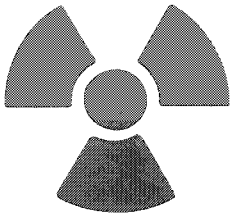


BNL 22627

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

INFORMAL REPORT

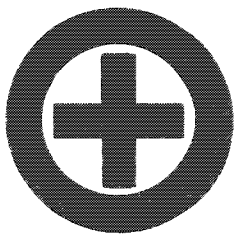
1976 ENVIRONMENTAL MONITORING REPORT

Compiled and Edited by J. R. Naidu

Reviewed by A. P. Hull

April, 1977

BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973



1976 ENVIRONMENTAL MONITORING REPORT

Compiled and Edited by J. R. Naidu

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April, 1977

Brookhaven National Laboratory
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BROOKHAVEN NATIONAL LABORATORY
ENVIRONMENTAL MONITORING REPORT

CONTENTS

CONTENTS (cont'd)

TABLES

TABLES (cont'd)

INTRODUCTION

Brookhaven National Laboratory is a multidisciplinary scientific research center situated in the geographical center of Suffolk County on Long Island, about 113 kilometers (km) east of New York City. Its location with regard to surrounding communities is shown in Figure 1. The principal nearby population centers are located in shoreline communities. Much of the land area within 16 km is mostly either forested or under cultivation. However it is in transition and considerable recent and projected development of suburban housing is located within the environs of the Laboratory.

The Laboratory site is shown in Figure 2. It consists of some 2130 hectares (ha) most of which is wooded, except for a central developed area of about 405 ha. The site terrain is gently rolling, with elevations varying between 36.6 and 12.2 meters, above sea level. The land lies on the western rim of the shallow Peconic River watershed, with the river itself rising in marshy areas in the north and east sections of the site.

In terms of meteorology, the Laboratory can be characterized as a well ventilated site. In common with most of the eastern seaboard, its prevailing winds are from the southwest during the summer of the year, from the northwest during the winter, and about equally from these two directions during the spring and fall. This is reflected in the annual wind distribution, as observed by the BNL Meteorology Group between 1960 - 1976, which is shown in Figure 3.

Studies of the hydrology and geology (1-3) of Long Island in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are locally between 31 - 61 meters thick, are generally sandy and highly permeable. Water penetrates them readily and there is little direct run-off into surface streams except during periods of intense precipitation. The average annual precipitation is 122 cms per year. About half is lost to the atmosphere through evapotranspiration and half percolates to recharge ground water. As indicated in Figure 4 (from ref. 1), the ground water in Laboratory vicinity moves predominantly in a horizontal direction to the Great South Bay. This is modified toward a more easterly direction in the Peconic River watershed portion of the site. The estimated rate of movement at the ground water surface is about 15 cm/day.

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

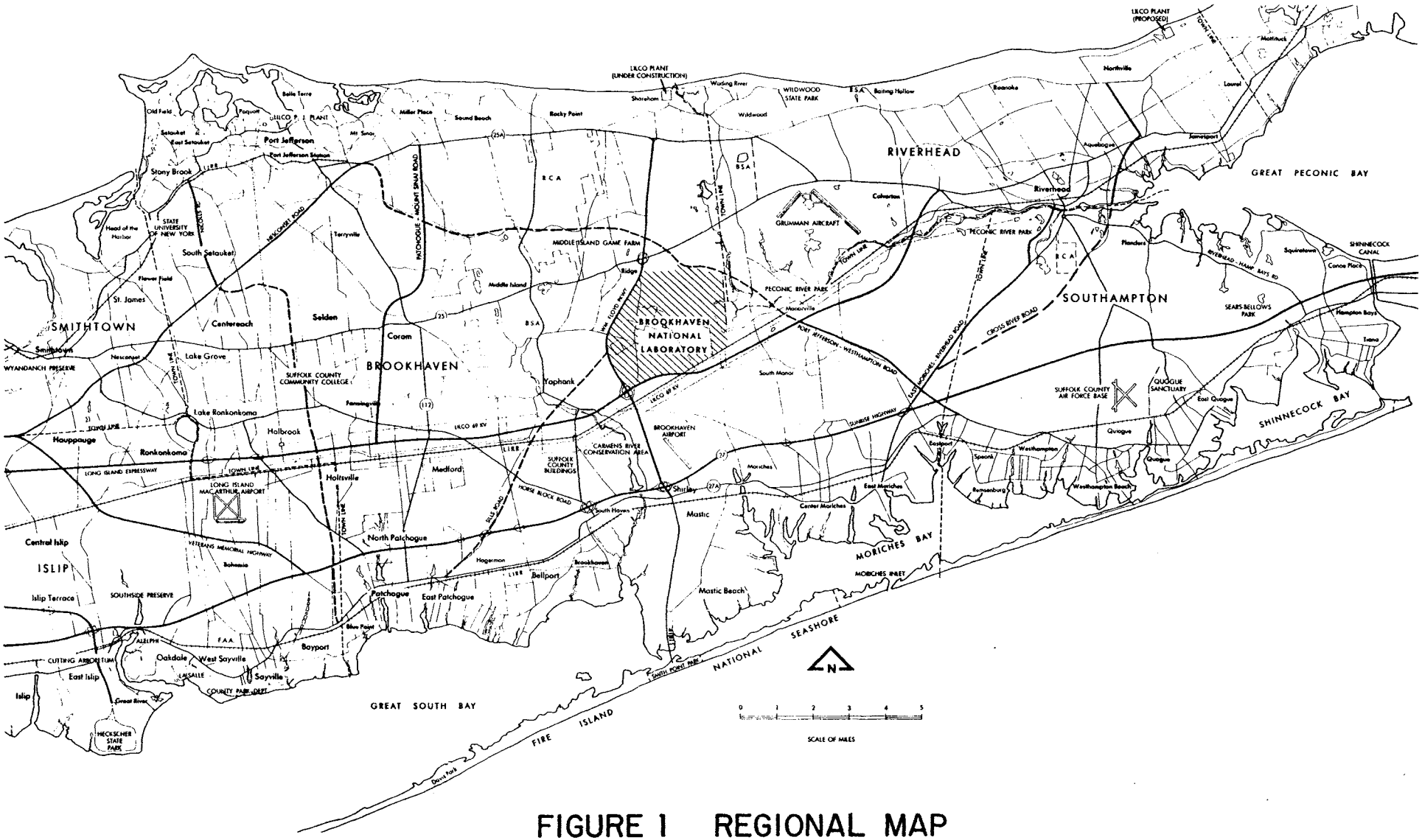
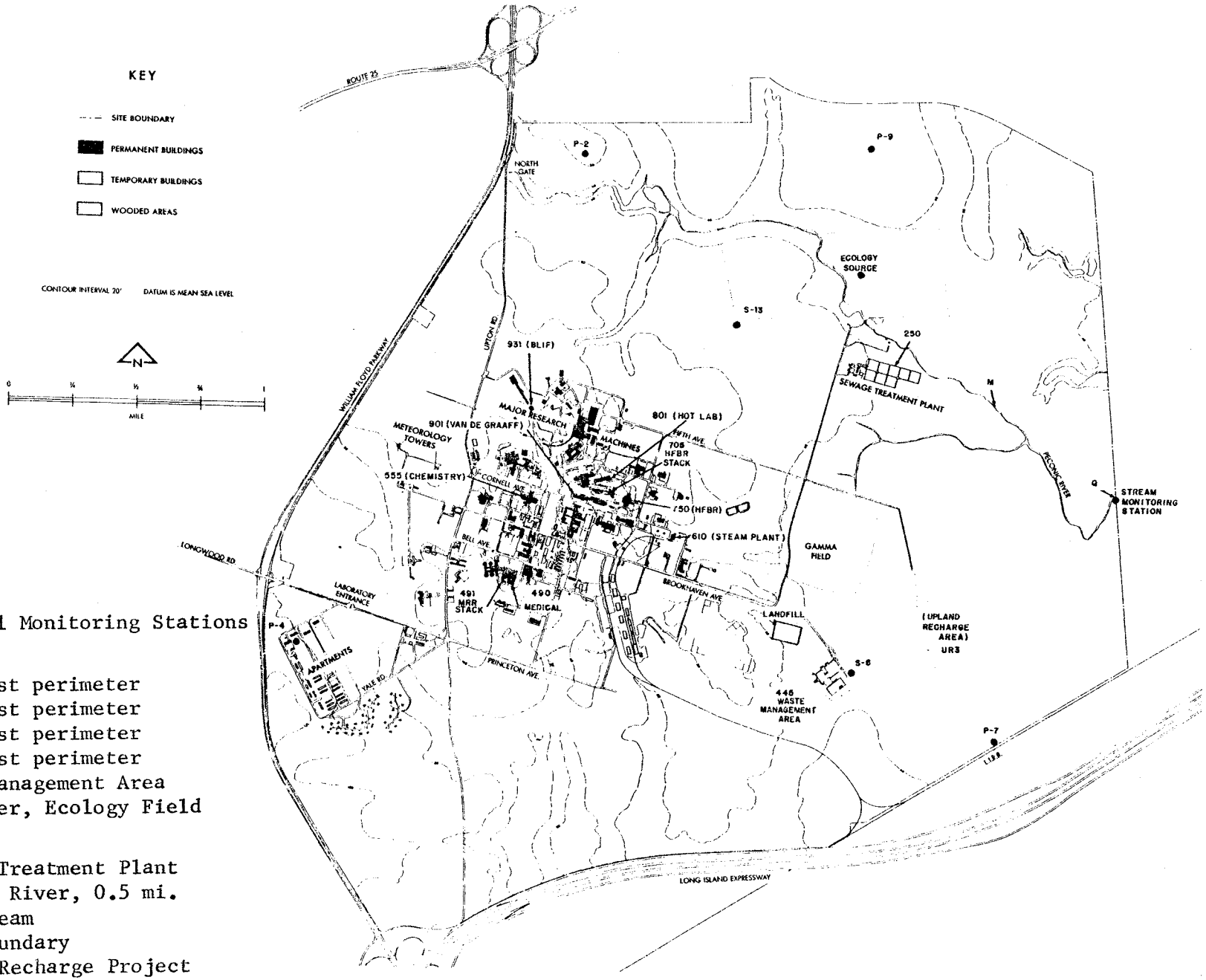


FIGURE 1 REGIONAL MAP



nvironmental Monitoring Stations

ir
-2 Northwest perimeter
-4 Southwest perimeter
-7 Southeast perimeter
-9 Northeast perimeter
-6 Waste Management Area
-13 SW Corner, Ecology Field

later
50 Sewage Treatment Plant
1 Peconic River, 0.5 mi. downstream
) Site Boundary
JR-3 Upland Recharge Project

FIGURE 2

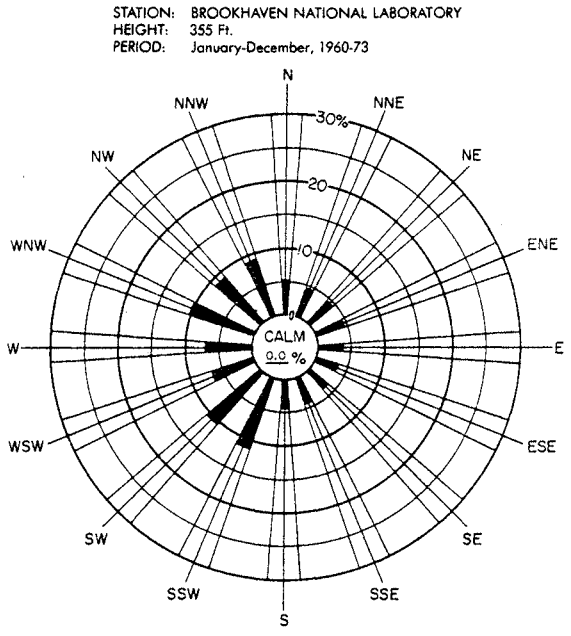
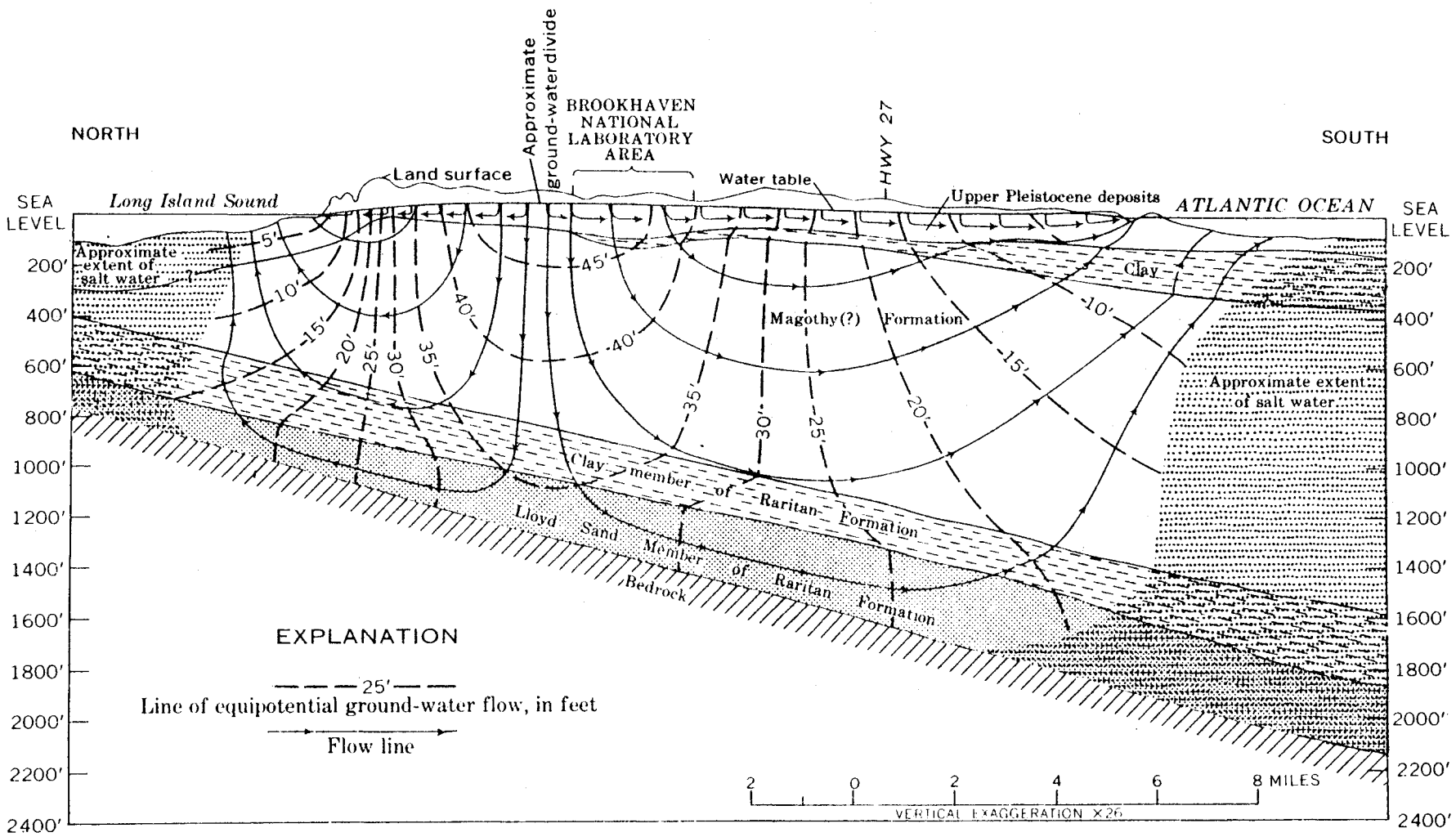

STATION: BROOKHAVEN NATIONAL LABORATORY
HEIGHT: 355 Ft.
PERIOD: January-December, 1960-73
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20
10
0
CALM
0.0 %

FIGURE 3



Schematic ground-water flow lines, central Upton area.

FIGURE 4

1) Fundamental structure and properties of matter.

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

3) Physical, chemical and biological effects of radiation, and of other energy-related environmental pollutants.

4) Radioisotopes and other nuclear applications.

5) Nuclear and energy-related technology.

6) Energy sources, transmission and utilization, including their environmental effects.

Among the major scientific facilities operated at the Laboratory to carry out the above programs are:

1) The High Flux Beam Reactor (HFBR) which is fueled with enriched uranium, heavy water moderated and cooled, and has a routine power level of 40 MW.

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

3) The Alternating Gradient Synchrotron (AGS), a proton accelerator which operates at energies up to 33 GeV.

4) The 200 MeV Proton Linac, which serves as an injector for the AGS, but also supplies continuous currents of protons for isotope production by spallation reactions, in the Brookhaven Linac Isotopes Production Facility (BLIP).

5) The Tandem Van de Graaff, 60-inch Cyclotron, Research Van de Graaff, Vertical Accelerator and Chemistry Van de Graaff, which are used in medium energy physics investigations, as well as for special isotope production.

Additional programs involving irradiations and/or the use of radionuclides for scientific investigations are carried on at other Laboratory facilities including the Medical Research Center, the Biology Department (including one multicurie field irradiation source), the Chemistry Department, and the Department of Applied Science. The latter includes the Hot Laboratory, where special purpose radioisotopes are developed and processed for on- and off-site use. This facility also contains a waste treatment center, which includes an evaporator for the decontamination of liquid wastes.

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 and Medical Research Centers. The first two also produce significant fractions of the Laboratory's liquid radioactive effluents, but additional significant contributions originate from

the Medical Research Center, the Hot Laboratory complex, as well as from decontamination and laundry operations.

The Department of Applied Science, in cooperation with the Town of Brookhaven, conducts the Meadow-Marsh Project, a study of the use of natural ecosystems to treat sewage and to return clean water to the ground water aquifer. This experiment is conducted adjacent to a cultivated agricultural area previously established by the Biology Department in the southeast zone of the Laboratory site. It utilizes a portion of the flow from the sanitary waste treatment plant, and therefore constitutes a potential route for the release of small amounts of radioactivity to ground water.

SUMMARY

The environmental levels of radioactivity and other environmental pollutants found in the vicinity of Brookhaven National Laboratory during 1976 are summarized in this report. As an aid in the interpretation of the data, the amounts of radioactivity and other pollutants released in airborne and liquid effluents from Laboratory facilities to the environment are also indicated. The environmental data includes external radiation levels; radioactive air particulates; tritium and iodine concentrations; the amounts and concentrations of radioactivity in precipitation; the amounts and concentrations of radioactivity in and the quality of the stream into which liquid effluents are released; the concentrations of radioactivity in sediments and biota from the stream; the concentrations of radioactivity in and the quality of ground waters underlying the Laboratory; and concentrations of radioactivity in milk, grass and soil samples obtained in the vicinity of the Laboratory.

The external radiation level for 1976 at the north boundary of the Laboratory attributable to an ecology forest irradiation source was 74.4 mrem, or 14% of the applicable Radiation Protection Standard. (4)*

At the boundary of the Laboratory, about 1.0 km northwest of the Alternating Gradient Synchrotron (AGS), the calculated dose due to skyshine (reflected radiation) was about 1.2 mrem/yr or 0.23% of the standard. This was too small to be measured. Due to their limited range, the external radiations from the AGS and those from the gamma forest source did not produce a measurable additive effect at off-site locations.

Other than tritium, there was no indication of BNL radioactive effluents in environmental air and precipitation samples. The largest concentration of tritium in air at the site boundary, 502 pCi/m^3 (50.2×10^{-11} $\mu Ci/ml$) was 0.3% of the Radiation Concentration Guide (RCG). The largest average concentration of tritium in precipitation, 398 pCi/liter (3.98×10^{-7} $\mu Ci/ml$) was 0.01% of the RCG for drinking water.

At the Central Steam Plant, the most recent (1974) measurement of the stack emission of air particulates indicated that the rate was 0.6 $lb/10^6$ BTU. This was 600% of the New York State emission standard. A detailed test is scheduled in early 1977 to re-evaluate these releases. However, a calculation based on meteorological parameters indicates that at the site boundary, the concentration of air particulates was 1.89 $\mu g/m^3$, or 2.6% of the yearly average ambient Air Quality Standard. (5) The calculated site boundary concentrations of SO_2 and NO_x emitted from the plant were 0.0016 and 0.0009 ppm, respectively, which were 4.7 and 1.6% of their respective ambient air quality standards.

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*The applicable Radiation Protection Standards and Radiation Concentration Guides for persons in uncontrolled areas are shown with the relevant tabulated data.

About 85% of the liquid effluent released onto the sand filter beds of the Laboratory sewage treatment plant flowed directly into the Peconic River. Most of the balance was assumed to have percolated into the ground water underlying the beds. The gross beta concentration of the bed output was 40.6 pCi/liter (4.06×10^{-8} μCi/ml), or 1.4% of the RCG. The tritium concentration was 12.7 nCi/liter (12.7×10^{-6} μCi/ml) or 0.6% of the RCG.

Of the combined flow from the sand filter beds and upstream from the Peconic River, about 13% permeated into the ground water underlying the stream bed between the sewage treatment plant outfall and the Laboratory perimeter, mostly during the latter half of the year. As established at a midway stream sampling location, the gross beta concentration was 29.5 pCi/liter (2.95×10^{-8} μCi/ml) or 1% of the RCG, and the tritium concentration was 7.9 nCi/liter (7.9×10^{-6} μCi/ml) or 0.3% of the RCG. At the site boundary, the gross beta concentration was 28.1 pCi/liter (2.81×10^{-8} μCi/ml), or 1% of the RCG, and the tritium concentration was 6.1 nCi/liter (6.1×10^{-6} μCi/ml), or 0.2% of the RCG.

About 3.7% of the total flow from the clarifier was utilized by the Meadow-Marsh Project. Its average gross beta concentration was 21.0 pCi/liter (2.10×10^{-8} μCi/ml) or 0.7% of the RCG, and its tritium concentration 4.04 nCi/liter (4.04×10^{-6} μCi/ml), or 0.1% of the RCG.

The effluent utilized by the Meadow-Marsh Project contained Cu in a concentration of 0.7 ppm, which is about twice the water purity standard, Fe in a concentration of 3.7 ppm, which is six times the standard, and Zn in a concentration of 1.4 ppm, which is less than three times the applicable water purity standard. (6) However, there is no direct runoff of these effluents and the project is designed to assess the retention of agents commonly present in sewage by various plant systems.

Except for two daily pH and two BOD_5 removal levels which were out of limit, all reportable parameters, were within the limits set forth in the Laboratory's permit, issued by EPA under the National Pollution Discharge Elimination System. The average water quality of the sewage treatment plant effluent before dilution was at or within water quality standards for the receiving body of water.(5)

Bimonthly sampling indicated a decrease of concentrations of radioactivity downstream in the Peconic River. At a location 4.8 km downstream, the average gross beta concentration as established by bimonthly "grab" sampling was 4.2 pCi/liter (4.2×10^{-9} μCi/ml) or 0.15% of the RCG, and the tritium concentration less than 0.9 nCi/liter (0.9×10^{-6} μCi/ml) or 0.02% of the RCG. About 24 km downstream, at the river's mouth, where the flow was about 25 times that at the Laboratory's site boundary, the average concentration of gross beta activity was 16.1 pCi/liter (16.1×10^{-9} μCi/ml) and that of tritium was 0.3 nCi/liter (3×10^{-7} μCi/ml). Thus it was apparent that the total gross beta activity in the river at that location greatly exceeded that at the Laboratory's site boundary.

Seasonal sampling of Peconic River bottom sediments, stream vegetation and of miscellaneous aquatic fauna was conducted. The data indicated that small concentrations of ^{51}Cr, ^{60}Co, and ^{65}Zn, which are unique to the Laboratory's effluents, as well as ^{22}Na, ^{137}Cs, and ^{144}Ce in slight excess of ambient fallout related concentrations, were present in sediments and vegetation. The data from a few fish obtained from the river at the former site boundary, suggested the presence of small amounts of the Laboratory's effluent activity. The average concentration of ^{137}Cs, 1750 pCi/kg (1.75×10^{-6} μCi/g), was less than 0.2% of the RCG, calculated on an assumed average ingestion of 50 g/day.

About 19 million liters of water per day were used for "once through" cooling and returned to ground water in on-site recharge basins. The concentration of gross beta activity in it was only very slightly greater than that of the supply wells and was less than 0.4% of the RCG. Tritium concentrations were less than the minimum detectable, which is 0.2% of the RCG.

Ground water surveillance was conducted in a network of some 75 sampling wells installed adjacent to and downstream from identified areas where there is a potential for the percolation to and migration of radioactivity and other agents in ground water. Immediately adjacent to the sand filter beds and to the Peconic River on-site and at the site boundary, gross beta, tritium and ^{90}Sr concentrations approached those observed during the current or recent years in the Laboratory's liquid effluent. These were up to a few percent of the RCG's. The largest gross alpha concentration, 1.5 pCi/liter (1.5×10^{-9} μCi/ml) was 1.5% of the RCG for unidentified mixtures containing alpha activity other than ^{226}Ra. It was not directly relatable to any known Laboratory effluent releases. The largest average gross beta concentration, 62.8 pCi/liter (6.28×10^{-8} μCi/ml) was accompanied by a ^{90}Sr concentration of 1.5 pCi/liter (0.15×10^{-8} μCi/ml), which was 0.3% of the controlling RCG. The largest average tritium concentration, 2.9 nCi/liter (2.9×10^{-6} μCi/ml), was 0.1% of the RCG.

