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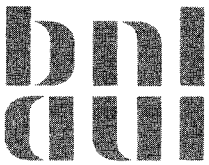
1984 ENVIRONMENTAL MONITORING REPORT

L.E. Day, R.P. Miltenberger, and J.R. Naidu, Editors



April 1985

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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L.E. Day, R.P. Miltenberger, and J.R. Naidu, Editors

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SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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BROOKHAVEN NATIONAL LABORATORY
ANNUAL ENVIRONMENTAL REPORT

CONTENTS

CONTENTS (Cont'd)

FIGURES

TABLES

APPENDIX D TABLES

APPENDIX D TABLES (Cont'd)

APPENDIX D TABLES (Cont'd)

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 have functioned as designed and planned from the standpoint of containment of radioactivity, and

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

The Laboratory's environmental monitoring program is designed and developed to accomplish these two primary objectives. While this annual report for calendar year 1984 follows the recommendations given in 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), the scope has been broadened to meet site-specific environmental monitoring needs at BNL. This program also includes the sampling and analysis of nonradiological pollutants, and indices of water quality. These latter aspects reflect the concern about environmental quality, particularly with regard to the local interest in the preservation of the purity of the aquifer underlying Long Island (3).

1.2 Site Characteristics

Brookhaven National Laboratory is a multidisciplinary scientific research center. It is located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its situation with regard to surrounding communities is shown in Figure 1. About 1.3 million persons reside in Suffolk County (4) and about 0.38 million persons reside in Brookhaven Township, within which the Laboratory is situated. The nearby population centers are located in shoreline communities. The distribution of the resident population within 80 km of the BNL site is shown in Figure 1. Although much of the land area within a 16 km radius is either forested or under cultivation, there has been continuing development of suburban housing west of the Laboratory during recent years.

The Laboratory site is shown in Figure 2. It consists of some 2130 hectares (ha), most of which is wooded, except for a developed area of about 655 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, with a principal tributary of the river rising in marshy areas in the northern and eastern sections of the site.

In terms of meteorology, the Laboratory can be characterized as a well-ventilated site. In common with most of the eastern seaboard, its prevailing ground level winds are from the southwest during the summer, from the northwest

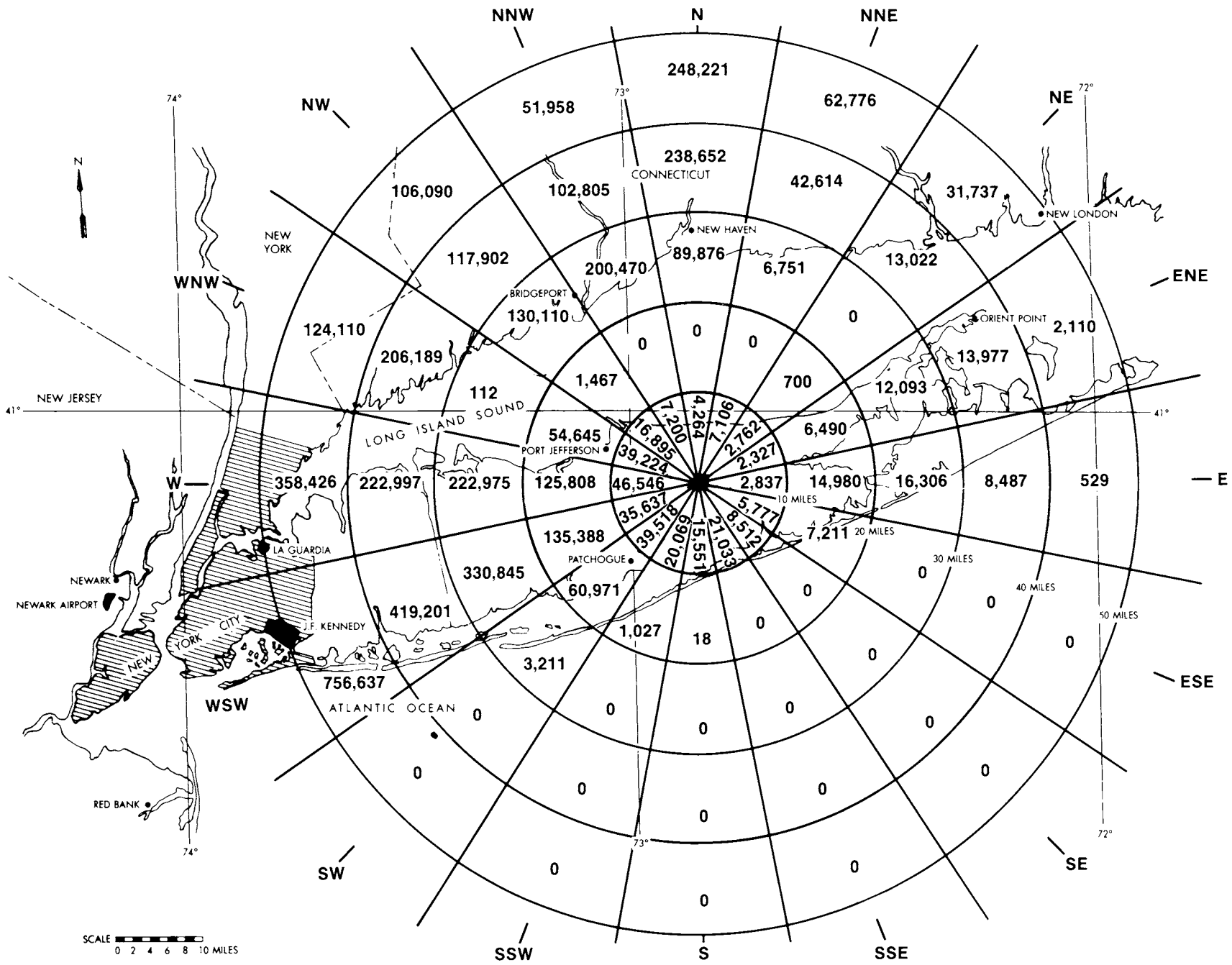
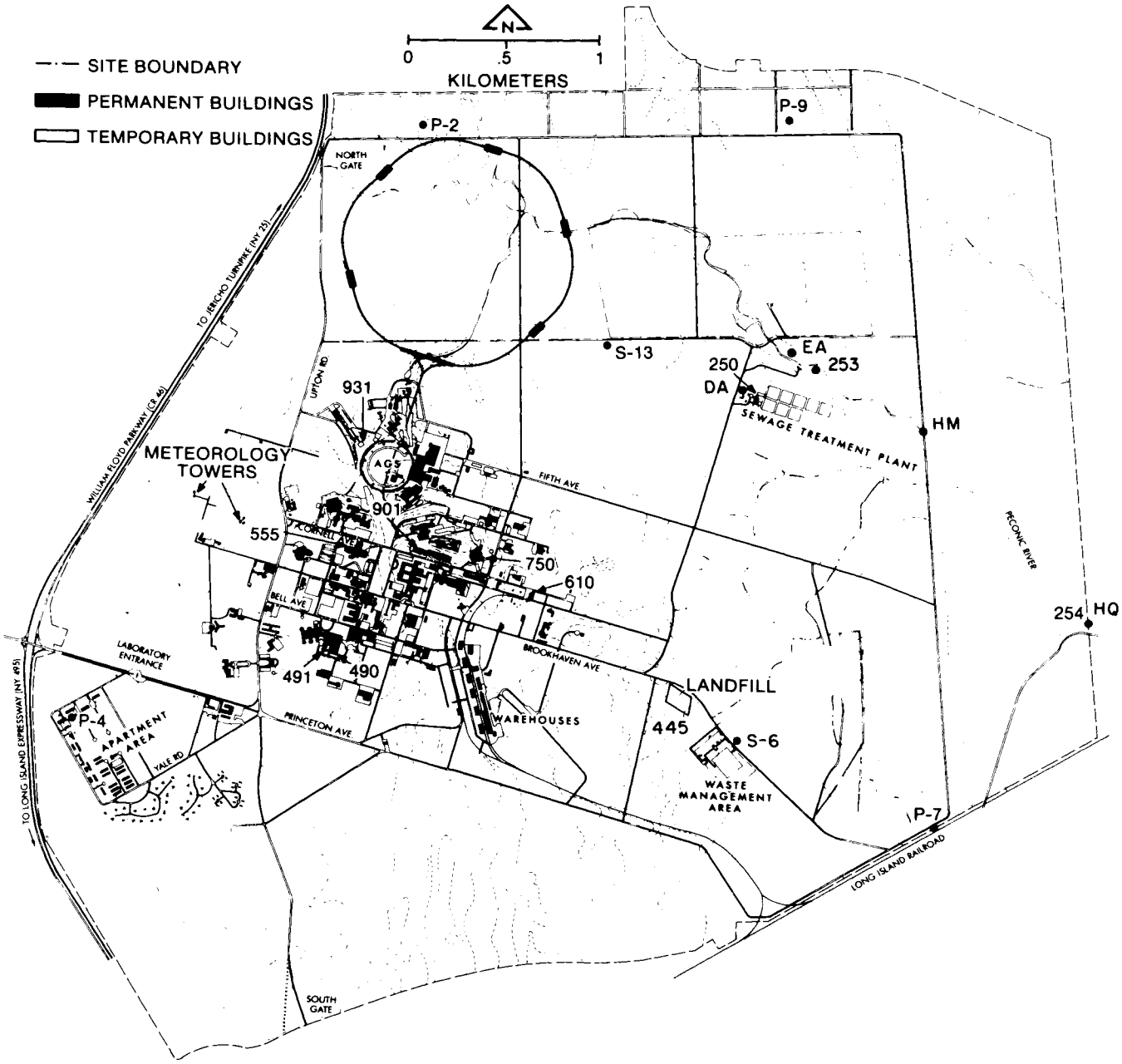


Figure 1. 1984 Resident population within a 50 mile radius of BNL.

BROOKHAVEN NATIONAL LABORATORY SITE



ENVIRONMENTAL MONITORING STATIONS	
AIR	
P-2	NORTHWEST PERIMETER
P-4	SOUTHWEST PERIMETER
P-7	SOUTHEAST PERIMETER
P-9	NORTHEAST PERIMETER
S-6	WASTE MANAGEMENT AREA
S-13	SW CORNER, ECOLOGY FIELD
WATER	
DA	SEWAGE TREATMENT PLANT INFLUENT
EA	SEWAGE TREATMENT PLANT EFFLUENT
HM	PECONIC RIVER, 0.5 MI. DOWNSTREAM FROM TREATMENT PLANT
HQ	SITE BOUNDARY

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

Figure 2.

during the winter, and about equally from these two directions during the spring and fall [5].

Studies of Long Island hydrology and geology [6-8] 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 1984 was 144 cm. On the average about half of this annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates to recharge groundwater. The groundwater in the vicinity of the Laboratory moves predominantly in a horizontal direction to the Great South Bay [6]. It takes a more easterly direction in the Peconic River watershed portions of the site. The estimated rate of movement at the groundwater surface is about 30 cm d^{-1} [6].

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 include the following:

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

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

3) The Alternating Gradient Synchrotron (AGS), a proton accelerator, operates at energies up to 33 GeV, and is used for high energy physics research.

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

5) The Tandem Van de Graaff, Vertical Accelerator, and Chemistry Van de Graaff are used in medium energy physics investigations, as well as for special nuclide production.

6) The National Synchrotron Light Source utilizes a linear accelerator and booster synchrotron as an injection system for two electron storage rings which operate at energies of 700 MeV vacuum ultraviolet (VUV) and 2.5 GeV (x-ray). It is used for VUV spectroscopy and for x-ray diffraction studies.

Additional programs involving irradiations and/or the use of radionuclides for scientific investigations are carried on at other Laboratory facilities including those of the Medical Research Center, 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. Liquid radioactive waste is processed at the BNL waste concentration facility.

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, BLIP and the research Van de Graaff, with lesser contributions from the Chemistry Building and Medical Research Center. The HFBR and BLIP contribute principally to the Laboratory's liquid radioactive wastes. Additional smaller contributions originate from the Medical Research Center, the Hot Laboratory complex, as well as from decontamination and laundry operations.

2.0 SUMMARY

The environmental monitoring program has been designed to ensure that BNL facilities operate such that the applicable environmental standards and effluent control requirements have been met. A listing, as required by DOE Order 5484.1 of BNL facilities, of environmental agencies and permits is provided in the Environmental Program Information Section 3.0, Table B.

Since the aquifer underlying Long Island has been designated a "sole source" aquifer, the Environmental Protection Agency (EPA) Drinking Water Standards have been used in the assessment of ground water data. However, the limits prescribed in the regulations are not directly applicable to the monitoring well data since (i) the standards apply to a community water supply systems, i.e., one serving more than 25 individuals, and (ii) the standards represent an annual average concentration. Since the monitoring wells are not components of the Laboratory's water supply system, the EPA drinking water standards are employed as reference criteria to which the surveillance well data is compared. The standards also serve as guidance levels for any appropriate remedial action.

A significant feature of the "sole source" aquifer designation is that standards applicable to ground water are much more stringent than surface water standards (if not designated as potable supply). For example, with reference to radioactivity, the EPA standards are applied to ground water community supply systems while the Radiation Concentration Guides (RCG) are applied to non-potable surface waters. This results in BNL effluents being compared to two sets of evaluative criteria.

In 1984, the surveillance program determined that the Laboratory has operated within applicable environmental standards. The principal radionuclide of significance detected off-site was tritium. At the site boundary, the concentration of tritium was 0.003% of the RCG in air, 0.2% of the RCG in surface water, and 27% of the EPA Drinking Water Standard in an off-site ground water surveillance well. The total dose for all pathways to the off-site population within 80 km of the Laboratory was 0.05 person-rem.

The environmental levels of radioactivity and other pollutants found in the vicinity of BNL during 1984 are summarized in this report. Detailed data are not included in the main body of the report, but are tabulated and presented in Appendix D. The environmental data include external radiation levels; radioactive air particulates; tritium concentrations; the amounts and concentrations of radioactivity in and the water quality of the stream into which liquid effluents are released; the concentrations of radioactivity in biota from the stream; the concentrations of radioactivity in and the water quality of ground waters underlying the Laboratory; and concentrations of radioactivity in milk samples obtained in the vicinity of the Laboratory. Due to the length of the analytical procedure, all strontium-90 data will be presented in an addendum to this report.

2.1 External Radiation

Thermoluminescent Dosimeter (TLDs) were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1984 was 62.5 mrem while the off-site integrated dose was 59.7 mrem. Based on statistical analysis of these data, there is no significant difference between these two mean values. The Laboratory did not have a measurable impact on the exposure rate at the site boundary.

2.2 Air and Rainfall

2.2.1 Radioactivity

Tritium was the predominant BNL radioactive effluent detected in environmental air samples. Other radionuclides detected were I-126 and Be-7. The largest annual concentration of tritium in air at the site boundary, 5.2 pCi m^{-3} was 0.003% of the RCG. In precipitation, the major radionuclides detected were tritium and Be-7. The largest average concentration of tritium in precipitation was 120 nCi m^{-2} and 19 nCi m^{-2} for Be-7. The total site wide deposition was 6.8 Ci of tritium and 0.75Ci of Be-7.

2.2.2 Air - Nonradioactive

At the central Steam Plant, stack testing conducted in 1983 on the combustion of Alternate Liquid Fuels as part of an EPA study (30) indicated that SO_2 and NO_x emissions were reduced by 70% and 64%, respectively, when compared to the combustion of No. 6 oil. Calculations based on meterological parameters indicate that at the site boundary, the average concentrations of SO_2 and NO_x, resulting from the steam plant operations, were 0.04 $\mu g\ m^{-3}$, and 0.03 $\mu g\ m^{-3}$ respectively. These values are approximately 1% of the applicable ambient air quality standards. The EPA tests also indicated that 99.99% destruction efficiencies were achieved for the designated principal organic hazardous constituents (POHCs) present in the waste fuel (30).

2.3 Soil and Vegetation

No nuclides were detected that were attributable to Laboratory operations.

2.4 Liquid Effluents

2.4.1 Sewage Treatment Plant

Of the sewage effluent released onto the sand filter beds of the Laboratory sewage treatment plant, 88% flowed directly into the Peconic River. The balance (12%) was assumed to have percolated into the ground water underlying the beds. The gross beta concentration of the output from them was 15.8 pCi l^{-1}, or 0.5% of the Radiation Concentration Guide (RCG). The tritium concentration was 12.5 nCi l^{-1}, or 0.4% of the RCG. The same concentration was assumed for the infiltration into groundwater.

During the fall, elevated levels of tritium were detected in the sewage treatment plant effluent. The maximum concentration was 17% of the New York State (26) and DOE effluent release criteria (14).

2.4.2 State Pollutant Discharge Elimination System Permit

Except for 5 daily pH levels which were lower than the permit limit, and one instance of Fe and Zn concentrations, all reportable non-radiological parameters of the Laboratory sewage effluent were within the limits set forth in the Laboratory's permit, issued by the New York State Department of Environmental Conservation under the State Pollution Discharge Elimination System (SPDES). The average water quality of the sewage treatment plant effluent at the point of discharge was at or within water quality standards for the receiving body of water, and in most instances, met drinking water quality standards.

2.5 Peconic River

2.5.1 On-Site

At the former site boundary (Station M), the gross beta concentration was 5.32 pCi l^{-1}, or 0.2% of the RCG, and the tritium concentration was 5.92 nCi l^{-1},

or 0.2% of the RCG. At the site boundary, the gross beta concentration was 5.51 pCi l^{-1}, or 0.2% of the RCG, and the tritium concentration was 5.7 nCi l^{-1}, or 0.2% of the RCG.

2.5.2 Off-Site

The Peconic River was sampled in Riverhead, approximately 19.5 km downstream of the site boundary, on a proportional basis for nine months of calendar year 1984. The average gross alpha concentration was 0.33 pCi/ℓ; the average gross beta concentration was 2.91 pCi/ℓ; and the average tritium concentration was 0.25 nCi/ℓ. These data are 2.2%, 5.8%, and 1.3%, respectively, of the EPA drinking water standards. In addition, ^{60}Co and ^{137}Cs were detected in second and third quarter samples at concentrations less than 0.03% of the applicable RCGs.

2.5.3 Aquatic Biological Studies

Fish were collected at Donahue's Pond (Peconic Lake) for radionuclide analysis. The maximum concentration of ^{137}Cs in fish was about 208 pCi kg^{-1}. This concentration would result in a dose commitment that was less than 1% of the RCG, based on an assumed ingestion of 50 g of fish per day.

2.6 Ground Water

2.6.1 Recharge Basins

About 14 million liters of water per day obtained from on-site supply wells were used for "once through" cooling and returned to groundwater in on-site recharge basins (Figure 7). The average concentrations of gross beta activity at points of recharge were slightly above background. The average concentrations of gross beta activity discharged to the HN basin was about 7% of the EPA Drinking Water Compliance Level Standard. With the exception of HS, the tritium concentrations were near or at the (minimum detection limit) MDL, which is about 1% of the EPA Drinking Water Standard.

2.6.2 Potable Supply Wells

With the exception of one well (well no. 1), all tritium concentrations were at or near the minimum detection limit. The average tritium concentration at this well, 870 pCi/ℓ corresponded to 4.4% of the EPA drinking water standard. Detectable quantities of Cobalt-60 and Sodium-22 in two wells were small fractions (<0.05%) of the applicable Radiation Concentration Guides (RCG) (14). No heavy metals were detected in the water supply wells. Trace levels of chlorocarbons were detected in several wells; levels were within the drinking water standards or advisory limits.

2.6.3 Surveillance Wells

Groundwater surveillance was conducted in a network of some 100 sampling wells installed adjacent to and downstream from identified areas where there is

a potential for the percolation and migration of radioactivity and other contaminants in groundwater.

2.6.3.1 On-Site Wells

Monitoring adjacent to the sand filter beds and to the Peconic River on-site and at the site boundary showed levels of gross alpha, gross beta, and tritium which were variable when compared to previous years. This is due to decreases in concentration caused by decay, dilution, and ground water migration. The annual average concentrations were less than EPA and NYS Drinking Water Standards. In this area, well XL exhibited the highest annual average gross alpha and beta concentration. The alpha concentration of 0.87 pCi l^{-1} was 6% of the EPA Drinking Water Standard for unidentified mixtures containing alpha activity other than ^{226}Ra. It was not directly relatable to any known Laboratory effluent releases. The average gross beta concentration was 5.6 pCi l^{-1}, corresponding to 11% of the EPA Drinking Water Compliance level. The maximum annual average tritium concentration was 11.0 nCi l^{-1} (11.0 x 10^{-6} μCi ml^{-1}), observed at well XA and corresponded to 55% of the EPA Drinking Water Standard.

On-site, adjacent to the Waste Management Area, the current landfill, and the decontamination facility storm sewer sump, above ambient background concentrations of gross beta activity and tritium were found in a number of nearby groundwater surveillance wells.

At the Waste Management Area, the largest ^{3}H concentration, 85,000 pCi l^{-1}, or 4 times the EPA Drinking Water Standard, was observed in a well southeast of the Waste Management Area perimeter.

At the landfill, an average gross alpha concentration of 4.2 pCi l^{-1} (4.2 x 10^{-9} μCi ml^{-1}), or 0.3 times the EPA Drinking Water Standard, an average gross beta concentration of 135 pCi l^{-1}, or 2.7 times the EPA Drinking Water compliance level, and an average tritium concentration of 8.0 nCi l^{-1}, or 0.4 times the EPA Drinking Water Standard, were the largest found.

At the decontamination facility storm sewer sump, a gross beta concentration of 55.3 pCi l^{-1}, equivalent to the EPA compliance level, was found in a surveillance well within a few meters of the sewer outfall into a sump.

Iron and zinc were found in excess of their respective standards (0.6 and 0.3 ppm for drinking water) in numerous sampling wells on-site. However, this is believed to be related to corrosion from the well casings and not to Laboratory effluents, except for a few wells adjacent to the Landfill. There, the largest concentration of iron was 113 ppm and of zinc, 6.7 ppm.

