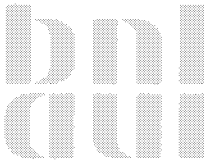
BNL 51993

1985 ENVIRONMENTAL MONITORING REPORT

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



April 1986

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

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SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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BROOKHAVEN NATIONAL LABORATORY
ANNUAL ENVIRONMENTAL REPORT

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1.0 INTRODUCTION

1.1 Background

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

1) facility operations, waste treatment, and control systems have functioned as designed from the standpoint of containment of environmental pollutants, 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 1985 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 includes the sampling and analysis for radioactivity, water quality indices, metals, and organic compounds.

1.2 Site Characteristics

Brookhaven National Laboratory is a multidisciplinary scientific research center. It is located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to surrounding communities is shown in Figure 1. About 1.3 million persons reside in Suffolk County [3] and about 0.38 million persons reside in Brookhaven Township, within which the Laboratory is situated. The distribution of the resident population within 80 km of the BNL site is also 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 near the Laboratory during recent years.

The Laboratory site is shown in Figure 2. It consists of some 21.3 square kilometers (2130 hectares (ha)), most of which is wooded, except for a developed area of about 6.7 square kilometers (670 ha). The site terrain is gently rolling, with elevations varying between 36.6 and 13.3 m above sea level. The land lies on the western rim of the shallow Peconic River watershed, 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, like most eastern seaboard areas, as a well-ventilated site. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall [4,5].

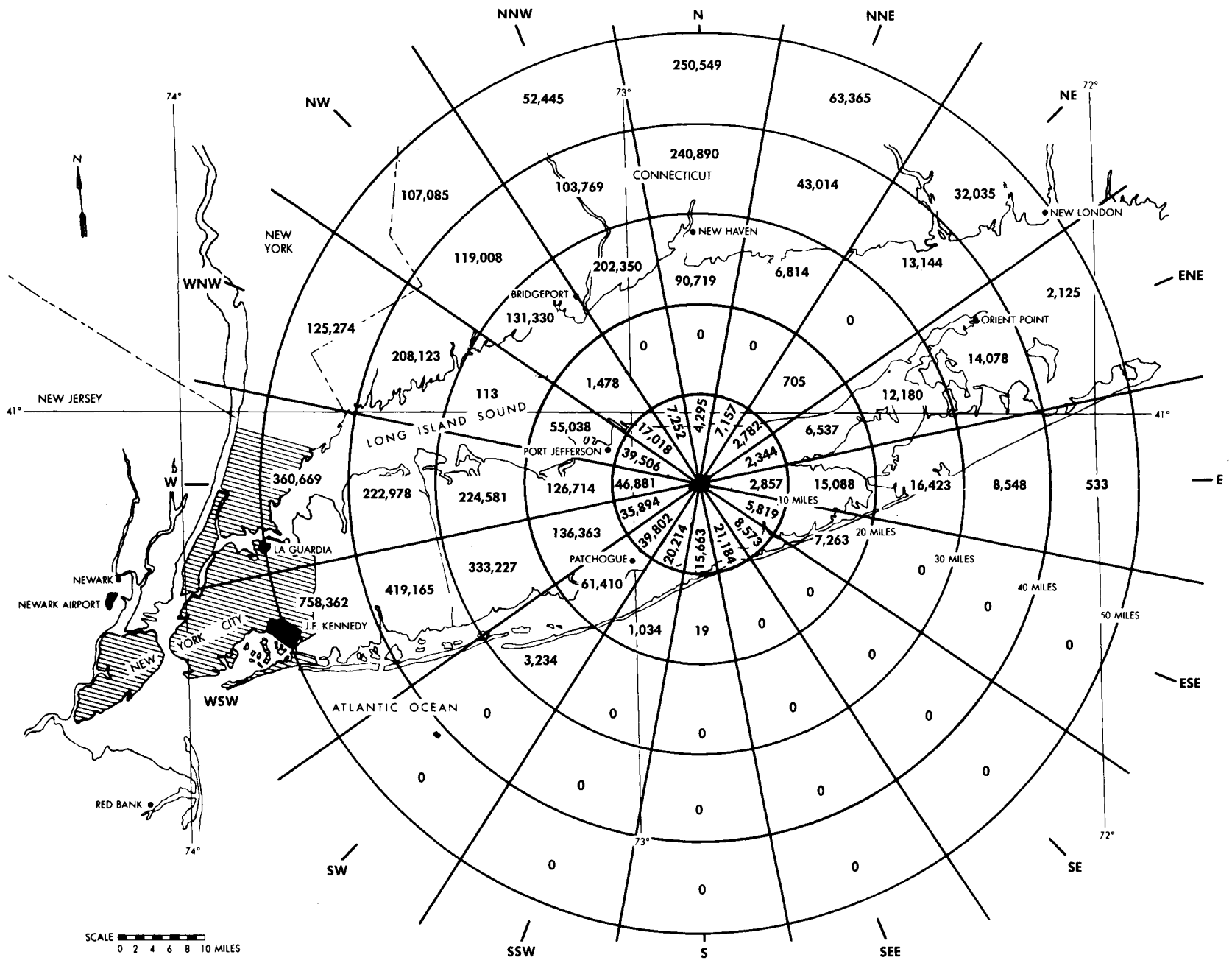


FIGURE 1: RESIDENT POPULATION (1985) WITHIN A 80 Km RADIUS OF BNL

FIGURE 2

OVERLAY FOR BASE 3, BROOKHAVEN

PREPARED IN 1983

0 100 METERS 400 500 600 700
0 500 FEET 1500 2000

BROOKHAVEN NATIONAL LABORATORY

40 52 15 N 72 52 45 W
(LABORATORY LOCATION)

MAJOR FACILITIES

Studies of Long Island hydrology and geology [6-9] in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are between 31-61 m thick, are generally sandy and highly permeable. Water penetrates them readily and there is little direct run-off into surface steams, except during periods of intense precipitation. The total precipitation for 1985 was 93 cm. On the average, about half of this annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge ground water. The ground water in the vicinity of the Laboratory moves predominantly in a horizontal, southerly direction to the Great South Bay [6-9], taking a more easterly direction in the Peconic River watershed portions of the site. The estimated rate of movement at the ground water surface is about 30 cm d^{-1} [9].

1.3 Existing Facilities

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

1) the fundamental structure and properties of matter,

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

3) the physical, chemical, and biological effects of radiation, and of other energy-related environmental pollutants,

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

5) energy and nuclear related technology, and

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

The major scientific facilities which are operated at the Laboratory to carry out the above programs 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 research Van de Graaff are used in medium energy physics investigations, as well as for special nuclide production.

6) The National Synchrontron Light Source (NSLS) utilizes a linear accelerator and booster synchrontron 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.

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

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

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, BLIP and the research Van de Graaff, with lesser contributions from the Chemistry Building and MRC. The HFBR and BLIP contribute principally to the Laboratory's liquid radioactive wastes. Additional smaller contributions originate from the MRC, the Hot Laboratory complex, as well as from decontamination and laundry operations. Liquid radioactive waste is processed at the BNL waste concentration facility.

2.0 SUMMARY

The environmental monitoring program has been designed to determine that BNL facilities operate such that the applicable environmental standards and effluent control requirements have been met. The data were evaluated using the appropriate environmental regulatory criteria. The environmental levels of radioactivity and other pollutants found in the vicinity of BNL during 1985 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 water quality of the potable supply wells; the concentrations of radioactivity in biota from the stream; the concentrations of radioactivity in and the water quality of ground waters underlying the Laboratory; concentrations of radioactivity in milk samples obtained in the

vicinity of the Laboratory; and the 1984 strontium-90 data which was not available for inclusion in the 1984 Environmental Monitoring Report. In 1985, the results of the surveillance program demonstrated that the Laboratory has operated within the applicable environmental standards.

2.1 Airborne Effluents

Argon-41, oxygen-15, and tritium were the predominant radionuclides released from BNL facilities. In 1985, 1100 Ci of argon-41 were released from the MRR stack; 1900 Ci of oxygen-15 were released from BLIP; and 338 Ci of tritium were released from the Van de Graaff, MRC, and HFBR stacks.

The principal release point for nonradioactive pollutants is the Central Steam Facility. Analyses of results obtained from EPA-sponsored emissions testing have indicated that combustion efficiency and ambient air quality standards were met.

2.2. Liquid Effluents

The effluent from the Laboratory sewage treatment plant is subject to the conditions of the State Pollutant Discharge Elimination System (SPDES) Permit No. NY 000 5835, authorized by the New York State Department of Environmental Conservation (NYSDEC). Operations at the sewage treatment plant resulted in a greater than 99% compliance rate in meeting permit requirements.

At the sewage treatment plant, the concentrations of gross alpha, gross beta, strontium-90, and gamma emitting radionuclides have remained virtually constant. Tritium releases were 71% below those of 1984.

Approximately 16 million liters per day (MLD) of water were returned to the aquifer through on-site recharge basins. The monitoring data indicates that only trace quantities of radioactivity were discharged to the recharge basins as a result of routine facility operations. These concentrations were all small fractions of the applicable guides or standards. Analysis of non-radiological water quality parameters indicates that, with the exception of iron, the discharge to the recharge basins met NYS drinking water standards.

2.3 External Radiation Monitoring

Thermoluminescent dosimeters (TLDs) were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1985 was 68.9 mrem while the off-site integrated dose was 59.7 mrem. The difference between the on-site and off-site integrated exposure is not attributable to on-site radiation levels, but appears to be an artifact resulting from the measurement process (see Section 3.3.1).

2.4 Atmospheric Radioactivity

Tritium was the predominant radioactive effluent detected in environmental air samples. The maximum annual average tritium concentration at the site boundary was 4.7 times the average annual tritium air concentration measured at the control stations. This concentration would result in an

annual effective dose equivalent of 0.01 mrem to the maximally exposed individual residing at the site boundary.

2.5 Radioactivity in Precipitation

In rainfall, the following radionuclides were detected: tritium, beryllium-7, cesium-137, and strontium-90. The measured concentrations were consistent with typical wash-out values associated with atmospheric scrubbing [10].

2.6 Radioactivity in Soil or Vegetation

No nuclides attributable to Laboratory operations were detected in samples collected from dairy farms in the vicinity of the Laboratory.

2.7 Peconic River

Concentrations of metals and indices of water quality were comparable to the sewage treatment plant effluent; well within drinking water standards and reflecting ambient levels. At the former site boundary, the annual average gross beta concentration was 7.8 pCi/L or 7.8% of the Radiation Concentration Guide (RCG); and the average tritium concentration was 2.6 nCi/L or 0.1% of the RCG. At the site boundary, the average gross beta concentration was 8.4 pCi/L or 8.4% of the RCG; and the average tritium concentration was 3.6 nCi/L or 0.1% of the RCG.

The Peconic River was sampled in Riverhead, approximately 19.5 km downstream of the site boundary. The average gross alpha concentration was 0.20 pCi/L; the average gross beta concentration was 2.4 pCi/L, and the average tritium concentration was below the analytical detection limit of the system. The gross alpha and beta concentrations were 0.03% and 2.4%, respectively, of the RCGs. In addition, cobalt-60 and cesium-137 were detected in second and third quarter samples at concentrations less than 0.03% of the applicable RCGs.

2.8 Aquatic Biological Surveillance

Fish were collected at Donahue's Pond (shown in Figure 10) and at control locations for radionuclide analysis. Tritium, strontium-90, and cesium-137 were detected in the edible portions of these fish. The committed effective dose equivalent to the maximum individual would be less than 0.13 mrem.

2.9 Potable Water Supply

With the exception of one well, all tritium concentrations were at or near the minimum detection limit. The average tritium concentration at this well, 1080 pCi/L corresponded to 5.4% of the EPA drinking water standard. Other nuclides, including beryllium-7, cobalt-60, cesium-137, chromium-51, sodium-23, and strontium-90 were detectable in several wells at small fractions (<0.03%) of the applicable RCG [11]. No heavy metals were detected in the water supply wells. Trace levels of chlorocarbons were detected in the

wells, at levels which were well within the drinking water standards or advisory guidelines.

2.10 Ground Water Surveillance

In addition to comparsion of ground water concentrations to the applicable RCGs, the monitoring well data were evaluated against the more restrictive Environmental Protection Agency (EPA), New York State Department of Environmental Conservation (NYSDEC), and Department of Health (NYSDOH) Drinking Water Standards since the aquifer underlying Long Island has been designated a "sole source" aquifer [12]. However, the prescribed limits are not directly applicable to the monitoring well data as these standards apply to community water supplies serving more than 25 individuals [13].

2.10.1 Radionuclide Analysis

Elevated gross beta and tritium concentrations have been found on-site adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to water losses from the tile collection field underlying the sand filter beds and the recharge of the Peconic River in these areas. In 1985, on-site gross beta and tritium concentration ranges were 24% and 37%, respectively, of the NYS regulations [13,14]. Adjacent to the Peconic River at the site boundary, the annual average gross beta and tritium concentrations were less than or equal to 15% of the limits. At a surveillance well located adjacent to the Peconic River and several hundred meters downstream of the site boundary, the annual average tritium concentration was 50% of the NYS standards.

In addition to the BNL off-site surveillance wells, private potable wells were sampled and analyzed for tritium as part of a co-operative program with the Suffolk County Department of Health. Two off-site areas were identified with detectable quantities of tritium in the potable water. The annual average tritium concentrations at both locations were less than 10% of the NYS Drinking Water Standard.

At the sanitary landfill area, the maximum gross beta concentration was 50% of the applicable guide while the maximum tritium concentration observed was 1.3 times the NYS Drinking Water Standard. Given the distance to the site boundary, radioactive decay alone would serve to reduce the tritium concentration to a level well below the drinking water standard.

The data from the ground water program at the Hazardous Waste Management area indicate that the tritium, fission and activation products that have entered the ground water system are migrating from their source. The concentrations of cesium-137 and cobalt-60 were 0.003% and 0.002%, respectively, of the RCGs.

2.10.2 Analysis of Metals, Organics, and Water Quality

Iron, lead, and zinc were found in excess of the NYS standards (0.6, 0.025, and 0.3 mg/L for drinking water) in numerous sampling wells on-site. However, with the exception of wells which monitor the landfill, this appears

to be related to corrosion from the well casings and not to Laboratory effluents. At the landfill, the maximum concentrations of iron, zinc, and lead, were 91, 7.5 and 0.24 mg/L respectively. Trace levels of chlorocarbons were detected in two monitoring wells near the sand filter beds, in one well near the current landfill, in one off-site well near the Peconic River, and in wells which monitor the former landfill. The annual average concentrations were less than 16% of the drinking water limits.

Elevated levels of chlorocarbons (low ppm range) were measured in wells which monitor the Hazardous Waste Management Facility. During 1985, the Laboratory determined the extent of chlorocarbon contamination, which is currently confined to the Laboratory property [9]; and has adopted an agressive plan for aquifer restoration.

2.11 Off-Site Dose Estimates

For the year 1985, the collective dose-equivalent attributable to Laboratory sources, for the population up to distance of 80 km, was calculated to be 4.8 person-rem. This can be compared to a collective dose-equivalent to the same population of approximately 300,000 person-rem due to natural sources.

3.0 ENVIRONMENTAL PROGRAM INFORMATION: Facility Effluents, Environmental Measurements and Analyses

3.1 Airborne Effluents

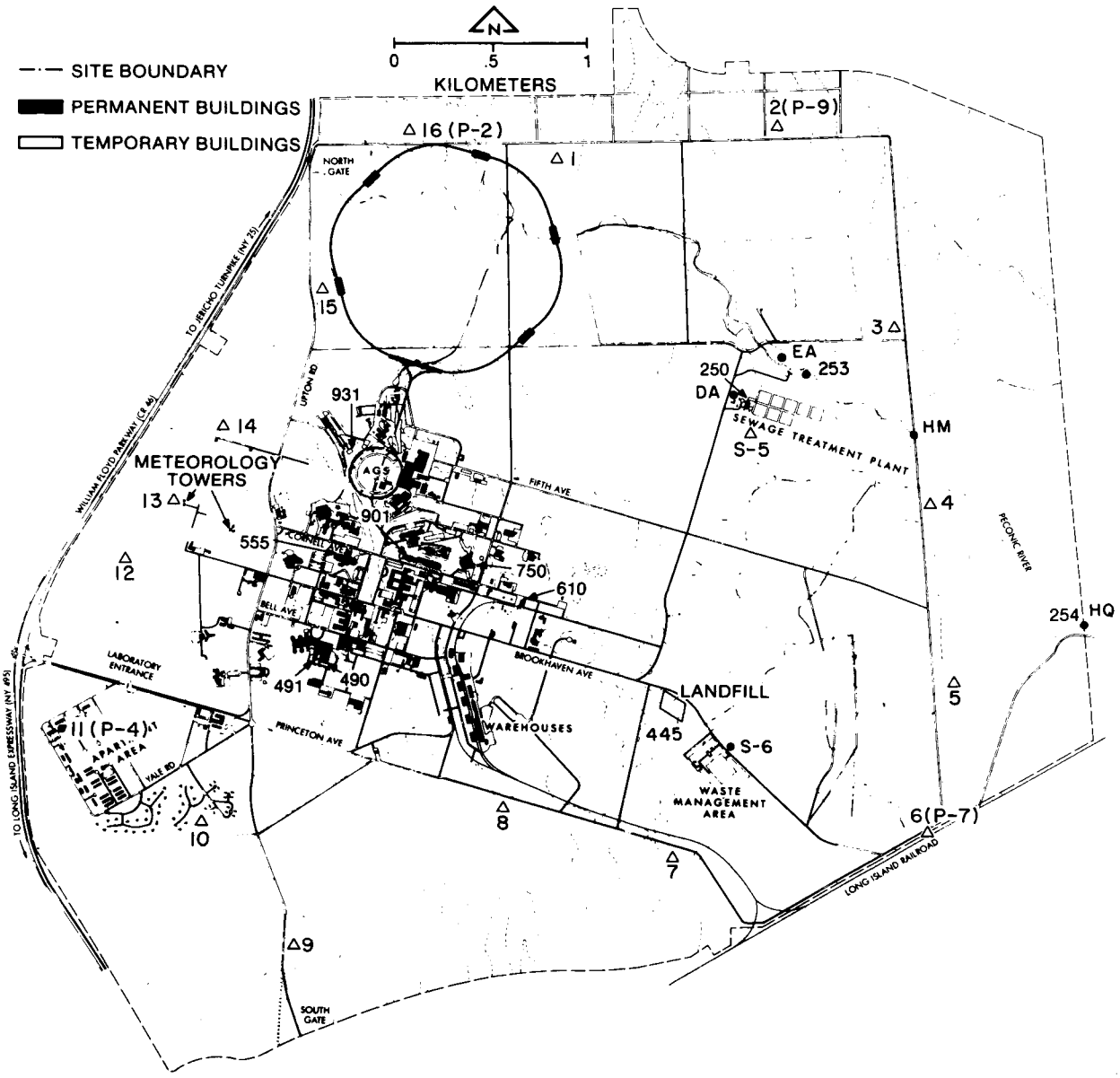
The locations of principal Laboratory facilities from which radioactive effluents are released to the atmosphere are shown in Figure 3. The installed on-line effluent monitors, sampling devices, and the types and amounts of effluents released during 1985 are indicated in Appendix D, Table 2. Tritium was the major radionuclide detected at the site boundary which was attributable to Laboratory operations.

3.1.1 Airborne Radioactive Effluents

At the BLIP facility, oxygen-15, which has a two minute half-life, is produced by the interaction of protons and water in the beam tubes and generated at an estimated rate per unit beam current of 0.21 Ci per ampere-hour. It is calculated that 7.6×10^3 Ci of oxygen-15 was produced in the beam tubes at the BLIP facility during 1985 and approximately 25% (1.9×10^3 Ci) was released via the airborne stack. Modifications to the target radiation chamber in 1985 were responsible for the reduction in oxygen-15 releases (when compared to prior years) to the atmosphere. At the Medical Research Reactor, argon-41, which has a 110-minute half-life, is produced by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the stack at an estimated rate of 2 Ci $MW^{-1}h^{-1}$. The release estimate for the MRR stack during 1985 was 1.1×10^3 Ci of argon-41. Of the 338 Ci of tritium released from the Laboratory research facilities during 1985, 200 Ci were in the gaseous elemental form, and 138 Ci were released as tritiated water (HTO) vapor.

FIGURE 3

BROOKHAVEN NATIONAL LABORATORY SITE



△ ENVIRONMENTAL MONITORING STATIONS

AIR
I THRU 16 PERIMETER STATIONS
S-6 WASTE MANAGEMENT AREA
S-5 SEWAGE TREATMENT PLANT

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

Effluent Release Points and Environmental Monitoring Stations

The Laboratory incinerates certain wastes which contain low-level radioactivity in the Hazardous Waste Management Incinerator (Figure 3). The total quantities of the individual radionuclides that were incinerated during 1985 are shown in Appendix D, Table 3. Tritium was the radionuclide released from the incinerator in the largest quantity, 13.2 mCi. Site meterological characteristics and administrative limits on the amount of material incinerated ensure that airborne concentrations at the site boundary are small fractions of the applicable standards.

Gamma emitting nuclides released from the HFBR stack are shown in Appendix D, Table 4. Mercury-203, iodines, xenons, cerium-139, and zirconium-95 and daughter products result from operational activities at the Hot Laboratory. The remaining nuclides are presumed to be the result of experimental studies conducted at the HFBR.

3.1.2 Airborne Elemental and Hydrocarbon Effluents

The potential sources of elemental and hydrocarbon air pollutants emitted by BNL facilities are listed in Appendix D, Table 5, which lists all environmental permits issued to the Department of Energy at BNL. Under the air permits issued by the NYSDEC, individual stack monitoring is not required since emissions are reduced at the source point through the use of pollution control equipment appropriate for the specific process.

Most of the heating and cooling requirements for the principal buildings at the Laboratory are supplied by the Central Steam Facility (Figure 3). From 1976 to the present, the Laboratory has utilized light feed stock (LFS) materials, such as mineral spirits, alcohol, solvents, jet fuel, and reconstituted fuels in addition to No.6 oil. These materials are classified as EPA-regulated hazardous waste due to their ignitability and are blended with No.6 oil to form Alternate Liquid Fuel (ALF). In 1985, 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 NYSDEC regulatory limit of 1% sulfur content in No.6 oil [15]. NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum [15]. Stack testing, conducted in accordance with NYSDEC requirements, has demonstrated the mean fuel combustion efficiency over the entire range of boiler loading capacities to be greater than 99.9% for the individual boiler units firing alternate liquid fuels (ALF) [16,17], thus meeting the state criteria.

A recent study [18] sponsored by EPA involved analysis of the stack gas emissions during the firing of No.6 oil and a representative blended ALF. Constituents measured included heavy metals, principal organic hazardous constituents (POHC), products of incomplete combustion (PIC), and the EPA criteria pollutants. The degree of this potential environmental effect was evaluated through: (i) comparisons of measured stack gas emissions and the ambient air quality standards/emission goals, and (ii) comparisons of combustion and destruction efficiences with current regulatory requirements. The reported data [18] indicated that during ALF firing, the concentrations of SO_2 and NO_x were reduced 70% and 64% respectively, when compared to the firing of straight No.6 oil.