Slightly higher concentrations of gross alpha and gross beta and ^{90}Sr radioactivity were found in a sampling well about 305 m east of the site boundary, than those at the boundary itself. The gross alpha concentration, 2.0 pCi/liter (2.0×10^{-9} μCi/ml) was 2.0% of the RCG. However, this was not directly relatable to any known current or recent Laboratory effluents. The gross beta concentration was 13.5 pCi/liter (13.5×10^{-9} μCi/ml) and the ^{90}Sr concentration 1.8 pCi/liter (1.8×10^{-9} μCi/ml). The latter was 2.0% of the RCG.

Except for pH levels slightly less than the Water Quality Standard, but within the local natural variation, most other indices of water quality in these surveillance wells were within the standards. In a limited sampling of a few on-site wells immediately adjacent to the sand filter beds and to the Peconic River on site, Fe and Zn were found up to ten times and two times their respective Water Quality Standards. These

levels exceeded those found in recent Laboratory liquid effluents, and might be an artifact produced by the sampling well casings rather than being present in ground water itself.

On site, adjacent to the Solid Waste Management area, the landfill, the former open dump, the decontamination facility storm sewer sump, and at the Meadow-Marsh Project area, above ambient background concentrations of gross beta activity, ^{90}Sr and tritium were found in a number of nearby ground water surveillance wells. Much of the gross beta activity appeared to be related to ^{90}Sr.

At the Waste Management area, the largest ^{90}Sr concentration, 62.1 pCi/liter (6.21×10^{-8} μCi/ml), or 23% of the RCG, was found in a well 152 m south of the site of a known inadvertent injection into ground water which occurred in 1960.

At the landfill, a gross alpha concentration of 10.1 pCi/liter (1.01×10^{-8} μCi/ml) or 11% of the RCG, a gross beta concentration of 64.3 pCi/liter (6.43×10^{-8} μCi/ml) or 2% of the RCG, and a tritium concentration of 401 nCi/liter (4.01×10^{-4} μCi/ml) or 10.7% of the RCG were the largest found. They occurred in wells between the landfill and a location 61 m south of the boundary of the working area.

At the decontamination facility storm sewer sump, a ^{90}Sr concentration of 60.1 pCi/liter (6.01×10^{-8} μCi/ml) or 20% of the RCG was found in a surveillance well about 46 m southeast of the sewer outfall into the sump.

At the Meadow-Marsh Project, the largest gross beta concentration was 13.6 pCi/liter (1.36×10^{-8} μCi/ml) or 0.5% of the RCG, and the largest tritium concentration was 2.2 nCi/liter (2.2×10^{-6} μCi/ml) or 0.1% of the RCG.

With the exception of the presence of Fe and Zn in wells adjacent to the landfill area, all on-site water quality and purity parameters were within the established standards. Immediately adjacent to the landfill, the concentration of Fe was 139 ppm, or 231 times the standard and that of Zn 0.8 ppm, or 1.3 times the standard.

All of the above on-site levels of radioactivity or other agents above ambient background in ground water appeared to be confined to within a few hundred feet of their origin, and would require decades of travel before reaching the site boundary. Concentrations of radioactivity, and water quality parameters, in ground water from perimeter surveillance wells (other than those adjacent to the Peconic River) were at or near background and only a few percent of RCG's.

Milk samples were obtained by the New York State Department of Environmental Conservation on a monthly basis from two Suffolk County dairy farms, one 10 km southeast and one 40 km east of the Laboratory

site. The yearly average concentration of ^{90}Sr in milk from the closer farm, 7.4 pCi/liter (7.4×10^{-9} μCi/ml) was 35% greater than in that from the more distant farm. However, this did not seem connected with Laboratory effluents. The data were within the variations of ^{90}Sr concentrations in recent milk samples within New York State. The yearly average mentioned above did not include the months of October, November and December. This was treated separately consequent to the Chinese nuclear tests of September and November 1976. Once again, the closer farm showed a maximum concentration of ^{131}I (289 pCi/liter) that was almost twice that of the more distant farm (164 pCi/liter). The differences have been attributed to feeding patterns (open grazing and stored feed).

The total population dose (up to a distance of 50 miles or 80 km) attributable to Laboratory sources was calculated to be 169.82 person-rems, as compared to a natural background dose to the same population of about 419,000 person-rems.

MONITORING DATA COLLECTION, ANALYSIS AND EVALUATION

External Exposure Monitoring

External radiation levels at the site boundary, including natural background (as influenced by fallout) and increments attributable to Laboratory activity, were measured by the use of CaF thermoluminescent dosimeters exposed for monthly periods at each of the four perimeter monitoring stations P-2, P-4, P-7 and P-9, as shown in Figure 2.

The observed monthly average radiation levels are set forth in Table I. There was no addition to the natural background attributable to Laboratory activities, except at the northeast perimeter. At this location, the Ecology Forest irradiation source, which contained about 6304 curies of ^{137}Cs (as of 1/1/76), produced a radiation level of $4.16 \pm .004$ mrem/yr, or 0.8% of the Radiation Protection Standard for a hypothetical individual at this location on the Laboratory perimeter.

AIRBORNE EFFLUENTS AND GROUND-LEVEL AIR PARTICULATES, TRITIUM AND RADIOIODINE MONITORING

Facilities and Effluents

The principal Laboratory facilities that currently discharge radioactive effluents to the atmosphere are listed in Table II, in which the installed on-line effluent monitoring and sampling devices are also indicated. The location of these facilities on the Laboratory site is shown in Figure 2. The types and amounts of these effluents released during 1976 are shown in Table III.

Oxygen-15 and argon-41 are radioactive gases and are environmentally significant as sources of increased external radiation. Calculations indicate that oxygen-15, which has a half-life of two minutes, is evolved from the Linear Isotopes Production Facility (BLIP) at a rate of 0.6 Ci/min, when it is operated at full beam current of 180 μamps. Thus, at equilibrium, the largest ambient amount at any one time would be 1.75 Ci. Argon-41, which has a half-life of 110 minutes, is evolved from the Medical Reactor Stack at a rate of 1 Ci/hr when it is operated at full power of 3 MW, so that the maximum ambient amount would be 3.8 Ci. These amounts of oxygen-15 and argon-41 were too small to produce a detectable increase in radiation levels at the site boundary.

Tritium has a half-life of 12.3 years, and is a very low energy beta emitter. Its principal environmental significance is in the tritium oxide or vapor form, in which it is taken up and utilized by living systems as water vapor. Of the 1194 Ci of tritium released from the Laboratory facilities during 1976, 912 Ci (76%) was in the gaseous form, and 282 Ci (24%) was released as tritium vapor.

The amounts of conventional pollutants released from the Central Steam Plant are shown in Table IV. Those for SO_2 and NO_x are derived from reported emission factors for comparable plants,(7) supplemented by analysis for sulphur content of the fuel oil utilized at the plant. The amount of particulates was based on the average concentration found in stack sampling of the principal steam boiler unit in a series of tests conducted during 1974. This stack emission rate of particulates, 0.6 $lb/10^6$ BTU, was above the emission limit of 0.1 $lb/10^6$ BTU set forth by the New York State Department of Environmental Conservation (Part 227, Stationary Combustion Installations). The Laboratory has recently conducted extensive tests, and the results have been presented to EPA for further action. Preliminary data indicates that we are within the emission limit.

Sampling and Analysis

The Brookhaven Environmental Monitoring air sampling program is conducted to distinguish among concentrations of airborne radioactivity

attributable to natural sources, to activities remote from the Laboratory, i.e., above ground nuclear weapons tests, and to Laboratory activities. All of that detected during 1976 was attributable to the first two sources. In addition, fresh fallout from the Chinese nuclear tests of September 1976 and November 1976, were also monitored extensively.

High volume (500 liters/min) positive displacement air pumps (Gast 3040) were operated at a monitoring station east of the Solid Waste Management area (Fig. 2, S-6), and at the northeast and southwest perimeter stations (P-9 and P-4). The air sampling media consisted of a 7.6 cm diameter air particulate filter (Gelman type G) followed by a 7.6 cm x 2.5 cm bed of petroleum-based charcoal (Columbia Grade LC 12/28 x mesh) for sampling of radiohalogens. Short term fluctuations in air particulate concentrations may be indicative of the presence of recent weapons tests debris, which was indeed borne out following the Chinese nuclear tests of 1976. Accordingly, the Solid Waste Management area air particulate filter was changed and counted on a daily (during work week) basis. The remaining samples were changed and counted on a two week basis.

After allowing several days for the decay of short lived natural radioactivity, gross alpha counts of air particulate samples from the solid waste packaging area station were made, using a 12.7 cm diameter Zn-S coated photomultiplier. After a similar delay, gross beta counts were made of air particulate samples from all locations, using a 12.7 cm beta scintillator. These data are shown in Table V. The seasonal trend, with an early spring maximum which was seen in 1975, was less pronounced in 1976. No consistent differences between sampling locations were apparent and there was no indication of the Laboratory's effluent radionuclides in air particulate samples at any location. The nearly 50% decrease from 1975 levels, attributed to the radioactive decay of previous years weapons test airborne activity, was offset during October consequent to the Chinese nuclear test conducted in September 1976.

Sampling for tritium vapor was accomplished at the same air sampling stations by drawing a small side stream of air ($\sim$100 cm^3/min) through silica gel cartridges. These were rotated on a monthly basis. During colder months when their absolute capacity of air for unsaturated water vapor was decreased, the sampling cycle was lengthened accordingly. The collected vapor was subsequently removed from the gel by heating. It was then condensed and assayed by beta scintillation counting. The tritium air concentration data obtained during 1976 is indicated in Table VI. The background concentration was inferred from that found in precipitation collected off site. The largest yearly average net concentration at the site boundary, about 502 pCi/m^3 (5.02×10^{-10} $\mu Ci/cm^3$), was 0.25% of the applicable Radiation Concentration Guide (RCG).

In addition to the gross beta counts indicated above, shortly after the end of each month, analyses for gamma emitting nuclides were performed on a monthly composite of all individual air particulate samples.

Additional gamma analyses were also scheduled at six month and one year post-collection to facilitate the resolution of short and long lived nuclides with photopeaks too close to be resolved by the NaI detection system employed. The charcoal samples were reanalyzed at one month post-collection to determine ^{131}I by decay in its photopeak region during this time. Available data are reported in Table VII. Recent fission products such as ^{131}I, ^{140}Ba-La and ^{141}Ce were detected during October and November; therefore the 32.5 day ^{141}Ce was taken into consideration in evaluating the reported concentrations of ^{144}Ce during October and November. The decreases in ^{95}Zr-Nb and ^{144}Ce concentrations observed during 1975 was offset consequent to the Chinese nuclear test. These data did not disclose any indication of Laboratory effluent components.

The current Laboratory Environmental Monitoring program does not include air sampling for other than radioactive substances. The calculated annual average concentrations at the site boundary of the conventional pollutants released from the Central Steam Plant are indicated in Table IV. All were less than 2% of the EPA Primary Air Quality Standard for these constituents. Of the 6,374,156 gallons (24.1×10^6 liters) of fuel oil utilized by the Central Steam Plant during 1976, 0.06% was automotive waste oil. Pb determinations in the automotive waste oil in 1975 indicated a concentration of 392 mg/liter, which gave an average concentration of Pb in air at the site boundary of 0.004 to 0.015 $\mu g/m^3$ (0.1% of the New York State Department of Environmental Conservation - Air Quality Guide of 10 $\mu g/m^3$ (8). This determination was not repeated in 1976 as the contribution of Pb to the atmosphere, based on the 1975 results, was considered negligible, especially since the 1976 consumption of waste oils was only 3,913 gallons (14,811 liters) as compared to 520,849 gallons (1,971,413 liters) in 1975.

Since emphasis of the Upland Recharge Project has been shifted from spray application of a characteristic sewage effluent to agricultural and forest plots, only the meadow-marsh features of this experiment remained in operation throughout the year. Thus, the possibility of the generation of microbial aerosols was greatly reduced. The literature (9, 10) indicates an initial rapid die-off of such aerosol bacterial within a few hundred meters of similar sources (trickling filter sewage plants). In view of this and the remoteness of the project from any nearby population, these aerosols do not seem to present a significant off-site airborne hazard. To date, sampling for them has not been conducted, on or off site.

About 227 kg of various pesticides, chiefly organo-phosphates, carbaryl and parathion, were applied (11) on site during 1976, principally to protect crops which were grown for biological research purposes. All of these pesticides were considered biodegradable, with persistence times in the order of a week, and were furthermore applied with a "sticker" additive to minimize their subsequently becoming airborne.

Precipitation

Two pot-type rain collectors, each with a surface area of 0.33 m^2, are situated adjacent to the Laboratory's filter beds (see Fig. 2). Two routine collections were made from these, one whenever precipitation was observed during a previous 24 hour (or weekend) period, and the other once a week whether or not precipitation occurred. Part of each collection was evaporated for gross beta counting, a small fraction composited for monthly tritium analysis, and the balance put through ion exchange columns for subsequent quarterly ^{89}Sr-^{90}Sr and gamma analyses. The data for 1976 are reported in Table VIII (with the exception of tritium). There was no detectable indication in the on-site precipitation collection of the washout of Laboratory released airborne radioactivity. The amounts of naturally produced gamma emitters, such as ^{7}Be and ^{22}Na were reduced by a factor of two when compared to 1975 values. Those of shorter lived fission and activation products, such as ^{54}Mn, ^{65}Zn, ^{95}Zr-Nb were about the same despite the Chinese nuclear test in September. However, there was significant increase in ^{131}I for the months of October and November.

To obtain an indication of tritium washout, small precipitation collectors, in addition to the pot-type collectors, were established at the perimeter stations (P-2, P-4, P-7, P-9) and at Blue Point, some 20 km southwest of the Laboratory site. As indicated in Table IX, the average tritium concentration in the collectors located at station P-9 and at the sewage treatment plant (in the predominant downwind direction from Laboratory release locations) were only slightly higher than those of other collectors, although in 1975 they were two to three times higher. However, the largest concentration (on site) was 0.01% of the RCG for drinking water. The estimated total deposition of tritium on the Laboratory site during 1976 was 5.9 curies (using the average of on-site and perimeter concentrations). The washout of Laboratory effluent appears to have been about 3 curies, or about 1% of the reported stack release of tritium vapor.

Liquid Effluent Monitoring

To minimize the volumes of liquids that could require decontamination prior to on-site release or processing into solid form for off-site burial, the basic principle of liquid waste management at the Laboratory is confinement and containment. Accordingly, liquid wastes are segregated on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

The primary water cooling systems of such facilities as the Alternating Gradient Synchrotron, the High Flux Beam Reactor, and the Medical Research Reactor, each of which contain multicurie amounts of radioactivity, are closed systems with no direct connection to any Laboratory waste system.

Small volumes (up to a few liters) of concentrated liquid wastes containing radioactivity or other hazardous agents are withheld from the Laboratory waste systems. They are stored at their sources in small containers for pickup by the Laboratory's Waste Management Group and subsequent packaging for off-site disposal (in the case of hazardous agents, by an EPA licensed contractor).

Facilities which may produce larger volumes (up to several hundred liters/batch) of radioactive or otherwise contaminated waste liquids are provided with dual waste handling systems, one for "active" (D-probably contaminated) and one for "inactive" (F-probably uncontaminated) wastes. As shown in Figure 5, wastes placed into the "active" or D system are collected in holdup tanks. After sampling and analysis, they are either transferred by installed pipelines or tank truck to storage tanks adjacent to the Laboratory liquid waste evaporator. At this facility they are concentrated about a thousand fold and ultimately disposed of as solid wastes. If found to be of sufficiently low concentration, D wastes may be routed directly from holdup tanks to the Laboratory sanitary waste system.

As shown in Figure 5, "inactive" or F wastes are routed directly to the Laboratory sanitary waste system, where they are diluted by large quantities (approaching 4,000,000 liters/day) of cooling and other uncontaminated water routinely produced by diverse Laboratory operations. Sampling and analysis of facility holdup tanks are done to facilitate waste management; while effluent sampling to establish the concentrations and amounts of environmental releases, is performed at the sewage treatment plant.

The small amounts of low level radioactive waste effluents that may be routinely disposed of by release into the Laboratory's sanitary waste system are established by administrative limits, (12) which correspond to those applicable to sewage systems. Within these limits, individual releases are kept as low as reasonably achievable.

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

A schematic of the sewage treatment plant and its related sampling arrangements are shown in Figure 6. In addition to the inplant flow measurement and sampling instrumentation, totalizing flowmeters (Leopold and Stevens TP 61-2), with provision for taking a sample for each 7576 liters of flow in combination with positive action battery operated samplers (Brailsford DU-1), are located at the chlorine house, at the former site boundary which is 0.8 km downstream on the Peconic River, and at the site boundary, 2.6 km downstream.

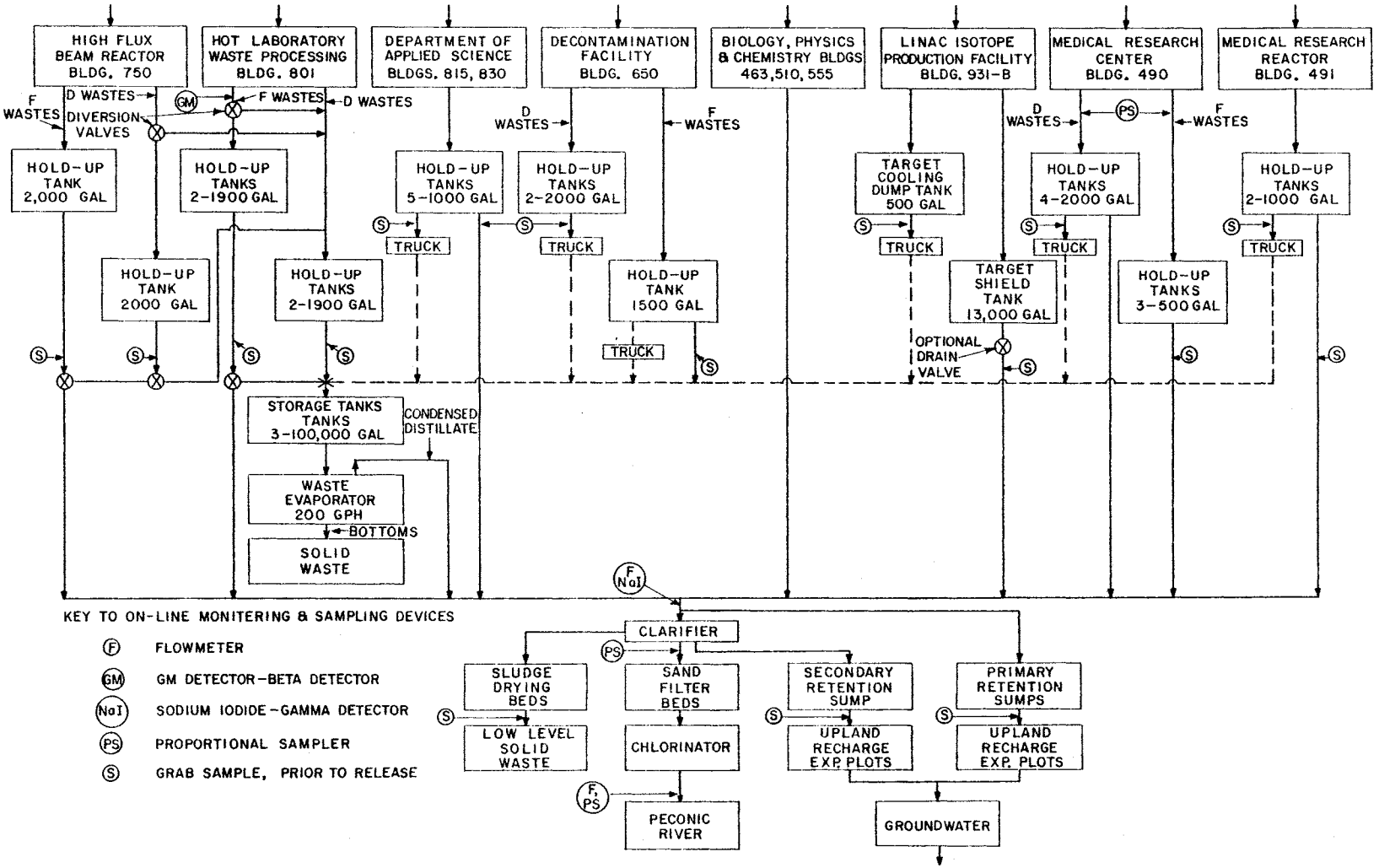

HIGH FLUX BEAM REACTOR BLDG. 750
HOT LABORATORY WASTE PROCESSING BLDG. 801
DEPARTMENT OF APPLIED SCIENCE BLDGS. 815, 830
DECONTAMINATION FACILITY BLDG. 650
BIOLOGY, PHYSICS & CHEMISTRY BLDGS 463,510, 555
LINAC ISOTOPE PRODUCTION FACILITY BLDG. 931-B
MEDICAL RESEARCH CENTER BLDG. 490
MEDICAL RESEARCH REACTOR BLDG. 491
F WASTES
D WASTES
DIVERSION VALVES
GM
F WASTES
D WASTES
D WASTES
F WASTES
D WASTES
PS
F WASTES
HOLD-UP TANK 2,000 GAL
HOLD-UP TANKS 2-1900 GAL
HOLD-UP TANKS 5-1000 GAL
HOLD-UP TANKS 2-2000 GAL
TARGET COOLING DUMP TANK 500 GAL
HOLD-UP TANKS 4-2000 GAL
HOLD-UP TANKS 2-1000 GAL
TRUCK
TRUCK
TRUCK
TRUCK
TRUCK
TRUCK
HOLD-UP TANK 2000 GAL
HOLD-UP TANK 2-1900 GAL
HOLD-UP TANK 1500 GAL
TARGET SHIELD TANK 13,000 GAL
HOLD-UP TANKS 3-500 GAL
TRUCK
OPTIONAL DRAIN VALVE
S
STORAGE TANKS TANKS 3-100,000 GAL
CONDENSED DISTILLATE
WASTE EVAPORATOR 200 GPH
BOTTOMS
SOLID WASTE
F NaI
KEY TO ON-LINE MONITERING & SAMPLING DEVICES
F FLOWMETER
GM GM DETECTOR-BETA DETECTOR
NaI SODIUM IODIDE-GAMMA DETECTOR
PS PROPORTIONAL SAMPLER
S GRAB SAMPLE, PRIOR TO RELEASE
CLARIFIER
PS
SLUDGE DRYING BEDS
SAND FILTER BEDS
SECONDARY RETENTION SUMP
PRIMARY RETENTION SUMPS
S
S
S
LOW LEVEL SOLID WASTE
CHLORINATOR
UPLAND RECHARGE EXP. PLOTS
UPLAND RECHARGE EXP. PLOTS
F, PS
PECONIC RIVER
GROUNDWATER

FIGURE 5

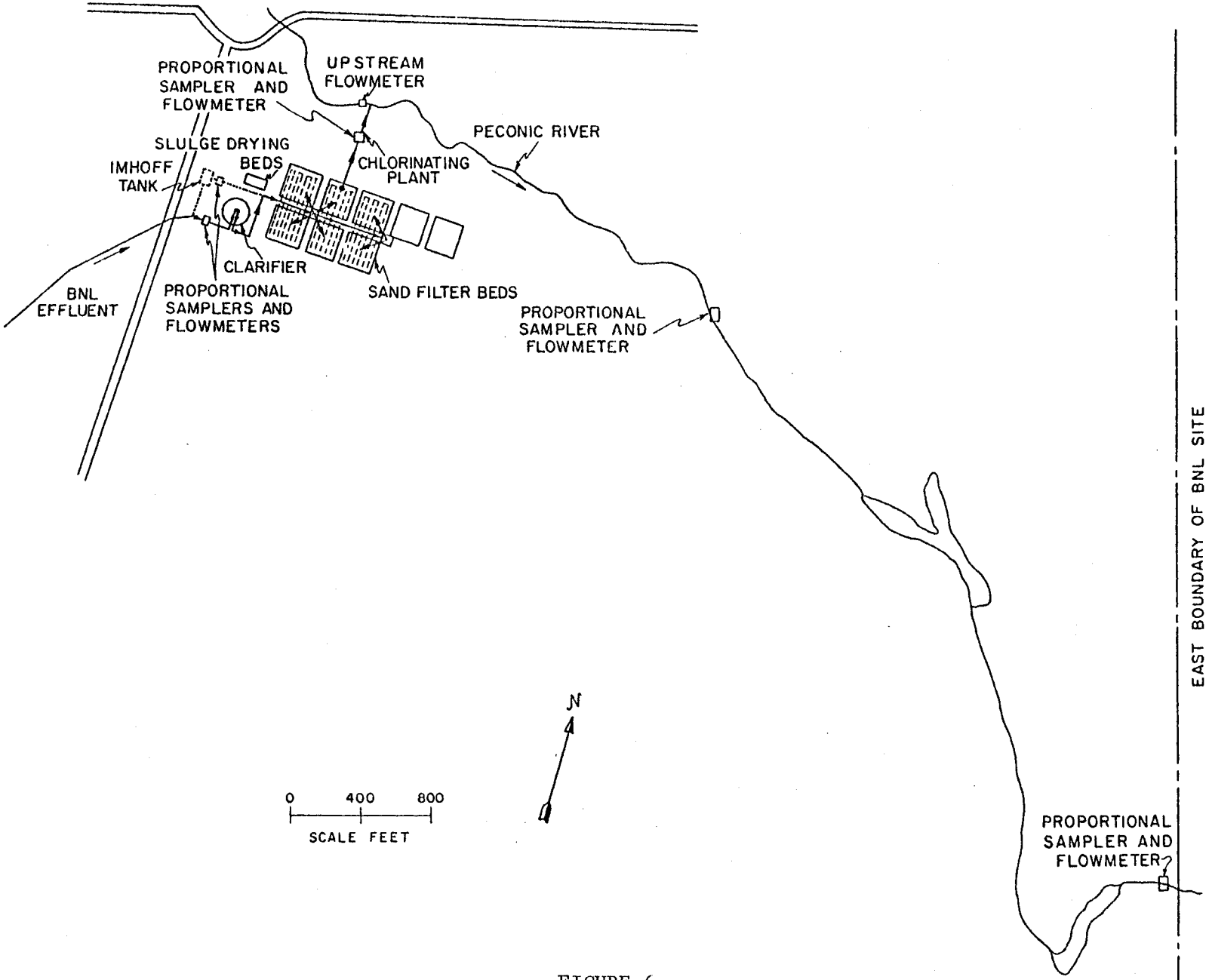

PROPORTIONAL SAMPLER AND FLOWMETER
UPSTREAM FLOWMETER
PECONIC RIVER
SLUDGE DRYING BEDS
IMHOFF TANK
CHLORINATING PLANT
CLARIFIER
BNL EFFLUENT
PROPORTIONAL SAMPLERS AND FLOWMETERS
SAND FILTER BEDS
PROPORTIONAL SAMPLER AND FLOWMETER
EAST BOUNDARY OF BNL SITE
N
0 400 800
SCALE FEET
PROPORTIONAL SAMPLER AND FLOWMETER

FIGURE 6

An aliquot of each daily (or weekend) sample of the input to the sand filter beds and of their output to the chlorine house outfall was evaporated for gross alpha and gross beta analysis, and another was counted directly for tritium analysis. Samples from the two downstream locations were obtained three times a week. Aliquots of each sample were similarly analyzed for gross beta and for tritium; and another aliquot, proportional to the measured flow during the sampling period, was passed through ion exchange columns for subsequent analysis of an integrated sample. Unless the gross beta count indicated a reason for more immediate identification for each location, one set of these columns was analyzed directly on a monthly or quarterly basis for gamma emitting nuclides and another was eluted for radiochemical processing for ^{90}Sr analysis.