Low levels of chlorocarbons were detected in one monitoring well (XA) near the sand filter beds and in several wells (principally chloroform) near the current landfill. The average concentrations in two of the wells were in slight excess of the drinking water standard. Trace levels of chlorocarbons were also detected in wells which monitor the former landfill. Significantly elevated levels of chlorocarbons (low ppm range) were detected in wells which monitor the

Waste Management Area. An outside consulting firm was retained for a special investigation and will define the remedial options available to the Laboratory.

2.6.3.2 Off-Site Wells

Elevated tritium concentrations were observed in a monitoring well located approximately 0.3 km east of the site boundary and adjacent to the Peconic River. The concentrations are related to the discharge of tritium from the BNL Waste Concentration Facility in the fall of 1984. The average concentration observed at this location was 5300 pCi/ℓ or 27% of the EPA Drinking Water Standard. The highest gross beta concentration, detected at well X5, 5.3 pCi l^{-1}, was 10% of the EPA Drinking Water Compliance Level Standard.

2.7 Total Population Dose Resulting from Laboratory Sources

For the year 1984, the collective dose-equivalent attributable to Laboratory sources, for the population up to a distance of 80 km, was calculated to be 0.05 person-rem. This can be compared to a natural background collective dose-equivalent to the same population of about 303,000 person-rem.

3.0 ENVIRONMENTAL PROGRAM INFORMATION: MONITORING DATA COLLECTION, ANALYSIS AND EVALUATION

3.1 External Radiation Monitoring

Dose-equivalent rates from gamma radiation at the site boundary, including natural background (as influenced by weapons testing fallout) and that attributable to Laboratory activity, were determined through the use of CaF_2:Dy thermoluminescent dosimeters (TLD) [9]. They were exposed for monthly periods at each of the four perimeter monitoring stations P-2, P-4, P-7, and P-9, the locations of which are shown in Figure 2. The observed rates, as measured by these TLDs at the site boundary, are given in Appendix D, Table 2. The dose-equivalent rate from external radiation at the site perimeter averaged 62.5 mrem a^{-1}.

Figure 3 shows the locations of the off-site TLDs with respect to the Laboratory (HFBR Stack, #750 as the center; Figure 2). The standard 16 sectors with sector #1 centering on true North have been used to locate the TLDs. The dose-equivalent rates observed are given in Appendix D, Table 4. The annual average dose-equivalent rate as indicated by these TLDs was 59.7 mrem a^{-1}.

If Laboratory operations contributed to the external dose rate, TLD measurements at the site perimeter should be elevated with respect to rates observed at greater distances from the site. That is, a spatial pattern should be evident; the data should be spatially autocorrelated. The 1984 data for each season were evaluated using Morans' spatial autocorrelation coefficient (35). No significant spatial pattern was found in the data for any season, which suggests that external dose rates near the Laboratory are not higher than rates at a greater distance from the site. The data was further evaluated using a Student's t-test. Two classes were used in the analysis:

(i) TLDs 0-3.0 km from the center of the site, and

(ii) TLDs located 8.0-17.0 km from the center of the site. No significant difference was found between the means of the two classes for any season ($p > .05$). This was true under both the assumption of equal and unequal variances. The conclusion for the 1984 data is that laboratory operations did not have an impact on the external dose rate.

In an effort to determine if the 1983 dose rate attributed to BNL operations was due to the physical location of the on-site perimeter TLD; a separate study of site perimeter TLD locations was conducted in the fall of 1984. TLDs were placed at the following heights: two meters above-ground (routine position), one meter above-ground (one meter from the station), and one meter above-ground (greater than three meters from the station). The data collected in this study are shown in Appendix D, Table 3.

Several conclusions seem apparent from the data. The contribution to external exposure from artificial fill at station P-9 is statistically significant (in excess of 10% during the study period) and justifies the exclusion of this station from the site boundary average. It also appears that the placement of site perimeter TLDs at the two-meter level (roof-top) results in a reduction of the exposure rate of approximately 6%, as compared to placement at the one-meter level. The one meter height corresponds to the placement of the TLDs in the off-site TLD network. Discussion of additional analyses conducted on the 1983 data is presented in Appendix C.

3.2 Airborne Effluents, Tritium and Radioiodine Monitoring

3.2.1 Effluents Released from Facilities

The locations of principal Laboratory facilities from which radioactive effluents are released to the atmosphere are shown in Figure 2. The installed on-line effluent monitors, sampling devices, and the types and amounts of effluents released during 1984 are indicated in the table which follows, Table A. With the exception of tritium and ^{126}I, there were no radionuclides detected at the site boundary which are attributed to Laboratory effluents.

Oxygen-15, which has a two minute half-life, is produced by the interaction of protons and water in the beam tubes in the BLIP facility and generated at an estimated rate per unit beam current of 0.21 Ci μA^{-1} h^{-1}. It is calculated that 1.93×10^4 Ci of oxygen-15 was produced in the beam tubes at the BLIP facility during 1984. Argon-41, which has a 110-minute half-life, is produced by the activation of stable atoms of Argon-40 by neutrons in the ventilating air of the reflector in the Medical Research Reactor. It is released from the stack at an estimated rate of 1 Ci $MW^{-1}h^{-1}$. The release estimate for the MRR stack during 1984 was 4.66×10^2 Ci of argon-41.

Tritium (^3H) has a 12.3-year half-life, and is a very low energy beta emitter. It is most significant in the environment when it is in the form of tritiated water (HTO) vapor, which is taken up and utilized by living systems as is ordinary water. Of the 323 Ci of tritium released from the Laboratory re-

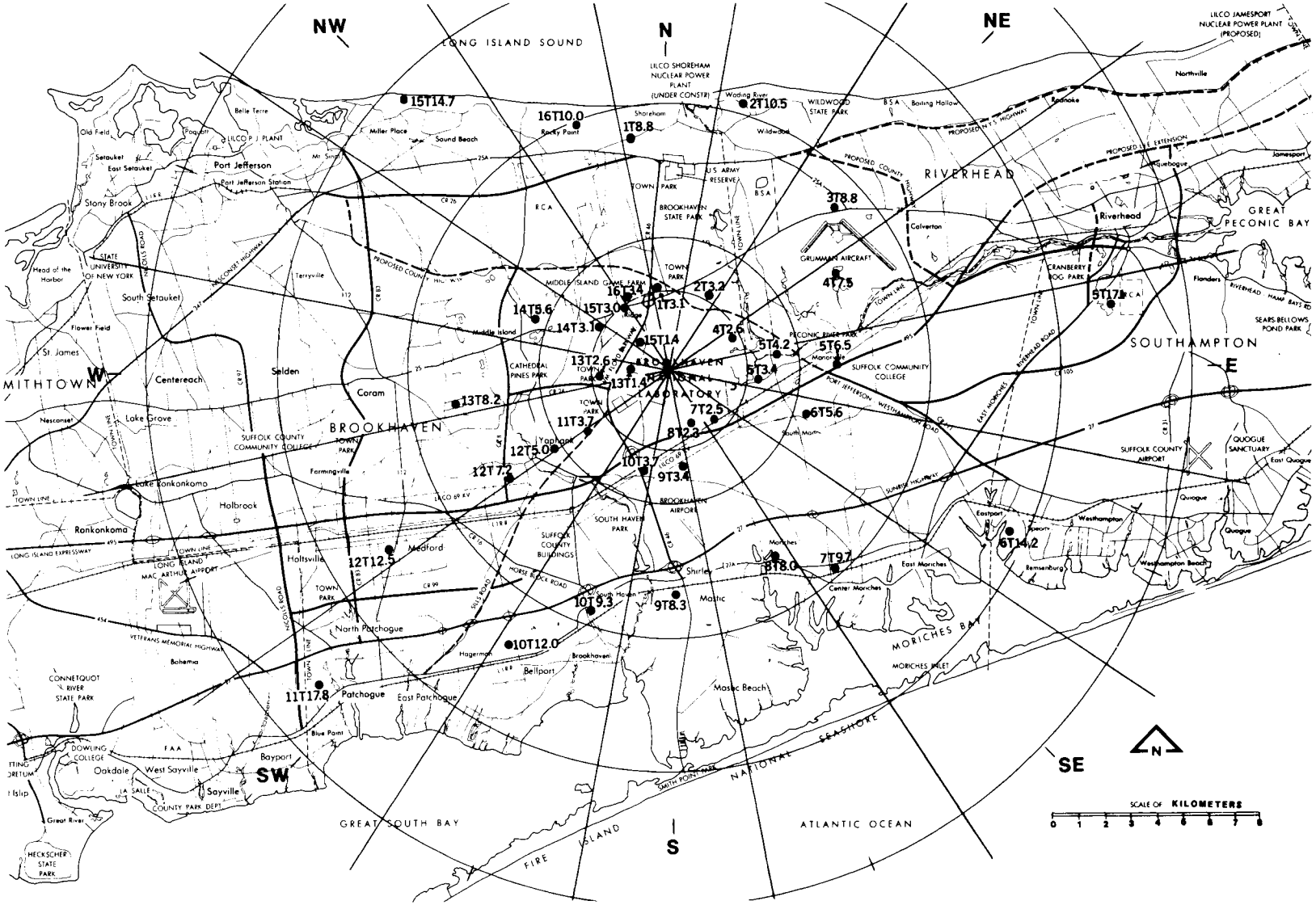


Figure 3. Location of off-site thermoluminescent dosimeters Brookhaven National Laboratory

Table A

1984 BNL Environmental Monitoring

Atmospheric Effluent Release Locations and Radionuclide Activity

Building No.[a]	Facility and Release Point	Release Height[b] (meters)	Principal Radionuclide	On-Line Monitoring	Fixed Sampling Devices	Amount Released During 1984 (Ci)
490	Medical Research Center Roof Stack	13.7	Tritium	None	Dessicant for tritium vapor	4.4×10^{-1}
491	Medical Research Reactor Stack	45.7	Argon-41	Moving tape for radioparticulates	Charcoal for radioiodines	4.66×10^{2}[c]
555	Chemistry Roof Stack	16.8	Tritium	None	Dessicant for tritium vapor	2.92×10^{-1}
750	High Flux Beam Reactor Stack	97.5	Tritium	None	Dessicant for tritium vapor	2.44×10^{2}
801	Hot Laboratory		Gross Beta Particulates	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	1.6×10^{-5}
901	Van de Graff Accelerator	18.3	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	5.83×10^{1} (vapor) 7.84×10^{1} (gas & vapor)
931	Linac Isotope[e] Facility	18.3	Oxygen-15	G-M Detector for radioactive gases	Dessicant for tritium vapor	1.93×10^{4} Ci[d]
			Tritium			2.0×10^{-2}
445	Incinerator		See Table 5	None	None	See Table 5

(a) Locations given 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 amp full beam current. This quantity is generated in the beam tube and represents the absolute maximum.
(e) Facility shut down in June 1984 for major modifications.

search facilities during 1984 (Table A), 20 Ci (6%) were in gaseous elemental form, and 303 Ci (94%) were released as HTO. Tritium releases have continued to decrease as the Laboratory continues to employ as low as reasonable achievable practices.

The Laboratory incinerates certain categories of waste in the Waste Management Incinerator. The individual radionuclides, their half-lives and total quantities in the waste material which was incinerated during 1984 are shown in Appendix D, Table 5. Tritium was the radionuclide released from the incinerator in the largest quantity, 94.3 mCi. Limits on the amount incinerated and meterological dispersion are utilized to assure that airborne concentrations at the site boundary are small fractions of the Radiation Concentration Guides (RCG).

Gamma emitting nuclides released from the HFBR stack are shown in Appendix D, Table 6. ^{203}Hg, ^{123}I, ^{124}I, ^{126}I, ^{123}Xe, ^{69}Ge, ^{125}Xe, and daughter products result from operational activities at the Hot Laboratory. The remaining γ emitting nuclides are presumed to be the result of experimental studies conducted at the HFBR.

Most of the heating requirements for the principal buildings at the Laboratory are supplied by the Central Steam Plant (Figure 2). In 1976 the Laboratory initiated the utilization of light feed stock (LFS), such as mineral spirits, alcohol, solvents, jet fuel and reconstituted fuels. The LFS is blended with #6 oil to form Alternate Liquid Fuel (ALF). In 1984, the fraction of LFS relative to total fuel consumption, was approximately 70%. These light stock fuels typically have a weighted average sulfur content of 0.5% or less as compared to the regulatory limit of 1% sulfur content in #6 oil. In 1983, the mean fuel combustion efficiency over the entire range of boiler loading capacities was determined to be 99.8% for No. 5 Boiler firing alternate liquid fuels (ALF) [27]. Under typical operating conditions the combustion efficiency is higher, since the upper limits of the boiler loading capacity are rarely reached [29]. In addition, stack testing conducted in 1983 as part of an EPA Study [30] demonstrated that SO_2 and NO_x emissions resulting from combustion of ALF were reduced by 70% and 64%, respectively, when compared to the combustion of No. 6 oil [30]. Samples of LFS used in the preparation of ALF are analyzed for lead and polychlorinated biphenyls (PCBs) to ensure that the burning of ALF does not constitute a potential environmental problem.

In October of 1984, it was determined that 300,000 gallons of off-specification military fuels contained low levels of PCBs at a concentration of 80 ppm. U.S. EPA and NYSDEC were notified and the Laboratory has applied for a provisional EPA permit (in accordance with 40 CFR 761) to burn the fuel. Such a provisional EPA permit was sought since the boilers are suitable for PCB incineration under EPA rules.

Other potential sources of non-radiological air contaminants are associated with processes listed in Table B.

Table B

1984 BNL Environmental Monitoring

BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Expiration Date
134	blueprint machine	NYSDEC-Air Quality	11/30/86
197	blueprint machine	NYSDEC-Air Quality	11/30/86
208	lead melting	NYSDEC-Air Quality	11/30/86
208	vapor degreaser	NYSDEC-Air Quality	11/30/86
208	sandblasting	NYSDEC-Air Quality	11/30/86
208	sanblasting	NYSDEC-Air Quality	11/30/86
422	cyclone collector	NYSDEC-Air Quality	11/30/86
422	cyclone clollector	NYSDEC-Air Quality	11/30/86
422	paint spray booth	NYSDEC-Air Quality	11/30/86
422	paint spray booth	NYSDEC-Air Quality	11/30/86
423	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
444	incinerator	NYSDEC-Air Quality	11/30/86
452	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
457	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
462	machining, grinding exhaust	NYSDEC-Air Quality	11/30/86
462	machining, grinding exhaust	NYSDEC-Air Quality	11/30/86
479	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
493	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
493	incinerator	NYSDEC-Air Quality	11/30/86
510	blueprint machine	NYSDEC-Air Quality	11/30/86
515	blueprint machine	NYSDEC-Air Quality	11/30/86
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
610	new boiler unit construction	NYSDEC-Air Quality	submitted, status pending
BNL Site	major petroleum facility	NYSDEC-Water Quality	submitted, status pending
STP[a] & RCB[b]	sewage plant & recharge basins	NYSDEC-Water Quality	5/01/88
CLF[c]	current landfill	NYSDEC-Solid Waste	submitted, status pending
CSF/HWM[d]	waste management	U.S. EPA	submitted, status pending
650	shot blasting	NYSDEC-Air Quality	11/30/86
650	scrap lead recycling	NYSDEC-Air Quality	11/30/86
835	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86
903	blueprint machine	NYSDEC-Air Quality	11/30/86
911	blueprint machine	NYSDEC-Air Quality	11/30/86
T30	combustion unit-No.4 oil	NYSDEC-Air Quality	11/30/86

(a) Sewage treatment plant.

(b) Recharge basins.

(c) Current landfill.

(d) Central Steam Facility/Hazardous Waste Mangement Facility.

3.2.2 Sampling and Analysis

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. Most of the of radioactivity detected in air during 1984 was attributable to natural sources. The only detectable nuclides in the air at the site boundary attributable to Laboratory activities were tritium and ^{126}I.

3.2.3 Air Samples

During 1984, positive displacement air pumps were operated at a nominal flow rate of 15 ℓ min^{-1} at one, on-site monitoring station adjacent to the solid waste management area (S-6), and at four site boundary stations P-2, P-4, P-7 and P-9 (see Figure 2 for locations). The sampling media consisted of a 5 cm diameter air particulate filter (Gelman type) followed by a 62.5 cm^3 bed of triethylene diamine (TEDA) impregnated charcoal for the collection of radiohalogens.

The air particulate samples were counted for gross beta activity using an anti-coincidence proportional counter. The data are shown in Appendix D, Table 7. In addition to counting for gross beta activity, analyses for gamma emitting nuclides were performed on charcoal filters and on a composite of all air particulate samples at the end of each month. Radionuclides attributable to the residue from past atmospheric weapons test were detected. The average annual air concentrations of ^{137}Cs, ^{7}Be and ^{126}I in the charcoal filter samples were 0.002 pCi/m^3, and 0.002 pCi/m^3, 0.0003 pCi/m^3, respectively. The average annual air concentrations of ^{137}Cs and ^{7}Be in the composite air particulate samples were 0.002 pCi/m^3 and 0.02 pCi/m^3, respectively.

Sampling for tritium vapor was also performed at each of the air sampling stations by drawing a small side stream of air ($\sim$200 cm^3 min^{-1}) through silica gel cartridges. These cartridges were normally changed on a weekly basis. The collected vapor was subsequently removed from the gel by heating; then condensed, collected, and assayed by liquid scintillation counting. The tritium vapor concentration data obtained in this manner during 1984 are shown in Appendix D, Table 8.

The highest weekly average concentration was observed during the month of August at station P-4. The highest annual average concentration, 5.16 pCi/m^3, was observed at station P-9. This value was 0.003% of the Radiation Concentration Guide (RCG) [14].

The current Laboratory environmental monitoring program does not include routine air sampling for nonradioactive substances. Based upon 0.5% sulfur and 0.8% nitrogen content [12,33], the calculated annual average concentrations at the site boundary of the conventional pollutants released from the central steam plant were 0.04 $\mu g\ m^{-3}$ SO_2 and 0.03 $\mu g\ m^{-3}$ NO_x. These values are approximately 1% of the applicable ambient air quality standards [13].

3.2.4 Precipitation

Two pot-type rain collectors are situated adjacent to the sewage treatment plant (see Figure 2). Routine collections were made whenever precipitation was observed. Part of each collection was evaporated for gross alpha and beta counting, a fraction was composited for monthly tritium analysis, and the balance was put through ion exchange columns for gamma analyses. The data for 1984 are reported in Appendix D, Table 9A.

3.2.5 Milk Samples

Milk samples were collected from two dairy farms in the vicinity of the site. Fallout radionuclide concentrations were not detected in these milk samples. The range of ^{40}K detected in these samples was 1.0×10^{-6} to 1.4×10^{-6} µCi/ml. The only other nuclide detected in one sample was ^{7}Be at a concentration of 1.2×10^{-7} µCi/mℓ. These nuclides are not attributable to Laboratory Operations.

3.2.6 Soil and Vegetation Samples

The results of soil and vegetation sampling conducted at five dairy farms in the vicinity of the site are shown in Appendix D, Table 9B. The results are consistent with data collected in previous years [10], with no nuclides detected attributable to Laboratory operations.

3.3 Liquid Effluent Monitoring

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

Small volumes (up to a few liters) of concentrated liquid wastes containing radioactivity or other hazardous agents are withheld from the Laboratory waste systems. They are stored at their sources of generation in small containers, collected by the Laboratory waste management group, and subsequently packaged in accordance with DOT regulations for licensed off-site disposal (in the case of hazardous wastes as defined by DOE Order 5480.2).

Facilities which may routinely produce larger volumes (up to several hundred liters) of radioactive or otherwise contaminated waste liquids are provided with dual waste handling systems, one for "active" (D, probably contaminated) and one for "inactive" (F, probably uncontaminated) wastes. As shown in Figure 4, wastes placed into the "active" or D system are collected in holdup tanks. After sampling and analysis, they are either discharged directly to the sanitary waste system [16] or are transferred by installed pipelines or tank truck to the Liquid Waste Concentration Facility. At this facility, liquid waste is distilled to remove particulates, suspended and dissolved solids. These are transferred to the Waste Management Area for off-site disposal.

Subject to the results of analysis, "inactive" wastes are routed directly to the Laboratory sanitary waste system, where they become mixed with large quantities (approaching 4,000,000 l d^{-1}) of cooling and other uncontaminated water routinely produced by diverse Laboratory operations. Sampling and analysis of the waste in facility holdup tanks is performed to facilitate waste management, while effluent sampling is performed at the sewage treatment plant to establish the concentration and amounts of environmental releases.

Radionuclide concentrations in BNL effluent, measured at the influent and effluent of the sewage treatment plant, are shown in Appendix D, Tables 11A and 11B. In 1984, two unusual releases occurred. Approximately 3 mCi of Sodium-24 was released over a 12 hour period on October 11 directly to the F waste system. The plant influent concentrations triggered the alarms at the sewage treatment plant with all influent being diverted to the lined holding pond for the following two days. When plant influent levels returned to normal, discharge to the sand filter beds was resumed. The water in the holding pond was retained until the Sodium-24 had decayed to non-detectable levels. The liquid was then discharged to the Peconic River.

In October and early November, elevated tritium concentrations were detected in the liquid effluent. These concentrations resulted from the processing of "D" waste at the BNL Waste Concentration Facility. During this interval, 8.7 Ci of tritium was discharged to the "F" waste system as distillate from the waste concentration process. From October 31 to November 2, the concentration in the BNL sewage treatment plant effluent reached the maximum level of approximately 5.1×10^{-4} μCi/mℓ. This concentration is nominally 17% of the New York State [26] and DOE effluent release criteria [14] and corresponds to a release rate of 1 Ci per day. From November 2, 1984 to December 11, 1984 operation of the Waste Concentration Facility was suspended and the source of the tritium was determined. The facility was subsequently operated on three occasions in December with a resultant release of 0.9 Ci to the Peconic River.

3.3.1 State Pollutant Discharge Elimination System Permit

The effluent from the Laboratory sewage treatment plant is subject to the conditions of the State Pollutant Discharge Elimination System Permit No. NY 000 5835, authorized by the New York State Department of Environmental Conservation (NYSDEC). A yearly summary of the 1984 data collected for the permit (station EA) and additional analyses is shown Appendix D, Table 10. The Laboratory sewage treatment plant effluent was within the permit requirements, with the exception of five daily pH levels and one monthly instance of iron and zinc concentrations. The effluent pH variations were within the local natural range of groundwater (pH 5.5-6.0).