Lead is the only heavy metal for which there are amibient air quality standards to which the measured concentrations can be compared. The NYS ambient air quality standard for lead is 1.5 ug/m^3 [19]. Reference criteria for evaluating the other measured metal concentrations were obtained from the EPA Multimedia Environmental Goals (MEG) and Assessment Document [20] which provides stack emission and ambient air quality target goals. The measured stack concentrations and the MEGs are shown in Appendix D, Table 6. For 10 of the 14 metals, the stack concentrations were approximately equal to or significantly less than the respective MEGs. Dilution factors of 10-fold would reduce the cadmium, chromium and nickel concentrations to the MEG levels. Using the exit flow rate at Boiler #5 of 16m^3/sec and an average X/Q dispersion parameter of 3.8 x 10^{-8} m^3/sec (calculated by the BNL meterology group for the 1973-1983 period) for all CSF stacks, the calculated concentrations at the site boundary were well below the EPA ambient goals shown in Appendix D, Table 6. Based on these available data, metal emissions do not exceed the environmental goals.

The designated POHCs were also evaluated with respect to the EPA stack emission and ambient air quality goals [20]. Benzene, toluene, phenol, and total xylenes were well below the stack emission goals. Calculated concentrations (Appendix D, Table 6) at the site boundary were several orders of magnitude below the ambient air quality goals.

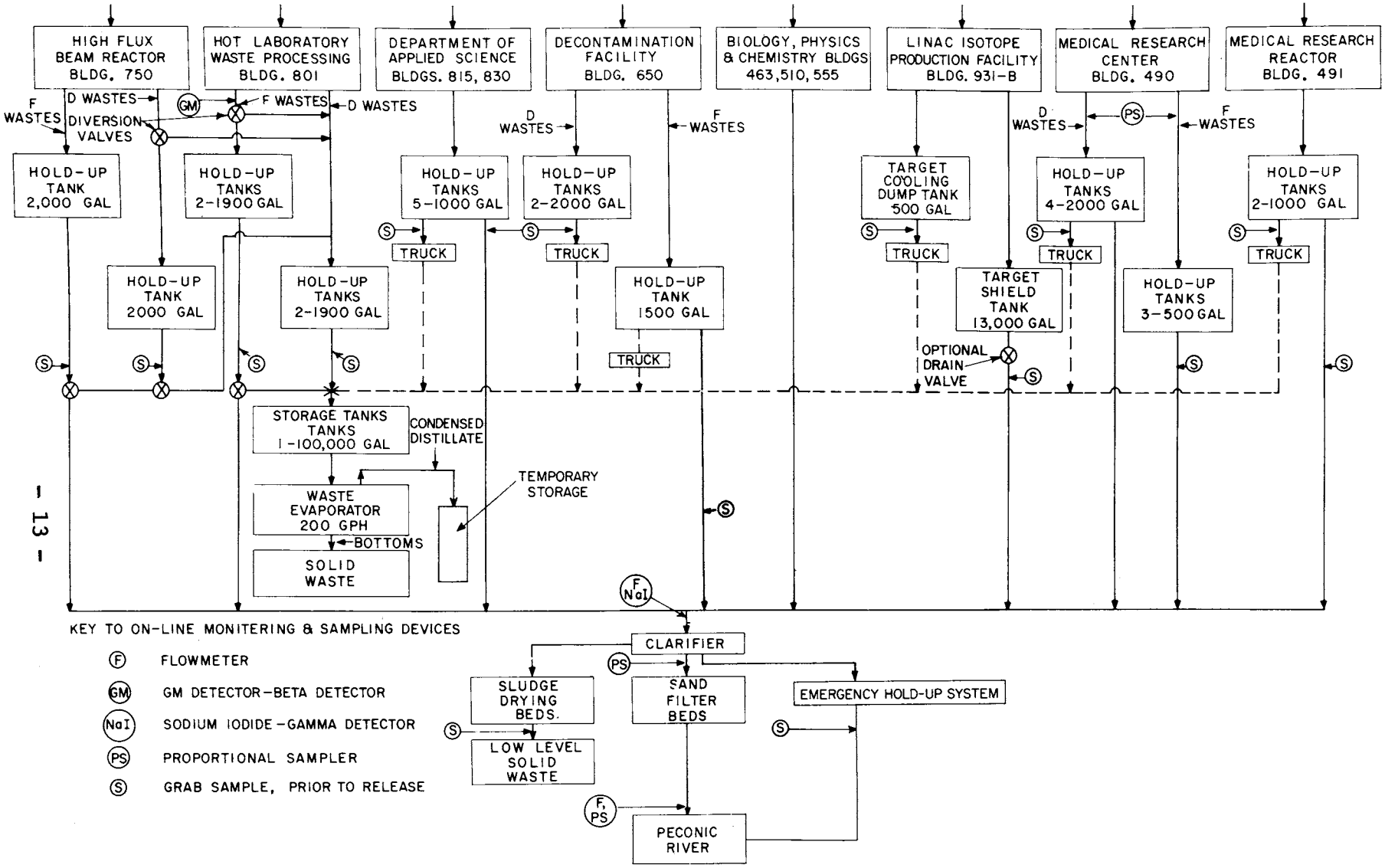
Samples of all LFS used in the preparation of ALF are routinely analyzed for polychlorinated biphenyls (PCBs) to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations. In October of 1984, it was determined that 300,000 gallons of off-specification military fuels contained low levels of PCBs at a concentration of 80 ppm. The U.S. EPA and NYSDEC were notified and the Laboratory applied for a provisional EPA permit (in accordance with 40 CFR 761) to burn the fuel. A 10% fuel firing rate will ensure that the concentration will be well below the EPA limit of 50 ppm. The demonstrated destruction and combustion efficiencies and the installation of additional monitoring equipment during 1985 indicates that the EPA requirements will be satisfied.

3.2 Liquid Effluents

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 [21]. Accordingly, liquid wastes are segregated at the point of origin on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

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

Facilities which may routinely produce larger volumes (up to several hundred liters) of aqueous radioactive waste liquids are provided with dual waste handling systems, one for "active" (D), and one for "inactive" (F), wastes. As shown in Figure 4, a schematic of the liquid waste system, wastes



Liquid effluent systems Brookhaven National Laboratory.

FIGURE 4

placed into the D and F systems are collected in holdup tanks. After sampling and analysis, they are either discharged directly to the sanitary waste system [22] or are transferred by underground pipelines or tank truck to the Waste Concentration Facility (WCF). At this facility, liquid waste is distilled to remove particulates, suspended and dissolved solids. The residues from the evaporator are transferred to the Waste Management Area for off-site disposal. Wastes routed directly to the Laboratory sanitary waste system become mixed with large quantities (approaching 4,000,000 l d^{-1}) of cooling and other uncontaminated water routinely produced by diverse Laboratory operations.

3.2.1 Sewage Treatment Plant (STP)

Primary treatment of the liquid stream collected by the santitary waste system to remove suspended solids was provided by a 950,000 liter clarifier. The liquid effluent flows from it onto sand filter beds (secondary treatment), from which about 87% of the water was recovered by an underlying tile field. This recovered water was then released into a small stream that contributes to the headwaters of the Peconic River. The balance, about 13%, was assumed to have percolated to the ground water 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. Volume proportional and grab samples were collected each working day at the STP.

3.2.1.1 Radionuclide Analysis

The proportional samples collected at station DA, the influent to the STP clarifier, and station EA, the STP discharge point into the Peconic River, are analyzed daily for gross alpha, beta and tritium. An aliquot is composited for monthly strontium-90 and gamma spectroscopy analysis. The results of these measurements are reported in Appendix D, Tables 7 and 8.

The gross alpha and beta concentrations at both stations remained virtually constant between 1984 and 1985. The concentrations of strontium-90 being discharged to the Peconic River have remained relatively constant; ranging from 0.4 to 0.88 pCi/L over the last 6 years with 1984 and 1985 values of 0.72 and 0.75 pCi/L, respectively. Although slight fluctuations are observed, the released quantities and the radiological profile of gamma emitting radionuclides has also remained constant over the past few years. All radioactive releases were substantially below applicable standards or radiation concentration guides.

The tritium released to the Peconic River decreased by 71%, when compared to 1984, as a result of administrative controls that were implemented in 1985. The discharge of condensate from the Waste Concentration Facility (WCF) to the sanitary sewage system was diverted to the Emergency Holding Pond (Figure 2). All tritiated waste in excess of 5 mCi is transferred to the WCF. An exception occurred in July, when elevated concentrations at the Van de Graaff resulted in 1.2 Ci of tritium being discharged to the sewage system.

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

The effluent from the Laboratory sewage treatment plant (station EA) is

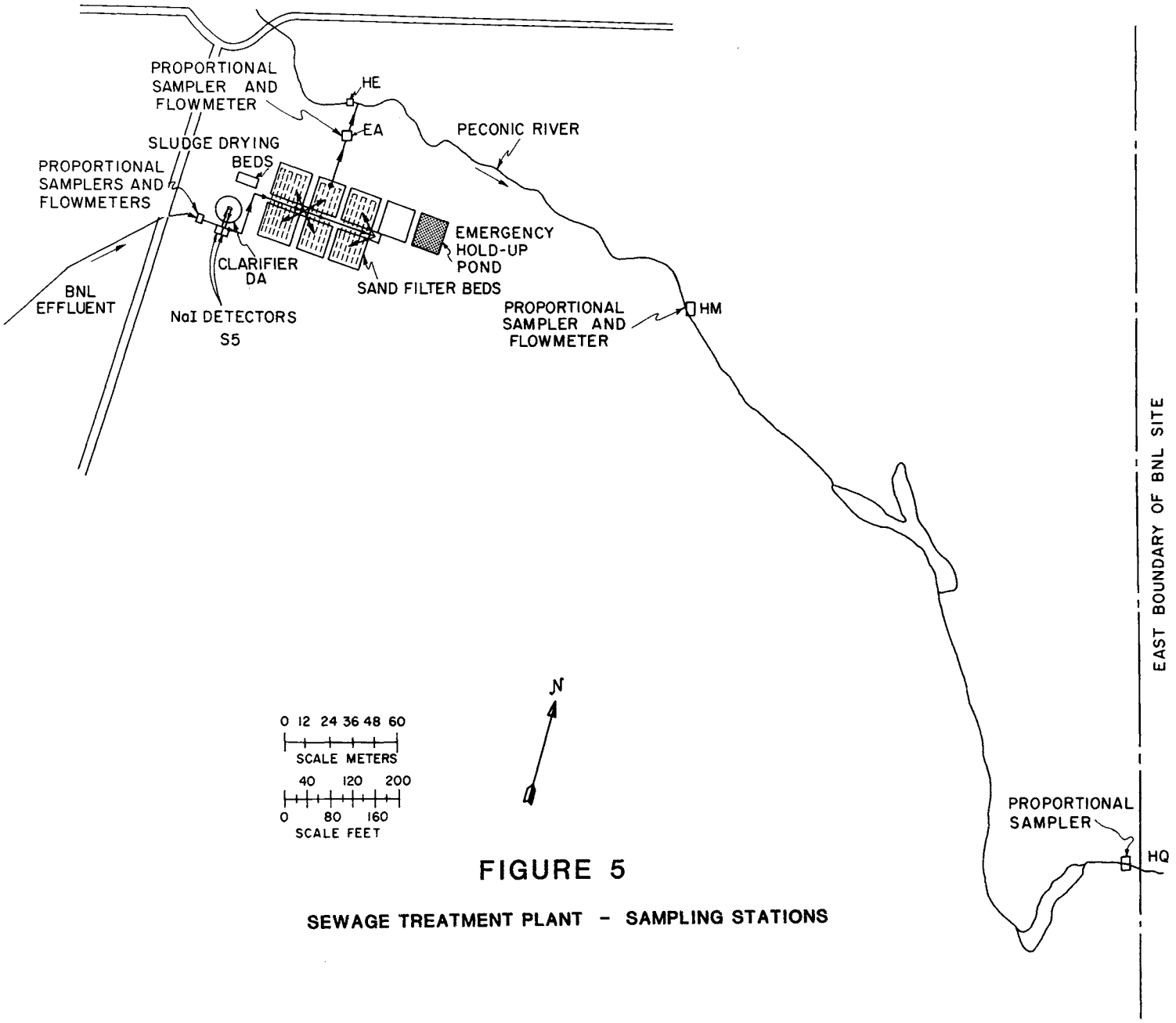


FIGURE 5

SEWAGE TREATMENT PLANT - SAMPLING STATIONS

subject to the conditions of the State Pollutant Discharge Elimination System (SPDES) Permit No. NY 000 5835, authorized by the New York State Department of Environmental Conservation (NYSDEC). Monitoring reports which include analytical results are submitted on a monthly basis to the NYSDEC and the Suffolk County Division of Health Services (SCDHS). A yearly summary of these data for 1985 is shown in Appendix D, Table 9. The summary includes data required under the permit and additional analyses which were performed under the Laboratory's broader surveillance program. Operation at the sewage treatment plant resulted in a greater than 99% compliance rate in meeting permit requirements. The exceptions of ten daily pH levels, although not in compliance with permit conditions, were within the local natural range of ground water (pH 5.5-6.0). For the parameters listed in Appendix D, Table 9, the sewage treatment plant effluent met drinking water standards for metals and other water quality criteria.

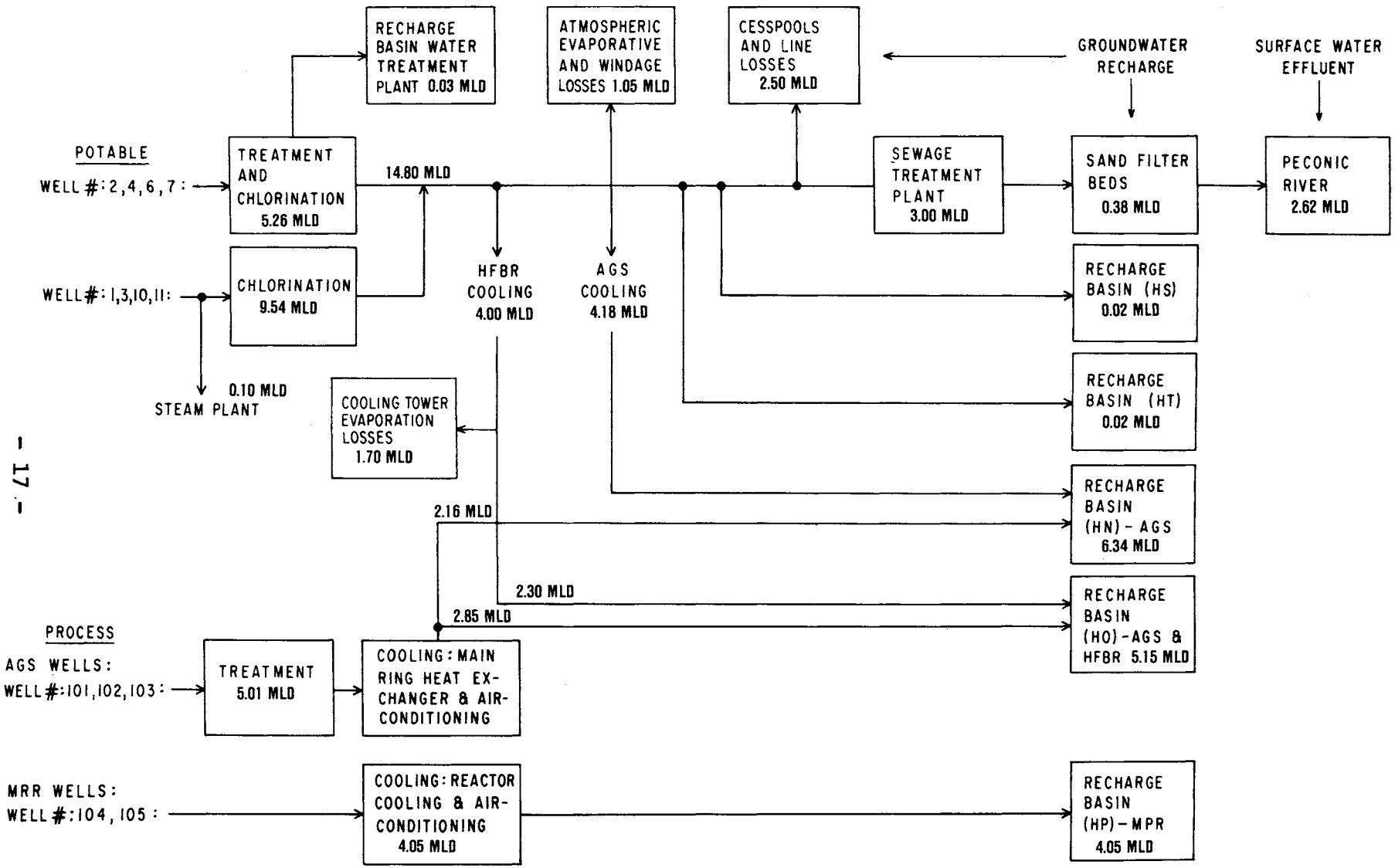
3.2.2 Recharge Basins

An overall schematic of water use at the Laboratory is shown in Figure 6. After use in "once through" heat exchangers and process cooling, approximately 16 million liters per day (MLD) of water was returned to the aquifer through on-site recharge basins; 6.3 MLD to basin HN located about 610 m northeast of the AGS; 5.2 MLD to basin HO about 670 m east of the HFBR; and 4.1 MLD to basin HP located 305 m south of the MRR. The locations of the basins on the Laboratory site are shown in Figure 7. A polyelectrolyte and dispersant was added to the AGS cooling and process water supply to keep the ambient iron in solution. Of the total AGS pumpage, approximately, 2.2 MLD was discharged to the HN basin, and 2.9 MLD to the HO basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and was treated with inorganic polyphosphate and mercaptobenzothiozone to control corrosion and deposition of solids. The blowdown from this system (2.3 MLD) was also discharged to the HO basin. The coolant (4.1 MLD) was adjusted to a neutral pH prior to use and then discharged to the HP basin. Grab samples were collected monthly at recharge basins HN, HO, HP, and HT and daily at basin HS for the analysis of water quality.

3.2.2.1 Recharge Basins - Radionuclide Analysis

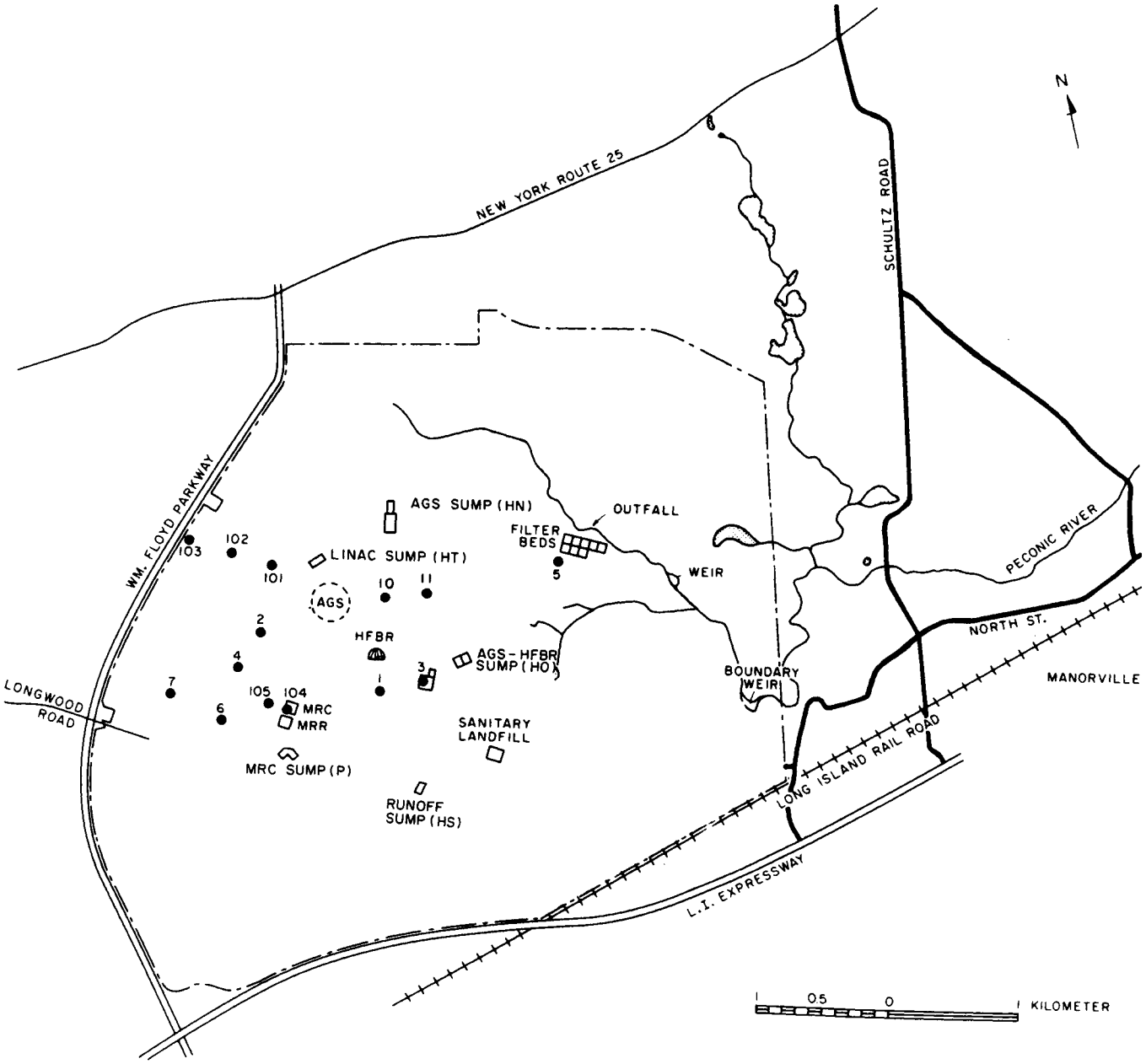
Radiological results for recharge basin samples are reported in Appendix D, Table 10. The data indicate that trace quantities of activity were discharged to all recharge basins. A significant fraction of activity detected in the basins can be attributed to the radionuclides initially present in the potable and supply wells (additional discussion, section 3.3.8.1).

The remaining activity results from normal operational conditions. The activity detected at recharge basin HN results from the discharge of primary magnet rinse water into the recharge basin. The observed concentration of beryllium-7, approximately twice that observed in precipitation, result from high energy particle interactions in the cooling water at both the AGS and Linac facilities.



BROOKHAVEN NATIONAL LABORATORY: SCHEMATIC OF WATER USE AND FLOW

FIGURE 6



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

FIGURE 7

Tritium is present as a result of its use in research activities conducted in a number of Laboratory facilities. Its concentrations in the recharge basin were small fractions of the applicable guides or standards.

3.2.2.2 Recharge Basins - Metals and Water Quality Analysis

The BNL SPDES permit requires that records be maintained of the pH and quantity of water discharged to the basins. In 1985, the 16 MLD which were recharged had a pH range of 5.9 to 8.4.

In addition to meeting these requirements, the BNL program includes routine analysis of selected water quality parameters. The results are presented in Appendix D, Table 11. With the exception of iron, the discharge to the basins met NYS drinking water standards for metals and other water quality criteria.

