10-84-0346. The data from the current landfill wells indicate that pH, conductivity, chlorides, sulfates, nitrate-nitrogen, and all metals are consistent when compared with previous years' observations [22]. The data from surveillance wells at the former landfill and control wells were also all consistent with prior observations [22]. The presence of the above parameters in any monitoring well indicates proximity to a landfill which is consistent with the historic land use in this area of the BNL site.

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 three locations and in each case the concentrations were in excess of the Drinking Water Standard of 0.005 mg/L. No other organic compounds were detected in samples collected near the current landfill. At the former landfill, seven wells contained concentrations of 1,1,1-trichloroethane and one well contained trace quantities of tetrachloroethylene, chloroform and bromodiachloromethane. None of these concentrations exceeded the Drinking Water Standard. Three designated control wells were found to contain 1,1,1-trichloroethane and two wells contained chloroform and trichloroethylene. The trichloroethylene concentrations exceeded the Drinking Water Limits. The wells at the landfill areas will continue to be sampled to monitor the impact of past or current BNL operations on the local aquifer.

The average water quality and metals data for the HWMF are presented in Appendix D, Table 52 and 53. Metals such as silver, cadmium, chromium, copper and mercury were not detected in any of the wells. Measureable concentrations of iron, manganese, lead, and zinc were observed in several wells. In general, lead, and sodium concentrations were consistent with the 1986 data [22] while iron and zinc concentrations declined slightly.

The wells in the vicinity of the HWMF were also analyzed for organics. These results are presented in Appendix D, Tables 54 - 56. Currently, only two wells exhibit average concentrations of volatile organics which exceed either the New York State Drinking Water Standards or the NYSDOH advisory guidelines. The impact of the spray aeration project is clearly reflected by these results in the reduced number of locations which exhibit volatile organic concentrations which exceed Drinking Water Standards. At the aquifer restoration project, monthly samples of well water and residual spray were analyzed for chlorocarbon, trihalomethane, and BTX content. The results are presented in Appendix D, Tables 57 - 59. The highest observed organic concentrations were found in Well No. PW3A. The concentration of the 1,1,1-trichloroethane reported for this well is an underestimate of the true value. The concentration exceeded that of the highest standard used to establish the instrument calibration curve. Since replicate samples were not available, the value for this sample was reported as the upper limit of the calibration curve. The chlorocarbon concentrations in recharged water were at or below the detection limits. These data indicate that the chlorocarbon removal efficiency of the spray aeration technique is 90% to 100%.

In 1987, two new areas were monitored for potential ground water contamination; the Major Petroleum Facility (MPF) and the WCF. The MPF is located south of the CSF and is the holding area for most fuels used at the CSF. One well upgradient and three wells downgradient of the facility are used to monitor the ground water for water quality, metals, free product and BTX. These sample results are presented in Appendix D, Tables 60 and 61. Except for pH, iron and manganese, all other parameters were within the limits specified in the Drinking Water Standards. BTX analysis of these samples indicates that toluene is present in Well No. D14. 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. Except for pH and iron, all other water quality and metals results indicate that the water meets the Drinking Water Standards. Organic analyses were not performed on samples from this area because the purpose of these wells was to assess the radiological impact of the WCF on ground water. The results of this sampling program are presented in Appendix D, Table 62.

3.3.9 Deer and Small Game

The environmental program was expanded in 1986 to include the analysis of deer and small game. Deer and racoon samples were collected in 1987 from animals on-site and adjacent to the Laboratory. Samples were analyzed for gamma-emitting radionuclides and the results are reported in Appendix D, Table 30. The data indicate that the cesium-137 activity present in the meat is the result of global fallout from the weapons testing program.

4.0 OFF-SITE DOSE ESIMATES

4.1 Collective 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 63. The highest annual average site boundary concentration of tritium vapor was 5.38 pCi/m^3 at Station 3 and the committed effective dose equivalent (inhalation and skin absorption) was 0.004 mrem for the hypothetical individual residing at that location. By comparison, the calculated site boundary tritium committed effective dose equivalents using AIRDOS-EPA are presented in Appendix, Table 64. The overall correlation is quite good with the predicted and measured maximum dose being the same although not 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 radionuclides were calculated using AIRDOS-EPA and are presented in Appendix D, Table 65. The maximum site-boundary dose-equivalent from argon-41 and oxygen-15 was calculated to be 0.06 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 dose equivalents resulting from the 10 meter and 100 meter release heights are shown in Appendix D, Tables 66 and 67, respectively. Argon-41 effectively contributed the entire collective dose equivalent, 2.23 person-rem. The dose equivalent contributions from tritium and radioiodines were 0.2 and 0.007 person-rem, respectively. The computer model AIRDOS-EPA was used to determine the collective and maximum individual dose estimates. The program was modified to use the International Commission on Radiation Protection (ICRP) Publication No. 30 [25] dose conversion factors for the ingestion and inhalation pathways. The 1987 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 2.40 person-rem. This can be compared to the 1987 population collective dose-equivalent due to cosmic and terrestrial natural background of 300,000 person-rem. The Laboratory airborne releases comprised 0.0009% of the total dose due to natural background.

4.2 Collective Dose Equivalents Due to Liquid Effluents

Since the Peconic River is not used as a drinking water supply [26], 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 1987, 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 1,500 pCi/L. The average concentration for the group of four positive tritium concentrations was 770 pCi/L. This corresponds to a committed effective dose equivalent to the maximum individual of 0.000068 rem and a collective dose equivalent to the population at risk (assumed to be not more than 500 persons) of 0.012 rem.

The radionuclide concentration in the fish samples that were analyzed in 1987 were summarized in Appendix D, Table 30. Using these data, the DOE/ICRP No. 30 dose conversion factors [25,27], an estimated population at risk of 600 [28], and a maximum consumption rate of 7 kg/yr [28], the maximum individual committed effective dose equivalent was calculated to be 0.00039 rem and the collective dose equivalent for the population at risk was 0.150 person-rem. The water and fish pathway dosimetric results are summarized in Appendix D, Table 68.

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 1987 was the sum of the three component pathways discussed above, 2.60 person-rem. The data is summarized in Appendix D, Table 69.

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 OIL SPILLS

During 1987, Plant Engineering and Safety and Environmental Protection responded to 17 petroleum product spills. Eleven of these incidents occurred indoors and 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 impact as a result of the occurrence. On six occassions, petroleum spills required EPA, NYSDEC, and SCDHS notification because soil contamination occurred. These spills were cleaned up and contaminated soil was disposed of in an approved manner. All cleanup operations were approved by NYSDEC and SCDHS. No further remediation was required for any of the above spills.

6.0 PROJECT ENVIRONMENTAL REVIEW

The following major projects were reviewed during various stages of design by members of the Safety and Environmental Protection Division to ensure facility compliance with applicable environmental regulations and DOE Orders: (1) Modification of the Building 705 effluent air flow to receive WCF distillate, (2) Neutral Beam Test Facility, (3) AGS Booster, (4) review of new chemical and petroleum storage facilities for compliance with SCDHS Sanitary Code - Article 12, and (5) Environmental Analysis of the AGS Booster Construction. An additional requirement in 1987 was the review of the above projects by SCDHS following an agreement between BNL and SCDHS, whereby all projects would be reviewed for compliance with environmental requirements of the

Suffolk County Sanitary Codes. On a smaller scale, modifications to existing facilities, e.g. upgrades or preventive maintenance, were reviewed on a routine basis to ensure that construction specifications met appropriate environmental codes.

7.0 SPECIAL STUDIES

Special environmental analyses or activities where performed in the following areas: (1) DOE Environmental Survey, (2) assessment of BNL potable well water quality, (3) historic oil spill at Building 610, (4) Building 830 "D" waste line leak, (5) monitoring the unsaturated zone, (6) ponded water near the HWMF, (7) petroleum and hazardous materials storage tank inventory, (8) tritium and volatile organics in the aquifer restoration project well water, (9) biomonitoring of the STP liquid effluent, (10) PCB inventory update, (11) NESHAPS applications, (12) dump site location study, (13) Environmental Management Plan, (14) BNL-Suffolk County Agreement, (15) dosimetric evaluation of liquid effluent using the TRACES computer model, (16) SPDES permit renewal.

7.1 DOE Environmental Survey

The concept of conducting an Environmental Survey of all DOE facilities materialized following the Environmental Initiatives put forward by Secretary John Herrington in February, 1985. Following a memorandum issued by Mary Walker, Assistant Secretary for Environmental, Safety and Health, detailing the scope and schedule for the Survey, BNL mobilized a task force to prepare for the Survey. The responsibility of the task force was to assure that the required documentation of environmental activities, details on environmental monitoring, assessment and regulatory activities were available to the DOE Survey Team. These issues pertain to documentation of environmental activities, details on environmental monitoring and assessment programs and regulatory compliance activities.

The Survey was conducted during the period April 6 - 17, 1987. At the close-out a draft report was submitted to BNL by Larry Weiner, Team Leader. This report represented a photograph of conditions that existed at the time of the Survey and was based on observations by the Survey Team as well as information supplied by BNL. This report was further revised based on additional actions taken by BNL and information supplied to the team.

Survey findings are placed in one of four categories based generally on the hazards they pose, the amount of information available on the problem, and the budgetary implications of required remedial action.

Briefly, there were: no Category I findings; seven Category II findings which relate mostly to the adequacy of the programs for PCB transformer and capacitor inventories, drum storage, and ground water monitoring; eight Category III findings which address on-site and off-site ground water contamination and its potential sources; and thirty-one Category IV findings, many of which relate to administrative and compliance issues.

A status report was prepared by BNL immediately following the draft Findings Report and was submitted to the Brookhaven Area Office (BHO) on April

27, 1987. Since that time, the Laboratory has been continuing its responses to the findings.

It should be noted that the survey process has been a dynamic one, in that data and information are being continuously exchanged between the principals, e.g., BNL, CHO, BHO, HQRS, and the Survey Team Leader. This process permits the DOE Survey staff to review the findings and assess whether any findings should be upgraded, downgraded, or removed from the findings list. All the actions being taken by BNL are in a constant state of flux and updates are being issued every six months.

7.2 Assessment of BNL Potable Well Water Quality

Potable water samples were collected in November, 1986 and April, 1987 to determine the quality of drinking water on-site. The results of the sampling program indicate that the water quality at the potable supply well heads is excellent. Samples from buildings indicate that in high use areas such as kitchens and toilet facilities, the water quality, except for iron, is well within the New York State Drinking Water Limits. Fixtures that have infrequent use such as those at the end of a line or are in low occupancy areas have occasionally shown elevated concentrations of lead and iron. These fixtures were identified and tagged out of service. Another sampling program is scheduled for the spring of 1988 to re-examine the lead and iron concentrations in building water samples.

7.3 Historic Oil Spill at Building 610

On November 26, 1977, approximately 25,000 gallons of ALF, a mixture of mineral spirits and No. 6 fuel oil leaked in the vicinity of the CSF. EPA approved remedial action recovered approximately 80% of the spilled material. In December, 1986, during installation of ground water wells as part of the MPF requirements, oil contaminated soil was encountered.

International Technology Corporation (IT Corp) was given a contract to conduct an investigation of the subsurface oil contamination in the vicinity of the CSF. They commenced their work in August, 1987 after reviewing Laboratory supplied information by conducting a soil gas survey of the spill and adjacent sites. Subsequent work included drilling of soil borings (five) and installation of monitor wells (five) in areas defined by the soil gas survey. Split spoon samples, collected during the soil boring and monitor well construction process, and water samples collected from the developed wells were submitted for base/neutral compounds, total organic carbon and biological oxygen demand analyses. In addition, slug tests and drawdown tests were also conducted to determine the hydraulic conductivity of the aquifer. Following the receipt of the analytical results, IT Corp will recommend a cost effective remediation procedure.

7.4 Building 830 "D" Waste Line Leak

In 1986, approximately, 900 gallons of "D" waste could not be accounted for through a mass balance assessment of liquid radioactive waste discharged from the Building 830. In 1987, further investigations revealed that the underground transfer line from the building to the waste holding tank had developed leaks as a result of interior corrosion. The transfer line was

disconnected from the building and sealed. Removal of the line, tanks and remedial action for potentially contaminated soil are planned for 1988. Ground water monitoring wells will also be installed based on recommendations from IT Corporation, the Laboratory's consultant on ground water program issues.

7.5 Monitoring of the Unsaturated Zone

Lysimeter studies were continued in the HWMF during 1987. The rate of movement for tritium and cesium-137 were identical to that observed during 1986. In 1987, metal analyses were performed for the first time and the results indicate that:

a. the concentration of chromium, cadmium and lead in the water collected from the lysimeter at a depth of four feet was about 50 to 100 times that seen in the antecedent rainfall; and

b. the concentrations of these elements in the water collected showed the following order: lead > chromium > cadmium.

7.6 Ponded Water Near the HWMF

Water collects at two areas adjacent to the HWMF immediately after rainfall. DOE Environmental Survey team members requested that these areas be sampled and the water analyzed for radioactive materials. Their concern was that this water could be an additional source term for activity entering the Peconic River as a result of rainwater runoff from the HWMF or recharging to ground water. In order to address this question, samples were collected from the two areas and analyzed for radioactivity. The results indicate that the pond on the west side of the facility contained tritium, cesium-137 and sodium-22 at the following concentrations 4090 pCi/L, 12.4 pCi/L and 0.46 pCi/L respectively. The second pond, located still further west of the HWMF and across the street from the first pond, contained tritium, cesium-137 and strontium-90 at the following concentrations: 567 pCi/L, 0.35 pCi/1 and 1.2 pCi/L respectively. These concentrations are above concentrations typically observed in control rainwater samples analyzed for the same radionuclides. Run-off from the HWMF is the most likely source of the activity detected in the water. The ponded water exists because of a clay lens that is located in the southeast section of the BNL site. Water that collects in this area is most likely to remain stationary and either evaporate or slowly recharge to ground water. No further sampling is planned for this area because the concentration levels are consistent with the effluent release concentrations at the STP and because ground water sampling from shallow wells and lysimeter studies at the HWMF provide sufficient information to adequately assess the impact of BNL operations on the local environment.

7.7 Petroleum and Hazardous Materials Storage Tank Inventory

On September 23, 1987, the Laboratory agreed to conform to the applicable environmental requirements of SCDHS Sanitary Code - Articles 6, 7, 10 and 12. Article 12 regulates the storage and handling of toxic and hazardous materials in an effort to protect the water resources of the county. In order to determine the status of all BNL aboveground, underground and indoor storage tanks used to contain hazardous or toxic materials, a site-wide inventory was

conducted in the fourth quarter of 1987. The results of the inventory will be available in 1988 and will be used to determine a compliance schedule.

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

A review of volatile organic data for aquifer restoration wells and for wells in the area of the HWMF for the years 1985, 1986 and 1987 indicate that the concentrations of chlorocarbon and trihalomethane compounds in most well water samples continued decline. Ground water samples from surveillance Well Nos. MW2 and MW6 continue to have elevated tetrachloroethylene concentrations. Water from Well No. D17 has elevated 1,1,1-trichloroethane levels. The sample collected from this well was obtained during the repiping of restoration Well Nos. PW3 and PW4. The lack of pumping in this region may be the cause of the elevated concentration at Well No. D17 since the efficiency of the spray units has remained in the 90 to 100% removal range for volatile organics.

Radionuclide data for these same wells presents several interesting findings. First, as expected, strontium-90 analyses performed on pre and post spray water samples indicates that there is essentially no change in concentration as a result of spraying the water. The second observation is that in addition to the organic plume, there is a plume of tritium contaminated water that is following the path of the organic plume. Restoration Well No. PW3 clearly intercepts the plume and Well Nos. MW8, MW13, D17, and MW10 provides the boundaries of the plume. The increased tritium concentrations in these wells in 1987 prompted the repiping of restoration Well Nos. PW3 and PW4 so that sprayed water is recharged back at the HWMF instead of locally at the well head. These wells were also pumped all year long as opposed to the April to December pumping schedule for restoration Well Nos. PW1, PW2, and PW5. The change in recharge location and pumping schedule was made in order to minimize tritium concentrations that could migrate off-site. Because of the continued presence of organic and radionuclide concentrations in the restoration wells, the Laboratory expects to operate the restoration wells again in 1988.

7.9 Biomonitoring of the STP Liquid Effluent

Analysis of STP effluent water quality and radioactivity are performed on a routine basis in order to monitor the effectiveness of control technology, and verify compliance with regulatory permits. Beginning in 1987 and continuing through 1988, a biomonitoring study is in progress which monitors the effect of BNL effluent on aquatic biota. The study was designed to use brown trout as the indicator species. This species has the unique quality of being very sensitive to changes in temperature, pH, or dissolved oxygen. All these characteristics support the desirable quality of water that should be discharged into the Peconic River ecosystem. The experimental set up consists of a once through flow system of the effluent through an aquarium. Dissolved oxygen, temperature and pH are monitored daily. Integrated water samples are collected in conjunction with the fish sampling schedule. Preliminary results indicate a rapid intake of the principal radionuclide cesium-137 to a concentration factor of about 40 (pCi/kg-wet per pCi/L). This observation is not surprising as the source of uptake was through the water medium and not through the food chain. Conditions of the effluent seemed to indicate good growth rate, thus testifying to the viability of the effluent stream. Further

analyses of the fish samples are in progress to determine the degree of elemental uptake. This study will be repeated with other endemic species of fish in later monitoring experiments.

7.10 PCB Inventory Update

A preliminary finding of the DOE Environmental Survey was that the BNL PCB inventory of equipment maintained by Plant Engineering needed to be updated and that future inventories should include equipment owned by research groups. An extensive Department-wide inventory was conducted following the DOE Survey and was completed by the end of June. The inventory is scheduled to be updated on an annual basis.

7.11 NESHAPS 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). One application was for the construction of the AGS Booster and the second application was for the modification of the Building 705 stack to receive WCF distillate. The documents specified the location of the proposed air emission source, the radionuclide(s) in use, the air handling systems and the projected site boundary and collective dose that would result as a consequence of operating the new or modified facility. In both cases, the environmental impact was negligible. The applications were submitted in October and notification of authorization is expected in 1988.

7.12 Dump Site Location Study

In June, 1986, the SCDHS in conjunction with Cornell University established an inventory of potential dump sites located in Suffolk County. Of the 656 sites identified, 29 were located on BNL property. These sites were reviewed by BNL and compared to an in-house list previously developed as part of the information required in BNL's RCRA Part B Submission to DOE.

Of the 29 sites, nine could be considered as potential waste and/or pollution areas which had been identified and their impact assessed in historic BNL reports. Nineteen sites were actually recharge basins, biology fields, warehouses, sanitary lines or areas which were disturbed by construction activities. One site, labeled Army Landfill in Figure 3, was the only new finding for the Laboratory. This was a World I and II dump used by the military. An investigation of this area will be conducted in 1988.

7.13 Environmental Management Plan

An Environmental Program Audit done in August, 1985 recommended that the Laboratory develop long-range plans for upgrade and remediation of environmental monitoring programs. In response to this recommendation, the Laboratory developed an Environmental Management Plan that has as its objectives:

a. operation of an effective environmental protection program;

b. assessment of Laboratory operations to determine their adequacy to limit significant impacts on the environment;

c. identification of facilities or environments that have been impacted by past activities and need corrective action;

d. establishment of priorities for corrective actions based on health and safety concerns, regulatory compliance, programmatic considerations, and budget constraints; and

e. estimation of the cost and schedules for implementation of the plan.

The draft Plan was completed in October, 1987, and will be finalized for submission to DOE in the first quarter of 1988. The Plan, as it stands, covers the period 1988 to 1992 and has identified a number of environmental issues resulting from the operation of the facilities on-site which can be grouped into the following major categories: liquid effluents, air emissions, environmental monitoring, and solid waste management.