3.3.2 Peconic River

Primary treatment of the liquid stream collected by the sanitary waste system to remove suspended solids is provided by a 950,000 liter clarifier. The liquid effluent from it flows onto sand filter beds, from which about 88% of the water was recovered by an underlying tile field. This recovered water was then released into a small stream that forms one of the headwaters of the Peconic

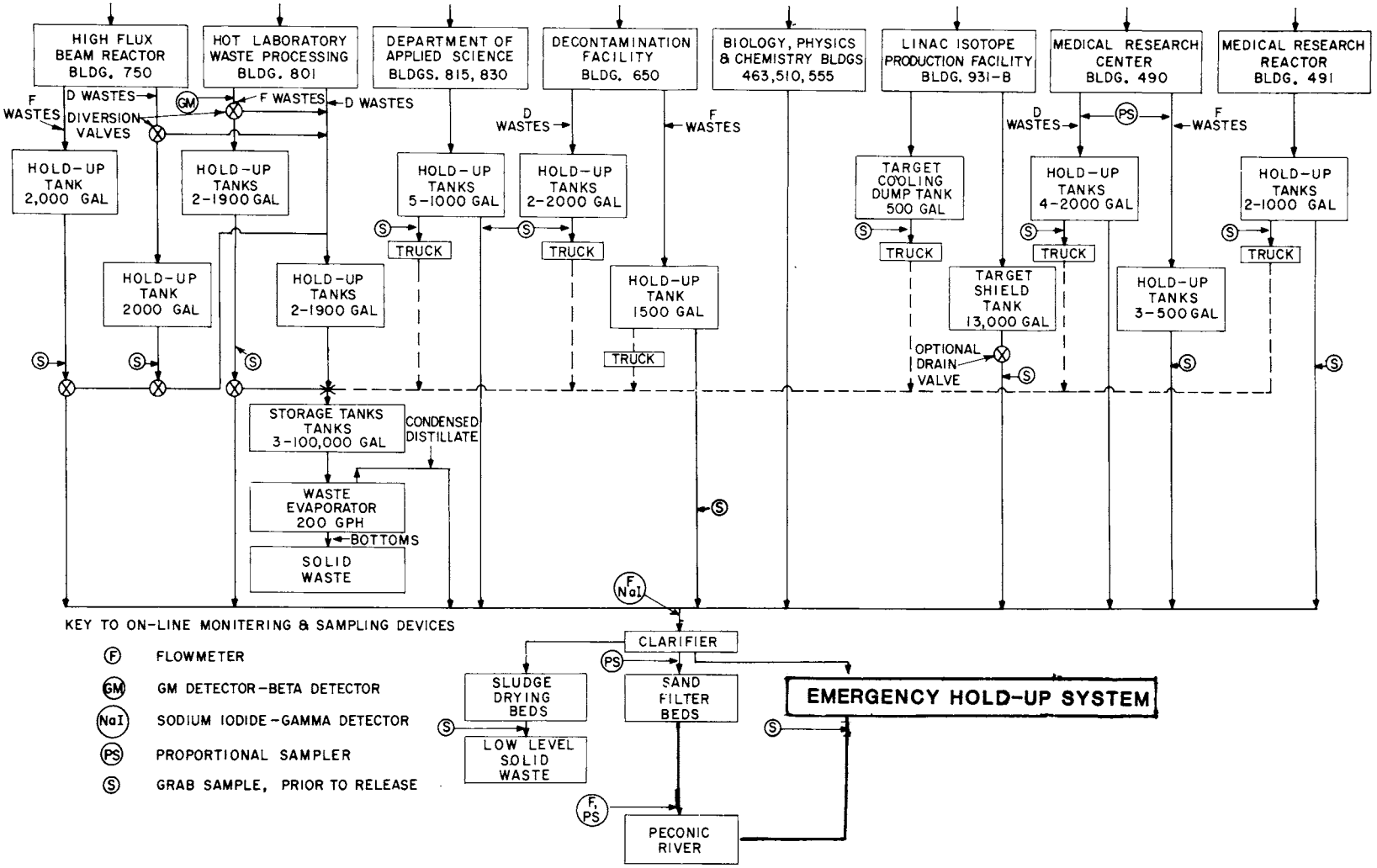


Figure 4. Liquid effluent systems Brookhaven National Laboratory.

River. The balance about 12%, was assumed to have percolated to the groundwater under the beds and/or lost through evaporation. A schematic of the sewage treatment plant and its related sampling arrangements is shown in Figure 5.

An aliquot of each daily (or weekend) sample of the input to the sand filter beds and of their output to the Peconic River was evaporated for the analysis of gross alpha and gross beta activity. Another aliquot was counted directly for tritium. The average radionuclide concentrations at the clarifier (input to the filter beds) and at the outfall (output from the beds) are shown in Appendix D, Tables 11A and 11B. Yearly totals are also indicated. During 1984, about 88% of the total flow into the clarifier appeared in the output at the chlorine house after passing through the sand filter beds.

Samples from the two downstream locations (HM and HQ) were obtained three times a week. Aliquots of each were analyzed for gross beta, gross alpha, and tritium. Another aliquot, proportional to the measured flow during the sampling period, was passed through ion exchange columns for subsequent analysis as an integrated sample. Unless the gross beta count on a given sample indicated the need for immediate radionuclide identification, these columns were analyzed directly on a monthly basis for gamma emitting nuclides.

Radionuclide concentration data for the former site boundary sampling location (HM) and at the present site boundary (HQ) are also shown in Tables 11A and 11B. Non-proportional continuous stream samples were collected based on stream flow measurements using a v-notch weir. However, during 1984, accurate flow measurements were not possible due to equipment failure and flow rates which exceeded the measurement capability of the v-notch weir at station M, and elevated water levels on the down side of the v-notch weir at station Q. Consequently, no estimates of total activity released at stations M and Q were calculated.

Peconic River - Off-Site

Radionuclide measurements were also performed on samples of water collected from the Peconic River upstream of the effluent discharge point, and at a sampling station located 19.5 km downstream (locations are shown in Figure 5). A summary of the radiological data for 1984 is shown in Appendix D, Table 12. All measured concentrations were well below the applicable standards.

Measurements of selected water quality parameters were performed at the Sewage Treatment Plant, at the monitoring stations on the Peconic River, and at control locations in order to provide a comparison with the same parameters in the Laboratory effluent. These limited "grab" sample data are shown in Appendix D, Table 10. The results indicate that, in general, the levels decrease with distance from the treatment plant outfall to levels comparable with the upstream control location. Metal concentrations reflect ambient levels (3).

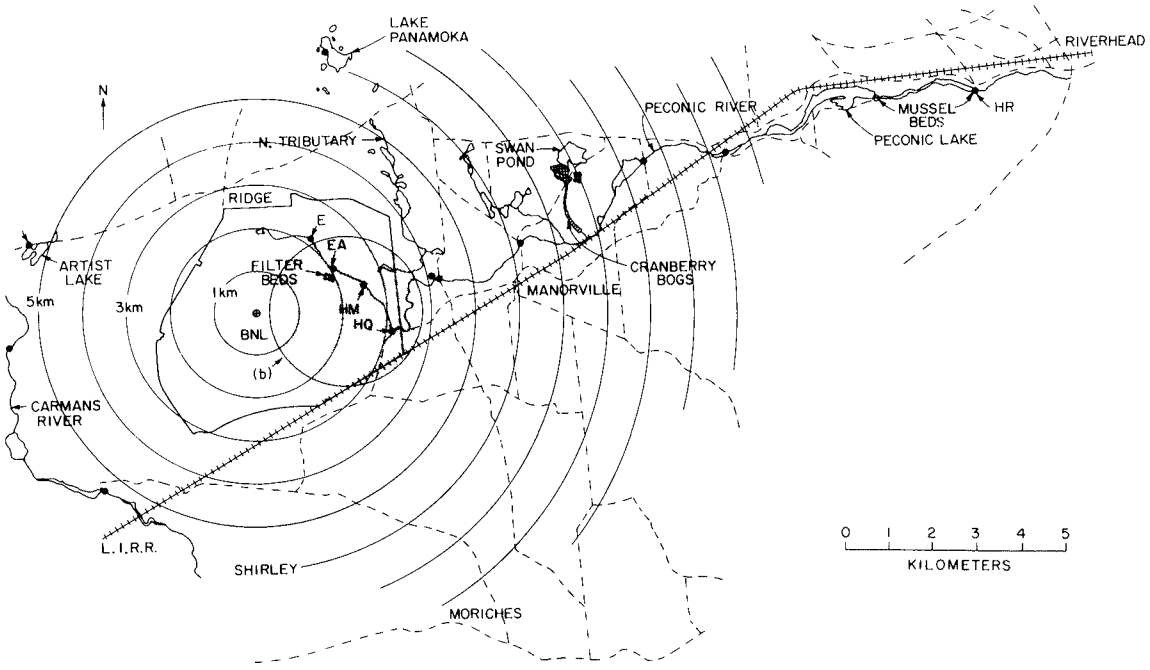


Figure 5. a) On-site and downstream sampling locations.

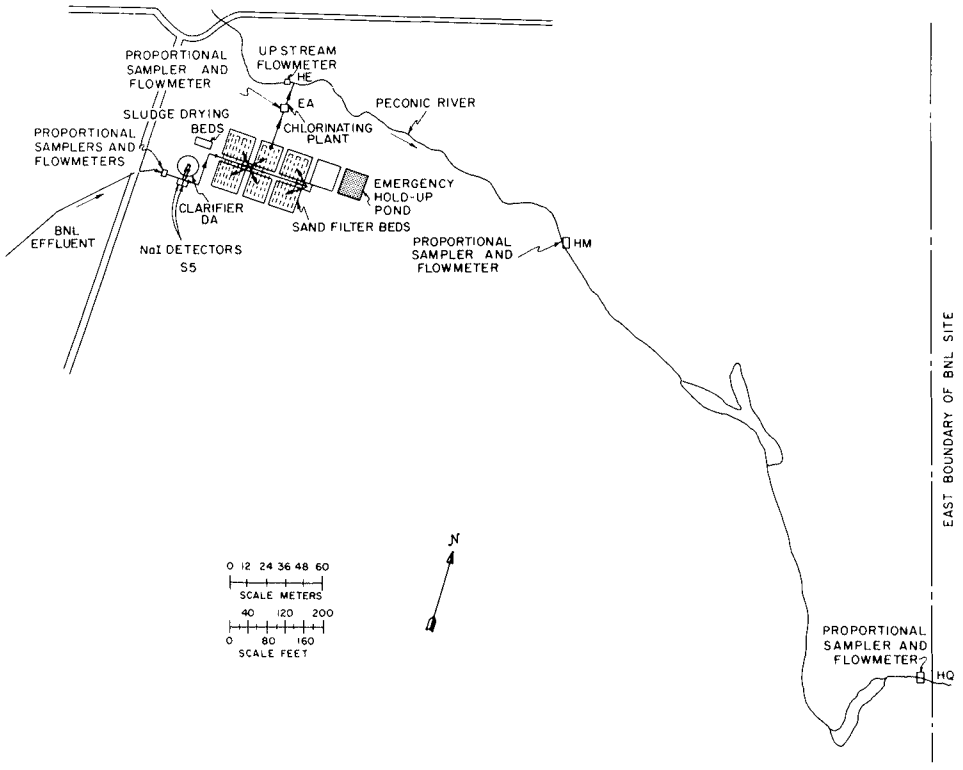


Figure 5. b) Sewerage treatment plant: sampling locations.

3.3.3 Recharge Basins:

After use in "once through" heat exchangers and process cooling, approximately 14 million 1 d^{-1} (MLD) of water was returned to the aquifer through on-site recharge basins; 6.1 MLD to basin HN located about 610 m northeast of the AGS; 4.4 MLD to basin HO about 670 m east of the HFBR; and 3.5 MLD to basin HP located 305 m south of the MRR (see Figs. 6 and 7). A polyelectrolyte and dispersant is added to the AGS cooling and process water supply, to maintain a phosphate concentration of about 2 ppm in order to maintain the ambient iron in solution. Of the total AGS pumpage, approximately, 1.6 MLD was discharged to then N basin, and 2.1 MLD to the HO basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and is treated with inorganic polyphosphate and mercaptobenzothiozone to control corrosion and deposition of solids. Blowdown from this system, 2.3 MLD, which contained about 6-8 ppm inorganic polyphosphate and 3-4 ppm mercaptobenzothiozone, was also discharged to the HO basin. The untreated MRR-MRC "once through" coolant (3.5 MLD), after adjustment to a neutral pH, was discharged to the HP basin.

Concentrations of radioactivity in the water discharged into these and other smaller basins are monitored by grab sampling. The average concentrations of gross alpha, gross beta, tritium, and other radionuclides are given in Table 13. The average concentrations of gross beta activity in the basins were slightly above background. The HN basin receives water that has been used to cool the LINAC beam stops at the AGS; the process results in the formation of short lived radionuclides that are released to the HN basin. The average concentration of gross beta activity discharged to the HN basin was about 7% of the EPA Drinking Water Compliance Level Standard (15). In general, the average concentrations of gross beta activity in the other basins were slightly above those in the Laboratory supply wells which indicate the baseline water quality of the ground water underlying the laboratory. With the exception of HS, tritium concentrations were at or near the MDL. Basin HS receives air conditioning condensate from several buildings on site. The condensate contains low levels of tritium as a result of ground level atmospheric releases from experimental facilities. Trace levels of several gamma emitting radionuclides were observed in the sumps. The observed levels were small fractions (<0.5%) of the applicable standards.

The BNL SPDES permit requires measurement of pH and recording of gallonage discharged. In 1984, there were 47 instances of pH value exceptions; these being due to the naturally acidic ground water underlying the site.

3.3.4 Aquatic Biological Surveillance

Fish were collected from the Peconic River, near the sewage treatment plant outfall, and were analyzed for gamma emitters. ^{137}Cs was the only radionuclide of biological significance found in detectable concentrations above the MDL. The average wet weight concentration of ^{137}Cs in edible flesh was 208 pCi/kg (995pCi/kg dry). The assessment of this dose pathway is discussed in Section 4.0 of this report.

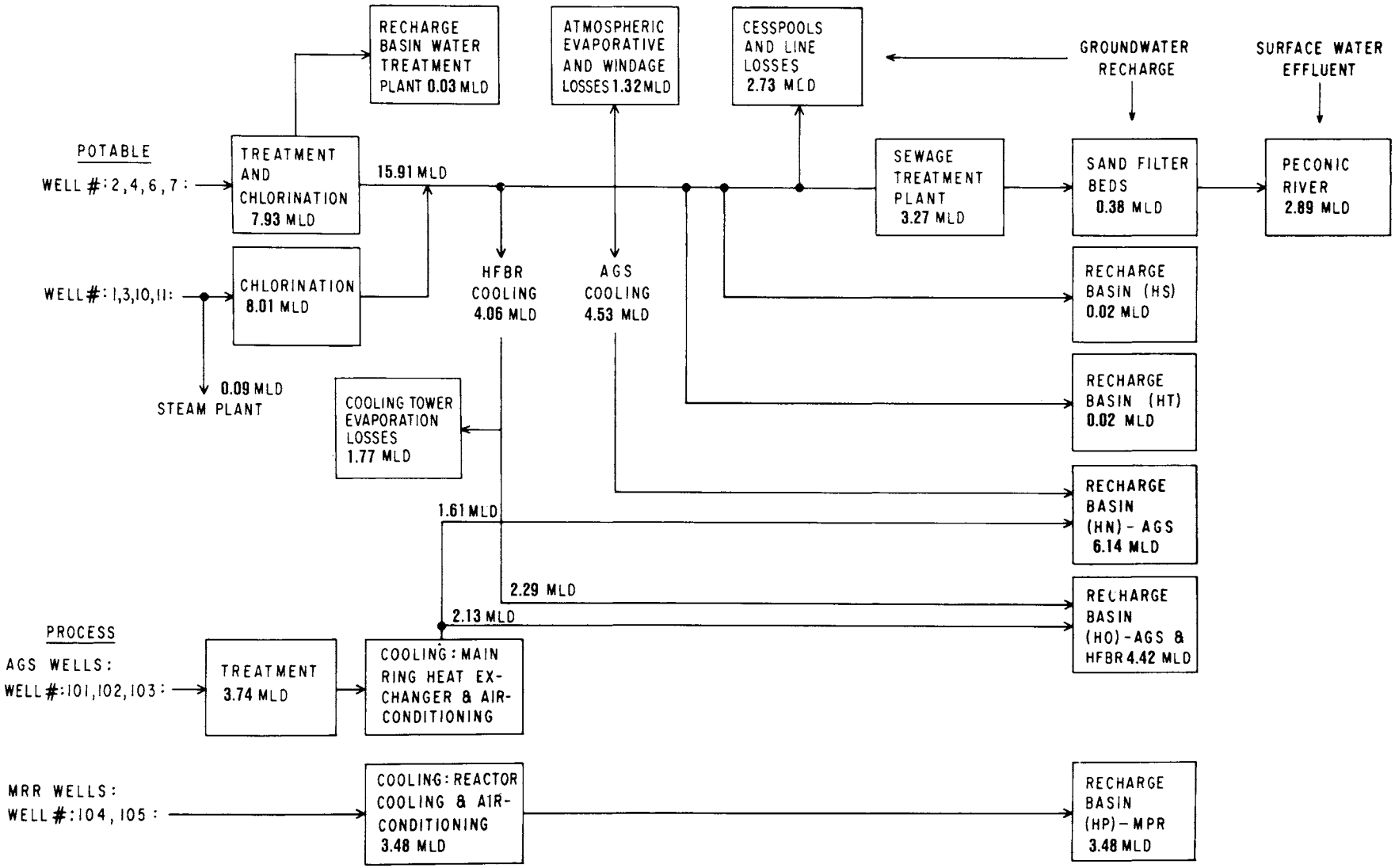


Figure 6. Brookhaven National Laboratory: schematic of water use and flow.

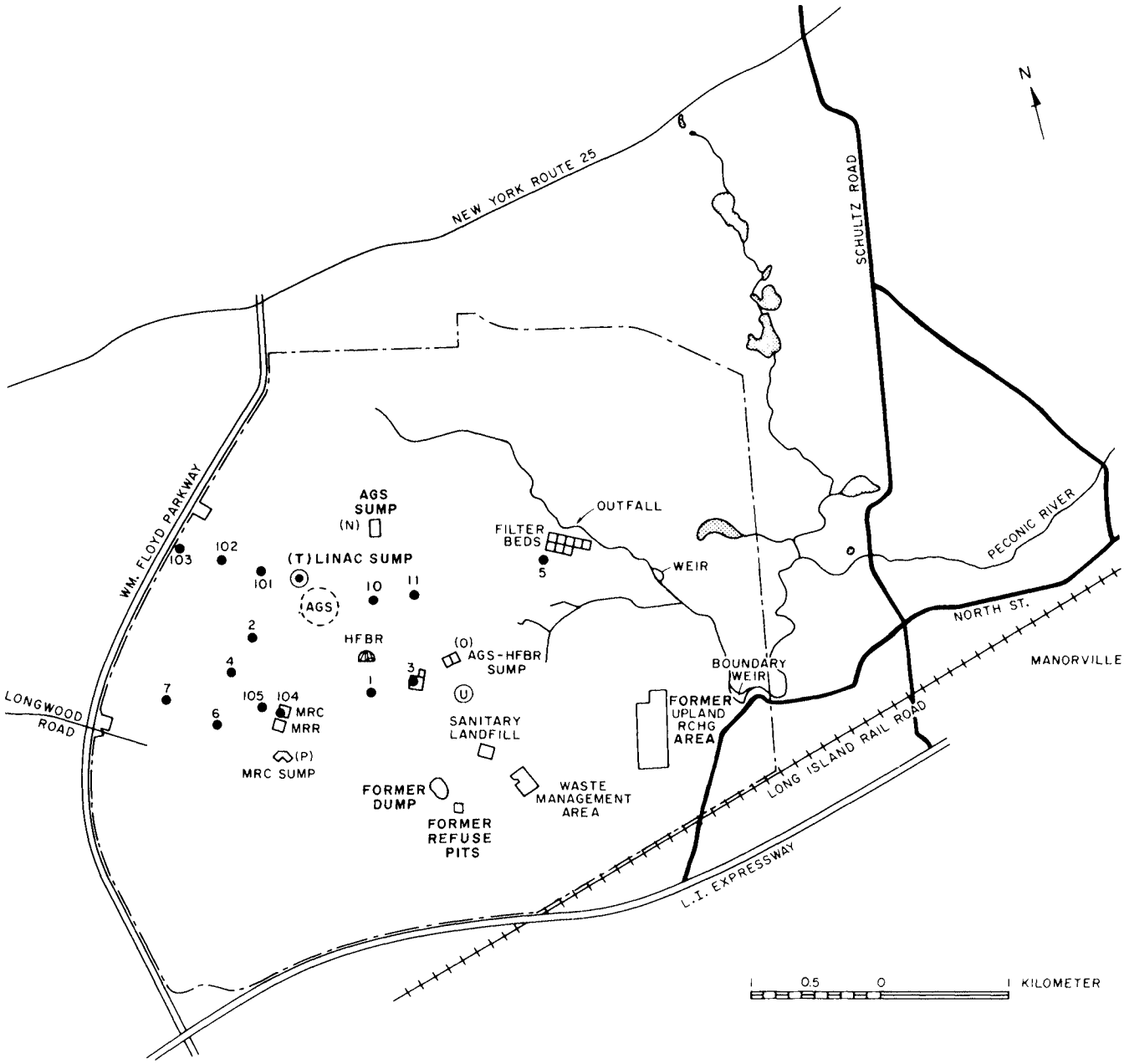


Figure 7. On-site: potable and supply wells and recharge sumps.