The monthly average flow and the monthly totals of gross beta and principal nuclide activities at the clarifier (input to the filter beds) and at the chlorine house (output from the beds) are shown in Table X. Yearly totals and average concentrations are also indicated. During 1976, 85% of the liquid effluent flow into the sand filter beds appeared in the output from them and 4% was utilized by the Meadow-Marsh Project. The balance was assumed to have percolated to the ground water flow under the beds. Estimates of the amounts of radioactivity released to the ground water in this manner during 1976 are also shown in Table X. These were calculated on the additional assumption that the average concentrations of the contained nuclides corresponded to those in the output from the beds, as observed at the chlorine house. Radionuclide concentrations as compared to 1975, were either up or lowered by a factor of two. Those nuclides showing an increase were ^{3}H, ^{7}Be, ^{22}Na, ^{54}Mn, ^{57}Co, ^{95}Zn-Nb, ^{125}Sb and ^{144}Ce, and those showing a decrease were ^{51}Cr, ^{60}Co, ^{65}Zn, ^{131}I, ^{134}Cs and ^{137}Cs. In tracing the fate of these radionuclides from the clarifier to the sand filter beds and at the chlorine house, it was observed that, with the exception of ^{3}H and ^{137}Cs, all the radionuclides decreased by factors ranging from two to ten. Tritium remained the same, but ^{137}Cs did show an almost four fold increase, indicating release of this radionuclide from the beds possibly from previous years input. Such a situation was not seen in the case of ^{90}Sr, though it was observed to do so, along with ^{137}Cs, in 1975.

Flow, activity and concentration information at the former site boundary sampling location, 0.8 km downstream (see Fig. 6), and at the present site boundary are shown in Table XIA. A much greater stream flow was observed at the former site boundary than at the chlorine house, reflecting the upstream addition to the Laboratory stream effluent, which during 1976 totaled 2.36×10^{11} cm^3. With the exception of ^{137}Cs, there was a general decrease in the total activity in the stream between the sewage treatment plant outfall and the site boundary. The increase in ^{137}Cs was due to stream bottom deposition and uptake by plant and animals. Infiltration into ground water was evident from the decrease in flow at the boundary measuring weir during the third quarter of the year. Upper limit estimates of the total activity which may in this manner have percolated to the underlying ground water during these months are also shown in Table XI. These are based on the decrease in total activity between the former site boundary and the perimeter during this period.

Analysis of monthly composite samples of the Peconic River at the former site boundary (0.8 km downstream from the chlorine house) during this period showed that, on the average, 5% of the total activity consisted of ^{90}Sr and that no appreciable amounts of long half-life radioactive iodine or bone-seeking nuclides such as radium were present. Under these circumstances the applicable RCG was 3000 pCi/liter (3.0×10^{-6} μCi/ml). The gross beta concentration in the portion which percolated to ground water was 32.3 pCi/liter (3.23×10^{-8} μCi/ml) or 1% of the RCG.

At the Laboratory perimeter (2.6 km downstream from the chlorine house), 3% of the yearly activity was ^{90}Sr. The applicable RCG was also 3000 pCi/liter. The observed concentration of the water released downstream was 28.1 pCi/liter (2.81×10^{-8} μCi/ml) or 0.95% of the RCG.

After digestion, the solids removed by the clarifier are dried on sludge drying beds. In the past dried sludge has been, after performing radionuclide analysis on aliquots of this sludge, transferred to the on-site sanitary landfill. However, ERDA has recommended that the use of the landfill for the disposal of radioactive waste be discontinued. This communique was not brought to the attention of Grounds Maintenance in time, and on December 9, 1976, a calculated 70 m^3 of dried sludge containing 102 mCi of beta emitters and 0.62 mCi of alpha emitters (by gross analysis) was removed from the sewage treatment plant (STP) to the landfill. This was in apparent contravention to the above recommendation. Table XIB compares the sludge activities to the maximum permissible concentration (MPC) for uncontrolled release of insoluble radioactivity (ERDAM 0524). Our experience to date has demonstrated that with the exception of ^{90}Sr, the radioactive elements in the sludge are essentially immobile in soil. The sludge, in this case, was spread out evenly on the top of the landfill, about 15 m above the water table in the area. In addition to the time required for any strontium that might be leached to groundwater, our experience with ^{90}Sr in groundwater suggests that it would require about 50 years for it to move from the landfill to the site boundary. The landfill has been used for sludge disposal several times in the past decade. The largest concentrations of ^{90}Sr in wells immediately adjacent and 61 m south of the working area are about 10 pCi/liter. Therefore, the Laboratory does not foresee this inadvertent dumping of sludge on the landfill in the above amounts and concentrations to add materially to the long term need for monitoring or restriction of the use of this landfill for other purposes.

As of January 31, 1975, the effluent from the Laboratory sewage treatment plant was subject to the conditions of National Pollutant Discharge Elimination System (NPDES) Permit No. NY 000 5835. Monthly reports were prepared in accordance with this permit with data obtained by the sewage treatment plant operators. A yearly summary of these data, which follows the same format as these monthly reports, is shown in Table XIIA. It includes a specification of the permit conditions. The Laboratory effluent was well within these conditions, with the exception of two daily pH levels and two instances where the % BOD_5 removal were "out of limit" as set by the permit.

Though the two pH daily levels were only slightly below the lower level set forth in the permit but within the local natural range of groundwater, a study was initiated to determine the causative factors behind such "out of limit pH values". The study indicated that the low pH of rainfall on Long Island is a significant factor in lowering the pH of the Laboratory effluent as it passes through the sand filter beds.

The two exceptions to the stipulated 85% removal of BOD_5 effluent occurred in October and November. An analytical error, compounded by variations in sampling times, resulted in a single sample showing low BOD_5 % removal. This was carried through in the calculations resulting in an "out of limit" average % removal of BOD_5. The plant's operation, therefore, was not considered responsible for the 82% removal.

In addition to the above measurements, the Laboratory Safety and Environmental Protection Division conducts routine measurements of a number of indications of water quality and purity of the filter bed effluent, upstream of the Peconic River, at the former perimeter of the Laboratory (0.8 km downstream) and at the present Laboratory perimeter (2.6 km downstream). A summary of these data for 1976 is shown in Table XIIB. The outflow from the sand filter beds into the Peconic River was considerably above water quality standards for minimum dissolved oxygen (DO) (6, 13). Although occasionally below the standard, the pH was within the range of local ambient backgrounds. After mixing with the upstream flow, the temperature increment was within the standard (14) 0.8 km downstream. Monthly analyses for selected metals in the filter bed effluent were also performed. The data are shown in Table XIIC. Their yearly average concentrations were, before dilution, at or within the standard for the receiving body of water (6, 13). It was observed that the Zn values are usually at or slightly in excess of the limits during the months of December, January, February, March and April. The month of December coincides with the time when all the air conditioning systems are cleaned with fungicides and algaecides containing zinc. At present, a study is under way to quantify the total usage of such zinc containing agents and investigating other possible sources of zinc.

A small portion of the liquid effluent flow from the clarifier was diverted from the sand filter beds for application to the Meadow-Marsh experimental plots. It utilized a simulated typical sewage treatment effluent, which was prepared by blending cesspool pumpings, gathered by scavengers in the Town of Brookhaven, with the extremely dilute Laboratory effluent, characteristically in a 1:3 ratio. A summary of the total flows and of the gross beta, tritium and the ^{90}Sr activities and concentrations is shown in Table XIII.

Water quality parameters of the mixtures utilized in the Meadow-Marsh Project were evaluated by the Department of Applied Science (BNL) (15) and cooperating outside agencies. These data are shown in Table XIV. The applied effluents met the standards for ground surface discharge, with the exception of the metals Cu, Fe and Zn (6). It should be noted that the purpose of this experiment is to determine the efficiency of natural

ecosystems for the removal of pollutants in the applied effluents and was based on the premise that the "effluent" percolating to the saturated zone (3 - 4.5 m below the ground surface in the area) would be within ground water quality standards.

Due to the permeable nature of the local soils, there was no surface runoff from the experimental area, and hence no direct route by which these effluents might reach a potable water supply.

Monthly "grab" water samples were obtained at on- and off-site locations along the upper tributary of the Peconic River, into which the Laboratory routinely discharges low level radioactive wastes. Reference "grab" samples were also obtained from other nearby streams and bodies of water outside the Laboratory's drainage area. The sampling locations, as shown in Figure 7, were as follows:

Off Site (Peconic River, proceeding downstream)

- A - Peconic River at Schultz Road, 4.85 km downstream
- B - Peconic River at Wading River-Manorville Road, 7.04 km downstream
- C - Peconic River at Manorville, 10.67 km downstream
- D - Peconic River at Calverton, 14.23 km downstream
- R - Peconic River at Riverhead, 19.35 km downstream

Controls (Not in the Laboratory drainage)

- E - Peconic River, upstream from the Laboratory effluent outfall
- F - Peconic River, north tributary (independent of the Laboratory drainage)
- H - Carman's River, outfall of Yaphank Lake
- I - Northeast corner of Artist's Lake on Route 25

Individual monthly and yearly average gross beta, tritium and ^{90}Sr concentrations at downstream and control locations are shown in Table XVA. A comparison with the on-site and perimeter concentrations shown in Table XIA suggests that the concentrations of Laboratory effluents in the Peconic River, downstream of the outfall, diminish rapidly to near background levels at the more distant sampling locations. Considering the concentrations of radioactivity near the mouth of the Peconic River at Riverhead, where the flow was about 25 times that at the Laboratory perimeter, it was evident that the total amounts of radioactivity at this location was much greater than those released into the Peconic River at the Laboratory perimeter. During 1976 measurements of selected water quality and purity parameters at downstream locations on the Peconic River and at control locations were initiated in order to provide some perspective on the same parameters in the Laboratory effluent (as reported in Table XIIB). These limited "grab" sample data are shown in Table XVB. The effect of somewhat elevated levels of some parameters in the Laboratory effluent such as chlorides, dissolved solids, nitrate, and phosphorus, was not significantly apparent downstream.

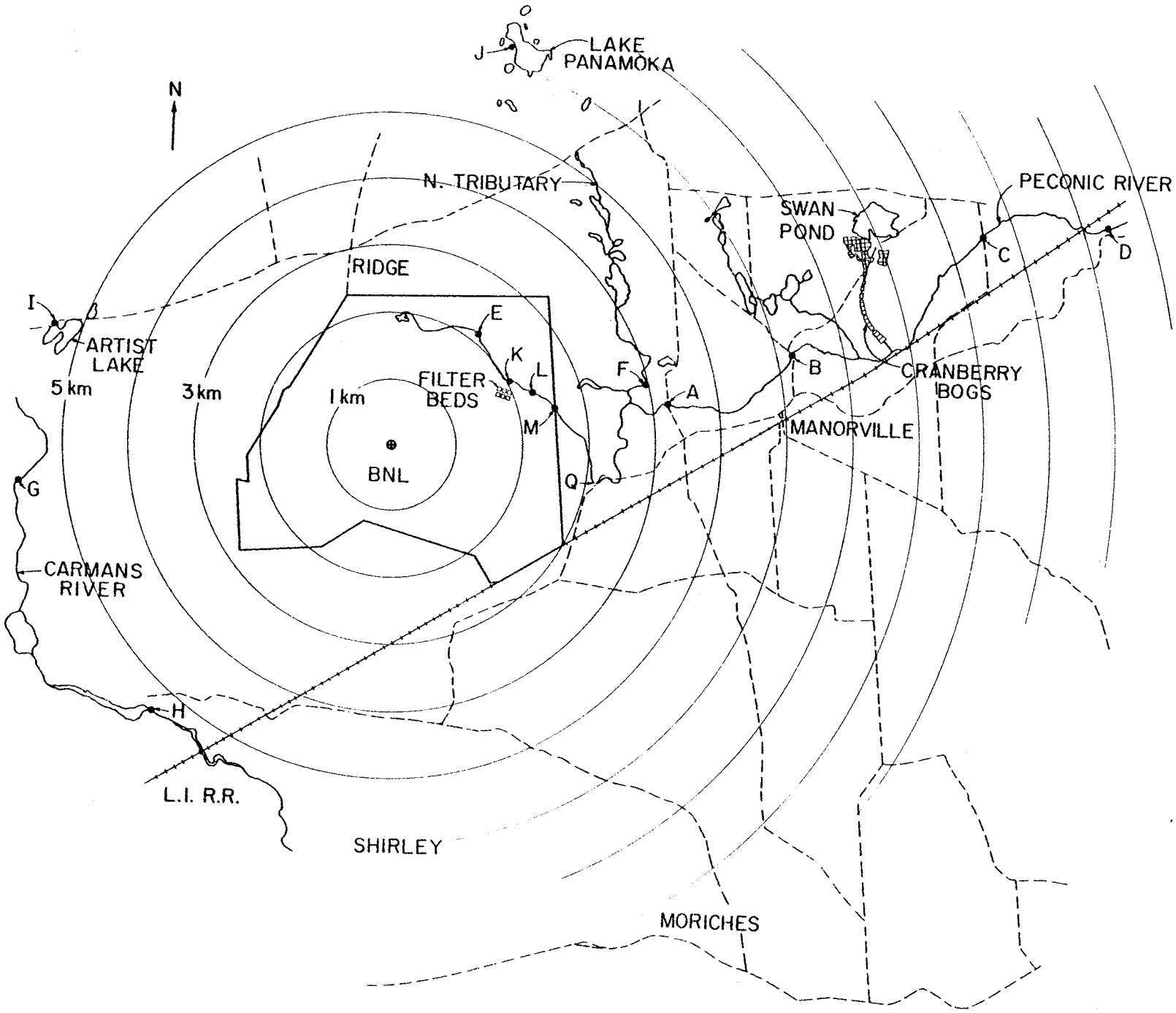

N
LAKE PANAMOKA
J
N. TRIBUTARY
PECONIC RIVER
SWAN POND
C
D
RIDGE
I
ARTIST LAKE
E
K
L
M
F
A
B
CRANBERRY BOGS
5 km
3 km
1 km
FILTER BEDS
BNL
MANORVILLE
Q
G
CARMANS RIVER
H
L.I. R.R.
SHIRLEY
MORICHES

FIGURE 7

During June and July of 1976 additional sampling of stream bottom sediment, of immersed vegetation, and of small stream fauna were conducted along the length of the Peconic River. Control samples were obtained upstream and from off-site "control" locations. Most of these locations correspond to those used for monthly water samples. In addition, samples were obtained at the following locations:

On site (proceeding downstream)

K - Peconic River, 8 m below outfall

L - Peconic River, 396 m below outfall

M - Peconic River, 793 m below outfall (at former boundary)

Q' - Peconic River, 1402 m below outfall

Q - Peconic River, 2103 m downstream (at the Laboratory boundary)

A' - Peconic River, 2377 m downstream

A - Peconic River, 3658 m downstream

B - Peconic River, 3962 m downstream

G - Carman's River at the intersection of Middle Island Road and Longwood Road

J - On the west shore of Lake Panamoka

G, J, considered as controls.

The sediment data are shown in Table XVI. Small concentrations of ^{60}Co, which is not generally present in the environment and is, therefore, attributable to Laboratory effluents, were apparent in a few on-site and immediately downstream samples. Concentrations of ^{137}Cs in samples obtained on site and in the upper reaches of the Peconic River were somewhat greater than those in downstream and control samples, and were also indicative of Laboratory effluent releases. The largest concentrations were found at locations where the stream was impounded. The corresponding vegetation data are shown in Table XVII. These show a similar pattern. Small concentrations of ^{60}Co, which is unique to Laboratory effluent releases, were found in samples obtained on site, at the Laboratory perimeter, and in nearby locations downstream. There was also some indication in these samples of Laboratory effluent activity, insofar as larger concentrations of other nuclides were found in samples from on site, at the perimeter and in or nearby the downstream region of the Peconic River, as compared with remote downstream and control samples (which reflect accumulations of some

of these same nuclides from fallout of atmospheric weapons tests or from natural origin).

A few samples of fish, turtles and frogs were also obtained along the upper reaches of the Peconic River. These data, along with data on water, soil and vegetation are shown in Table XVIII. They are insufficient to establish to what extent, if any, the samples contained Laboratory effluent radioactivity. The largest concentration of ^{137}Cs found in any of these samples was 1750 pCi/kg or less than 0.2% of RCG's (calculated on the basis of an assumed intake of 50g/day). This program will be enlarged in 1977.

An attempt was made in this table (Table XVIII) to include all the available radionuclide data on surface water samples from those same regions from which soil, vegetation and animal samples were collected. This permitted one to look for patterns in concentrations across the various phases of an environment. It was obvious, even though the data were scanty, that the sediment was indeed the reservoir for most of the radionuclides. Potassium-40 seemed to be uniformly distributed along the Peconic River in all phases of the environment, but ^{137}Cs decreased with distance away from the effluent outfall. Concentrations across the phases do indicate three order increases over water in animal tissues. This has been observed in other studies concerning ^{137}Cs. The levels in control regions, G and J, do reflect the absence of any Laboratory effluent contributions.

Potable Water and Process Supply Wells

The Laboratory's potable water wells and cooling water supply wells are screened at a depth of about 30 m, or about 15 m below the water table, in the Long Island surface layer of glacial outwash, sand and gravel. As apparent from Figure 8, most of these wells are located in the local ground water flow pattern generally west to northwest, and therefore upstream of the Laboratory's principal facilities. A total of about 2.46×10^4 m^3/day was pumped from them.

Bimonthly grab samples were obtained from these wells. These were analyzed for gross alpha, gross beta and tritium. All gross alpha concentrations were <1 pCi/liter ($<10^{-9}$ μCi/ml), and almost all tritium concentrations were <1.0 nCi/liter ($<10^{-6}$ μCi/ml). The gross beta and tritium results are set forth in Table XIX. There were no difference in the gross beta concentrations among these wells which might be attributed to Laboratory effluents.

Recharge Basins

After use in "once through" heat exchangers and for process cooling, about 18 million liters per day (MLD) of the water utilized by the

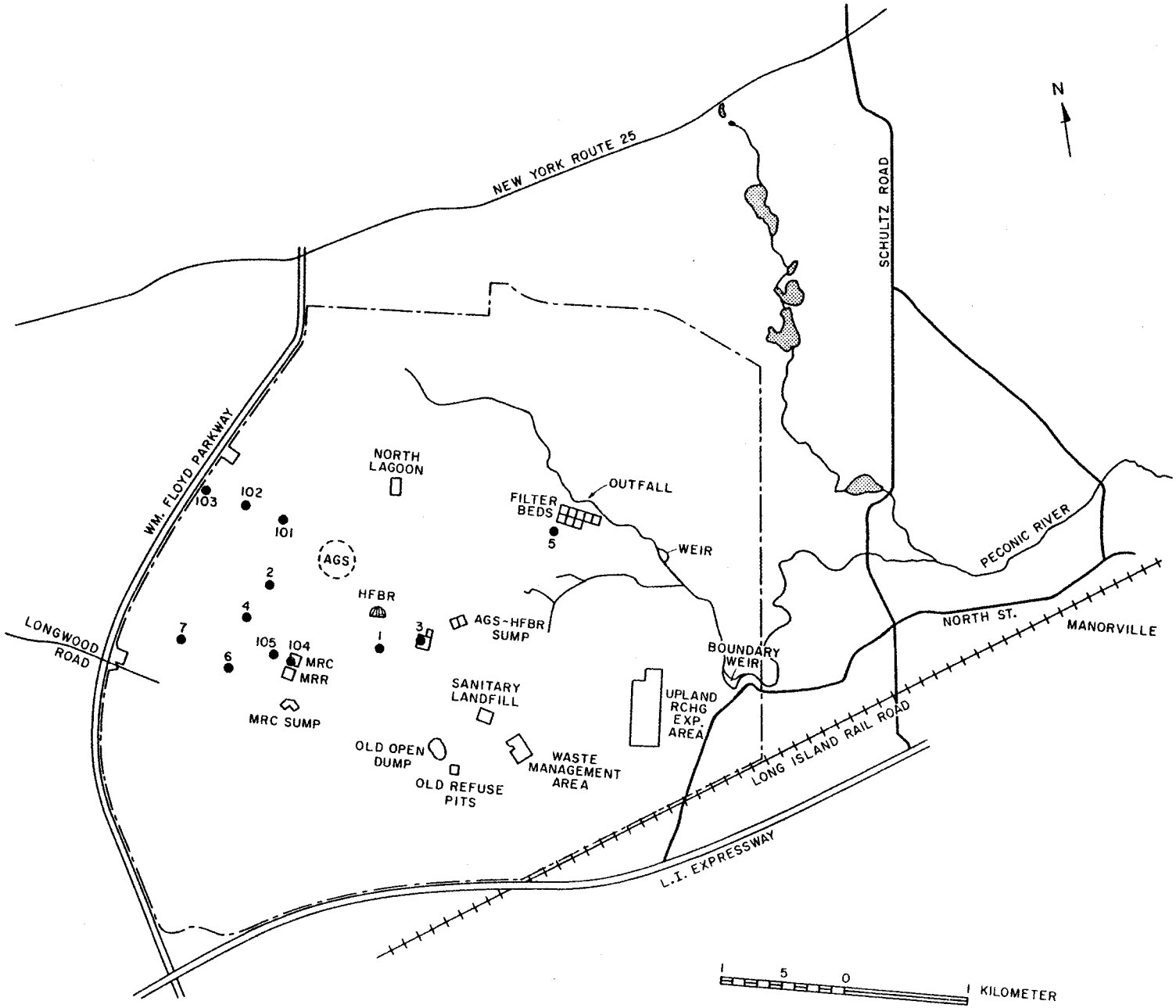

NEW YORK ROUTE 25
SCHULTZ ROAD
N
WM. FLOYD PARKWAY
NORTH LAGOON
OUTFALL
FILTER BEDS
WEIR
PECONIC RIVER
103
102
101
AGS
2
4
7
HFBR
105
104
MRC
MRR
6
1
3
AGS-HFBR SUMP
LONGWOOD ROAD
BOUNDARY WEIR
NORTH ST.
MANORVILLE
SANITARY LANDFILL
UPLAND RCHG EXP. AREA
MRC SUMP
OLD OPEN DUMP
OLD REFUSE PITS
WASTE MANAGEMENT AREA
LONG ISLAND RAIL ROAD
L.I. EXPRESSWAY
1 5 0 1 KILOMETER