3.3 Environmental Measurements and Analyses

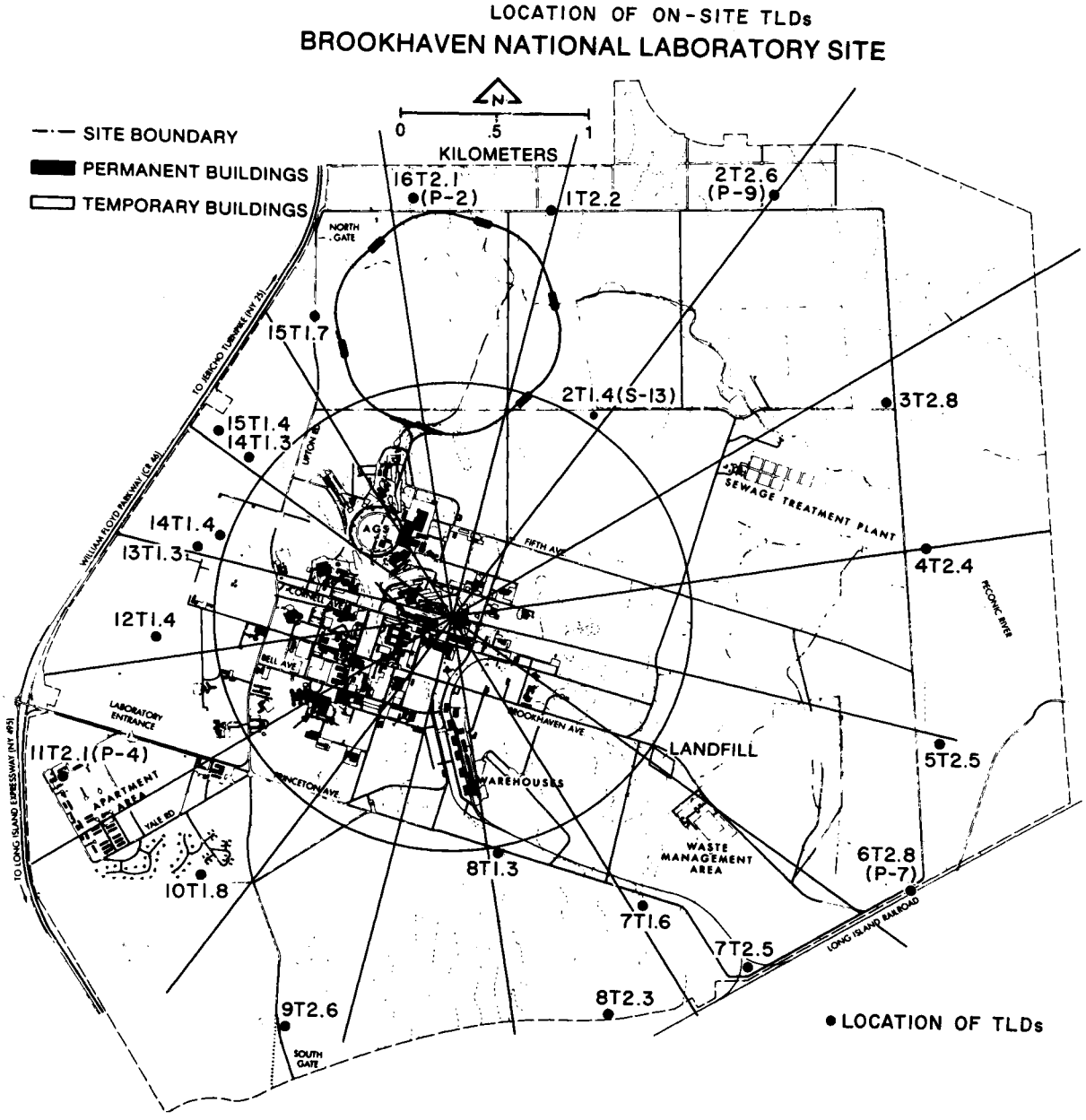
3.3.1 External Radiation Monitoring

Dose-equivalent rates from gamma radiation at the site boundary, including natural background, weapons test fallout, and that attributable to Laboratory activities were determined through the use of CaF_2:Dy thermoluminescent dosimeters (TLD) [23]. The locations of the on-site and off-site TLDs are shown in Figures 8 and 9, respectively. 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 12. The annual average dose-equivalent rate as indicated by all TLDs was 63.7 mrem a^{-1}. The dose-equivalent rate at the site boundary was 70.2 mrem a^{-1}, while the off-site average rate was 59.7 mrem a^{-1}.

Although the initial comparison indicates an average difference of 10 mrem a^{-1} between on-site and off-site measurements, this appears to be related to differences in TLD exposure periods. At the on-site locations, TLDs were exposed for periods of one month, while off-site TLDs were deployed for a three month exposure period. At three on-site locations (Sectors 4, 13 and 14), measurements were made on both a monthly and quarterly frequency. A comparison of the monthly and quarterly dose-equivalent rates at these locations indicates that annual average dose rates obtained from the monthly exposures were 3 to 11 mrem greater than the rates measured by the dosimeters deployed on a quarterly basis. The background control data for the monthly exposure period also exhibits an elevated bias when compared to the quarterly measurements. Similar results have been reported at other facilities [24].

At this point, the observed differences between site perimeter and off-site exposure rate measurements appear to be related to method of measurement and calculation, and not attributable to Laboratory operations. The models used to determine system response and efficiency are being evaluated to determine that current calculations adequately characterize the detector response. During 1986, all measurements are to be made on the same time frequency in order to eliminate this potential source of measurement bias.

FIGURE 8


LOCATION OF ON-SITE TLDs
BROOKHAVEN NATIONAL LABORATORY SITE
SITE BOUNDARY
PERMANENT BUILDINGS
TEMPORARY BUILDINGS
N
0
.5
1
KILOMETERS
16T2.1 (P-2)
1T2.2
2T2.6 (P-9)
NORTH GATE
15T1.7
2T1.4(S-13)
3T2.8
15T1.4
14T1.3
SEWAGE TREATMENT PLANT
14T1.4
13T1.3
4T2.4
12T1.4
FIFTH AVE
RECONIC RIVER
BELL AVE
LABORATORY ENTRANCE
BROOKHAVEN AVE
LANDFILL
11T2.1(P-4)
APARTMENT AREA
PRINCETON AVE
WAREHOUSES
5T2.5
WASTE MANAGEMENT AREA
6T2.8 (P-7)
8T1.3
10T1.8
7T1.6
7T2.5
LONG ISLAND RAILROAD
8T2.3
9T2.6
SOUTH GATE
LOCATION OF TLDs

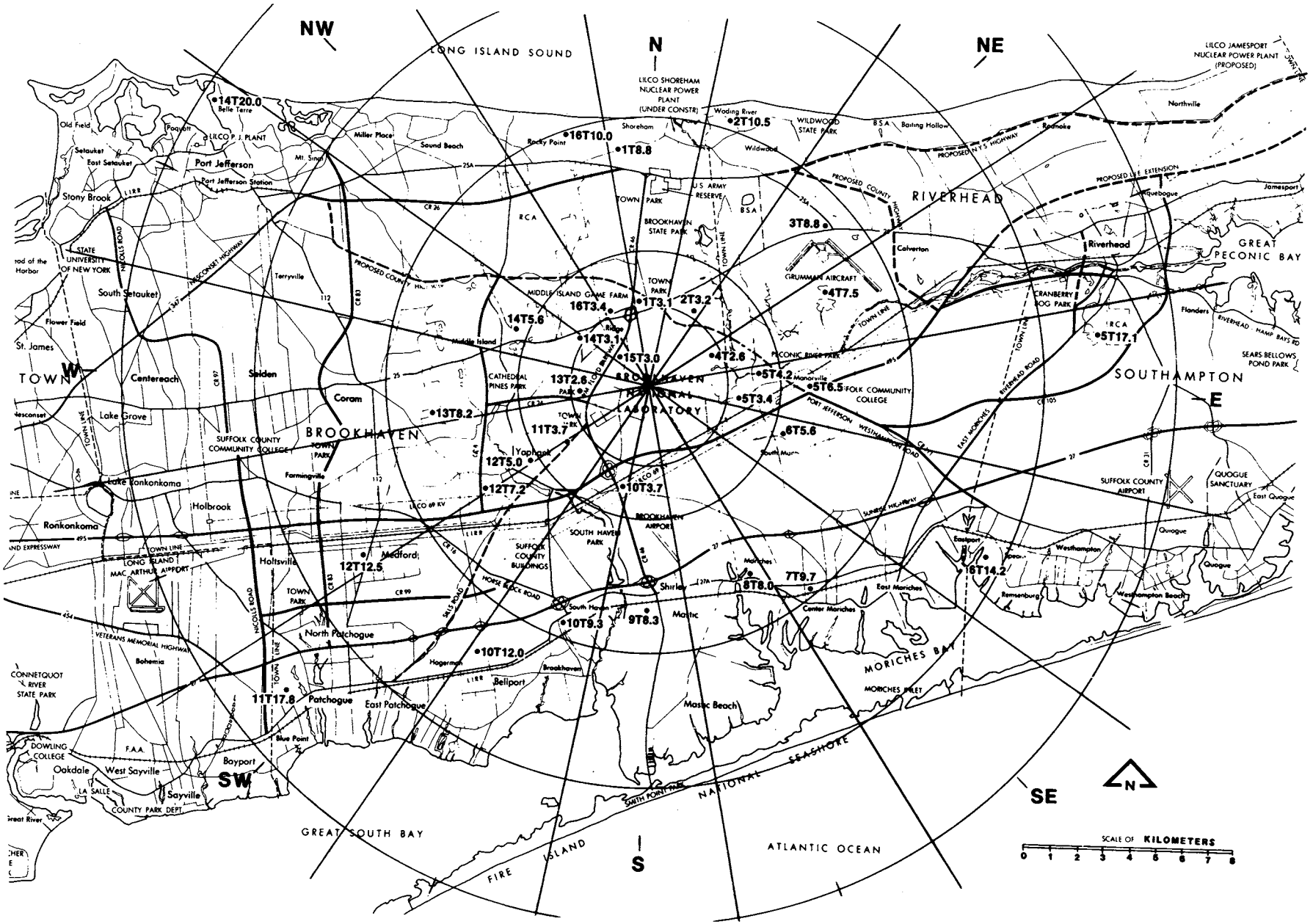


FIGURE 9

LOCATION OF OFF-SITE TLD's

3.3.2 Atmospheric Radioactivity

The Laboratory's environmental air monitoring program is designed to identify and quantify airborne radioactivity attributable to natural sources, to activities unrelated to the Laboratory (e.g., above ground nuclear weapon tests), and to Laboratory activities. The predominant radionuclide measured in air at the site boundary was tritium.

3.3.2.1 Tritium Analyses

In February 1985, the number of sample stations was increased in order to provide better correlation between measured and predicted concentrations of tritium in air at the site boundary. Sampling for tritium vapor was performed at 26 on-site (shown in Figure 3) and 2 off-site air sampling locations. Water vapor was collected by drawing a stream of air through silica gel cartridges. The data collected from the site perimeter, analytical laboratory, and control monitoring stations are presented in Appendix D, Table 13. Other on-site monitoring stations are presented in Appendix D, Table 14. The maximum annual average tritium concentration at the site boundary was observed at station 8 and was 4.7 times the average annual tritium air concentration measured at the control stations.

The highest annual average air concentration measured was within the analytical laboratory area. This is attributable to its location which is in a building proximal to tritium airborne effluent release points. The airborne tritium concentrations measured in this building reflect ambient air concentrations for the central part of the Laboratory site. Station 17, located to the north side of the building which houses the analytical laboratory, indicated similar concentrations. Although these levels are substantially in excess of the control stations, contamination of environmental samples is not apparent. This is reflected in the number of less than detectable values that have been observed.

In addition to the perimeter sampling program, tritium monitoring was conducted at the Hazardous Waste Management Facility (HWMF) and the Sewage Treatment Plant. The monitoring stations at the Sewage Treatment Plant were installed in August, 1985 to monitor the air concentrations resulting from the use of the Emergency Holding Pond as a solar evaporator for the disposal of 70,000 gallons of tritiated distillate from the Waste Concentration Facility (WCF). The total activity discharged to the pond was 4 Ci of tritium. The data from this project and the HMWF are presented in Appendix D, Table 14. The airborne concentrations of tritium measured at the holding pond indicated that this did not contribute to the levels detected at the site boundary.

3.3.2.2 Radioactive Particulates

During 1985, positive displacement air pumps were operated at five on-site monitoring stations (S-6, P-2, P-4, P-7 and S-5). The sampling media consisted of a 5 cm diameter air particulate filter 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 alpha and beta activity using an anti-coincidence proportional counter. In addition,

analyses for gamma emitting nuclides were performed on the charcoal bed. No radiohalogens were detected on the charcoal filters. The gross alpha and beta analytical results are shown in Appendix D, Table 15. Measured concentrations at the site boundary were small fractions of the RCGs [11].

3.3.3 Radioactivity in Precipitation

A pot-type rain collector is situated adjacent to the sewage treatment plant (see Figure 3). Collections were made whenever precipitation was observed. Portions of each collection were processed for gross alpha, beta, and tritium analysis, a fraction was composited for monthly strontium-90 analysis, and the balance was put through ion exchange columns for gamma analysis. The data for 1985 are reported in Appendix D, Table 16 and reflect typical wash-out values associated with atmospheric scrubbing [10].

3.3.4 Radioactivity in Milk

A milk sample was collected at a dairy farm in the vicinity of the Laboratory site. The only radionuclide detected was naturally occurring potassium-40 at a concentration of 1.5×10^{-6} uCi/ml. This is consistent with previous years' results [25].

3.3.5 Radioactivity in Soil and Vegetation

The results of soil and vegetation sampling conducted at five dairy farms in the vicinity of the site are shown in Appendix D, Table 17. The results are consistent with data collected in previous years [25]. No nuclides attributable to Laboratory operations were detected; the observed concentrations represent the contribution of primordial and cosmogenic sources, and weapons test fallout.

3.3.6 Peconic River Aquatic Surveillance

3.3.6.1 Peconic River - Radionuclide Analysis

Radionuclide measurements were performed on surface water samples collected from the Peconic River at 3 locations; HM, the location of the former site boundary approximately 225 meters downstream of the discharge point; HQ, located at the current site boundary, 700 meters from the discharge point; and HR, located 19.5 km downstream from the discharge point (Figure 5).

Samples collected at stations HM, HQ and HR were time-proportional samples. No estimate of total flow was made at these stations during the sample period. Sample collection at station HQ was terminated due to low flow conditions and damage to the station resulting from hurricane Gloria in September.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 18A and 18B. The data in general indicate that the radionuclide concentrations remained relatively constant from the release point to station HQ. Further downstream at station HR where the average daily flow rate is approximately 30 times [26] the BNL average daily discharge rate, the only detectable radionuclides were

strontium-90 and cesium-137. The presence of these radionuclides is common in surface water samples as a result of fallout from the atmospheric weapons testing programs. The average strontium-90 concentration in New York State surface water in 1983, as reported by the EPA [27], was 2.5 pCi/L. The presence of this radionuclide in the HR samples does not appear to be the result of BNL operations. This conclusion is supported by estimates of the BNL contribution from mass balance considerations. Using the average difference in daily flow rates between the discharge point and station HR, the predicted strontium-90 concentration (ignoring factors such as sedimentation) would be 0.027 pCi/L or 4% of the reported value. Cesium-137 was not detected in the EPA surface water sampling program [27]. Based on the amount of cesium-137 released from the effluent discharge point and the dilution received as a function of distance from the release point, the expected concentration would be 0.055 pCi/L. This corresponds to 50% of the measured value and indicates that the cesium-137 activity measured at station HR is directly related to BNL activities.

3.3.6.2 Peconic River - Metals and Water Quality Analysis

Measurements of selected non-radiological water quality parameters were performed at the former site boundary location (HM). The pH range was 5.9-6.9. Heavy metals such as chromium, cadmium, silver, mercury, and lead were not detected. Concentrations of iron, zinc, manganese, copper, and nitrates were comparable to the sewage treatment plant effluent; well within drinking water standards and reflecting ambient levels.

3.3.7 Aquatic Biological Surveillance

The Laboratory, in collaboration with the New York State Department of Environmental Conservation (NYSDEC) Fisheries Division, has an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies (Figure 10). Efforts to collect fish from the site boundary (HQ) were hampered by lack of adequate flow. Fish samples were collected at Donahue's Pond (Figure 10), downstream from the site boundary on the Peconic River, where active fishing by the general public occurs. Control samples were obtained at other fresh water ponds/streams which are not related to the Peconic River.

The principal radionuclides detected in fish were: tritium, strontium-90, and cesium-137. The data are shown in Appendix D, Table 19. Analysis for tritium and strontium-90 in fish from control locations were not performed during the current year. These analyses will be done on all fish sampled in 1986.

The range of tritium concentrations (709 to 1742 pCi/kg wet) seems to be a function of age and thus water content in the flesh [28]. The lack of any correlation between strontium-90 concentration (113 to 259 pCi/kg) in fish and their feeding habits could be due to the varying amounts of skeleton involved in the analysis. The concentration of cesium-137, which is predominantly distributed in flesh, indicates that on the average, fish from Donahue's Pond show similar values to fish from control locations.

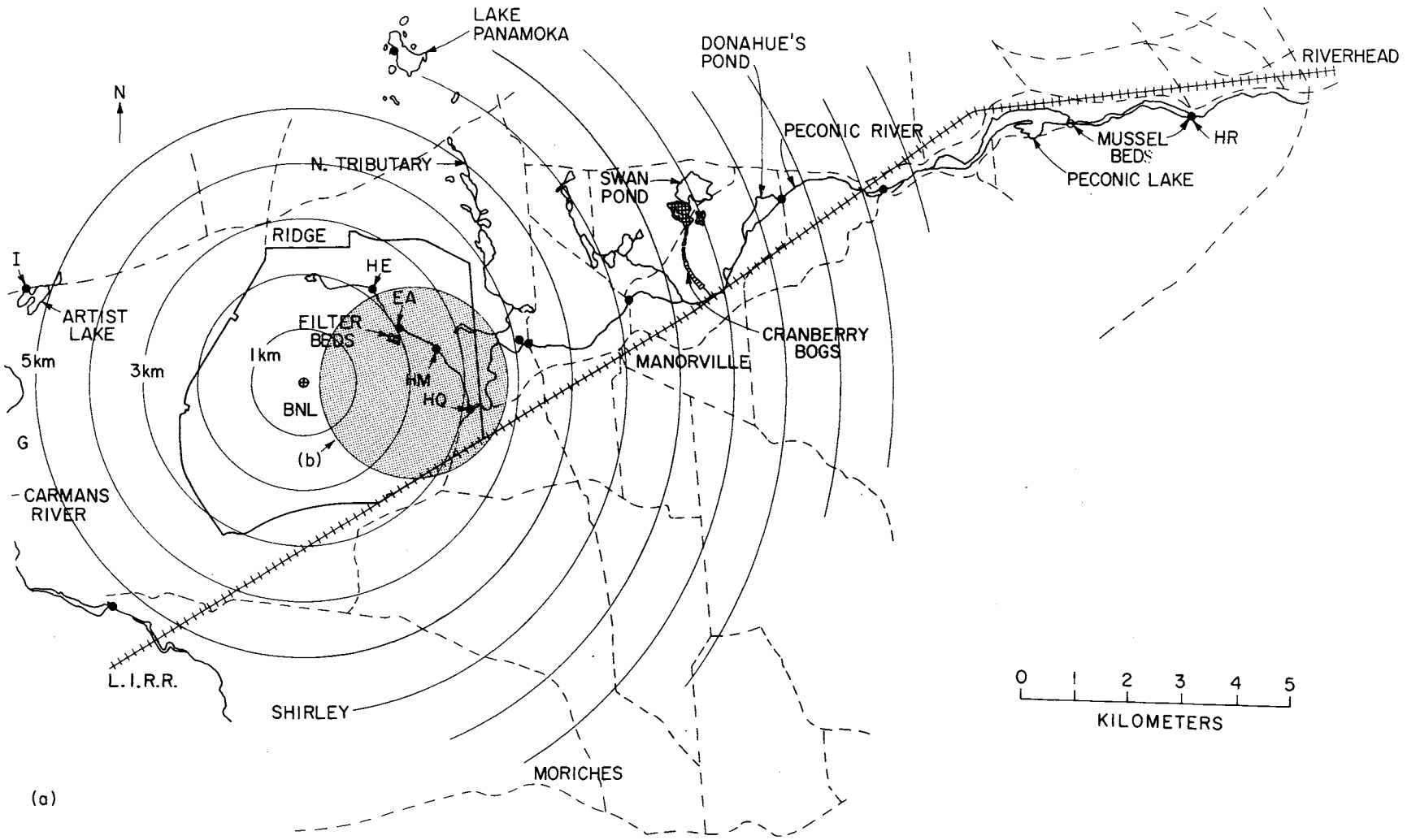


FIGURE 10

PECONIC RIVER SAMPLING STATIONS

3.3.8 Potable Water and Process Supply Wells

The Laboratory's potable water wells and cooling water supply wells are screened from a depth of about 15 m to about 46 m, in the upper glacial aquifer, with one exception. Well No. 104 is screened at a depth of 60 to 90 m in the Magothy. As was shown in Figure 7, most of these wells are located west to north of the Laboratory's principal facilities and 'upgradient' to them in the local ground water flow pattern. As was indicated in Figure 6, about 23 MLD were pumped from them in 1985. Monthly grab samples obtained from these wells were analyzed for radioactivity, water quality indices, metals, and volatile organic compounds.

3.3.8.1 Radionuclide Analysis

The average radionuclide concentrations are reported in Appendix D, Table 20. The presence of tritium, cobalt-60, sodium-22, strontium-90, cesium-137, and chromium-51 in Well Nos. 1, 3, 4 and 10, although present at small fractions of the applicable standards, appear related to Laboratory operations. The presence of beryllium-7 is most likely caused by cosmogenic production of beryllium-7 in the atmosphere and subsequent rainout. In 1985, the beryllium-7 precipitation concentration was approximately a factor of 40 greater than the average concentration observed in well water.

Well Nos. 1,2,4,6,7, 10, and 11 supply water for potable use. Well No. 3, located at the Central Steam Facility (CSF), is used exclusively for boiler make-up water at the CSF. Radionuclide concentrations in potable water are all fractions of the applicable water standards or guides and do not pose a safety or health risk to individuals who drink or use the water on-site.

3.3.8.2 Metals, Water Quality, and Organic Compound Analyses

The water quality and metals data for the Laboratory potable supply wells are shown in Appendix D, Table 21. With the exception of pH and iron, indices of water quality such as nitrates, sulfates, chlorides, fluorides, and metals were all well within the limits established in the New York State Drinking Water Standards [13,14]. The lower pH values represent values typical of Long Island. The water supplies were analyzed monthly for residual chlorine and the presence of coliform bacteria and monthly reports were submitted to the Suffolk County Division of Health Services (SCDHS). The analyses indicated that bacteria were not detected in samples and the BNL potable supply is well within the requirements of the EPA National Primary Drinking Water Standards [30] and the New York State Sanitary Code [13].

The majority of metals including silver, arsenic, barium, cadmium, chromium, mercury, lead, selenium and zinc were not detected in the Laboratory supply system. Copper, manganese, and sodium were present at ambient levels which were well within the New York State Standards. Elevated levels of iron were observed in several wells. However, iron is a nuisance element and is indigenous to the Long Island glacial aquifer. Because there are no toxic effects [31] associated with iron, copper, manganese, and sodium, federal primary drinking water standards have not been established for them [30].