3.3.5 Ground Water Quality:

3.3.5.1 Potable Water and Process Supply Wells

With the exception of Well #104, 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 Long Island surface layer of glacial outwash, sand and gravel. Well #104 is screened at at depth of 60 to 90 m. As shown in Figure 7, most of these wells are located west to north of the Laboratory's principal facilities which is 'upgradient' of the local groundwater flow pattern. As indicated in Figure 6, about 23 MLD was pumped from them in 1984.

Grab samples were obtained from these wells. These were analyzed for radioactivity, water quality indices, metals, and several chlorocarbons. The results are shown in Appendix D, Tables 14A-C and 15L. All gross alpha concentrations were <0.5 pCi/liter. With the exception of well No. 1, all tritium concentrations were at or near the MDL. The average tritium concentration at this well, 870 pCi/ℓ, was 4.4% of the EPA Drinking Water Standard as set forth in the Safe Drinking Water Act. There are some fluctuations in the gross beta concentrations among these wells but the variations are not considered significant. During 1984, analysis of potable well samples for gamma emitting radionuclides was initiated. Wells 1 and 10 exhibited detectable quantities of ^{60}Co and ^{22}Na, respectively. The observed levels were small fractions (<0.05%) of the applicable Standards and account for the total activity of ^{60}Co and ^{22}Na detected at the ultimate discharge point, the sewage treatment plant. With the exception of pH, indices of water quality such as nitrates, sulfates, chlorides and fluorides were all well within the limits established in the New York State Drinking Water Standards. No heavy metals were detected in the potable well samples; only iron was detected in concentrations in excess of the New York State Drinking Water Standards. However, iron is a nuisance element and occurs naturally in the Long Island aquifer. Since there are no toxic effects associated with iron, no primary federal drinking water limits have been established. In 1984, potable wells were analyzed for several chlorocarbons, specifically 1,1,1-trichloroethane, trichloroethylene, chloroform, and tetrachloraethylene (Appendix D, Table 15L). Only trace concentrations of chlorocarbons were detected in potable wells, with measurements being below the state standard or advisory limit.

3.3.5.2 Groundwater Surveillance

Samples of groundwater were obtained from a network of shallow surveillance wells which have been installed in the vicinity of several locations where a potential has existed for the percolation of radioactivity or other pollutants from the surface downward into the saturated zone of groundwater. These include areas adjacent to the on-site recharge basins, the sand filter beds, the Peconic River, the solid waste management area, the former landfill area, the current landfill and the decontamination facility sump. The locations of most of these groundwater surveillance wells are shown in Figure 8, except for those installed at the landfill and solid waste management area which are shown in Figure 9.

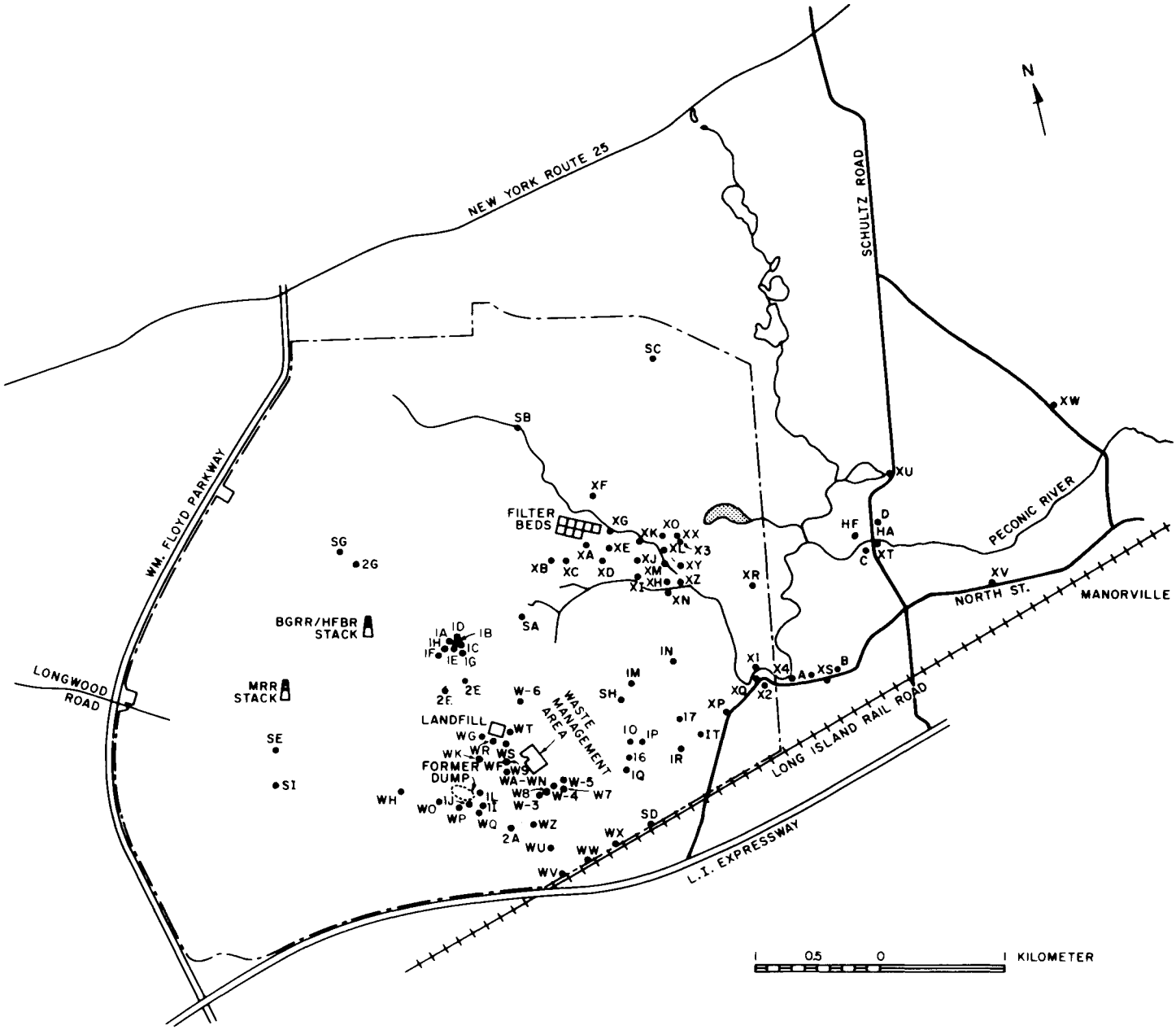


Figure 8. Location of groundwater surveillance wells.

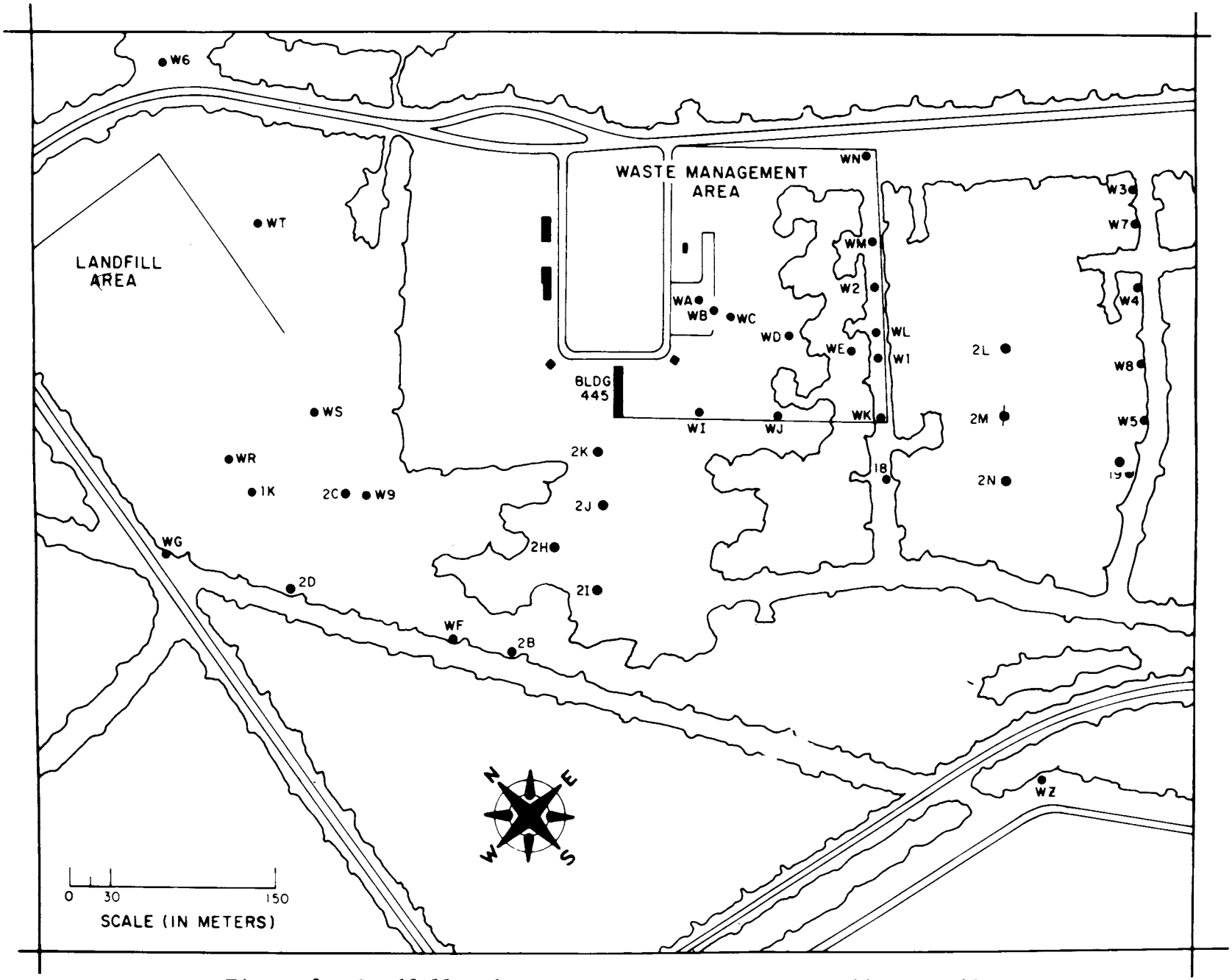


Figure 9. Landfill and waste management area surveillance wells.

For convenience in assessing the data, the wells have been divided into several groups. Yearly average radionuclide concentrations of the wells adjacent to the sand filter beds, and downstream on the Peconic River are summarized in Appendix D, Table 15A. Corresponding radionuclide data for wells downstream (with reference to groundwater movement) of the solid waste management area, the current and former landfills, and the radioactive decontamination facility sump (about 1 km east of the HFBR) are summarized in Appendix D, Tables 15B and 15C. Since the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" [23], the data are compared to the EPA and NYS Drinking Water Standards [15,17].

Elevated concentrations of gross alpha and gross beta emitters, and tritium have been found on-site adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to losses from the tile collection field underlying the sand filter beds and activity released to the Peconic River. In 1984, on-site concentration ranges were 1-6% for gross alpha, 1-12% for gross beta, and 1-55% for ^{3}H of the Drinking Water Standards [15,17]. Adjacent to the Peconic River at the site boundary (wells X1 and X2), the maximimum gross alpha, gross beta and tritium concentrations were less than or equal to 4% of the Drinking Water Standards.

Off-site monitoring wells X4, XS, and XT were monitored extensively during the fourth quarter of 1984 for gross alpha, gross beta, and tritium in response to the elevated tritium release rates from the BNL Waste Concentration Facility. The gross alpha, beta, and tritium results for wells XS and XT represent ambient concentrations for this location. All results are less than 4% of the EPA Drinking Water Standards for community water supply systems. Elevated tritium concentrations at monitoring well X4 were detected in the last weeks of December. The average tritium concentrations during the sampling period corresponds to 27% of the EPA Drinking Water Standard.

At the former landfill area, upland recharge area, and miscellaneous wells on-site, radionuclide concentrations ranged from nondetectable to background levels.

In the majority of the wells adjacent to the Waste Management Area (Table 15B), the concentrations of gross alpha and beta activity exhibited a general decline when compared to 1983. The detection of fission and activation products in several wells is attributable to the inadvertent injection of approximately one Ci of aged fission products at well WA in 1960, and to the open storage of activated material. The tritium levels observed in wells WK, WL, W2, 2M and 2N reflect the south/southeasterly migration of tritium resulting from past activities at the Landfill and/or the Waste Management Area. The tritium concentrations measured in wells WL and 2M are factors of 1.3 and 4.3, respectively, greater than the drinking water standard.

In general, gross alpha and beta concentrations were observed to decrease in wells which monitor the landfill. This is attributed both to the discontinuation of the disposal of radioactive waste on the landfill since 1976, as well as the movement and dilution of radioactivity in the ground water adja-

cent to it. Compared to 1983, tritium concentrations decreased in wells WS, 1K, W9, 2J, 2K, and 2I, indicating migration of ground water away from the landfill. The detection of activation products in several wells results from the disposal of material that has no detectable activity. This material, however, may contain low levels of radionuclides which are subsequently detected by the more sensitive environmental measurement techniques. The measured concentrations did not exceed the drinking water standards in any of the landfill monitoring wells.

At the decontamination facility (Bldg. 650) sump, radionuclide levels exhibited some variation from previous years. Gross beta levels substantially declined in wells 1E and 1H, but increased in well 1G.

The groundwater surveillance also included the evaluation of several water quality, metal and organic parameters. 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 15D, 15E, and 15K. The data for wells adjacent to the solid waste management area (Tables 15F, 15G and 15N), the current and former landfill (Tables 15H, 15I and 15M), and miscellaneous and potable supply wells (Tables 15J and 15L) are also shown.

In general, the data for samples obtained from wells adjacent to the sand filter beds and the Peconic River were comparable to those observed during previous years. All analyzed water quality parameters were within New York State Water Quality Standards (17), with some exceptions for pH, Fe, and Zn. The occasional lower pH levels appear to reflect natural ambient levels, since higher pH levels were present in the input to and output from the sewage treatment plant (see Table 10). Concentrations of Fe and Zn in excess of water quality standards were found in several wells throughout the site. The detection of Zn and Pb is believed to reflect a well-casing effect, i.e., leaching of Zn from the galvanized pipe and Pb from the soldering material used. The elevated levels of Fe in the current landfill monitoring wells are believed to reflect the former practice of landfilling the Fe flocculant from the water treatment plant. Other wells reflect elevated Fe levels; this is apparently due to the corrosion of the well casing. It should be noted that high Fe concentration is indigenous to groundwater in this region. Zn and Fe are nuisance elements and do not pose significant health hazards. Consumer taste preference and staining of plumbing fixtures were the criteria used in the formulation of regulatory limits (34).

Low levels of chlorocarbons were detected in one monitoring well near the sand filter beds and in several wells near the current landfill. Trace levels of chlorocarbons were also detected in wells which monitor the former landfill. These wells will continue to be monitored to ensure that no significant environmental impact occurs.

Significantly elevated levels of chlorocarbons (low ppm range) were detected in wells which monitor the Waste Management Area (Appendix D, Table 15N). Considerable additional information is needed to identify the source and extent of the contamination. An outside consulting firm was retained for a special investigation of this site. During 1984, the site geohydrology was reviewed and reconnaissance test borings and additional monitoring well installa-

tion was performed. The final report will be issued in 1985 and will define the remedial options available to the Laboratory.

3.4 Unusual Occurrences

3.4.1 Oil Spills

During 1984, five minor oil spills (10-50 gallons) occurred on site. In each case, clean-up procedures were instituted immediately, to prevent potential groundwater contamination. The absorbents used to clean up the spills were disposed of according to New York State Department of Environmental Conservation recommendations. These spills were reported to NYSDEC within two hours of the incident in accordance with the requirements set forth in the Laboratory's Spill Prevention, Control, and Countermeasures Plan.

3.4.2 Releases to the Sanitary Sewage System

In 1984, two unusual releases of radioactivity to the sanitary system occurred. These were discussed in Section 3.3 of this report.

4.0 OFF-SITE DOSE ESTIMATES

The doses to the public from the reported levels of radiation and concentrations of radioactivity in air and water, above ambient background, are principally attributable to radioactive airborne and liquid effluents. These are discussed below, and the collective dose-equivalent during 1984 due to these sources is calculated.

4.1 Collective Dose Equivalents Due to Airborne Effluents

The major radionuclides released at BNL airborne effluent discharge points are Tritium (gaseous and vapor), Oxygen-15 and Argon-41. The highest annual average site boundary concentration of tritium vapor was 5.2 $pCi\ m^{-3}$ at station P-9. The calculated maximum dose equivalent was 2.5×10^{-6} rem for the hypothetical individual residing at that location (32). The exposure rates due to ^{41}Ar and ^{15}O, and air concentrations of gaseous ^{3}H were not measurable. The calculated per capita annual average dose-equivalent rates for these radionuclides at the site boundary were 3.2×10^{-5} rem a^{-1}, 8.8×10^{-5} rem a^{-1}, and 2.2×10^{-9} rem a^{-1}, respectively.

The collective (population) dose equivalent was estimated for radionuclides released to the airborne environment using measured effluent release data and recorded BNL meterological parameters. Due to their short half-lives, ^{41}Ar and ^{15}O were not included in the calculation of the collective dose equivalent. Using actual source terms and meterological 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 micrometerological conditions which may exist; resulting in differences between the measured and expected tritium concentrations at the perimeter monitoring stations.

Dose equivalents are shown in Table 16. Methods used to calculate the dose equivalents are described in Appendix C. The 1984 population collective dose-equivalent resulting from the release of radioiodine by the Laboratory was 0.046 rem. This can be compared to the 1984 population collective dose-equivalent due to natural background of 3.0×10^5 rem. The Laboratory releases were 1.5×10^{-7} 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, nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. However, the Peconic River does recharge the aquifer at certain times of the year and the upper portions of the river are used for occasional recreational fishing by the local population, thus constituting an indirect pathway. Based on data collected from periods potable drinking wells located adjacent to the site and at control locations in Riverhead and Ridge, only one household closest to the Laboratory discharge point in the Peconic River exhibited tritium at concentrations in excess of ambient-levels. The concentration of 3100 pCi/ℓ, if used as the sole source of fluid intake would result in a committed dose equivalent of 0.6 mrem a^{-1} to each member living in that household.

Using data provided by the New York State Department of Environmental Conservation on fish productivity in the Peconic River, it was assumed that: (a) the fish analyzed was the most frequently caught; (b) 100 fishermen caught 500 kg of fish in 1984 and that their families consumed all of these fish; and (c) a population consisting of 372 adults and children above 12 years of age and 66 children below 12 years [4]. Thus, the estimated annual average fish consumption by the adult group was 1.36 kg/yr and for children below 12 years was 0.46 kg/yr (as compared to the USNRC Regulatory Guide [22] value of 21 kg/yr and 6.9 kg/yr, respectively). Based on these values for consumption of fish and other relevant assumptions recommended in the NRC Regulatory Guide 1.109 [22], and the maximum observed concentration of ^{137}Cs in fish [208 pCi/kg(wet)], the collective dose equivalent to total body from this indirect pathway can be estimated to be 0.005 rem (0.014 mrem x 372 persons) for adults and 0.0003 rem (0.005 mrem x 66 persons) for infants.

4.3 Dose Equivalents Due to Alternating Gradient Synchrotron

The AGS is located 1180 meters from the nearest site boundary. Although the machine is heavily shielded, some neutrons do penetrate the shield and others escape from areas where experiments are in progress. Presumably, some of these neutrons reach off-site areas either directly, or more likely by scattering from the air. In 1982 and 1983, a study was conducted at three Laboratory environmental monitoring stations P-2, P-4, and S-5. Neutron dose equivalents at these locations were determined to be 0.44 mRem, 1.26 mRem, and 0.45 mRem, respectively, for the period October 22, 1982 to March 2, 1983. Using these data, an annual dose equivalent at the above environmental stations was estimated to be 1.23 mRem, 3.51 mRem and 1.25 mRem, respectively. These values correspond to typical dose-equivalent values due to cosmic sources [28]. Since the neutron dose due to AGS operations was not detectable in these years, the program was

discontinued and as such there is no collective dose equivalent attributable to AGS operations.

4.4 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 1984 is the sum of the values due to the three components discussed above was 0.05 person-rem.

The collective dose equivalent due to external radiation from natural background, to the population within a 80 km radius of the Laboratory, amounts to about 3.0×10^5 rem a^{-1}, to which about 9.7×10^4 rem a^{-1} (person-rem a^{-1}), should be added for internal radioactivity from natural sources.

APPENDIX A

QUALITY CONTROL

Radioactive Measurements

Radiation measurement instruments were standardized with certified radioactive standards obtained from the National Bureau of Standards, U.S. Department of Commerce, are used to standardize radiation measurement instruments. These standards are certified to be within 5% of stated values. In some cases, certified standards, traceable to the National Bureau of Standards, were also obtained from Amersham/Searle for this purpose. Daily checks of instrument performances are made with these standards. Backgrounds are measured daily for gross alpha and beta counting systems. Backgrounds are measured weekly for gamma and alpha spectroscopy equipment. For tritium measurements a number of standards and blanks are included with each run of a liquid scintillator counter, which has a programmed automatic sample changer.

The Analytical Laboratory of BNL's Safety and Environmental Protection Division was a participant in the EPA, NRC-Batelle Northwest, and DOE interlaboratory comparison of samples of different matrices such as water, air filters, soil, vegetation, bone and artifical urine which contain a number of frequently encountered radionuclides. The results of the quality assurance program are shown on the following table. The matrices were assayed for ^{3}H, ^{90}Sr, ^{239}Pu isotopes, and several gamma emitting nuclides. Most results were within the ±20% acceptance criteria. Outlying results were examined and corrective action implemented.

Measurements of Water Quality Parameters

The procedures utilized for the assay of nonradioactive contaminants were those presented in Methods for the Examination of Water and Wastes, EPA-600/4-79-020, Revised March 1983; Determiantion of Polychlorinated Biphenyls in Transformer Fluids and Waste OIls, EPA-600/4-81-045, September 1982; and Standard Methods for the Examination of Water and Wastes (16th edition).