Under each of the issues, the needs are identified and the program along with the required funding to mitigate these issues are presented. The Plan is intended to be a living document with annual updates.

7.14 BNL-Suffolk County Agreement

In September, 1987, Brookhaven National Laboratory and Suffolk County formalized an agreement 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 the Suffolk County from any problems arising at the BNL property, facilities and operations, by making every effort to conform to local, state, and federal regulations related to public health and environmental protection. Since then, BNL and Suffolk County have set up protocols and schedules to review all facilities and recommend steps to be taken by BNL to achieve compliance in accordance with the Sanitary Code Articles 6, 7, 10 and 12. Review of construction activities have already started and review of facilities will begin in the first quarter of 1988.

7.15 Dosimetric Evaluation of Liquid Effluent Using the TRACES Computer Models

At the conclusion of the 1986 DOE Chicago Operations Office Environmental Appraisal, BNL committed to purchase and run a computer model which would evaluate the liquid effluent release pathway. The laboratory purchased LADTAP and TRACES. In 1987, the liquid effluent releases from the STP were evaluated using the TRACES computer program. TRACES was developed by Morton and Potter for accidental release conditions to translate radioactive concentrations in environmental media to dose estimates. The program can be used for routine effluent releases by simply specifying the duration of release as one year instead of a shorter time period. TRACES runs on an IBM PC model XT or equivalent equipment and uses NUREG 1.109 standard values for environmental media and dose conversion factors.

The source term used in this analysis was 50% of the 1987 annual average effluent release concentrations as reported in Appendix D, Tables 7 and 8. The factor of two reduction in source term was determined by comparing historic concentrations at the STP effluent release point to those at the site boundary. The program TRACES assumes that the source term data were obtained

from the environmental media used as the starting point in the pathway analysis. Because the Peconic River is not used for irrigation, recreational activities other than fishing or boating and is not a direct source of drinking water, this analysis represents an assessment of what would be the critical pathways should this water ever be used directly.

The results of this assessment for hypothetical uses of STP effluent in terms of fraction of total dose are presented in Appendix D, Table 70. These data indicate that for children, teenagers and adults, direct ingestion of the water and use of the water to irrigate vegetation represent the largest components of dose. For infants, the dose is controlled by the milk and direct ingestion pathways. Swimming, the only pathway which approximates the actual use of Peconic River water by this model, contributes no dose to any of the critical population.

The actual pathways of concern are the recharge of surface water to ground water and the ingestion of fish caught in the region of the Peconic River which is influenced by the Laboratory's present and past releases. These pathways are addressed through the existing Environmental Monitoring Program by the analysis of Peconic River fish samples and off-site potable water.

7.16 SPDES Permit Renewal

In the fall of 1987, the Laboratory submitted a request to renew its State Pollutant Discharge Elimination System Permit to the NYSDEC. The SPDES permit authorizes the discharge of sanitary waste, storm water runoff, and non-contact cooling water into the Peconic River and the recharge basins. The submission listed the location of all outfalls as well as the maximum and the annual average concentrations of pollutants which are typically found in BNL discharge waters. In addition, an extensive Industrial Chemical Survey was conducted as part of the SPDES renewal application.

APPENDIX A

A.1 Glossary of Terms

AGS	- Alternating Gradient Synchrotron
ALF	- Alternate Liquid Fuels
BHO	- Brookhaven Area Office
BLIP	- Brookhaven LINAC Isotope Production Facility
BNL	- Brookhaven National Laboratory
BTX	- Benzene Toluene Xylene
CLIF	- Chemistry LINAC Irradiation Facility
CSF	- Central Steam Facility
DAS	- Department of Applied Science
DOE	- Department of Energy
DOT	- Department of Transporation
EPA	- Environmental Protection Agency
HFBR	- High Flux Beam Reactor
HWMF	- Hazardous Waste Management Facility
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
ND	- Not Detected
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
USGS	- United States Geologic Survey
WCF	- Waste Concentration Facility

A.2 Glossary of Units

a	- Annum
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
cm	- Centimeter
cm/d	- Centimeters per day
d	- Day
GeV	- Giga electron volt
GeV/amu	- Giga electron volt per atomic mass unit
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
mrem	- Millirem
MW	- Megawatts
nCi/L	- Nanocuries per liter
pCi/kg	- Picocuries per kilogram
pCi/L_3	- Picocuries per liter
pCi/m^3	- Picocuries per cubic meter
pH	- Hydrogen ion concentration
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 1987 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 Medical 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) [25,27], 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, uCi

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, uCi

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

P = Population at risk

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the average concentration was determined from five positive tritium results. The population at risk in this area was assumed to be approximately 500.

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

Only one fish sample was analyzed during calendar year 1986. The results of this analysis were used to calculate dose for the the 1986 calendar year. The method used to make this estimate and subsequent estimates, when the data become available, is outlined below. 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 [28].

c. Committed Dose Equivalent Tables [33] were used to get the 50 year Committed Dose Equivalent Factor - rem/uCi intake.

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

^{3}H: 6.3E-05 rem/uCi intake

^{90}Sr: 1.2E-03 rem/uCi intake

^{137}Cs: 5.0E-02 rem/uCi intake

d. Calculation:
Intake (7 kg/yr) x Activity in flesh uCi/kg
x Factor rem/uCi intake = rem

e. Because there are a cesium-137 and strontium-90 background as determined by the control location data, this background was subtracted from all data prior to use for dosimetric purposes.

4. Data Presentation

Analytical results of the environmental and effluent monitoring programs are reported in the tables of Appendix D. Some strontium-90 data are incomplete due to a change in contractor laboratory which suspended analysis during the fourth quarter of 1986. The data presented in these tables were generated in the following way.

First, gross alpha, beta, and tritium results are reported as the 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 (uCi/ml)	MDL (uCi)
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 uCi/g	300ml MDL uCi/ml	12000ml MDL uCi/ml	Charcoal MDC uCi
^{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	0.02
Cd	0.004
Cr	0.016
Cu	0.03
Fe	0.05
Hg	0.0002
Mn	0.03
Na	0.025
Pb	0.02
Zn	0.01
Ammonia-N	0.02
Nitrite-N	0.01
Nitrate-N	0.5
Specific Conductance	10 umhos/cm
Chlorides	9.0
Sulfates	9.0
1,1,1-trichloroethane	0.004
trichloroethylene	0.004
tetrachloroethylene	0.006
chloroform	0.006
chlorodibromomethane	0.007
bromodichloromethane	0.006
bromoform	0.006
benzene	0.005
toluene	0.004
xylene	0.005

APPENDIX D

Tabulated Analytical Results

Table 1
1987 BNL Environmental Monitoring
Resident Population Distribution[a] Within 80-Km Radius of BNL

Sector	0 - 16 Km	16 - 32 Km	32 - 48 Km	48 - 64 Km	64 - 80 Km	Total	Remarks
SSW	20,814	1,065	0	0	0	21,879	Beyond 32 Km - Atlantic Ocean
SW	40,984	63,233	3,330	0	0	107,547	Beyond 48 Km - Atlantic Ocean
WSW	36,959	140,411	343,119	423,045	767,571	1,711,105	Beyond 80 Km - Part of New York City
W	48,272	130,476	231,248	225,042	366,352	1,001,390	Beyond 80 Km - New York City
WNW	40,679	56,672	115	211,693	127,422	436,581	Beyond 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut and New York
NW	17,523	1,522	133,582	121,050	109,052	382,729	Same as WNW
NNW	7,467	0	205,821	105,549	53,345	372,182	Between 16 Km and 32 Km - Long Island Sound; Beyond 32 Km - Connecticut
N	4,423	0	92,275	245,022	254,846	596,566	Same as NNW
NNE	7,370	0	6,931	43,752	64,452	122,505	Same as NNW
NE	2,865	726	0	13,369	32,585	49,545	Between 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut
ENE	2,414	6,731	12,542	14,496	2,188	38,371	North Fork of Long Island
E	2,942	15,536	16,911	8,802	549	44,740	South Fork of Long Island and Atlantic Ocean
ESE	5,992	7,479	0	0	0	13,471	Long Island; Beyond 32 Km - Atlantic Ocean
SE	8,827	0	0	0	0	8,827	Beyond 16 Km - Atlantic Ocean
SSE	21,813	0	0	0	0	21,813	Same as SE
S	16,128	22	0	0	0	16,150	Beyond 32 Km - Atlantic Ocean
TOTAL	285,472	423,873	1,045,874	1,411,820	1,778,362	4,945,401	

(a) Population estimated from data supplied by the Long Island Regional Planning Board [3].

Table 2
1987 BNL Environmental Monitoring
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 1987 (Ci)
490	Medical Research Center Roof Stack	9.5	Tritium	None	Dessicant for tritium vapor	3.9
491	Medical Research Reactor Stack[c]	45.7	^{41}Ar	Moving tape for radioparticulates	Charcoal for radioiodines	1,500
555	Chemistry Roof Stack	16	Tritium	None	Dessicant for tritium vapor	0.7
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	169 0.009 0.001 0.00007
705	Hot Laboratory	97.5	^{126}I ^{131}I ^{127}Xe ^{68}Ga ^{124}I ^{77}Br	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	0.0025 0.00013 0.00073 0.0042 0.00046 0.014
901	Van de Graff Accelerator	21	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	12 (gas) 14.3 (vapor)
931	Linac Isotope[d] Facility	20	^{15}O Tritium ^{127}Xe ^{82}Sr	G-M Detector for radioactive gases	Dessicant for tritium vapor, particulate filter for gross beta, and charcoal filter for radionuclides	582 0.003 0.00008 0.00006
445	Incinerator	8.7	See Table 3	None	None	See Table 3

(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 3
1987 BNL Environmental Monitoring
Estimated Radioactivity in Incinerated Material

Month in 1987	^{3}H	^{99}Tc	^{125}I	^{14}C	^{35}S	^{113}Sn	^{51}Cr	^{59}Fe	^{131}I	^{99m}Tc	^{32}P
	<---------- mCi ---------->										
January	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0	0	0	0	0
May	15.8	0.012	0.046	0.145	0.005	0.010	0.062	0	0	0	0
June	0	0.020	0.003	0.070	0	0	0.005	0.001	0.016	0.010	0
July	0	0	0.006	0	0	0	0.005	0	0.00001	0	0
August	14.5	0.010	0.012	0	0	0	1.4	0	0.005	0	0
September	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0	0
December	127.0	0	0.022	0	2.49	2.77	0.053	0	0.15	0	0.0009
Total	157.0	0.042	0.089	0.22	2.5	2.78	1.52	0.001	0.17	0.010	0.0009

Table 4
1987 BNL Environmental Monitoring
Airborne Activity Released via Building 705 100-m Stack

Month	H-3	Br-82	I-131	I-133	I-126	Xe-127	Xe-131m	Eu-155	Se-75	As-72	As-74	Br-77	Sb-124	I-124	Na-22	Mn-54	Hg-203	Zn-65	Ta-177	Ba-140	Co-60	Ga-68	Sc-44m	Ce-143
	<---------- uCi ---------->																							
January	2.36E7	4.24E2	4.31E0	4.19E0	2.01E0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
February	1.24E7	2.25E2	8.02E0	3.20E0	2.26E0	3.33E2	4.51E1	4.07E0	2.18E1	1.06E1	3.23E1	2.21E3	2.05E0	-	-	-	-	-	-	-	-	-	-	-
March	3.13E7	3.14E2	4.34E1	1.23E1	1.61E3	2.63E2	-	-	2.46E1	-	5.25E0	1.28E2	-	3.88E2	2.23E-1	8.75E-1	-	5.42E0	-	-	5.8E-2	-	-	-
April	1.17E7	9.60E2	4.67E1	1.08E1	7.99E2	4.09E0	-	-	3.89E1	-	-	-	-	4.51E1	-	-	5.1E-1	-	-	-	-	-	-	-
May	1.96E7	2.89E2	2.30E1	1.89E1	3.32E1	-	-	-	4.45E0	-	-	-	-	-	-	-	6.37E-1	-	-	-	3.81-1	-	-	-
June	1.24E7	3.78E3	4.69E0	1.02E3	3.72E1	1.10E1	-	-	1.15E1	-	4.53E0	1.11E4	-	2.57E1	-	-	-	-	9.44E1	2.47E0	-	-	-	-
July	7.17E6	5.07E2	7.96E0	-	2.60E1	7.05E1	-	-	9.77E0	-	-	7.22E2	-	7.74E-1	-	-	5.29E-1	-	-	-	4.97E0	-	-	-
August	8.01E6	5.07E2	3.32E0	1.35E1	3.74E0	4.71E-1	-	-	1.15E0	-	-	-	-	-	-	-	-	-	-	-	5.95E1	4.20E3	-	-
September	1.94E7	1.17E3	5.52E0	-	-	5.56E0	-	-	1.20E0	-	-	-	-	-	3.66E1	2.53E-1	-	3.90E0	-	-	-	2.20E1	2.07E0	-
October	3.08E6	2.77E0	9.62E0	-	-	4.23E1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
November	1.36E7	8.74E2	5.43E0	5.03E1	-	1.40E0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
December	7.04E6	2.09E2	3.03E1	1.37E1	-	4.67E-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.41E0
Total uCi	1.69E8	9.26E3	1.92E2	1.15E3	2.51E3	7.32E2	4.51E1	4.07E0	1.13E2	1.06E1	4.21E1	1.42E4	2.05E0	4.60E2	3.68E1	1.13E0	1.68E0	9.32E0	9.44E1	2.47E0	6.49E1	4.23E3	2.07E0	2.41E0
Avg. uCi/cc	2.88E-7	1.58E-11	3.27E-13	1.96E-12	4.28E-12	1.25E-12	7.69E-14	6.9E-15	2.28E-13	1.81E-14	7.18E-14	2.42E-11	3.49E-15	7.84E-13	6.27E-14	1.93E-15	2.86E-15	1.59E-14	1.61E-13	4.21E-15	1.11E-13	7.21E-12	3.53E-15	4.11E-14

Table 5
1987 BNL Environmental Monitoring
Airborne Activity Released via 10 Meters or 45 Meters Stacks

Month	^{41}Ar 45 m	^{3}H* 10 m	^{15}O 10 m	^{127}Xe 10 m	^{60}Co 10 m	^{7}Be 10 m	^{82}Sr 10 m	^{75}Se 10 m	^{77}Be 10 m
	<---------- uCi ---------->								
January	8.27E+07	2.28E+06	1.16E+08	7.31E+01	-	-	-	-	-
February	9.31E+07	1.68E+06	1.44E+08	3.80E+00	-	-	-	-	-
March	1.10E+08	2.09E+06	4.71E+07	8.95E-01	1.21E-01	2.63E+00	-	-	-
April	1.72E+08	1.58E+06	-	-	-	-	-	-	-
May	1.69E+08	6.46E+05	1.20E+08	-	-	1.87E+00	1.72E+01	-	-
June	1.92E+08	4.96E+06	1.06E+08	-	-	-	4.19E+01	-	-
July	1.04E+08	2.17E+06	-	-	1.30E-01	-	-	1.76E-01	-
August	1.07E+08	9.70E+04	-	-	1.54E-01	-	-	-	6.68E-01
September	1.19E+08	1.66E+05	-	-	-	5.90E-01	-	-	-
October	1.43E+08	4.50E+05	4.33E+07	-	-	-	-	-	-
November	1.08E+08	1.75E+06	-	-	1.06E+00	-	-	-	-
December	9.60E+07	1.08E+06	6.23E+06	-	-	-	-	-	-
Total	1.50E+09	1.89E+07	5.83E+08	7.78E+01	1.46E+00	5.09E+00	5.91E+01	1.76E-01	6.68E-01
Average Conc. uCi/cc	2.64E-05	1.97E-07	7.90E-05	1.05E-11	1.98E-13	6.89E-13	8.0E-12	2.38E-14	9.05E-14

*Total tritium reported is tritiated water vapor.

Table 6
1987 BNL Environmental Monitoring
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number
134	blueprint machine	NYSDEC-Air Quality	472200 3491 13401
197	blueprint machine	NYSDEC-Air Quality	472200 3491 19701
208	lead melting	NYSDEC-Air Quality	472200 3491 20801
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42204
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205
423	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 42304
444	incinerator	NYSDEC-Air Quality	472200 3491 44401
452	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45204
457	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45704
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46201
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202
479	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 47904
493	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 49304
493	incinerator	NYSDEC-Air Quality	472200 3491 493A0
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002
705	building ventilation	U. S. EPA - NESHAPS	submitted, status pending
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101
T30	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 T3004
AGS Booster	accelerator	U. S. EPA - NESHAPS	submitted, status pending
BNL Site	major petroleum facility	NYSDEC-Water Quality	annual renewal
STP[a] & RCB[b]	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005385
CLF[c]	current landfill	NYSDEC-Solid Waste	10-84-0346
HWMF[d]	waste management	U.S. EPA	submitted, under review

(a) Sewage treatment plant.

(b) Recharge basins.

(c) Current landfill.

(d) Hazardous Waste Management Facility.

Table 7
1987 BNL Environmental Monitoring
Sewage Treatment Plant Influent and Effluent Radionuclide Concentrations

Location	Month	Volume X10^7 liters	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
			<---------- pCi/L ---------->								
DA	January	6.47	0.32	-1.13	1.98	7.19	2.62	17.5	1,574	-651	5,120
	February	6.04	0.35	-1.28	1.54	4.89	-0.57	10.0	1,214	0	4,290
	March	6.79	0.032	-1.54	1.79	7.04	2.27	18.3	688	-1,650	4,020
	April	7.11	-0.20	-2.05	1.02	7.81	0.19	35.1	926	-652	5,130
	May	6.82	-0.16	-2.56	2.05	6.53	-1.51	29.7	595	-932	2,670
	June	9.90	0.16	-2.82	1.54	5.85	3.02	11.0	2,840	618	9,240
	July	10.9	0.18	-3.33	1.79	8.08	1.51	17.2	5,712	2,170	13,100
	August	10.3	0.20	-1.02	2.05	8.17	1.89	22.3	5,357	2,190	11,900
	September	8.65	0.31	-1.28	2.05	9.91	4.16	22.7	7,548	2,320	12,200
	October	7.97	0.52	-1.54	2.30	10.95	3.59	26.1	2,224	0	6,220
	November	7.44	0.27	-0.77	1.54	12.5	3.78	40.2	1,359	-306	4,580
	December	6.17	0.20	-1.28	1.54	14.75	0.76	36.1	956	-3,000	7,080
	Avg. Monthly Value	7.88	0.19	-	-	8.58	-	-	2,933	-	-
	Total*	94.56	0.18	-	-	8.11	-	-	2,774	-	-
EA	January	7.34	1.03	-1.69	3.39	5.82	1.57	12.90	1,654	92	4,740
	February	6.53	0.46	-0.77	1.79	3.08	-0.76	10.20	1,142	0	2,050
	March	7.30	0.20	-1.54	2.82	5.84	1.51	11.30	846	-641	3,080
	April	7.63	-0.05	-3.33	4.10	5.72	0.57	14.70	955	-1,020	5,870
	May	6.74	0.32	-2.82	2.56	4.04	-1.70	9.44	477	-1,390	1,780
	June	8.22	0.49	-1.28	2.30	5.92	3.21	12.70	3,135	1,440	8,200
	July	7.93	0.88	-2.05	2.30	4.81	0.19	8.31	6,933	2,790	11,800
	August	7.76	0.42	-1.54	2.05	7.71	2.83	12.30	5,119	1,810	10,300
	September	5.94	0.28	-0.51	2.05	5.94	3.58	4.98	8,611	3,570	13,700
	October	5.49	0.78	-0.77	2.82	7.43	2.83	15.30	6,365	2,380	10,200
	November	5.01	0.32	-1.28	1.79	7.54	3.59	16.10	4,923	640	9,360
	December	4.34	0.56	-2.56	2.82	7.49	1.32	12.50	2,591	-2,300	16,700
	Avg. Monthly Value	6.69	0.47	-	-	5.85	-	-	3,475	-	-
	Total*	80.23	0.38	-	-	4.70	-	-	2,788	-	-
	New York State Drinking Water Standard		15.0			50.0			20,000		
	Typical Minimum Detectable Concentration		2.7			5.7			1,200		

*Total volume is reported in 10^7 liters and total activity is in units of mCi.