Water samples from potable wells were also analyzed for volatile organic compounds. The data are shown in Appendix D, Table 22. On a monthly basis, the potable wells were analyzed for selected chlorocarbons which had been previously detected and are common contaminants detected in Long Island wells: 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and chloroform [32]. On a less frequent basis (twice per year), the wells were analyzed for the broader range shown in Appendix D, Table 22. Chloroform and 1,1,1-trichloroethane were detected in small concentrations in the majority of samples collected from the potable wells on the BNL site. With the exception of Well No. 2, which was removed from service in August, 1985, the observed concentrations were well within the NYS Drinking Water Standards or advisory limit [13,14,30]. The wide distribution of the two compounds apparently represents an extended zone of very low-level contamination in the developed portion of the BNL site. However, since a number of wells are located in areas upstream from the principal facilities, it is not clear whether the low concentrations are due to past Laboratory practices, or to those of the Department of Army during its use as Camp Upton. The concentrations of chloroform and 1,1,1-trichloroethane in Well No.2 are more clearly related to Laboratory activities.

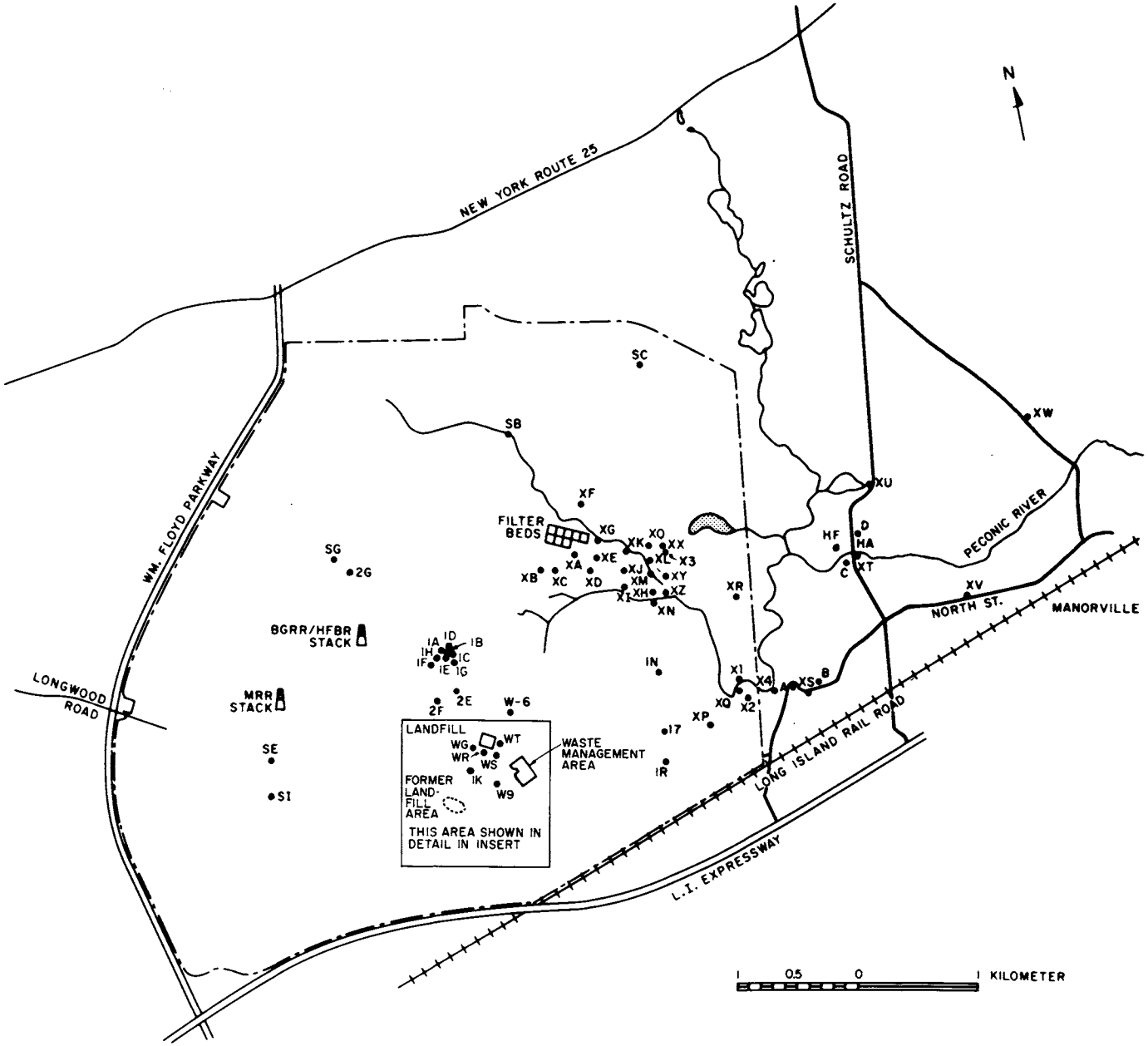
3.3.9 Ground Water Surveillance

Samples of ground water were obtained from a network of surveillance wells which have been installed in the vicinity of several locations where the potential for ground water contamination exists or has been confirmed. These include areas adjacent to the on-site recharge basins, the sand filter beds, the Peconic River, the hazardous waste management facility, the former landfill area, the current landfill, and the decontamination facility sump. The locations of most of these ground water surveillance wells are shown in Figure 11. Wells installed at the landfill and solid waste management area are shown in Figure 12. Because the aquifer underyling Nassau and Suffolk Counties has been designated as a "Sole Source" [12], the data are compared to the EPA [30] and NYS Drinking Water Standards [13,14].

3.3.9.1 Radionuclide Analysis

The yearly average concentrations of radionuclides in samples from the wells adjacent to the sand filter beds at the sewage treatment plant, and downstream on the Peconic River are summarized in Appendix D, Table 23. Elevated gross beta and tritium concentrations have been found in on-site wells adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to losses from the tile collection field underlying the sand filter beds and from the recharge to ground water from the Peconic River in this area. In 1985, on-site concentration ranges were 1-24% for gross beta and 1-37% for tritium of the applicable limits [13,14,30]. Adjacent to the Peconic River at the site boundary (wells X1 and X2), the average gross beta and tritium concentrations were less than or equal to 3% and 15%, respectively, of the guidance levels or limits.

The ground water monitoring program for radiological constituents was expanded at selected on-site and off-site surveillance wells adjacent to the Peconic River in response to the elevated discharges of tritium to the Peconic during the fourth quarter of 1984 [25]. The results of all analyses are



Location of groundwater surveillance wells.

FIGURE 11

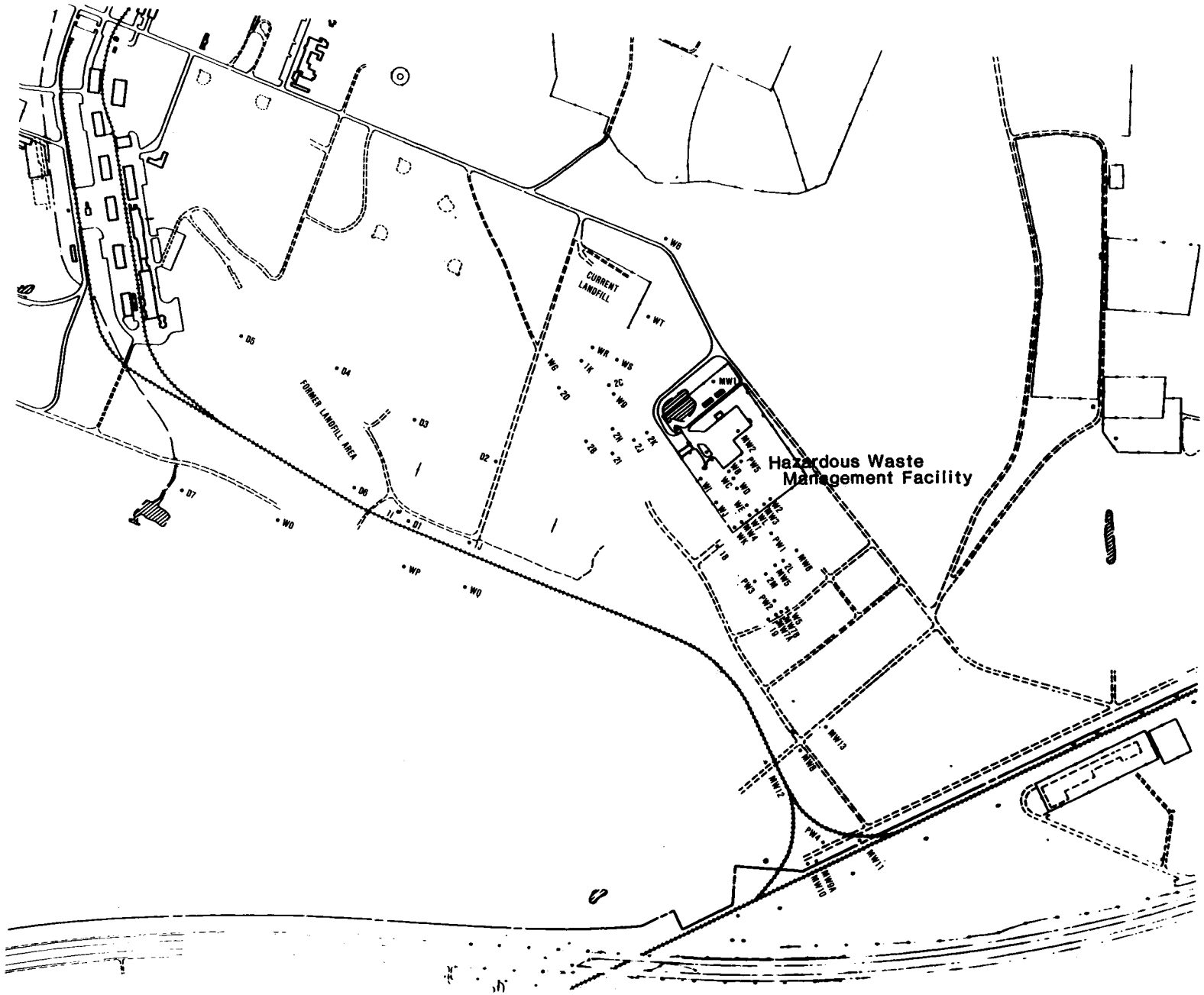


FIGURE 12

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

summarized in Appendix D, Table 23. When the concentration of tritium in one off-site monitoring well (X4) reached the drinking water standard [13,30] for community water supply systems, the Suffolk County Department of Health (SCDH) and the U.S. EPA were notified. Subsequently, the tritium concentration has gradually declined. The sampling frequency was reduced from daily to monthly for the remainder of 1985. The annual average tritium concentration at this monitoring well (10,300 pCi/L) was 50% of the drinking water standard.

Wells X1 and X2 were sampled periodically throughout the year and represent a control location (X1) and a point (X2) directly opposite the large, ponded area created by the weir at the site perimeter. The radiological data from X1 indicates that tritium levels were at or near the minimum detection limit (MDL) of 300 pCi/L and that gross alpha and beta concentrations reflect background levels. Data from Well X2 indicates that tritium was the only parameter observed in excess of ambient levels with the annual average concentration being 3,020 pCi/1. These data indicate that the ponded area acts as a localized source of ground water recharge during certain times of the year.

Following the Laboratory's notification of the SCDH, a cooperative program was developed for the collection and analysis of samples from wells serving private homes. The program commenced during the last week of January and is now an ongoing part of the SCDH water quality program. Results from the program indicated that tritium was present in private well samples received from two homes located adjacent to the Laboratory, along the Peconic River. The private wells, screened at depths of 50 and 200 feet, had tritium concentrations that ranged from 900 to 1870 pCi/1. Although above background, the data were consistent with data collected since 1978, and were less than 10% of the EPA Drinking Water Standard for community water supplies. The presence of tritium results from the localized recharge from the Peconic River in this area.

The data for the samples from wells adjacent to the past and present BNL landfills are shown in Appendix D, Table 24. In general, gross alpha concentrations in wells which monitor the landfill did not differ from results observed in the previous years; remaining near background. The concentrations of tritium and activation products in several wells result from the past practices of placing low specific activity material on the landfill. This means of disposal was discontinued in 1978. With the exception of tritium concentrations in two wells, the measured concentrations of radioactivity did not exceed the drinking water standards in any of the landfill monitoring wells. The range of annual average gross beta concentration was 4-50% of the drinking water limit. Measured concentrations of cesium-137 and sodium-22 were less than 0.01% of the RCGs [11].

The ground water monitoring program conducted at the HWMF consists of the shallow well network located near the facility and a newer set of wells that were installed during 1984 and 1985. The radiological results for the samples collected from this program are presented in Appendix D, Table 25. The data indicate that as the measureable activity migrates from its source, the concentrations decrease with distance from the facility. The observed levels were well within drinking water standards at the site boundary, reflecting the effects of radioactive decay and dilution.

3.3.9.2 Metals, Water Quality and Organic Analysis

The data for wells adjacent to the sand filter beds and downstream of the Peconic River on- and off-site, are shown in Appendix D, Tables 26-28. In general, the data for samples obtained from these wells were comparable to those observed during previous years [25]. All analyzed water quality parameters were within New York State Water Quality Standards [14], with some exceptions for pH, Fe, Pb, and Zn. The occasional lower pH levels appear to reflect natural ambient levels, since higher pH levels were present in both the influent and effluent from the sewage treatment plant (refer to Appendix D, Table 9). Concentrations of Fe, Pb, and Zn in excess of water quality standards were found in several wells along the Peconic. These species were not observed in significant concentrations in either the influent or effluent from the sewage treatment plant. The presence of Fe, Pb, and Zn is believed to reflect a well-casing effect, i.e., leaching of Fe and Zn from piping, and Pb from the soldering material used in the joints.

Chloroform and trichloroethylene were also detected at trace levels, <10 ug/L in wells X2 and XT, respectively. 1,1,1-trichloroethane has been measured at similar trace quantities, <10 ug/L, in wells XA and XE which are adjacent to the sand filter beds and monitor the loss of treated effluent to the aquifer. The detection in XA and XE indicate that small quantities of trichloroethane reach the Laboratory's sewage system.

The surveillance data for the current and former landfills, and control wells are shown in Appendix D, Tables 29 and 30. The BNL landfill is operated in accordance with the permit issued by NYSDEC, Permit No. 52-S-20. The data is consistent with observations of previous years: elevated levels of zinc, manganese, and lead were detected in several wells near the current landfill. Iron was observed at elevated concentrations in wells near both the current and former landfills (refer to Figure 12). When compared to the control wells (located in remote areas of the site), the observed levels of iron, manganese, lead, and zinc appear to result from (i) the past practice of landfilling the iron flocculant from the water treatment plant and (ii) the placement of metal debris on the landfills during the course of normal operations. The observed levels of specific conductance, >500 umhos/cm at the current landfill support this conclusion.

Trace levels of several chlorocarbons, principally 1,1,1-trichloroethane, were detected in one well near the current landfill, in two wells near the former landfill, and in two of the designated control wells. All chlorocarbon concentrations were well within NYSDOH drinking water limits or advisory guidelines. While sources could be attributed to past operations at the landfills, the source of trichloroethane which was measured in the wells located in the undeveloped areas of the site is not readily apparent. The wells at the landfill areas will continue to be sampled to ensure that no significant aquifer impact occurs as a result of past or current operations. The expansion of sampling activities at the former landfill is planned.

At the HWMF, the observed concentrations of metals and water quality indices were also consistent with previous year's results [25]. Heavy metals

such as silver, cadmium, chromium, and mercury were not detected in any of the wells. Measureable concentrations of iron, lead, and zinc were observed in several wells with metal casings. In wells with plastic casings, background levels were observed.

The project to determine the extent of chlorocarbon contamination in this area was completed in 1985. The results of the project indicate that the contamination is currently confined to the Laboratory site [9]. The compounds detected were chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. The concentrations measured during the field activities and subsequent 1985 efforts ranged from non-detectable to 2.0 mg/L of total volatile organics. The individual monitoring well data is shown in Appendix D, Table 31; and locations of the wells were shown in Figure 12. The Laboratory has committed to an aggressive program of aquifer restoration in this area to avoid potentially adverse effects in the off-site environment. In accordance with the recommendations of the contracted engineering firm [9], the clean-up system is presently under construction and will commence operation in April, 1986. Briefly, the restoration project consists of five high-capacity pumping wells, with associated spray aeration equipment installed at each pumping location for removal of the organic compounds and recharge of the decontaminated water to the aquifer. It is projected that the majority of the clean-up will be completed in four to six months after pumping is initiated.

4.0 OFF-SITE DOSE ESIMATES

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 tritium concentrations and dose equivalents at the site boundary are shown in Appendix D, Table 33A. The highest annual average site boundary concentration of tritium vapor was 21.1 pCi m^{-3} at station 8. The calculated maximum dose equivalent was 0.01 mrem for the hypothetical individual residing at that location [37]. The exposure rates due to argon-41 and oxygen-15 were not measured at the site boundary. The calculated per capita annual average dose-equivalent rates for these radionuclides at the site boundary was 0.34 mrem a^{-1}.

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 its short half-life, oxygen-15 was 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 airborn concentrations, and thus dose to the general population. This approach also minimizes the effects of local micrometeorological conditions which may exist; resulting in differences between the measured and expected tritium concentrations at the perimeter monitoring stations. A ten meter release height was selected for argon-41, as this results in the maximum (most conservative) dose equivalent estimate.

Collective dose equivalents resulting from the 10 meter and 100 meter release heights are shown in Appendix D, Tables 33B and 33C, respectively. Argon-41 effectively contributed the entire dose equivalent, 4.77 rem. The

dose equivalent contributions from tritium and radioiodines were 0.02 and 0.002 rem, respectively. Methods used to calculate the dose equivalents are described in Appendix B. The 1985 population collective dose equivalent resulting from the release of airborne radionuclides by the Laboratory was 4.8 rem. This can be compared to the 1985 population collective dose-equivalent due to natural background of 300,000 rem. The Laboratory airborne releases comprised 0.0016% 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 [29], 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. The collective dose equivalent resulting from the discharge of radioactive materials to the Peconic River has been computed by evaluating two critical intake pathways: potable water and fish consumption.

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 1870 pCi/l. The average concentration for the group of homes (approximately 25 homes and 100 persons) was 560 pCi/l. This corresponds to a committed effective dose equivalent to the maximum individual of 0.000095 rem and a collective dose equivalent to the population at risk of 0.0029 rem.

The radionuclide concentrations in fish were summarized in Appendix D, Table 19. Using these data, the DOE dose conversion factors [33], an estimated population at risk of 600 [34], and a maximum annual consumption rate of 7 kg/yr [34], the maximum individual committed effective dose equivalent and the average collective dose equivalent were calculated. The results for the fish pathway are present in Appendix D, Table 33D, and indicate that the maximum individual would receive less than 0.00013 rem and the collective dose equivalent for the population at risk would be 0.0069 rem.

The total collective dose for the drinking water pathway is 0.0098 rem.

4.3 Collective (Population) Dose Equivalent

The collective (population) dose equivalent (total population dose) beyond the site boundary, within a radius of 80 km, attributed to Laboratory operations during 1985 was the sum of the three component values discussed above, 4.8 person-rem. The data is summarized in Appendix D, Table 33E.

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 300,000 rem a^{-1}, to which about 97,000 rem a^{-1} should be added for internal radioactivity from natural sources.

5.0 Unusual Occurrences

During 1985, one oil spill (770 gallons) of No. 1 oil occurred on site at

the Motor Pool. Clean-up procedures were instituted immediately and the contaminated soil was disposed of according to the 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. The site was inspected by representatives of NYSDOT and SCDHS; clean-up operations conducted by the Laboratory were found to be satisfactory.

Drewsperse 744 is a commerical compound added to the AGS magnet cooling water to keep the ambient iron in solution. The principal constituent in the solution is potassium hydroxide. On October 2, 1985, the AGS department determined that 3800 liters of Drewsperse had leaked from a storage tank located adjacent to supply well No. 102. The chemical had dispersed onto the ground and had been absorbed by the top 2 feet of soil, the pH being approximately 12. The EPA National Response Center and the NYSDEC were informed of the spill. Sodium bicarbonate (2800 kg) was tilled into the soil to lower the pH to a neutral range. No further remedial action was required.

6.0 Project Environmental Review

The following major projects were reviewed during various stages of design by members of the Safety and Environmental Protection Division to ensure facility compliance with all applicable environmental regulations and DOE Orders: (1) Radiation Effects Facility, (2) Neutral Particle Beam Facility, (3) AGS Booster, (4) Central Steam Facility Fuel Storage and Treatment Facility (5) Central Shops Alteration and Addition, (6) HFBR Vault Complex, and (7) National Synchrotron Light Source Phase III. On a smaller scale, modifications to existing facilities, e.g., upgrades or preventive maintenance, are reviewed on a frequent basis to ensure construction specifications meet all environmental codes.

7.0 Special Studies

Non-routine surveys were performed in the following areas: (i) tritium at off-site ground water monitoring wells, (ii) organic solvent ground water contamination at the HWMF, (iii) evaporation of tritiated distillate at the sewage treatment plant emergency holding pond, and (iv) assessment of the potable well water quality. The results of these investigations have been discussed in the main text of the report. Additional studies which were conducted during 1985 are discussed in the following sections.

7.1 Sewage Treatment Plant Sludge

In the fall of 1983, sludge from the anaerobic digestor was placed on sludge drying beds located at the sewage treatment plant. Prior to placement on the beds, the material was analyzed for characteristics of Extraction Procedure Toxicity. The results demonstrated that the material was not an EPA hazardous [35] waste and its ultimate means of disposal would depend on radioactive content. The sludge was determined to contain low levels of cobalt-60, cesium-137, americium-241, strontium-90, europium-154, cadmium-109, and potassium-40. Because the sludge contained radioactive materials in excess of the excempt quantities [36], the material is to be packaged and shipped

off-site for disposal at a radioactive burial facility. During the summer of 1985, a pilot waste disposal program was conducted to determine the airborne concentrations resulting from the resuspension of particulate material during the packaging operation. The results of this study indicated that there was no measureable resuspended activity in the down-wind vicinity of the area, demonstrating that there was neither an occupational or environmental hazard associated with the packaging of the material.

7.2 Monitoring the Unsaturated Zone

The initial ground water monitoring program was established around known pollution sources with the potential for aquifer contamination. The current ground water monitoring program has served to identify the extent of pollutant plume migration and this has been the basis for the implementation of an aquifer restoration project at the HWMF. However, the program serves to monitor only the movement of pollutants in the aquifer. Therefore, lysimeters are being utilized in a field investigation of the rate of potential continued leaching of contaminants from the unsaturated soil. Initiated in 1985, lysimeters have been placed at different depths in the unsaturated zone (the zone beneath the soil surface and the water table) and collect any leachate generated by rainfall. During 1985, the preliminary tests have resolved problems associated with the use of lysimeters in the field. In 1986, it is expected that these instruments will become an integral part of the monitoring program at some of the sites where surface pollution sources exist.

7.3 Test Boring and Gamma Logging

A 120-foot deep test boring was drilled near monitoring well D-1, along the easternmost portion of the former landfill area near the former chemical pit disposal site. There was no evidence of the Gardiner's Clay or any other layer of relatively low vertical permeability which would act as a confining layer(s) relative to vertical movement of ground water and the possible movement of heavier-than-water contaminants present in the aquifer. Only highly permeable sands and gravels were observed in the study area.