Radionuclide Results from EML & EMSL

Summary of Quality Assessment Program

Date	Sample Matrix	QAP Program	Radio-nuclide	Reported Value	% Error	Ratio RP/Known
11/83	soil	DOE-EML	K-40 *	8.72	4	0.69
11/83	soil	DOE-EML	Cs-137	0.92	3	0.92
11/83	soil	DOE-EML	Ra-226*	0.38	11	0.58
11/83	tissue	DOE-EML	Cs-137	1.40	2	0.79
11/83	vegetation	DOE-EML	K-40 *	7.78	3	0.56
11/83	vegetation	DOE-EML	Cs-137	1.14	1	0.83
11/83	vegetation	DOE-EML	Ra-226	<0.05	-	-
11/83	water	DOE-EML	H-3	71.3	4	1.03
11/83	water	DOE-EML	Cr-51	43.6	-	1.03
11/83	water	DOE-EML	Mn-54	4.66	-	1.02
11/83	water	DOE-EML	Co-60	4.56	-	1.02
11/83	water	DOE-EML	Cs-137	5.51	-	1.01
5/84	air	DOE-EML	Be-7	51300	1	1.12
5/84	air	DOE-EML	Be-7	56600	1	1.23
5/84	air	DOE-EML	Be-7	45300	1	0.99
5/84	air	DOE-EML	Cs-137	4910	1	1.01
5/84	air	DOE-EML	Cs-137	5300	1	1.09
5/84	air	DOE-EML	Cs-137	4300	1	0.88
5/84	soil	DOE-EML	K-40	190	3	0.90
5/84	soil	DOE-EML	K-40	211	2	1.00
5/84	soil	DOE-EML	K-40	204	2	0.97
5/84	soil	DOE-EML	Cs-137	0.343	7	0.84
5/84	soil	DOE-EML	Cs-137	0.390	5	0.95
5/84	soil	DOE-EML	Cs-137	0.392	4	0.96
5/84	soil	DOE-EML	Ra-226	1.1	17	0.99
5/84	soil	DOE-EML	Ra-226	1.05	5	0.95
5/84	soil	DOE-EML	Ra-226	0.88	4	0.79
5/84	vegetation	DOE-EML	K-40	170	6	0.73
5/84	vegetation	DOE-EML	K-40	257	3	1.1
5/84	vegetation	DOE-EML	K-40	226	2	0.97
5/84	vegetation	DOE-EML	Co-60	1.21	5	0.74
5/84	vegetation	DOE-EML	Co-60	1.96	5	1.20
5/84	vegetation	DOE-EML	Co-60	1.59	3	0.97
5/84	vegetation	DOE-EML	Cs-137	6.3	2	0.74
5/84	vegetation	DOE-EML	Cs-137	10.3	1	1.20
5/84	vegetation	DOE-EML	Cs-137	7.96	1	0.93
5/84	water	DOE-EML	Cs-137	4.63	1	1.01
5/84	water	DOE-EML	Cs-137	4.64	1	1.01
5/84	water	DOE-EML	Cs-137	4.80	1	1.05
3/84	air	DOE-EMSL	Gross Alpha	17	-	1.13
3/84	air	DOE-EMSL	Gross Beta	54	-	1.06
3/84	air	DOE-EMSL	Cs-137	13.5	-	1.35

Radionuclide Results from EML & EMSL

Summary of Quality Assessment Program

Date	Sample Matrix	QAP Program	Radio-nuclide	Reported Value	% Error	Ratio RP/Known
8/84	water	DOE-EMSL	H-3 *	3452	-	1.23
8/84	milk	DOE-EMSL	I-131	45	-	1.05
8/84	milk	DOE-EMSL	Cs-137	35	-	1.00
8/84	milk	DOE-EMSL	K-40	1708	-	1.14
7/84	artifical urine	Battelle	Pu-238	0	-	1.0
7/84	artifical urine	Battelle	Pu-238	0.154	-	0.85
7/84	artifical urine	Battelle	Pu-238	0.675	-	0.94
7/84	artifical urine	Battelle	Pu-238 MDA *	0.1	-	1.67
7/84	artifical urine	Battelle	Sr-89	0	-	1.0
7/84	artifical urine	Battelle	Sr-89	50.35	-	1.38
7/84	artifical urine	Battelle	Sr-89	159.60	-	1.47
7/84	artifical urine	Battelle	MDL Sr-89	0.85	-	0.085
7/84	artifical urine	Battelle	Sr-90	0	-	1.0
7/84	artifical urine	Battelle	Sr-90	39.93	-	0.87
7/84	artifical urine	Battelle	Sr90	0.82	-	0.082
7/84	artifical urine	Battelle	Sr-90	109.0	-	0.88
7/84	artifical urine	Battelle	Cs-137	0	-	1.0
7/84	artifical urine	Battelle	Cs-137	278.1	-	1.19
7/84	artifical urine	Battelle	Cs-137	1218	-	0.95
7/84	artifical urine	Battelle	MDL Cs-137	9.4	-	0.24
7/84	artifical urine	Battelle	Co-60	0	-	1.0
7/84	artifical urine	Battelle	Co-60	242	-	1.20
7/84	artifical urine	Battelle	Co-60	1018	-	1.03
7/84	artifical urine	Battelle	MDL Co-60	11	-	0.28
7/84	artifical urine	Battelle	H-3	0	-	1.0
7/84	artifical urine	Battelle	H-3	10.6	-	0.90
7/84	artifical urine	Battelle	H-3	157	-	1.02
7/84	artifical urine	Battelle	H-3	1503	-	1.00
7/84	artifical urine	Battelle	MDL H-3	1.18	-	0.018

Acceptance Criteria

1) DOE-EML — Control limits for gamma emitter, strontium 90, and tritium are based on the number of replicates. The control limits for 1 analysis is ± 30%, 2 analyses ± 32% and 3 analyses ± 17%

2) EPA-EMSL — Control limit is ± 3 times the standard error of the mean. Warning limit is ± 2 times the standard error of the mean.

3) Battelle — Pass if $-0.25 \leq$ average bias ≤ 0.40
Pass if relative precision ≤ 0.40
Pass if reported MDA $\leq$ AMDA (Ration Reported/Known ≤ 1.0).

* indicates analyses that failed acceptance criteria.

APPENDIX B

Minimum Detectable Concentration for Gamma Emitting Radionuclides in Air and Water Samples

Medium	Air		Well Water		Surface Water	
*Detector	#1 & #2	#3	#1 & #2	#3	#1 & #2	#3
Units	← μCi/mℓ →		← μCi/mℓ →		← μCi/mℓ →	
Nuclide						
^{7}Be	$1.1x10^{-14}$	$1.1x10^{-14}$	$1.3x10^{-9}$	$1.2x10^{-9}$	$2.5x10^{-9}$	$2.3x10^{-9}$
^{54}Mn	$2.0x10^{-15}$	$1.3x10^{-15}$	$2.3x10^{-10}$	$1.3x10^{-10}$	$4.3x10^{-10}$	$2.5x10^{-10}$
^{60}Co	$2.6x10^{-15}$	$2.0x10^{-15}$	$2.7x10^{-10}$	$2.0x10^{-10}$	$5.1x10^{-10}$	$3.8x10^{-10}$
^{131}I	$1.5x10^{-15}$	$1.4x10^{-15}$	$1.9x10^{-10}$	$1.6x10^{-10}$	$3.6x10^{-10}$	$3.0x10^{-1}$
^{134}Cs	$2.2x10^{-15}$	$1.5x10^{-15}$	$2.5x10^{-10}$	$1.6x10^{-10}$	$4.6x10^{-10}$	$3.0x10^{-1}$
^{137}Cs	$2.1x10^{-15}$	$1.3x10^{-15}$	$2.4x10^{-10}$	$1.5x10^{-10}$	$4.5x10^{-10}$	$2.8x10^{-1}$
^{144}Ce	$8.7x10^{-15}$	$7.3x10^{-15}$	$1.2x10^{-9}$	$9.3x10^{-10}$	$2.3x10^{-9}$	$1.8x10^{-9}$

*Intrinsic Germanium

APPENDIX C - METHODOLOGIES

1. Methodology for Dose-Equivalent Calculations

Dispersion (χ/Q) was calculated for release elevations of 10 and 100 meters 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. The resulting dispersion values represent a monthly integral of the dispersion for a given distance and sector. The radionuclide specific release rates (μCi/sec) for a given month from the HFBR stack, the Chemistry Building roof vent, the Medical Building roof vent, the van de Graaff roof vent, and the Hazardous Waste Management Incinerator stack were then used to estimate the air concentration at a given sector and distance. The air concentration, multiplied by the adult breathing rate (22.8 m^3 d^{-1}), the number of days per month, the dose conversion factor for a given radionuclide (32), and the dispersion and population values for that sector and distance resulted in the monthly population nuclide-specific dose equivalent for each sector with distance. This procedure was conducted for each month, radionuclide, and release point. The dose equivalents were then summed to obtain the total population dose equivalent resulting from BNL operations.

2. Discussion of 1983 Reported TLD Results and Analysis

The three way ANOVA used to analyze the 1983 TLD data (EM report 1983) found a significant overall model (α = .05) with significant main effects (sector, ring and season) and some significant interactions (sector-ring, ring-season). The Scheffe' test found that the ring closest to the site had a significantly higher exposure rate than the rings further from the site. This test is, however, invalidated because of the significant interactions found in the model [36].

In order to assess the extent of spatial pattern in the data, TLDS were located by latitude/longitude. The three way ANOVA indicated an effect of season as well as location so each season was analyzed separately to identify differences between the seasons.

The data for each season were tested for spatial autocorrelation using Moran's spatial autocorrelation coefficient. A significant spatial pattern was found for season 3. No significant spatial pattern was found for seasons 1,2 and 4.

The difference between TLDs close to the laboratory site and those far from the site was further evaluated using a Student's t-test for the difference between the means of two classes of data. The two classes were used in the analysis were: CLASS 1 TLDS close to the site (0. to 3.0 km from the HFBR stack), and CLASS 2 TLDS far from the site (8.0 to 17.0 km from HFBR stack)

A significant difference was found between the means of the two classes for season 3, but not for season 1,2 or 4. This was true under both the assumption of equal variances and the assumption of unequal variances. There was no laboratory operation or function that can be related to this difference between on-site and off-site TLD results. The test for spatial pattern in the data, and the results of the three way ANOVA are corroborated by this result.

APPENDIX D

TABULATED ANALYTICAL RESULTS

Table 1

1984 BNL Environmental Monitoring

1984 Resident Population Distribution[a] Within 80 Km Radius of BNL

Sector	0-16 Km (10 mi)	16-32 Km (20 mi)	32-48 Km (30 mi)	48-64 Km (40 mi)	64-80 Km (50 mi)	Total	Remarks
SSW	20,069	1,027	0	0	0	21,096	Beyond 32 Km - Atlantic Ocean
SW	39,518	60,971	3,211	0	0	103,700	Beyond 48 Km - Atlantic Ocean
WSW	35,637	135,388	330,845	419,201	756,637	1,677,708	Beyond 80 Km - Part of New York City
W	46,546	125,808	222,975	222,997	358,426	976,752	Beyond 80 Km - New York City
WNW	39,224	54,645	112	206,189	124,110	424,280	Beyond 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut and New York
NW	16,895	1,467	130,110	117,902	106,090	372,464	Same as WNW
NNW	7,200	0	200,470	102,805	51,958	362,433	Between 16 Km and 32 Km - Long Island Sound; Beyond 32 Km - Connecticut
N	4,264	0	89,876	238,652	248,221	581,013	Same as NNW
NNE	7,106	0	6,751	42,614	62,776	119,247	Same as NNW
NE	2,762	700	0	13,022	31,737	48,221	Between 32 Km and 48 Km - Long Island Sound: Beyond 48 Km - Connecticut
ENE	2,327	6,490	12,093	13,977	2,110	36,997	North Fork of Long Island
E	2,837	14,980	16,306	8,487	529	43,139	South Fork of Long Island and Atlantic Ocean
ESE	5,777	7,211	0	0	0	12,988	Long Island; Beyond 32 Km - Atlantic Ocean
SE	8,512	0	0	0	0	8,512	Beyond 16 Km - Atlantic Ocean
SSE	21,033	0	0	0	0	21,033	Same as SE
S	15,551	18	0	0	0	15,569	Beyond 32 Km - Atlantic Ocean
Total	275,258	408,705	1,012,479	1,385,846	1,742,594	4,825,152	

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

Table 2

1984 BNL Environmental Monitoring

Site-Perimeter External Dose-Equivalent Rates

Period Start	Period End	Location[a] Northwest Perimeter (P-2)	Southwest Perimeter (P-4)	Southeast Perimeter (P-7)	Northeast Perimeter (P-9)	Perimeter Average[b]
		mrem				
12/30/83	2/2/84	5.4	5.7	5.4	6.1	5.5
2/2/84	2/29/84	4.9	5.0	5.1	5.0	5.0
2/29/84	3/30/84	4.9	5.1	4.9	5.6	4.9
3/30/84	4/30/84	5.1	5.5	5.5	5.6	5.4
4/30/84	5/31/84	5.3	5.5	5.4	5.4	5.4
5/31/84	6/29/84	5.2	5.6	5.7	5.1	5.5
6/29/84	7/31/84	5.1	5.3	5.5	5.4	5.3
7/31/84	9/7/84	5.5	6.0	6.2	No data	5.9
9/7/84	9/28/84	3.6	3.7	4.1	4.4	3.8
9/28/84	10/31/84	5.2	5.9	5.9	6.4	5.7
10/31/84	11/30/84	4.3	4.8	4.9	No data	4.7
11/30/84	12/31/84	5.3	5.3	5.6	5.6	5.4
Average (Monthly)		5.0 ± 0.5	5.3 ± 0.6	5.3 ± 0.5	5.5 ± 0.6	5.2 ± 0.6
Total (Annual)		59.8 ± 6.4	63.4 ± 7.3	64.2 ± 6.6	66.7 ± 6.7	62.5 ± 6.7

(a) Locations of monitoring stations are shown in Figure 2.

(b) Station P-9 lies on a bed of coal cinders which contain radium and thorium at concentrations larger than the foundation material used at other perimeter stations. This accounts for a 24% increase in the external dose-equivalent rate as measured at this location. Consequently, this station was not used to estimate the perimeter average external dose equivalent rate.

Table 3
1984 BNL Environmental Monitoring
Special Study of Site Perimeter Dose Rate Sample Locations
External Dose-Equivalent Rates (mrem)

Period		Northwest Perimeter (P-2)			Southwest Perimeter (P-4)		
Start	End	routine (2m)	fence (1m)	tree (1m)	routine (2m)	fence (1m)	tree (1m)
9/7/84	9/28/84	3.6	3.8	4.0	3.7	4.1	4.1
9/28/84	10/31/84	5.2	5.6	5.6	5.9	5.8	5.9
10/31/84	11/30/84	4.3	4.8	4.8	4.8	5.0	4.9
11/30/84	12/31/84	5.3	5.4	5.5	5.3	5.6	5.7
Daily Average		0.160	0.170	0.173	0.171	0.178	0.179
Total		18.4	19.6	19.9	19.7	20.5	20.6

Period		Southeast Perimeter (P-7)			Northeast Perimeter (P-9)		
Start	End	routine (2m)	fence (1m)	tree (1m)	routine (2m)	fence (1m)	tree (1m)
9/7/84	9/28/84	4.1	4.1	4.4	4.4	4.5	3.8
9/28/84	10/31/84	5.9	5.6	6.3	6.4	6.5	5.4
10/31/84	11/30/84	4.9	4.9	5.3	ND	ND	ND
11/30/84	12/31/84	5.6	5.6	6.1	5.9	ND	5.2
Daily Average		0.178	0.176	0.192	0.196	0.204	0.169
Total		20.5	20.2	22.1	16.7	11.0	14.4

ND: No data.

Table 4

1984 BNL Environmental Monitoring

External Dose-Equivalent Rates, mrem a^{-1}

TLD Number[a]	1983 Annual Total	1st quarter 1984 91	2nd quarter 1984 91	3rd quarter 1984 92	4th quarter 1984 92	1984 Annual Total
1T3.1	62.2	13.6	13.4	14.7	14.3	56.0
1T8.8	50.7	14.2	13.9	15.0	12.3	55.4
2T3.2	60.7	15.4	13.7	19.6	15.7	64.4
2T10.5	61.7	13.3	17.4	17.4	17.2	65.6
3T8.8	59.7	14.2	13.9	14.1	14.2	56.4
4T2.6	58.2	14.1	14.2	15.3	15.8	59.4
4T7.5	57.2	14.4	11.9	13.8	13.6	53.7
5T4.2	56.3	13.6	11.4	14.6	12.2	51.8
5T6.5	52.7	15.8	12.8	14.1	13.1	55.8
5T17.1	54.3	12.4	15.1	16.0	13.8	57.3
6T5.6	59.2	14.3	12.3	15.0	12.8	54.4
6T14.2	50.7	12.3	14.2	13.3	12.7	52.5
7T2.5[c]	57.2	16.9	16.5	17.6	17.4	68.4
7T9.7	71.7	12.7	14.6	17.0	15.6	59.9
8T1.2[c]	58.2	12.7	13.6	14.0	13.6	53.9
8T.8.0	76.7	16.3	16.0	16.6	15.1	64.0
9T3.4[c]	61.2	11.9	TLD Lost	12.6	TLD Lost	
9T.8.3	74.2	18.2	13.9	18.0	13.1	63.2
10T3.7	68.7	17.4	16.9	16.1	16.7	67.1
10T9.3	53.8	14.4	13.7	13.2	11.8	53.1
10T12.0	62.2	14.4	17.4	17.5	16.4	65.7
11T3.7	58.8	14.8	13.2	16.2	13.6	57.8
11T17.8	52.7	13.6	14.4	14.3	12.8	55.1
12T5.0	60.2	13.9	14.2	15.2	14.8	58.2
12T7.2	57.7	12.7	10.5	14.1	14.3	51.6
12T12.5	60.2	15.3	16.3	16.9	15.8	64.3
13T1.4[c]	65.2	14.2	16.2	18.0	15.5	63.9
13T2.6	59.7	14.3	15.3	14.8	13.6	58.0
13T8.2	56.3	12.8	13.9	13.7	13.7	54.1
14T3.1	62.7	15.8	16.3	17.6	16.7	66.4
14T5.6	70.1	18.0	18.9	20.4	17.1	74.4
15T1.4[c]	67.7	14.7	17.5	20.0	16.2	68.4
15T3.0	52.3	Stolen	14.3	15.2	13.5	56.8[b]
15T14.7	62.2	15.1	13.8	15.7	15.3	59.9
16T3.4	61.7	15.3	14.7	15.1	15.1	60.2
16T10.0	59.7	13.1	15.1	17.6	15.3	61.1
Shielded TLD	19.8	--	--	--	--	21.2
Average	60.4	14.5	14.6	15.9	14.6	59.7
SD	±6.3	±1.6	±1.8	±2.0	±1.6	±5.72
Maximum	50.7	11.9	10.5	12.6	11.8	51.6
Minimum	76.7	18.0	18.9	20.4	17.4	74.4

(a) Location of off-site TLDs are shown in Figure 3.
(b) Annual dose rate estimated for period where missing data exists. Annual dose rate not included in overall average.
(c) Located on BNL site.
SD Standard deviation.

Table 5

1984 BNL Environmental Monitoring

Estimated Amounts of Radionuclides in Incinerated Materials [a]

Radionuclide[b]	Half-Life	Quantity (mCi)
^{3}H	12.2y	94.3
^{125}I	60.2d	1.0
^{14}C	5730y	2.1
^{131}I	8.1d	0.3
^{32}P	14.3d	0.2
^{7}Be	53.0d	3.0
^{51}Cr	27.8d	1.4
^{55}Fe	2.60y	0.2
^{113}Sn	118.0d	0.2
^{117m}Sn	14.0d	0.2

y = year

d = day

(a) Incinerated in the Waste Management Incinerator.

(b) Radionuclides released in annual quantities of less than 0.1 mCi have not been included.

Table 6

1984 BNL Environmental Monitoring

Emissions from HFBR Stack-Gamma Spectroscopy Data[a]

Date	Total Flow (10^7 m^3)	^{82}Br	^{131}I	^{133}I	^{123}I	^{124}I	^{126}I	^{137}Cs	^{60}Co	^{147}Nd	^{125}Xe	^{69}Ge	^{123}Xe	^{203}Hg	$^{106}RuRh$
		pCi/m^3													
January	1.30	620	0.38	--	0.92	--	0.185	--	0.0068	0.12	0.029	--	--	--	--
February	1.18	190	0.50	--	1.45	0.075	0.26	--	0.0048	--	--	1.13	--	--	--
March	1.20	37.2	0.10	--	--	--	0.086	--	--	--	0.15	1.79	0.81	--	--
April	1.30	--	2.3	--	--	--	--	0.0014	--	--	--	0.22	--	0.0081	--
May	1.23	0.18	0.27	1.2	--	--	--	0.0027	0.0023	--	--	0.012	--	0.67	--
June	1.19	1.6	0.31	0.23	--	--	--	0.0030	0.0073	0.012	--	--	--	0.0044	--
July	1.30	2.0	0.41	0.16	--	--	0.0057	0.0037	0.0029	--	--	--	--	0.0013	0.013
August	1.25	1.6	0.54	3.3	--	--	--	--	--	0.11	--	--	--	0.0013	--
September	1.15	6.5	0.20	0.17	--	--	--	--	0.0014	--	--	--	--	0.0037	0.0058
October	1.345	2.4	0.42	0.35	--	--	--	0.0013	0.0069	--	--	--	--	--	1.2
November	1.224	1.3	0.018	--	--	--	--	0.0024	--	--	--	--	--	0.013	--
December	1.26	6.3	0.020	--	--	--	--	0.0014	--	--	--	--	--	0.026	--
Monthly Average	1.24	73.8	0.47	0.45	0.19	0.0059	0.0441	0.0013	0.0027	0.021	0.0146	0.25	0.065	0.060	0.11
Annual Total[b]	14.9	11	0.069	0.067	0.029	0.00089	0.0066	0.0002	0.00041	0.0031	0.0022	0.0378	0.00972	0.00896	0.0164
		mCi													

-- Indicates not detected.