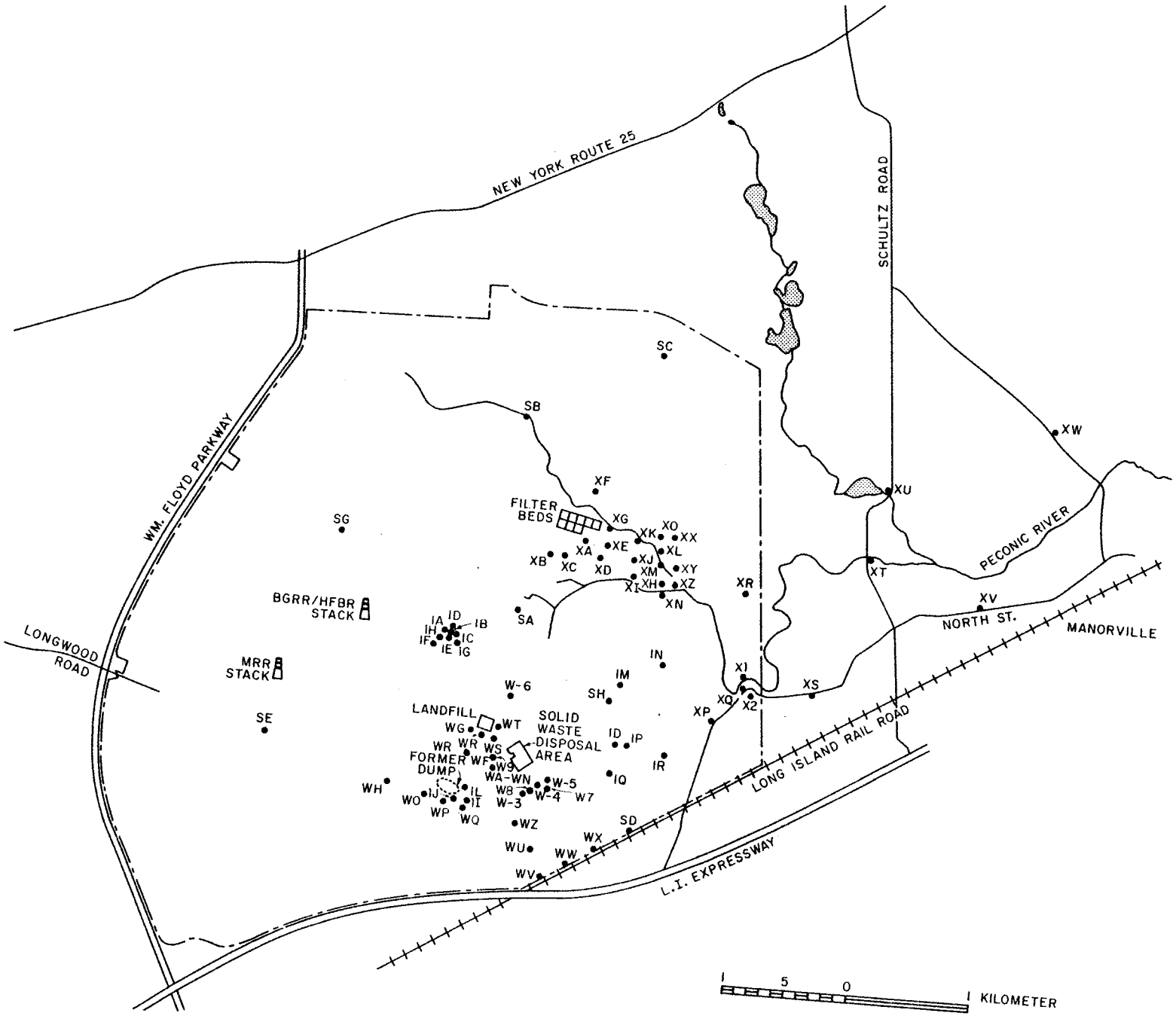
FIGURE 8

Laboratory was returned to ground water in on-site recharge basins: about 6.4 MLD to basin "N" located about 610 m northeast of the AGS; about 5.7 MLD to basin "O" about 670 m east of the HFBR; and about 6.1 MLD to basin "P" 305 m south of the MRR (see Fig. 8). Sodium hexametaphosphate was added to the AGS cooling and process water supply, which is independent of the Laboratory potable supply, to establish a PO_4 concentration of about 2 ppm in order to keep the ambient iron in solution. Of the total AGS pumpage, about 5.3 MLD was discharged to the "N" basin, and 2.7 MLD to the "O" basin. The HFBR secondary cooling system recirculates through mechanical cooling towers. It is treated to control corrosion and the deposition of solids. Blowdown from this system, about 0.38 MLD contains PO_4 in a concentration of about 10 ppm and benzotriazole in a concentration of 3 - 4 ppm. It is also discharged to the "O" sump. The MRR-MRC "once through" coolant is not routinely treated and is discharged to the "P" basin. Concentrations of radioactivity and other agents in these basins are monitored by routine weekly grab sampling. The average gross beta and tritium concentrations are shown in Table XXA. The average gross beta concentration in the sump north of the AGS was slightly above background, due to the occasional release of short lived nuclides contained in AGS beam stops. It was 0.4% of the applicable RCG. The average gross beta and tritium concentrations in the other basins were only very slightly increased above those in the Laboratory supply wells, and were about 0.1% of the applicable RCG for unidentified gross beta emitters, and less than 0.2% of that for tritium in drinking water.

Water quality data is obtained from periodic (approximately monthly) analyses of "grab" samples from the recharge basins, and from a culvert which conducts some air conditioning tower blowdown and other storm sewer influents from the southeast Laboratory building complex to a natural sump south of the warehouse area (about 1.2 km south of Building 610, see Fig. 2). The data for 1976 are shown in Table XXB. All were within established standards for ground water quality.

Ground Water Surveillance

Samples of ground water were obtained from a network of shallow wells previously installed in the vicinity of several areas from which there was a potential for the percolation of radioactivity downward from the surface into the saturated zone of ground water. The included areas were adjacent to on-site recharge basins, to the sand filter beds, to the downstream Peconic River, to the Solid Waste Management area, to the former open dump, to the sanitary landfill, to the decontamination facility sump, and to the Upland Recharge and Meadow-Marsh Project area. The locations of most of these ground water surveillance wells are shown in Figure 9-A. The locations of the several wells installed at the landfill and Solid Waste Management area are shown in Figure 9-B, and of those installed in the Upland Recharge and Meadow-Marsh area in Figure 9-C.


NEW YORK ROUTE 25
SCHULTZ ROAD
WM. FLOYD PARKWAY
LONGWOOD ROAD
PECONIC RIVER
NORTH ST.
MANORVILLE
LONG ISLAND RAIL ROAD
L.I. EXPRESSWAY
FILTER BEDS
BGRR/HFBR STACK
MRR STACK
LANDFILL
SOLID WASTE DISPOSAL AREA
FORMER DUMP
SA
SB
SC
SD
SE
SG
SH
IA
IB
IC
ID
IE
IF
IG
IH
IM
IN
IP
IQ
IR
WA-WN
W-3
W-4
W-5
W-6
W7
W8
W9
WD
WE
WF
WG
WH
WI
WJ
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WV
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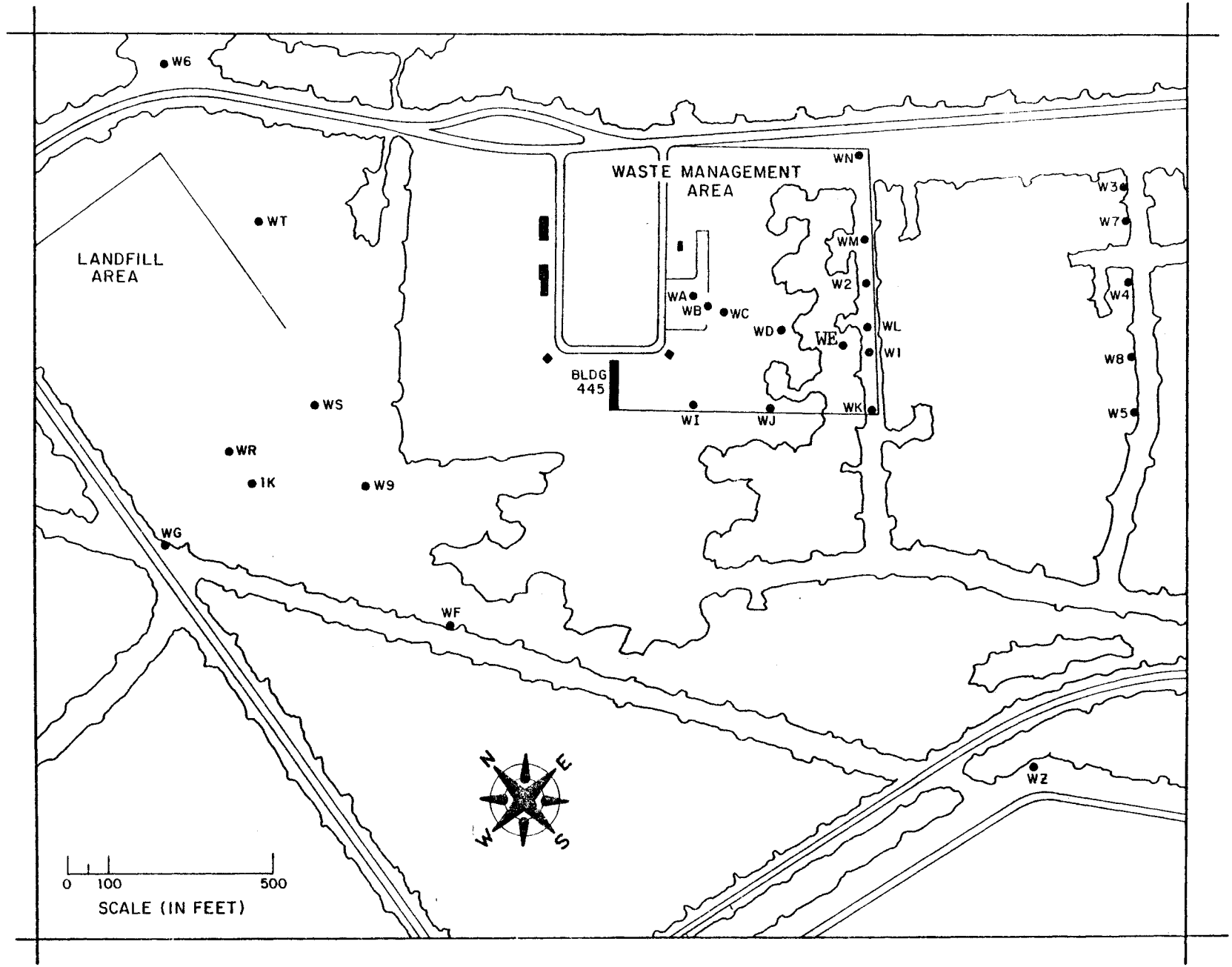
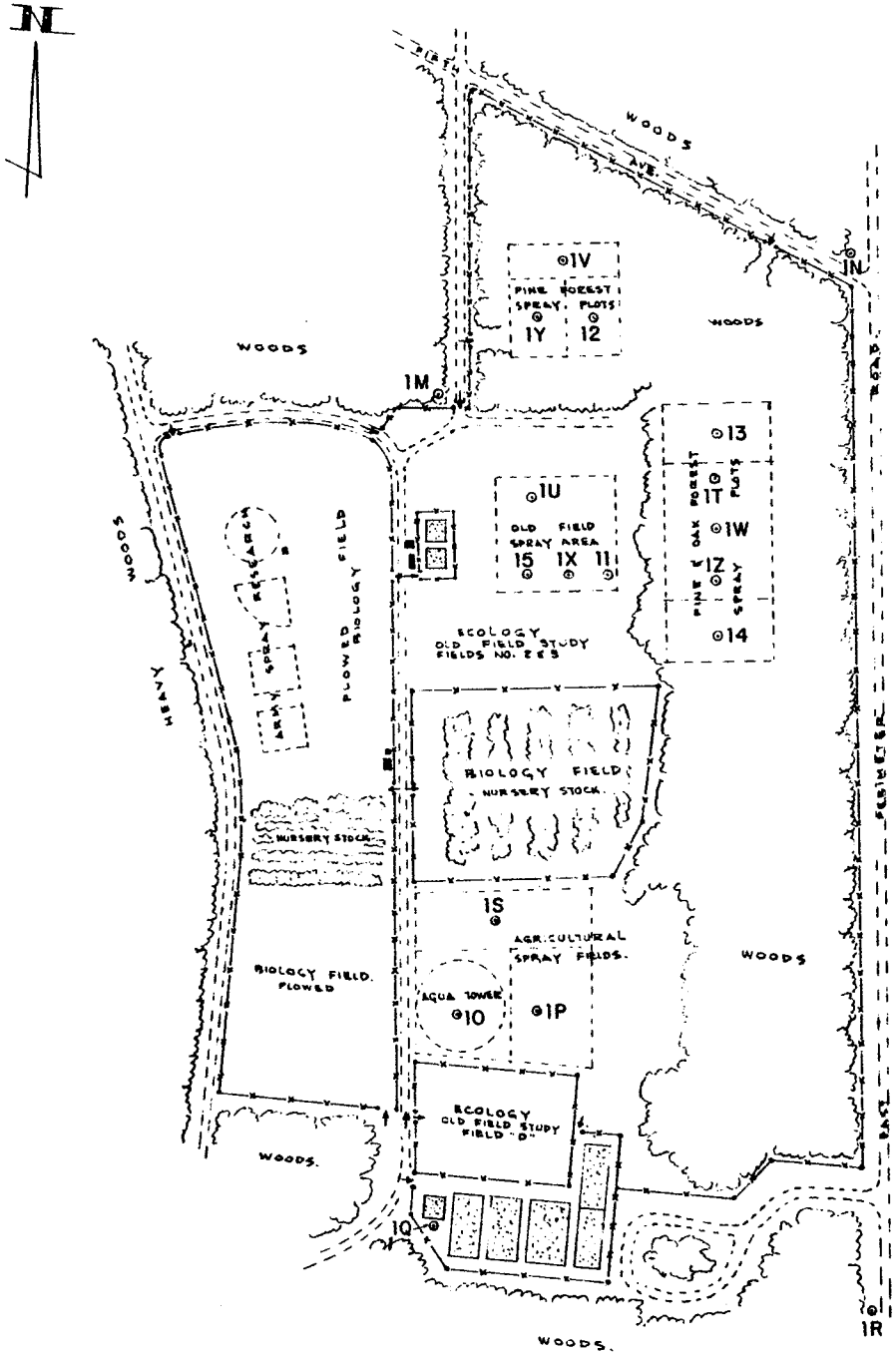
WZ
XA
XB
XC
XD
XE
XF
XG
XH
XI
XJ
XK
XL
XM
XN
XO
XP
XQ
XR
XS
XT
XU
XV
XW
XX
XY
XZ
X1
X2
0
5
1 KILOMETER

FIGURE 9-A



LANDFILL AND WASTE MANAGEMENT AREA SURVEILLANCE WELLS

FIGURE 9-B



MAP LEGEND

- WIRE FENCING
- CONTROLLED ACCESS - SECURED GATES
- WOODS OR BRUSH LINE
- LIGHT DUTY ROAD
- MONITORING WELL
- SPRAY PLOT
- HOLDING POND, MARSH OR MEADOW
- BUILDING

UPLAND RECHARGE WELLS

For convenience in assessing the data, the wells have been divided into several groups. Yearly average gross alpha, gross beta and tritium concentrations of the wells adjacent to the sand filter beds, and downstream on the Peconic River are summarized in Table XXI. During the year, at least one sample from locations adjacent to the recharge basins and from locations most immediately adjacent to the sand filter beds and the Peconic River was also analyzed for ^{90}Sr and ^{137}Cs (by gamma analysis). These data are also indicated. Corresponding information for the wells generally in the proximity of downstream of the solid waste management area, the landfill and former dump zones, and of the decontamination facility sump (about 1 km east of the HFBR) is summarized in Table XXII, and for the wells in the Meadow-Marsh Project area in Table XXIII.

From these data it appears that the spread of radioactivity from Laboratory operations into ground water remained limited to within a few hundred meters of the identifiable foci. Above background concentrations of beta emitters, tritium and ^{90}Sr were found on site adjacent to the sand filter beds and to the Peconic River, at small fractions of the RCG's. They were generally reduced slightly when compared to those of 1975. Adjacent to the Peconic River at the site boundary, all concentrations were equal to or less than 0.1% of Radiation Concentration Guides. Compared with 1975, gross beta, ^{90}Sr and tritium concentrations were generally similar in several wells immediately adjacent to the Solid Waste Management area. The elevated ^{90}Sr concentrations, approaching 20% of the Radiation Concentration Guide, in wells WK and W-1 are continuing to reflect the inadvertent release in the order of 1 Ci of this nuclide to ground water at well WA in 1960. Increased gross beta and tritium concentrations were also apparent in several wells immediately adjacent to the landfill area. Little change was apparent in wells adjacent to the former open dump and the decontamination facility (650) sump, except for a decrease in ^{90}Sr in wells 1A and 1-E. The largest was 60% of the Radiation Concentration Guide. Tritium above minimum detectable concentration was found in several wells within the Lowland Recharge Project plots, but not in the "control" wells at its area boundaries. Concentrations of radioactivity in wells on or near the site boundary, other than adjacent to the Peconic River, were at or only slightly above background levels and at small fractions of Concentration Guides.

Several water quality and purity parameters were also evaluated, for all ground water surveillance wells. The data for those wells proximate to on-site sumps, the sand filter beds, and downstream of the Peconic River on and off site, are shown in Table XXIVA. Those for wells proximate to the Solid Waste Management area, the landfill and dump area and the Building 650 sump, are shown in Table XXIVB. Those for wells in the Upland Recharge Project plots and at its outer perimeter are shown in Table XXIVC. Analyses for selected metals were conducted for a few wells immediately adjacent to the sand filter beds, to the Peconic and to the landfill area. These data are shown in Table XXIVD.

In general, the data were comparable to those found in 1975. With the exception of pH, all analyzed water quality parameters were well within New York State Water Quality Standards. The somewhat lower pH data appear to reflect natural ambient levels, since higher pH levels were present in the input to and output from the sewage treatment plant (see Table XIIA). Concentrations of Fe and Zn in excess of water quality standards were found in wells immediately adjacent to the sand filter beds, the Peconic River, the landfill areas and the 650 sump area. It is not clear to what extent they may be an artifact produced by the sampling well casings, or to reflect the leaching of accumulations of these metals from past Laboratory releases. Much lower levels of Zn were found in the Laboratory supply wells. Several contain Fe in excess of the standard, but most of this is removed prior to use.

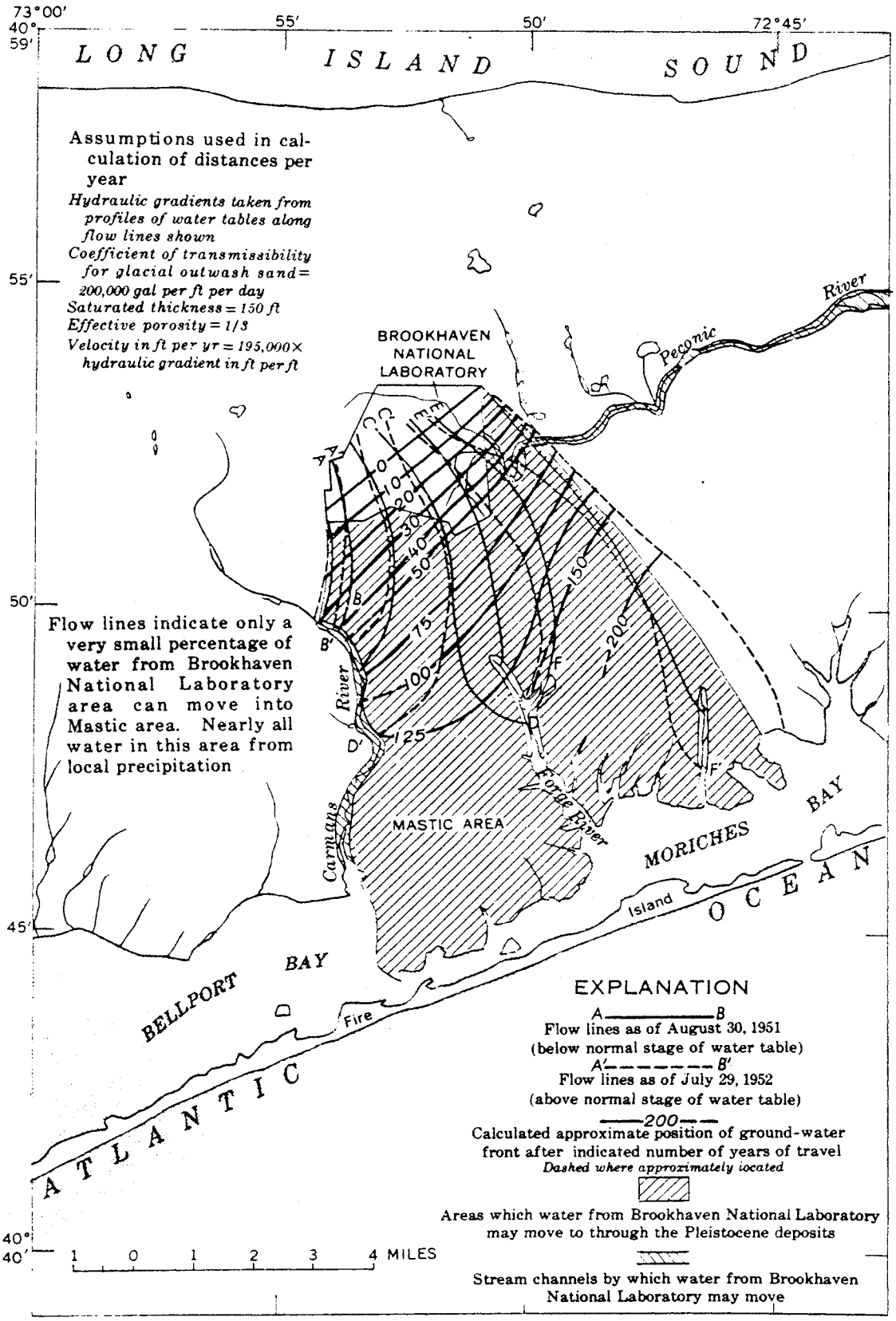
A generalized depiction of the direction and rate of ground water movement originally published in the U. S. Geological Survey Study, is shown in Figure 10. The Upland Recharge Project (16) has determined a ground water velocity of 13.4 cm/day, which is in good agreement with the U. S. Geological Survey Study estimate of 16.2 cm/day. Thus, it appears that many years of travel time would be required for ground water containing radioactivity or other pollutants to reach an off-site well, during which considerable dilution by infiltration of precipitation would be anticipated.

Milk Sampling

Monthly samples of milk were obtained and analyzed by the New York State Department of Environmental Conservation from two local dairy farms, one located 10 km south-southeast and a "control" located 40 km east of the Laboratory. Their reported data (17) are indicated in Table XXV. As was the case during recent years, the average concentration of ^{90}Sr in the milk from the farm 10 km southeast of the Laboratory, as reported by the Department, was higher than the more remote "control" location. This effect is not relatable to any Laboratory effluents, past or present, but appears to be related to differences in soil conditions and/or farming practices. (18-20)

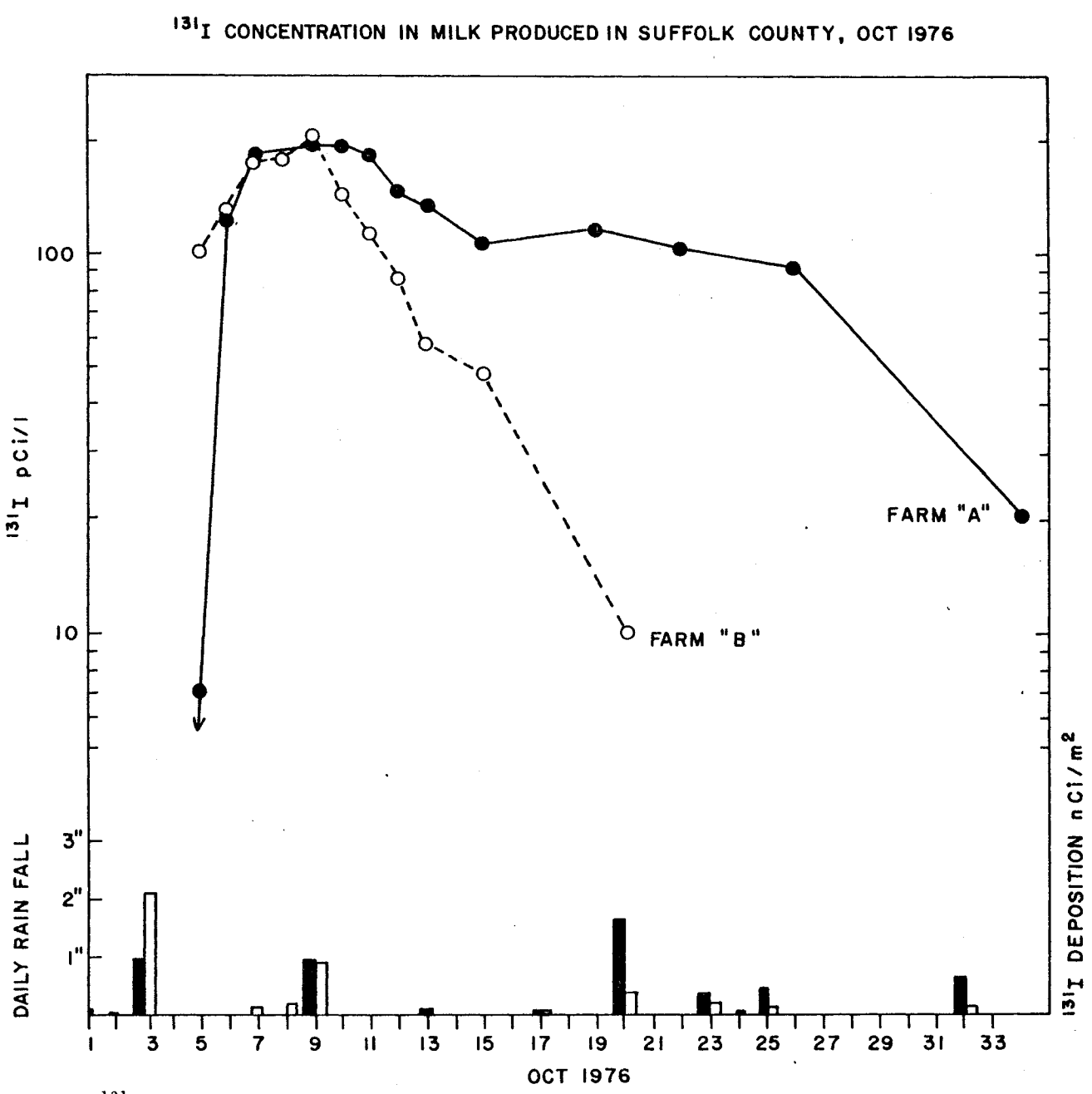
Chinese Nuclear Test

A Chinese nuclear weapons test on September 26, 1976 (18th in their series) in the atmosphere led to readily detectable fallout radiation over much of northeastern United States in the weeks following initial detection on October 2, 1976. In addition to other State and Federal agencies, Brookhaven National Laboratory was the lead agency for monitoring the nuclear fallout on Long Island. Table XXVI and Figure 11 summarize the observations.