Table 8
1987 BNL Environmental Monitoring
1987 BNL Sewage Treatment Plant Input and Effluent Gamma Spectroscopy and Strontium-90 Data

Month	Volume x 10^7 L	^{22}Na	^{60}Co	^{137}Cs	^{40}K	^{54}Mn	^{57}Co	^{65}Zn	^{83}Rb	^{134}Cs	^{51}Cr	^{58}Co	^{131}I	^{90}Sr
		<---------- pCi/L ---------->												
Sample Location DA														
January	6.47	1.78E-01	3.09E-01	6.75E-01	9.74E+00	ND	ND	ND	ND	ND	ND	ND	ND	6.2E-01
February	6.04	1.45E-01	1.85E-01	2.40E-01	3.44E+00	ND	ND	ND	ND	ND	ND	ND	ND	8.0E-02
March	6.79	5.87E-02	2.16E-01	1.63E-01	2.82E+00	1.09E-01	1.21E-01	3.10E-01	7.70E-01	ND	ND	ND	ND	<7.0E-02
April	7.11	8.53E-02	2.42E-01	6.45E-01	2.13E+00	6.56E-02	5.62E-01	3.26E-01	ND	ND	ND	ND	ND	4.6E-01
May	6.82	ND	2.17E-01	2.54E-01	2.72E+00	ND	9.09E-02	4.56E-01	3.87E-01	6.73E-02	ND	ND	ND	5.0E-02
June	9.90	6.09E-02	1.43E-01	1.80E-01	2.31E+00	ND	ND	1.36E-01	ND	ND	1.29E+00	3.38E-02	ND	<5.0E-02
July	10.9	3.21E-02	7.38E-02	1.37E-01	1.71E+00	3.27E-02	2.66E-02	9.30E-02	7.20E-02	ND	3.99E-01	4.18E-02	1.39E+00	1.4E-01
August	10.3	9.81E-02	7.77E-02	9.26E-01	2.30E+00	ND	ND	3.98E-01	ND	4.49E-02	ND	ND	ND	1.2E+00
September	8.65	7.40E-02	1.52E-01	2.32E+00	2.70E+00	ND	3.55E-02	1.93E-01	4.80E-01	2.78E-01	ND	ND	ND	6.1E-01
October	7.97	3.29E-01	2.07E-01	6.35E-01	3.68E+00	ND	ND	2.25E-01	ND	5.69E-02	ND	ND	7.51E-01	3.5E-01
November	7.44	2.42E-01	2.15E-01	7.49E-01	3.14E+00	ND	ND	3.90E-01	ND	ND	ND	ND	ND	5.4E-01
December	6.17	ND	2.14E-01	3.49E-01	3.53E+00	ND	ND	1.04E-01	ND	ND	ND	ND	ND	6.5E-01
Avg. Monthly Concentration	7.88	1.06E-01	1.77E-01	6.23E-01	3.17E+00	1.65E-02	6.32E-02	2.22E-01	1.35E-01	4.00E-02	1.81E-01	8.35E-03	2.23E-01	4.03E-01
Total*	94.5	0.101	0.167	0.589	2.997	0.016	0.060	0.210	0.128	0.038	0.171	0.008	0.211	0.381
Sample Location EA														
January	7.35	2.38E-01	1.26E-01	8.69E-01	2.38E+00	-	ND	1.77E-01	ND	ND	-	ND	ND	4.5E-01
February	6.52	1.78E-01	2.54E-01	1.07E+00	9.85E+00	-	ND	ND	ND	ND	-	ND	ND	3.2E-01
March	7.30	6.23E-02	2.17E-01	1.16E+00	2.86E+00	-	5.46E-02	1.91E-01	4.62E-01	ND	-	ND	ND	3.2E-01
April	7.63	1.04E-01	1.41E-01	1.22E+00	2.65E+00	-	8.34E-02	2.40E-01	ND	ND	-	ND	ND	4.8E-01
May	6.74	3.65E-02	2.20E-01	1.66E+00	3.11E+00	-	ND	2.31E-01	3.35E-01	ND	-	ND	ND	1.1E-01
June	8.22	5.17E-02	1.44E-01	1.15E+00	1.98E+00	-	ND	1.30E-01	1.70E-01	ND	-	ND	ND	5.0E-01
July	7.93	ND	1.55E-01	1.44E+00	2.34E+00	-	5.30E-02	1.00E-01	1.52E-01	ND	-	7.01E-02	6.12E-01	6.5E-01
August	7.76	8.05E-02	7.81E-02	1.36E+00	2.62E+00	-	ND	1.41E-01	ND	4.39E-02	-	ND	ND	9.9E-01
September	5.94	ND	1.93E-01	1.38E+00	9.40E-01	-	ND	ND	ND	ND	-	ND	ND	8.4E-01
October	5.49	3.64E-01	1.27E-01	1.26E+00	3.06E+00	-	ND	ND	2.31E-01	ND	-	ND	ND	5.5E-01
November	5.01	2.33E-01	1.66E-01	9.17E-01	2.56E+00	-	ND	1.72E-01	ND	ND	-	ND	ND	4.2E-01
December	4.34	3.17E-02	8.77E-02	8.82E-01	2.42E+00	-	ND	1.76E-01	ND	ND	-	ND	ND	6.5E-01
Avg. Monthly Concentration	6.68	1.09E-01	1.60E-01	1.21E+00	3.05E+00	-	1.81E-02	1.33E-01	1.18E-01	4.2E-03	-	6.93E-03	6.05E-02	5.24E-01
Total*	80.2	0.088	0.128	0.973	2.45	-	0.015	0.107	0.095	0.003	-	0.006	0.049	0.420
NYS Drinking Water Standards		-	-	-	-	-	-	-	-	-	-	-	8.0	-
Radiation Concentration Guides		30,000	30,000	20,000	-	100,000	400,000	100,000	-	9,000	2,000,000	90,000	300	-

ND: Not detected.

* Total volume is reported in 10^7 liters a ND total activity is reported in units of mCi.

Table 9
1987 BNL Environmental Monitoring
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)	1.8-12.0	5.8-6.6	5.8-9.0
Conductivity (umhos/cm)	(b)	196	(c)
Temperature maximum (^{o}C)	(d)	15	32
Total coliform (per 100 ml)	(d)	2,120	10,000
Fecal coliform (per 100 ml)	(d)	334	2,000
Results in mg/L			
Dissolved Oxygen	(d)	7.0	(c)
Chlorides	(d)	28.7	(c)
Settleable Solids	0.6	0.0	0.1
Suspended Solids - max	144.0	0.0	10.0
- avg	25.5	0.0	5.0
BOD_5 - max	39.6	5.7	20.0
- avg	22.7	2.6	10.0
Ammonia-Nitrogen	(d)	0.22	2.0
Nitrate-Nitrogen	(d)	4.5	(c)
Total Phosphorous	0.39	0.38	(c)
Ag	0.021	0.018	0.05
Cd	<0.003	0.004	(c)
Cr	<0.017	0.019	(c)
Cu	0.063	0.090	0.40
Fe	0.486	0.210	0.60
Hg	<0.0002	<0.0003	(c)
Mn	0.030	<0.05	(c)
Na	23.3	22.6	(c)
Pb	0.02	0.008	0.067
Zn	0.073	0.082	0.30

(a) Locations shown in Figure 5.
(b) Metered.
(c) Effluent limitation not specified.
(d) No analysis performed.

Table 10
1987 BNL Environmental Monitoring
Radioactivity Detected in On-Site Recharge Basin Water

Location	Quarter of Year	Gross Alpha	Gross Beta	Tritium	^{7}Be	^{22}Na	^{60}Co	^{40}K	^{57}Co	^{58}Co	^{65}Zn	^{137}Cs	^{90}Sr
		<---------- pCi/L ---------->											
HN	1	-0.11	2.55	-655.0	6.12	1.78	0.26	1.24	ND	ND	ND	ND	NA
	2	0.15	5.33	0.0	25.00	0.80	0.14	3.40	0.32	0.31	0.69	0.43	<0.1
	3	-0.21	10.20	330.0	30.00	1.84	ND	4.44	ND	ND	0.54	ND	NA
	4	0.36	1.66	87.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Average	0.05	4.94	-59.5	20.37	1.47	0.13	3.03	0.11	0.10	0.41	0.14	<0.1
HO	1	0.57	1.29	-54.0	ND	0.82	0.97	40.0	ND	ND	ND	ND	NA
	2	0.21	2.34	-27.4	ND	ND	ND	3.53	ND	ND	ND	ND	<0.1
	3	-0.21	1.51	510.0	ND	ND	1.50	8.37	ND	ND	ND	ND	NA
	4	0.26	1.44	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Average	0.21	1.65	107.1	ND	0.28	0.82	17.30	ND	ND	ND	ND	<0.1
HP	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA
	2	0.41	2.30	219.0	ND	ND	ND	ND	ND	ND	ND	ND	<0.1
	3	-0.21	1.96	390.0	ND	0.23	ND	1.98	ND	ND	ND	ND	NA
	4	0.21	2.15	232.0	ND	ND	ND	3.28	ND	ND	ND	ND	NA
	Average	0.14	2.14	280.3	ND	0.08	ND	1.75	ND	ND	ND	ND	<0.1
HS	1	0.11	0.94	297.0	2.13	ND	ND	ND	ND	ND	ND	ND	NA
	2	0.61	3.55	82.3	ND	ND	ND	0.70	ND	ND	ND	0.86	<0.1
	3	0.15	1.25	210.0	ND	ND	ND	3.97	ND	ND	ND	ND	NA
	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA
	Average	0.29	1.91	196.4	0.71	ND	ND	1.56	ND	ND	ND	0.29	<0.1
HT	1	0.28	2.62	54.1	ND	1.98	0.38	2.99	ND	ND	ND	ND	NA
	2	0.05	1.44	137.0	ND	ND	ND	ND	ND	ND	ND	0.23	<0.1
	3	0.21	0.45	180.0	ND	ND	ND	0.60	ND	ND	ND	ND	NA
	4	0.10	0.60	145.0	ND	ND	ND	2.21	ND	ND	ND	ND	NA
	Average	0.16	1.28	129.0	ND	0.50	0.09	1.45	ND	ND	ND	0.06	<0.1
HZ	2	0.10	0.83	219.0	ND	0.44	0.47	2.13	ND	ND	ND	ND	<0.1
NYS Drinking Water Standard		15	50	20,000	-	-	-	-	-	-	-	-	8
Radiation Concentration Guides					2,000,000	30,000	30,000		400,000	90,000	100,000	20,000	-
Typical Minimum Detection Limits		0.53	1.17	300	2.0	0.25	0.24	3.6	0.19	0.23	0.54	0.25	0.1

NA: Not analyzed.
ND: Not detected.
NS: Not sampled.

Table 11
1987 BNL Environmental Monitoring
Recharge Basins
Average Water Quality and Metals Data

Parameter	Location[a] HN	HO	HP	HT	HS	HZ	NYS Drinking Water Standards
No. of Samples	4	4	3	3	3	1	
pH (SU)	5.0-7.2	6.5-6.8	5.0-6.8	5.0-7.3	7.0-9.5	6.6	6.5-8.5
Specific Conductance (umhos/cm)	133	147	218	290	152	128	(b)
Temperature (^{o}C)	18	17	17	17	18	17	(b)
Results in mg/L							
Nitrate-N	<2.5	<2.5	<2.5	<2.5	<2.5	2.0	10.0
Chlorides	16.5	17.7	24.9	18.2	13.0	17.0	250.0
Sulfates	8.9	13.5	16.1	12.1	8.6	17.7	250.0
Ag	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cu	0.02	<0.05	<0.02	<0.05	<0.05	0.03	1.0
Fe	0.85	1.26	0.32	0.08	0.88	0.11	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.002
Mn	0.03	0.18	0.07	<0.02	<0.02	<0.02	0.3
Na	11.7	14.3	27.0	10.7	15.9	15.0	(b)
Pb	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.025
Zn	0.05	0.03	<0.01	0.01	0.08	<0.01	5.0

(a) Locations of recharge basins are shown in Figure 11.

(b) No standard specified.

Table 12
1987 BNL Environmental Monitoring
External Dose-Equivalent Rates for All TLD Locations

Location	Alternate Name	1987 1st Quarter	1987 2nd Quarter	1987 3rd Quarter	1987 4th Quarter	Measured Total	Adjusted 365 Days
		<---------- mrem ---------->					
1T3.0		15.1	13.4	13.0	13.4	54.9	55.1
1T8.8		12.7	11.6	13.0	11.2	48.5	50.1
2T3.2		15.9	-	-	14.9	30.8	59.8
3T2.8		-	-	-	13.8	13.8	61.4
3T8.8		17.0	15.1	18.9	13.9	64.9	63.8
4T2.4		13.6	13.2	17.8	-	44.6	56.7
4T2.6		15.5	14.0	13.2	14.5	57.2	57.4
4T7.5		15.6	13.4	18.7	12.3	59.9	59.0
5T2.5		17.3	16.3	23.0	17.0	73.6	72.8
5T4.2		13.4	12.8	12.8	11.4	50.4	50.5
5T6.5		14.8	12.9	21.5	12.0	61.3	60.3
5T17.1		12.9	13.2	14.4	12.5	53.0	54.8
6T2.8		14.2	16.0	20.4	15.5	66.1	65.3
6T5.6		13.4	13.2	13.2	12.2	52.0	52.1
6T14.2		11.2	12.1	12.7	11.4	47.4	49.0
7T1.6		18.6	-	-	17.8	36.4	77.7
7T2.5		19.3	17.3	23.7	15.7	76.1	74.8
7T9.7		13.8	14.8	14.9	14.1	57.6	59.5
8T1.3		16.3	-	23.0	15.0	54.3	71.6
8T2.3		15.3	13.5	18.4	12.8	60.0	59.1
8T8.8		16.6	13.6	15.2	14.0	59.4	59.5
9T8.3		17.5	14.6	16.0	14.9	63.1	63.2
10T1.8		14.3	16.0	21.0	15.9	67.2	66.5
10T3.7		19.3	18.4	24.9	16.8	79.5	78.2
10T12.0		14.0	15.8	17.8	14.0	61.6	63.7
11T2.1		14.2	14.1	-	-	28.3	57.1
11T3.7		-	-	15.7	-	15.7	63.8
11T17.8		12.0	12.6	13.2	11.8	49.6	51.3
12T1.4		15.1	16.5	20.7	16.9	69.1	68.4
12T5.0		15.3	14.2	14.2	13.4	57.0	57.1
12T7.2		-	13.8	20.8	13.3	47.9	62.6
12T12.5		14.3	16.0	18.6	15.1	64.1	66.3
13T1.3		14.3	16.6	21.6	17.4	69.9	69.1
13T1.4		13.9	15.3	17.3	14.0	60.5	62.6
13T2.6		15.7	14.8	20.8	14.1	65.4	64.4
13T8.2		13.9	12.3	12.9	11.9	51.1	51.2
14T1.3		14.3	15.7	21.4	16.8	68.3	67.5
14T5.6		16.3	16.0	22.2	15.9	70.6	73.0
15T1.4		15.4	15.7	18.1	14.9	64.1	66.3
15T1.7		15.6	15.8	-	15.0	46.4	64.4
15T3.0		12.8	13.1	12.1	13.0	51.1	51.2
15T14.7		16.5	15.2	23.1	12.8	67.6	66.5
16T2.1		14.2	15.3	19.1	13.9	62.5	61.9
16T3.4		16.5	14.8	21.5	13.6	66.4	65.3
16T10.0		18.5	-	15.2	-	33.7	67.2
Control A		4.86	5.31	5.94	4.37	20.48	20.3
Control B		4.42	4.53	3.85	4.30	17.1	17.1
Control C		4.77	4.79	7.44	4.24	21.24	21.24
Control M		4.92	3.98	5.17	3.79	17.86	18.47

Adjusted Annual Average On-Site External Dose (16 observations, stations 7T1.6 and 8T1.6 due to the proximity to the Hazardous Waste Management Area) = 64.5 ± ± 5.4 mrem.

Adjusted Annual Average Off-Site External Dose (27 observations) = 59.9 ± 7.35 mrem.

Table 13
1987 BNL Environmental Monitoring
Ambient Air Tritium Concentrations at Perimeter and Control Locations