Geophysical profiles were recorded for the deep test boring and thirteen shallow monitoring wells located in this area. There was no evidence of intermittent clay lenses in the uppermost fifty feet of the unconsolidated deposits. The results of the field activities were confirmed by radionuclide specific analyses which indicated high concentrations of the naturally occurring thorium and radium series.

As a result of field observations, soil samples were analyzed for the base neutral priority pollutants. Only di-n-butyl phthalate, a plasticizer, was detected at a concentration of 0.34 mg/kg. Additional sampling and analysis is planned for this area to determine if the compound has entered the aquifer system.

7.4 External Radiation Components

In an effort to determine if the observed difference between on-site and off-site external exposure rates [24] was due to variations in terrestrial or

cosmic and atmospheric sources, a study was initiated in 1985. Gamma spectrometry measurements were made at 18 field locations to evaluate the contributions of primodial sources and weapons test fallout. The preliminary data indicated that the terrestrial component was relatively uniform with the widest variations in the radionuclide composition of the soil not correlating with external dose rate differences. The study will conclude when all stations have been surveyed; the expected completion date is 1987.

7.5 Tritium Evaporation

Following the release of tritiated distillate from the Waste Concentration Facility (WCF), the operation of this facility was suspended until the Laboratory had completed its review of the various distillate disposal options.

Solar evaporation was one option that offered the advantages of terminating WCF discharges to the sanitary sewage system (and thus to the Peconic River) and could be tested immediately to determine the viability of large scale operations. The pilot study called for operation of the WCF during the late summer and early fall when solar evaporative losses would be at their maximum. The program began in August and continued until mid-October. During this period, approximately 265,000 liters of distillate containing 4 curies of tritium were placed in the sewage treatment plant Emergency Holding Pond. The pond is underlain by an impermeable black plastic liner and open to the atmospheric environment. While this maximizes evaporative losses, it allows the addition of water from precipitation. During the time frame of the study, there was no net evaporative gain but there was a factor of 1.8 reduction in the amount of tritium in the pond. At the end of November, 1985, the total activity in the pond was estimated to be approximately 1.7 curies.

In addition to monitoring the concentration in the pond, six airborne tritium monitors were positioned in the STP area to monitor the tritium vapor concentrations. The monitors were positioned as follows: four at the pond's perimeter, one at the sand filter beds, and one at the STP control office. The results are found in Appendix D, Table 7B and were discussed in Section 3 of this report.

APPENDIX A.

Glossary of Terms

AGS	- Alternating Gradient Synchotron
ALF	- Alternate Liquid Fuels
BLIP	- Brookhaven Linear Isotope Production Facility
CSF	- Central Steam Facility
DOT	- Department of Transporation
EPA	- Environmental Protection Agency
HFBR	- High Flux Beam Reactor
HWMF	- Hazardous Waste Management Facility
LFS	- Light Feed Stocks
MEG	- Multimedia Environmenal Goals
MLD	- Million liters per day
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
PCB	- Polychlorinated biphenyls
PIC	- Product of Incomplete Combustion
POHC	- Principal Organic Hazardous Constituent
RCG	- Radiation Concentration Guide
SCDHS	- Suffolk County Division of Health Services
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
WCF	- Waste Concentration Facility

APPENDIX B - METHODOLOGIES

1. Methodology for Dose-Equivalent Calculations - Inhalation Pathway

Dispersion (X/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 (uCi/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, the BLIP stack, and the Hazardous Waste Management Incinerator stack were then used to estimate the air concentrations at a given sector and distance. The air concentration, multiplied by the adult breathing rate (22.8 m^3 d^{-1}), the number of days per month, the dose conversion factor for a given radionuclide [33,37], 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. Method for Tritium Dose-Equivalent Calculations - Potable Water Ingestion Pathway

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

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

where: AI = Activity Intake, uCi

C = annual average water concentration (563 for the population and 1873 for the maximum individual), pCi/L

IR = Ingestion Rate (2.2) L d^{-1}

T = Time, 365 d

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

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

where: H = committed effective dose equivalent, rem

AI = Activity Intake, uCi

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

P = Population at risk

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the following assumptions were made concerning the population at risk:

- the number of homes with the potential to have tritium in their potable well water is approximately 25.
- the number of residents per household was 4.

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

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

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

b. In the past the figure used for fish consumption was 1.6 kg/yr and was based on a study done by the NYSDEC in 1978 for the Peconic River area. However, based on a recent study conducted in the same area, they suggest that the figure should be 7 kg/yr [34]. We have therefore used the figure 7 kg/yr as the fish consumption rate in the 1985 calculations.

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

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

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

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

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

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

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

4. Data Presentation

Analytical results of the environmental and effluent monitoring programs are reported in the Tables of Appendix D for strontium-90 data not reported in 1984 and for all analyses performed on samples that were collected during calendar year 1985. The data presented in these tables require some degree of explanation in order for the reader to understand how the values were generated.

First, gross alpha and beta analyses were converted from the traditional reporting of less than values as the result to reporting the measured quantity effective 6/1/85. Data collected from 1/1/85 to 5/31/85 were used in the computation of results entered in the tables only if the result exceeded the minimum detection concentration (MDC). Results at or below the MDC were assigned a value of zero for the purpose of computing average concentrations. From 6/1/85 to 12/31/85, all data (positive, negative and zero) were used to compute average concentrations.

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

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

APPENDIX C

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

Nuclide	Matrix	Aliquot (ml)	MDC (uCi/ml)	MDL (uCi)
Gross alpha	water	1	3E-7	3E-7
		100	3E-9	
		500	6E-10	
Gross beta	water	1	6E-7	6E-7
		100	6E-9	
		500	1E-9	
Tritium	water	1	1.3E-6	1.3E-6
		7	2.0E-7	

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

Appendix C, continued

Constituent	(All concentration values in Mg/L except where noted)
Ag	0.02
As	0.001
Ba	0.5
Cd	0.005
Cr	0.025
Cu	0.05
Fe	0.05
Hg	0.0002
Mn	0.02
Na	0.025
Pb	0.50
Se	0.008
Zn	0.01
Ammonia-N	0.02
Nitrite-N	0.01
Nitrate-N	0.5
Specific Conductance	25 umhos/cm
Chlorides	5.0
Fluorides	0.02
Sulfates	5.0
1,1,1-trichloroethane	0.007
trichloroethylene	0.008
Chloroform	0.007
Tetrachloroethylene	0.008

APPENDIX D. Tabulated Anaytical Results

Table 1

1985 BNL Environmental Monitoring

1985 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	20,214	1,034	0	0	0	21,248	Beyond 32 Km - Atlantic Ocean
SW	39,802	61,410	3,234	0	0	104,446	Beyond 48 Km - Atlantic Ocean
WSW	35,894	136,363	333,227	419,165	758,362	1,683,011	Beyond 80 Km - Part of New York City
W	46,881	126,714	224,581	222,978	360,669	981,823	Beyond 80 Km - New York City
WNW	39,506	55,038	113	208,123	125,274	428,054	Beyond 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut and New York
NW	17,018	1,478	131,330	119,008	107,085	375,919	Same as WNW
NNW	7,252	0	202,350	103,769	52,445	365,816	Between 16 Km and 32 Km - Long Island Sound; Beyond 32 Km - Connecticut
N	4,295	0	90,719	240,890	250,549	586,453	Same as NNW
NNE	7,157	0	6,814	43,014	63,365	120,350	Same as NNW
NE	2,782	705	0	13,144	32,035	48,666	Between 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut
ENE	2,344	6,537	12,180	14,078	2,125	37,264	North Fork of Long Island
E	2,857	15,088	16,423	8,548	533	43,449	South Fork of Long Island and Atlantic Ocean
ESE	5,819	7,263	0	0	0	13,082	Long Island; Beyond 32 Km - Atlantic Ocean
SE	8,573	0	0	0	0	8,573	Beyond 16 Km - Atlantic Ocean
SSE	21,184	0	0	0	0	21,184	Same as SE
S	15,663	19	0	0	0	15,682	Beyond 32 Km - Atlantic Ocean
Total	277,241	411,649	1,020,971	1,392,717	1,752,442	4,855,020	

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

Table 2

1985 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 1985 (Ci)
490	Medical Research Center Roof Stack	13.7	Tritium	None	Dessicant for tritium vapor	4.2×10^{1}
491	Medical Research Reactor Stack[c]	45.7	Argon-41	Moving tape for radioparticulates	Charcoal for radioiodines	1.1×10^{3}
555	Chemistry Roof Stack	16.8	Tritium	None	Dessicant for tritium vapor	2.6×10^{-1}
750	High Flux Beam Reactor Stack	97.5	Tritium	None	Dessicant for tritium vapor	9.3×10^{1}
801	Hot Laboratory		Gross Beta Particulates	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	1.5×10^{-5}
			^{126}I			2.8×10^{-5}
			^{131}I			2.3×10^{-5}
			^{127}Xe			1.3×10^{-5}
901	Van de Graff Accelerator	18.3	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	2.0×10^{2} (gas) 2.4×10^{0} (vapor)
931	Linac Isotope[d] Facility	18.3	Oxygen-15	G-M Detector for radioactive gases	Dessicant for tritium vapor	1.9×10^{3}
			Tritium			9.0×10^{-5}
445	Incinerator		See Table 5	None	None	See Table 5

(a) Locations shown in Figure 2.
(b) Above ground level.
(c) Calculated from reported operating time and "one-time" measured emission rate at 3MW power level.
(d) Calculated from reported operating and estimated production rate at 180 uamp full beam current. This quantity is generated in the beam tube and represents the absolute maximum. Facility shut down in June 1984 for major modifications.

Table 3

1985 BNL Environmental Monitoring

Estimated Amounts of Radionuclides in Incinerated Materials [a]

Radionuclide[b]	Half-Life	Quantity (mCi)
^{3}H	12.2 y	13.18
^{14}C	5730 y	4.93
^{32}P	14.3 d	6.87
^{35}S	87.2 d	3.72
^{51}Cr	27.8 d	3.67
^{57}Co	271 d	0.36
^{117m}Sn	14.0 d	0.24
^{125}I	60.2 d	0.61

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 4
1985 BNL Environmental Monitoring
Airborne Activity Released via the 100 M HFBR Stack
(Activity in uCi)

	January	February	March	April	May	June	July	August	September	October	November	December	Total
^{82}Br	18.2	8.18	268	177	229	153	201	102	62	ND	ND	ND	1218
^{60}Co	0.073	ND	ND	0.76	0.42	0.36	0.31	0.11	0.184	ND	ND	ND	2.2
^{123}I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	603	ND	603
^{124}I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	165	165
^{126}I	ND	ND	ND	ND	ND	ND	ND	8.41	ND	ND	ND	272	280
^{131}I	184	0.93	2.77	8.03	5.38	1.93	10.3	16.9	0.784	0.154	ND	0.41	232
^{133}I	2.42	10.1	10.8	0.84	29.3	7.4	29.4	33.8	8.17	ND	ND	ND	132
^{125}Xe	ND	ND	ND	ND	ND	ND	1082	ND	ND	ND	ND	ND	1082
^{127}Xe	ND	ND	ND	ND	ND	ND	224	ND	ND	ND	ND	144	368
^{203}Hg	0.21	0.25	0.015	0.07	ND	ND	ND	ND	0.018	0.226	0.14	0.117	1.0
^{44m}Sc	ND	ND	0.35	0.51	0.30	0.37	ND	ND	ND	ND	ND	ND	1.5
^{95}Zr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.4	4.43
^{139}Ce	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0	1.97
^{3}H	20.2E6	10.3E6	4.71E6	1.47E6	6.26E6	5.86E6	2.49E6	12.2E6	5.07E6	13.1E6	5.08E6	6.23E6	93.0E6

ND: Not Detected.

Table 5

1985 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
BNL Site	major petroleum facility	NYSDEC-Water Quality	annual renewal
STP[a] & RCB[b]	sewage plant & recharge basins	NYSDEC-Water Quality	5/01/88
CLF[c]	current landfill	NYSDEC-Solid Waste	4/30/88
HWMF[d]	waste management	U.S. EPA	submitted, under review
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) Hazardous Waste Management Facility.

Table 6
1985 BNL Environmental Monitoring
Central Steam Facility Stack Emission Data[a]

Constituent	Stack Concentrations	EPA Emmission Goals [a]	Calculated Site Boundary Concentrations [c]	EPA Ambient Air Quality Goals [d]
	---------- mg/m^3 ----------			
As	1.4 E-2	1.0 E-2	8.5 E-9	2.4 E-5
Cd	1.1 E-1	1.0 E-2	6.7 E-8	1.2 E-4
Co	3.3 E-2	5.0 E-2	2.0 E-8	1.2 E-4
Cr	6.4 E-2	1.0 E-3	3.9 E-8	1.2 E-4
Cu	9.8 E-2	2.0 E-1	6.0 E-8	5.0 E-4
Hg	9.0 E-4	5.0 E-2	5.5 E-10	1.0 E-4
Mn	6.5 E-2	5 E0	4.0 E-8	1.2 E-2
Ni	3.3 E-1	1.5 E-2	2.0 E-7	2.4 E-4
Pb	1.1 E-0	1.5 E-3[b]	6.7 E-7	3.6 E-4
Sb	4.6 E-3	5.0 E-1	2.8 E-9	1.2 E-3
Se	6.0 E-3	2.0 E-1	3.7 E-9	5.0 E-4
Sr	1.2 E-2	3 E0	7.3 E-9	5.5 E-3
V	6.1 E-1	5.0 E-1	3.7 E-7	1.2 E-3
Zn	1.1 E0	5.0 E0	6.7 E-7	9.5 E0
Benzene	2.0 E-2	3.0 E0	1.2 E-8	7.1 E-2
Toluene	2.0 E-3	3.8 E+2	1.2 E-9	8.9 E-1
Phenol	1.0 E-3	1.9 E+1	6.1 E-10	4.5 E-2
Total Xylenes	1.6 E0	4.4 E+2	9.8 E-7	1.0 E-1

[a] Stack testing and measurements performed during December, 1983 [30].

[b] NYS ambient air quality standard.

[c] Calculated using exit flow rate of 16m^3/sec (Boiler #5) and an average X/Q dispersion parameter of $3.8 \times 10^{-8} \frac{sec}{m^3}$

[d] Multimedia Environmental Goals for Environmental Assessment, EPA-600/7-77-1366

Table 7
1985 BNL Environmental Monitoring
Sewage Treatment Plant Influent and Effluent
Average Radionuclide Data

Date	Location (a)	Flow, 1×10^7 l	Gross Alpha	Gross Beta	^{90}Sr 1984	^{90}Sr 1985	^{3}H (d)
			(pCi/l)				(nCi/l)
January	DA	8.75	0.60	66.5	0.18	0.13	0.493
February		7.49	0.45	11.1	0.59	0.40	0.901
March		8.34	0.45	10.4	1.00	0.59	0.877
April		7.74	<2.6	5.8	0.84	0.81	1.090
May		9.95	0.32	16.6	0.44	3.98	3.132
June		9.54	0.41	23.0	1.10	DL	2.802
July		12.94	0.52	6.7	0.26	DL	13.863
August		10.87	0.41	8.4	0.35	DL	7.149
September		9.29	0.32	6.4	0.34	DL	4.442
October		8.99	-0.04	10.8	0.49	DL	2.321
November		8.31	0.65	8.5	0.31	0.44	2.373
December		7.31	0.53	9.5	0.25	1.25	1.797
Annual Average		9.13	0.42	15.5	0.512	1.17	3.99
					mCi		
Total		110	0.641	17.0	0.613	1.28*	4,370
January	EA	7.55	0.31	16.1	1.25	0.40	0.698
February		7.11	0.30	11.7	0.94	0.31	0.629
March		7.44	0.21	8.2	0.92	0.44	0.757
April		7.27	0.27	5.0	0.99	0.47	1.220
May		9.00	0.36	7.3	1.11	0.78	2.892
June		8.72	0.60	15.1	0.67	2.21	2.415
July		10.5	0.52	6.1	0.55	DL	16.937
August		9.12	0.64	6.8	1.08	DL	6.623
September		7.01	0.90	4.6	0.59	DL	5.119
October		6.91	0.57	7.2	0.66	DL	2.369
November		7.20	0.05	17.0	0.41	0.74	1.450
December		7.89	0.59	3.3	0.46	0.51	1.882
Annual Average		7.98	0.46	9.25	0.724	0.765	4.05
					mCi		
Total		95.8	0.555	8.90	0.765	0.733*	3,880
NYS Drinking Water Standard			15.0	50		8.0	20
Radiation Concentration Guide			600	100		300	3,000

DL: Samples lost in transit to contractor laboratory. Data lost.
*: Total release was estimated as the product of the annual average concentration and the total flow.

Table 8
1985 Environmental Monitoring
Sewage Treatment Plant Influent and Effluent
Gamma Spectroscopy Results

Location	Month	Flow 1×10^7 l	^{22}Na	^{51}Cr	^{54}Mn	^{60}Co	^{65}Zn	^{134}Cs	^{131}I	^{137}Cs	^{40}K	^{7}Be	^{57}Co
			(pCi/l)										
DA	January	8.75	0.035	1.39	0.050	1.11	0.35	ND	0.18	0.11	2.4	ND	ND
	February	7.49	ND	0.43	0.049	0.45	0.24	ND	ND	0.19	2.0	0.64	ND
	March	8.34	0.011	ND	ND	0.44	0.31	ND	0.84	0.18	1.8	0.15	ND
	April	7.74	0.020	ND	0.021	0.84	0.29	ND	ND	0.52	0.83	0.19	0.067
	May	9.95	0.034	ND	ND	0.52	0.14	ND	ND	3.50	1.93	ND	ND
	June	9.54	0.009	12.3	0.061	0.93	0.38	ND	ND	2.40	1.70	ND	ND
	July	12.94	ND	1.28	0.020	0.49	0.15	ND	0.26	0.71	1.37	ND	ND
	August	10.87	ND	1.42	ND	0.53	0.071	ND	0.48	0.36	1.25	ND	ND
	September	9.29	0.024	0.81	ND	0.42	0.072	ND	ND	0.50	1.95	ND	ND
	October	8.99	0.022	ND	ND	0.75	0.25	ND	ND	0.70	2.09	ND	ND
	November	8.31	0.064	ND	ND	1.2	ND	ND	ND	0.32	2.18	ND	ND
	December	7.31	ND	0.31	ND	0.86	ND	ND	ND	0.99	2.04	ND	ND
	Average	9.13	0.017	1.56	0.022	0.70	0.20	ND	0.15	0.91	1.77	0.072	0.0055
			mCi										
	Total	109.	0.019	1.71	0.024	0.76	0.22	ND	0.17	1.00	1.94	0.079	0.006
EA	January	7.55	ND	0.56	ND	0.47	0.56	0.041	ND	1.74	3.2	ND	ND
	February	7.11	0.030	ND	0.062	0.22	0.38	0.030	ND	1.65	2.5	ND	ND
	March	7.44	0.028	ND	ND	0.15	0.51	ND	0.18	1.20	2.4	ND	ND
	April	7.27	0.042	ND	ND	0.33	0.39	ND	ND	1.19	2.85	ND	0.023
	May	9.00	ND	ND	ND	0.20	0.22	ND	ND	1.16	2.10	ND	ND
	June	8.72	ND	1.0	ND	0.50	0.27	ND	ND	1.38	2.10	ND	ND
	July	10.5	ND	0.59	ND	0.31	0.23	ND	ND	1.74	2.39	ND	ND
	August	9.12	ND	0.61	ND	0.27	0.13	ND	ND	2.41	3.06	ND	0.021
	September	7.01	ND	ND	ND	0.28	0.087	ND	ND	1.93	2.80	ND	ND
	October	6.91	ND	ND	ND	0.42	0.10	0.040	ND	1.87	3.07	ND	ND
	November	7.20	0.081	ND	ND	0.59	0.26	ND	ND	1.28	2.30	ND	ND
	December	7.89	ND	ND	ND	0.41	0.34	ND	ND	0.98	2.68	ND	ND
	Average	7.98	0.013	0.25	0.0045	0.34	0.28	0.008	0.013	1.54	2.51	ND	0.0038
			mCi										
	Total	95.8	0.013	0.25	0.0044	0.33	0.28	0.008	0.013	1.50	2.44	-	0.0037
Radiation Concentration Guide			30,000	2,000,000	100,000	30,000	200,000	9,000	300	20,000	-	2,000,000	400,000

ND: Not Detected.

Table 9
1985 BNL Environmental Monitoring
Sewage Treatment Plant[a]
Average Water Quality and Metals Data

	Sewage Treatment Plant Influent (DA)	Sewage Treatment Plant Effluent (EA)	SPDES Effluent Limitation
pH (SU)	5.3-7.8	5.3-6.5	5.8-9.0
Conductivity (umhos/cm)	d	187	c
Temperature maximum (°C)	b	25	32
Total coliform (per 100 ml)	b	623	10,000
Fecal coliform (per 100 ml)	b	146	2,000
Results in mg/L			
Dissolved Oxygen	b	9.3	3.0
Chlorides	b	29.4	c
Settleable Solids	0.8	0.0	0.1
Suspended Solids	134	14	10.0 maximum
	26.3	0.8	5.0 average
BOD_5	33.6	5.1	20.0 maximum
	24.2	3.1	10.0 average
Ammonia-Nitrogen	b	0.16	2.0
Nitrate-Nitrogen	b	5.0	c
Total Phosphorous	b	0.82	c
Ag	<0.02	<0.02	0.05
Cd	<0.005	<0.005	c
Ba	<0.50	<0.50	c
Cr	<0.025	<0.025	c
Cu	0.07	0.09	0.40
Fe	0.31	0.11	0.60
Hg	<0.0002	<0.0002	c
Mn	0.02	0.01	c
Na	26.3	28.7	c
Pb	<0.03	0.005	0.067
Zn	0.07	0.07	0.30

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

Table 10
1985 BNL Environmental Monitoring
Recharge Basins
Average Radionuclide Data

Location[a]	No. of Samples	Gross Alpha	Gross Beta	^{3}H	^{48}V	^{7}Be	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{52}Mn	^{137}Cs	^{56}Mn	^{22}Na	^{65}Zn
		pCi/l													
HN	11	0.34	6.38	<280	0.31	107	0.96	0.64	1.7	0.42	0.96	ND	0.16	0.354	0.27
HO	11	0.20	2.48	350	ND	ND	ND	ND	ND	1.14	ND	ND	ND	0.051	ND
HP	8	0.11	1.12	320	ND	ND	ND	ND	ND	0.19	ND	0.36	ND	0.027	ND
HT	11	0.18	1.93	440	ND	132	ND	ND	ND	0.095	ND	0.25	ND	1.93	ND
HS	222	0.46	4.28	570	no samples analyzed by gamma spectroscopy										
NYS Drinking Water Standard		15.0	50.0[b]	20,000											
Radiation Concentration Standards					3E4	2E6	1E5	4E5	9E4	3E4	3E4	2E4	1E5	3E4	2E5

(a) Locations of Recharge Basins are shown in Figure 7.
(b) Compliance level.
ND: Not Detected.