Direction and time of travel of ground water laterally in upper Pleistocene deposits from the Brookhaven National Laboratory area to points of discharge.

FIGURE 10



^{131}I Concentrations in Milk produced in Suffolk County following the Chinese test, September 26, 1976.

FIGURE 11

Concentrations of ^{131}I in excess of 200 pCi/liter were found in milk produced at Long Island dairy farms early in October. These peak concentrations were considerably in excess of those found in milk by Brookhaven National Laboratory following any of the reported seventeen previous Chinese atmospheric tests, and were comparable to the measured concentrations during the series of United States and USSR tests in the fall of 1962.

The recently observed concentrations of ^{131}I in milk were clearly associated with a large deposition of fallout fission products, including ^{131}I, in a rainfall along the eastern seaboard on October 3, 1976. A review of the data indicates that fallout deposition in rainfall was also the principal contributor to the previously observed levels of ^{131}I in milk.

The current and previous data also suggest that for single trans-Pacific tests, dry deposition (in the absence of rainfall) is unlikely to lead to significant levels of ^{131}I in milk. However, even larger concentrations may occur under unusual meteorological conditions. This is documented by a local rainfall on December 29, 1967 during which the deposition of gross beta activity was 1745 nCi/m^2 and of ^{131}I was 68 nCi/m^2. These are thrity times the recently observed amounts. Had they occurred during the grazing season, the recent experiences suggest that "peak" ^{131}I concentrations approaching 6000 pCi/liter would have been found in locally produced milk.

The nineteenth Chinese test -- an atmospheric detonation on November 17, 1976 -- did not deposit significantly detectable amounts of ^{131}I as it was followed mainly by dry deposition.

OFF SITE DOSE ESTIMATES

Increased levels of radiation and concentrations of radioactivity, above ambient background, with resulting increased doses to people, result from the following four Laboratory sources:

Airborne radioactive effluents, primarily tritium;

Radioactive liquid effluents;

The ^{137}Cs source in the Biology Department Ecology Forest;

Skyshine from the Alternating Gradient Synchrotron (AGS).

These are discussed below, and the total off site dose (in person-rem) due to Laboratory operations during 1976 is calculated.

Doses Due to Airborne Effluents

As indicated in Table III, a total of 1194 Ci of tritium was released from various Laboratory facilities during 1976, making it a principal source of airborne dose to persons off site.

Concentrations of tritium at the site boundary were so low that measurement was difficult. Data given in Table VI indicate an average concentration of 426 pCi/m^3 at the site boundary (~2500 meters from the HFBR stack) in addition to the background value, which equaled about 1 pCi/m^3. Continuous exposure at the radiation concentration guide (2×10^5 pCi/m^3) would result in a dose of 500 mrem/yr. Thus, the dose rate at this distance attributable to Laboratory air effluent tritium was $(426 / 2 \times 10^5)$ (500) or 1.07 mrem/yr, or 0.22% of the Radiation Protection Standard. Since the background exposure rate in this area was about 81 mrem/yr, this tritium dose rate amounts to an increase at the site boundary of only 1.3%, which is within the temporal and spatial variations of the background itself.

Some 333 Ci of radioactive argon gas (^{41}A) was released from the stack of the Medical Research Reactor. This quantity was too small to produce a measurable increase in annual dose rates at the site boundary. During operation of the Brookhaven Linac Isotope Facility (BLIP), ^{15}O was released at a rate calculated as 0.6 Ci/min, for a total amount of 38,507 Ci during 1976. Its half-life was 2 minutes and its effect was not observable at the site boundary.

Routine analyses for air particulate radioactivity and for radiohalogens were made throughout 1976 on air samples collected at several locations. Although several nuclides attributable to fallout from weapons testing, especially after the Chinese nuclear tests were found in September and November, there was no evidence of activity attributable to Laboratory operations.

Beyond the site boundary dose rates due to tritium in air effluents from the Laboratory were very small, compared with background and variations in background. This should be considered in the interpretation of the computation of the total population exposure attributable to this Laboratory effluent, as shown in Table XXVII. The parameter $\underline{X}/Q$, tabulated in the second column, is the ratio of ground level concentration to rate of emission, i.e., concentration per unit emission rate, and is a function of meteorological conditions and distance from the source. The values have been calculated for the 300 m release height of the HFBR stack and are averages for a whole year and for all sixteen tabulated directions. While their use produces an underestimate at close-in distances for releases from shorter stacks, overall it results in some overestimation of population exposure, since $\underline{X}/Q$ values in the direction of major population centers to the west of the Laboratory are lower than the 360° averages. Values of dose rate in the third column are derived from the measured value for the 1.6 to 3.2 km interval (1.89 mR/yr) by multiplying by the appropriate ratios of $\underline{X}/Q$ values. The total population dose due to the Laboratory tritium effluent was 169.33 person-rems and due to natural background (81 mR/yr) was 419,109 person-rems. (See Addendum, p. 41a.)

Doses Due to Liquid Effluents

Since the Peconic River is not utilized as a drinking water supply, nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. The upper portions of the river, in which a small excess of radioactivity above background concentrations (principally ^{137}Cs) was found in sediments, vegetation and fish, is utilized for occasional recreational fishing. Making the assumption that the total catch of fish by 100 fishermen was 1×10^3 kg, and the ^{137}Cs concentration was 1750 pCi/kg, which is representative of fish samples from the Peconic River in 1976; the total ingestion would have been 1.75×10^{-6} Ci. This corresponds to an average individual dose commitment of 0.56 mrems, or 0.11% of the Radiation Protection Standard. The estimated total dose from this indirect pathway is 0.056 person-rems. It may reasonably be assumed that there was also some accumulation of ^{90}Sr from Laboratory effluents in these fish. Since this nuclide is concentrated principally in the inedible bone, the resulting dose appeared to have been small in comparison to ^{137}Cs.

Although not directly relatable to the Laboratory liquid effluents during 1976, a ^{90}Sr concentration of 1.8 pCi/liter was found in an off-site surveillance well, about 305 km east of the Laboratory site boundary at the Peconic River. Using dose commitment factors published by Shleien (21), a potential individual 50 year bone dose commitment of 8 mrem for infants and 7 mrem for adults may be calculated for a small number of people living in the adjacent area. This is about 0.2% of the Radiation Protection Standard. This calculation is based on the assumption that during 1976, all of their drinking water was obtained from shallow water supply wells, containing ^{90}Sr in a concentration equal to that of the surveillance well. It is estimated that not more than twenty-five people

reside in this locality and thus that the total dose commitement did not exceed 0.30 person-rems. Their dose from natural background (including internal radiation) would have been about 2.5 person-rems during 1976.

Doses Due to the Gamma Forest ^{137}Cs Source

A 6304 curie* ^{137}Cs source is located in the northeast part of the BNL site, 1010 meters (3310 ft; 0.628 miles) from the north boundary. The dose rate at this boundary during 1976, as determined by the Laboratory Environmental Monitoring Group, was 4.16 mRem/yr, or 0.8% of the Radiation Protection Standard.

Population doses beyond the site boundary due to this source have been computed using a population count by segments centered on the HFBR stack. Average dose rates for each population segment and for each distance from the source are given in Table XXVIII.

Since the dose rate from this source decreases very rapidly with distance, only population segments located ≤3 miles from the source were considered. The total off site dose is 0.08 person-rem/yr, and appreciable contributions are found only in the NNE and NE sectors.

Doses Due to Alternating Gradient Synchrotron

The Alternating Gradient Synchrotron (AGS) is a 33 GeV proton synchrotron located 1180 meters from the nearest site boundary. Although the machine is heavily shielded, some neutrons do escape through it or from areas where experiments are in progress. Some of these neutrons reach off-site areas either directly, or in most cases, by scattering from the air, which is called skyshine.

Dose rates due to AGS skyshine were measured at a distance of 850 meters from the machine. The relationship between these does rates and values of the AGS circulating beam intensity has previously been established. From this relationship and machine operating records, the dose due to AGS operation during 1976 at a distance of 850 meters is estimated to be 11.0 ± 6 mrem.

The decrease in dose rate at distances >850 meters is due to an inverse-square factor and exponential absorption by the air. Measurements of dose rate previously made at various distances out to 900 meters by the AGS Health Physics Research Group indicate that the dose rate decreases with a relaxation length of 600 meters. Values of dose rate beyond the site boundary can be computed by using the following equation:

$$\text{mrem/yr} = 2.0(854/r)^2 e^{-(r-854)/600}$$

where r = distance in meters from the AGS centroid.

*As of 1/1/76

Values of dose rate in mrem/year for a selection of distances from the AGS are shown in the following table:

r, km	$(854/r)^2$	(r-854)/600	e - (r-854)/600	mrem/yr
1	0.73	0.243	0.784	5.78
2	0.182	1.91	0.148	0.297
3	0.0811	3.58	0.0279	0.0249
4	0.0455	5.25	0.00525	0.00262
4.5	0.0360	6.08	0.00229	0.00091
5	0.0291	6.90	0.00101	0.00032

At the site boundary nearest to the AGS, about 1.0 km to the northwest, the estimated dose was 1.2 mrem/yr, or 0.23% of the Radiation Protection Standard.

Population doses beyond the site boundary due to this source have been computed, with use of an available population count with relation to distance from the HFBR stack. Average dose rates for each population segment and for each distance from the source are also given in Table XXVIII.

Since the dose rate from this source decreases rapidly with distance, only population segments with radii of 1.6 to 3.2 and 3.2 to 4.8 kms were considered. The total off site dose was 0.05 person-rem/yr, and appreciable contributions were found only in the NW and NNW sectors.

Total Population Dose

The total population dose beyond the site boundary due to Laboratory operations during 1976 is the sum of the values due to the five components discussed above, as shown below:

Airborne effluents	169.33
Liquid effluents	0.06
	0.30
Gamma-forest source	0.08
AGS skyshine	0.05
Total	169.82

The total annual dose, due to external radiation from natural background, to the population within a 80 km radius of the Laboratory amounts to about 419,000 person-rems, to which about 129,000 person-rems should be added for internal radioactivity from natural sources.

ADDENDUM

The high tritium values (Table VI of the 1976 Environmental Monitoring Report) could be attributed to:

a) The silica-gel that was used in the airfiltering system. It was observed that a specific batch of silica-gel introduced into the air sample substance(s) causing spurious counts to be added to the tritium counts in the liquid scintillation systems used to assay the tritium content of an air sample. This was confirmed by changing the silica-gel stock which immediately reduced the observed tritium content of samples to levels normally observed (ex. the tritium values during the later part of the year being significantly reduced).

b) Micrometerological conditions causing significant intrasite variations.

It was also noted that there were no cases of large amounts of tritium released to the environment from any of the facilities on site (Table III).

Based on estimated contributions from the silica-gel and also the micrometerological variations, the total person-rem can be reduced by a factor of two. However, it is felt that the 1976 reported value of 169 person-rem should remain as such to avoid any uncertainty in underestimating the exposure to the population.

The Quality Control Program and the use of a new Beckman Liquid Scintillation System will assure us of a reliable estimate of the tritium content of the samples for 1977.

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APPENDIX A

QUALITY CONTROL

The accuracy of the reported measurements of radioactivity is established by the use of standards supplied by the National Bureau of Standards (NBS), U. S. Department of Commerce. These are generally available within an uncertainty range of 1 - 5%. Alternatively, for nuclides not available from NBS, standards within a similar uncertainty are obtained from Amersham/Searle. Daily checks of counter and/or gamma system performance are made using point sources of ^{36}Cl, ^{60}Co, ^{137}Cs, and ^{239}Pu, as well as background counts. In addition, use has been made of the International Atomic Energy Agency's program on "Intercomparison of Methods for Processing (GeLi) Gamma-ray Spectra (G-1)". This exercise has permitted us to maximize the efficiencies and resolution of the gamma-ray analysis. A tritium standard and one or more blanks is included with each run of a liquid scintillation counter (which includes an automatic sample changer).

The Analytical Laboratory of the Safety and Environmental Protection Division also participates in intercomparisons of radioactivity in samples of air filters, water and other media distributed by the ERDA through Health and Safety Laboratory, New York, on a quarterly basis. This was started in September 1976, and the results of the first test were submitted in January 1977. Another area where a study on accuracy has been initiated concerns the ^{131}I determinations in milk.

Procedures for nonradioactive contaminants are those presented in Standard Methods for the Examination of Water and Wastewater (13th ed., 1971). All standards are prepared from standard reference grade, and analytical grade reagents in accordance with the requirements of Standard Methods. Standards are run with each set of samples analyzed. At least one duplicate and blank is also run with each set.

TABLE I

1976 BNL Environmental Monitoring Background
and Source Radiation Levels
(mrem/wk)

Month	Location			Northeast perimeter P-9A		Average** Background
	P-2	P-4	P-7	Total	Source*	
January	1.51	1.48	1.50	1.50	0.01	1.49
February	1.68	1.68	1.76	1.81	0.10	1.70
March	1.54	1.51	1.56	1.54	0.01	1.53
April	1.48	1.41	1.49	1.60	0.14	1.46
May	1.16	1.17	1.25	1.28	0.09	1.19
June-July 19	1.14	1.08	1.18	1.29	0.16	1.13
July 19- Aug.	1.06	1.07	1.18	1.24	0.14	1.10
September	1.34	1.27	1.37	1.38	0.05	1.33
October	1.32	1.32	1.34	1.36	0.04	1.32
November	1.40	1.35	1.41	1.41	0.02	1.39
December	1.26	1.20	1.32	1.33	0.07	1.26
Total (mrem/yr)	70.2	68.6	72.8	74.4	4.16	14.90
Average	1.35	1.32	1.40	1.43	0.08	1.36
Error (2 S.D.)	±0.38	±0.38	±0.34	±0.34	±0.10	±0.36

*Source level derived by substracting average background at other stations from total measured level at northeast perimeter.

**Average of P-2, P-4 and P-7, unaffected by BNL on site radiations or effluents.

Radiation Protection Standard:(4) 500 mrem/year.

TABLE II

1976 BNL Environmental Monitoring BNL Gaseous Effluent
Release Locations and On-Line Monitoring and Sampling Devices

Building	Facility and release point radioactive effluents	Release height ft. (m)	Principal nuclide(s)	On-Line monitoring	Sampling devices
490	Medical Research Center Roof Stack	45 (113.7)	Tritium (vapor)	None	Desiccant for tritium vapor
491	Medical Research Reactor Stack	150 (45.7)	Argon-41	Moving tape for radio-particulates; charcoal for radioiodines	None
555	Chemistry Building Roof Stack	55 (16.8)	Tritium (vapor)	None	Desiccant for tritium vapor
705	High Flux Beam Reactor/ Hot Laboratory Stack	320 (97.5)	Tritium (vapor)	Beta scintillator for radioactive gases; Kanne chamber for tritium (gas+vapor)	Desiccant for tritium vapor; particulate filter for gross beta; charcoal cartridge for radioiodines
901	Van de Graaff Accelerator Roof	60 (18.3)	Tritium (gas+vapor)	Kanne chamber for tritium (gas+vapor)	Desiccant for tritium vapor*
931	Linac Isotope Facility	60 (18.3)	Tritium (vapor) Oxygen-15	G-M detector for radiogases	Desiccant for tritium vapor
Steam Plant Effluents					
610	Central Steam Plant Stack	65 (19.8)	Particulates; SO_2; NO_x	None	None

*Tritium gas evaluated from Kanne Chamber indications.

TABLE III

1976 BNL Environmental Monitoring Airborne Effluent Data
Radioactive Effluents

Building	Facility and release point	Elevation* (ft)	Nuclide	Amount (Ci)
491	Medical Research Reactor Stack	150	^{41}Ar	333**
490	Medical Research Center Stack	45	^{3}H (vapor)	1.5
555	Chemistry Building Stack	55	^{3}H (vapor)	86.68*
705	High Flux Beam Reactor/	320	^{3}H (vapor)	160.8
	Hot Laboratory Stack	320	^{127}Xe	2.58
			Gross beta (particulate)	1.13×10^{-5}
901	Van de Graaff Accelerator Stack	60	^{3}H (gas)	912.5
			^{3}H (vapor)	32.8
931	Linac Isotope Production	60	^{3}H (vapor)	0.039
	Facility		^{15}O	30,507†

*Above ground level.

**Calculated from reported operating time and "one-time" measured emission rate at 3 MW power level.

†Calculated from reported operating time and estimated production rate at 180 uAmp full beam current.

TABLE IV

1976 BNL Environmental Monitoring Emission of SO_2, NO_x and Particulates from Central Steam Plant (Bldg. 610)

Effluent	Total kg	Calculated stack concentration	Average boundary concentration*	EPA Primary Air Quality Standard[5]
SO_2	5.13×10^{5}**	398 ppm	1.56×10^{-3} ppm	0.03 ppm
NO_x	2.30×10^{5}	231 ppm	8.89×10^{-4} ppm	0.05 ppm
Particulates	2.52×10^{5}†	0.51 gm/m^3	1.89 $\mu g/m^3$	75 $\mu g/m^3$

*Based on average X/Q of 2.4×10^{-7} sec/m^3 calculated by BNL Meteorology Group.

**Based on average 1.0 % sulfur content.

†Based on measured average value during February 1974 stack sampling conducted on main steam boiler unit.

TABLE V

1976 BNL Enviromental Monitoring Average Gross Alpha and Gross Beta Concentrations
Air Particulate Filters (pCi/m^3 or 1.03×10^{-12} $\mu Ci/ml$)

Month	Location	Gross Alpha No.	Gross Alpha Average	Gross Alpha Maximum	Gross Alpha Minimum	Gross Beta No.	Gross Beta Average	Gross Beta Maximum	Gross Beta Minimum
January	Waste area	20	.0006	.0014	.0000	20	.0450	.0694	.0277
	S.W. perimeter					4	.0172	.0223	.0075
	N.E. perimeter					4	.0402	.0604	.0252
February	Waste area	19	.0007	.0015	.0001	19	.0697	.1370	.0306
	S.W. perimeter					4	.0376	.0461	.0292
	N.E. perimeter					4	.0502	.0912	.0379
March	Waste area	23	.0006	.0013	.0000	23	.0534	.0836	.0196
	S.W. perimeter					5	.0284	.0349	.0220
	N.E. perimeter					5	.0542	.1630	.0368
April	Waste area	22	.0005	.0019	.0000	22	.0488	.1210	.0143
	S.W. perimeter					4	.0390	.0603	.0216
	N.E. perimeter					4	.0378	.0588	.0178
May	Waste area	20	.0004	.0017	.0000	20	.0397	.0804	.0196
	S.W. perimeter					4	.0329	.0509	.0213
	N.E. perimeter					4	.0317	.0492	.0211
June	Waste area	21	.0004	.0013	.0000	21	.0437	.1600	.0117
	S.W. perimeter					5	.0342	.0449	.0186
	N.E. perimeter					5	.0365	.0509	.0256
July	Waste area	19	.0004	.0014	.0000	19	.0547	.1110	.0311
	S.W. perimeter					4	.0392	.0463	.0366
	N.E. perimeter					4	.0401	.0439	.0343
August	Waste area	20	.0007	.0020	.0001	20	.0537	.2180	.0163
	S.W. perimeter					6	.0413	.0715	.0056
	N.E. perimeter					5	.0382	.0519	.0279
September	Waste area	22	.0013	.0072	.0001	22	.0577	.1300	.0295
	S.W. perimeter					4	.0526	.0606	.0343
	N.E. perimeter					4	.0494	.0678	.0340
October	Waste area	23	.0005	.0011	.0000	22	.3631	5.5000	.0384
	S.W. perimeter					8	.5516	6.5000	.0712
	N.E. perimeter					9	.6734	6.3700	.0528
November	Waste area	20	.0008	.0020	.0000	21	.2437	.6310	.0742
	S.W. perimeter					5	.2834	.5680	.2020
	N.E. perimeter					5	.2604	.4300	.2040
December	Waste area	20	.0009	.0023	.0002	20	.1312	.2450	.0680
	S.W. perimeter					4	.1308	.2150	.0906
	N.E. perimeter					4	.1054	.1260	.0766
Yearly	Waste area	249	.0007	.0072	.0000	248	.1016	5.5000	.0117
Summary	S.W. perimeter					57	.1083	6.5000	.0056
	N.E. perimeter					5	.1080	6.3700	.0178
Estimated % error of individual sample				25				10	
Radiation Concentration Guide[4] for unidentified mixtures				0.100				100	

TABLE VI

1976 BNL Environmental Monitoring Average Tritium Vapor Concentration in Air
(pCi/m^3 or 10^{-12} $\mu Ci/ml$)

Period	Waste Management Area	Southwest Perimeter	Northeast Perimeter	Background*
12/31-3/19	62	29	31	1.19
3/19-5/11	2448	1151	310	
5/11-6/24	1154	408	4660	1.08
6/24-7/21	1154	270	1001	
7/23-8/24	284	580	179	
8/24-10/1	241	131	109	
10/1-10/29	44	116	132	NA
10/29-12/7	11	3	8	
12/7-1/6/77	91	7	8	
Average	722	351	502	
Radiation Concentration Guide[4]	2×10^5	2×10^5	2×10^5	

*Calculated from concentration of tritium in precipitation collected off site. Assuming average temperature of 15° C and 50% relative humidity.

NA: Not Available

TABLE VII

1976 BNL Environmental Monitoring Monthly Average Concentrations of Gross Beta Activity and of Gamma Emitting Nuclides in Monthly Composite Air Particulate and Charcoal Filters

(pCi/m^3 or 10^{-12} $\mu Ci/ml$)

Month	Average* Gβ	Sample Volume m^3	NUCLIDES 7 Be	65 Zn	95 Zr-Nb	103 Ru	106 Ru	131 I†	137 Cs	140 Ba-La	141 Ce	144 Ce
January	0.0357	61220	0.0933	<0.0002	<0.0002		0.0009	<0.0005	<0.0001	<0.0001		0.0005
February	0.0572	47370	0.1054	<0.0002	<0.0002		0.0011	<0.0012	<0.0001	<0.0042		0.0020
March	0.0481	59870	0.1375	<0.0002	0.0002		0.0009	<0.0004	0.0001	<0.0001		0.0016
April	0.0436	49850	0.1267	<0.0002	0.0002		0.0008	<0.0004	0.0003	<0.0001		0.0009
May	0.0356	50557	0.1021	<0.0002	0.0002		0.0008	<0.0004	0.0001	<0.0001		0.0004
June	0.0388	59390	0.1076	<0.0002	<0.0002		0.0009	<0.0004	<0.0001	<0.0001		0.0012
July	0.0454	48950	0.1184	<0.0002	<0.0002		0.0015	<0.0004	<0.0001	<0.0001		<0.0004
August	0.0438	54130	0.1172	<0.0002	<0.0002		0.0015	<0.0004	<0.0001	<0.0001		0.0012
September	0.0599*	53090	0.1220	<0.0003	<0.0002		<0.0010	<0.0005	<0.0001	<0.0003		<0.0006
October*	0.4878	56650	0.1145*	<0.0001	0.0551	0.0191††	0.0204	<0.0020**	<0.0010	0.0068	0.0160δ	0.0118
November	0.2595	50470	0.1145*	<0.0006	0.0292	0.0187††	0.0113	<0.0020	0.0009	0.0013	0.0093δ	0.0119
December	0.1214	45050	0.1780	<0.0003	0.0098		0.0084	<0.0004	<0.0002	<0.0001		0.0166
Average	0.1064		0.1198	<0.0002	0.0080	0.0189	0.0041	0.0007	<0.0003	0.0011	0.012	0.0041
Radiation Concentration Guide(4)	100		4×10^4	2×10^3	1×10^3	2×10^4	200	100	500	1000	5000	200

*Estimated from average trends. Additional activity in this energy region attributed to ^{103}Ru.