Collection Date	Sample Location																			
	1T	2T	3T	4T	5T	6T1	6T2	7T	8T	9T	10T	11T	12T	13T	14T	15T	16T	17T	18T	20T
	<---------- pCi/m^3 ---------->																			
01/08/87	NS	NS	-1.35	-0.24	-1.68	-0.45	0.15	-0.87	-0.69	NS	-1.38	1.22	-0.52	-2.23	-0.52	-0.47	NS	14.40	NS	1.45
01/15/87	NS	NS	-5.79	-1.47	0	0	-0.14	-0.41	-0.52	NS	-0.93	-1.51	-0.60	-1.33	-0.66	-2.40	NS	17.60	NS	20.70
01/22/87	NS	NS	0.24	2.08	-0.18	-0.76	1.73	1.07	0.99	NS	0.36	0.79	0.36	2.13	7.65	0.54	NS	16.80	NS	5.44
01/30/87	NS	NS	0.26	1.37	0.92	1.44	0.73	0.54	1.52	NS	0.41	0.22	-0.56	1.08	4.15	0.27	NS	16.80	NS	6.34
02/05/87	NS	NS	2.42	4.13	2.69	4.57	2.48	1.77	NS	NS	0.68	1.15	1.87	1.14	3.09	1.73	NS	7.60	NS	4.82
02/13/87	NS	NS	0.93	NS	1.03	0.49	0.56	0.40	NS	NS	1.09	0	-0.56	0.68	0.85	2.39	NS	7.60	NS	-5.97
02/19/87	NS	NS	-0.07	NS	0.96	0.62	0.49	1.39	NS	NS	0.25	0.18	0.15	0.15	0.41	0.08	NS	4.82	NS	0.62
02/27/87	NS	NS	0.10	0.21	0.10	1.17	0	5.28	3.38	NS	2.35	0.72	3.10	1.92	1.72	0.48	0.69	4.82	NS	1.75
03/06/87	NS	NS	3.90	7.22	3.75	10.50	26.90	4.15	4.52	NS	1.59	7.26	6.20	7.58	4.58	4.32	3.83	18.40	NS	3.68
03/12/87	NS	NS	6.69	4.89	3.53	2.31	3.82	3.85	2.64	NS	3.99	5.55	4.91	3.31	7.16	8.08	10.90	1620.00	0.45	15.90
03/18/87	NS	NS	318.00	30.90	23.60	4.73	3.12	35.80	72.90	NS	6.82	3.44	5.94	5.94	4.48	6.82	9.56	868.00	0.45	8.68
03/24/87	NS	NS	NS	3.75	7.37	6.72	8.69	1.92	4.01	NS	0	1.08	2.01	NS	3.51	2.49	1.22	2970.00	0.45	3.90
03/30/87	NS	NS	12.20	7.49	NS	20.60	17.60	18.10	4.73	NS	2.15	0.27	1.17	1.39	1.78	3.17	2.79	57.00	0.45	NS
04/10/87	NS	NS	2.25	2.85	11.20	7.12	1.12	NS	1.07	NS	4.77	0.99	2.38	1.71	3.75	2.95	0.43	43.30	0.45	6.70
04/15/87	NS	NS	4.10	5.68	3.52	5.01	3.88	NS	1.83	NS	NS	0.51	5.00	0.85	3.57	NS	1.14	5.90	0.45	2.76
04/23/87	NS	NS	0.33	-0.55	1.72	0.29	0.32	2.04	13.00	NS	5.81	0.72	-0.40	0.88	NS	-0.10	1.28	7.20	NS	2.28
04/29/87	NS	NS	0.68	1.10	0	0.21	-0.26	3.24	3.43	NS	-0.54	0.59	0	-0.27	-1.54	-3.14	-1.44	3.40	0.23	-0.13
05/08/87	NS	NS	-0.16	-0.22	NS	3.33	9.46	NS	0.85	NS	0.23	2.33	0.68	1.02	0	NS	-1.00	5.70	0.23	2.04
05/15/87	NS	NS	0.75	2.47	NS	0.45	1.18	2.48	0.77	NS	-0.99	-0.31	-1.11	0.37	1.48	NS	0.47	4.30	NS	0.81
05/22/87	NS	NS	0	1.06	1.16	-0.26	-1.33	4.52	0.69	NS	-0.78	1.10	2.29	2.60	0.82	0	0.50	3.00	NS	0
05/29/87	NS	NS	1.54	1.30	0.92	3.87	1.92	-1.30	1.27	NS	0.87	0.83	-1.30	1.61	0	5.74	-0.38	8.20	NS	1.60
06/05/87	NS	NS	1.09	1.72	0	1.15	0	0.83	-1.17	NS	2.06	0	2.11	-0.55	1.07	-1.74	0	8.20	NS	1.26
06/11/87	NS	NS	3.71	7.94	7.05	2.25	-0.83	11.50	4.96	1.32	4.53	-3.39	NS	3.05	4.88	2.88	0.36	17.10	0.38	6.29
06/18/87	NS	NS	4.27	6.08	1.67	3.39	1.89	30.40	4.04	2.39	2.54	3.74	NS	2.14	1.53	1.52	4.08	17.50	0.38	36.60
06/24/87	NS	NS	2.50	3.64	4.11	0.49	1.57	4.66	5.23	4.29	4.30	2.53	NS	3.49	2.21	2.68	0.56	65.50	NS	15.40
06/30/87	NS	NS	11.00	7.58	12.60	1.62	3.50	12.80	14.90	5.41	17.50	4.98	NS	12.00	10.00	18.70	1.30	14.10	NS	10.60
07/06/87	NS	NS	NS	9.95	10.30	6.17	12.50	15.10	13.00	23.00	25.20	24.80	NS	9.11	8.91	10.20	7.22	14.10	NS	19.90
07/16/87	NS	NS	14.60	12.40	9.63	12.90	2.70	3.54	3.98	1.93	9.98	2.94	NS	2.95	12.40	15.90	6.93	7.03	NS	2.37
07/23/87	NS	NS	-3.42	0.75	0	3.10	4.19	0.80	1.20	-1.37	-1.68	81.70	NS	-2.32	0.38	-2.19	1.05	5.06	NS	3.12
07/31/87	NS	NS	1.57	4.65	15.90	-1.06	2.34	28.60	14.50	17.00	11.90	-1.27	3.04	3.22	2.14	3.31	0.97	5.37	NS	4.72
08/06/87	NS	0	-0.56	1.48	1.51	0.79	-2.06	3.35	-2.20	13.10	-0.40	-1.67	0.57	-0.96	-0.58	1.84	0.28	4.66	NS	-0.50
08/12/87	NS	-0.73	3.46	-0.93	0.51	1.32	-1.40	5.23	8.55	2.74	0.97	-0.81	2.28	0.90	2.50	0.52	0	4.20	NS	1.36
08/18/87	NS	NS	0.54	-1.10	1.25	0.42	-1.00	4.65	2.49	0	0.37	1.17	0.49	0.51	-1.42	0.97	-0.45	12.80	NS	0.45
08/24/87	NS	NS	6.32	7.50	10.40	3.48	6.17	2.64	2.73	3.87	2.04	7.56	5.66	3.15	2.86	1.97	4.47	19.00	NS	9.31
08/31/87	NS	1.69	2.95	2.88	42.60	2.70	3.16	-1.48	5.83	3.45	4.53	4.81	2.79	3.89	2.74	3.09	3.79	12.80	NS	5.17
09/08/87	NS	7.58	4.05	1.99	5.83	0	4.83	6.68	4.12	4.58	2.58	4.35	4.44	4.09	2.20	4.80	5.58	11.80	NS	6.66
09/15/87	3.30	2.05	3.70	5.24	2.41	4.38	5.63	7.95	1.63	0	2.74	6.09	4.98	2.69	4.68	1.35	3.43	4.23	NS	8.60
09/23/87	2.11	2.07	0.84	3.63	5.75	0	5.80	4.67	1.20	2.18	0	2.40	0.92	0.82	1.27	1.34	4.05	7.69	NS	4.57
09/30/87	0	1.06	2.14	1.36	2.41	5.11	2.07	2.45	3.06	1.85	-1.15	0.59	NS	0.78	0	0	0.79	4.57	NS	0.78
10/07/87	1.09	-1.02	0.98	1.02	0	-2.86	-5.76	0.37	0.35	-1.02	-0.21	-2.91	4.52	1.02	0	0	2.94	4.57	NS	1.71
10/15/87	0.52	0	0.23	3.08	0.69	0	0	NS	1.96	0.73	0.53	2.70	1.29	1.30	0.56	1.80	3.22	8.43	NS	4.99
10/22/87	-0.31	1.28	0.52	1.79	0	-2.70	1.48	4.40	4.22	-1.45	1.37	-1.46	3.27	-0.33	-1.19	1.00	NS	40.00	NS	1.83
10/30/87	4.09	1.93	3.37	44.00	4.81	2.61	0	2.96	3.12	4.26	1.89	4.25	0.48	1.54	1.34	4.51	1.40	NS	NS	9.46
11/06/87	0	0.81	4.63	1.06	3.86	0.25	1.56	NS	3.70	-0.76	1.12	2.33	2.11	-0.23	6.04	5.27	9.74	NS	NS	6.82
11/12/87	0.46	0.21	-0.39	NA	NS	0.23	0.67	0.22	0.91	0.46	1.48	9.45	-1.78	-0.85	-0.25	-0.95	-0.76	6.13	NS	2.00
11/19/87	0.56	-4.84	0.91	0.22	NS	1.02	2.19	NS	5.27	0.90	0.90	0.90	1.13	16.80	2.58	1.01	3.56	6.13	NS	3.00
11/24/87	0.72	1.11	0.48	0.22	0.50	37.50	0.60	NS	5.27	0.90	0.37	1.73	0.27	0.95	NS	0	0.37	5.43	NS	4.26
12/01/87	0	1.57	1.60	0.50	1.15	12.40	0.24	-5.66	0.42	1.06	-2.41	1.64	0.24	-0.51	NS	0	NS	8.58	NS	4.26
12/08/87	NS	1.61	-0.30	-0.89	-0.69	-0.48	-0.71	NS	0	-0.93	1.60	-1.43	-1.23	-1.42	-0.52	-0.94	-1.19	4.87	NS	4.11
12/15/87	-0.35	-0.28	-1.29	-2.44	-0.52	-0.89	-0.18	3.67	-1.20	-1.07	-1.59	-1.13	-0.12	-1.21	-1.06	NS	-0.95	3.09	NS	2.73
12/22/87	0.16	NS	0.96	1.66	2.67	-0.64	-0.47	1.45	0.69	-0.39	0.34	0.67	-0.80	1.11	0	0.50	3.97	1.06	NS	3.06
12/30/87	NS	0.16	0.32	0.59	0	2.74	1.19	NS	NS	0.47	1.58	0.60	0.63	0.63	1.57	0.33	0.31	NS	NS	NS
Annual Average	0.95	1.07	5.38	4.39	4.00	3.10	2.58	5.29	4.81	2.74	2.28	3.55	1.44	1.79	2.01	1.92	1.98	101.47	0.43	5.17
Net Average Air Concentration	0.52	0.64	4.95	3.96	3.57	2.67	2.15	4.86	4.38	2.31	1.85	3.12	1.01	1.36	1.58	1.49	1.55	101.24	0	4.74

Table 14
1987 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location 16T2.1

Month in 1987	No of Measure-ments	Gross Alpha Concentration Average	Mininum	Maximum	Gross Beta Concentration Average	Mininum	Maximum
		<---------- pCi/m^3 ---------->			<---------- pCi/m^3 ---------->		
January	0	POWER LOSS AT STATION					
February	1	-0.00052	-	-	0.0088	-	-
March	5	0.00036	-0.00038	0.0016	0.0118	0.0020	0.0338
April	4	0.00075	0.00022	0.0021	0.0080	0.0033	0.0147
May	4	0.00165	0.00110	0.0024	0.0157	0.0118	0.0267
June	5	0.00073	-0.00040	0.0016	0.0141	0.0022	0.0196
July	4	0.00150	-0.00068	0.0009	0.0098	-0.0017	0.0159
August	5	0.00062	-0.00040	0.0014	0.0074	-0.0026	0.0138
September	4	0.00059	0	0.0010	0.0069	-0.0018	0.0146
October	4	0.00067	-0.00018	0.0019	0.0186	0.0007	0.0281
November	5	0.00186	0.00131	0.0027	0.0159	0.0091	0.0259
December	4	0.00105	-0.00021	0.0018	0.0156	0.0076	0.0240
Annual	45	0.00079			0.0122		
Typical Minimum Detectable Conc.		0.002			0.004		

Table 15
1987 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location 11T2.1

Month in 1987	No of Measure-ments	Gross Alpha Concentration			Gross Beta Concentration		
		Average	Mininum	Maximum	Average	Mininum	Maximum
		<---------- pCi/m^3 ---------->					
January	4	0.00061	0.00057	0.00065	0.0122	0.0077	0.0173
February	4	0.00034	-0.00064	0.00119	0.0148	0.0099	0.0192
March	5	0.00093	-0.00078	0.00330	0.0142	0.0012	0.0235
April	4	0.00040	-0.00020	0.00069	0.0076	0.0029	0.0183
May	4	0.00086	-0.00034	0.00142	0.0116	-0.0011	0.0169
June	5	0.00083	-0.00017	0.00169	0.0121	0.0006	0.0227
July	4	0.00083	0.00031	0.00135	0.0121	0.0118	0.0124
August	5	0.00103	0	0.00196	0.0133	0.0025	0.0205
September	4	0.00178	0.00148	0.00204	0.0208	0.0108	0.0331
October	4	0.00140	0.00094	0.00257	0.0262	0.0214	0.0387
November	5	0.00144	0.00033	0.00296	0.0192	0.0031	0.0394
December	4	0.00117	0.00086	0.00147	0.0328	0.0288	0.0371
Annual	52	0.00086			0.0116		
Typical Minimum Detectable Conc.		0.002			0.004		

Table 16
1987 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air at Particulate Filters from Location 6T2.8

Month in 1987	No of Measure-ments	Gross Alpha Concentration			Gross Beta Concentration		
		Average	Mininum	Maximum	Average	Mininum	Maximum
		<---------- pCi/m^3 ---------->			<---------- pCi/m^3 ---------->		
January	4	0.00086	0	0.00195	0.0148	0.0122	0.0200
February	4	0.00072	0	0.00157	0.0121	0.0085	0.0184
March	5	0.00102	0	0.00169	0.0144	0.0074	0.0228
April	4	0.00046	0	0.00064	0.0034	-0.0005	0.0086
May	4	0.00029	-0.00017	0.00074	0.0040	0.0007	0.0088
June	5	0.00058	0	0.00193	0.0077	0.0001	0.0143
July	4	0.00086	0.00034	0.00131	0.0148	0.0069	0.0182
August	5	0.00105	0	0.00274	0.0105	0.0020	0.0164
September	4	0.00028	0	0.00045	0.0060	-0.0075	0.0085
October	4	0.00012	-0.00100	0.00111	0.0046	0.0028	0.0078
November	5	0.00049	-0.00040	0.00142	0.0108	0.0070	0.0189
December	4	0.00116	0.00033	0.00222	0.0194	0.0166	0.0247
Annual	52	0.00067			0.0103		
Typical Minimum Detectable Conc.		0.002			0.004		

Table 17
1987 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location 4T2.4

Month in 1987	No of Measure-ments	Gross Alpha Concentration			Gross Beta Concentration		
		Average	Mininum	Maximum	Average	Mininum	Maximum
		<---------- pCi/m^3 ---------->			<---------- pCi/m^3 ---------->		
January	4	0.00084	-0.00021	0.00207	0.0160	0.0113	0.0235
February	4	0.00132	0.00105	0.00185	0.0181	0.0137	0.0250
March	5	0.00095	0.00039	0.00301	0.0177	0.0007	0.0313
April	4	0.00083	0	0.00142	0.0146	0.0093	0.0305
May	4	0.00128	0.00087	0.00159	0.0169	0.0126	0.0192
June	5	0.00082	-0.00034	0.00209	0.0133	-0.0013	0.0193
July	4	0.00068	-0.00031	0.00167	0.0121	-0.0059	0.0198
August	5	0.00100	0	0.00199	0.0078	0.0002	0.0149
September	4	0.00096	-0.00016	0.00149	0.0119	0.0064	0.0170
October	4	0.00062	0.00015	0.00119	0.0036	0.0015	0.0063
November	6	0.00092	-0.00039	0.00141	0.0075	0.0026	0.0140
December	4	0.00118	0.00017	0.00172	0.0284	0.0149	0.0378
Annual	53	0.00095			0.0142		
Typical Minimum Detectable Conc.		0.002			0.004		

Table 18
1987 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location S-6

Month in 1987	No of Measure-ments	Gross Alpha Concentration			Gross Beta Concentration		
		Average	Mininum	Maximum	Average	Mininum	Maximum
		<---------- pCi/m^3 ---------->			<---------- pCi/m^3 ---------->		
January	18	0.00107	-0.00376	0.0061	0.0121	-0.0668	0.0593
February	18	0.00153	-0.00060	0.0099	0.0198	0.0004	0.0393
March	22	0.00123	-0.01160	0.0096	0.0159	0.0037	0.0758
April	21	0.00053	-0.00688	0.0083	0.0242	-0.0088	0.0494
May	20	0.00012	-0.00718	0.0081	0.0154	-0.0151	0.0448
June	22	0.00171	-0.00390	0.0082	0.0228	0.0122	0.0401
July	21	0.00116	-0.00060	0.0060	0.0161	-0.0550	0.0766
August	21	0.00206	-0.00391	0.0105	0.0137	-0.0300	0.0465
September	21	0.00150	-0.00235	0.0048	0.0160	-0.0765	0.0702
October	22	0.00142	-0.00845	0.0085	0.0242	-0.0425	0.0979
November	18	0.00160	-0.00367	0.0138	0.0264	-0.0166	0.0637
December	22	0.00234	-0.00355	0.0245	0.0186	-0.0467	0.0701
Annual	246	0.00138			0.0186		
Typical Minimum Detectable Conc.		0.0129			0.028		

Table 19
1987 BNL Environmental Monitoring
Composite Air Particulate Filter Radionuclide Data

Month in 1987	Flow cc	^{7}Be	^{40}K	^{75}Se	^{137}Cs	^{126}I	^{134}Cs
		<----------	----------	----------	pCi/m^3	----------	---------->
January	3.37E+09	4.90E-02	2.60E-03	ND	ND	ND	ND
February	3.66E+09	7.30E-02	9.00E-04	3.70E-03	1.30E-03	ND	ND
March	4.48E+09	6.43E-02	5.40E-03	8.20E-04	ND	1.19E-01	8.10E-04
April	4.09E+09	1.36E-01	ND	ND	ND	ND	4.90E-04
May	4.21E+09	7.12E-02	7.49E-04	ND	4.34E-04	ND	ND
June	4.36E+09	6.91E-02	4.20E-04	ND	2.59E-04	ND	ND
July	4.77E+09	5.21E-02	4.46E-03	ND	ND	ND	ND
August	4.65E+09	4.33E-02	1.41E-03	ND	3.49E-04	ND	ND
September	4.33E+09	5.72E-02	3.60E-02	ND	3.92E-03	ND	ND
October	4.29E+09	3.31E-02	1.01E-04	ND	2.07E-02	ND	ND
November	4.58E+09	2.72E-02	1.97E-03	ND	1.72E-03	ND	ND
December	4.75E+09	2.96E-02	9.79E-03	ND	8.91E-04	ND	ND
Average Concentration	4.29E+09	5.79E-02	5.45E-03	3.34E-04	2.47E-03	1.04E-02	1.09E-04
Typical Minimum Detection Limit		2.7E-03	5.3E-03	4.0E-04	3.4E-04	7.9E-04	3.5E-04
		<----------	----------	----------	pCi	----------	---------->
Total	5.15E+10	2980	281	17	127	533	5.6

ND: Not detected.

Table 20
1987 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location 16T2.1

Month in 1987	Flow cc	^{137}Cs	^{40}K	^{226}Ra	^{60}Co
		<----------	pCi/m^3	----------	----->
January	6.42E+08	ND	ND	ND	ND
February	1.47E+08	ND	1.8	ND	ND
March	6.71E+08	0.0026	0.41	ND	0.0031
April	6.46E+08	ND	0.43	ND	ND
May	5.40E+08	ND	0.51	0.006	ND
June	6.94E+08	0.0033	0.45	ND	ND
July	6.88E+08	0.0029	0.41	ND	ND
August	6.73E+08	ND	0.44	ND	ND
September	6.46E+08	ND	0.48	0.035	0.0043
October	6.48E+08	0.0027	0.45	ND	ND
November	6.68E+08	ND	0.87	ND	ND
December	6.71E+08	0.0051	0.43	0.014	ND
Average	6.11E+08	0.0015	0.47	0.0048	0.0007
Typical Minimum Detectable Activity		0.002	0.04	0.008	0.003

ND: Not detected.

Table 21
1987 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location 11T2.1

Month in 1987	Flow cc	^{137}Cs	^{40}K	^{226}Ra	^{60}Co	^{141}Ce	^{7}Be
		<---------- pCi/m^3 ---------->					
January	6.42E+08	0.0031	0.34	ND	0.0025	0.0044	ND
February	6.04E+08	ND	0.43	ND	0.0022	ND	ND
March	6.73E+08	ND	0.66	ND	ND	ND	ND
April	6.43E+08	0.0030	0.41	ND	ND	ND	ND
May	6.06E+08	ND	0.43	ND	ND	ND	0.023
June	4.92E+08	ND	0.51	0.0113	ND	ND	ND
July	6.44E+08	0.0048	0.43	ND	ND	ND	ND
August	6.72E+08	0.0015	0.14	ND	ND	ND	0.021
September	6.48E+08	ND	0.43	ND	ND	ND	ND
October	6.06E+08	0.0031	0.22	ND	0.0022	ND	0.030
November	6.65E+08	0.0020	0.40	ND	ND	ND	ND
December	6.23E+08	0.0031	0.41	0.0026	ND	ND	ND
Average	6.27E+08	0.0015	0.40	0.0001	0.0006	0.0004	0.006
Typical Minimum Detectable Conc.		0.002	0.04	0.008	0.003	0.003	0.02

ND: Not detected.

Table 22
1987 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location 6T2.8

Month in 1987	Flow cc	^{137}Cs	^{40}K	^{226}Ra	^{7}Be
		<---------- pCi/m^3 --------->			
January	6.28E+08	0.0027	0.30	0.006	ND
February	6.04E+08	ND	0.44	ND	ND
March	6.71E+08	ND	0.41	ND	0.02
April	6.01E+08	0.0023	0.34	ND	ND
May	5.94E+08	ND	0.82	ND	ND
June	6.91E+08	ND	0.41	ND	ND
July	6.44E+08	0.0020	0.42	ND	ND
August	6.71E+08	0.0028	0.42	ND	ND
September	6.48E+08	ND	0.38	ND	ND
October	6.48E+08	0.0024	0.44	0.016	ND
November	6.69E+08	0.0023	0.31	ND	ND
December	6.79E+08	0.0044	0.35	ND	ND
Average	6.46E+08	0.0016	0.42	0.0017	0.0017
Typical Minimum Detectable Conc.		0.002	0.04	0.008	0.02

ND: Not detected.