(a) Natural radioactive isotopes of potassium, radium and thorium were detected but are not reported as effluent emissions.

(b) Other radionuclides were detected, but at annual/qualities less than 1 μCi and have not been reported.

Table 7A
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location S6 (AA)

Month	No of Samples	Gross Alpha			Gross Beta			^{7}Be	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	19	0.0012	0.0052	0.0001	0.0295	0.1206	0.0035	<MDL	0.0041
February	21	0.0010	0.0073	0.0001	0.0170	0.0290	0.0046	<MDL	<MDL
March	18	0.0014	0.0087	0.0002	0.0135	0.0384	0.0013	<MDL	0.0040
April	21	0.0016	0.0108	0.0002	0.0147	0.0802	0.0012	<MDL	0.0024
May	22	0.0012	0.0038	0.0001	0.0171	0.0412	0.0002	<MDL	0.0037
June	21	0.0019	0.0061	0.0001	0.0280	0.261	0.0056	0.024	0.0025
July	20	0.0020	0.0154	0.0001	0.0177	0.0669	0.0046	<MDL	<MDL
August	23	0.0021	0.0079	0.0002	0.0376	0.350	0.0082	<MDL	0.0048
September	19	0.0183	0.138	0.0001	0.0543	0.272	0.0016	<MDL	0.0055
October	22	0.0019	0.0066	0.0002	0.0183	0.0523	0.0002	<MDL	<MDL
November	20	0.0020	0.0119	0.0000	0.0176	0.0539	0.0024	<MDL	0.0035
December	19	0.0010	0.0042	0.0001	0.0218	0.0552	0.0049	<MDL	<MDL
Annual Average	245	0.0028	0.1380	0.0000	0.0239	0.3503	0.0002	0.0019	0.0024

Table 7B
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location P-2 (AB)

Month	No of Samples	Gross Alpha			Gross Beta			^{7}Be	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	4	0.00079	0.0014	0.00003	0.0195	0.0300	0.0143	<MDL	0.0024
Feburary	4	0.00084	0.0016	0.00003	0.0093	0.0188	0.0000	<MDL	0.0032
March	4	0.00085	0.0010	0.00056	0.0098	0.0135	0.0058	<MDL	<MDL
April	5	0.00011	0.0015	0.00066	0.0100	0.0123	0.0076	<MDL	0.0016
May	4	0.00089	0.0015	0.00019	0.0109	0.0137	0.0063	0.031	<MDL
June	4	0.00047	0.0012	0.00003	0.0128	0.0304	0.0035	<MDL	0.0029
July	5	0.00042	0.0006	0.00003	0.0097	0.0135	0.0049	0.018	0.0016
August	4	0.00124	0.0016	0.00056	0.0254	0.0652	0.0167	<MDL	0.0029
September	3	0.0011	0.0020	0.00050	0.0181	0.0231	0.0127	<MDL	0.0042
October	5	0.00077	0.0018	0.00096	0.0135	0.0236	0.0002	<MDL	0.0023
November	4	0.00030	0.0008	0.00003	0.0073	0.0119	0.0039	<MDL	0.0025
December	4	0.00096	0.0015	0.00045	0.0157	0.0179	0.0084	<MDL	<MDL
Annual Average	50	0.00081	0.0016	0.00003	0.0131	0.0652	0.0000	0.0035	0.0020

Table 7C
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location P-4 (AC)

Month	No of Samples	Gross Alpha			Gross Beta			^{7}Be	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	4	0.00078	0.00166	0.00004	0.0236	0.0448	0.0086	<MDL	0.0033
Feburary	4	0.00058	0.00114	0.00003	0.0144	0.0305	0.0044	<MDL	0.0019
March	4	0.00055	0.00056	0.00049	0.0064	0.0113	0.0025	0.034	<MDL
April	5	0.00081	0.00144	0.00029	0.0046	0.0079	0.0009	0.024	<MDL
May	4	0.00102	0.00281	0.00003	0.0137	0.0343	0.0043	<MDL	0.0023
June	4	0.00054	0.00104	0.00003	0.0119	0.0267	0.0008	<MDL	0.0027
July	5	0.00064	0.00131	0.00028	0.0111	0.0235	0.0015	<MDL	<MDL
August	4	0.00097	0.00189	0.00041	0.0150	0.0201	0.0115	<MDL	0.0024
September	3	0.00117	0.00196	0.00058	0.0093	0.0211	0.0040	<MDL	0.0058
October	5	0.00106	0.00200	0.00003	0.0192	0.0287	0.0015	<MDL	<MDL
November	4	0.00069	0.00104	0.00003	0.0095	0.0152	0.0048	<MDL	0.0020
December	4	0.00118	0.00143	0.00087	0.0210	0.0441	0.0107	<MDL	<MDL
Annual Average	50	0.00083	0.00281	0.00003	0.0133	0.0448	0.0008	0.0048	0.0016

Table 7D
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location S-5 (AD)

Month	No of Samples	Gross Alpha			Gross Beta			^{126}I	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	5	0.0019	0.0029	0.00090	0.0258	0.0427	0.0091	<MDL	0.0046
Feburary	3	0.00065	0.0017	0.00003	0.0098	0.0165	0.0018	<MDL	<MDL
March	4	0.00094	0.0014	0.00056	0.0127	0.0230	0.0024	<MDL	0.0023
April	5	0.00065	0.00089	0.00004	0.0121	0.0149	0.0080	<MDL	0.0021
May	4	0.00095	0.0014	0.00003	0.0150	0.0204	0.0104	0.008	<MDL
June	4	0.0013	0.0023	0.00003	0.0182	0.0312	0.0134	<MDL	0.0016
July	5	0.0010	0.0013	0.00047	0.0138	0.0166	0.0114	<MDL	0.0031
August	4	0.00087	0.0014	0.00041	0.0208	0.0418	0.0117	<MDL	0.0013
September	4	0.00091	0.0016	0.00015	0.0136	0.0220	0.0045	<MDL	<MDL
October	5	0.00063	0.0014	0.00009	0.0252	0.0415	0.0138	<MDL	<MDL
November	4	0.0011	0.0019	0.00003	0.0140	0.0221	0.0052	<MDL	0.0018
December	4	0.0015	0.0024	0.00087	0.0209	0.0241	0.0149	<MDL	<MDL
Annual Average	51	0.001	0.0029	0.00003	0.0171	0.0427	0.0018	0.0001	0.0015

Table 7E
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location P-9 (AE)

Month	No of Samples	Gross Alpha			Gross Beta			^{126}I	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	5	0.00123	0.00188	0.00004	0.0234	0.0384	0.0165	0.013	0.0029
Feburary	4	0.00039	0.00091	0.00003	0.0113	0.0126	0.0091	<MDL	0.0044
March	4	0.00131	0.00179	0.00042	0.0345	0.0762	0.0143	<MDL	<MDL
April	4	0.00069	0.00088	0.00044	0.0098	0.0108	0.0089	V	V
May	4	0.00168	0.00258	0.00102	0.0163	0.0184	0.0126	<MDL	0.0035
June	4	0.00105	0.00203	0.00038	0.0151	0.0271	0.0099	<MDL	0.0040
July	5	0.00083	0.00141	0.00003	0.0154	0.0232	0.0102	<MDL	0.0013
August	4	0.00196	0.00256	0.00156	0.0197	0.0229	0.0155	<MDL	0.0014
September	3	0.00146	0.00237	0.00049	0.0203	0.0246	0.0159	<MDL	0.0021
October	5	0.00123	0.00232	0.00004	0.0221	0.0306	0.0132	<MDL	0.0013
November	0	V	V	V	V	V	V	V	V
December	3	0.00145	0.00213	0.00136	0.0219	0.0332	0.0192	<MDL	0.0027
Annual Average	45	0.00121	0.00258	0.00003	0.0192	0.0762	0.0089	0.0011	0.0023

V: Vandalism, data and equipment destroyed.

Table 7F
1984 Environmental Monitoring
Gross Alpha and Beta Concentrations in Air at Perimeter Monitoring Stations

Sample Location P-7 (AF)

Month	No of Samples	Gross Alpha			Gross Beta			^{126}I	^{137}Cs
		Ave	Max	Min	Ave	Max	Min		
		pCi/m^3							
January	4	0.00134	0.00154	0.00113	0.0248	0.0331	0.0143	<MDL	0.0040
Feburary	4	0.00069	0.00132	0.00003	0.0100	0.0154	0.0025	<MDL	<MDL
March	4	0.00066	0.00084	0.00038	0.0104	0.0135	0.0059	<MDL	0.0022
April	5	0.00115	0.00176	0.00056	0.0113	0.0138	0.0084	<MDL	0.0027
May	4	0.00084	0.00153	0.00019	0.0176	0.0254	0.0090	0.011	0.0029
June	4	0.00179	0.00436	0.00048	0.0173	0.0280	0.0124	<MDL	0.0042
July	5	0.00079	0.00116	0.00065	0.0139	0.0204	0.0107	<MDL	0.0020
August	4	0.00188	0.00220	0.00156	0.0185	0.0245	0.0143	<MDL	0.0046
September	3	0.00189	0.00204	0.00172	0.0205	0.0267	0.0156	<MDL	0.0028
October	4	0.00144	0.00264	0.00033	0.0223	0.0248	0.0178	<MDL	0.0026
November	4	0.00097	0.00284	0.00003	0.0155	0.0203	0.0130	<MDL	<MDL
December	4	0.00104	0.00131	0.00064	0.0180	0.0242	0.0143	<MDL	<MDL
Annual Average	49	0.00120	0.00436	0.00003	0.0166	0.0331	0.0025	0.00085	0.0023

Table 8A

1984 BNL Environmental Monitoring

Tritium Vapor Concentrations in Air at the Site Perimeter[a]

(pCi/m^3)

Month	P-2 Northwest Perimeter NNW (326.25°-348.75°)	P-4 Southwest Perimeter SW (168.75°-258.75°)	P-7-1	P-7-2 Southeast Perimeter ESE[b] (101.25°-123.75°)	P-9 Northeast Perimeter[a] NNE (11.25°-33.75°)
January	1.29	1.33	1.10	1.18	5.1
February	2.85	4.30	14.40	13.72	22.5
March	1.70	2.14	1.73	2.32	1.37
April	2.91	1.84	1.72	1.73	1.95
May	2.36	1.90	1.91 (26.82)[d]	2.10	1.91
June	3.57	2.73	3.18	3.46	3.52
July	5.19	4.77	4.31	5.10	4.93
August	4.09	41.91 (4.44)[e]	4.10	4.63	7.90
September	3.03	4.10	3.67	3.86	4.10
October	3.93	3.48	3.83	3.70	4.07
November	1.76	1.99	3.31	2.28	2.80
December	1.61	2.15	2.56	1.66	8.67
Average	2.66	4.81	3.50	3.79	5.16

(a) Location of perimeter monitoring stations are shown in Figure 2.
(b) Duplicate samples collected at station P-7.
(c) The term positive results indicates that tritium vapor concentrations were measurable, i.e., greater than the minimum detection limit.
(d) This result represents an artifact and was excluded because replicate sampling did not confirm the presence of activity at that level.
(e) Value in parentheses represents monthly average exclusive of single outlier.

Table 8B
1984 BNL Environmental Monitoring
Tritium Concentrations in On-site Precipitation[a]
(pCi/m^3)

Month	HWM[b] Area	S-6	S-5
January	24.0	27.2	ND
February	24.8	20.8	ND
March	15.8	11.4	62.2
April	10.5	14.6	23.4
May	28.1	28.2	16.8
June	46.2	62.0	ND
July	211	66.7	ND
August	142	40.7	ND
September	86.4	64.0	ND
October	56.8	23.2	ND
November	21.8	19.0	ND
December	18.0	26.3	ND
Average	46.8	30.7	27.95

(a) Location of stations shown in Figure 2.
(b) Hazardous Waste Management Area.

Table 9A

1984 BNL Environmental Monitoring

Quarterly Average Radionuclide Activity in Precipitation

Quarter	Rainfall (cm)	Gross α	Gross β	^{3}H	^{7}Be	^{60}Co	^{137}Cs	$^{106}RuRh$
		nCi/m^2						
First	41	0.12	1.12	84	19	ND	ND	ND
Second	51	0.15	0.87	120	10	0.013	0.012	0.049
Third	51	0.15	0.67	69	3.4	0.0060	0.0047	ND
Fourth	21	0.063	0.26	47	3.0	0.012	0.015	ND
Total Deposition (nCi)	144	0.48	3.0	320	35.4	0.031	0.032	0.049

ND: Not Detected in the sample.

Table 9B

1984 BNL Environmental Monitoring

Radionuclide Concentrations in

Vegetation and Soil at Farms in the vicinity of BNL

Location	Sample Matrix	-- Results, pCi/kg --- ^{40}K	^{137}Cs	^{7}Be	^{228}Th	^{226}Ru
JA	vegetation	2000	130	1500	ND	ND
JB	vegetation	3200	ND	990	ND	ND
JD	vegetation	3800	ND	720	ND	ND
JE	vegetation	1500	83	840	ND	ND
JZ	vegetation	3400	ND	950	ND	ND
OA	soil	2400	520	170	460	270
OB	soil	450	35	400	ND	ND
OD	soil	4300	150	130	750	600
OE	soil	2500	490	ND	210	200
OZ	soil	5900	520	ND	890	720

ND: Not detected.

Table 10

1984 BNL Environmental Monitoring

Sewage Treatment Plant, Peconic River, and Off-site Locations[b]

Average Water Quality and Metals Data

Location	pH (SU)	Conductivity (μmhos/cm)	Dissolved Oxygen	Chlorides	Nitrate-Nitrogen	Total Phosphorous	Ag	Cd	Cr	Cu	Fe	Hg	Pb	Zn
							mg/l							
Peconic River														
Sewage Treatment Plant Influent (DA)	6.4-7.7				a		<0.02	<0.01	<0.03	0.07	0.31	<0.0002	0.021	0.057
Sewage Treatment Plant Effluent (EA)	5.6-6.8	156	10.0	28.0	2.7	0.68	<0.02	<0.01	<0.03	0.06	0.20	<0.0002	0.007	0.26
Former Perimeter (M)	4.8-6.8	107	9.2	20.2	0.94	0.28	<0.02	<0.01	<0.03	0.20	0.80	<0.0002	<0.01	0.05
Site Perimeter (Q)	3.9-7.2	94	6.4	18.8	0.75	0.23				a				
19.35 km Downstream (R)	5.5-6.7	88	9.1	15.6	0.95	a				a				
Upstream of Laboratory Outfall (E)	4.4-7.0	71	5.8	12.9	0.57	0.06				a				
NYS Drinking Water Standard	6.5-8.5	-	-	250.0	10.0	-	0.05	0.01	0.05	1.0	0.3	0.002	0.025	5.0

a: Analysis not done.

b: Locations shown in Figure 5.

Table 11A
1984 BNL Environmental Monitoring
Sewage Treatment Plant Influent and Effluent, On-site Peconic River
Average Radionuclide Data

Date	Location (a)	Flow $1x10^7$ l	Gross α (b) (pCi/l)	Gross β (c) (pCi/l)	^{90}Sr (pCi/l)	^{3}H (d) (nCi/l)	Location (a)	Flow $1x10^7$ l	Gross α (b) (pCi/l)	Gross β (c) (pCi/l)	^{90}Sr (pCi/l)	^{3}H (e) (d) (nCi/l)
January	DA	8.99	1.53	6.34		2.40	EA	7.84	1.57	6.36		2.37
February		8.04	1.32	12.6		3.47		7.25	1.22	6.48		3.16
March		9.45	1.36	25.7		9.14		8.85	1.46	6.68		8.39
April		8.87	1.32	6.43		10.5		6.93(f)	1.70	11.0		9.42
May		10.09	1.30	9.24		4.20		2.13(f)	1.86	6.41		3.56
June		11.32	2.03	24.9		5.40		10.65	1.41	7.07		4.85
July		12.65	1.55	5.74		4.23		11.97	1.66	6.47		4.27
August		12.26	1.48	7.03		4.35		10.96	1.43	12.0		4.22
September		10.04	1.51	23.0		9.16		8.69	1.43	11.6		11.29
October		11.15	1.52	43.9		28.1		8.84	1.53	14.4		36.04
November		8.50	1.61	8.78		65.9		6.47	1.60	14.2		51.92
December		8.30	1.65	12.2		11.0		7.22	1.56	14.2		16.57
Annual Average		9.975	1.51	15.8		12.5		8.87(e)	1.54(e)	9.54(e)		11.77(e)
					mCi					mCi		
Total		119.7	1.82	18.9		14,950		105.6(e)	1.62(e)	10.07(e)		12,430(e)
				(pCi/l)		(nCi/l)				(pCi/l)		(nCi/l)
January	HM	No	1.60	4.88		1.53	HQ	No	1.44	5.94		2.49
February		flow	1.26	5.62		1.27		flow	1.30	4.62		3.25
March		data	1.31	4.43		2.49		data	1.22	7.50		2.13
April		avail-	1.44	4.16		1.97		avail-	1.40	5.51		2.20
May		able	1.46	5.61		1.06		able	1.39	4.36		1.70
June			2.56	5.62		1.11			2.25	4.34		1.76
July			1.72	4.23		1.15			1.64	4.34		0.78
August			1.63	3.86		2.44			1.50	4.08		2.78
September			1.56	4.94		7.28			1.42	6.00		3.87
October			1.64	7.97		16.67			1.65	7.06		18.93
November			1.85	5.85		23.23			1.54	4.9		20.39
December			1.74	6.79		11.15			1.66	7.52		3.37
Annual Average		--	1.65	5.32		5.92			1.54	5.51		5.70

(a) Locations shown in Figure 5.
(b) Counting error is $\leq$ 40%.
(c) Counting error is $\leq$ 25%.
(d) Counting error is $\leq$ 20%.
(e) Data includes April and May values normalized to expected annual values.
(f) Low flow due to measuring device out of service 4/23 to 5/25.

Table 11B
1984 Environmental Monitoring
Sewage Treatment Plant Influent and Effluent, On-site Peconic River
Gamma Spectroscopy Results

Location	Month	Flow	^{22}Na	^{51}Cr	^{54}Mn	^{60}Co	^{65}Zn	^{122}Sb	^{132}Cs	^{134}Cs	^{131}I	^{137}Cs	^{40}K	^{7}Be	^{57}Co	^{113}Sn	^{58}Co	^{24}Na	^{123}I
										(pCi/l)									
DA	January	8.99	0.022	0.62	0.049	0.50	0.79	3.6	0.47	0.088	1.9	0.039	0.60	-	-	-	-	-	-
	February	8.04	0.086	2.5	0.041	0.52	0.21	-	-	0.084	15.0	0.18	2.4	0.65	-	-	-	-	-
	March	9.45	-	0.44	0.027	0.53	0.58	-	-	-	21.0	0.32	1.5	0.61	0.025	0.087	-	-	-
	April	8.87	0.059	-	0.051	0.65	0.76	-	-	-	-	3.4	2.0	1.7	0.089	0.077	0.22	-	-
	May	10.09	0.036	-	0.034	0.41	0.13	-	-	-	-	1.4	1.2	1.6	0.028	0.030	0.087	-	-
	June	11.32	0.10	-	0.13	1.0	0.80	-	-	0.030	-	2.0	2.0	4.4	0.11	-	0.21	-	-
	July	12.65	0.024	0.26	0.063	1.0	0.89	-	-	-	-	0.72	1.3	1.4	0.029	-	0.029	-	-
	August	12.26	-	-	0.069	0.68	1.2	-	-	-	-	0.37	1.4	1.2	0.026	-	0.056	-	-
	September	10.04	0.066	-	0.057	0.45	-	-	-	-	-	1.0	2.0	0.32	-	-	-	-	-
	October	11.15	0.018	-	0.051	0.66	0.22	-	-	-	4.8	0.95	1.8	-	-	-	-	31.4	0.099
	November	8.50	0.020	2.9	0.051	0.96	0.44	-	-	-	-	0.32	2.5	0.40	-	-	-	-	-
	December	8.30	-	-	0.056	2.30	0.22	-	-	-	-	0.12	1.2	-	-	-	-	-	-
	Average	9.975	0.035	0.48	0.058	0.79	0.55	0.27	0.035	0.015	3.3	0.92	1.6	1.1	0.027	0.015	0.052	2.9	0.0092
											mCi								
	Total	119.7	0.042	0.58	0.070	0.95	0.65	0.32	0.042	0.018	3.9	1.1	2.0	1.3	0.032	0.018	0.063	3.5	0.011
EA	January	7.84	0.066	-	-	1.5	0.69	-	-	-	0.41	0.66	1.4	-	-	-	-	-	-
	February	7.25	0.062	0.23	-	0.60	0.10	-	-	0.016	1.4	0.20	0.60	-	-	-	-	-	-
	March	8.85	0.026	-	-	-	0.50	-	-	-	5.1	0.50	1.5	-	-	-	-	-	-
	April	6.93[a]	-	-	-	0.30	0.50	-	-	0.045	-	1.0	2.6	-	0.032	-	0.064	-	-
	May	2.13[a]	0.060	-	-	0.79	0.29	-	-	-	-	1.3	2.5	-	-	-	-	-	-
	June	10.65	0.056	-	-	0.77	0.29	-	-	0.044	-	1.2	1.8	-	0.044	-	0.059	-	-
	July	11.97	0.025	-	-	0.90	0.27	-	-	0.040	-	1.5	2.0	-	-	-	0.020	-	-
	August	10.96	0.021	-	-	0.52	0.41	-	-	0.031	-	1.7	2.2	-	0.017	-	-	-	-
	September	8.69	0.026	-	-	0.25	0.22	-	-	0.014	-	1.1	1.6	-	-	-	-	-	-
	October	8.84	0.029	-	-	0.55	0.35	-	-	-	-	1.3	1.9	-	-	-	-	-	-
	November	6.47	0.037	-	-	0.37	0.38	-	-	0.022	-	1.3	2.4	-	-	-	-	-	-
	December	7.22	0.069	-	-	0.74	0.51	-	-	-	-	1.5	-	-	-	-	-	-	-
	Average	8.87[b]	0.039	0.016	-	0.62	0.37	-	-	0.019	0.55	1.1	1.8	-	0.0086	-	0.013	-	-
											mCi								
	Total	105.6[b]	0.042	0.017	-	0.65	0.39	-	-	0.020	0.58	1.2	1.8	-	0.0091	-	0.014	-	-
HM	January	No	-	-	-	0.36	0.27	-	-	-	0.58	0.36	1.3	-	-	-	-	-	-
	February	Flow	0.10	-	-	0.28	0.19	-	-	-	1.5	0.28	0.72	0.68	-	-	-	-	-
	March	Data	0.068	-	-	0.29	0.16	-	-	-	-	0.35	1.2	1.4	-	-	-	-	-
	April		0.055	-	-	0.38	0.057	-	-	0.049	-	1.6	2.2	3.0	-	-	-	-	-
	May		0.043	-	0.018	0.48	-	-	-	-	-	0.26	0.35	0.36	-	-	-	-	-
	June		0.037	-	0.050	0.80	-	-	-	-	-	0.29	1.2	0.38	0.058	-	0.060	-	-
	July		0.025	-	-	0.15	-	-	-	-	-	0.07	0.26	-	0.011	-	-	-	-
	August		0.38	-	-	1.7	-	-	-	-	-	3.4	5.3	-	-	-	-	-	-
	September		-	-	-	0.22	-	-	-	-	-	0.46	1.2	0.32	-	-	-	-	-
	October		-	-	-	0.66	0.15	-	-	-	1.1	0.53	0.77	-	-	-	-	-	-
	November		0.064	-	-	1.0	0.59	-	-	-	-	1.2	2.9	-	-	-	-	-	-
	December		0.038	-	-	0.53	-	-	-	-	-	0.78	2.8	-	-	-	-	-	-
	Average		0.073	-	0.0057	0.56	0.12	-	-	0.0041	0.27	0.80	1.7	0.51	0.0058	-	0.035	-	-
											mCi								
	Total																		
HQ	January	No								No Sample Collected									
	February	Flow	0.14	-	-	0.34	-	-	-	0.065	-	1.5	1.6	-	-	-	-	-	-
	March	Data	0.042	-	-	0.10	0.067	-	-	-	0.32	0.39	0.87	2.3	-	-	0.017	-	-
	April		0.023	-	-	0.16	0.076	-	-	-	-	0.17	0.52	0.37	-	-	-	-	-
	May		0.10	-	-	0.22	-	-	-	-	-	1.5	1.2	0.47	-	-	-	-	-
	June		0.11	-	-	0.24	0.019	-	-	0.023	-	1.3	1.4	0.53	-	-	-	-	-
	July		0.23	-	-	0.51	0.95	-	-	-	-	0.60	0.85	-	-	-	-	-	-
	August		0.10	-	-	0.61	-	-	-	-	-	0.74	0.36	-	-	-	-	-	-
	September		0.11	-	-	0.51	0.086	-	-	-	-	1.5	2.4	-	-	-	-	-	-
	October		0.074	-	-	0.52	0.16	-	-	-	-	1.4	2.0	-	-	-	-	-	-
	November		-	-	-	0.42	-	-	-	-	-	1.4	2.9	-	-	-	-	-	-
	December		0.026	-	-	0.52	0.14	-	-	0.017	-	0.93	1.8	0.41	-	-	-	-	-
	Average		0.087	-	-	0.38	0.14	-	-	0.0095	0.029	1.0	1.4	0.37	-	-	0.0016	-	-
											mCi								
	Total																		