**Composite results results of an individual sample of 10/8/76 to 10/9/76 resulted in 0.062 pCi/m^3 ^{131}I attributed to the Chinese bomb test.

†Charcoal filter collections, all other nuclides collected on particulate filters.

††Estimate based on ^{7}Be fit.

δBased on ^{144}Ce fit.

TABLE VIII

1976 Monthly Average Gross Beta Concentration
Total Gross Activity and Individual Nuclide Activity in Precipitation

Month	Rainfall (cm)	Average Gβ concentration (pCi/liter or 10^{-9} μCi/ml)	Gβ	Nuclide activity (nCi/m^2 or 10^{-3} μCi/m^2)											
				^{7}Be	^{22}Na	^{54}Mn	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{103}Ru*	^{131}I	^{137}Cs	^{140}BaLa	^{141}Ce**	^{144}Ce
January	13.14	5.22	.69												
February	7.01	9.08	.64	9.86	0.06	<0.03	<0.26	0.008	<0.04	NA	<0.45	<0.02	<0.03	NA	<0.22
March	5.54	10.29	.57												
April	4.55	14.34	.65												
May	8.64	9.36	.81	2.07	0.01	<0.01	<0.02	0.019	<0.01	NA	<0.05	<0.01	<0.01	NA	<0.06
June	6.74	19.99	1.35												
July	8.04	3.44	.28												
August	23.06	5.68	1.31	11.74	0.09	<0.03	<0.18	0.006	<0.05	NA	<0.90	<0.03	<0.12	NA	<0.25
September	4.94	6.70	.33												
October	11.13	738.0	82.2	2.26	0.02*	<0.29	<1.01	0.010	<0.41	1.23	3.25	<0.27	1.42	2.44	<0.26
November	2.32	234.7	5.4												
December	5.68	22.0	1.3	.32	.02	<0.01	<0.10		0.07		<0.04	<0.01	.02		<0.09
Total	100.79		95.4	26.25	.20	<0.37	<1.57	0.043	<0.58	1.23	4.69	<0.34	1.60	2.44	<0.88
Average Radiation Concentration Guide[4]		94.7													
		$3x10^3$													

*Due to Chinese bomb test of 9/26/76.
**Based on ^{141}Ce fit.
NA - Not Available.

TABLE IX

1976 BNL Environmental Monitoring Monthly Average Tritium Concentration and Activity in Precipitation ($pCi/liter$ or 10^{-9} $\mu Ci/ml$)

Period	Location					
	P-2	P-4	P-7	P-9	BNL Sewage Treatment Plant	Off Site (Blue Point)
January-March	470	406	171	208	NA	191
April-June	126	279	NA	NA	228	
July-September	NA	166	528	257	329	181
October-December	NA	NA	NA	< 550	< 550	NA
Yearly Average*	298	284	350	306	355	186
Estimated Error	±30	±35	±30	±65	±55	±45
Radiation Concentration Guide**[4]	$3x10^6$	$3x10^6$	$3x10^6$	$3x10^6$	$3x10^6$	$3x10^6$
Yearly Total (nCi/m^2 or 10^{-3} $\mu Ci/m^2$)	162	398	221	282	324	139

*Quarterly concentrations weighted on basis of amount of precipitation.

**From tritium in water released to off site environment.

NA - Not available.

TABLE X

1976 BNL Environmental Monitoring Total Activities and Concentrations of Identifiable Nuclides in Liquid Effluents

Month	Flow x 10^{10} cm^3	Gβ (mCi)	Gβ+γ only* (mCi)	NUCLIDES ^3H	^7Be	^{22}Na	^{24}Na	^{51}Cr	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	$^{95}ZrNb$	^{125}Sb	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce
Clarifier (mCi)																				
January	7.92	2.36	3.16	557	0.5450	0.1070	-	0.1990	0.0556	<0.0091	0.0250	<0.0066	0.0690	0.0467	<0.0085	0.0280	0.8710	0.0086	0.0092	0.1160
February	7.66	2.32	2.71	1749	0.0930	0.0070	-	0.2870	0.0070	<0.0060	<0.0090	0.0240	<0.0040	0.0276	<0.0060	0.0080	1.0500	<0.0055	0.0260	<0.0450
March	10.29	2.65	3.20	3825	0.4410	0.0440	-	0.0630	0.0420	<0.0065	0.0210	0.0280	0.0120	0.0617	<0.0065	0.0240	<0.0120	0.0220	0.0360	0.0120
April	10.62	27.49	28.55	1302	<0.2871	0.1388	-	0.9659	0.0964	0.0999	0.1033	0.3411	0.5073	0.1774	0.3654	0.1661	0.3441	0.5087	022242	0.2335
May	10.62	6.04	7.83	1828	1.4490	0.1570	-	0.2491	0.0903	0.0719	<0.0568	0.2422	0.1729	0.0775	0.2684	<0.0426	0.1206	1.2310	1.0910	<0.1961
June	15.28	2.44	2.92	350	0.0316	0.0101	-	0.4320	0.0211	0.0234	0.0283	0.0677	<0.0280	0.1390	0.0451	0.0435	0.0119	0.0579	<0.0116	<0.0727
July	14.19	1.56	1.67	351	0.0335	0.0034	-	0.0656	0.0122	0.0116	<0.0105	0.0233	<0.0160	0.1093	0.0058	<0.0087	<0.0203	0.0270	0.0047	<0.0437
August	15.73	3.09	3.26	588	0.0326	0.0036	-	0.1236	0.0127	0.0061	<0.0093	0.0429	0.0167	0.1195	0.0057	0.0087	0.0109	0.0058	0.0044	0.0448
September	13.17	1.63	1.95	683	0.1383	0.0071	-	0.1646	0.0176	0.0068	<0.0115	0.1210	0.0145	0.1554	0.0070	0.0150	0.0141	0.0449	0.0620	0.0507
October	11.09	1.87	2.68	297	0.6177	0.0550	-	0.1797	0.0134	0.0102	<0.0160	0.0751	0.0461	0.0843	0.0095	0.0150	<0.0145	0.0872	0.3460	0.0753
November	11.29	18.62	28.54	1824	7.7337	2.7548	-	1.1222	1.0658	0.1535	<0.4595	0.4245	<0.5837	0.0971	0.2585	<0.3460	<0.3466	4.5160	0.6571	<1.1403
December	10.59	6.87	20.46	1433	11.7867	0.3410	-	0.4702	1.3290	0.0401	0.6523	0.3113	0.1049	0.1504	0.3569	0.2309	0.0863	1.1829	0.0852	0.2976
Total	138.45	76.94	106.93	14787	22.9457	3.6288	-	4.3219	2.7631	0.4343	1.1164	1.7044	1.2593	1.2459	1.3329	0.7379	2.7057	7.6948	2.5516	1.5789
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)			66.49	10680	16.58	2.62	-	3.12	2.00	0.31	0.81	1.23	0.91	0.90	0.96	0.53	1.95	5.56	1.84	1.14
% of Total			100	-	15	2	-	3	2	< 1	1	1	1	1	1	< 1	2	5	2	1
Groundwater (Sand Filter Beds) (mCi)																				
Total	16.01	1.89	2.11	657	0.1262	0.0880	-	0.0953	0.0272	0.0105	0.0090	0.0385	0.0268	0.0517	0.0127	0.0252	0.0762	0.0670	0.3583	0.1031
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)		11.81	13.18	4104	0.7883	0.5497	-	0.5953	0.1699	0.0656	0.0562	0.2405	0.1674	0.3229	0.0793	0.1574	0.4760	0.4185	2.238	0.6440
% of Total			100	-	6	4	-	5	1	0.5	0.4	2	1	2.5	0.6	1	3.6	3	17	5
Chlorine House (mCi)																				
January	7.17	2.50	3.30	367	0.3396	0.0578	-	0.4511	0.0059	<0.0115	<0.0151	<0.0073	<0.0170	0.053	0.0038	<0.0163	0.3875	0.0884	0.7289	0.3172
February	6.43	2.58	3.28	1311	0.1297	0.0269	-	0.5745	<0.0094	<0.0149	<0.0195	<0.0099	<0.0212	0.041	0.0204	<0.0217	0.6614	0.0644	0.9067	0.1175
March	8.53	2.22	2.34	3223	0.1117	0.0410	-	0.0533	0.0107	0.0478	<0.0140	<0.0066	<0.0155	0.074	0.0173	<0.0147	<0.0126	0.0740	1.042	0.0193
April	8.79	9.94	10.33	1358	<0.2890	0.0220	-	0.3574	0.0353	<0.0713	<0.0758	0.0589	<0.1148	0.089	0.0271	0.4221	0.5159	<0.0576	0.9168	1.020
May	8.77	5.11	5.18	2607	0.0297	0.0206	-	<0.0852	0.0421	0.0027	<0.0211	0.0442	0.0719	0.132	<0.0122	<0.0201	0.0475	0.0904	0.8579	0.0516
June	12.88	4.09	4.27	325	0.1674	0.0310	-	<0.0796	0.0103	0.0148	<0.0206	0.0450	0.0617	0.167	0.0126	<0.0200	<0.0146	0.0410	0.1584	0.2202
July	11.51	1.98	2.08	312	0.0382	0.0099	-	0.0442	0.0221	0.0068	<0.0108	0.0153	0.0417	0.134	0.0220	<0.0099	<0.0130	0.0963	0.5813	0.0501
August	13.74	2.27	2.41	467	0.0398	0.0117	-	0.0835	0.0154	0.0073	<0.0117	0.0157	0.0404	0.148	0.0249	<0.0107	<0.0104	0.169	0.6719	0.0536
September	10.49	1.61	1.80	572	0.0523	0.0119	-	0.1175	0.0216	0.0085	<0.0151	0.0333	0.0408	0.117	<0.0152	<0.0124	<0.0210	0.2727	0.5644	<0.0624
October	8.84	1.17	1.45	237	0.1671	0.0206	-	0.0990	0.0182	0.0112	<0.0185	0.0519	0.1291	0.038	0.0281	<0.0164	<0.0177	0.2298	0.7470	<0.0827
November	10.23	5.50	6.13	2261	0.5565	1.3708	-	<0.4573	0.0771	0.0703	<0.1473	0.4644	<0.2179	0.066	0.0957	<0.1207	<0.1002	0.2148	0.5084	<0.5217
December	9.88	3.96	5.08	1842	1.0799	0.3685	-	<0.1304	0.0350	0.0202	<0.0376	0.1531	<0.0650	0.111	0.0230	<0.0322	<0.0336	0.1670	0.4268	0.1502
Total	117.26	47.93	47.65	14882	2.8563	1.9927	-	2.1568	0.6165	0.2386	0.2039	0.8713	0.6063	1.170	0.2880	0.5699	1.7239	1.5167	8.1104	2.3337
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)			40.64	12691	2.44	1.70	-	1.84	0.53	0.20	0.17	0.74	0.52	1.00	0.25	0.49	1.47	1.29	6.92	1.99
% of Total			100	-	6	4	-	5	1.3	< 1	< 1	2	1	2.5	< 1	1	4	3.2	17	5
Lowland Recharge (mCi)																				
Total	5.18	-	1.09	209	0.1096	0.0080	-	-	0.0090	0.0088	0.0153	0.0378	<0.0068	-	0.0024	0.0095	-	0.0427	-	<0.0013
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)			21.04	4035	2.12	0.15	-	-	0.17	0.17	0.30	0.73	<0.13	-	0.05	0.18	-	0.82	-	<0.03
% of Total			100	-	10	0.7	-	-	0.8	0.8	1.4	3.5	<0.6	-	0.2	0.9	-	4	-	<0.1
Radiation Concentration Guide[4] (10^{-9} μCi/ml)				$3x10^{3}$**	$3x10^{6}$	$2x10^{6}$	$4x10^{4}$		$2x10^{6}$	$1x10^{5}$	$5x10^{5}$		$5x10^{4}$	$1x10^{5}$	300		$1x10^{5}$	300	$9x10^{3}$	$2x10^{4}$	$1x10^{4}$

*Includes gamma only emitters, does not include tritium.

**For mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$, or long lived alpha emitters.

TABLE XIA

1976 BNL Environmental Monitoring Total Activities and Average Concentrations of Identifiable Nuclides in Liquid Effluents

Month	Flow x 10^{10} cm^3	Gβ	Gβ + γ* only	^{3}H	Nuclides														
					^{7}Be	^{22}Na	^{24}Na	^{51}Cr	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	$^{95}ZrNb$	^{125}Sb	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce
Former Perimeter (mCi)																			
January	10.16	2.05	3.52	357	0.2689	0.0157	-	0.9616	<0.0041	<0.0063	<0.0189	0.0029	0.0102		0.0122	<0.0068	1.8750	0.0306	0.2655	0.0455
February	18.28	2.75	3.52	1463	0.1852	0.0232	-	0.5791	0.0100	<0.0165	<0.0218	0.0059	0.0226	0.696	0.0311	<0.0238	0.7988	0.0848	1.2970	0.1221
March	16.76	2.73	2.80	3171	0.1787	0.0331	-	0.1787	0.0133	<0.0073	<0.0107	0.0108	0.0211		0.0115	0.0107	0.0152	0.0919	1.1470	0.1227
April	14.59	10.46	10.59	1172	0.1000	0.9770	-	0.3660	0.0130	<0.0980	<0.0270	0.0240	0.0310		0.0160	0.1690	0.1260	0.0870	3.2819	0.6770
May	14.67	4.87	4.94	1416	0.0298	0.0131	-	0.0334	0.0094	<0.0054	<0.0081	0.0185	0.0092	0.444	0.0109	<0.0077	<0.0091	0.0259	0.3427	0.0398
June	15.55	3.71	3.84	275	0.0590	0.0180	-	0.0651	0.0078	<0.0107	<0.0163	0.0195	0.0239		0.0115	<0.0082	<0.0096	0.0274	0.7990	0.0791
July	10.60	1.59	1.71	245	0.0342	0.0103	-	0.0767	0.0120	0.0060	<0.0096	0.0159	0.0139		0.0101	<0.0087	<0.0124	0.0967	0.5207	0.0442
August	12.35	2.05	2.18	424	0.0633	0.0090	-	0.0494	0.0131	0.0079	0.0127	0.0424	0.0190	0.704	0.0194	<0.0116	<0.0124	0.1297	0.5234	0.0585
September	8.89	1.41	1.55	420	0.0859	0.0121	-	0.0476	0.0047	0.0061	<0.0107	0.0217	0.0148		0.0064	<0.0087	<0.0227	0.1226	0.3928	<0.0449
October	8.04	1.21	1.38	173	0.1090	0.0127	-	0.0496	0.0077	0.0054	<0.0088	0.0162	0.0409		0.0150	<0.0078	<0.0092	0.0963	0.3116	<0.0400
November	8.90	1.95	2.15	1295	0.1781	0.4028	-	<0.1609	0.0246	0.0250	<0.0477	0.1501	0.0659	0.474	0.0436	<0.0404	<0.0378	0.0796	0.2597	<0.1857
December	7.25	4.61	5.07	1119	0.4434	0.4185	-	<0.1475	0.0209	0.0217	<0.0416	0.1623	0.0558		0.0264	<0.0342	<0.0430	0.1043	0.1859	0.1677
Total	146.04	39.09	43.01	11530	1.7355	1.9455	-	2.5615	0.1387	0.1467	0.1241	0.4902	0.3283	2.318	0.2141	0.2588	2.8932	0.9763	6.3263	1.492
Average Concentration(pCi/liter or 10^{-9} μCi/ml)			29.45	7895	1.19	1.33	-	1.75	0.09	0.10	0.08	0.34	0.21	1.59	0.14	0.17	1.90	0.67	4.33	1.02
% of Total			100		4	2	-	6	< 1	< 1	< 1	1	< 1	5	< 1	< 1	7	2	15	3
Site Boundary (mCi)																			
January	23.04	3.72	3.94	525	0.1020	0.0213	-	0.1185	0.0071	0.0010	0.0089	0.0122	<0.0100		0.0145	<0.0086	0.1205	0.0315	0.3681	0.0324
February	29.14	4.43	4.64	1646	0.0490	0.0060	-	0.1280	0.0874	<0.0050	<0.0075	0.0052	<0.0085	0.307	0.0019	<0.0071	0.0255	0.0282	0.1943	0.0373
March	28.59	3.97	4.19	3779	0.1026	0.0199	-	0.0957	<0.0037	<0.0053	<0.0079	0.0062	<0.0086		0.0104	0.0042	<0.0116	0.0256	0.4009	0.0689
April	23.89	17.86	18.20	1411	<0.1020	0.2050	-	0.2400	<0.0130	<0.0200	<0.0270	0.0250	<0.0290		0.0430	0.1350	0.1340	<0.0190	0.4350	0.3050
May	14.92	3.96	4.08	1164	0.0556	0.0134	-	0.0614	<0.0033	0.0016	0.0069	0.0184	<0.0078	0.624	0.0074	0.0021	<0.0084	0.0047	0.3719	0.0126
June	10.45	2.31	2.38	252	0.0304	0.0065	-	0.0357	0.0039	0.0052	<0.0080	0.0113	<0.0118		0.0049	<0.0074	<0.0114	0.0386	0.3307	0.0382
July	8.29	1.41	1.51	212	0.0289	0.0028	-	0.0651	0.0065	0.0049	<0.0079	0.0126	<0.0115		0.0048	0.0069	<0.0140	0.0498	0.2571	0.0362
August	12.51	1.65	1.69	297	0.0374	0.0078	-	<0.0304	0.0033	0.0042	<0.0066	0.0051	<0.0101	0.279	<0.0040	0.0061	0.0143	0.0513	0.1145	0.0311
September	7.09	0.95	1.05	333	0.0394	0.0053	-	0.0556	0.0047	0.0061	<0.0106	0.0328	<0.0115		0.0065	<0.0086	<0.0316	0.0509	0.2396	0.1628
October	5.71	1.42	1.89	88	0.3249	0.0211	-	0.1346	0.0081	0.0104	<0.0164	0.0420	<0.0252		0.0323	0.0147	0.0191	0.0790	0.2675	0.1311
November	4.27	0.71	0.82	417	0.0589	0.0024	-	0.0493	0.0053	0.0041	<0.0063	0.0145	<0.0099	0.162	0.0101	0.0059	0.0081	0.0227	0.0797	0.0304
December	2.53**	2.95	3.50	311	0.4279	0.3040	-	0.1090	0.0142	0.0153	<0.0283	<0.0229	<0.0500		0.0179	0.0236	<0.0355	0.0538	0.1942	0.1138
Total	170.27	45.34	47.89	10435	1.3590	0.4355	-	1.1081	0.1550	0.0628	<0.0833	0.1968	0.1100	1.372	0.1557	0.2144	0.3635	0.4451	3.1655	0.7429
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)			28.13	6128	0.80	0.26	-	0.65	0.09	0.03	<0.05	0.12	<0.06	0.8	0.09	0.13	0.21	0.26	1.86	0.55
% of Total			100	-	3	1	-	2	< 1	< 1	< 1	< 1	< 1	3	< 1	< 1	< 1	< 1	7	1.95
Ground Water (Stream Bed) (mCi)																			
Total	20.87		6.73	1678	0.4559	0.4950	-	<0.2414	0.0346	0.0347	<0.6400	0.2023	0.0962	1.049	0.0514	<0.0519	<0.0607	0.1917	0.8010	0.2615
Average Concentration(pCi/liter, or 10^{-9} μCi/ml)			32.30	8040	2.18	2.37	-	<1.20	0.17	0.17	<3.10	1.00	0.50	5.00	0.25	<0.25	<0.30	0.92	3.84	1.30
% of Total			100	-	7	7	-	< 4	0.5	0.5	< 1	3	1.5	16	0.8	0.8	0.9	3	12	4
Radiation Concentration Guide (pCi/liter or 10^{-9} μCi/ml).			$3x10^{3}$***	$3x10^{6}$	$2x10^{6}$	$4x10^{4}$	-	$2x10^{6}$	$1x10^{5}$	$5x10^{5}$		$5x10^{4}$	$1x10^{5}$	300			300	$9x10^{3}$	$2x10^{4}$	$1x10^{4}$

*Includes gamma emitters, but does not include tritium.

**Grab samples only: due to vandalism at the station.

***For mixtures of radionuclides containing <10% ^{90}Sr, $^{125\text{-}133}I$, or long lived alpha emitters.

TABLE XIB

1976 Dried Sludge Radioactivity in Comparison with the Maximum Permissible Concentration (MPC) for Uncontrolled Release of Insoluble Radioactivity (ERDAM 0524)

Radionuclide	MPC(Insoluble, pCi/ml)	BNL Sludge (pCi/g)
^{90}Sr-Y	4×10^{-5}	4.34×10^{-5}
^{155}Eu	$2 \times .0^{-4}$	1.15×10^{-5}
^{137}Cs	4×10^{-5}	6.21×10^{-5}
^{134}Cs	4×10^{-5}	1.46×10^{-6}
^{54}Mn	1×10^{-4}	1.06×10^{-5}
^{65}Zn	2×10^{-4}	5.58×10^{-5}
^{22}Na	3×10^{-5}	2.20×10^{-6}
^{60}Co	3×10^{-5}	1.33×10^{-4}
^{144}Ce	1×10^{-5}	2.94×10^{-7}
α(Unidentified)	3×10^{-6}	4.56×10^{-6}
α(U)	2×10^{-5}	4.56×10^{-6}

TABLE XIIA

1976 BNL Environmental Monitoring National Pollution Discharge Elimination System
Summary of Monthly Report Data

Parameter	Status	Quantity					Concentration					Frequency of analysis	Sample type
		Minimum	Average	Maximum	Units	No. ex	Minimum	Average	Maximum	Units	No. ex		
Flow	Reported	0.65	0.74	1.02	MGD	0	XX	XX	XX	XX	0	Cont.	NA
	Permit condition	XX	2.3	XX		-	XX	XX	XX	XX	-	Cont.	NA
pH In flow	Reported	6.3	XX	7.0	Std.	0	XX	XX	XX	XX	0	5/7	Grab
	Permit condition	XX	XX	XX	Units.	-	XX	XX	XX	XX	-	Daily	Grab
pH Effluent	Reported	5.8	XX	6.4	Std.	2	XX	XX	XX	XX	0	5/7	Grab
	Permit condition	5.8	XX	9.0	Units.	-	XX	XX	XX	XX	-	Daily	Grab
BOD_5 Influent	Reported	XX	220	XX	lbs/	-	21.1	26.2	33.2	mg/l	0	Weekly	8 hr
	Permit condition	XX	XX	XX	day	-	XX	XX	XX		-	Monthly	8 hr
BOD_5 Effluent	Reported	XX	24.8	XX	lbs/	0	2.8	3.8	4.6	mg/l	0	Weekly	8 hr
	Permit condition	XX	575	863	day	-	XX	30	35		-	Monthly	8 hr
Percent removal, BOD_5	Reported	XX	89	XX	%	2	XX	XX	XX	XX	0	XX	XX
	Permit condition	XX	85	XX		-	XX	XX	XX	XX	-	XX	XX
Suspended solids, Influent	Reported	XX	180	XX	lbs/	0	15.4	21.4	27.0	mg/l	0	Biweekly	8 hr
	Permit condition	XX	XX	XX	day	-	XX	XX	XX		-	Monthly	8 hr
Suspended solids, Efffuent	Reported	XX	4.3	XX	lbs/	0	0.2	1.2	1.3	mg/l	0	Biweekly	8 hr
	Permit condition	XX	575	863	day	-	XX	30	45	mg/l	-	Monthly	8 hr
Percent removal, Suspended solids	Reported	XX	97.5	XX	%	0	XX	XX	XX	XX	0	XX	XX
	Permit condition	XX	85	XX		-	XX	XX	XX	XX	-	XX	XX
Settleable solids, Influent	Reported	XX	XX	XX	XX	-	.4	1.2	2.8	ml/l	0	5/7	Grab
	Permit condition	XX	XX	XX	XX	-	XX	XX	XX		-	Daily	Grab
Settleable solids, Effluent	Reported	XX	XX	XX	XX	-	0.0	0.0	0.0	ml/l	0	5/7	Grab
	Permit condition	XX	XX	XX	XX	-	XX	XX	XX		-	Daily	Grab
Residual Chlorine, Effluent	Reported	XX	XX	XX	XX	-	.7	.9	1.1	mg/l	0	5/7	Grab
	Permit condition	XX	XX	XX	XX	-	XX	XX	XX		-	Daily	Grab
Temperature, Effluent	Reported	12	14.7	17.5	^{o}C	-	XX	XX	XX	XX	0	5/7	Grab
	Permit condition	XX	XX	XX		-	XX	XX	XX	XX	-	Daily	Grab
Fecal coliform, Effluent	Reported	0	0	0	n/100	0	XX	XX	XX	XX	-	Weekly	Grab
	Permit condition	XX	200	400	ml	-	XX	XX	XX	XX	-	Monthly	Grab

XX indicate not required.