Table 23
1987 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location 4T2.4

Month in 1987	Flow cc	^{137}Cs <---------- pCi/m^3 ---------->	^{40}K
January	6.48E+08	0.0036	0.38
February	6.04E+08	0.0028	0.46
March	6.71E+08	ND	0.43
April	6.47E+08	ND	0.49
May	6.27E+08	ND	0.39
June	6.80E+08	ND	0.46
July	6.68E+08	0.0025	0.42
August	7.16E+08	ND	0.40
September	6.48E+08	ND	0.44
October	4.95E+08	ND	0.50
November	6.46E+08	ND	0.33
December	6.55E+08	ND	0.33
Average	6.42E+08	0.0007	0.42
Typical Minimum Detectable Conc.		0.002	0.04

ND: Not detected.

Table 24
1987 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location S-6

Month in 1987	Flow cc	^{137}Cs	^{40}K	^{226}Ra	^{60}Co	^{228}Th	^{7}Be
		<---------- pCi/m^3 ---------->					
January	6.48E+08	0.0070	0.26	0.007	ND	ND	ND
February	6.03E+08	ND	0.47	ND	ND	ND	ND
March	6.71E+08	0.0046	0.44	ND	0.0002	ND	ND
April	6.46E+08	ND	0.42	0.032	ND	ND	ND
May	6.47E+08	ND	0.41	0.020	ND	ND	ND
June	6.70E+08	0.0027	0.39	0.005	ND	ND	ND
July	6.66E+08	0.0040	0.46	ND	ND	ND	ND
August	6.70E+08	ND	0.45	ND	ND	ND	ND
September	6.48E+08	ND	0.54	ND	ND	ND	ND
October	6.91E+08	ND	0.47	ND	ND	ND	ND
November	6.91E+08	ND	0.47	ND	ND	0.0068	ND
December	6.71E+08	0.0017	0.41	ND	ND	ND	ND
Annual	6.60E+08	0.0017	0.43	0.005	0.00002	0.0006	ND
Typical Minimum Detectable Conc.		0.002	0.04	0.008	0.003	0.005	0.02

ND: Not detected.

Table 25
1987 BNL Environmental Monitoring
Radionuclide Concentration in Precipitation

Quarter	Precipitation cm	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{40}K	^{7}Be	^{137}Cs	^{90}Sr
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum				
		<---------- nCi/m^2 ---------->												
1st	35.31	0.102	-0.040	0.452	0.835	0.222	3.02	-1.48	-96.7	143.0	0.124	9.71	ND	ND
2nd	20.35	0.067	-0.042	0.230	0.903	0.260	1.99	-6.62	-61.3	6.0	0.072	17.30	0.42	ND
3rd	25.17	0.056	0.013	0.103	0.737	0.493	1.11	13.7	-37.0	58.4	0.227	13.89	ND	0.008
4th	22.78	0.109	0.012	0.232	0.811	0.396	1.21	13.5	-19.1	121.0	0.230	7.88	0.036	ND
Total	103.61	0.334	-	-	3.286	-	-	19.1	-	-	0.653	48.78	0.078	0.008
Typical Minimum Detectable Concentration		0.136			0.300			77.0			0.315	0.16	0.02	0.009

ND: Not detected.

Collection Area = 0.343 m^2

Table 26
1987 BNL Environmental Monitoring
Radionuclide Concentrations in Milk, Vegetation and Soil
in the Vicinity of BNL

Location	Sample Matrix	Radionuclides				
		^{40}K	^{7}Be	^{137}Cs	^{226}Ra	^{228}Th
		<---------- pCi/kg ---------->				
Cow Neck Farm	Milk	11.6*	ND	ND	ND	ND
	Strawberries	1,340	ND	ND	ND	ND
	Grass	4,560	847	ND	ND	ND
Honor Farm	Grass	3,950	355	ND	ND	ND
Game Farm	Grass	1,500	500	65.2	ND	ND
Berenzy Farm	Grass	3,730	323	ND	ND	ND
Cow Neck Farm	Soil	3,790	ND	602	795	523
Berenzy	Soil	6,480	ND	266	793	695
Typical Minimum Detectable Concentration		580	312	40	130	140

ND: Not detected.

*Small aliquot size used in analysis. Result is artificially low.

Table 27
1987 BNL Environmental Monitoring
Gross Alpha, Gross Beta, Tritium, and Sr-90 Concentrations
in Peconic and Carmens River Surface Water

Location	Sample Period	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr* Conc.
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	
			<---------- pCi/L ----------									---------->
HM	January	12	0.518	-0.57	1.41	6.82	2.62	11.7	1,582	-187	4,370	-
	February	10	0.057	-1.54	1.54	4.48	0.94	8.3	790	-185	2,020	-
	March	13	0.016	-1.79	1.54	5.76	1.13	10.0	1,147	-368	3,150	0.77
	April	13	-0.197	-2.30	1.79	5.32	-0.38	16.1	1,379	-467	5,590	-
	May	12	0.085	-3.33	1.79	4.20	0	7.2	746	-835	3,720	-
	June	13	0.473	-2.05	2.05	6.19	3.02	7.9	3,188	1,040	6,330	0.33
	July	15	0.341	-0.51	2.05	5.92	1.32	13.4	6,803	3,580	11,100	-
	August	13	0.058	-1.28	1.28	6.61	1.13	11.5	5,176	1,010	8,920	-
	September	12	0.085	-0.77	1.02	6.66	3.59	11.7	8,922	6,090	11,800	0.24
	October	13	0.295	-0.77	2.30	7.22	3.21	18.9	6,410	3,690	9,330	-
	November	11	0.325	-1.28	2.30	9.44	5.67	14.9	4,911	306	9,170	-
	December	14	0.128	-1.28	1.54	7.56	3.78	12.7	1,456	-1,700	6,980	0.59
	Average		0.183	-	-	6.36	-	-	3,604	-	-	0.48
Typical Minimum Detectable Concentration			2.7			5.7			1,200			0.1
HC	August	1	NA	-	-	NA	-	-	NA	-	-	0.3
HW	July	1	NA	-	-	NA	-	-	NA	-	-	1.1
HT	July	1	NA	-	-	NA	-	-	NA	-	-	<0.1
HR	January	1	0.057	-	-	1.43	-	-	-162	-	-	NA
	April	1	0.154	-	-	1.32	-	-	-274	-	-	NA
	June	1	0.307	-	-	2.57	-	-	-180	-	-	NA
	July	1	-	-	-	-	-	-	-	-	-	<0.1
	September	1	0.256	-	-	1.40	-	-	58	-	-	NA
	Average	-	0.193	-	-	1.68	-	-	-140	-	-	<0.1
HH	January	1	0.113	-	-	0.49	-	-	-54	-	-	NA
	February	1	0.358	-	-	1.55	-	-	27	-	-	NA
	April	1	0.154	-	-	1.10	-	-	-110	-	-	NA
	June	1	0.256	-	-	0.98	-	-	-150	-	-	NA
	September	1	0.205	-	-	1.13	-	-	29	-	-	NA
	Average	-	0.217	-	-	1.05	-	-	-52	-	-	NA
Typical Minimum Detectable Concentration			0.53			1.17			300			0.1

NA: Not analyzed.

*The ^{90}Sr samples collected at Station HM are flow proportional composites for a quarter.

Table 28
1987 BNL Environmental Monitoring
Nuclide Specific Concentration in Peconic and Carmens River
Surface Water Samples

Month in 1987	Aliquot Liters	^{22}Na	^{60}Co	^{65}Zn	^{137}Cs	^{40}K	^{57}Co	^{83}Rb	^{134}Cs	^{131}I
		<---------- pCi/L ---------->								
HM										
January	3.90E+01	5.44E-01	2.28E-01	2.21E-01	1.55E+00	4.09E+00	ND	ND	ND	ND
February	2.13E+01	3.90E-01	4.18E-01	ND	2.87E+00	8.93E+00	ND	ND	ND	4.22E-01
March	4.37E+01	1.15E-01	2.06E-01	4.55E-01	1.79E+00	4.54E+00	1.14E-01	5.82E-01	ND	ND
April	6.24E+01	1.44E-01	1.84E-01	2.91E-01	1.13E+00	2.28E+00	ND	3.72E-01	ND	ND
May	7.16E+01	4.13E-02	1.89E-01	5.03E-01	1.37E+00	2.61E+00	2.23E-02	4.64E-01	ND	ND
June	1.06E+02	8.16E-02	1.90E-01	1.48E-01	1.09E+00	2.41E+00	1.73E-02	1.24E-01	3.73E-02	ND
July	7.81E+01	4.66E-02	3.33E-01	1.75E-01	1.59E+00	2.90E+00	4.54E-02	1.15E-01	3.65E-02	ND
August	6.14E+01	1.37E-01	1.83E-01	1.53E-01	1.38E+00	2.60E+00	ND	ND	6.81E-02	ND
September	7.65E+01	1.27E-01	2.34E-01	8.84E-01	1.32E+00	2.89E+00	3.44E-02	ND	2.33E-02	ND
October	2.63E+01	5.08E-01	4.22E-01	1.61E-01	1.74E+00	6.22E+00	ND	4.31E-01	ND	ND
November	2.40E+01	2.81E-01	4.21E-01	ND	1.07E+00	2.28E+00	ND	ND	ND	ND
December	1.10E+01	ND	ND	ND	1.24E+00	4.25E+00	ND	ND	ND	ND
Average	5.18E+01	1.56E-01	2.39E-01	3.11E-01	1.41E+00	3.23E+00	2.35E-02	1.86E-01	2.05E-02	1.45E-02
HH										
June	1.20E+01	ND	ND	ND	ND	ND	ND	ND	ND	ND
September	1.20E+01	ND	ND	ND	ND	2.29E+00	ND	ND	ND	ND
Average	1.20E+01	ND	ND	ND	ND	1.15E+00	ND	ND	ND	ND

ND: Not detected.

Table 29
1987 BNL Environmental Monitoring
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	5.6-6.3	172	16.9	3.9	26.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	February	5.9-6.4	155	18.8	4.6	29.0	<0.020	<0.005	<0.025	0.40	0.15	NA	0.04	22.7	<0.025	0.07
	March	5.8-6.4	159	16.5	4.1	26.0	<0.020	<0.005	<0.025	0.33	NA	NA	<0.02	20.4	<0.025	0.07
	April	5.7-6.4	185	16.4	4.1	23.7	<0.020	<0.005	<0.025	0.26	0.08	<0.0002	0.05	18.4	<0.025	0.07
	May	5.3-6.2	197	18.0	5.6	24.5	<0.020	<0.005	<0.025	0.28	0.08	<0.0002	0.05	18.9	<0.025	0.08
	June	5.6-6.2	229	16.9	4.0	23.6	<0.020	<0.005	0.025	0.17	0.08	<0.0002	0.05	19.8	<0.025	0.07
	July	5.5-6.2	240	16.2	3.5	25.4	<0.020	0.001	<0.005	0.11	0.12	<0.0002	0.02	20.0	<0.005	0.06
	August	5.6-6.3	208	17.6	3.7	26.2	<0.020	0.001	<0.005	0.15	0.14	NA	0.03	20.7	<0.005	0.05
	September	5.8-6.2	204	19.3	4.0	27.2	<0.020	0.001	<0.005	0.09	0.08	NA	0.03	21.0	<0.005	0.05
	October	6.1-6.6	213	NA	NA	NA	<0.020	0.001	<0.005	0.27	0.09	NA	<0.02	28.8	NA	0.04
	November	5.7-6.3	205	NA	NA	NA	<0.025	NA	<0.005	0.18	0.14	<0.00004	<0.05	29.8	0.008	0.05
	December	5.8-6.3	167	16.9	4.5	29.9	<0.025	<0.0007	<0.005	<0.05	0.40	NA	<0.05	21.7	0.008	0.06
HR	April	6.5	78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA: Not analyzed.

Table 30
1987 BNL Environmental Monitoring
Radionuclide Concentrations in Edible Meat from
Racoon, Deer, Clams and Fish

Common Name	Sample Location	Collection Date	^{137}Cs Average	^{137}Cs Minimum	^{137}Cs Maximum	^{40}K Average	^{40}K Minimum	^{40}K Maximum
			<---------- pCi/kg wet ---------->					
Brown Bullhead	Donahue's Pond	08/29/87	442	434	450	2,647	1,961	3,332
	Sandy Pond	08/29/87	575	518	627	3,027	2,417	3,954
Pickerel	Peconic River - BNL Station EA	07/24/87	1,429	998	1,859	4,921	3,129	6,713
Pumpkin Seed	Peconic River - BNL Station EA	07/29/87	1,040	-	-	2,356	-	-
Large Mouth Bass	Peconic River - BNL Station M	07/29/87	658	-	-	2,185	-	-
Racoons	BNL Site - AGS	12/20/86	94	91	96	1,920	1,626	2,214
Control Stations								
Brook Trout	Connectiquot River	12/08/86	ND	-	-	2,714	2,474	2,953
Brook Trout	Carmens River	07/24/87	105	-	-	3,549	-	-
Blue Gill	Swan Pond	08/29/87	108	88	127	2,356	2,253	2,459
Brown Bullhead	Willow Pond	07/10/87	130	-	-	3,618	-	-
	Kahler's Pond	08/20/87	52	-	-	2,728	-	-
	Lake Panamoka	06/04/87	121	-	-	3,024	-	-
	Forge Pond	07/31/87	92	-	-	1,628	-	-
Pickerel	Swan Pond	08/29/87	319	-	-	2,319	-	-
Large Mouth Bass	Connectiquot River	12/08/86	ND	-	-	2,986	-	-
	Lake Panamoka	07/23/87	212	-	-	3,338	-	-
Hard Shell Clam	Raritan Bay	06/10/87	ND	-	-	745	-	-
Deer	Ridge-West of BNL	12/22/86	69	-	-	2,986	-	-

ND: Not detected.

Table 31
1987 BNL Environmental Monitoring
On-Site Potable and Cooling Water Radionuclide Concentration Data

Well ID	Number of Samples	Annual Pumpage x 10^8 L	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr	^{60}Co	^{22}Na	^{137}Cs
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum				
			<---------- pCi/L ---------->												
WTP-IN	4		0.269	0.051	0.665	1.07	0.453	2.00	42	-60	174	<0.1	ND	ND	ND
WTP-Eff	4		0.230	-0.051	0.614	1.12	0.11	1.78	-51	-190	188	0.05	ND	ND	ND
4 (FD)	4	0.063	0.282	0.102	0.461	1.06	0.79	1.51	18	-29	99	<0.1	ND	ND	ND
5 (FE)	3	Not Used	0.410	0.102	0.717	2.77	1.51	4.95	170	-27	463	<0.1	ND	ND	ND
6 (FF)	4	1.52	0.269	0.102	0.614	1.35	0.60	2.08	-71	-176	0	0.08	ND	ND	0.78
7 (FG)	4	4.23	0.320	0.205	0.512	1.20	0.60	2.15	45	-82	124	<0.1	ND	ND	ND
10 (FO)	4	1.08	0.154	-0.051	0.461	1.51	0.53	2.42	132	29	215	0.03	0.09	0.74	ND
11 (FP)	3	1.82	0.017	-0.051	0.102	1.45	0.72	2.12	283	245	331	<0.2	2.37	ND	ND
12 (FQ)	4	1.89	0.128	0	0.307	1.36	0.79	2.00	342	59	592	<0.1	NA	NA	NA
104 (FK)	1	2.54	NA	-	-	NA	-	-	NA	-	-	NS	ND	ND	ND
105 (FL)	3	1.65	0.256	0.102	0.358	2.41	1.78	3.14	164	27	242	<0.1	0.25	0.19	ND
NYS Drinking Water Standard			15.0			50.0			20,000			8.00	30,000	30,000	20,000
Radiation Concentration Guide															
Typical Minimum Detectable Concentrations			0.53			1.17			300			0.1	0.24	0.25	0.25

NA: Not analyzed.

ND: Not detected. See List of Minimum Detectable Concentration Tables.

WTP-IN: Water Treatment Plant Influent.

WTP-EFF: Water Treatment Plant Effluent.

Table 32
1987 BNL Environmental Monitoring
Potable Water from Building 535B and Distilled Water

Location	Sample Period	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
			<---------- pCi/L ---------->								
Bldg. 535B	January	19	0.505	-1.13	2.54	2.02	-1.92	11.0	-15	-652	1,020
	February	18	0.096	-1.03	1.28	0.79	-2.27	3.40	327	-370	1,190
	March	21	-0.418	-2.05	1.54	1.53	-1.70	3.78	221	-1,010	924
	April	22	-0.244	-2.82	1.28	3.30	-2.27	11.7	419	-830	7,170
	May	20	-0.256	-2.82	1.28	-1.03	-18.9	4.34	130	-1,090	3,910
	June	22	0.128	-2.05	1.28	1.61	-2.27	6.04	70	-1,150	1,040
	July	22	0.081	-3.33	1.02	0.83	-1.70	4.16	12	-753	1,140
	August	21	0.183	-1.28	1.54	1.20	-1.51	5.29	-15	-1,180	803
	September	21	-0.037	-1.54	1.28	0.76	-3.40	4.91	273	-425	1,100
	October	22	0.268	-1.28	1.79	2.01	-1.51	5.67	373	-625	1,810
	November	17	0.166	-1.79	1.28	2.13	-0.76	5.10	-377	-1,530	747
	December	22	0.047	-1.28	2.05	2.33	-0.19	5.48	38	-2,200	3,340
	Annual	247	0.038	-	-	1.47	-	-	129	-	-
Distilled Water	January	19	0.520	-0.57	2.82	1.33	-3.32	9.42	-34	-837	1,480
	February	18	0.018	-1.02	1.54	0.88	-5.29	3.40	184	-926	2,380
	March	22	-0.290	-1.79	0.77	0.50	-3.21	4.91	290	-461	1,480
	April	22	-0.501	-3.07	1.02	-0.63	-6.99	2.46	115	-838	1,760
	May	20	-0.704	-3.07	0.77	0.08	-7.74	3.97	-55	-1,590	587
	June	22	-0.105	-1.79	1.28	1.33	-1.89	6.23	81	-840	1,150
	July	22	-0.012	-3.33	2.05	0.99	-2.08	5.10	130	-420	729
	August	21	-0.049	-1.28	0.77	0.51	-2.08	5.29	214	-1,090	2,480
	September	21	-0.025	-1.54	1.79	1.05	-1.70	7.55	373	-201	1,790
	October	22	0.489	-0.77	2.82	0.98	-0.57	4.16	440	-1,100	2,310
	November	17	-0.105	-1.79	1.28	0.77	-2.08	4.16	-5	-1,020	1,520
	December	22	-0.112	-1.02	1.54	0.58	-4.72	4.91	61	-2,200	3,540
	Annual	248	-0.076	-	-	0.69	-	-	155	-	-
Typical Minimimum Detectable Concentration			2.7			5.7			1,200		

Table 33
1987 BNL Environmental Monitoring
Potable Supply Wells, Average Water Quality and Metals Data

	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
Number of samples	4	4	4	4	3	4	
pH (SU)	5.6-5.9	6.1-6.2	6.0-6.1	6.2-6.7	6.1	6.4-6.5	6.5-8.5
Specific conductance (umhos/cm)	95	110	89	114	108	125	(a)
Total coliforms[b]	ND	ND	ND	ND	ND	ND	4/100 ml
Results in mg/L							
Ammonia-N	<0.02	0.01	<0.02	<0.02	<0.02	<0.02	(a)
Nitrate-N	0.3	0.15	0.25	0.55	0.5	0.45	10.0
Nitrite-N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	(a)
Total solids	83.0	78.0	75.0	113.0	143.0	89.0	(a)
Chlorides	17.6	17.3	12.7	14.0	14.4	18.7	250.0
Sulfates	9.6	8.6	6.6	11.0	12.1	15.4	250.0
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cu	0.03	<0.05	0.02	<0.05	<0.05	<0.05	1.0
Fe	0.25	4.35	1.61	<0.075	<0.075	<0.075	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.002
Mn	0.01	0.07	0.06	<0.05	<0.05	<0.05	0.3
Na	8.4	10.8	7.9	9.5	10.0	14.6	(a)
Pb	0.004	0.002	<0.025	<0.025	<0.025	<0.025	0.025
Zn	<0.02	<0.02	<0.02	0.01	<0.02	<0.02	5.0

ND: Not detected.