(a) Low flow due to measuring device out of service 4/23 to 5/25.
(b) Data includes April and May values normalized to expected annual values.
- Indicated not detected.

Table 12

1984 BNL Environmental Monitoring

Peconic River and Control Samples, Average Radionuclide Data

Location[a]	Quarter	No of Samples	Gross α	Gross β	^{3}H	^{60}Co	^{137}Cs
			------ pCi/l ------		nCi/l	--- pCi/l -----	
HA	---------- no samples collected from this station ----------						
HH	---------- no samples collected from this station ----------						
HE	1st	24	1.43	10.4	0.79	b	b
	2nd	26	1.39	7.36	0.79	b	b
	3rd	24	1.63	3.82	0.20	b	b
	4th	24	1.70	5.04	0.11	b	b
Annual Average			1.53	6.67	0.12	-	-
HR	1st	0	------ no samples collected during this period ------				
	2nd	4	0.313	4.71	0.206	0.45	0.47
	3rd	6	0.359	1.72	0.223	0.039	0.33
	4th	4	0.313	2.50	0.414		
Annual Average			0.333	2.91	0.257		
Applicable Standard			15[c]	50[d]	20.0[c]	30,000[e]	20,000[e]

(a) Locations shown in Figure 5.

(b) No samples collected for these analysis.

(c) NYS Drinking Water Standard.

(d) Compliance level.

(e) RCGs.

Table 13
1984 BNL Environmental Monitoring
Recharge Basins
Average Radionuclide Data

Location[a]	No. of Samples[b]		Gross α	Gross β	^{3}H	^{7}Be	^{58}Co	^{60}Co	^{137}Cs	^{22}Na
			pCi/l							
HN	6	Minimum	0.28	0.52	190	b	b	b	b	b
		Maximum	0.85	6.29	245	55	0.23	b	b	b
		Mean	0.41	3.32	223	18.1	0.079			
HO	6	Minimum	0.30	0.71	190	b	b	0.31		
		Maximum	0.56	4.1	245			2.21		
		Mean	0.40	1.8	223			0.84		
HP	5	Minimum	0.20	0.53	190	b	b	b	b	b
		Maximum	0.56	4.28	240					0.17
		Mean	0.38	2.20	218					0.059
HT	6	Minimum	0.29	0.73	190	b	b	b	b	b
		Maximum	0.53	4.29	245	2.3			0.41	
		Mean	0.38	2.09	273	0.79			0.14	
HS	234	Minimum	0.54	1.4	730					
		Maximum	5.8	56.7	3030	---------- No Sample Analyzed ----------				
		Mean	1.5	5.3	854					
NYS Drinking Water Standard			15.0	50.0[c]	20,000					
RCG						2,000,000	90,000	30,000	20,000	30,000

(a) Locations of Recharge Basins are shown in Figure 7.
(b) Below the minimum detection limit of the system.
(c) EPA compliance level.

Table 14A
1984 BNL Environmental Monitoring
Potable Supply Wells and Cooling Water Wells
Average Radionuclide Data

Well ID[a]	Number of Samples	Annual Pumpage (10^6 liters)	Gross α	Gross β	^3H	^{60}Co	^{22}Na
			pCi/l				
1 (FA)	3	457	0.38	4.33	870	9.5	ND
2 (FB)	3	5.48	0.30	0.912	216	ND	ND
3 (FC)	3	50.8	0.24	3.81	216	ND	ND
4 (FD)	4	845	0.21	1.19	216	ND	ND
5 (FE)	1	Not pumped	0.38	0.42	192	ND	ND
6 (FF)	3	332	0.28	1.04	216	ND	ND
7 (FG)	3	1722	0.39	0.54	216	ND	ND
10 (FO)	2	1299	0.24	0.78	229	ND	0.18
11 (FP)	2	1159	0.35	0.94	221	ND	ND
101 (FH)		Not pumped					
102 (FI)	1	722	0.39	1.84	208	ND	ND
103 (FJ)		647					
104 (FK)	1	470	0.45	1.4	208	ND	ND
105 (FL)	1	805	0.38	1.1	208	ND	ND
NYS Drinking Water Standard			15.0	50.0[b]	20,000		
Radiation Concentration Guide						30,000	30,000
FN[c]	245	--	1.5	6.9	828	NA	NA
ZB[d]	245	--	1.5	6.4	1122	NA	NA

ND: Not Detected in Sample.
NA: Not Analyzed.
(a) Location of Potable and Cooling Water Wells are Shown in Figure 7.
(b) Compliance Level.
(c) FN is the Daily Tap Water Sample.
(d) ZB is the Daily Distilled Water Sample.

Table 14B

1984 BNL Environmental Monitoring

Potable Supply Wells,

Average Metals Data

BNL[a] Well ID	Ag	As	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Se	Zn
	mg/l												
1	<0.02	<0.02	<0.16	<0.01	<0.02	<0.03	0.48	<0.0002	<0.02	16.27	<0.008	<0.0002	<0.01
2	<0.02	<0.02	<0.16	<0.01	<0.02	0.09	0.30	<0.0002	<0.02	13.9	<0.008	<0.0002	<0.01
3	<0.02	<0.02	<0.16	<0.01	<0.02	0.10	0.10	<0.0002	<0.02	13.26	<0.008	<0.0002	0.01
4	<0.02	<0.02	<0.16	<0.01	<0.02	<0.03	1.62	<0.0002	0.09	15.11	<0.008	<0.0002	<0.01
6	<0.02	<0.02	<0.16	<0.01	<0.02	<0.05	2.90	<0.0002	0.05	17.91	<0.008	<0.0002	<0.01
7	<0.02	<0.02	<0.16	<0.01	<0.02	0.06	2.01	<0.0002	0.06	10.96	<0.008	<0.0002	<0.01
10	<0.02	<0.02	<0.16	<0.01	<0.02	<0.03	0.09	<0.0002	<0.02	17.90	<0.008	<0.0002	<0.01
11	<0.02	<0.02	<0.26	<0.01	<0.02	<0.03	0.07	<0.0002	<0.02	11.55	<0.008	<0.0002	0.01
Tap Water	<0.01	<0.01	<0.02	<0.01	<0.01	b	0.13	<0.0001	<0.01	18.8	<0.01	<0.01	b
NYS Drinking Water Standard	0.05	0.025	1.0	0.01	0.05	1.0	0.3	0.002	0.3	--	0.025	0.02	5.0

(a) Locations of Potable Water Supply Wells are shown in Figure 7.

(b) No analysis done.

Table 14C

1984 Environmental Monitoring

Potable Supply Wells

Average Water Quality Data

Well ID	Temperature (°c)	pH (Su)	Conductivity (umhos/cm)	Dissolved Oxygen	Total Dissolved Solids	Amnonia	Nitrate	Nitrite	Chlorides	Fluorides	Sulfates	Phosphates
				mg/l								
1	12	5.6-6.4	76	8.1	95.0	<0.2	1.18	<0.04	18.16	<0.1	15.25	<0.05
2	15	5.8-6.1	73	7.0	93.0	<0.2	0.51	<0.04	20.0	<0.1	10.55	<0.05
3	15	6.1-6.3	74	8.1	69.0	<0.2	0.60	<0.04	22.88	<0.1	10.10	0.095
4	9	6.1-6.2	47	8.4	84.0	<0.2	0.64	<0.04	29.80	<0.1	8.0	a
6	11	5.8-6.1	87	8.1	107.0	<0.2	0.63	<0.04	24.84	<0.1	11.1	<0.05
7	10	5.6-6.0	54	8.9	78.0	<0.2	0.22	<0.04	14.69	<0.1	7.65	<0.05
10	12	6.0-6.2	64	8.5	84.0	<0.2	0.41	<0.04	18.25	<0.1	10.9	<0.05
11	11	5.7-5.9	63	8.5	69.0	<0.2	0.38	<0.04	13.19	<0.1	7.9	<0.05
Tap Water	a	6.0	11	a	62.0	<0.2	0.37	<0.04	12.8	<0.1	a	a
NYS Drinking Water Standards	--	6.5-8.5	--	--	--	--	10.0	--	250.0	1.5	250.0	--

a: No analysis done

Table 15A
1984 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Radionuclide Data

Well ID	No. of Samples	Gross α	Gross β	^{3}H	^{60}Co	^{137}Cs	^{22}Na	^{7}Be
		pCi/l						
XB	1	0.22	0.56	230	(a)	(a)	(a)	(a)
XC	1	0.32	1.1	230	(a)	(a)	(a)	(a)
XA	4	0.62	2.3	11,000	0.78	(a)	(a)	(a)
XD	4	0.37	0.81	210	0.06	(a)	(a)	(a)
XE	4	0.29	0.81	210	(a)	0.02	(a)	(a)
XJ	1	0.29	0.80	230	(a)	(a)	(a)	(a)
XI	1	0.19	0.49	230	(a)	(a)	(a)	(a)
XM	2	0.64	2.6	230	(a)	0.7	0.06	0.5
XN	1	0.34	1.2	3,900	(a)	(a)	(a)	(a)
XF	3	0.38	0.78	210	(a)	0.09	(a)	(a)
XK	2	0.39	5.5	5,800	0.10	(a)	(a)	(a)
XO	1	0.55	2.4	210	(a)	(a)	(a)	(a)
XL	3	0.87	5.6	2,300	(a)	0.19	(a)	(a)
X1	1	0.24	2.0	230	(a)	(a)	(a)	(a)
X2	1	0.65	1.9	230	(a)	(a)	(a)	(a)
X4	9	0.37	2.5	5,300	na	na	na	na
X5	1	0.23	0.69	230	(a)	(a)	(a)	(a)
XS	8	0.67	5.3	270	na	na	na	na
XT	8	0.54	1.4	240	na	na	na	na
NYS Drinking Water Standard		15.0	50.0(c)	20,000				

(a) Below the minimum detection limit.
(b) No sample collected for analysis.
(c) Compliance level.

Table 15B
1984 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Radionuclide Data

Well ID	No. of Samples	Gross α	Gross β	^{3}H	^{137}Cs	^{60}Co	^{22}Na
		pCi/l					
WI	1	na	na	na	0.12	(a)	(a)
WJ	1	0.31	0.69	210	(a)	(a)	(a)
WB	3	0.29	8.80	2560		(a)	1.7
WC	3	0.21	2.60	2980	0.34	(a)	4.0
WD	3	0.48	5.10	7890	0.08	0.06	0.84
WE	2	0.27	8.80	220	0.04	0.05	0.04
W1	2	0.40	12.10	620	(a)	(a)	0.80
18	1	0.36	2.70	210	(a)	(a)	(a)
WK	2	0.30	0.90	1230	(a)	0.18	0.44
WL	3	0.31	21.0	25430	(a)	0.12	0.33
W2	2	0.54	15.0	1180	(a)	(a)	(a)
WN	1	0.16	0.38	210	(a)	0.14	(a)
2L	3	0.31	0.63	220	(a)	0.04	(a)
2M	3	0.27	0.71	85000	(a)	(a)	(a)
2N	2	0.26	0.67	2230	(a)	(a)	(a)
W3	1	0.16	0.38	210	(a)	(a)	(a)
W7	1	0.16	0.38	210	(a)	(a)	(a)
W4	1	0.28	0.79	210	(a)	0.22	(a)
W8	1	0.31	1.84	210	(a)	(a)	(a)
WU(b)	4	0.34	1.80	640	0.14	(a)	(a)
WV(b)	1	0.32	0.73	230	(a)	(a)	(a)
WW(b)	1	0.32	0.79	230	na	na	na
WX	3	0.35	1.10	220	(a)	(a)	(a)
WZ	2	0.36	1.40	210	0.05	(a)	(a)
NYS Drinking Water Standards		15.0	50.0(c)	20,000			

(a) Below the minimum detection limit.
(b) Wells are downgradient of Waste Management, current landfill & former landfill.
(c) Compliance level.
na Not analyzed.

Table 15C
1984 BNL Environmental Monitoring
Landfill Areas, 650 Sump, and Miscellaneous On-Site Locations
Ground Water Surveillance Wells, Average Radionuclide Data

Well ID	No. of Samples	Gross α	Gross β	^{3}H	^{137}Cs	^{60}Co	^{22}Na
		pCi/l					
Current Landfill							
2E[e]	4	0.99	9.80	210	0.08	(a)	(a)
W6	3	0.51	0.91	220	(a)	(a)	(a)
WT	2	1.2	1.60	220	(a)	(a)	(a)
WG	2	0.91	3.1	1050	(a)	(a)	0.32
WR	3	3.6	26.50	4790	0.38	0.08	0.11
WS	5	3.6	16.70	3000	(a)	(a)	0.46
1K	4	4.2	22.0	870	4.5	(a)	1.0
2C[d]	3	2.1	13.0	8000	6.7	0.06	0.64
W9	3	1.9	9.98	2520	0.05	(a)	0.19
2D	1	1.8	13.0	220	(a)	(a)	1.1
2H	1	0.32	5.50	470	(a)	(a)	0.34
2J	1	0.15	0.50	560	(a)	(a)	0.75
2K	1	0.85	3.50	200	0.26	(a)	0.33
2I	1	0.15	0.50	770	(a)	(a)	0.51
2A	3	0.36	3.70	220	(a)	(a)	(a)
Former Landfill							
1I	1	na	na	na	(a)	0.19	(a)
1L	1	0.58	0.86	240	0.56	0.13	(a)
1J	1	0.29	0.75	240	(a)	(a)	(a)
WQ	2	0.96	3.20	230	(a)	0.08	(a)
WO	3	0.49	0.90	890	(a)	(a)	(a)
WP	2	0.37	1.10	320	(a)	(a)	(a)
Former Upland Recharge Area							
1N	1	0.19	0.48	210	(a)	(a)	(a)
1R	1	0.33	3.40	210	(a)	(a)	(a)
1T	2	0.93	4.10	230	(a)	(a)	(a)
1Y	1	0.34	0.98	230	(a)	(a)	(a)
650 Sump							
1F	1	0.29	1.90	220	(a)	0.82	(a)
1A	1	0.66	55.30	220	(a)	0.24	(a)
1B	1	0.33	3.80	220	(a)	4.2	(a)
1H	1	0.28	50.0	220	(a)	(a)	(a)
1D	1	0.20	5.30	220	(a)	(a)	0.44
1C	1	0.43	2.40	220	na	na	na
1E	1	0.46	40.0	220	0.13	(a)	(a)
1G	1	0.49	2.5	220	(a)	1.1	(a)
Miscellaneous Wells							
SD	1	0.38	3.4	210	(a)	(a)	(a)
SE	1	0.31	0.79	240	(a)	(a)	(a)
SG	1	0.41	1.3	210	(a)	(a)	(a)
SI	1	0.30	0.71	240	(a)	(a)	(a)
SJ	1	0.26	0.55	200	na	na	na
2G	1	0.22	0.64	210	(a)	(a)	1.6
NYS Drinking Water Standards		15.0	50.0	20,000			

(a) Below the minimum detection limit
(b) Compliance level.
(c) No sample collected.
(d) ^{54}Mn was detected in this well at an average concentration of 0.05 pCi/l.
(e) Upgradient of the Current Landfill.
na Not analyzed.

Table 15D

1984 BNL Environmental Monitoring

Sand Filter Beds and Peconic River

Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	Temperature (°C)	pH (SU)	Conductivity (μmhos/cm)	Dissolved Oxygen	Chlorides	Sulfates	Nitrate-Nitrogen	Phosphates
					mg/l				
XB	1	9	6.3	124	7.0	4.65	8.40	0.31	<0.02
XC	1	9	6.1	34	11.8	6.21	7.90	0.36	<0.02
XA	3	15	4.6-5.9	120	10.5	37.06	17.26	3.93	<0.04
XE	3	12	5.3-6.0	26	9.3	4.12	8.20	0.74	<0.04
XD	3	10	4.9-6.6	26.6	3.4	3.63	5.65	0.41	<0.04
XJ	1	13	4.4	38.6	5.8	4.30	7.67	<0.5	<0.05
XI	1	12	4.4	35.8	10.2	13.30	9.25	<0.5	<0.05
XM	2	10	6.2	80	6.6	18.46	21.76	0.28	<0.09
XN	1	6	4.8	a	6.8	7.24	20.90	0.56	<0.02
XF	2	12	6.1-6.6	42	8.2	7.53	3.75	0.26	<0.05
XK	2	8.5	6.0-6.9	111	1.9	24.90	16.35	0.33	<0.05
XO	1	8	3.8	33	10.0	5.73	7.58	0.38	<0.05
XL	2	10	6.2	115	1.8	22.16	16.09	0.29	0.06
X1	1	12	4.1	35.7	8.0	4.40	10.52	<0.5	<0.05
X2	1	12	5.4	94.7	4.0	22.50	12.29	<0.5	<0.05
17		10	4.9	22.7	13.0	11.30	5.71	1.1	<0.05
X5	1	11	4.9	102	6.8	22.50	15.88	<0.5	<0.05
NYS Drinking Water Standards		--	6.5-8.5	--	--	250.0	250.0	10.0	--

a: No analysis done.

Table 15E

1984 BNL Environmental Monitoring

Sand Filter Beds and Peconic River

Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn
		mg/l									
XB	1	<0.025	<0.50	<0.006	<0.025	a	a	<0.0002	a	0.023	a
XC	1	<0.025	<0.50	<0.006	<0.025	a	a	<0.0002	a	<0.01	a
XA	3	<0.015	<0.45	<0.007	<0.03	0.074	0.21	<0.0001	<0.02	0.038	0.88
XE	3	<0.015	<0.45	<0.007	<0.03	0.042	0.16	<0.0001	0.11	<0.005	1.77
XD	3	<0.014	<0.45	<0.007	<0.03	<0.03	0.38	<0.0001	<0.02	<0.005	0.89
XJ	1	<0.013	<0.25	<0.006	<0.025	a	a	<0.0002	a	<0.005	a
XI	1	<0.013	<0.25	<0.006	a	a	a	<0.0002	a	<0.005	a
XM	2	<0.013	<0.25	<0.006	<0.025	0.097	9.31	<0.0002	0.065	<0.005	a
XN	1	<0.025	<0.50	<0.006	<0.025	a	a	<0.0002	a	<0.01	a
XF	2	<0.013	<0.25	<0.006	<0.025	0.071	0.23	<0.0002	<0.025	0.037	a
XK	2	<0.013	<0.25	<0.006	<0.025	<0.025	2.36	<0.0002	0.080	<0.005	10.30
XO	1	<0.025	<0.50	<0.006	<0.025	a	a	<0.0002	a	<0.01	a
XL	2	<0.013	<0.25	<0.006	<0.025	<0.025	5.04	<0.0002	0.071	<0.005	1.29
X1	1	<0.013	<0.25	<0.006	<0.025	a	a	<0.0002	a	<0.005	a
X2	1	<0.013	<0.25	<0.006	<0.025	a	a	<0.0002	a	<0.005	a
17	1	<0.013	<0.25	<0.006	<0.025	<0.025	0.105	<0.0002	<0.025	<0.005	0.185
X5	1	<0.013	<0.25	<0.006	<0.025	a	a	<0.0002	a	<0.005	a
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	1.0	0.30	0.002	0.3	0.025	5.0

a: No analysis done.