TABLE XIIB

1976 BNL Environmental Monitoring Liquid Effluent Quality and Purity

Location	Sample	Chlorides (ppm)	Chlorine residual (ppm)	Coliform total (no./100 ml)	Coliform fecal (no./100 ml)	Dissolved oxygen (ppm)	Dissolved solids (ppm)	Nitrate* nitrogen (ppm)	Total* phosphorus (ppm)	pH	Temperature °C
Sand Filter Bed Effluent	No.	52	249	249	249	249	12	52	52	249	249
	Average	26.7	0.8	<1†	<1†	8.6	123	3.22	0.59	6.1†	15
	Maximum	29.5	2.6	<1	<1	12.9	195	4.15	0.81	7.4	24
	Minimum	24.4	0.0	0	0	6.0	94	2.48	0.45	5.2	3
Upstream of Outfall	No.	18	-	100	100	100	14	18	18	100	100
	Average	6.6	-	159†	36†	6.8	38	0.30	0.05	5.9†	10
	Maximum	8.5	-	551	141	10.6	57	0.42	<0.08	7.6	24
	Minimum	5.0	-	<1	0	3.3	21	0.13	<0.05	4.9	0
Former Perimeter (0.5 mi down-stream)	No.	52	150	150	150	150	12	52	52	150	150
	Average	21.0	0.0	199†	33†	9.3	90	2.18	0.43	6.2†	15
	Maximum	27.9	0.0	603	148	13.0	127	2.93	0.62	6.9	24
	Minimum	14.7	0.0	1	0	6.0	53	0.94	0.27	5.3	0
BNL Perimeter (1.6 mi down-stream)	No.	52	-	155	155	155	12	52	52	155	155
	Average	20.3	-	170†	61†	7.8	90	1.28	0.38	6.6†	11
	Maximum	25.2	-	654	199	15.1	130	2.55	0.57	8.1	28
	Minimum	13.9	-	1	1	1.8	49	0.71	0.22	5.2	0
Water Quality Standard[6,13]	ppm	-	-	-	-	≥4.0	-	-	-	6.5-8.5	Tmax <30

*Weekly composite samples.
†Geometric mean.

TABLE XIV

1976 Meadow-Marsh Project Water Quality and Purity

Parameter	Units	Average		Maximum		Minimum		Water Quality Standard(6)
		Influent	Effluent	Influent	Effluent	Influent	Effluent	
BOD	ppm	148	18	2700	46	11	1	30
Chlorides	ppm	35	31	110	46	25	18	250
MBAS	ppm	0.3	0.2	3.0	1.4	<0.02	<0.02	0.5
pH		6.8	7.5	8.9	9.1	4.8	6.2	6.5 - 8.5*
Suspended Solids	ppm	331	43	4300	100	50	14	30
Dissolved Solids	ppm	203	164	1000	250	127	112	500
Total N	ppm	25	10	91	25	13	2	10
Total P	pmm	7.2	2.2	23.5	5.7	2.5	0.4	-
Total Coliform	Geometric Mean #/100	53900	2080	13750	4900	28400	540	4
Chromium	ppm	0.05	0.01	0.5	0.03	0.01	<0.01	0.05
Copper	ppm	0.7	0.03	3.2	0.14	0.04	<0.01	0.4
Iron	ppm	3.7	1.2	20.0	5.5	0.3	0.3	0.6
Manganese	ppm	0.14	0.1	0.74	0.3	0.06	0.04	0.6
Zinc	ppm	1.4	0.2	4.0	0.6	0.2	0.06	0.6

*Or Natural range

TABLE XVA

1976 BNL Environmental Monitoring Downstream and Control Water Samples

Month	Downstream locations A	B	C	D	R*	Control locations E	F	H
GROSS BETA (pCi/liter or 10^{-9} μCi/ml)								
January	4.56	3.25	3.59	3.54	7.53	3.09	3.05	3.66
February	-	-	-	-	-			
March	5.45	3.74	3.14	4.69	5.25	3.33	3.41	1.33
April	-	-	-		9.23			
May	<1.42	5.87	4.43	<1.46	10.93	2.92	2.79	2.12
June	-	-	-		11.12			
July	5.60	3.84	4.34	4.61	9.08	2.23	1.29	0.99
August	-	-	-	-	9.53			
September	4.91	3.93	4.10	3.50	11.82	2.87	2.68	1.51
October	-	-	-		9.82			
November	4.75	6.14	4.14	5.67	66.65	7.82	3.75	2.11
December	-	-	-	-	-			
Average	4.45	4.46	3.95	3.97	16.08	3.71	2.83	1.95
TRITIUM (HTO) (nCi/liter or 10^{-6} μCi/ml)								
January	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55
February	-	-	-	-	-	-	-	-
March	4.45	3.39	1.39	1.43	0.76	<0.48	<0.51	<0.48
April	-	-	-	-	0.69	-	-	-
May	0.78	<0.55	<0.55	<0.55	<0.33	<0.55	<0.55	<0.55
June	-	-	-	-	<0.26	-	-	-
July	<0.85	<0.85	<0.85	<0.85	<0.60	<0.85	<0.85	<1.42
August	-				<0.40	-		
September	<0.55	<0.55	0.92	<0.55	<0.32	<0.55	<0.55	<0.55
October					<0.39	-		
November	0.93	<0.52	<0.52	<0.52	<0.36	<0.52	<0.52	<0.52
December	-	-	-	-	-	-	-	-
Average	1.35	1.07	0.79	0.74	0.31	<0.58	<0.59	<0.61
^{90}Sr (pCi/liter, or 10^{-9} μCi/ml)								
May	-	-	-	-	0.53	-	-	0.56
June	0.84	0.73	-	-		0.42	-	-
July	-	-	-	-	0.69	-	-	-
August	-	-	<0.09	0.56		-	-	-
November	-	-	-	-	3.48	-	-	<0.09
Radiation Concentration Guide (4)	Gross β: 3000 pCi/liter for mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$ and long lived alpha emitters; HTO: 3000 nCi/liter; ^{90}Sr 300 pCi/liter.							

*Grab samples for January and March. Continuous sampling - April through November.

TABLE XVB

1976 BNL Environmental Monitoring Downstream and Control Water Quality and Purity

Location	Sample	Chlorides (ppm)	Coliform total (no./100 ml)	Coliform fecal (no./100 ml)	Dissolved oxygen (ppm)	Dissolved solids (ppm)	Nitrate nitrogen (ppm)	Phosphorus total (ppm)	pH*	Temperature (°C)
A	No.	6	4	5	6	6	5	6	6	6
	Average	9.6	17*	9*	7.3	47	0.44	0.11	6.2*	12
	Maximum	10.0	114	120	10.8	70	0.88	0.17	6.5	21
	Minimum	9.0	0	0	4.2	24	0.1	0.05	5.8	1
B	No.	5	5	5	6	5	6	5	6	6
	Average	7.9	59*	12*	6.9	46	0.34	0.07	6.3*	12
	Maximum	9.7	620	96	10.6	75	0.79	0.15	6.7	20
	Minimum	5.5	30	0	4.0	28	0.10	0.05	6.0	1
C	No.	6	5	6	6	5	6	6	6	6
	Average	9.2	9*	4*	9.3	42	0.13	0.05	6.7*	12
	Maximum	10.5	160	48	12.6	57	0.15	0.05	7.0	23
	Minimum	8.0	0	0	6.4	33	0.10	0.05	6.4	1
D	No.	6	5	5	6	6	6	5	6	6
	Average	8.2	30*	9*	9.0	50	0.23	0.06	6.6*	12
	Maximum	9.2	510	124	12.2	67	0.37	0.08	7.0	24
	Minimum	8.0	0	0	4.6	38	0.10	0.05	6.1	2
R	No.**	17	18	19	19	13	17	17	19	19
	Average	10.5	168*	57*	9.9	58	0.49	0.11	7.1*	15
	Maximum	12.2	660	588	13.4	76	1.20	0.40	8.6	26
	Minimum	8.5	22	4	7.2	44	0.10	0.05	6.6	4
E	No.									
	Average	See TABLE XII-B								
	Maximum									
	Minimum									
F	No.	6	7	6	6	6	6	6	6	6
	Average	5.8	32*	10*	7.0	31	0.20	0.06	5.8*	13
	Maximum	6.0	360	150	9.2	45	0.53	0.08	6.2	23
	Minimum	5.5	0	0	4.2	18	0.10	0.05	5.4	1
H	No.	6	6	6	6	4	6	6	6	6
	Average	9.9	7*	2*	11	54	0.73	0.05	7.0*	12
	Maximum	12.5	112	30	13	67	1.33	0.05	8.3	23
	Minimum	8.0	0	0	8	35	0.10	0.05	6.7	3
I	No.	6	5	5	6	5	6	6	6	6
	Average	26	17*	8*	10.2	62	0.14	0.05	7.4*	14
	Maximum	28	140	60	12.8	86	0.24	0.05	8.2	28
	Minimum	15	0	0	8.0	20	0.10	0.05	6.8	1
Water Quality Standard[6,13] (ppm)					>4.0				6.5-8.5	Tmax<30

*Geometric mean.

**Continuous biweekly sampling.

TABLE XVI

1976 BNL Environmental Monitoring Concentrations of Selected Gamma Emitting Nuclides in Peconic River Sediments
(pCi/kg or 10^{-9} μCi/g, wet weight)

Location	No. Samples	Nuclides ^{60}Co	Nuclides ^{133}Cs	K g/kg
		Peconic River		
L	4	<2127	<208	4.5
M	4	<2444	<272	4.2
Q'	4	8389	381	3.4
Q	4	<1397	<239	3.8
A'	4	<6648	<429	4.2
A	4	<368	NA	2.1
B	4	<251	NA	3.6
		Reference		
E	4	453	NA	3.7
G	6	146	NA	2.8
J	4	NA	99	2.6
Estimated error at 95% confidence level		± 10%	± 10%	± 25%

NA - Not Available.

TABLE XVII

1976 BNL Environmental Monitoring Concentrations of Selected Gamma Emitting Nuclides in Peconic River and Reference Vegetation (pCi/kg or 10^{-9} μCi/g, wet weight*)

Location	No. Samples	Nuclides							K g/kg
		^{7}Be	^{54}Mn	^{60}Co	^{65}Zn	^{132}Cs	^{134}Cs	^{144}Ce	
					Peconic River				
L	4	NA	118	<362	115	768	39	81	<1.5
M	7	NA	<100	<323	95	<621	30	NA	<1.7
Q'	5	NA	<325	<991	114	<1050	NA	153	<2.4
Q	5	NA	<205	<453	NA	<1100	18	90	1.8
A'	6	NA	53	<279	NA	<2830	<44	NA	<2.0
A	5	NA	<160	<1090	NA	<285	NA	NA	<1.6
B	5	NA	<60	<380	NA	385	NA	NA	<1.0
					Reference				
E	5	NA	NA	NA	NA	<160	NA	NA	<2.6
G	5	NA	NA	NA	NA	4	NA	NA	1.6
J	6	66	NA	NA	NA	<49	NA	NA	1.6

*Wet Weight. Analyses made on dried samples. Data adjusted on the basis of assumed 90% moisture content.

NA - Not Available.

TABLE XVIII

Concentrations of Gamma-Emitting Nuclides in Water, Soil, Vegetation and Animals Obtained from the Peconic River

Station	Phase	Concentration	NUCLIDES											
			^{7}Be	^{24}Na	^{40}K	^{51}Cr	^{54}Mn	^{59}Fe	^{60}Co	^{65}Zn	^{134}Cs	^{137}Cs	$^{140}Ba\text{-}La$	^{144}Ce
E	Water	10^{-10} µCi/ml	-	<2.58	-	-	-	-	-	-	-	-	-	-
	Soil	10^{-10} µCi/g. wet	-	-	31050	-	-	-	<1430	-	-	<4530	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	21400	-	-	-	-	-	-	<1600	-	-
L	Water	10^{-10} µCi/ml	-	3.28	-	-	-	-	-	-	10.8	75.2	-	-
	Soil	10^{-10} µCi/g. wet	-	-	37440	-	-	-	<2080	-	-	<21270	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<12800	-	<1180	-	<3620	1150	392	7680	-	811
M	Water	10^{-10} µCi/ml	-	3.69	-	-	-	-	-	-	10.8	61.0	-	-
	Soil	10^{-10} µCi/g. wet	-	-	35230	-	-	-	<2720	-	-	<24440	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<14000	-	<997	-	<3230	950	<299	<6210	-	-
	Bass - Flesh	10^{-10} µCi/g. wet	-	-	28800	-	-	-	-	-	177	17500	-	-
	Bass - Bones	10^{-10} µCi/g. wet	-	-	-	-	-	-	-	-	-	11400	-	-
	Turtle	10^{-10} µCi/g. wet	-	-	10600	-	-	-	-	-	-	14410	-	-
Q'	Water	10^{-10} µCi/ml	-	5.27	-	<57.0	-	-	-	-	8.51	62.7	-	-
	Soil	10^{-10} µCi/g. wet	-	-	28530	-	-	-	3815	-	-	<83890	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<19900	-	<3250	-	<9910	<1140	-	<10500	-	1530
Q	Water	10^{-10} µCi/ml	-	13.9	-	-	231	<230	-	-	-	40.4	-	-
	Soil	10^{-10} µCi/g. wet	-	-	32150	-	-	-	<2390	-	-	<13970	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	14700	-	<2050	-	<4530	-	182	<11000	-	900
	Frog	10^{-10} µCi/g. wet	-	-	17990	-	-	-	-	-	-	9780	-	6520
A'	Water	10^{-10} µCi/ml	-	2.98	-	-	-	-	-	-	7.61	59.9	-	-
	Soil	10^{-10} µCi/g. wet	-	-	34780	-	-	-	<4290	-	-	<66480	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<1710	-	<530	-	<2790	-	<442	<28300	-	-
A	Water	10^{-10} µCi/ml	-	<2.41	-	-	-	-	-	-	-	17.7	<5.50	-
	Soil	10^{-10} µCi/g. wet	-	-	17290	-	-	-	-	-	-	<3680	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<1330	-	<1600	-	<1090	-	-	<2850	-	-
B	Water	10^{-10} µCi/ml	-	<2.56	-	-	-	-	-	-	-	9.93	<5.12	-
	Soil	10^{-10} µCi/g. wet	-	-	30570	-	-	-	-	-	-	<2510	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<8630	-	<594	-	<3800	-	-	3850	-	-
G	Water	10^{-10} µCi/ml	-	<2.46	-	-	-	-	-	-	-	-	-	-
	Soil	10^{-10} µCi/g. wet	-	-	23910	-	-	-	-	-	-	1460	-	-
	Vegetation	10^{-10} µCi/g. wet	-	-	<13300	-	-	-	-	-	-	<35	-	-
J	Water	10^{-10} µCi/ml	-	5.30	-	-	-	48.0	-	-	34.6	8.20	-	-
	Soil	10^{-10} µCi/g. wet	-	-	-	-	-	-	-	-	-	-	-	-
	Vegetation	10^{-10} µCi/g. wet	666	-	13800	-	-	-	-	-	-	<486	-	-

TABLE XIX

1976 BNL Environmental Monitoring Gross Beta and Tritium Concentrations in Potable Water and Cooling Water Supply Wells

Month	Wells											
	1	2	3	4	5	6	7	101	102	103	104	W&R
GROSS Beta (pCi/liter or 10^{-9} μCi/ml)												
February	<1.2	3.8	-	1.2	0.92	1.4	-	1.08	<1.1	<1.1	-	1.08
May	-	-	-	-	0.79	3.2	0.91	-	-	-	-	-
July	1.2	2.9	8.3	2.0		-	-	-	-	-	3.0	-
September	2.6	-	8.8	1.8	-	-	-	1.13	1.08	1.5	-	-
Average	1.7	3.4	8.5	1.7	0.85	2.3	0.91	1.10	0.82	1.0	3.0	1.08
Radiation Concentration Guide: 3000 pCi/liter (3.0×10^{-6} μCi/ml) for unidentified nuclides in absence of ^{90}Sr, ^{228}Ra or ^{129}I.												
Tritum Concentration(nCi/liter or 10^{-6} μCi/ml)												
February	0.74	<0.52	-	<0.52	<0.70	<0.52	-	-	-	-	-	<0.52
May	-	-	-	-	<0.52	<0.52	<0.52	<0.52	<0.52	<0.52	-	-
July	<0.60	<0.60	<0.60	<0.60	-	-	-	-	-	-	1.9	-
September	0.96	<0.56	<0.56	<0.56	-	-	-	<0.56	<0.56	<0.56	-	-
Average	0.76	<0.56	<0.58	<0.56	<0.61	<0.52	<0.52	<0.54	<0.54	<0.54	1.9	<0.52
Radiation Concentration Guide:(4) 3000 nCi/liter (3×10^{-3} μCi/ml)												

TABLE XXA

1976 BNL Environmental Monitoring Monthly Sump Samples
Gross Beta and ^{3}H Concentrations

Month	N North of AGS		O East of HIRDL		P Medical		*U E. of Steam Plant		*T Linac	
	No. Samples	Concen.	No. Samples	Concen.	No. Samples	Concen.	No. Samples	Concen.	No. Samples	Concen.
GROSS BETA (pCi/liter or 10^{-9} $\mu Ci/cm^3$)										
January	3	7.54	3	3.26	2	2.06	-	-	-	-
February	4	13.26	4	2.90	2	1.92	-	-	-	-
March	4	6.69	4	3.10	4	3.12	-	-	-	-
April	5	13.51	4	3.54	5	3.00	-	-	-	-
May	3	4.69	3	3.96	3	5.05	-	-	-	-
June	4	4.79	4	5.11	4	2.21	-	-	-	-
July	5	4.46	5	4.36	5	2.16	-	-	-	-
August	4	3.47	4	2.88	4	2.28	4	20.89	4	4.56
September	4	21.33	4	3.04	4	2.56	4	11.17	4	3.26
October	5	19.23	4	3.63	4	2.08	5	42.26	5	2.11
November	3	3.74	3	4.48	2	5.37	3	16.90	3	8.42
December	5	20.60	5	3.70	0	-	3	26.30	5	18.36
Total	49		47		39		19		21	
Average		10.92		3.66		2.82		23.50		7.34
Radiation Concentration Guide(4):		3000 pCi/liter or 3×10^{-6} $\mu Ci/ml$								
TRITIUM (nCi/liter or 10^{-6} $\mu Ci/cm^3$)										
January	3	<0.54	3	<0.54	2	<0.53	-	-	-	-
February	4	1.42	4	1.37	2	2.16	-	-	-	-
March	4	0.61	4	<0.55	4	<0.64	-	-	-	-
April	5	0.53	3	0.70	5	0.75	-	-	-	-
May	3	<0.48	4	<0.48	3	<0.48	-	-	-	-
June	4	<0.39	5	<0.36	4	<0.36	-	-	-	-
July	5	0.94	4	0.94	5	0.94	-	-	-	-
August	4	0.86	4	<0.55	4	<0.55	4	<0.55	4	<0.54
September	4	<0.65	4	<0.55	4	<0.55	4	<0.55	4	<0.55
October	5	<0.56	4	<0.42	4	<0.57	5	<0.56	5	<0.56
November	3	<0.53	3	<0.54	2	<0.54	3	<0.53	3	<0.54
December	5	<0.49	5	<0.49	-	-	3	<0.48	5	<0.39
Total	49		47		39		19		19	
Average		0.67		0.64		0.69		0.54		<0.51
Radiation Concentration Guide(4):		3000 nCi/liter or 3×10^{-3} $\mu Ci/ml$								

*Sampling began in August

TABLE XXB

1976 BNL Environmental Monitoring Recharge Basin Water Quality and Purity

Basin	Sample	Chlorides ppm	Coliform total no./100 ml	Dissolved oxygen ppm	Dissolved solids ppm	Nitrate nitrogen ppm	Total P ppm	pH	Temperature °C
N	No.	15	10	45	14	15	15	45	45
North of AGS	Average	19.7	2.4*	9.7	77	0.44	0.34	7.1	16
	Maximum	37.5	87	11.2	110	0.72	1.12	7.8	23
	Minimum	15.5	0	8.0	11	0.19	0.05	6.5	5
O	No.	15	10	45	14	15	15	45	45
East of HFBR	Average	18.2	1*	9.2	75	0.61	0.71	6.8	16
	Maximum	24.5	8	10.0	109	1.41	1.33	7.2	23
	Minimum	14.5	0	7.6	45	0.21	0.05	6.4	9
P	No.	12	10	38	10	11	11	38	38
South of MRR	Average	29.8	1.4*	5.8	105	1.36	0.06	6.5	16
	Maximum	38.6	40	10.7	124	2.05	0.10	7.7	22
	Minimum	18.0	0	4.2	50	0.35	0.05	5.3	9
S	No.	48	49	51	31	49	46	52	52
South of	Average	32.2	19*	9.7	573	0.79	0.16	7.2	14
Warehouse	Maximum	1050†	3080	13.2	13178†	3.05	1.44	8.3	26
	Minimum	5.7	0	7.6	25	0.02	0.05	6.2	0
Water Quality Standard[6]		500	-		1000	20.0	-	6.5-8.5	-

*Geometric mean.

†Correspond to time when roads were heavily salted and sanded.

TABLE XXI

1976 Environmental Monitoring Sand Filter Bed, Peconic River Area, and Miscellaneous On Site Surveillance Wells Gross Alpha, Gross Beta, Tritium, ^{90}Sr and ^{137}Cs, ^{22}Na, ^{58}Co
Average Concentrations

Well	No. Samples	Gross α pCi/liter	Gross β pCi/liter	HTO nCi/liter	^{90}Sr* pCi/liter	^{137}Cs pCi/liter	^{22}Na pCi/liter	^{58}Co pCi/liter	Remarks
				Sand Filter Bed and Peconic River Areas					
XA	6	0.46 ± 0.16	12.6 ± 0.5	7.2 ± 0.2	3.8 ± 0.3	<0.5			
XB	2	<0.15	1.5 ± 0.5	<0.5					
XC	3	0.66 ± 0.20	3.7 ± 0.5	<0.5					
XD	2	0.33 ± 0.20	1.1 ± 0.5	<0.5					
XE	3	<0.27	1.2 ± 0.5	<0.5					
XG	4	0.52 ± 0.23	6.5 ± 0.5	<0.5	0.8 ± 0.1				
XH	3	0.20 ± 0.11	1.5 ± 0.5	<0.5					
XI	1	0.41 ± 0.26	3.1 ± 0.8	<0.5	0.7 ± 0.2				
XJ	1	0.35 ± 0.25	4.7 ± 0.9	<0.5	0.7 ± 0.2				
XK	4	1.00 ± 0.50	18.7 ± 0.8	1.7 ± 0.3	1.4 ± 0.2	<0.5	2.0 ± 1.2††	0.4 ± 0.2	A
XL	3	1.10 ± 0.30	24.0 ± 1.0	2.5 ± 0.3	6.3 ± 0.3	<0.5	0.8 ± 0.2		
XM	4	0.93 ± 0.30	62.8 ± 1.3	1.8 ± 0.3	1.5 ± 0.2	0.7	0.7 ± 0.2	0.8 ± 0.2	
XN	3	1.50 ± 0.30	6.9 ± 0.6	<0.5					
XO	2	0.30 ± 0.20	6.2 ± 0.7	<0.5					
XP	2	0.30 ± 0.20	2.0 ± 0.5	<0.5	<0.09	<0.5			
XQ	4	0.50 ± 0.20	7.4 ± 0.6	2.9 ± 0.3	1.6 ± 0.2				
XR	1	0.50 ± 0.30	2.7 ± 0.7	<0.5	0.8 ± 0.1		0.7 ± 0.3	0.7 ± 0.2	
XS	2	2.00 ± 0.60	13.5 ± 1.0	<0.5	1.8 ± 0.2		0.8 ± 0.2	0.4 ± 0.2	
XT	2	<0.2	1.4 ± 0.5	<0.5					
XU	1	<0.2	2.4 ± 0.8	<0.5					
XV	1	<0.2	45.8 ± 2.7	<0.5					
XW	1	<0.8	1.0 ± 0.9	<0.5					
XX	3	0.30 ± 0.1	9.9 ± 0.7	<0.5	6.3 ± 0.3				
XY	2	0.30 ± 0.2	8.2 ± 0.8	0.6 ± 0.3	1.4 ± 0.1	2.3 ± 0.1	1.0 ± 0.2	0.9 ± 0.2	
XZ	2	<0.1	0.7 ± 0.5	<0.5					
X1	2	0.30 ± 0.2	1.6 ± 0.5	<0.5					
X2	2	<0.2	1.2 ± 0.5	1.0 ± 0.4					
				Miscellaneous On Site					
SA	2	<0.4	2.0 ± 0.6	<0.5					
SB	1	<0.2	1.4 ± 0.7	<0.4	0.2 ± 0.1				
SC	1	<0.2	<1.2	<0.5					
SD	1	<0.2	0.8 ± 0.6	<0.4					
SE	2	<0.3	2.3 ± 0.7	<0.5					
SG	2	<0.2	1.7 ± 0.6	<0.6					
Radiation Concentration Guide(4)		100**	3000†	3000	300	20,000			

*^{90}Sr and ^{137}Cs concentrations established from assay of one sample.

**If ^{226}Ra and ^{220}Ra <10% of activity.

†If $^{125\text{-}133}I$ and ^{90}Sr not present.

††Average of two samples.

A = Activities of additional identified isotypes were.