(a) No standard specified.

(b) Sampled monthly.

Table 34
1987 BNL Environmental Monitoring
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:	ND	ND	ND
		Min:			
		Max:			
WTP-EFF	1	Avg:	ND	ND	ND
		Min:			
		Max:			
4 (FD)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
6 (FF)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
7 (FG)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
10 (FO)	1	Avg:	ND	NA	NA
		Min:			
		Max:			
11 (FP)	2	Avg:	0.012	0.003	ND
		Min:	0.010	ND	
		Max:	0.014	0.005	
12 (FQ)	2	Avg:	ND	ND	ND
		Min:			
		Max:			
5 (FE)	1	Avg:	ND	0.05	ND
		Min:			
		Max:			
105 (FL)	1	Avg:	0.020	0.003	ND
		Min:	0.016	ND	
		Max:	0.024	0.006	
NYS Drinking Water Standards			0.050[a]	0.005	0.050[a]

NA: Not analyzed.
ND: Not detected. Average Method Detection Limits were:
1,1,1-trichloroethane - 0.004 mg/L; trichloroethylene - 0.005 mg/L;
tetrachloroethylene - 0.006 mg/L.

(a) NYSDOH advisory guidelines.

WTP-IN: Water Treatment Plant Influent
WTP-EFF: Water Treatment Plant Effluent

Table 35
1987 BNL Environmental Monitoring
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)	NYS Drinking Water Standards
	<---------- mg/L ---------->						
Benzene	ND	ND	ND	ND	ND	ND	0.005
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	0.005
Chloroform	0.004	ND	ND	0.002	ND	0.002	0.100
1,1-dichloroethane	ND	ND	ND	0.002	ND	ND	
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	0.005
1,1-dichloroethylene	ND	ND	ND	ND	ND	ND	0.007
o-dichlorobenzene	ND	ND	ND	ND	ND	ND	
p-dichlorobenzene	ND	ND	ND	ND	ND	ND	
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	
Methylene Chloride	ND	0.002	0.003	ND	ND	ND	
1,1,1,-trichloroethane	ND	ND	ND	0.004	0.007	0.001	
1,1,2-trichloroethylene	ND	0.001	ND	ND	ND	ND	0.005
Toluene	ND	ND	0.001	ND	ND	ND	
Tetrachloroethylene	ND	ND	ND	ND	ND	ND	
Vinyl Chloride	ND	ND	ND	ND	ND	ND	0.002
m-xylene	ND	ND	ND	ND	ND	ND	
o-xylene	ND	ND	ND	ND	ND	ND	
p-xylene	ND	ND	ND	ND	ND	ND	

ND: Not detected.

Note: Anlysis was performed once during the year.

Table 36
1987 BNL Environmental Monitoring
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:	0.004	ND	ND	ND
		Min:	ND			
		Max:	0.007			
WTP-EFF	1	Avg:	ND	ND	0.015	ND
		Min:				
		Max:				
4 (FD)	2	Avg:	0.006	ND	0.006	ND
		Min:	ND		ND	
		Max:	0.011		0.012	
6 (FF)	2	Avg:	ND	ND	0.004	ND
		Min:			ND	
		Max:			0.008	
7 (FG)	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
10 (FO)	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
11 (FP)	2	Avg:	0.003	ND	0.004	ND
		Min:	ND		ND	
		Max:	0.006		0.008	
12 (FQ)	2	Avg:	0.003	ND	ND	ND
		Min:	ND			
		Max:	0.006			
5 (FE)	1	Avg:	0.008	ND	0.008	ND
		Min:				
		Max:				
105 (FL)	2	Avg:	0.004	ND	ND	ND
		Min:	ND			
		Max:	0.007			
NYS Drinking Water Standards			0.100	0.100	0.100	0.100

ND: Not detected. Average Method Detection Limits were:
chloroform - 0.006 mg/L; chlorodibromomethane - 0.007 mg/L;
bromodichloromethane - 0.006 mg/L; bromoform - 0.006 mg/L

WTP-IN: Water Treatment Plant Influent
WTP-EFF: Water Treatment Plant Effluent

Table 37
1987 BNL Environmental Monitoring
Potable Water and Supply Wells,
Average BTX Data

Well ID	No. of Samples*		benzene	toluene	xylene
			<---------- mg/L ---------->		
WTP-IN	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
WTP-EFF	1 (0)	Avg:	ND	ND	NA
		Min:			
		Max			
4 (FD)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
6 (FF)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
7 (FG)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
10 (FO)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
11 (FP)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
12 (FQ)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
5 (FE)	1 (0)	Avg:	ND	ND	NA
		Min:			
		Max:			
105 (FL)	2 (1)	Avg:	ND	ND	ND
		Min:			
		Max:			
NYS Drinking Water Standards			0.005	(a)	(a)

NA: Not analyzed
ND: Not detected. Average Method Detection Limits were:
benzene - 0.005 mg/L; toluene - 0.004 mg/L; xylene - 0.005 mg/L.

* 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 38
1987 BNL Environmental Monitoring
Ground Water Surveillance Wells, Average Radionuclide Data for
Sand Filter Beds and Peconic River

Well ID	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr			^{60}Co	^{137}Cs	^{22}Na	^{54}Mn
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum				
		<---------- pCi/L ----------															
XA	4	0.179	-0.154	0.512	4.61	3.70	5.63	3,730	1,050	6,500	0.77	0.40	1.10	1.33	0.93	0.05	ND
XB	4	0.320	-0.051	0.614	1.61	1.13	2.00	36	0	59	0.28	0.20	0.30	ND	ND	ND	ND
XC	4	0.589	0.512	0.973	1.85	1.85	2.98	132	0	301	0.73	0.60	1.00	ND	ND	ND	ND
XD	4	0.141	0.051	0.256	0.65	-0.23	1.13	142	0	273	0.08	<0.1	0.3	ND	ND	ND	ND
XJ	1	0.205	-	-	0.72	-	-	88	-	-	0.50	-	-	ND	ND	ND	ND
XI	1	0.512	-	-	1.96	-	-	117	-	-	0.70	-	-	ND	ND	ND	ND
XN	1	-0.256	-	-	9.07	-	-	-895	-	-	0.40	0.20	0.80	ND	ND	ND	ND
XF	1	0.154	-	-	0.60	-	-	-90	-	-	NS	-	-	NS	NS	NS	ND
XK	1	0.307	-	-	5.14	-	-	3,010	-	-	DL	-	-	ND	0.14	ND	ND
XO	1	0.461	-	-	2.34	-	-	263	-	-	1.40	-	-	ND	ND	ND	ND
XL	1	-0.256	-	-	13.4	-	-	1,790	-	-	5.60	-	-	2.51	3.10	ND	ND
XY	1	0.102	-	-	1.47	-	-	761	-	-	NA	-	-	ND	ND	ND	ND
XZ	1	0.410	-	-	1.59	-	-	244	-	-	0.70	-	-	ND	ND	0.33	0.25
X1	4	0.359	0.154	0.614	1.73	1.36	2.15	165	-328	1,170	0.48	<0.1	0.7	ND	0.04	ND	ND
X2	4	0.179	-0.102	0.410	1.33	0.91	1.70	4,050	2,200	7,470	0.03	<0.1	0.1	ND	ND	ND	ND
X4	4	0.153	0.102	0.307	5.05	3.59	6.10	1,424	238	4,370	1.28	0.6	1.9	ND	ND	ND	ND
XS	4	1.140	0.87	1.33	6.58	5.48	7.82	49	-358	640	0.40	<0.1	0.6	ND	ND	ND	ND
XT	4	0.038	0	0.51	1.04	0.60	1.44	100	-358	907	0.05	<0.1	0.1	ND	ND	ND	ND
NYS Drinking Water Standard		15.0			50.0			20,000.0			8.0						
Radiation Concentration Guide														30,000	20,000	30,000	100,000
Typical Minimum Detection Limits		0.53			1.17			300			0.1			0.24	0.25	0.25	0.23

ND: Not detected.

NS: Not sampled.

DL: Sample lost in analysis.

Table 39
1987 BNL Environmental Monitoring
Off-Site Potable Water
Radionuclide Concentration, pCi/l

Location	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr	^{40}K	^{137}Cs
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum			
		<---------- pCi/L ---------->											
1	3	0.257	-0.051	0.563	0.29	-0.49	1.10	434	117	648	<0.2	NA	NA
2	4	0.141	-0.051	0.360	0.90	0.34	2.34	-41	-150	30	0.7	1.90	ND
3	1	0.410	-	-	17.50	-	-	-60	-	-	NA	17.40	ND
4	3	0.084	-0.154	0.256	0.78	0.53	0.98	91	-59	273	<0.1	NA	NA
5	4	0.089	-0.051	0.205	1.17	1.02	1.44	50	-117	328	0.4	2.12	ND
6	3	0.153	-0.102	0.410	1.30	0.98	1.47	-37	-234	149	<0.1	NA	NA
7	3	0.018	-0.205	0.260	0.69	0.42	1.02	794	464	983	<0.1	NA	NA
8	3	0.256	0.102	0.410	1.74	0.28	2.91	-278	-299	-263	0.3	NA	NA
9	1	0.358	-	-	-0.34	-	-	30	-	-	NA	ND	ND
10	4	0.179	-0.051	0.563	1.56	0.79	2.15	-17	-218	120	<0.1	3.31	ND
11	4	0.114	-0.051	0.307	0.52	0.42	0.76	81	-30	351	<0.1	1.99	ND
12	4	0.077	-0.050	0.205	0.09	-0.34	0.60	212	188	275	<0.2	2.26	ND
13	4	0.115	0	0.307	0.35	-0.26	1.51	31	-82	117	<0.1	0.13	ND
14	4	0.281	-0.051	0.560	1.78	1.32	2.49	-160	-205	-119	DL	0.50	0.11
15	3	0.359	0.307	0.461	1.61	1.10	1.89	49	-29	149	<0.1	NA	NA
16	1	0	-	-	2.98	-	-	-30	-	-	NA	4.79	ND
17	5	0.296	-0.102	0.610	1.44	0.38	2.64	377	-120	1,010	0.3	1.89	ND
18	2	0.128	0.051	0.205	0.88	0.45	1.28	0	0	0	NA	2.80	ND
19	4	0.192	-0.051	0.410	0.58	0.30	0.91	225	-88	600	<0.1	1.60	ND
20	4	0.141	0	0.358	2.03	1.62	2.49	1,471	842	2,470	0.2	1.80	ND
NYS Drinking Water Standard		15.0			50.0			20,000			8.0		
Typical Minimum Detectable Conc.		0.53			1.17			300			0.1	4.0	0.2

NA: Not analyzed for this parameter. Sr-90 samples were collected in the third quarter while gamma spectroscopy samples were collected in the fourth quarter.

NS: Not sampled.

Ground Water Surveillance Wells, Average Radionuclide Concentration Data
for the Landfill Areas, Ash Repository, Waste Concentration Facility, Central Steam Plant and Miscellaneous Wells

Well ID	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr			^{60}Co	^{22}Na	^{54}Mn	^{137}Cs	^{7}Be	^{88}Y
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum						
		<---------- pCi/L ---------->																	
Current Landfill																			
W6	4	0.154	-0.102	0.307	1.05	0.38	1.81	101	-25	176	0.18	<0.1	0.30	ND	ND	ND	ND	ND	ND
WT*	4	0.882	0.768	1.070	0.44	-0.07	2.53	251	147	319	0.10	<0.1	0.30	0.10	0.13	0.12	ND	ND	ND
WG*	1	0.563	-	-	2.04	-	-	0	-	-	<0.1	-	-	ND	ND	ND	ND	ND	ND
WR*	4	0.830	0.512	1.020	9.88	3.89	15.10	11,653	5,410	15,800	2.03	1.20	3.00	ND	0.12	ND	0.47	2.38	ND
WS*	4	1.331	-0.768	2.560	24.30	21.00	28.30	6,696	-558	11,500	3.08	2.50	3.70	ND	0.58	ND	0.04	ND	ND
1K*	4	1.124	0.665	1.790	14.33	12.30	18.10	19,959	994	74,000	2.28	1.60	2.80	ND	0.34	ND	0.47	ND	ND
2C*	4	0.257	-1.280	1.540	24.31	6.53	23.30	14,088	3,550	22,400	6.90	4.50	8.60	ND	0.37	ND	ND	ND	ND
W9*	1	0.608	0	1.790	19.85	4.00	32.90	5,662	-352	19,100	4.50	1.10	7.10	ND	0.54	ND	ND	ND	ND
Former Landfill																			
D1	4	0.127	-0.057	0.256	1.60	0.26	2.30	22	-81	140	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND
D2	7	0.106	-0.051	0.282	1.26	0.77	1.89	128	-108	360	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND
D3	4	0.018	-0.154	0.226	0.98	-0.15	1.89	-157	-811	123	0.85	0.30	1.40	ND	ND	ND	ND	ND	ND
D4	3	0.204	0.051	0.461	2.58	1.32	3.70	0	-92	145	0.30	0.30	0.30	ND	ND	ND	ND	ND	ND
D5	4	0.068	-0.102	0.169	0.51	-0.08	1.08	-206	-811	88	<0.1	<0.1	<0.1	ND	ND	ND	0.54	ND	ND
D6	4	0.216	0	0.454	12.36	11.30	17.40	33	-81	330	6.40	3.90	9.70	ND	ND	ND	ND	ND	ND
D7	5	0.283	-0.051	0.358	1.29	0.72	1.82	250	0	460	0.30	0.20	0.40	0.08	0.04	ND	ND	0.48	ND
1I	4	0.124	-0.169	0.410	0.98	0.63	1.44	350	88	460	<0.1	<0.1	<0.1	ND	ND	ND	0.52	ND	ND
1J	4	0.099	-0.169	0.307	0.92	0.38	1.32	-55	-125	28	<0.1	<0.1	<0.1	ND	ND	ND	0.19	ND	ND
WO	2	0.103	0	0.205	1.04	0.34	1.74	157	118	196	<0.1	<0.1	<0.1	0.40	ND	ND	ND	ND	ND
WP	2	0.179	0.051	0.307	0.83	0.72	0.94	84	0	168	NS	-	-	ND	ND	ND	ND	ND	ND
WQ	2	-0.128	-0.307	0.051	1.29	1.13	0.44	-28	-56	0	<0.1	-	-	1.45	ND	ND	1.10	ND	1.57
D16	2	0	0	0	1.53	1.51	1.55	99	59	139	<0.1	-	-	ND	ND	ND	ND	ND	ND
D18	4	0.154	0.051	0.256	0.65	-0.68	2.46	104	-28	146	0.40	<0.1	0.8	ND	ND	ND	ND	ND	ND
D19	4	0.294	0.051	0.563	0.89	0.15	2.19	173	56	292	0.10	<0.1	0.2	ND	ND	ND	0.05	ND	ND
Ash Repository																			
D20	1	0.154	-	-	1.74	-	-	83	-	-	NS	-	-	ND	ND	ND	ND	ND	ND
Central Steam Plant																			
D13	2	0.274	-0.169	0.717	2.28	1.54	3.02	-21	-175	134	0.27	0.10	0.40	0.60	ND	ND	ND	ND	ND
D14	2	0.298	0.256	0.339	1.17	0.87	1.47	-377	-804	50	2.87	<0.1	8.60	0.38	0.11	ND	ND	ND	ND
D15	2	0.448	0.282	0.614	1.18	-0.03	2.27	-79	-107	-50	0.07	<0.1	0.20	0.16	ND	ND	ND	ND	ND
IT1	1	NA	-	-	NA	-	-	NA	-	-	0.5	-	-	NA	NA	NA	NA	NA	NA
IT2	1	NA	-	-	NA	-	-	NA	-	-	2.6	-	-	NA	NA	NA	NA	NA	NA
IT3	1	NA	-	-	NA	-	-	NA	-	-	0.4	-	-	NA	NA	NA	NA	NA	NA
IT4	1	NA	-	-	NA	-	-	NA	-	-	0.2	-	-	NA	NA	NA	NA	NA	NA
IT5	1	NA	-	-	NA	-	-	NA	-	-	0.5	-	-	NA	NA	NA	NA	NA	NA
Waste Concentration Facility																			
D8	2	-0.026	-0.205	0.154	2.95	2.38	3.51	212	-	-	3.50	2.00	5.00	0.26	2.91	ND	ND	ND	ND
D9	1	0.307	-	-	2.34	-	-	80	-	-	<0.1	-	-	0.21	1.25	ND	2.17	ND	6.21
D10	1	0.307	-	-	2.57	-	-	80	-	-	<0.1	-	-	0.91	1.45	ND	ND	ND	ND
D11	1	0.102	-	-	1.85	-	-	239	-	-	0.50	-	-	3.08	ND	ND	ND	ND	ND
D12	1	0	-	-	4.80	-	-	451	-	-	3.20	-	-	4.85	ND	ND	ND	ND	ND
Miscellaneous Wells																			
SI	2	0.134	0.113	0.154	1.61	1.47	1.74	-204	-558	150	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND
SE	2	0.159	0.113	0.205	2.50	1.33	3.66	100	50	150	<0.1	<0.1	<0.1	ND	ND	ND	ND	ND	ND
SG	2	0.028	0	0.057	1.34	1.28	1.40	102	25	180	<0.1	<0.1	<0.1	0.42	ND	ND	ND	ND	ND
NYS Drinking Water Standards		15.0			50.0			20,000			8.0			-	-	-	-	-	-
Radiation Concentration Guide														30,000	30,000	100,000	20,000	2,000,000	NL
Typical Minimum Detection Limits		0.53			1.17						0.1			0.24	0.25	0.23	0.25	2.0	0.22

NA: Not analyzed.

ND: Not detected, activity less than the minimum detectable activity.

NS: Not sampled.

*Due to elevated dissolved solids in these water samples, they are analyzed for gross alpha and gross beta concentrations using 100 ml instead of 500 ml aliquots. Consequently, the minimum detectable concentrations for these samples are five times the minimum detectable gross alpha and gross beta concentrations reported in this table.