Table 11
1985 BNL Environmental Monitoring
Recharge Basins
Average Water Quality and Metals Data

Parameter	Location[b] HN	HO	HP	HT	HS	NYS Drinking Water Standards
No. of Samples	11	11	8	9	49	
pH (SU)	6.0-8.4	6.1-7.5	6.0-7.6	6.7-7.6	5.9-8.2	6.5-8.5
Specific Conductance (umhos/cm)	103	160	166	109	173	c
Temperature (C)	17	18	16	17	15	c
Results in mg/L						
Nitrate-N	1.27	1.36	1.87	0.83	a	10.0
Chlorides	17.2	18.5	31.9	17.3	a	250
Sulfates	8.8	10.8	11.6	10.1	a	250
Ag	<0.02	<0.02	<0.02	<0.02	a	0.05
As	<0.01	<0.01	<0.01	<0.01	a	0.025
Ba	<0.5	<0.5	<0.5	<0.5	a	1.0
Cd	<0.005	<0.005	<0.005	<0.005	a	0.01
Cr	<0.025	<0.025	<0.025	<0.025	a	0.05
Cu	0.05	<0.05	<0.05	<0.05	a	1.0
Fe	2.96	0.65	1.32	0.22	a	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	a	0.002
Mn	0.22	0.05	0.09	0.05	a	0.3
Na	10.9	19.7	26.3	16.5	a	c
Pb	<0.04	<0.04	<0.03	<0.04	a	0.025
Se	<0.01	a	<0.01	<0.01	a	0.02
Zn	0.013	0.044	<0.01	0.011	a	5.0

a: No analysis performed.
b: Locations of recharge basins are shown in Figure 7.
c: No standard specified.

Table 12
1985 BNL Environmental Monitoring
External Dose-Equivalent Rates for All TLD Locations

Location	Sample Frequency (M=Monthly Q=Quarterly)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Dose
		mrem				
1T2.2	M	14.5	14.2	15.7	16.2	60.5
1T3.0	Q	14.0	13.5	14.9	14.3	56.8
1T8.8	Q	14.7	12.4	14.1	13.5	54.8
2T1.4	M	15.4	16.1	16.8	17.6	65.8
2T2.6	M	16.6	17.2	18.2	17.6	59.6
2T2.6B(P-9)	M	16.7	16.0	17.9	17.5	68.0
2T3.2	Q	13.4	14.3	16.1	15.8	59.6
2T10.5	Q	17.3	16.0	17.0	17.9	68.3
3T2.8	M	14.9	15.5	17.4	17.9	65.7
3T8.8	Q	13.0	14.8	15.0	ND	58.2
4T2.4	M	14.8	15.9	15.8	15.8	62.3
4T2.6	Q	13.3	14.9	15.0	16.2	59.4
4T7.5	Q	13.0	13.9	15.1	15.0	56.9
5T2.5	M	17.9	18.3	21.0	19.8	76.9
5T4.2	Q	12.2	13.0	ND	13.9	52.0
5T6.5	Q	13.3	13.8	14.7	14.6	56.4
5T17.1	Q	16.3	13.3	14.9	14.5	59.0
6T2.8(P-7)	M	15.0	16.6	18.1	18.0	67.8
6T5.6	Q	12.7	13.0	14.5	13.9	54.1
6T14.2	Q	14.3	12.1	12.9	13.4	52.6
7T1.6	M	21.6	21.3	24.2	22.0	88.6
7T2.5	Q	15.9	17.4	18.6	18.3	70.1
7T9.7	Q	16.6	15.3	15.7	15.8	63.4
8T1.3	M	18.0	18.3	20.7	19.5	76.5
8T2.3	Q	12.9	14.7	15.3	14.3	57.2
8T8.0	Q	15.1	13.4	15.7	14.7	59.0
9T2.6	M	16.8	17.7	16.7	17.4	68.9
9T8.3	Q	12.2	12.9	ND	15.7	54.1
10T1.8	M	17.3	17.1	20.4	19.3	74.0
10T3.7	Q	15.7	17.8	18.8	17.2	69.6
10T9.3	Q	10.6	13.9	16.7	13.5	54.7
10T12.0	Q	15.9	15.3	16.8	17.1	65.6
11T2.1(P-4)	M	14.6	16.1	16.9	17.4	65.0
11T3.7	Q	13.3	14.7	16.0	12.3	56.3
11T17.8	Q	15.2	12.7	13.8	14.2	55.9
12T1.4	M	17.7	17.7	20.9	20.0	76.3
12T5.0	Q	11.9	14.0	15.0	15.1	56.1
12T7.2	Q	12.9	14.8	15.2	15.6	58.5
12T12.5	Q	17.0	15.7	14.9	18.1	65.6
13T1.3	M	17.5	17.2	20.2	21.0	76.1
13T1.4	Q	16.7	14.7	16.8	16.7	64.7
13T2.6	Q	13.3	15.2	16.7	ND	61.6
13T8.2	Q	12.2	13.4	13.4	13.9	52.9
14T1.3	M	17.0	17.3	20.9	19.9	75.2
15T1.4	Q	19.9	15.2	18.4	16.4	70.8
14T3.1	Q	14.9	16.7	18.1	16.2	65.8
14T5.6	Q	18.4	16.9	18.6	18.5	72.4
14T20.0	Q	13.8	15.3	17.6	15.6	62.3
15T1.7	M	16.9	16.7	20.3	19.0	73.0
15T3.0	Q	11.4	13.3	13.6	14.1	52.4
16T2.1(P-2)	M	14.3	16.0	16.5	16.9	63.6
16T3.4	Q	13.6	15.5	16.8	15.9	61.8
16T10.0	Q	15.4	14.9	ND	17.2	63.0
* Control A	Q	4.42	5.72	4.55	4.33	19.01
* Control B	Q	4.21	4.10	5.28	4.24	17.82
* Control C	Q	4.92	4.35	4.67	4.55	18.49
** Control M	M	4.98	4.90	6.00	8.02	23.89

Annual Average Perimeter Monthly Samples (18 observations) = 70.2 mrem ± 7.41 mrem
Annual Average Perimeter Quarterly Samples (5 observations) = 64.4 mrem ± 6.13 mrem
Annual Average Offsite Quarterly Samples (31 observations) = 59.7 mrem ± 5.71 mrem
* Background Control data for TLDs exposed for 3 month periods. Controls are lead shielded.
** Background Control data for TLDs exposed for 1 month periods. Controls are lead shielded.
ND: Not Detected.

Table 13
1985 BNL Environmental Monitoring
Tritium Air Concentrations
(pCi/m^3)

Sample Station	1	3	4	5	6(P-7A)	6(P-7B)	7	8	9	10	11(P-4)	12	13	14	15	16(P-2)	Control[a]	Control[b]	Analytical
Wind Rose Sector	N	NE	ENE	E	ESE	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW			Laboratory
Date																			
1/8/85	ns	ns	ns	ns	2.76	2.33	ns	ns	ns	ns	1.24	ns	ns	ns	ns	2.47	ns	ns	ns
1/17/85	ns	ns	ns	ns	1.55	1.86	ns	ns	ns	ns	14.4	ns	ns	ns	ns	0.698	ns	ns	ns
1/24/85	ns	ns	ns	ns	<0.65	<5.8	ns	ns	ns	ns	2.91	ns	ns	ns	ns	<0.73	ns	ns	ns
1/31/85	ns	ns	ns	ns	1.03	1.53	ns	ns	ns	ns	2.38	ns	ns	ns	ns	<0.77	ns	ns	ns
2/7/85	ns	ns	ns	ns	2.77	1.84	ns	ns	ns	ns	2.01	ns	ns	ns	ns	2.56	ns	ns	ns
2/14/85	ns	ns	ns	ns	8.55	5.28	ns	ns	ns	ns	5.16	ns	ns	ns	ns	3.85	ns	ns	ns
2/21/85	21.0	8.3	2.9	2.4	<1.23	<4.86	4.3	3.9	14.0	5.1	2.58	18.0	7.2	2.9	4.2	<1.22	ns	ns	ns
2/28/85	3.7	<2.2	<2.2	<2.5	<1.95	4.12	<1.9	<2.1	<3.8	<1.5	5.13	<2.9	9.6	3.3	<1.9	<2.08	ns	ns	ns
3/7/85	ns	ns	ns	<1.5	1.92	4.12	4.4	ns	<1.7	<1.3	3.07	<1.2	2.8	1.7	2.5	1.57	ns	ns	ns
3/14/85	ns	<2.3	<2.1	<2.1	<1.76	<1.06	5.3	<2.0	<2.1	<1.2	2.41	<1.9	<1.7	<1.5	<1.8	<1.29	ns	ns	ns
3/21/85	2.5	2.2	3.5	2.1	2.83	3.13	<1.1	3.3	2.2	1.9	2.60	<1.0	2.8	6.8	6.6	<0.83	ns	ns	ns
3/29/85	5.6	20.0	<2.2	19	2.49	1.90	8.3	5.6	<2.2	3.5	7.78	2.2	<2.0	<1.3	23.0	2.43	ns	ns	ns
4/4/85	11.0	5.9	<2.2	3.8	<1.19	<1.35	9.9	4.9	5.2	<1.8	1.56	7.8	7.7	9.3	<1.5	<1.46	ns	ns	ns
4/11/85	3.7	<3.3	3.5	5.4	1.71	<1.63	<2.0	2.9	<3.3	ns	1.63	3.2	<1.6	<2.9	7.9	<2.03	ns	ns	ns
4/18/85	ns	<2.9	ns	<1.6	<1.79	<1.63	<2.3	<2.4	<2.3	<1.7	ns	2.4	<2.8	<1.6	<2.9	<2.07	ns	ns	ns
4/25/85	<4.8	ns	ns	<2.3	<2.51	<2.67	ns	<4.1	ns	<2.5	<1.97	<4.0	<4.3	4.4	ns	<2.78	ns	ns	ns
4/30/85	<4.2	3.1	4.7	3.3	<3.71	<2.81	4.2	<3.3	4.1	4.4	8.33	ns	<3.8	<3.1	4.8	5.40	ns	ns	ns
5/9/85	<4.5	<3.4	ns	ns	<3.63	<3.63	<3.2	3.0	4.4	<2.6	2.67	<3.2	<3.6	2.3	ns	<4.19	ns	ns	ns
5/16/85	<4.7	<3.7	<4.4	<3.9	<4.79	<4.51	4.7	<5.5	<5.2	3.0	4.32	<4.0	<3.8	<3.7	<4.0	<5.14	ns	ns	ns
5/23/85	<4.2	<4.2	6.3	4.8	<4.73	<4.45	<4.3	<3.5	<4.6	<6.0	ns	<4.7	<3.1	<3.5	<4.1	<3.72	ns	ns	ns
5/31/85	<6.7	<4.1	<5.5	<3.8	<5.42	<5.94	<5.2	<4.1	<3.9	<3.6	<7.13	<3.9	<4.4	<3.7	<4.6	-	ns	ns	ns
6/7/85	<1.8	<6.6	<6.2	<6.6	<6.43	<8.31	<7.1	ns	<5.9	<7.1	<6.94	<5.9	<5.1	<6.5	ns	<6.67	<7.1	<5.4	5.7
6/14/85	<13	<8.3	<7.0	<7.2	<7.90	<6.06	<6.9	<6.9	<6.3	<8.4	<6.73	<6.5	<4.8	<7.4	<6.7	<8.73	ns	<7.3	<5.7
6/20/85	<5.7	<4.8	<5.5	<5.3	<8.18	<6.02	<5.3	<1.5	<5.1	<6.7	<19.1	ns	<5.0	<5.5	<5.0	<8.61	ns	<6.3	24
6/28/85	ns	<5.8	<6.0	<4.7	<5.2	<5.48	<4.1	<4.3	<4.6	<4.6	<4.94	<4.0	<7.1	<5.1	<4.9	<4.96	15.0	15	6.4
7/8/85	<6.8	<8.8	<7.0	<12	<7.23	<7.49	<6.9	1.1	ns	<15	<11.1	<7.2	<7.6	<6.3	<11	<7.6	<4.9	3.3	23
7/16/85	24	<7.9	<8.5	ns	<8.44	<10.5	<5.5	46	<8.2	<7.4	<10.5	<7.9	<11	<8.9	18	12.4	<7.7	<3.7	21.6
7/24/85	32	<8.9	7.7	ns	<8.12	<7.3	8.6	ns	12.0	<6.5	<6.37	<7.2	ns	<7.7	12	<7.2	<4.6	<7.2	426
7/31/85	9.7	20.0	<8.8	<53	<8.19	<11.2	23	11.0	11	34.0	10.5	21	17	9.9	21	15.7	9.0	14.0	ns
8/8/85	15	16	22	ns	10.5	<9.37	24	ns	<6.50	<7.2	<9.73	<6.8	37	37	9.5	<7.25	ns	19.0	60
8/15/85	<8.0	<7.8	17	<13	<7.67	<9.99	nc	ns	<7.40	<8.7	<5.52	<5.7	<6.2	7.9	8.5	<6.22	11	<5.9	50
8/23/85	<7.8	<10	<8.8	ns	<10.5	<10.2	<6.2	6.9	ns	9.9	<13.7	12.0	10	9.5	<7.8	<8.72	<5.3	ns	38
8/30/85	<5.2	<5.3	<6.0	ns	<6.30	<6.3	<6.0	6.4	ns	<7.3	<8.1	<5.6	<6.9	<5.3	<5.6	<6.23	ns	ns	23
9/6/85	<9.5	25.0	<8.8	<14	<9.18	<7.58	<7.0	<7.7	ns	ns	<7.42	19.0	<8.6	<8.1	<9.2	<8.79	ns	ns	23
9/13/85	<9.5	<1.7	<5.2	<6	<6.43	<6.9	<4.9	<4.0	ns	ns	<4.55	<5.1	<6.0	<1.8	5.9	<5.08	ns	ns	58
9/20/85	<3.2	ns	8.3	ns	<2.71	<4.5	6.6	4.6	ns	4.82	<4.32	<3.7	<4.0	ns	<3.5	<3.09	ns	ns	32
9/27/85	<3.5	nc	nc	nc	<8.16	<2.1	nc	nc	ns	nc	ns	nc	nc	nc	nc	<5.68	ns	ns	nc
10/1/85	43.7	238	ns	ns	ns	ns	ns	26.1	ns	ns	<5.88	9.05	ns	<5.7	185	ns	ns	ns	61.6
10/17/85	<8.46	33	ns	ns	43.6	58.3	30.5	470	ns	116	9.01	14.7	<4.3	8.5	123	ns	ns	ns	72.9
10/31/85	ns	12.7	27.4	22.9	34.4	25.9	<3.2	13.5	ns	27.3	35.2	19.9	47.8	57.1	60.5	ns	ns	ns	59.8
11/14/85	7.33	18.6	37.1	23.7	13.7	44.7	10.8	37.1	ns	ns	64.3	14.0	3.69	<2.2	10.1	21.4	ns	ns	12.0
11/27/85	6.73	77.8	209	60	9.5	11.7	116	50.9	ns	33	28.9	<6.66	29.3	8.72	35.8	2.02	ns	ns	13.4
12/11/85	ns	ns	<2.6	8.1	116	79.3	5.53	8.5	ns	ns	128.0	<3.1	8.39	5.27	6.9	4.06	3.54	ns	ns
12/23/85	<2.40	6.76	3.2	ns	1.94	5.98	17.6	ns	ns	ns	17.9	ns	ns	<1.87	2.75	9.12	<1.6	ns	19.2
Annual Average	6.04	9.93	10.1	5.8	5.94	5.86	7.22	21.1	2.33	7.87	9.1	4.1	6.63	4.30	19.3	2.09	3.76	5.28	54.8

ns = Not sampled.
nc = Sample not changed at this time.
a: Control located at residence of BNL employee living in Patchogue.
b: Control located at residence of BNL employee living in Rocky Point.

Table 14
1985 BNL Environmental Monitoring
Tritium Air Concentrations
(pCi/m^3)

Sample Station Date	HWM	S-6	17	STPN*	STPE*	STPS*	STPW*	STPL*	STPF*
1/8/85	9.5	14	ns	ns	ns	ns	ns	ns	ns
1/17/85	6.0	11	ns	ns	ns	ns	ns	ns	ns
1/24/85	2.4	15	ns	ns	ns	ns	ns	ns	ns
1/31/85	6.6	19	ns	ns	ns	ns	ns	ns	ns
2/6/85	12	11	ns	ns	ns	ns	ns	ns	ns
2/14/85	19	22	ns	ns	ns	ns	ns	ns	ns
2/21/85	13	23	ns	ns	ns	ns	ns	ns	ns
2/28/85	12	31	ns	ns	ns	ns	ns	ns	ns
3/7/85	14	15	ns	ns	ns	ns	ns	ns	ns
3/14/85	6.3	24	ns	ns	ns	ns	ns	ns	ns
3/21/85	9.4	22	ns	ns	ns	ns	ns	ns	ns
3/29/85	14	32	ns	ns	ns	ns	ns	ns	ns
4/4/85	7.8	18	ns	ns	ns	ns	ns	ns	ns
4/11/85	3.5	27	ns	ns	ns	ns	ns	ns	ns
4/18/85	8.8	25	ns	ns	ns	ns	ns	ns	ns
4/25/85	<2.8	<2.2	ns	ns	ns	ns	ns	ns	ns
4/30/85	12	32	ns	ns	ns	ns	ns	ns	ns
5/9/85	9.3	44	ns	ns	ns	ns	ns	ns	ns
5/16/85	16	43	ns	ns	ns	ns	ns	ns	ns
5/23/85	17	48	ns	ns	ns	ns	ns	ns	ns
5/30/85	27	38	ns	ns	ns	ns	ns	ns	ns
6/7/85	26	28	<6.5	ns	ns	ns	ns	ns	ns
6/14/85	27	36	<7.2	ns	ns	ns	ns	ns	ns
6/20/85	121	60	16.0	ns	ns	ns	ns	ns	ns
6/28/85	865	41	<4.6	ns	ns	ns	ns	ns	ns
7/8/85	47	51	<16	ns	ns	ns	ns	ns	ns
7/16/85	64	77	15	ns	ns	ns	ns	ns	ns
7/24/85	80	69	1240	ns	ns	ns	ns	ns	ns
7/31/85	110	92	29	ns	ns	ns	ns	ns	ns
8/8/85	184	138	18	ns	ns	ns	ns	ns	ns
8/15/85	214	207	ns	ns	ns	ns	ns	ns	ns
8/23/85	199	179	21	ns	ns	ns	ns	ns	ns
8/30/85	63	69	9.3	60	71.0	49	72	<7.7	<14
9/6/85	100	110	26.0	33	102	33	45	<8.1	<12
9/13/85	105	37	8.4	114	131	104	129	7.8	<15
9/20/85	106	73	20.0	68	129	58	112	21	9.2
9/27/85	ns	42	nc	nc	nc	nc	nc	nc	nc
10/1/85	ns	ns	ns	306	200	77.6	576	97	282
10/17/85	481	114	ns	215	209	154	246	33.9	ns
10/31/85	ns	53	22.0	ns	181	106	257	14.0	35.1
11/14/85	152	110	22.5	84.9	ns	54.5	159	9.35	28.2
11/27/85	ns	36	12.5	56.6	71.3	80.4	186	26.2	ns
12/11/85	ns	102	9.09	15.4	69.7	37.2	57.5	ns	55.6
12/23/85	ns	12.9	ns	ns	39.5	15.2	16.9	ns	7.89
Annual Average	57.7	42.2	60.9	76.2	128	68.4	137	23.3	33.2
Committed Effective Dose Equiv. (40 hr. per week) rem	8.72	6.38	9.21	11.5	19.4	10.3	20.7	3.52	5.02

ns = Not sampled.
* Location Identification:
HWM = Hazardous Waste Management, center of facility.
S-6 = Hazardous Waste Management, facility perimeter.
STPN = Sewage Treatment Plant Emergency Holding Pond, Center of North side.
STPE = Sewage Treatment Plant Emergency Holding Pond, Center of East side.
STPS = Sewage Treatment Plant Emergency Holding Pond, Center of South side.
STPW = Sewage Treatment Plant Emergency Holding Pond, Center of West side.
STPF = Sewage Treatment Plant area, center of Sand filter beds.
STPL = Sewage Treatment Plant Laboratory.

Table 15A
1985 Environmental Monitoring
Gross Alpha, Beta and Gamma Concentrations
in Air at Environmental Monitoring Stations

Sample Location S6 (AA)

Month	No of Samples	Gross Alpha			Gross Beta		
		Ave	Max	Min	Ave	Max	Min
		pCi/m^3					
January	23	1.0E-3	1E-2	2E-4	2.4E-2	1E-1	2E-3
February	19	2.1E-3	8E-3	6E-4	2.5E-2	2E-1	9E-3
March	21	7.1E-4	5E-3	9E-4	2.8E-2	1E-1	8E-3
April	22	1.2E-3	6E-3	3E-3	1.9E-2	9E-2	4E-3
May	22	-1.9E-4	9E-3	-9E-3	1.2E-2	8E-1	-6E-3
June	18	2.0E-3	2E-2	-4E-3	1.5E-2	3E-2	-5E-3
July	21	1.2E-3	9E-3	-8E-3	2.1E-2	2E-1	-4E-3
August	22	3.6E-3	2E-2	-1E-2	2.9E-2	1E-1	0
September	19	8.0E-3	1E-2	-7E-3	3.3E-2	2E-1	-1E-2
October	23	1.8E-3	1E-2	-6E-3	1.6E-2	6E-2	-7E-3
November	18	-6.1E-4	4E-3	-6E-3	1.4E-2	5E-2	-5E-3
December	20	2.4E-3	1E-2	-8E-3	1.3E-2	9E-2	0
Annual Average		1.41E-3	2E-2	-9E-3	2.0E-2	8E-1	-6E-3

Table 15B
1985 Environmental Monitoring
Gross Alpha, Beta and Gamma Concentrations
in Air at Environmental Monitoring Stations

Sample Location P-2 (AB)

Month	No of Samples	Gross Alpha			Gross Beta		
		Ave	Max	Min	Ave	Max	Min
		pCi/m^3					
January	4	1.2E-3	2E-3	7E-4	1.4E-2	2E-2	1E-2
February	4	7.4E-4	1E-3	8E-4	1.1E-2	2E-2	7E-3
March	4	8.3E-4	2E-3	1E-3	1.3E-2	1E-2	9E-3
April	5	8.2E-4	5E-4	5E-4	4.4E-2	2E-1	6E-3
May	3	7.4E-4	2E-3	1E-4	2.5E-2	7E-2	6E-3
June	4	6.1E-4	2E-3	-2E-4	1.3E-2	2E-2	1E-2
July	4	4.0E-4	2E-3	-8E-4	1.1E-2	1E-2	9E-3
August	4	1.1E-3	1E-3	9E-4	1.8E-2	2E-2	1E-2
September	3	5.6E-4	1E-3	0	1.3E-2	2E-2	1E-2
October	2	1.7E-3	2E-3	7E-4	1.6E-2	2E-2	1E-2
November	4	4.9E-4	1E-3	-4E-4	1.2E-2	2E-2	7E-3
December	5	1.7E-3	2E-3	1E-3	1.2E-2	2E-2	2E-3
Annual Average		8.1E-4	2E-3	-8E-4	1.7E-2	2E-2	2E-3

Table 15C
1985 Environmental Monitoring
Gross Alpha, Beta and Gamma Concentrations
in Air at Environmental Monitoring Stations

Sample Location P-4 (AC)