0.5 ± 0.2	^{60}Co
8.7 ± 3.5	^{7}Be

TABLE XXII

1976 BNL Environmental Monitoring Solid Waste Management Area, Landfill and Former Dump Area and 650 Sump Area on Site Surveillance Wells
Gross Alpha, Gross Beta, Tritium, ^{90}Sr and ^{137}Cs

Well	No. Samples	Gross α pCi/liter	Gross β pCi/liter	HTO nCi/liter	^{90}Sr* pCi/liter	^{137}Cs pCi/liter	^{22}Na pCi/liter	Remarks
				Waste Management Area				
WB	1	<0.6	96.7 ± 3.1	2.5 ± 0.6	7.9 ± 0.5	<0.5		D
WC	1	0.3 ± 0.2	14.2 ± 1.3	0.9 ± 0.1	5.0 ± 0.3	<0.5		
WD	1	0.6 ± 0.4	36.6 ± 2.1	9.2 ± 0.5		<0.5		
WE	1	<0.2	8.0 ± 1.0	1.2 ± 0.4	1.7 ± 0.2			
WI	1	0.8 ± 0.4	5.6 ± 0.9	<0.5	0.2 ± 0.1	<0.5		
WK	1	0.7 ± 0.4	67.0 ± 5.2	6.7 ± 0.7	3.2 ± 0.3			
W1	2	<0.2	63.4 ± 1.9	10.7 ± 0.5	10.7 ± 0.4			
W3	1	<0.4	0.9 ± 0.6	<0.5	<0.09			
W4	1	<0.6	3.1 ± 0.8	<0.5	<0.09			
W5	1	<0.6	3.9 ± 0.9	<0.5				
W7	1	<0.6	<1.0	<0.5	<0.09			
W8	1	<0.6	4.0 ± 0.9	<0.5				
WV	1	<0.2	1.7 ± 0.7	<0.5				
WW	1	<0.3	2.6 ± 0.8	<0.5				
WX	1	<0.2	2.2 ± 0.7	<0.5				
WZ	2	<0.2	1.2 ± 0.5	<0.5	0.3 ± 0.11			
WL	1	<0.4	111.0 ± 2.7	1.1 ± 0.2	62.1 ± 0.9			
				Landfill Area				
WF	2	<0.3	34.9 ± 1.5	<0.5	<0.16			
WG	2	0.3 ± 0.2	2.1 ± 0.5	0.6 ± 0.3				
WR	3	10.1 ± 3.9	56.0 ± 3.0	401.0 ± 1	5.5 ± 0.7	<0.5	6.4 ± 0.4	A
WS	4	3.7 ± 1.3	64.3 ± 2.8	282.0 ± 2	3.5 ± 0.3	<0.5	4.8 ± 0.2	B
WT	1	0.8 ± 0.5	2.5 ± 0.8	<0.4	0.1 ± 0.1			
W6	2	<0.7	3.3 ± 0.7	<0.5	0.4 ± 0.1			
W9	2	5.2 ± 2.1	62.2 ± 2.2	81.2 ± 2.6	16.6 ± 1.5	<0.5		C
1K	3	5.3 ± 2.6	12.2 ± 1.4	42.7 ± 0.7	3.4 ± 0.3	<0.5	1.4 ± 0.2	
				Former Dump Area				
WH	2	<0.4	2.6 ± 0.6	<0.5	0.4 ± 0.1			
WO	2	<0.4	1.3 ± 0.6	<0.5	<0.1			
WP	2	<0.2	2.8 ± 1.6	0.7 ± 0.3	<0.2			
WQ	2	<0.2	1.3 ± 0.6	<0.5	<0.1			
1I	3	<0.2	3.2 ± 0.5	<0.5				
1J	3	<0.2	1.4 ± 0.4	<0.5				
				650 Sump Area				
1A	2	<0.2	25.6 ± 1.3	0.6 ± 0.5	21.6 ± 0.6	<0.5		
1B	1	<0.5	3.0 ± 0.8	<0.5	0.3 ± 0.1			
1C	1	<0.5	2.5 ± 0.8	<0.5				
1E	2	<0.3	65.8 ± 1.9	0.7 ± 0.5	60.1 ± 0.8	<0.5		
1F	1	<0.3	21.1 ± 1.8	<0.5	0.2 ± 0.1	<0.5		
1G	1	<0.5	2.8 ± 0.8	<0.5				
1H	2	<0.3	175.0 ± 3.0	<0.7	51.2 ± 0.8	<0.5		
Radiation Concentration Guide[4]		100**	3000†	3000	300	2×10^4		

*^{90}Sr and ^{137}Cs concentrations established from assay of one sample.

**If ^{226}Ra and ^{220}Ra absent.

†If $^{125\text{-}133}I$ and ^{90}Sr absent.

Remarks:

A Activities of additional identified isotopes 3.0 ± 0.5 pCi/liter of ^{60}Co
5.6 ± 2.3 pCi/liter of ^{7}Be
0.9 ± 0.3 pCi/liter of ^{58}Co

B Activities of additional identified isotopes 3.1 ± 0.5 pCi/liter of ^{60}Co
16.7 ± 3.6 pCi/liter of ^{7}Be

C Activities of additional identified isotopes 0.6 ± 0.2 pCi/liter of ^{60}Co

D Activities of additional identified isotopes 32.3 uCi/ml of ^{7}Be

TABLE XXIII

1976 BNL Environmental Monitoring Lowland Recharge Surveillance Wells, Gross Alpha, Gross Beta, and Tritium Concentrations

Well	No. Samples	Gross α (pCi/liter)	Gross β (pCi/liter)	HTO (nCi/liter)
1N	2	<0.2	1.9 ± 0.5	<0.5
1Q'	1	<0.2	2.3 ± 0.8	<0.5
1Q	2	<0.2	9.7 ± 0.8	<0.5
1R	2	<0.2	2.0 ± 0.5	0.8 ± 0.5
1T	2	<0.2	7.8 ± 0.8	<0.5
1W	2	0.6 ± 0.3	3.7 ± 0.6	1.1 ± 0.3
1X	1	0.9 ± 0.5	3.5 ± 0.9	1.5 ± 0.5
1Y	2	1.4 ± 0.9	13.6 ± 1.2	1.5 ± 0.9
1Z	1	0.6 ± 0.4	2.9 ± 0.6	<0.5
11	1	6.9 ± 3.4	4.3 ± 1.4	2.2 ± 0.6
12	2	<0.5	5.7 ± 0.8	1.2 ± 0.4
14	1	<0.4	3.0 ± 0.8	1.5 ± 0.5
15	1	<0.3	8.5 ± 1.3	2.1 ± 0.6
Radiation Concentration Guide[4]		100*	3000**	3000

*If long lived alpha emitters not present.

**If ^{90}Sr, $^{125\text{-}133}I$ not present.

TABLE XXIVA

1976 BNL Environmental Monitoring Sand Filter Beds, Peconic River and Miscellaneous On Site Ground Water Surveillance Wells, Water Quality and Purity*

Well	Samples	pH	Chlorides ppm	Do ppm	Dissolved solids ppm	Nitrate nitrogen ppm	Total P ppm	Temperature °C
			Sand Filter Bed and Peconic River Area					
XA	5	6.0	24.0	6.8	117	3.7	<0.05	16
XB	2	6.6	6.1	5.8	40	<0.1	0.07	11
XC	2	5.7	6.8	1.3	31	<0.1	<0.05	11
XD	3	6.1	4.4	4.0	33	<0.1	0.08	12
XE	3	5.5	5.3	6.8	35	0.3	<0.05	13
XG	4	6.0	9.7	6.5	58	0.2	0.10	13
XH	3	6.1	6.9	4.9	29	0.1	<0.05	11
XI	1	5.4	7.0	5.8	33	0.1	<0.05	10
XJ	1	5.5	6.0	3.2	33	0.1	<0.05	9
XK	4	6.2	25.1	1.6	111	0.2	0.07	12
XL	3	6.3	20.8	2.7	109	0.3	0.05	12
XM	4	6.0	21.5	7.6	86	0.6	0.06	17
XN	3	4.7	6.7	6.9	48	0.6	<0.05	8
XQ	5	6.3	21.1	2.1	85	0.1	<0.05	13
XR	1	5.6	4.2	6.8	18	0.1	0.12	10
XS	2	5.5	10.8	7.2	79	0.7	<0.05	11
XT	2	7.2	5.0	2.4	56	<0.1	0.22	12
XU	1	5.3	6.0	1.3	222	<0.1	<0.05	11
XW	1	5.4	28.7	1.5	84	<0.1	<0.05	12
XX	3	5.8	8.3	1.6	40	<0.1	0.09	11
XY	2	5.1	13.5	2.5	56	0.3	<0.05	13
XZ	2	5.5	4.8	5.0	37	1.0	<0.05	12
X1	2	5.2	6.5	5.0	40	<0.1	<0.05	10
X2	2	5.8	18.9	2.7	66	0.2	<0.05	12
			Miscellaneous On Site Wells					
SA	2	5.8	29.5	3.5	111	0.4	<0.05	12
SB	1	5.8	6.5	8.6	36	<0.1	<0.05	10
SC	1	6.0	5.5	6.8	34	<0.1	<0.05	11
SD	1	5.5	6.5	8.8	23	<0.1	<0.05	10
SE	2	6.4	23.0	7.8	113	1.4	<0.05	14
SG	2	6.2	11.8	8.4	63	<0.1	<0.05	12
Water Quality Standard[6]		6.5-8.5	500		1000	20		

*All samples were analyzed for fecal and total coliforms. All results were less than 1 colony/100ml.

TABLE XXIVB

1976 BNL Environmental Monitoring Solid Waste Management Area, Landfill and Dump Area, and 650 Sump Area Groundwater Wells, Water Quality and Purity*

Well	No. Samples	pH	Chlorides ppm	DO ppm	Dissolved solids ppm	Nitrate nitrogen ppm	Total P ppm	Temperature °C
			Solid Waste Management Area					
WB	2	5.8	7.8	6.6	44	0.44	<0.05	15
WC	2	5.5	5.1	4.6	51	<0.10	<0.05	14
WD	2	5.6	6.4	6.6	79	1.85	<0.05	13
WE	2	5.9	2.6	8.4	34	<0.10	<0.05	12
WI	1	5.7	3.5	5.2	52	<0.10	<0.05	10
WK	1	5.6	8.0	7.2	66	1.27	<0.05	10
W-1	2	5.6	3.5	8.8	40	0.55	<0.05	12
W-3	2	6.2	6.4	6.2	92	1.31	<0.05	11
W-4	1	6.1	3.4	10.0	37	0.31	<0.05	10
W-5	1	6.1	4.9	9.2	44	0.11	<0.05	10
W-7	1	6.3	6.8	6.2	56	0.53	<0.05	10
W-8	1	6.2	3.4	9.0	38	0.15	<0.05	11
WV	1	5.8	5.0	8.0	28	0.10	<0.05	11
WW	1	5.7	9.5	8.8	46	0.35	<0.05	10
WX	1	6.0	8.5	7.0	40	0.36	<0.05	9
WZ	2	6.3	7.0	8.2	48	0.10	<0.05	11
			Landfill Area					
WF	2	5.9	6.2	8.8	39	0.43	0.06	12
WG	2	5.7	4.3	9.1	34	<0.10	<0.05	13
WR	3	6.7	4.8	3.2	658	0.29	<0.05	14
WS	4	6.8	4.3	1.7	437	0.25	<0.05	12
WT	1	5.7	9.5	1.8	64	<0.10	<0.05	11
W6	2	6.8	27.6	1.9	223	0.19	<0.05	9
W9	3	7.0	4.8	3.1	582	0.38	<0.05	12
1K	3	6.6	86.0	1.5	457	0.22	<0.30	12
			Former Dump Area					
WH	2	6.2	19.2	7.2	91	0.40	<0.05	16
WO	2	6.0	6.3	8.5	47	<0.10	<0.05	11
WP	2	5.4	8.6	3.1	46	2.02	<0.05	12
1-I	4	5.6	6.8	8.6	39	0.30	<0.05	12
1-J	2	5.8	5.8	10.9	30	<0.10	<0.05	12
			650 Sump Area					
1-A	2	6.2	17.8	7.1	67	0.40	0.06	16
1-B	1	6.6	15.5	5.5	74	0.40	<0.05	17
1-C	1	6.6	18.5	6.9	83	0.50	0.35	17
1-D	1	6.6	16.0	6.2	72	0.40	<0.05	17
1-E	2	6.2	18.3	7.9	63	0.50	<0.05	15
1-F	1	6.5	15.7	7.9	68	0.90	0.07	15
1-G	1	7.2	18.5	6.4	79	0.50	<0.05	17
1-H	1	5.8	13.0	5.0	76	1.08	<0.05	17
Water Quality Standard(6)		6.5-8.5**	500		1000	20.0		

*Each sample analyzed for total and fecal coliforms. All results were less than 1 colony/100 ml.
**Or natural background range.

TABLE XXIVC

1976 BNL Environmental Monitoring Samples, Meadow-Marsh Project - Ground Water Surveillance Wells, Quality and Purity

Plot	Type	Map No.	pH*	Chlorides ppm	Conductance μmho/cm	Nitrate N	Total P ppm	Dissolved Oxygen ppm	Total Coliforms MPN/100*
Boundary	Control	1N	6.3	6.1	72	0.25	0.05	9.8	0
	Control	1Q	5.5	3.6	102	1.65	0.06	0.8	0
	Control	1R	5.6	5.1	35	0.56	0.05	9.2	0
Pine and Oak Forest	Primary	1W	5.8	5.7	52	1.65	0.05	9.2	0
	Secondary	1Z	5.7	6.8	47	0.10	0.05	9.2	0
	Control	1T	5.1	10.4	78	2.13	0.05	9.2	0
Pine Forest	Primary	1Y	5.7	11.5	148	8.40	0.05	6.0	0
	Secondary	1-2	5.7	7.3	96	1.50	0.05	3.2	0

*Geometric Mean.

TABLE XXIVD

1976 BNL Environmental Monitoring Groundwater Surveillance Wells, Water Quality-Metals

Well	Samples	Metals (in ppm) Ag	Cd	Cr	Cu	Fe	Pb	Zn
				Sand Filter Beds				
XA	1	0.010	0.0007	0.015	0.006	0.13	0.004	0.177
XB	1	0.004	0.0005	0.007	0.006	0.30	0.022	0.450
XK	1	0.004	0.0005	0.007	0.006	1.78	0.004	0.770
				Peconic Downstream				
XM	2	0.007	0.0006	0.011	0.011	7.46	0.005	1.010
XQ	1	0.007	0.0011	0.008	0.005	3.50	0.009	0.235
XX	1	0.010	0.0004	0.015	0.006	4.40	0.003	0.146
				Upland Recharge				
1Q	1	0.010	0.0004	0.015	0.006	0.22	0.036	0.015
				Landfill and Former Dump				
1I	1	0.005	0.0020	0.008	0.006	1.47	0.005	0.025
WF	1	0.005	0.0005	0.008	0.007	0.10	0.007	0.458
WG	1	0.005	0.0050	0.008	0.007	0.79	0.004	0.135
WH	1	0.005	0.0050	0.008	0.007	0.14	0.006	0.417
WP	1	0.004	0.0009	0.007	0.011	1.41	0.004	0.030
WR	1	0.010	0.0020	0.008	0.022	1.57	0.108	0.240
WS	1	0.010	0.0020	0.008	0.034	86.00	0.041	0.630
W9	1	0.010	0.0020	0.008	0.011	139.00	0.115	0.200
				Potable Supply				
2	1	0.007	0.0005	0.008	0.014	1.51	0.006	0.008
5	1	0.005	0.0050	0.008	0.009	0.21	0.004	0.169
6	1	0.005	0.0005	0.008	0.021	0.48	0.006	0.009
7	1	0.005	0.0005	0.008	0.007	2.26	0.005	0.008
104	1	0.007	0.0005	0.008	0.005	0.73	0.005	0.011
Water Quality Standard (6)		0.100	0.020	0.100	0.400	0.600	0.100	0.600

TABLE XXV

1976 BNL Environmental Monitoring Concentrations of ^{90}Sr, ^{131}I and ^{137}Cs in Milk[a]

		Farm - 10 km SE					Farm - 40 km E				
Quarter/Month	Sample	HTO pCi/liter	^{90}Sr pCi/liter	^{131}I pCi/liter	^{137}Cs pCi/liter	K g/liter	HTO pCi/liter	^{90}Sr pCi/liter	^{131}I pCi/liter	^{137}Cs pCi/liter	K g/liter
1	No.	3	4	3	3	3	3	4	3	3	3
(January	Average	<400	8.1	<2.3	<14	1.64	<467	4.7	2.2	10.7	1.60
February	Maximum	<400	8.6	<	<19	1.75	<600	5.3	<3	15	1.65
March)	Minimum	<400	7.5	<2	<10	1.49	<400	3.8	<1.7	<8	1.55
March[b]	1 sample	-	-	<10	28.2	1.31	-	-	-	-	-
2	No.	3	5	3	3	3	2	4	2	2	2
(April, May	Average	<267	5.4	<2.0	<14	1.48	<300	5.4	<1.8	<17	1.37
June)	Maximum	<300	10.7	<3.0	<16	1.65	<300	6.6	<1.8	<17	1.43
	Minimum	<200	2.7	<1.3	<12	1.36	<300	3.9	<1.8	<17	1.31
3	No.	2	3	2	2	2	2	3	2	2	2
(July, August	Average	<500	8.7	<3	<17	<1.41	<500	4.3	<3	<15	1.27
September)	Maximum	<500	14.0	<4	<19	<1.53	<600	6.7	<3	<18	1.42
	Minimum	<500	2.7	<2	<15	<1.29	<400	1.1	<3	<12	1.31
July[b]	2 samples	-	-	<10	29.4	1.25	-	-	<10	31.5	1.16
October 5[b,c]	1 sample	-	-	<7	-	-	-	-	98	-	-
October	No.	-	7	6	-	-	-	2	7	-	-
5-9[b,c]	Average		8.9	185				3.2	128		
	Maximum		11.80	289				4.2	169		
	Minimum		6.00	151				2.2	70		
October	No.	-	1	5	-	-	-	1	5	-	-
10-15[b,c]	Average		10.6	79				5.6	118		
	Maximum			150				-	121		
	Minimum			67					47		
October 19 to	No.	-	-	6	-	-	-	-	6	-	-
November 24[b,c]	Average			<36					<50		
	Maximum			<50					<87		
Radiation Concentration Guide(4)		3×10^6	200[d]	100[d]	4×10^4	-	3×10^6	200[d]	100[d]	4×10^4	-

[a] Data from sampling and analyses by New York State Department of Environmental Conservation.

[b] Done by Safety and Environment Protection.

[c] Corresponds to the period of fallout from the Chinese tests of September and November 1976.

[d] Based on Federal Radiation Council Guide[(22)] Range II, upper limit, and on assumed intake of 1 liter/day.

TABLE XXVI

1976 BNL Environmental Monitoring: Concentrations of ^{131}I and other Gamma Emitting Nuclides in Precipitation, Air Particulates, Vegetation and Milk, following the Chinese Bomb Test of September 26, 1976

Phase	Grass						Grass	Milk	Grass	Milk	Rainfall	Air Particulates
Nuclide	← ^{95}Zn-Nb →		← ^{140}Ba-La →		← ^{141}Ce* →		←			^{131}I		→
Concentration	←		pCi/kg			→	pCi/kg	pCi/l	pCi/kg	pCi/l	mCi/m^2	pCi/m^3
Location	A	B	A	B	A	B	A	A	B	B	←	BNL →
Date												
9-30											2.11	
10-4												
10-5								<7		126		1.9×10^{-14}
10-6								156		146		
10-7		11000		2100		18300		189	2500	142		
10-8								289		164	0.53	$<8 \times 10^{-15}$
10-9								172		80		6.2×10^{-14}
10-10	12000	6000	2500	2200	15000	10000	3300	153*	2800	121		$<10^{-14}$
10-11								67		95		$<10^{-14}$
10-12								133		78		
10-13	15000	14000	2200	2500	23000	23000	1900	135	2000	53		
10-15								107		47		
10-19								77		<15		
Estimated Minimum Detection Limit	300		100		100		100	10	100	10	5pCi/l	

*Base on ^{144}Ce Fit.
**Average of three samples.

Note: Milk: Ambient ^{131}I levels less than minimum detectable.

Location: A: Thee's Dairy, Center Moriches, 10 km SE (Suffolk Co.)
B: Cowneck Farm, Southhampton, 40 km E (Suffolk Co.)

TABLE XXVII

1976 BNL Environmental Monitoring Incremental Population Exposure Due to BNL Airborne Effluents Compared with Background

Distance from HFBR stack (mi.)	X/Q	Dose rate mrem/yr	Population	Annual dose person-rem	Background dose, person-rem
1-2	2.4×10^{-7}	1.8859	1,672	3.153	136
2-3	1.0×10^{-7}	0.8043	5,710	4.592	464
3-4	6.0×10^{-8}	0.4604	11,030	5.078	895
4-5	3.9×10^{-8}	0.2995	19,300	5.780	1,565
5-10	1.7×10^{-8}	0.1331	258,710	34.434	20,981
10-15	8.0×10^{-9}	0.0638	241,240	15.391	19,565
15-20	5.5×10^{-9}	0.0416	184,250	7.665	14,943
20-30	3.8×10^{-9}	0.0277	994,060	27.535	80,618
30-40	2.7×10^{-9}	0.0222	1,502,900	33.364	121,885
40-50	2.1×10^{-9}	0.0166	1,948,290	32.342	158,057
1-50	-	-	5,167,192	169.334	419,109

TABLE XXVIII

1976 BNL Environmental Monitoring Off Site Dose Rates and Doses Due to BNL Gamma Forest and AGS

		Gamma Forest				AGS			
Sector	r miles	Distance miles	Dose rate mR/yr	Population	Man rem	Distance miles	Dose rate mR/yr	Population	Man rem
SSW	1-2	--	--	0	--	--	--	0	--
	2-3	>3	$<10^{-13}$	310	$<10^{-13}$	2.73	2.3×10^{-4}	310	7.1×10^{-5}
SW	1-2	--	--	0	--	--	--	0	--
	2-3	>3	$<10^{-13}$	215	$<10^{-13}$	2.67	2.9×10^{-4}	215	6.2×10^{-5}
WSW	1-2	--	--	0	--	--	--	0	--
	2-3	>3	$<10^{-13}$	495	$<10^{-13}$	2.48	7.4×10^{-4}	495	3.7×10^{-4}
W	1-2	2.7	2.7×10^{-12}	200	5.3×10^{-13}	1.55	1.7×10^{-2}	200	3.3×10^{-3}
	2-3	>3	$<10^{-13}$	990	$<10^{-13}$	2.39	7.4x10-4	990	7.4×10^{-4}
WNW	1-2	2.6	1.8×10^{-11}	255	4.5×10^{-12}	1.33	4.1×10^{-3}	255	1.1x10-3
	2-3	>3	$<10^{-13}$	735	$<10^{-13}$	2.26	1.1×10^{-3}	735	8.4×10^{-4}
NW	1-2	2.1	1.3×10^{-11}	255	3×10^{-12}	1.22	6.8×10^{-2}	255	1.7×10^{-2}
	2-3	>3	$<10^{-13}$	175	$<10^{-13}$	2.17	1.7×10^{-3}	175	2.9×10^{-4}
NNW	1-2	1.73	1.1×10^{-6}	200	2.1×10^{-7}	1.22	6.8×10^{-2}	200	1.4×10^{-2}
	2-3	>3	$<10^{-13}$	86	$<10^{-14}$	2.15	1.7×10^{-3}	86	1.4×10^{-4}
N	1-2	1.31	2.6×10^{-9}	335	8.9×10^{-10}	1.44	2.7×10^{-2}	335	9×10^{-3}
	2-3	--	--	0	--	--	--	0	--
NNE	1-2	0.84	0.045	200	0.009	1.55	1.7×10^{-2}	200	3.3×10^{-3}
	2-3	1.48	2.7×10^{-5}	495	1.31×10^{-5}	2.26	1.1×10^{-3}	495	5.6×10^{-4}
NE	1-2	0.73	0.81	99	0.08	1.77	7.0×10^{-3}	99	7.0×10^{-4}
	2-3	1.22	5.3×10^{-4}	240	1.27×10^{-4}	2.15	1.1×10^{-3}	240	2.7×10^{-4}
ENE	1-2	--	--	0	--	--	--	0	--
	2-3	--	--	0	--	--	--	0	--
E	1-2	--	--	0	--	--	--	0	--
	2-3	1.72	1.33×10^{-6}	135	1.79×10^{-7}	2.15	5.2×10^{-4}	135	7.0×10^{-5}
ESE	1-2	--	--	0	--	--	--	0	--
	2-3	2.2	1.77×10^{-9}	280	5.0×10^{-10}	2.70	2.7×10^{-4}	280	7.5×10^{-5}
SE	1-2	--	--	0	--	--	--	0	--
	2-3	--	--	0	--	--	--	0	--
SSE	1-2	2.5	1.32×10^{-10}	63	8.36×10^{-12}	2.11	2.1×10^{-3}	63	1.3×10^{-4}
	2-3	>3	$<10^{-13}$	700	$<10^{-13}$	2.79	1.9×10^{-4}	700	1.3×10^{-4}
S	1-2	2.7	2.66×10^{-12}	-	1.67×10^{-13}	2.03	2.7×10^{-3}	63	1.7×10^{-4}
	2-3	>3	$<10^{-13}$	855	$<10^{-13}$	2.79	1.9×10^{-3}	855	1.6×10^{-3}
Total					0.08				0.05

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