Table 41
1987 BNL Environmental Monitoring
Ground Water Surveillance Well Radionuclide Data for Waste Management Area

Well ID	Number of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr	^{22}Na	^{60}Co	^{137}Cs
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum				
		<---------- pCi/L ---------->												
MW1	4	0.192	-0.051	0.512	3.55	1.36	7.03	2,854	390	8,110	1.9	0.27	ND	ND
MW2	3	0.051	-0.102	0.154	89.47	62.90	133.0	5,153	3,460	6,580	46.0	NA	NA	NA
WC	2	0.205	0.154	0.256	21.4	20.4	22.4	1,330	1,010	1,650	14.9	0.60	0.14	ND
WD	2	0.128	0	0.256	17.2	12.2	22.1	1,067	823	1,310	12.2	0.25	ND	0.08
WE	1	0.102	-	-	36.6	-	-	108	-	-	NA	NA	NA	NA
MW3	2	-0.179	-0.307	-0.051	0.89	0.57	1.21	560	439	681	<0.1	0.70	ND	ND
MW4	2	-0.128	-0.154	-0.102	4.46	3.93	4.99	473	409	536	1.6	0.45	ND	ND
MW6	3	-0.103	-0.205	0.051	0.49	-0.04	0.83	2,145	844	3,490	0.03	0.08	ND	ND
2L	3	-0.699	-2.560	0.410	2.91	2.23	4.16	1,541	823	2,590	1.1	0.80	ND	ND
MW5	3	-0.017	-0.256	0.102	3.17	2.08	3.78	760	0	1,200	1.2	0.70	ND	ND
2M	2	0.205	-0.154	0.563	2.40	2.19	2.61	1,741	732	2,750	0.1	0.73	ND	ND
2N	2	0.256	0.051	0.461	1.74	1.44	2.14	1,172	793	1,550	<0.1	0.79	ND	ND
MW7A	2	1.384	0.717	2.050	227.50	63.0	392.0	1,026	701	1,350	49.7	0.82	ND	ND
MW7B	2	1.358	0.665	2.050	10.77	5.14	16.4	808	-	-	0.25	0.49	ND	ND
MW13	8	0.395	0	0.960	3.21	2.38	3.93	7,694	1,200	15,400	<0.1	ND	ND	ND
MW8	8	0.324	0	0.847	3.17	1.96	3.93	30,550	13,500	43,000	0.52	ND	0.37	ND
MW12	7	0.271	0	0.512	2.58	1.21	4.00	649	435	1,020	0.03	1.15	0.20	0.14
MW11	3	0.227	-0.051	0.563	4.28	3.02	4.92	0	-125	150	<0.1	ND	ND	ND
MW10	1	-0.051	-	-	3.17	-	-	2,240	-	-	<0.1	ND	0.06	ND
D17	3	0.222	0	0.358	3.77	3.48	4.27	5,943	3,660	10,100	<0.1	ND	ND	ND
NYS Drinking Water Standards		15.0			50.0			20,000			8.0			
Radiation Concentration Guides												30,000	30,000	20,000
Typical Minimum Detection Limits		0.53			1.17			300			0.1	0.25	0.24	0.25

NA: Not analyzed.

ND: Not detected.

Table 42
1987 BNL Environmental Monitoring
Radionuclide Concentrations in Recovery Wells

Sample Location	Number of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr	^{22}Na
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum		
		<---------- pCi/L ---------->										
PW1-A	1	NA	-	-	NA	-	-	NA	-	-	2.9	NA
PW1-B	16	0.067	-0.205	0.614	4.02	0.41	8.27	593	28	987	2.35	0.40
PW2-B	14	0.142	-0.256	0.665	3.72	2.38	5.85	948	134	1,540	1.50	0.16
PW3-B	5	0.184	-0.154	0.870	1.83	0.57	3.29	39,480	19,400	62,400	NS	ND
PW4-B	7	0.007	-0.205	0.154	1.92	0.68	3.78	753	138	1,620	NS	ND
PW5-A	1	NA	-	-	NA	-	-	NA	-	-	3.70	NA
PW5-B	16	0.131	-0.102	0.461	5.56	2.72	8.39	668	-54	3,650	3.15	0.29
Typical Minimum Detectable Concentrations		0.53			1.17			300			0.1	0.25

NA: Not analyzed.

ND: Not detected.

NS = Not sampled.

Table 43
1987 BNL Environmental Monitoring
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	Sulfates	Nitrate-Nitrogen
				<---------- mg/L ---------->		
XF	1	6.1	61	<10.0	<10.0	<2.5
XB	4	6.1 - 6.5	65	2.2	<10.0	<2.5
XC	4	5.6 - 6.3	50	<10.0	1.8	<2.5
XA	4	6.1 - 6.5	207	25.4	17.9	5.7
XD	4	5.4 - 5.8	59	9.0	<10.0	<2.5
XK	1	6.2	178	24.2	10.7	<1.5
XI	1	5.1	57	11.8	3.9	<1.5
XJ	1	5.0	55	9.2	<6.0	<1.5
XY	1	(a)	88	15.3	14.8	<1.5
XZ	1	(a)	62	7.6	16.9	<1.5
XO	1	5.3	78	11.3	<6.0	<1.5
XN	1	5.6	65	<6.0	8.1	<1.5
XL	1	6.3	171	29.0	9.3	<1.5
X1	4	5.0 - 5.5	56	3.4	6.5	0.7
X2	4	5.9 - 6.1	129	20.7	16.7	<2.5
X4	4	6.2 - 6.4	118	18.7	11.4	1.0
XS	4	5.6 - 6.0	68	1.6	<10.0	<2.5
XT	4	6.0 - 6.9	84	<10.0	<10.0	<2.5
NYS Drinking Water Standards		6.5 - 8.5	(b)	250.0	250.0	10.0

(a) No analysis performed.

(b) No standard specified.

Table 44
1987 BNL Environmental Monitoring
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 ---------->									
XF	1	<0.020	0.005	<0.025	<0.02	0.12	<0.0002	<0.02	4.6	0.050	2.0
XB	4	<0.025	<0.005	<0.025	<0.05	0.35	<0.0002	0.03	3.7	<0.025	4.75
XC	4	<0.025	<0.005	<0.025	<0.05	0.30	<0.0002	0.36	4.0	<0.025	0.34
XA	4	<0.025	<0.005	<0.025	0.02	0.10	<0.0002	<0.05	22.7	<0.025	0.30
XD	4	<0.025	<0.005	<0.025	<0.05	<0.05	<0.0002	0.04	4.5	0.013	0.24
XK	1	<0.020	<0.001	<0.005	<0.02	3.80	(a)	0.12	23.3	(a)	0.06
XJ	1	<0.020	<0.001	<0.005	<0.02	0.16	(a)	0.14	4.6	<0.005	0.10
XI	1	<0.020	<0.001	<0.005	<0.02	0.08	(a)	0.09	5.5	<0.005	0.10
XY	1	<0.020	<0.001	<0.005	<0.02	0.20	(a)	0.14	10.1	<0.005	0.45
XZ	1	<0.020	<0.001	<0.005	<0.02	<0.05	(a)	0.21	3.0	<0.005	0.01
XN	1	<0.020	<0.001	<0.005	<0.02	7.50	(a)	0.07	3.3	<0.005	0.23
XO	1	<0.020	<0.001	<0.005	<0.02	<0.05	(a)	0.27	5.8	(a)	0.42
XL	1	<0.020	<0.001	<0.005	<0.02	1.84	(a)	0.05	27.0	(a)	0.07
X1	4	<0.025	<0.005	<0.025	<0.05	<0.075	<0.0002	0.05	4.5	<0.025	0.40
X2	4	<0.025	<0.005	<0.025	<0.05	<0.075	<0.0002	1.41	15.7	<0.025	0.47
X4	4	<0.025	<0.005	<0.025	<0.05	0.57	<0.0002	0.03	15.6	0.001	0.08
XS	3	<0.025	<0.005	<0.025	<0.05	4.50	<0.0002	0.17	3.2	<0.025	0.13
XT	4	<0.025	<0.005	<0.025	<0.05	1.63	<0.0002	0.34	3.9	<0.025	0.25
NYS Drinking Water Standards		0.025	0.01	0.05	1.0	0.30	0.002	0.3	(b)	0.025	5.0

(a) No analysis performed.

(b) No standard specified.

Table 45
1987 BNL Environmental Monitoring
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 ---------->		
XF	1	ND	ND	ND
XA	1	ND	ND	ND
XB	1	ND	ND	ND
XK	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
X1	2	ND	ND	ND
X2	2	ND	ND	ND
X4	2	ND	ND	ND
XS	2	ND	ND	ND
XT	2	ND	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]

ND: Not detected. Average Method Detection Limits were: 1,1,1-trichloroethane - 0.004 mg/L; trichloroethylene - 0.005 mg/L; tetrachloroethylene - 0.006 mg/L

(a) NYSDOH advisory guidelines.

Table 46
1987 BNL Environmental Monitoring
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 ---------->			
XF	1	ND	ND	ND	ND
XA	1	0.008	ND	ND	ND
XB	1	NR	ND	ND	ND
XK	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
X1	2	ND	ND	ND	ND
X2	2	ND	ND	ND	ND
X4	2	ND	ND	ND	ND
XS	2	ND	ND	ND	ND
XT	2	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100

ND: Not detected. Average Method Detection Limits were: chloroform - 0.006 mg/L; chlorodibromomethane - 0.007 mg/L; bromodichloromethane - 0.006 mg/L; bromoform - 0.006 mg/L

NR: Not reported. The sample was analyzed, but the result was not reported since data failed quality assurance tests.

Table 47
1987 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average BTX Data

Well ID	No. of Samples	benzene	toluene	xylene
		<----------	mg/L ----------	---------->
XF	1	NA	NA	NA
XA	1	NA	NA	NA
XB	1	NA	NA	NA
XK	1	ND	0.003	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
X1	1	ND	ND	ND
X2	1	ND	ND	ND
X4	1	ND	ND	ND
XS	1	ND	ND	ND
XT	1	ND	ND	ND
NYS Drinking Water Standards		0.005	(a)	(a)

NA: Not analyzed.

ND: Not detected. Average Method Detection Limits were:
benzene - 0.005 mg/L; toluene - 0.004 mg/L; xylene - 0.005 mg/L

(a) No standard specified.

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	6.8-7.6	357	37.9	17.0	<2.5	<0.025	<0.005	<0.025	<0.05	0.08	<0.0002	0.01	18.7	<0.025	0.11
WR	4	6.3-6.5	775	37.8	5.0	<2.5	<0.025	<0.005	<0.025	<0.05	85.38	<0.0002	4.15	39.1	<0.025	0.21
WS	4	6.4-6.8	1,036	59.0	<10.0	<2.5	<0.025	<0.005	<0.025	<0.05	109.50	<0.0002	1.66	50.4	<0.025	0.06
WT	4	5.1-5.4	183	39.5	19.9	<2.5	<0.025	<0.005	<0.025	<0.05	1.51	<0.0002	0.46	16.5	<0.025	0.59
1K	4	6.1-6.8	706	39.0	<10.0	<2.5	<0.025	<0.005	0.006	<0.05	86.90	<0.0002	5.68	29.0	<0.025	0.18
2C	4	6.2-6.7	899	43.3	6.4	<2.5	<0.025	0.002	<0.025	<0.05	49.90	<0.0002	2.02	33.2	0.008	0.01
W9	4	6.2-6.4	872	47.4	19.6	<2.5	<0.025	<0.005	<0.025	<0.05	86.80	<0.0002	2.33	29.6	<0.025	0.14
WG	1	5.4	175	<10.0	11.6	<2.5	<0.020	<0.005	<0.025	<0.02	7.40	<0.0002	NA	4.6	<0.025	0.70
Former Landfill Area																
D1	4	5.7-5.9	114	<10.0	6.1	<2.5	<0.020	<0.005	<0.025	<0.02	0.02	<0.0002	0.59	3.9	<0.025	0.06
D2	4	5.8-6.1	60	<10.0	3.5	<2.5	<0.020	<0.005	<0.025	<0.05	<0.05	<0.0002	<0.02	4.4	<0.025	0.01
D3	4	5.4-6.2	56	<10.0	2.6	<2.5	<0.020	<0.005	<0.025	0.05	<0.05	<0.0002	0.09	3.6	<0.025	0.02
D4	3	5.8-6.5	115	5.7	13.9	<2.5	<0.020	<0.005	<0.025	<0.02	0.35	<0.0002	0.07	8.3	<0.025	0.02
D5	4	5.7-5.8	77	3.5	9.7	<2.5	<0.020	<0.005	<0.025	<0.05	0.04	<0.0002	<0.02	7.5	0.008	0.03
D6	4	6.3-6.9	284	8.3	43.9	0.7	<0.020	<0.005	<0.025	<0.05	0.01	<0.0002	<0.02	9.4	<0.025	0.02
1I	4	5.4-5.7	71	<10.0	<10.0	<2.5	<0.020	<0.005	<0.025	<0.02	1.06	0.002	0.05	4.5	0.002	0.02
1J	4	5.6-6.0	53	3.3	3.1	<2.5	<0.020	0.001	<0.025	<0.05	0.28	<0.0002	0.06	4.4	<0.025	<0.01
D18	4	6.0-6.7	58	2.2	6.7	<2.5	<0.020	<0.005	<0.025	<0.05	<0.05	<0.0002	<0.02	4.0	<0.025	<0.01
WQ	2	6.0-6.2	61	5.7	10.0	<1.5	<0.020	<0.005	<0.025	<0.02	1.12	<0.0002	0.14	5.2	<0.025	0.01
WP	2	5.4-5.6	60	<6.0	9.1	<1.5	<0.020	<0.005	<0.025	<0.02	2.64	<0.0002	0.12	3.8	<0.025	0.01
WO	3	5.8-6.2	58	<6.0	12.1	<1.5	<0.020	<0.005	<0.025	<0.02	0.92	<0.0002	0.08	3.9	<0.025	<0.01
D19	4	5.7-5.9	79	3.4	7.2	<2.5	<0.020	<0.005	<0.025	<0.05	<0.05	<0.0002	<0.02	3.9	<0.025	<0.01
D16	2	6.0	140	7.3	22.6	<1.5	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	<0.02	6.5	<0.025	<0.01
D20	3	6.3-6.4	122	14.9	5.6	<2.5	<0.020	<0.005	<0.025	<0.05	<0.05	<0.0002	0.04	10.1	<0.025	<0.01
D7	5	6.1-7.1	244	17.5	14.3	<2.5	<0.020	<0.005	<0.025	<0.05	0.32	<0.0002	0.04	19.1	<0.025	0.06
On-Site Control Wells																
SE	1	6.1	476	19.4	16.3	<2.5	<0.020	<0.005	<0.025	<0.05	0.59	<0.0002	0.02	22.0	<0.025	0.01
SI	2	6.3-6.6	348	23.4	16.2	<2.5	<0.020	<0.005	<0.025	<0.05	0.17	<0.0002	0.02	23.0	<0.025	<0.01
SG	2	6.5-6.6	153	24.7	17.7	<2.5	<0.020	<0.005	<0.025	<0.05	0.12	<0.0002	<0.02	19.6	<0.025	0.01
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 49
1987 BNL Environmental Monitoring
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	1	ND	ND	ND
WR	1	ND	ND	ND
WS	1	ND	ND	ND
WT	1	ND	ND	ND
1K	1	ND	ND	ND
2C	1	ND	ND	ND
W9	1	ND	ND	ND
WG	1	ND	ND	ND
Former Landfill				
D1	1	0.021	ND	ND
D2	1	ND	ND	ND
D3	3	0.005	ND	0.002
D4	2	ND	ND	ND
D5	2	ND	ND	ND
D6	1	ND	ND	ND
1I	2	0.007	ND	ND
1J	2	ND	ND	ND
D18	1	ND	ND	ND
WQ	1	0.015	ND	ND
WP	2	0.003	ND	ND
WO	2	ND	ND	ND
D19	1	0.002	ND	ND
D16	1	NA	NA	NA
D20	1	ND	ND	ND
D7	2	ND	ND	ND
On-Site Control Wells				
SE	1	0.024	0.007	ND
SI	2	0.019	0.006	ND
SG	2	0.003	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]

NA: Not analyzed

ND: Not detected.

(a) NYSDOH advisory guidelines.

Table 50
1987 BNL Environmental Monitoring
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	1 (1)	ND	ND	ND	ND
WR	1 (1)	NA	ND	ND	ND
WS	1 (1)	ND	ND	ND	ND
WT	1 (1)	ND	ND	ND	ND
1K	1 (1)	NA	ND	ND	ND
2C	1 (1)	ND	ND	ND	ND
W9	1 (1)	ND	ND	ND	ND
WG	1 (1)	NA	ND	ND	ND
Former Landfill					
D1	4 (1)	ND	ND	ND	ND
D2	1 (1)	ND	ND	ND	ND
D3	3 (3)	0.002	ND	0.012	ND
D4	2 (2)	ND	ND	ND	ND
D5	2 (2)	ND	ND	ND	ND
D6	1 (1)	ND	ND	ND	ND
1I	2 (2)	ND	ND	ND	ND
1J	2 (2)	ND	ND	ND	ND
D18	2 (1)	ND	ND	ND	ND
WQ	1 (1)	ND	ND	ND	ND
WP	2 (2)	ND	ND	ND	ND
WO	2 (2)	ND	ND	ND	ND
D19	1 (1)	ND	ND	ND	ND
D16	1 (0)	NA	NA	NA	NA
D20	1 (1)	ND	ND	ND	ND
D7	2 (2)	ND	ND	ND	ND
On-Site Control Wells					
SE	2 (1)	0.006	ND	ND	ND
SI	2 (2)	0.007	ND	ND	ND
SG	2 (2)	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100

NA: Not analyzed

ND: Not detected.

* Number inside parenthesis represents number of chloroform samples; number outside parenthesis represents number of samples for all other trihalomethane compounds.

Table 51
1987 BNL Environmental Monitoring
Landfill Areas
Ground Water Surveillance Wells, Average BTX Data

Well ID	No. of Samples	benzene	toluene	xylene
		<---------- mg/L ---------->		
Current Landfill				
W6	1	ND	ND	NA
WR	1	NA	NA	NA
WS	1	0.008	ND	NA
WT	1	ND	ND	NA
1K	1	NA	NA	NA
2C	1	0.019	ND	NA
W9	1	0.009	ND	NA
WG	1	NA	NA	NA
Former Landfill				
D1	1	ND	ND	NA
D2	1	NA	NA	NA
D3	2	ND	ND	ND
D4	2	ND	ND	ND
D5	1	ND	ND	ND
D6	1	NA	NA	NA
1I	1	ND	NA	NA
1J	1	ND	NA	NA
D18	2	ND	ND	ND
WQ	1	ND	ND	ND
WP	1	ND	ND	ND
WO	2	NA	NA	NA
D19	1	ND	ND	ND
D16	1	NA	NA	NA
D20	1	ND	ND	ND
D7	1	ND	ND	ND
On-Site Control Wells				
SE	1	NA	ND	ND
SI	1	NA	ND	ND
SG	1	NA	ND	ND
NYS Drinking Water Standards		0.005	(a)	(a)

NA: Not analyzed.
ND: Not detected.
(a) No standard specified.