Month	No of Samples	Gross Alpha			Gross Beta		
		Ave	Max	Min	Ave	Max	Min
		pCi/m^3					
January	4	7.6E-4	1E-3	4E-4	1.5E-2	2E-2	1E-2
February	4	9.8E-4	2E-3	4E-4	1.5E-2	2E-2	1E-2
March	4	3.1E-4	9E-4	9E-4	2.0E-2	7E-2	8E-3
April	5	6.6E-4	1E-3	1E-3	1.5E-2	2E-2	8E-3
May	3	1.4E-3	2E-3	1E-3	1.4E-2	2E-2	1E-2
June	4	4.2E-4	1E-3	2E-4	2.9E-2	2E-2	1E-2
July	4	8.4E-4	2E-3	-6E-4	1.5E-2	2E-2	1E-2
August	4	4.6E-4	1E-3	-3E-4	1.3E-2	2E-2	-4E-4
September	3	5.7E-4	9E-4	2E-4	1.9E-2	3E-2	1E-2
October	5	8.5E-4	3E-3	-3E-4	1.1E-2	2E-2	1E-3
November	4	6.4E-4	2E-3	-5E-4	7.4E-3	1E-2	5E-3
December	5	1.3E-3	2E-3	-4E-4	1.3E-2	3E-2	1E-4
Annual Average		7.9E-4	3E-3	-6E-4	1.5E-2	8E-2	-4E-4

Table 15D
1985 Environmental Monitoring
Gross Alpha, Beta and Gamma Concentrations
in Air at Environmental Monitoring Stations

Sample Location S-5 (AD)

Month	No of Samples	Gross Alpha			Gross Beta		
		Ave	Max	Min	Ave	Max	Min
		pCi/m^3					
January	4	7.2E-4	1E-3	3E-5	1.7E-2	3E-2	1E-2
February	4	5.1E-4	1E-3	7E-4	1.5E-2	2E-2	9E-3
March	4	4.5E-4	2E-3	<1E-3	1.3E-2	2E-2	1E-2
April	5	4.1E-4	3E-3	<1E-3	1.7E-2	2E-2	1E-2
May	3	1.2E-3	2E-3	7E-4	1.3E-2	1E-2	1E-2
June	4	6.1E-4	2E-3	-6E-4	1.5E-2	2E-2	1E-2
July	4	1.0E-3	2E-3	-4E-4	1.5E-2	2E-2	1E-2
August	4	2.1E-3	3E-3	2E-3	1.7E-2	2E-2	2E-2
September	4	5.1E-4	8E-4	2E-4	1.9E-2	3E-2	2E-3
October	4	1.4E-3	2E-3	9E-4	1.9E-2	2E-2	1E-2
November	4	1.5E-4	1E-3	-4E-4	6.7E-3	2E-2	1E-3
December	5	1.3E-3	2E-3	6E-4	2.1E-2	5E-2	-4E-3
Annual Average		8.8E-4	3E-3	-6E-4	1.6E-2	5E-2	-4E-3

Table 15E
1985 Environmental Monitoring
Gross Alpha, Beta and Gamma Concentrations
in Air at Environmental Monitoring Stations

Sample Location P-7 (AF)

Month	No of Samples	Gross Alpha				Gross Beta		
		Ave	Max	Min	pCi/m^3	Ave	Max	Min
January	4	8.7E-4	1E-3	5E-4		1.5E-2	2E-2	1E-2
February	4	1.0E-3	2E-3	1E-3		2.4E-2	3E-2	1E-2
March	4	2.2E-4	9E-4	9E-4		1.5E-2	3E-2	1E-2
April	5	3.7E-4	2E-3	1E-3		1.4E-2	2E-2	7E-3
May	4	1.3E-3	2E-3	6E-4		1.2E-2	1E-2	9E-3
June	4	6.1E-4	1E-3	3E-4		1.2E-2	1E-2	1E-2
July	4	1.3E-3	2E-3	7E-4		1.5E-2	2E-2	1E-2
August	4	1.6E-3	2E-3	1E-3		2.1E-2	3E-2	2E-2
September	4	1.2E-3	2E-3	1E-4		2.3E-2	3E-2	2E-2
October	4	1.6E-3	2E-3	-6E-4		2.2E-2	3E-2	1E-2
November	4	9.6E-4	3E-3	-2E-4		1.6E-2	2E-2	9E-3
December	5	1.5E-3	2E-3	2E-4		2.2E-2	3E-2	2E-2
Annual Average		1.0E-3	3E-3	-6E-4		1.7E-2	3E-2	7E-3

Table 16
1985 BNL Environmental Monitoring
Quarterly Average Radionuclide Activity in Precipitation

Quarter	Rainfall (cm)	Gross Alpha	Gross Beta	^{3}H	^{7}Be	^{137}Cs	^{90}Sr 1984	^{90}Sr 1985
		nCi/m^2						
First	14	0.0998	0.69	33.1	13.0	0.033	0.004	0.004
Second	32.5	0.007	0.22	<11.6	2.3	ND	0.166	DL
Third	22.2	0.093	0.97	14.4	15.2	0.024	0.005	DL
Fourth	36.6	0.067	1.06	19.7	13.2	0.042	0.004	0.010
Total	92.8	0.267	2.94	78.8	43.7	0.099	0.18	0.014*

DL: Samples lost in transit to contracting laboratory.

* Does not include April thru September, 1985.

ND: Not Detected.

Collection area = 0.343m^2

Table 17

1985 BNL Environmental Monitoring

Radionuclide Concentrations in

Vegetation and Soil at Farms in the Vicinity of BNL

Location	Sample Matrix	Radionuclide					
		^{40}K	^{137}Cs	^{7}Be	^{228}Th	^{226}Ra	^{203}Hg
		pCi/kg					
JA	Grass	4800	101	1700	72	ND	ND
JB	Grass	4960	12	230	ND	ND	ND
JC	Grass	2900	ND	410	ND	ND	ND
JD	Grass	4860	ND	1340	33	ND	ND
JE	Grass	4440	111	2030	20	ND	ND
JZ	Strawberries	1340	ND	140	ND	ND	ND
OA	Soil	2740	275	ND	248	201	ND
OB	Soil	3890	657	ND	295	89	ND
OC	Soil	4500	216	ND	ND	500	ND
OD	Soil	6100	178	ND	869	657	ND
OE	Soil	5650	924	740	873	622	70

ND: Not Detected.

Table 18A
1985 BNL Environmental Monitoring
Aquatic Surveillance, Peconic River[a]
Average Radionuclide Data

Sampling Period		Number of Samples	Gross Alpha	Gross Beta	^{90}Sr[b] 1984	^{90}Sr[b] 1985	^{3}H
			(pCi/l)				(nCi/l)
January	HM	13	0.643	13.2			1.04
February		12	0.609	9.8			0.129
March		13	<2.41	8.0	0.7	0.30	0.509
April		13	0.172	5.1			0.513
May		14	0.201	6.4			1.94
June		12	-0.0458	12.9	1.7	0.76	1.94
July		12	0.189	6.41			8.18
August		13	0.479	5.32			6.48
September		11	0.026	4.84			3.86
October		13	0.478	8.77	ND	DL	2.90
November		12	0.234	8.76			1.84
December		12	0.355	9.16	0.43	0.38	2.43
Annual Average			0.281	7.81	0.94	0.48	2.62
January	HQ	13	0.185	8.18			0.45
February		12	0.28	7.58			0.23
March		13	0.18	7.54	0.57	0.43	0.63
April		13	<2.6	2.83			0.93
May		14	0.46	4.88			1.85
June		12	0.07	10.2	1.80	0.38	2.20
July		13	-0.20	5.43			16.70
August		13	0.37	8.38			5.96
September		11	2.18	14.3	0.28	DL	4.36
October		4	3.33	27.8	ns	ns	0.73
November		ns	ns	ns	ns	ns	ns
December		ns	ns	ns	0.52	ns	ns
Annual Average			0.490	8.40	0.79	0.41	3.60
1st Quarter	HR	3	0.20	3.2	ns	ns	<0.183
2nd Quarter		4	0.18	1.5	0.48	ns	<0.317
3rd Quarter		6	0.13	2.6	0.62	ns	<0.317
4th Quarter		4	0.33	2.4	0.58	0.74	<0.284
Annual Average			0.20	2.4	0.56	0.74	<0.280
NYS Drinking Water Standards			15	50[c]	8.0	8.0	20.0
Radiation Concentration Guide			600	100		300	3,000

(a) Locations shown in Figure 5.
(b) The ^{90}Sr results were generated from quarterly composite samples.
(c) Compliance level.

DL: Samples lost in transit to contractor laboratory.
ND: Not Detected.
ns: Not sampled.
*: Total release was estimated as the product of the annual average concentration and the total flow.

Table 18B
1985 Environmental Monitoring
Aquatic Surveillance, Peconic River
Gamma Spectroscopy Results

Location[a]	Month	^{22}Na	^{51}Cr	^{60}Co	^{65}Zn	^{134}Cs	^{137}Cs	^{40}K	^{7}Be
		(pCi/l)							
HM	January	0.092	ND	0.56	0.37	ND	1.2	2.61	ND
	February	0.016	ND	0.22	0.55	ND	1.5	3.60	ND
	March	0.077	ND	0.18	0.23	ND	0.87	1.60	0.69
	April	ND	ND	0.60	ND	ND	1.18	2.0	3.30
	May	0.037	ND	0.25	ND	ND	0.61	0.92	1.45
	June	0.22	0.95	0.74	0.17	ND	0.97	1.82	6.20
	July	ND	ND	0.54	ND	ND	1.22	2.10	1.63
	August	ND	ND	0.69	ND	ND	1.40	2.23	0.63
	September	ND	ND	0.61	ND	ND	0.69	4.10	ND
	October	ND	ND	0.50	ND	ND	0.77	1.11	ND
	November	ND	ND	ND	0.77	ND	ND	ND	2.68
	December	ND	ND	0.94	ND	ND	1.40	8.30	ND
	Average	0.039	0.065	0.45	0.20	ND	1.01	2.36	1.20
HQ	January	0.031	ND	0.40	0.30	0.023	1.16	2.37	0.47
	February	0.040	ND	0.23	0.32	ND	1.50	4.10	0.96
	March	ND	ND	ND	ND	ND	ND	ND	ND
	April	0.13	ND	0.59	ND	ND	1.46	3.40	5.36
	May	0.083	ND	0.50	0.11	ND	1.34	2.39	1.89
	June	0.22	ND	0.88	ND	ND	1.80	3.70	4.10
	July	0.044	ND	0.65	ND	ND	1.54	2.50	ND
	August	ND	ND	ND	ND	ND	ND	ND	ND
	September	ND	ND	0.20	ND	ND	0.60	1.67	ND
	October	ND	ND	ND	ND	ND	ND	ND	ND
	November	ND	ND	ND	ND	ND	ND	ND	ND
	December	ND	ND	ND	ND	ND	ND	ND	ND
	Average	0.063	ND	0.47	0.14	0.005	1.35	2.81	1.49
HR	1st Quarter	na	na	na	na	na	na	na	na
	2nd Quarter	na	na	na	na	na	na	na	na
	3rd Quarter	ND	ND	ND	ND	ND	0.101	ND	ND
	4th Quarter	ND	ND	ND	ND	ND	0.135	ND	ND
	Annual Average	ND	ND	ND	ND	ND	0.112	ND	ND
Radiation Concentration Standard		30,000	2,000,000	30,000	200,000	9,000	20,000	-	2,000,000

(a) Locations shown in Figure 5.
na: Not Analyzed.
ND: Not Detected.

Table 19
1985 BNL Environmental Monitoring
Radionuclide Concentrations in Fish

Location	Type of Fish	Tritium	^{90}Sr	^{137}Cs
		---------- pCi/kg. wet ----------		
Peconic River				
Donahue's Pond	Bluegrill Sunfish[c]	843	633	195
Donahue's Pond	Yellow Perch[c]	926	1025	581
Donahue's Pond	Chain Pickeral[a]	709	165	334
Donahue's Pond	Golden Shiner[c]	841	2597	194
Donahue's Pond	(1) Brown Bullhead[b]	1742	113	253
Donahue's Pond	(2) Brown Bullhead[b]	1470	3328	370
Average		1089	1310	321
Control Locations				
Artist Lake	Chain Pickeral[a]	na	na	285
Swan Pona	Chain Pickeral[a]	na	na	305
Carmen's River	Chain Pickeral[a]	na	na	290
Average				293

[a] Predator
[b] Bottom Feeder
[c] Omnivore
(1) Juvenile fish
(2) Adult fish

na: no analysis

Table 20
1985 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 Alpha	Gross Beta	^{3}H	^{7}Be	^{60}Co	^{137}Cs	^{22}Na	^{51}Cr	^{90}Sr
			pCi/l								
(F1)	3	ND	0.36	0.77	<280	ND	ND	ND	ND	ND	<0.19
(F2)	3	ND	0.19	1.2	<280	ND	ND	ND	ND	ND	<0.16
1 (FA)	11	425.3	0.13	3.93	1080	0.17	9.0	0.037	ND	ND	0.1
2 (FB)	9	5.6	0.34	3.46	57	1.4	ND	ND	ND	ND	0.029
3 (FC)	12	278.4	0.14	4.18	185	ND	0.49	ND	ND	0.33	3.01
4 (FD)	8	6.45	0.099	0.69	<280	0.71	ND	0.14	ND	ND	<0.42
5 (FE)	12	not pumped	0.12	1.42	<280	ND	ND	ND	ND	ND	<0.15
6 (FF)	8	323.3	0.16	1.09	<280	ND	ND	ND	ND	ND	<0.41
7 (FG)	9	1583.8	0.10	0.77	<280	ND	ND	ND	ND	ND	<0.08
10 (FO)	10	1216.7	0.038	0.73	33	3.6	ND	ND	0.16	ND	<0.12
11 (FP)	12	1597.7	0.057	1.0	<280	1.3	ND	ND	ND	ND	<0.34
102 (FI)	6	895.0	0.15	2.09	<280	0.98	ND	ND	ND	ND	na
103 (FJ)	1	934.8	na	na	na	ND	ND	ND	ND	ND	na
104 (FK)	3	496.0	0.075	0.86	106	ND	ND	ND	ND	ND	<0.37
105 (FL)	6	983.0	0.085	1.34	53	ND	ND	ND	0.22	ND	na
FN[c]	237	ND	0.35	4.80	222	na	na	na	na	na	na
ZB[d]	237	ND	0.12	1.75	209	na	na	na	na	na	na
NYS Drinking Water Standard			15.0	50.0[b]	20,000						8.0
Radiation Concentration Guide					2,000,000		30,000	20,000	30,000	2,000,000	

(a) Location of Potable and Cooling Water Wells are Shown in Figure 7. F1 and F2 denote the influent and effluent, respectively, at the Water Treatment Plant.
(b) Compliance Level.
(c) FN is the Daily Tap Water Sample.
(d) ZB is the Daily Distilled Water Sample.
ND: Not Detected.
na: Not analyzed.

Table 21
1985 BNL Environmental Monitoring
Potable Supply Wells,
Average Water Quality and Metals Data

	Well No.1	Well No.2	Well No.3	Well No.4	Well No.6	Well No.7	Well No.10	Well No.11	NYS Drinking Water Standard
Number of Samples	4	4	4	4	4	4	4	4	
pH (SU)	5.7-6.7	6.9-6.3	6.0-6.8	6.0-7.1	5.7-6.8	5.9-7.7	6.0-6.5	6.0-6.8	6.5-8.5
Specific Conductance (umhos/cm)	114	95	109	103	105	82	97	87	a
Total Coliforms[b]		ND	ND	ND	ND	ND	ND	ND	4/100ml
Results in mg/L									
Ammonia-N	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	a
Nitrate-N	0.97	0.72	0.86	1.49	0.69	0.69	0.56	0.77	10.0
Nitrite-N	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	a
Total Solids	86	61	80	78	95	54	65	75	a
Chlorides	15.9	17.3	20.0	16.5	18.0	12.2	13.8	14.0	250
Fluorides	0.03	0.03	0.04	0.05	0.04	0.05	0.03	0.03	1.5
Sulfates	15	8	12	9	12	8	13	11	250
Ag	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
As	0.001	0.001	0.001	<0.006	<0.006	<0.006	<0.006	<0.001	0.025
Ba	<0.4	<0.5	<0.4	<0.4	<0.3	<0.4	<0.4	<0.4	1.0
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05
Cu	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0
Fe	<0.04	0.09	0.03	0.79	4.99	2.26	<0.04	0.09	0.3
Hg	<0.0003	<0.0004	<0.0003	<0.0003	<0.0004	<0.0003	<0.0003	<0.0003	0.002
Mn	<0.03	<0.03	<0.03	0.091	0.060	0.057	<0.03	<0.03	0.3
Na	12.5	9.6	12.1	12.4	13.6	8.2	10.0	8.3	a
Pb	<0.04	<0.04	<0.04	<0.04	<0.03	<0.04	<0.04	<0.04	0.025
Se	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	0.02
Zn	<0.02	<0.03	<0.02	<0.02	<0.03	<0.03	<0.03	<0.03	5.0

a: No standard specified.
b: Sampled monthly.
ND: Not Detected

Table 22
1985 BNL Environmental Monitoring
Potable Water Supply Wells,
Average Volatile Organic Compound Data

	Well No.1	Well No.2	Well No.3	Well No.4	Well No.6	Well No.7	Well No.10	Well No.11	Plant Influent	Plant Effluent	Distribution System	NYS Drinking Water Standards
No. of Samples[c]	11	21	12	7	8	9	10	12	3	5	1	
	mg/L											
Acrolein	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Acrylonitrile	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	na	0.009	ND	
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	0.005
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Chlorodibromomethane	ND	ND	ND	ND	ND	ND	ND	ND	na	0.004	ND	
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Chloroform	0.002	0.010	0.003	0.012	0.004	ND	<0.001	<0.001	0.011	0.012	ND	0.100
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
1,1-dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
1,1-dichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Trans-1,2-dichlorethylene	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	na	na	ND	
Methylene Chloride[b]	ND	ND	ND	ND	<0.005	<0.005	ND	0.002	na	ND	0.011	
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Tetrachloroethylene	<0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	na	na	<0.010	
1,1,1-Trichloroethane	0.012	0.086	0.001	0.004	0.003	0.002	0.015	0.009	0.005	0.006	0.011	0.050[a]
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	0.0006
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10.010
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	na	ND	ND	0.005

(a): NYSDOH advisory guideline.
(b): The detection of methylene chloride ($MeCl_2$) is considered an artifact; it was detected in the quality control sample blank.
(c): Samples were collected on a monthly basis (when wells were on-line) and analyzed for 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and chloroform. The analysis for the remaining compounds was performed twice during the year.
na: Not analyzed.
ND: Not Detected.

Table 23
1985 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Radionuclide Data

Well ID	No. of Samples	Gross Alpha	Gross Beta	^{3}H	^{60}Co	^{137}Cs	^{24}Na	^{7}Be	^{90}Sr 1984	^{90}Sr 1985
		pCi/l								
XB	1	<3.0	1.43	<170	ND	ND	ND	ND	0.38	ns
XC	1	<3.0	2.10	<170	ND	ND	ND	ND	1.19	ns
XA	3	0.13	3.7	7460	0.77	ND	ND	ND	1.76	0.36
XD	2	0.20	0.54	<300	ND	ND	ND	ND	ns	ns
XE	3	0.09	1.13	3490	0.32	ND	ND	ND	0.40	0.31
XJ	ns	ns	ns	ns	ns	ns	ns	ns	0.72	ns
XI	ns	ns	ns	ns	ns	ns	ns	ns	0.86	ns
XM	ns	ns	ns	ns	ns	ns	ns	ns	0.99	ns
XN	2	0.11	4.17	<1340	ND	ND	ND	ND	0.38	ns
XF	2	-0.028	-0.35	<300	ND	ND	ND	ND	0.16	<0.09
XK	1	0.57	3.67	3840	ND	ND	ND	ND	1.52	ns
XO	1	<0.6	1.52	<190	ND	ND	ND	ND	ns	ns
XL	2	0.62	12.0	2840	ND	ND	ND	ND	6.33	10.5
X1	5	0.35	2.11	<280	0.172	ND	ND	12.0	0.54	0.48
X2	5	0.074	1.20	3020	ND	ND	ND	ND	0.53	<0.38
X3	1	0.17	2.03	<300	ND	ND	ND	ND	ND	0.57
X4	66	0.23	3.17	10300	ND	0.025	ND	ND	ND	1.06
XS	27	0.48	4.79	47	ND	0.20	ND	ND	ns	1.22
XT	26	0.08	2.07	<280	ND	ND	ND	ND	ns	<0.29
X5	1	ND	ND	ND	ND	ND	ND	ND	2.46	0.55
XV	2	0.14	7.2	<280	ND	ND	ND	ND	ns	<0.31
XW	2	0.085	1.4	<280	ND	ND	ND	ND	ns	0.057
XX	1	0.57	2.41	<300	ND	ND	ND	ND	ns	1.13
XY	1	0.395	2.83	1000	ND	ND	0.25	ND	ns	1.48
XZ	1	-0.22	1.22	<300	ND	ND	ND	ND	ns	0.33
NYS Drinking Water Standard		15.0	50.0(c)	20,000					8.0	8.0
Radiation Concentration Guide					30,000	20,000	30,000	2,000,000		

(a) Below the minimum detection limit.
(b) No sample collected for analysis.
(c) Compliance level.
ND: Not Detected.
ns: Not Sampled.

Table 24
1985 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 Alpha	Gross Beta	^{3}H	^{137}Cs	^{60}Co	^{22}Na	^{7}Be	^{90}Sr 1984	^{90}Sr 1985
		pCi/l								
Current Landfill										
2E[a]	0	ND	ND	ND	ND	ND	ND	ND	0.51	ns
W6	4	0.084	1.8	<280	ND	ND	ND	ND	0.28	0.23
WT	4	0.73	1.41	<280	ND	ND	ND	ND	0.69	0.10
WG	1	-0.57	1.1	na	ND	ND	ND	ND	1.61	<0.13
WR	4	0.63	15.0	14300	0.48	ND	ND	ND	3.02	1.57
WS	4	1.28	24.4	6530	ND	ND	0.21	ND	2.35	2.51
1K	4	2.78	19.0	1580	ND	ND	0.17	ND	2.71	3.77
2C	4	2.37	20.4	20000	ND	ND	0.58	ND	4.48	0.90
W9	4	1.97	14.3	26700	ND	ND	0.29	ND	1.58	2.67
2H	2	0.34	4.11	411	ND	ND	0.29	ND	na	na
2J	2	0.20	4.86	562	na	na	na	na	na	na
2K	2	0.057	5.17	703	0.76	ND	0.44	ND	ns	4.63
2I	2	0.42	6.0	1040	na	na	na	na	na	na
2A	0	ND	ND	ND	ND	ND	ND	ND	0.67	ns
2B	2	-0.03	-0.30	<280	ND	ND	ND	ND	ns	<0.20
Former Landfill										
D1	1			<280					ns	<0.60
D2	1			<280					ns	<0.30
D3	1			<280					ns	<0.50
D4	1			<280					ns	0.24
Miscellaneous Wells										
SA	1	-0.11	0.87	<300	ND	ND	ND	ND	ns	0.13
SD	1	<0.34	1.21	<700	ND	ND	ND	ND	ns	na
SE	1	-0.057	0.94	<280	ND	ND	ND	ND	ns	0.097
SG	1	0.28	0.28	<280	ND	0.72	ND	4.8	ns	0.093
SI	1	-0.11	0.11	<280	ND	ND	ND	ND	ns	0.088
SJ	5	-0.17	0.80	<280	ND	ND	0.58	ND	ns	na
2G	3	0.019	1.55	170	ND	ND	0.12	ND	0.22	1.07
NYS Drinking Water Standards		15.0	50.0[b]	20,000					8.0	8.0
Radiation Concentration Guide					20,000	30,000	30,000	2,000,000		

(a) Upgradient of the Current Landfill.
(b) Compliance level.
na Not analyzed.
ND Not Detected.
ns Not sampled.