Table 15F
1984 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	Temperature (°C)	pH (SU)	Conductivity (µmhos/cm)	Dissolved Oxygen	Chlorides	Sulfates	Nitrate-Nitrogen
					mg/l			
WI	1	10	4.9	50	10.2	4.69	13.30	<0.25
WJ	1	10	4.7	40	9.1	5.21	10.80	<0.25
WB	2	14	4.7-5.2	90	8.4	---------- a ----------		
WC	2	13	4.6-4.8	92	7.7	---------- a ----------		
WD	2	13	5.5-6.0	111	10.4	---------- a ----------		
WE	2	14	5.5	55	8.6	---------- a ----------		
W1	2	11	4.4-6.1	43	a	3.34	16.30	0.62
WK	3	11	4.7-5.5	4.8	11.6	7.15	14.70	<2.0
18	1	10	5.3	42	10.8	10.42	13.94	<0.25
WL	3	11	5.2-5.8	69	9.3	8.18	20.93	5.54
W2	3	12	5.5	100	a	6.74	33.20	1.57
WN	1	9	6.2	90	11.5	4.69	a	<0.25
2L	3	10	4.7-5.2	124	6.06	42.36	23.37	1.26
2M	3	10	4.6-4.8	87	2.6	23.98	9.77	1.84
2N	3	10	4.6-5.0	71	4.33	14.38	14.83	0.82
W3	1	9	4.5	80	9.2	5.73	a	0.74
W7	1	9	6.2	76	10.4	9.37	a	0.55
W4	1	9	5.3	29	13.2	6.77	7.25	<0.25
W8	1	9	6.1	46	11.2	7.29	6.66	<0.25
W5	1	9	5.9	40	14.4	42.18	8.30	<0.25
WU	4	10	4.6-7.0	44	8.65	11.30	15.23	1.13
WV	1	13	5.9	40	10.5	4.7	7.0	<2.0
WW	1	9	6.0	56	13.2	12.41	12.0	0.31
WX	3	10	5.6-5.8	58	12.0	11.32	8.6	0.66
NYS Drinking Water Standards		--	6.5-8.5	--	--	250.0	250.0	10.0

a: No analysis.

Table 15G

1984 BNL Environmental Monitoring

Waste Management Area

Ground Water Surveillance Wells, Average Metal Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn
		mg/l									
WI	1	<0.013	<0.25	<0.006	<0.025	0.075	7.93	<0.0002	0.040	1.11	20.40
WJ	1	<0.013	<0.25	<0.006	<0.025	<0.025	3.62	<0.0002	<0.025	0.28	15.95
WI	2	<0.02	<0.55	<0.008	<0.03	<0.03	0.31	<0.0001	0.01	<0.03	2.02
WK	2	<0.02	<0.55	<0.008	<0.03	<0.03	0.09	<0.0001	0.02	0.03	2.28
I8	1	<0.03	<0.50	<0.006	<0.03	<0.025	0.049	<0.0002	<0.025	0.01	0.016
WL	3	<0.02	<0.50	<0.009	<0.03	<0.03	8.26	<0.0002	<0.03	0.03	3.78
W2	2	<0.02	<0.55	<0.008	<0.03	<0.02	0.46	<0.0001	0.82	0.03	2.19
WN	1	<0.03	<0.50	<0.006	<0.03	<0.03	0.196	<0.0002	<0.025	<0.01	1.24
2L	3	<0.02	<0.50	<0.009	<0.03	<0.03	0.27	<0.0002	0.82	<0.04	0.03
2M	3	<0.02	<0.50	<0.009	<0.03	<0.03	0.17	<0.0002	0.14	<0.02	0.10
2N	3	<0.02	<0.50	<0.009	<0.03	<0.03	0.11	<0.0002	0.07	<0.02	0.03
W3	1	<0.03	<0.50	<0.006	<0.03	<0.025	0.056	<0.0002	<0.025	<0.01	0.88
W7	1	<0.03	<0.50	<0.006	<0.03	<0.025	0.169	<0.0002	<0.025	0.017	14.07
W4	1	<0.03	<0.50	<0.006	<0.03	<0.025	<0.03	<0.0002	<0.025	<0.01	1.08
W8	1	<0.03	<0.50	<0.006	<0.03	<0.025	0.39	<0.0002	<0.025	0.027	4.37
W5	1	<0.03	<0.50	<0.006	<0.03	0.046	0.060	<0.0002	<0.025	<0.01	2.61
WU	4	<0.02	<0.40	<0.007	<0.03	<0.03	0.603	<0.0002	0.035	0.104	5.70
WV	1	<0.002	<0.30	<0.01	<0.03	0.04	1.90	<0.0002	0.03	<0.005	8.15
WW	1	<0.03	<0.50	<0.006	<0.03	0.125	1.96	<0.0002	<0.025	<0.025	1.55
WX	3	<0.02	<0.40	<0.009	<0.03	<0.03	4.26	<0.0002	0.055	0.143	2.76
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	1.0	0.30	0.002	0.3	0.025	5.0

Table 15H

1984 BNL Environmental Monitoring

Landfill Areas

Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	Temperature (°C)	pH (SU)	Conductivity (μmhos/cm)	Dissolved Oxygen	Chlorides	Sulfates	Nitrate-Nitrogen	Dissolved Solides
					mg/l				
Current Landfill									
WG	2	12	5.5-6.3	275	1.4	4.72	6.70	<0.25	129
WR	3	12	6.0-6.3	984	5.4	20.50	6.80	<1.0	478
WS	3	12	6.0-6.6	900	5.4	34.37	11.42	<0.25	352
WT	2	9	5.5	116	6.5	18.88	15.18	<0.25	78
1K	3	11	5.6-6.5	602	4.3	16.42	14.42	<1.0	480
2C	3	11	6.3-6.5	460	1.7	11.78	8.72	0.52	465
2D	1	10	6.1	820	13.0	28.64	16.37	<0.25	a
W9	3	11	6.2-6.4	431	3.6	33.08	12.29	0.52	385
2H	1	10	5.2	58	7.8	20.31	8.88	<0.25	a
2K	1	11	6.0	74	4.4	19.79	6.86	0.39	a
2I	1	13	5.9	64	3.8	13.02	9.01	0.33	a
2J	1	9	4.8	54	3.8	7.81	10.17	<0.25	a
2A	3	9	4.8-5.1	39.9	10.5	12.25	17.07	1.43	a
W6	3	10	6.4-7.0	179	58.7	12.40	14.32	0.82	126
Former Landfill Area									
1I	2	10	5.2-6.8	69	10.0	18.10	4.0	<0.60	a
WP	3	10	4.7-5.2	71	11.7	9.08	7.45	0.37	35
1J	1	9	5.2	36	11.8	10.40	6.40	<0.60	a
1L	1	11	6.1	80	3.8	5.0	3.50	<2.0	a
WQ	2	10	4.8-70	53	13.9	32.80	3.50	20.60	a
WO	3	10	4.8-5.4	38	12.2	6.39	8.40	0.25	39
WZ	2	10	5.6-6.1	76	8.5	21.60	11.0	<2.0	a
NYS Drinking Water Standards		--	6.5-8.5	--	--	250.0	250.0	10.0	--

a: No analysis done.

Table 15i

1984 BNL Environmental Monitoring

Landfill Areas

Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn
		mg/l									
Current Landfill											
WG	2	<0.01	<0.45	<0.006	<0.03	<0.03	100.7	<0.0001	30.80	<0.005	3.36
WR	3	<0.02	<0.45	<0.007	<0.03	<0.02	80.7	<0.0001	2.91	0.11	1.89
WS	3	<0.02	<0.45	<0.007	<0.03	<0.02	84.5	<0.0001	1.03	0.02	1.66
WT	2	<0.01	<0.45	<0.006	<0.03	<0.03	10.79	<0.0001	0.19	0.084	7.22
1K	3	<0.01	<0.45	<0.007	<0.03	<0.03	113.0	<0.0001	3.66	0.074	1.39
2C	3	<0.01	<0.45	<0.005	<0.03	<0.03	75.6	<0.0001	1.55	<0.02	0.04
2D	1	<0.01	<0.25	<0.006	<0.025	a	87.42	<0.0002	a	<0.05	a
W9	3	<0.01	<0.45	<0.007	<0.03	<0.03	50.7	<0.0001	2.05	0.242	6.69
2H	1	<0.01	<0.25	<0.006	<0.025	a	<0.05	<0.0002	a	<0.005	a
2K	1	<0.01	<0.25	<0.006	<0.025	a	0.53	<0.0002	a	<0.005	a
2I	1	<0.01	<0.25	<0.006	<0.025	a	2.37	<0.0002	a	<0.005	a
2J	1	<0.01	<0.25	<0.006	<0.025	a	0.06	<0.0002	a	<0.005	a
2A	3	<0.02	<0.45	<0.009	<0.03	0.03	0.238	<0.0002	0.145	<0.02	0.583
WZ	2	<0.01	<0.40	<0.03	<0.03	<0.16	19.2	<0.0005	0.03	0.52	0.14
W6	3	<0.01	<0.45	<0.007	<0.03	<0.03	0.637	<0.0001	0.155	0.172	2.237
Former Landfill Area											
1I	2	<0.01	<0.25	<0.006	<0.03	<0.03	42.0	<0.0001	0.21	<0.005	0.107
WP	3	<0.01	<0.25	<0.006	<0.03	<0.03	16.22	<0.0001	0.473	<0.005	0.232
1J	1	<0.01	<0.25	<0.006	<0.028	<0.025	22.69	<0.0002	0.22	<0.005	0.036
1L	1	<0.02	<0.30	<0.001	<0.03	<0.03	2.31	<0.0002	0.04	<0.05	11.0
WQ	2	<0.01	<0.25	<0.006	<0.03	<0.03	4.27	<0.0002	0.149	<0.005	0.007
WO	1	<0.01	<0.25	<0.006	<0.03	<0.03	19.35	<0.0002	0.42	<0.005	0.034
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	0.10	0.30	0.002	0.3	0.025	5.0

a: No analysis done.

Table 15J

1984 BNL Environmental Monitoring

Miscellaneous On-Site Areas

Ground Water Surveillance Wells

Average Water Quality and Metals Data

Well ID	No. of Samples	Temperature (°C)	pH (SU)	Conductivity (μmhos/cm)	Dissolved Oxygen (mg/l)	Chlorides (mg/l)	Sulfates (mg/l)	Nitrate-Nitrogen (mg/l)
2E	3	11	5.3-6.0	87	9.2	7.3	29.5	<0.43
SE	1	13	6.5	155	8.2	19.7	15.8	1.27
SG	1	8	6.0	90	8.4	13.1	11.0	<0.60
SI	1	11	5.8	84	11.4	15.7	10.0	<0.60
SD	1	8	5.0	40	11.0	16.4	3.5	<1.0
2G	1	17	5.4	104	5.0	23.2	11.0	<1.0
1R	1	14	4.4	40	11.8	10.2	a	<1.0
1N	1	14	4.0	56.4	12.4	7.7	a	<1.0
NYS Drinking Water Standards		--	6.5-8.5	--	--	250.0	250.0	10.0

Well ID	No. of Samples	Ag (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Zn (mg/l)
2E	3	<0.02	<0.30	<0.007	<0.03	<0.03	0.44	<0.0002	<0.02	<0.025	0.30
SE	1	<0.01	<0.25	<0.006	<0.025	<0.025	7.24	<0.0002	0.62	<0.005	0.50
SG	1	<0.01	<0.25	<0.006	<0.025	<0.025	1.71	<0.0002	0.085	<0.005	0.183
SI	1	<0.01	<0.25	<0.006	<0.025	<0.025	6.21	<0.0002	0.115	<0.005	0.024
SD	1	<0.02	<0.50	<0.01	<0.03	<0.03	0.25	<0.0002	0.04	<0.005	0.460
2G	1	<0.02	<0.50	<0.01	<0.03	<0.03	0.10	<0.0002	<0.30	<0.005	<0.01
1R	1	<0.01	<0.30	<0.01	<0.03	<0.03	0.04	<0.0002	<0.04	<0.005	<0.01
1N	1	<0.01	<0.30	<0.01	<0.03	<0.03	0.06	<0.0002	0.08	<0.005	<0.01
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	1.0	0.30	0.002	0.3	0.025	5.0

a: No analysis.

Table 15K

1984 BNL Environmental Monitoring

Sand Filter Beds and Peconic River

Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/l			
XB	1	ND	ND	ND	ND
XC	1	ND	ND	ND	ND
XA	4	0.036	0.058	ND	ND
XE	3	ND	ND	ND	ND
XD	4	ND	ND	ND	ND
XJ	1	ND	ND	ND	ND
XI	1	ND	ND	ND	ND
XM	1	ND	ND	ND	ND
XF	1	ND	ND	ND	ND
XK	1	ND	ND	ND	ND
XL	2	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.050[a]	0.010	0.50[a]

ND: Not detected.
(a) NYS DOH advisory guidelines.

Table 15L
1984 BNL Environmental Monitoring
Miscellaneous and Potable Supply Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
		mg/l			
Miscellaneous On-site Wells					
2E	4	ND	ND	ND	ND
2G	1	ND	ND	ND	ND
SO	1	ND	ND	ND	ND
SI	1	ND	ND	ND	ND
17	1	ND	ND	ND	ND
1R	1	ND	ND	ND	ND
1N	1	ND	ND	ND	ND
Potable Supply Wells: Concentration Range					
1	5	ND-0.002	ND-0.011	ND-0.001	ND-0.002
2	6	ND-0.009	ND-0.004	ND-0.009	ND
3	6	ND-0.001	ND	ND	ND
4	4	ND-0.007	ND	ND-0.017	ND
6	5	ND	ND-0.004	ND	ND
7	5	ND	ND	ND	ND
10	5	ND-0.001	ND-0.014	ND	ND
11	6	ND-0.001	ND-0.010	ND	ND
NYS Drinking Water Standards( )		0.100	0.050(a)	0.010	0.050(a)

ND: Not detected.
(a) NYSDOH advisory guideline.

Table 15M
1984 BNL Environmental Monitoring
Landfill Areas
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/l			
Current Landfill					
W6	4	ND	ND	ND	ND
WG	2	0.12	ND	ND	ND
WR	3	0.070	ND	ND	ND
WS	4	0.040	ND	0.035	ND
WT	3	ND	ND	ND	ND
1K	3	0.025	ND	ND	ND
2C	2	0.15	ND	ND	ND
2D	1	ND	ND	ND	ND
W9	2	0.095	ND	ND	ND
2K	2	ND	ND	ND	ND
2H	1	ND	ND	ND	ND
2I	1	ND	ND	ND	ND
2A	3	0.005	ND	ND	ND
Former Landfill Area					
1I	3	0.007	0.016	0.014	ND
WP	2	0.018	0.018	0.007	ND
1J	2	0.003	0.008	0.005	ND
WQ	2	<0.001	ND	ND	ND
WO	2	0.005	ND	ND	ND
NYS Drinking Water Standard		0.100	0.050[a]	0.010	0.050[a]

ND: Not detected.
(a) NYSDOH advisory guidelines.

Table 15N
1984 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/l			
WI	2	ND	ND	ND	ND
WJ	2	ND	ND	ND	ND
WB	4	ND	0.019	ND	ND
WC	3	0.019	0.012	ND	ND
WD	4	0.037	0.096	ND	2.28
WE	3	ND	0.027	ND	0.014
W1	6	ND	0.368	ND	0.140
WK	6	ND	0.015	ND	ND
WL	7	0.233	4.65	0.013	1.97
W2	4	0.049	1.73	1.15	0.301
WN	4	0.004	ND	ND	0.017
2L	6	0.011	1.06	0.304	ND
2M	5	0.074	1.88	ND	0.043
2N	5	ND	0.005	ND	ND
W3	3	ND	ND	ND	ND
W7	4	ND	ND	ND	ND
W4	3	ND	ND	ND	ND
W8	3	ND	ND	ND	ND
W5	3	ND	ND	ND	ND
WU	3	ND	ND	ND	ND
18	2	ND	ND	ND	ND
19	2	ND	ND	ND	ND
WW	1	ND	ND	ND	ND
WX	3	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.050[a]	0.010	0.050[a]

ND: Not detected
(a) NYS DOH advisory guidelines.

Table 16A

1984 BNL Environmental Monitoring

1984 Population Committed Dose Equivalent Resulting from

Atmospheric Release of Radioactive Materials from BNL Operations

Month	Total Body (person-rem)	Thyroid (person-rem)	Collective Effective Committed Dose Equivalent (person-rem)
January	0.0030	0.00014	0.0030
February	0.0031	0.00058	0.0031
March	0.0037	0.00000055	0.0037
April	0.0036	0.00073	0.0036
May	0.0031	0.000059	0.0031
June	0.0017	0.0000054	0.0017
July	0.0044	0.0000097	0.0044
August	0.0056	0.0000023	0.0056
September	0.0055	0.0000062	0.0055
October	0.0072	0.00014	0.0072
November	0.0027	0.000000084	0.0027
December	0.0018	0.00000015	0.0018
Annual Total	0.046	0.0017	0.0046

Table 16B

1984 BNL Environmental Monitoring

Population Thyroid Committed Dose Equivalent Resulting from

Atmospheric Releases of Radioactivity at BNL from

the 100 Meter Elevation

Month	^{131}I	^{133}I	^{123}I	Total
	person-mrem			
January	2.99	-	0.078	3.065
Feburary	2.79	-	0.0794	2.869
March	0.55	-	-	0.55
April	16.6	-	-	16.5
May	0.91	0.847	-	1.757
June	0.853	0.122	-	0.975
July	2.39	0.186	-	2.576
August	4.39	5.26	-	9.65
September	1.93	0.334	-	2.264
October	5.28	0.91	-	6.19
November	0.0844	-	-	0.0844
December	0.153	-	-	0.153
Annual Total	38.92	7.659	0.154	46.7

Table 16C
1984 BNL Environmental Monitoring
Population Total Body Committed Dose Equivalent Resulting from
Atmospheric Releases of Radioactivity at BNL
from the 100m Elevation

Month	^{3}H	^{82}Br	^{131}I	^{133}I	^{123}I	^{69}Ge	Total
				person-mrem			
January	2.93	0.0332	0.00033	-	0.000071	-	2.96
February	1.8	0.0069	0.00031	-	0.0000076	0.0000135	1.81
March	2.62	0.0013	0.000061	-	-	0.0000223	2.62
April	2.1	-	0.00184	-	-	0.0000034	2.10
May	2.54	0.0000041	0.000101	0.0000941	-	0.000000063	2.54
June	1.01	0.0000297	0.0000948	0.0000136	-	-	1.01
July	0.959	0.0000772	0.000266	0.000021	-	-	0.959
August	4.36	0.0000878	0.000488	0.000585	-	-	4.36
September	2.67	0.000419	0.000215	0.0000371	-	-	2.69
October	4.55	0.000202	0.000586	0.000101	-	-	4.55
November	1.54	0.0000475	0.0000098	-	-	-	1.54
December	1.15	0.000269	0.000017	-	-	-	1.15
Annual Total	28.2	0.0426	0.00432	0.000852	0.0000146	0.000039	28.3

Table 16D

1984 BNL Environmental Monitoring

Population Total Body Committed Dose Equivalent Resulting from

Atmospheric Releases of Radioactivity at BNL from the 10m Elevation

Month	^{3}H	^{131}I	^{125}I	^{14}C	^{7}Be	^{75}Se	^{32}P	^{35}S	^{113}Sn	^{51}Cr	^{153}Gd	^{103}Ru	^{201}Tl	^{33}P	^{55}Fe	^{54}Mn	Total
	person-mrem																
January	0.0685	0.0156	-	-	0.0000145	0.00051	-	-	-	-	-	-	-	-	-	-	0.0841
February	1.23	-	0.048	0.00012	-	-	0.00015	0.000096	0.000537	0.0011	0.000765	-	-	-	-	-	1.278
March	1.06	-	-	0.000032	-	-	-	-	0.000249	0.000384	-	-	-	-	-	-	1.06
April	1.40	0.0204	0.045	0.00236	-	-	-	0.000082	0.00613	0.000060	0.00127	0.00013	0.0000245	0.000083	0.000073	-	1.465
May	0.548	-	0.00475	0.0000847	-	-	-	-	-	-	-	-	-	-	-	-	0.553
June	0.702	0.000344	0.000105	0.00195	0.0012	-	0.000043	-	-	-	-	-	-	-	-	0.000349	0.705
July	3.47	-	-	-	0.0011	-	-	-	-	-	-	-	-	-	-	0.00051	3.47
August	1.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.20
September	2.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.84
October	2.67	0.0117	0.00226	0.0217	-	-	0.0277	0.0000346	-	-	-	-	-	-	0.00139	0.000457	2.68
November	1.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.16
December	0.654	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.654
Annual Total	17.00	0.048	0.100	0.0262	0.0023	0.00051	0.0279	0.000213	0.000692	0.00154	0.00204	0.00013	0.0000245	0.000083	0.00146	0.00132	17.2

Table 16E
1984 BNL Environmental Monitoring
Population Thyroid Committed Dose Equivalent Resulting from
Atmospheric Releases of Radioactivity from the 10m Elevation

Month	^{131}I	^{125}I	Total
	person-mrem		
January	0.14	-	0.14
February	-	0.575	0.575
March	-	-	-
April	0.184	0.540	0.724
May	-	0.057	0.057
June	0.0031	0.0013	0.0044
July	-	-	-
August	-	-	-
September	-	-	-
October	0.105	0.027	0.132
November	-	-	-
December	-	-	-
Annual Total	0.432	1.20	1.63

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