Table 52
1987 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples*	pH (su)	Conductivity (umhos/cm)	Chlorides	Sulfates	Nitrate-Nitrogen
				<---------- mg/L ---------->		
MW1	3 (2)	5.3 - 5.8	110.3	18.3	11.6	<1.5
MW2	3 (2)	5.9 - 6.3	134.7	<8.0	28.9	<2.0
WC	2 (1)	5.5 - 5.7	104.5	<10.0	18.9	<2.5
WD	2 (1)	6.1 - 6.4	89.0	<10.0	13.8	<2.5
MW3	2 (2)	5.4 - 5.9	94.0	14.0	12.9	<1.5
MW4	2 (2)	5.8 - 6.0	96.5	12.8	13.5	<1.5
MW6	3 (2)	5.3 - 5.9	106.7	5.1	17.2	<1.5
2L	3 (2)	5.4 - 6.0	78.0	12.6	11.3	<2.5
MW5	3 (3)	5.4 - 6.5	99.0	13.4	14.1	<1.5
2M	2 (1)	6.0	81.5	12.3	12.6	<2.5
2N	2 (1)	5.9 - 6.0	85.0	12.7	13.5	<2.5
MW7A	2 (2)	5.3 - 5.4	114.0	13.2	16.4	<2.5
MW7B	2 (2)	5.5 - 5.9	89.5	14.0	13.3	<2.5
MW13	4 (3)	5.6 - 6.0	78.3	<10.0	9.0	<2.5
MW8	3 (3)	5.4 - 6.0	75.5	<10.0	13.8	<2.5
MW12	2 (2)	5.5 - 6.0	68.0	<10.0	13.4	<2.5
MW11	3 (3)	5.5 - 5.8	83.3	<10.0	13.1	<2.5
MW10	3 (3)	5.6 - 6.0	82.7	10.1	13.8	<2.5
D17	3 (3)	5.9 - 6.2	108.0	8.2	28.0	0.8
NYS Drinking Water Standards		6.5 - 8.5	(a)	250.0	250.0	10.0

(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 53
1987 BNL Environmental Monitoring
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	3	<0.025	<0.005	<0.025	<0.05	<0.075	<0.0002	0.24	9.1	<0.025	<0.02
MW2	3	<0.025	<0.005	<0.025	<0.05	<0.075	<0.0002	0.02	5.9	<0.025	<0.02
WC	2	<0.020	<0.005	<0.025	<0.02	0.27	<0.0002	0.04	8.8	<0.025	0.39
WD	2	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	<0.02	7.6	<0.025	0.65
MW3	2	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	<0.02	9.4	<0.025	<0.01
MW4	2	<0.020	<0.005	<0.025	<0.02	0.09	<0.0002	<0.02	8.4	<0.025	<0.01
MW6	3	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	<0.02	7.6	<0.025	<0.01
2L	3	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	0.05	7.5	<0.025	0.01
MW5	3	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	0.01	7.8	<0.025	<0.01
2M	2	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	0.04	8.1	<0.025	0.02
2N	2	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	0.01	7.9	<0.025	0.01
MW7A	2	<0.020	<0.005	<0.025	<0.02	0.36	<0.0002	0.03	7.8	<0.025	<0.01
MW7B	2	<0.020	<0.005	<0.025	<0.02	2.06	<0.0002	0.05	8.4	0.003	<0.01
MW13	4	<0.025	<0.005	<0.025	<0.05	0.38	<0.0002	0.02	5.6	<0.025	<0.02
MW8	3	<0.025	<0.005	<0.025	<0.05	0.25	<0.0002	0.02	5.7	<0.025	<0.02
MW12	2	<0.025	<0.001	<0.005	<0.05	0.44	<0.0002	0.03	5.7	0.003	0.02
MW11	3	<0.020	<0.005	<0.025	<0.05	0.22	<0.0002	0.02	4.0	0.046	<0.01
MW10	3	<0.020	<0.005	<0.025	<0.05	0.31	<0.0002	0.03	4.9	0.002	0.01
D17	3	<0.020	<0.005	<0.025	<0.02	<0.05	<0.0002	<0.02	5.9	<0.025	<0.01
NYS Drinking Water Standards		0.025	0.01	0.05	1.0	0.30	0.002	0.3	(a)	0.025	5.0

(a) No standard specified.

Table 54
1987 BNL Environmental Monitoring
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	0.027	ND	0.140*
WC	1	0.009	ND	ND
WD	1	ND	ND	ND
MW3	2	ND	ND	ND
MW4	2	ND	ND	ND
MW6	2	0.003	0.023	0.070*
2L	1	0.003	ND	ND
MW5	3	ND	ND	ND
2M	1	ND	ND	ND
2N	1	ND	ND	ND
MW7A	1	ND	ND	0.008
MW7B	2	ND	ND	0.004
MW13	3	0.014	0.002	ND
MW8	4	0.004	ND	ND
MW12	2	ND	ND	ND
MW11	2	ND	ND	ND
MW10	2	0.008	ND	ND
D17	1	0.038	ND	ND
NYS Drinking Water Standards		0.050[a]	0.005	0.050[a]

ND: Not detected.

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

(a) NYSDOH advisory guidelines.

Table 55
1987 BNL Environmental Monitoring
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	1	ND	ND	ND	ND
WC	1	ND	NA	ND	ND
WD	1	ND	NA	ND	ND
MW3	2	ND	ND	ND	ND
MW4	2	ND	ND	ND	ND
MW6	2	0.032	ND	ND	ND
2L	1	ND	ND	ND	ND
MW5	3	ND	ND	ND	ND
2M	1	ND	NA	ND	ND
2N	1	ND	NA	ND	ND
MW7A	1	ND	0.008	ND	ND
MW7B	2	ND	ND	ND	ND
MW13	3	ND	ND	ND	ND
MW8	4	ND	ND	ND	ND
MW12	2	0.003	ND	ND	ND
MW11	2	ND	ND	ND	ND
MW10	2	ND	ND	ND	ND
D17	1	ND	NA	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100

ND: Not detected.

NA: Not analyzed.

Table 56
1987 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average BTX Data

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

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 57
1987 BNL Environmental Monitoring
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	8	0.001	ND	ND
PW1-B	3	ND	ND	ND
PW2-A	10	ND	ND	ND
PW2-B	3	ND	ND	ND
PW3-A	2	0.097**	ND	ND
PW3-B	1	ND	ND	ND
PW4-A	3	0.015	ND	ND
PW4-B	1	ND	ND	ND
PW5-A	9	0.020	0.001	0.005
PW5-B	3	ND	ND	ND
NYS Drinking Water Standards		0.050(a)	0.005	0.050(a)

ND: Not detected. Average Method Detection Limits were:
1,1,1-trichloroethane - 0.004 mg/L; trichloroethylene - 0.005 mg/L;
tetrachloroethane - 0.006 mg/L.

* 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.

(a) NYSDOH advisory guidelines.

Table 58
1987 BNL Environmental Monitoring
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	7 (8)	ND	ND	ND	ND
PW1-B	8 (3)	ND	ND	ND	ND
PW2-A	9 (10)	ND	ND	ND	ND
PW2-B	8 (3)	ND	ND	ND	ND
PW3-A	2 (2)	ND	ND	ND	ND
PW3-B	2 (1)	ND	ND	ND	ND
PW4-A	3 (3)	0.014	ND	ND	ND
PW4-B	2 (1)	ND	ND	ND	ND
PW5-A	7 (9)	ND	ND	ND	ND
PW5-B	8 (3)	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.100	0.100	0.100

ND: Not detected. Average Method Detection Limits were:
chloroform - 0.006 mg/L; chlorodibromomethane - 0.007 mg/L;
bromodichloromethane - 0.006 mg/L; bromoform - 0.006 mg/L

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

** Number inside parenthesis indicates number of chloroform samples; number outside parenthesis indicates number of samples for all other trihalomethane compounds.

Table 59
1987 BNL Environmental Monitoring
Ground Water Restoration Project at Waste Management Area
Average BTX Data

Well ID*	No. of Samples**	benzene	toluene	xylene
		<---------- mg/L ---------->		
PW1-A	4 (4)	ND	ND	ND
PW1-B	8 (7)	ND	ND	ND
PW2-A	6 (6)	ND	ND	ND
PW2-B	8 (6)	ND	ND	ND
PW3-A	2 (2)	NA	NA	NA
PW3-B	2 (2)	ND	ND	NA
PW4-A	3 (3)	ND	ND	NA
PW4-B	2 (2)	ND	ND	NA
PW5-A	7 (5)	ND	ND	ND
PW5-B	8 (6)	ND	ND	ND
NYS Drinking Water Standards		0.005	(a)	(a)

NA: Not analyzed.

ND: Not detected. Average Method Detection Limits were: benzene - 0.005 mg/L; toluene - 0.004 mg/L; xylene - 0.005 mg/L.

* 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 60
1987 BNL Environmental Monitoring
Major Petroleum Facility (MPF)
Ground Water Surveillance Wells, Average Water Quality and Metals Data

	Well ID				NYS Drinking Water Standard
	D8	D13	D14	D15	
Number of Samples*	3 (2)	2 (2)	2 (2)	2 (2)	
pH (su)	5.8-6.6	6.4-6.6	5.9-6.3	5.8-6.3	6.5-8.5
Conductivity (umhos/cm)	144	406	209	129	(a)
Chlorides (mg/L)	24.4	18.3	16.6	11.9	250.0
Sulfates (mg/L)	19.4	15.8	18.3	15.3	250.0
Nitrates (mg/L)	1.1	<2.5	<2.5	<2.5	10.0
Results in mg/L					
Ag	<0.02	<0.02	<0.02	<0.02	0.05
Cd	<0.005	<0.005	0.0007	0.0007	0.01
Cr	<0.025	<0.025	<0.025	<0.025	0.05
Cu	<0.02	<0.05	<0.05	<0.05	1.0
Fe	0.54	0.09	1.14	0.03	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	0.002
Mn	0.02	0.15	0.04	6.1	0.3
Na	11.7	18.9	9.5	8.1	(a)
Pb	0.020	<0.025	<0.025	<0.025	0.025
Zn	0.01	0.02	0.01	<0.01	5.0

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

(a) No standard specified.

Table 61
1987 BNL Environmental Monitoring
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 (9)	max:	ND	ND	ND	ND
		min:				
D13	2 (12)	max:	ND	ND	ND	ND
		min:				
D14	2 (12)	max:	ND	0.017	ND	ND
		min:		ND		
D15	2 (12)	max:	ND	0.003	ND	ND
		min:		ND		
NYS Drinking Water Standards			0.005	(a)	(a)	

ND: Not detected. Average detection limits: benzene - 0.002 mg/L; toluene - 0.002 mg/L; xylene - 0.002 mg/L; free product - no visible sheen.

* 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 62
1987 BNL Environmental Monitoring
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	
lumber of Samples*	3 (2)	1 (1)	1 (1)	1 (0)	2 (1)	
H (su)	5.8-6.6	5.9	6.5	6.2	5.7-6.3	6.5-8.5
onductivity umhos/cm)	144	146	128	124	172	(a)
hlorides (mg/L)	24.4	23.6	17.3	NA	22.6	250.0
ulfates (mg/L)	19.4	16.3	16.3	NA	26.0	250.0
itrates (mg/L)	1.1	<2.5	<2.5	NA	2.8	10.0
esults in mg/L						
g	<0.02	<0.02	<0.02	NA	<0.02	0.05
d	<0.005	<0.005	<0.005	NA	<0.005	0.01
r	<0.025	<0.025	<0.025	NA	<0.025	0.05
u	<0.02	<0.02	<0.02	NA	<0.02	1.0
e	0.54	<0.05	<0.05	NA	<0.05	0.3
g	<0.0002	<0.0002	<0.0002	NA	<0.0002	0.002
n	0.02	<0.02	<0.02	NA	<0.02	0.3
a	11.7	13.7	11.6	NA	12.2	(a)
b	0.020	<0.025	<0.025	NA	<0.025	0.025
n	0.01	0.01	<0.01	NA	<0.01	5.0

IA: Not analyzed.

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

a) No standard specified.

Table 63
1987 BNL Environmental Monitoring
Tritium Committed Effective Dose Equivalent
at the Site Boundary Monitoring Stations

Location ID	Sector ID	Net Average Air Concentration pCi/m^3	Committed Effective Dose Equivalent* mrem
1T	N	0.52	4.1E-04
2T	NNE	0.63	5.1E-04
3T	NE	4.95	3.9E-03
4T	ENE	3.96	3.1E-03
5T	E	3.57	2.8E-03
6T1	ESE	2.67	2.1E-03
6T2	ESE	2.15	1.7E-03
7T	SE	4.86	3.9E-03
8T	SSE	4.38	3.5E-03
9T	S	2.31	1.8E-03
10T	SSW	1.85	1.5E-03
11T	SW	3.12	2.5E-03
12T	WSW	1.01	8.0E-04
13T	W	1.36	1.1E-03
14T	WNW	1.58	1.3E-03
15T	NW	1.49	1.2E-03
16T	NNW	1.55	1.2E-03
20T	Central Site	4.74	3.8E-03

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

Table 64
1987 BNL Environmental Monitoring
Site Boundary Tritium Committed Effective Dose Equivalent
Calculated and Measured Values

Direction	HWMA* 10M ^3H mrem	10M ^3H mrem	100M ^3H mrem	Total mrem	Total & Skin Absorption	Measured Dose mrem
N	4.5E-07	0.0013	0.00016	0.0015	0.0023	0.0004
NNW	3.1E-07	0.0016	0.00009	0.0017	0.0026	0.0012
NW	3.5E-07	0.0013	0.00010	0.0014	0.0021	0.0012
WNW	3.0E-07	0.0011	0.00010	0.0012	0.0018	0.0013
W	3.0E-07	0.0009	0.00013	0.0010	0.0015	0.0011
WSW	8.9E-07	0.0011	0.00014	0.0012	0.0018	0.0008
SW	1.1E-06	0.0009	0.00017	0.0011	0.0017	0.0025
SSW	1.2E-06	0.0012	0.00019	0.0014	0.0021	0.0015
S	1.4E-06	0.0016	0.00022	0.0018	0.0027	0.0018
SSE	1.4E-06	0.0016	0.00022	0.0018	0.0027	0.0035
SE	1.7E-06	0.0021	0.00025	0.0024	0.0036	0.0039
ESE	1.5E-06	0.0018	0.00021	0.0020	0.0030	0.0019
E	1.1E-06	0.0016	0.00014	0.0017	0.0027	0.0028
ENE	5.3E-07	0.0015	0.00012	0.0016	0.0024	0.0031
NE	6.9E-07	0.0020	0.00018	0.0022	0.0033	0.0039
NNE	8.0E-07	0.0021	0.00027	0.0024	0.0026	0.0005

*750 meters distance to site boundary used for WSW to E direction.

Table 65
1987 BNL Environmental Monitoring
External Exposure Rates at the Site Boundary from Argon-41 and Oxygen-15

Direction	^{41}Ar mrem	^{15}O mrem	Total mrem
N	0.025	0.005	0.030
NNW	0.016	0.003	0.019
NW	0.018	0.004	0.022
WNW	0.017	0.003	0.020
W	0.020	0.002	0.022
WSW	0.022	0.003	0.025
SW	0.026	0.004	0.030
SSW	0.029	0.006	0.035
S	0.035	0.007	0.042
SSE	0.035	0.007	0.042
SE	0.042	0.010	0.052
ESE	0.037	0.009	0.046
E	0.028	0.008	0.036
SNE	0.024	0.008	0.032
NE	0.034	0.010	0.044
NNE	0.046	0.010	0.056

Table 66
1987 BNL Environmental Monitoring
Collective Total Body and Thyroid Dose
from 10 and 45 Meter Stack Releases

Nuclide	Collective Dose person-mrem	Thyroid person-mrem
^{7}Be	6.27E-05	-
^{77}Br	3.28E-06	-
^{60}Co	5.98E-02	-
^{3}H	1.73E+02	-
^{15}O	2.99E-01	-
^{75}Se	4.72E-05	-
^{82}Sr	3.16E-03	-
^{127}Xe	7.82E-05	-
^{14}C	4.93E-03	-
^{51}Cr	1.90E-02	-
^{59}Fe	5.73E-04	-
^{125}I	4.60E-02	6.60E-01
^{131}I	4.31E-02	8.51E-01
^{32}P	5.62E-05	-
^{35}S	5.91E-03	-
^{113}Sn	1.70E-01	-
^{99}Tc	1.83E-02	-
^{99m}Tc	5.91E-06	-
^{41}Ar	2.23E+03	-
Total	2.40E+03	1.51E+00

Table 67
1987 BNL Environmental Monitoring
Collective Total Body and Thyroid Dose from 100 Meter Stack Releases

Nuclide	Collective Dose person-mrem	Thyroid person-mrem
^{74}As	1.83E-03	-
^{140}Ba	2.81E-05	-
^{77}Br	2.77E-02	-
^{82}Br	2.52E-01	-
^{143}Ce	1.02E-05	-
^{60}Co	1.69E+00	-
^{155}Eu	1.41E-03	-
^{3}H	2.40E+01	-
^{203}Hg	1.44E-04	-
^{124}I	1.39E-02	3.32E-01
^{126}I	3.84E-01	5.83E+00
^{131}I	2.04E-02	2.95E-01
^{133}I	9.65E-03	1.88E-01
^{54}Mn	2.01E-03	-
^{22}Na	1.79E-01	-
^{125}Sb	5.86E-04	-
^{75}Se	1.59E-02	-
Total	2.66E+01	6.65E+00

Table 68
1987 BNL Environmental Monitoring
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	0.068	12.0
Fish	^{137}Cs	0.39	150.0

Table 69
1987 Environmental Monitoring Report
Collective Dose from All Pathways

Pathway	Collective Dose person-mrem	Thyroid person-mrem
Air	2.40E+03	8.2
Water	1.20E+01	-
Fish	1.50E+02	-
Total	2.60E+03	8.2

Table 70
1987 Environmental Monitoring
Pathway Analysis for Hypothetical Site Boundary
Use of Liquid Effluent From the STP

Pathway	Critical Population	Fraction of Total Dose			
		^{3}H	^{90}Sr	^{137}Cs	All Nuclides
Direct Ingestion-Man	Infant	0.074	0.211	0.005	0.290
Water-Cow-Milk-Man		0.045	0.010	0.003	0.058
Water-Goat-Milk-Man		0.100	0.024	0.011	0.137
Water-Meat-Man		0	0	0	0
Water-Swimming-Man		0	0	0	0
Irrigation Water-Vegetation-Man		0	0	0	0
Irrigation Water-Forage-Cow-Milk-Man		0.037	0.089	0.029	0.163
Irrigation Water-Forage-Goat-Milk-Man		0.074	0.190	0.084	0.353
Irrigation Water-Forage-Meat-Man		0	0	0	0
TOTAL PATHWAY		0.33	0.524	0.132	1.00
Direct Ingestion-Man	Child	0.017	0.069	0.002	0.088
Water-Cow-Milk-Man		0.007	0.002	0.001	0.010
Water-Goat-Milk-Man		0.016	0.005	0.003	0.023
Water-Meat-Man		0.001	0	0	0.001
Water-Swimming-Man		0	0	0	0
Irrigation Water-Vegetation-Man		0.014	0.735	0.018	0.759
Irrigation Water-Forage-Cow-Milk-Man		0.006	0.019	0.007	0.033
Irrigation Water-Forage-Goat-Milk-Man		0.011	0.040	0.022	0.072
Irrigation Water-Forage-Meat-Man		0.001	0.002	0	0.003
TOTAL PATHWAY		0.073	0.872	0.053	0.984
Direct Ingestion-Man	Teenager	0.015	0.053	0.003	0.071
Water-Cow-Milk-Man		0.007	0.002	0.002	0.011
Water-Goat-Milk-Man		0.016	0.005	0.006	0.025
Water-Meat-Man		0.001	0	0	0.002
Water-Swimming-Man		0	0	0	0
Irrigation Water-Vegetation-Man		0.015	0.706	0.041	0.765
Irrigation Water-Forage-Cow-Milk-Man		0.006	0.018	0.016	0.041
Irrigation Water-Forage-Goat-Milk-Man		0.012	0.037	0.047	0.096
Irrigation Water-Forage-Meat-Man		0.001	0.002	0.001	0.004
TOTAL PATHWAY		0.073	0.823	0.116	1.015
Direct Ingestion-Man	Adult	0.024	0.078	0.007	0.109
Water-Cow-Milk-Man		0.006	0.002	0.002	0.010
Water-Goat-Milk-Man		0.014	0.004	0.007	0.024
Water-Meat-Man		0.003	0	0	0.003
Water-Swimming-Man		0	0	0	0
Irrigation Water-Vegetation-Man		0.015	0.644	0.058	0.711
Irrigation Water-Forage-Cow-Milk-Man		0.005	0.014	0.019	0.038
Irrigation Water-Forage-Goat-Milk-Man		0.010	0.029	0.058	0.098
Irrigation Water-Forage-Meat-Man		0.002	0.004	0.002	0.008
TOTAL PATHWAY		0.079	0.775	0.153	1.001

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 20% of all samples processed were connected with quality control, and these included blanks, replicates and spikes. Where possible, analysts participated in blind round robin tests organized by DOE, EPA, or NYSDEC.

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

APPENDIX F

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