Table 25
1985 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Radionuclide Data

Well ID	No. of Samples	Gross Alpha	Gross Beta	^{3}H	^{137}Cs	^{60}Co	^{22}Na	^{7}Be	^{134}Cs	^{90}Sr 1984	^{90}Sr 1985
		pCi/l									
MW1	3	0.25	3.72	207	ND	ND	0.21	ND	ND	ND	0.82
WI	1	<0.5	4.49	453	3.5	ND	ND	ND	ND	ns	ns
MW2	3	0.28	61.2	13300	0.41	1.73	ND	ND	ND	ND	34.7
WB	2	0.55	65.0	8370	7.9	0.56	8.95	ND	1.6	6.61	30.1
WC	3	0.43	18.7	12900	0.35	ND	7.14	ND	ND	3.74	6.69
WD	3	0.35	28.0	13200	ND	0.047	4.14	ND	ND	6.82	20.8
WE	2	0.14	7.07	4850	0.24	ND	ND	ND	ND	6.0	4.0
MW3	4	0.41	69.8	22800	ND	ND	81.0	ND	ND	ND	2.66
W1	1	-0.057	18.8	1450	ND	ND	ND	19.9	ND	15.	14.
WL	1	-0.23	22.8	1160	ND	0.14	ND	1.9	ND	31.7	13.5±2.4
W2	2	0.83	65.1	1410	1.53	ND	72	ND	ND	13.	7.2
MW4	3	-0.21	2.65	743	ND	ND	0.19	ND	ND	ND	0.19
MW6	3	0	0.71	<400	ND	ND	ND	ND	ND	ND	0.24
2L	3	0.076	1.31	107	ND	ND	ND	ND	ND	0.29	0.02
MW5	2	0.170	7.78	4500	ND	ND	0.26	ND	ND	ND	2.65
2M	2	0.029	1.90	11200	ND	0.15	0.14	ND	ND	0.28	<0.26
2N	2	-0.057	1.76	15600	ND	ND	ND	ND	ND	0.26	<0.04
WV	1	na	na	5470	na	na	na	na	na	ns	ns
WZ	1	0.056	0.88	<260	na	na	na	na	na	<0.94	ns
WK	0	ns	ns	ns	ns	ns	ns	ns	ns	12.6	ns
MW7A	3	0.36	45.6	5090	ND	ND	0.64	ND	ND	ND	18.8
MW7B	3	0.13	2.28	2640	ND	ND	ND	ND	ND	ND	0.17
MW13	2	2.40	7.79	580	0.27	0.27	0.015	ND	ND	ND	0.23
MW8	3	1.05	5.03	212	0.75	0.57	ND	ND	ND	ND	0.30
MW12	3	0.90	5.94	8300	ND	0.84	ND	ND	ND	ND	ns
MW11	3	1.32	6.24	97	ND	0.38	ND	ND	ND	ND	ns
MW9A	4	0.85	2.80	115	0.023	0.70	ND	ND	ND	ND	0.82
MW9B	2	1.84	5.78	<300	0.057	0.64	ND	ND	ND	ND	0.14
MW10	4	1.06	4.47	1220	ND	1.33	ND	ND	ND	ND	ns
NYS Drinking Water Standards		15.0	50.0[(a)]	20,000							8.0
Radiation Concentration Guide					20,000	30,000	30,000	2,000,000	40,000		

(a) Compliance level.
na Not analyzed.
ND Not detected
ns Not sampled.

Table 26
1985 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	pH (SU)	Conductivity (umhos/cm)	Chlorides	Sulfates	Nitrate-Nitrogen
				mg/L		
XF	2	6.1-6.8	57	6.4	<5.1	0.94
XB	1	6.5	38	6.7	<40.0	0.5
XC		a	a	6.2	<40.0	0.5
XA	3	6.0-6.9	190	26.6	17.8	4.9
XE	2	5.6-6.2	130	14.1	18.6	2.1
XD	2	5.6-5.7	47	5.4	7.4	1.1
XK	1	6.0	155	a	12.7	a
XY		5.7	109	12.0	a	0.81
XX	1	6.2	75	8.3	a	<0.5
XZ		6.3	59	5.5	a	<0.5
XO	1	4.8	31	6.2	a	<0.5
XN	2	5.0-5.6	49	7.0	11.5	0.84
X3	1	4.8	66	4.5	a	<0.5
XL	2	6.1-6.5	132	17.0	5.7	0.88
X1	5	5.0-5.6	48	a	<40.0	0.6
X2	5	5.6-6.3	114	a	<40.0	<0.5
X4	5	5.9-6.2	111	22.2	12.4	a
XS	6	5.5-6.9	129	11.3	12.4	5.0
XT	6	6.0-7.2	119	6.8	<5.0	0.6
XV	2	5.7-7.1	120	8.9	<40.0	2.44
XW	2	4.9-5.5	191	37.4	a	0.95
NYS Drinking Water Standards		6.5-8.5	b	250.0	250.0	10.0

a: No analysis performed.
b: No standard specified.

Table 27
1985 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	Na	Pb	Zn
		mg/L										
XF	1	<0.02	a	<0.005	<0.025	<0.05	0.08	<0.0002	<0.02	5.85	0.100	15.90
XB	1	<0.02	<0.5	<0.005	<0.025	<0.05	0.59	<0.0002	0.050	4.42	<0.050	1.770
XC	1	<0.02	<0.5	<0.005	<0.025	<0.05	24.7	a	0.320	3.51	<0.050	1.520
XA	3	<0.02	a	<0.005	<0.025	0.09	0.28	<0.0002	0.050	25.10	0.075	0.850
XE	3	<0.02	a	<0.005	<0.025	<0.05	00.23	<0.0002	0.040	7.73	<0.025	1.430
XD	2	<0.02	a	<0.005	<0.025	<0.05	0.27	<0.0002	0.040	3.09	0.028	2.130
XN	2	<0.02	<0.5	<0.005	<0.025	<0.05	5.30	<0.0002	0.049	3.88	0.05	1.80
XO	1	<0.02	2.35	<0.005	<0.025	<0.05	3.43	<0.0002	0.140	4.06	0.19	10.50
XL	2	<0.02	a	<0.005	<0.025	<0.05	6.87	<0.0002	0.140	8.79	<0.025	0.610
XK	1	<0.02	a	<0.005	<0.025	a	a	<0.0002	a	a	<0.025	a
X4	1	<0.02	a	<0.005	<0.020	<0.05	0.52	<0.0002	<0.050	20.3	0.086	a
XS	2	<0.02	<0.5	<0.005	<0.025	0.065	9.82	<0.0002	0.135	6.84	0.026	0.253
XT	3	<0.02	<0.5	<0.005	<0.025	<0.05	7.20	<0.0002	0.54	5.44	<0.038	0.666
XV	1	<0.02	<0.5	<0.005	<0.025	<0.05	4.65	<0.0002	<0.025	7.31	<0.050	0.93
XW	1	<0.02	<0.5	<0.005	<0.025	<0.05	1.86	<0.0002	0.100	33.3	<0.050	0.27
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0

a: No analysis performed.
b: No standard specified.

Table 28
1985 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			
XF	2	ND	ND	ND	ND
XA	3	ND	0.002	ND	ND
XE	3	ND	0.008	ND	ND
XD	2	ND	ND	ND	ND
XK	1	ND	ND	ND	ND
XL	2	ND	ND	ND	ND
XX	1	ND	ND	ND	ND
X3	1	ND	ND	ND	ND
XY	1	ND	ND	ND	ND
XZ	1	ND	ND	ND	ND
X1	2	ND	ND	ND	ND
X2	2	0.004	ND	ND	ND
X4	5	ND	ND	ND	ND
XS	4	ND	ND	ND	ND
XT	4	ND	ND	0.002	ND
XV	1	ND	ND	ND	ND
XW	1	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.050(a)	0.010	0.50(a)

(a) NYS DOH advisory guidelines.

ND: Not detected. Average Method Detection Limits were: chloroform - 7 ug/L; 1,1,1-trichloroethane - 6.7 ug/L; trichloroethylene - 7.6 ug/L; tetrachloroethylene - 8.5 ug/L

Table 29

1985 BNL Environmental Monitoring

Landfill Areas and On-site Control Wells

Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	pH (SU)	Conductivity (umhos/cm)	Chlorides	Sulfates	Nitrate-Nitrogen	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
				mg/l												
Current Landfill																
WG	1	4.9	78	6.0	8.4	a	<0.02	<0.005	<0.025	<0.05	0.98	<0.0002	a	a	<0.025	0.14
WR	4	6.0-6.4	883	41.6	10.9	<0.5	<0.02	<0.005	<0.025	<0.05	76.7	<0.0002	5.72	47.8	0.093	0.81
WS	4	6.2-6.4	595	22.8	17.9	3.3	<0.02	0.013	<0.025	<0.05	87.3	<0.0002	2.8	36.6	0.240	7.5
WT	4	5.0-5.6	186	27.3	13.5	0.9	<0.02	<0.005	<0.025	<0.05	15.5	<0.0002	0.30	11.8	0.072	5.79
1K	3	6.3-6.4	588	18.8	5.0	4.8	<0.02	<0.005	<0.025	<0.05	74.1	<0.0002	3.81	22.9	0.052	0.73
2C	4	6.0-6.6	531	4.1	7.5	0.9	<0.02	<0.005	<0.025	<0.05	73.0	<0.0002	a	a	<0.025	0.019
W9	4	5.7-6.6	560	15.7	6.9	0.5	<0.02	0.004	<0.025	<0.05	91.2	<0.0002	a	a	0.178	5.40
2H	2	5.7	74	9.8	11.4	1.0	a	<0.005	<0.025	<0.05	0.025	<0.0002	a	a	<0.015	0.029
2K	2	6.0	80	10.9	9.1	1.5	a	<0.005	<0.025	<0.05	1.05	<0.0002	a	a	0.065	0.116
2I	1	6.4	103	11.0	9.6	1.3	a	<0.005	<0.025	<0.05	3.22	<0.0002	a	a	0.050	4.1
2J	2	5.6	75	7.2	8.3	1.4	a	<0.005	<0.025	<0.05	0.82	<0.0002	a	a	<0.025	0.017
2B	2	5.5-5.7	63	5.6	11.3	1.2	<0.02	<0.005	<0.025	<0.05	<0.05	<0.0002	a	3.93	<0.025	<0.01
W6	4	6.5-6.9	270	19.5	10.6	1.2	<0.02	<0.005	<0.025	<0.05	0.76	<0.0002	0.24	11.3	0.032	0.56
Former Landfill Area																
D1	1	5.9	85	5.4	10.8	a	<0.02	<0.005	<0.025	<0.05	2.06	<0.0002	0.76	5.3	<0.025	0.05
D2	1	7.1	35	4.9	9.0	a	<0.02	<0.005	<0.025	<0.05	10.0	<0.0002	0.82	3.8	<0.025	0.04
D3	1	6.1	59	3.7	13.8	a	<0.02	<0.005	<0.025	<0.05	11.6	<0.0002	0.90	3.9	0.040	0.07
D4	1	5.7	53	5.6	12.6	a	<0.02	<0.005	<0.025	<0.05	8.8	<0.0002	0.58	4.8	<0.025	0.04
On-Site Control Wells																
SE	1	6.9	175	22.6	18.0	1.04	a	<0.005	<0.025	<0.05	1.30	<0.0002	0.04	25.8	<0.025	0.02
SG	1	6.3	125	14.5	11.6	1.10	a	<0.005	<0.025	<0.05	2.37	<0.0002	0.04	16.0	<0.025	0.07
SI	1	6.3	107	21.8	7.4	<0.05	a	<0.005	<0.025	<0.05	1.86	<0.0002	0.02	10.3	<0.025	<0.01
2G	3	6.4-6.6	225	16.0	31.5	0.96	<0.02	<0.005	<0.025	<0.05	0.073	<0.0002	<0.035	17.3	0.01	<0.01
NYS Drinking Water Standards		6.5-8.5	b	250.0	250.0	10.0	0.05	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0

a: No analysis performed.
b: No standard specified.

Table 30
1985 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	3	ND	ND	ND	ND
WR	2	ND	ND	ND	ND
WS	2	ND	ND	ND	ND
WT	2	ND	ND	ND	ND
1K	3	ND	ND	ND	ND
2C	2	0.008	0.008	0.005	ND
2K	1	ND	ND	ND	ND
2H	1	ND	ND	ND	ND
2I	2	ND	ND	ND	ND
2J	1	ND	ND	ND	ND
2B	1	ND	ND	ND	ND
Former Landfill Area					
D1	1	ND	0.008	ND	ND
D2	1	ND	ND	ND	ND
D3	1	ND	0.008	ND	ND
D4	1	ND	ND	ND	ND
On-Site Control Wells					
SA	1	ND	ND	ND	ND
SE	1	ND	0.034	ND	ND
SI	1	ND	ND	ND	ND
SG	1	ND	ND	ND	ND
2G	2	ND	0.004	ND	ND
NYS Drinking Water Standard		0.100	0.050[a]	0.010	0.050[a]

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

Table 31

1985 BNL Environmental Monitoring

Waste Management Area

Ground Water Surveillance Wells, Average Water Quality and Metals Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn	Chlorides	Sulfates	pH (SU)	Conductivity (umhos/cm)
		mg/L														
MW1	3	<0.02	<0.5	<0.005	<0.025	<0.05	0.31	<0.0002	a	a	<0.025	0.01	5.6	10.1	5.4-5.9	67
WI	1	<0.02	a	<0.005	a	<0.05	a	<0.0002	0.05	14.0	<0.05	0.66	a	<40.0	5.4	57
MW2	3	a	a	<0.005	<0.025	a	0.35	<0.0002	a	a	<0.025	0.01	4.9	33.8	5.5-6.0	132
WB	2	a	a	<0.005	<0.025	a	2.14	<0.0002	a	a	0.17	3.62	6.8	a	5.0-6.4	161
WC	3	a	a	<0.005	<0.025	a	2.04	<0.0002	a	a	0.11	3.15	5.3	42.9	4.8-6.2	148
WD	3	a	a	<0.005	<0.025	a	0.73	<0.0002	a	a	0.08	2.71	6.1	31.5	5.3-6.7	138
WE	2	a	a	<0.005	<0.025	a	4.96	<0.0002	a	a	0.29	5.41	3.0	7.9	5.7-6.0	81
W2		<0.02	<0.5	<0.005	<0.025	<0.05	0.24	<0.0002	0.105	7.2	<0.04	1.11	9.1	a	5.9-6.1	225
MW3	3	<0.02	a	<0.005	<0.025	a	0.30	<0.0002	a	a	0.045	0.03	14.4	11.9	5.1-6.6	100
WL	1	a	a	<0.005	<0.025	a	0.17	<0.0002	a	a	<0.025	0.52	4.5	a	6.1	72
W1	1	a	a	<0.005	<0.025	a	4.97	<0.0002	a	a	0.35	5.12	4.0	a	6.5	61
MW4	3	<0.02	a	<0.005	<0.025	a	0.70	<0.0002	a	a	0.067	0.05	16.7	8.5	5.6-6.8	140
MW6		a	a	<0.005	<0.025	a	0.55	<0.0002	a	a	0.035	0.06	10.4	11.4	5.5-6.1	72
2L	3	<0.02	<0.5	<0.005	<0.025	<0.05	0.33	<0.0002	0.19	11.1	<0.03	0.023	12.6	21.0	5.2-5.9	100
MW5	2	a	a	<0.005	<0.025	a	0.59	<0.0002	a	a	<0.025	0.07	4.3	a	5.1-5.6	114
2M	2	<0.02	<0.5	<0.005	<0.025	<0.05	0.23	<0.0002	0.16	11.6	<0.04	0.075	24.9	a	5.2-5.7	107
2N	2	<0.02	<0.5	<0.005	<0.025	<0.05	0.25	<0.0002	0.039	7.0	0.05	0.044	12.1	a	5.4-5.6	72
MW7A	3	a	a	<0.005	<0.025	a	0.57	<0.0002	a	a	0.035	0.06	10.5	12.9	5.3-5.6	76
MW7B	3	a	a	<0.005	<0.025	a	0.77	<0.0002	a	a	0.09	0.10	5.2	10.3	4.8-6.0	80
MW13	3	<0.02	<0.5	<0.005	<0.025	<0.05	2.60	<0.0002	0.13	16.8	<0.025	0.01	9.1	12.2	6.2-6.4	143
MW8	4	<0.02	<0.5	<0.005	<0.025	<0.05	1.14	<0.0002	0.032	27.4	<0.04	0.03	9.7	18.5	5.4-6.6	103
MW12	3	<0.02	<0.5	<0.005	<0.025	a	1.19	<0.0002	0.068	55.4	<0.03	0.01	7.6	30.5	6.3-7.8	122
MW10	5	<0.02	<0.5	<0.005	<0.025	<0.05	0.105	<0.0002	0.77	49.2	<0.04	0.02	8.8	28.4	5.7-7.5	158
MW9A	3	<0.02	<0.5	<0.005	<0.025	<0.05	1.54	<0.0002	0.090	39.3	<0.04	0.01	10.1	19.6	6.3-6.6	115
MW9B	3	<0.02	<0.5	<0.005	<0.025	<0.05	1.07	<0.0002	0.039	36.6	<0.03	0.02	12.2	19.3	5.7-6.1	114
MW11	4	<0.02	<0.5	<0.005	<0.025	<0.05	0.164	<0.0002	0.11	16.1	<0.03	0.01	6.4	16.2	6.0-6.3	79
NYS Drinking Water Standards		0.05	1.0	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0	250.0	250	6.5-8.5	b

a: No analysis performed.
b: No standard specified.

Table 32
1985 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			
MW1	3	ND	ND	ND	ND
WI	1	ND	ND	ND	ND
WJ	1	ND	ND	ND	ND
MW2	2	ND	0.089	0.002	1.80
WB	1	ND	0.029	ND	ND
WC	2	0.019	1.50	ND	ND
WD	2	0.014	0.373	ND	ND
WE	2	ND	0.004	ND	ND
W2	1	0.003	0.174	0.020	0.163
MW3	3	0.005	0.033	ND	0.057
WL	2	0.002	0.002	ND	0.038
W1	1	ND	ND	ND	0.008
MW4	3	ND	ND	ND	0.004
WK	1	ND	ND	ND	0.014
18	1	ND	ND	ND	ND
MW6	2	ND	ND	ND	0.002
2L	3	ND	0.049	0.044	ND
MW5	2	0.019	0.236	0.008	0.025
2M	3	0.047	1.018	ND	0.165
2N	2	ND	0.007	ND	ND
MW7A	3	0.088	0.106	0.001	0.414
MW7B	3	0.001	0.003	ND	0.005
MW13	3	0.195	0.067	0.005	0.020
MW8	4	0.101	0.136	ND	ND
MW12	4	0.006	0.153	ND	ND
MW11	3	ND	ND	ND	ND
MW9A	4	ND	ND	ND	ND
MW9B	3	ND	0.018	ND	ND
MW10	4	ND	0.020	ND	ND
NYS Drinking Water Standards		0.100	0.050(a)	0.010	0.050(a)

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

Table 33A
1985 BNL Environmental Monitoring
Tritium Dose Equivalent at the Site Boundary Monitoring Stations

Location ID	Sector ID	Average Air Concentration pCi/m^3	Committed Effective Dose Equivalent mrem
1T	N	6.04	0.003
3T	NE	9.93	0.005
4T	ENE	10.1	0.005
5T	E	5.8	0.003
P-7	ESE	5.94	0.003
P-2-2	ESE	5.86	0.003
2T	SE	7.22	0.004
8T	SSE	21.1	0.011
9T	S	2.33	0.001
10T	SSW	7.87	0.004
P-4	SW	9.1	0.005
12T	WSW	4.0	0.002
6T	W	6.63	0.004
7T	WNW	4.43	0.002
11T	NW	19.3	0.010
P-2	NNW	2.09	0.001
18T(a)	Control	3.76	0.002
19T(b)	Control	5.28	0.003
13T(c)	Analytical Laboratory	54.8	0.029

(a) Control located at residence of BNL employee residing in Patchogue.

(b) Control located at residence of BNL employee residing in Rocky Point.

(c) Analytical laboratory located in Building 535A, central portion of the BNL site.

Table 33B
1985 BNL Environmental Monitoring
Collective Dose Equivalent
from the 10 Meter Stack Effluent Releases

Nuclide	Whole Body Collective Dose (mrem)	Thyroid Collective Dose (mrem)
^{41}Ar	4770*	-
^{3}H	20.3	-
^{99}Tc	0.0014	-
^{125}I	0.078	2.64
^{14}C	0.042	-
^{32}P	0.316	-
^{35}S	0.035	-
^{m113}Sn	0.0025	-
^{131}I	0.0034	0.116
^{51}Cr	0.0059	-
^{99m}Tc	0.00001	-
^{55}Fe	0.0000042	-
^{57}Co	0.0113	-
^{21}Tl	0.000005	-
^{117m}Sm	0.0028	-
^{103}Ru	0.0031	-
Total	1560-4790	2.76

* Doses not reported in prior years. The maximum dose to the hypothetical individual residing at the site boundary is less than 0.5 mrem in any month.

Table 33C
1985 BNL Environmental Monitoring
Collective Committed Effective Dose Equivalent
from the 100 Meter Stack Effluent Releases

Nuclide	Total Collective Dose mrem	Thyroid Collective Dose mrem
^{82}Br	3.5E-3	-
^{60}Co	8.2E-4	-
^{123}I	2.9E-4	8.6E-3
^{124}I	5.1E-3	1.7E-1
^{126}I	2.0E-2	6.4E-1
^{131}I	2.6E-2	8.9E-1
^{133}I	1.7E-3	5.5E-2
^{125}Xe	5.4E-4	-
^{127}Xe	1.6E-4	-
^{203}Hg	1.44E-5	-
^{44m}Sc	2.4E-5	-
^{95}Zr	1.33E-4	
^{139}Ce	2.4E-5	
^{3}H	12.4E0	-
Others	7.5E-4	
Total	12.5	1.76

Table 33D

1985 BNL Environmental Monitoring

Committed Dose Equivalent from the Fish Consumption Pathway

Radionuclides	Control	Maximum Individual net dose	Average Individual net dose	Collective Dose
	mrem			
^{3}H	na	0.0008	0.0005	0.3
^{90}Sr	na	0.0280	0.0110	6.6
^{137}Cs	0.10	0.1008	0.88098	0.0059
Total (mrem)	0.10	0.13	0.0115	6.91

na: no analysis

Table 33E
1985 BNL Environmental Monitoring
Total Collective Dose from all Pathways

Pathway	Collective Committed Effective Dose Total Body (rem)	Collective Thyroid Dose (rem)
Airborne		
gas	4.8	-
particulates	0.03	0.005
Ingestion		
fish	0.007	-
water	0.003	-
Total	4.8	0.005

Appendix E. Quality Control and Quality Assurance

Quality control and quality assurance activities were dependent on the nature and frequency of measurement. Checks on instrument performance and on overall quality of the data were made with measurement control charts and with certified control organization. Up to 20% of all samples processed were connected with quality control, and these included blanks, replicates and spikes. Where possible, analysts participated in blind round robin tests organized by DOE, EPA, or NYSDEC.

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

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