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1979 ENVIRONMENTAL MONITORING REPORT

J.R. NAIDU, Editor

April 1980

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY

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J.R. NAIDU, Editor

Reviewed by: A.P. Hull
Data Compilation and Quality Control by: A.R. Moorthy and J.R. Steimers
Computer Data Analysis and Tabulation by: N.J. Fallon and A.V. Kuehner

Contributors

E. Hartmann	L.L. Olmer
D.M. Henze	D.L. Smith
D.P. Higby	J.R. Steimers
L.E. McHerron	A.M. Wallner
A.R. Moorthy	V.J. White
J.A. Nobile	P.E. Wildenborg

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SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY
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BROOKHAVEN NATIONAL LABORATORY
ENVIRONMENTAL MONITORING REPORT

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1.0 INTRODUCTION

1.1 Background:

The primary purpose of a routine environmental monitoring program, according to DOE Manual Chapter 0513(1), is to determine whether:

1) facility operations, waste treatment, and control systems have functioned as designed and planned from the standpoint of containment of radioactivity, and

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

Brookhaven National Laboratory's (BNL) environmental monitoring program is designed and developed to accomplish these two primary objectives. While this annual report follows the recommendations given in ERDA 77-24, "A Guide for Environmental Radiological Surveillance at DOE's Installations" (2), considerable latitude has been exercised in tailoring the scope and methodology to meet the site's specific environmental monitoring needs. In addition, the Laboratory has extended its surveillance program to include analysis of the environment for nonradiological components such as heavy metals and organics. This latter program is being regularly updated to reflect the growing concern about nonradiological pollutants.

1.2 Site Characteristics:

Brookhaven National Laboratory is a multidisciplinary scientific research center situated in the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to surrounding communities is shown in Figure 1. About 1.3 million people live in Suffolk County (3,4). The principal nearby population centers are located in shoreline communities. Table 1 gives the resident population distribution within 80 km of the BNL site. Though much of the land area within a 16 km radius is either forested or under cultivation, there is a transition towards development of suburban housing in proximity to the Laboratory.

The Laboratory site is shown in Figure 2. It consists of some 2130 ha, most of which is wooded, except for a developed area of about 655 ha. The site terrain is gently rolling, with elevations varying between 36.6 and 13.3 m above sea level. The land lies on the western rim of the shallow Peconic River watershed, with 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 ground level 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 at an elevation of 108 m, as observed by the BNL Meteorology Group, which is shown in Figure 3.

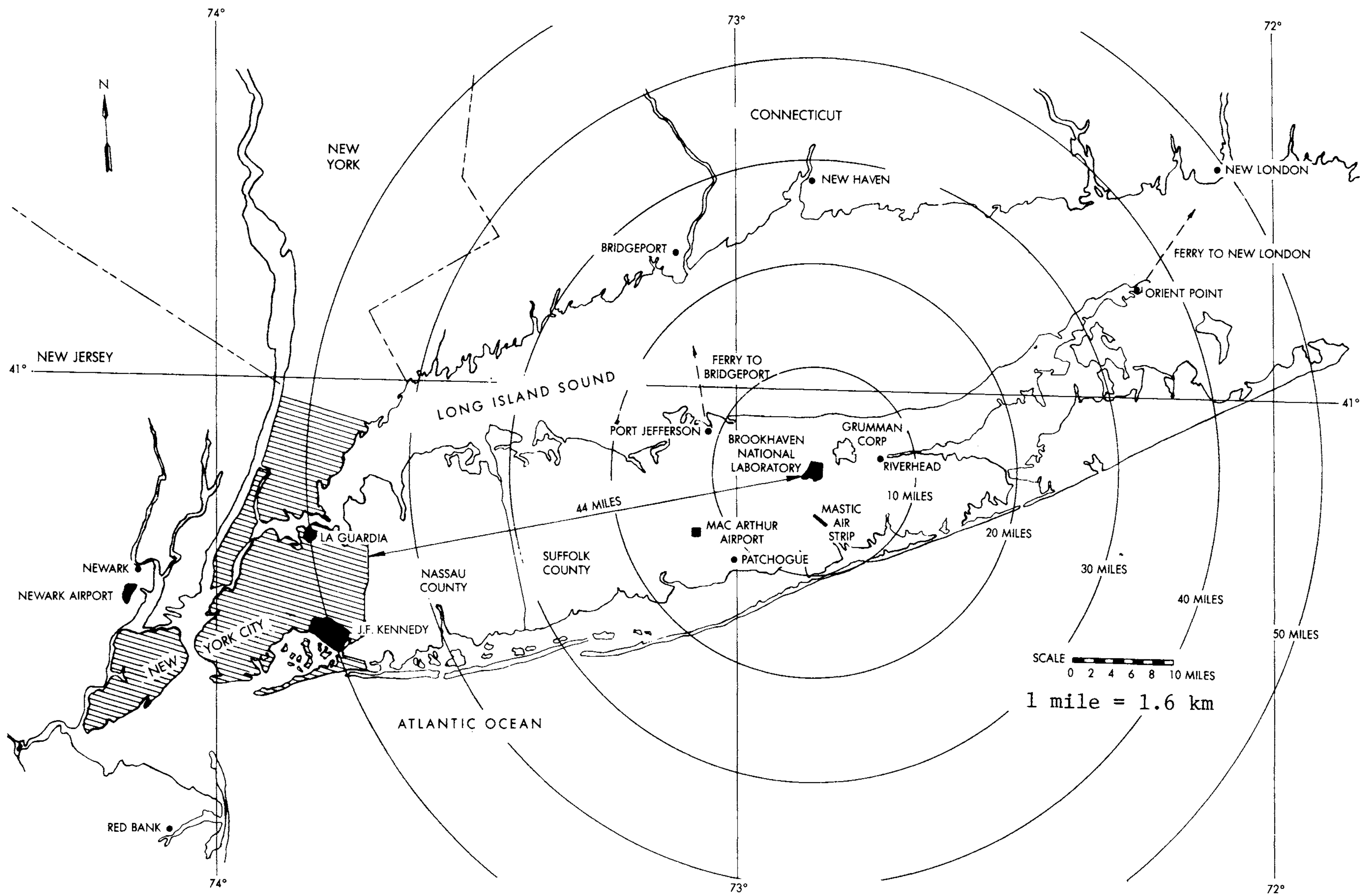


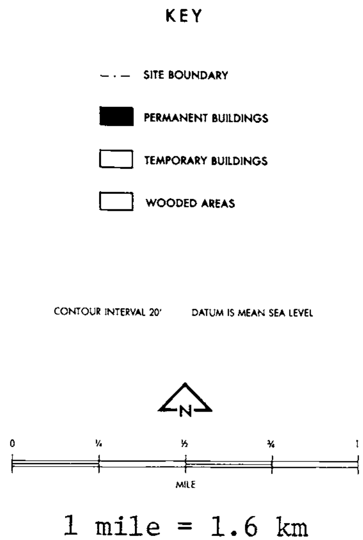
Figure 1. Map of the General Long Island Area Showing the Location of Brookhaven National Laboratory

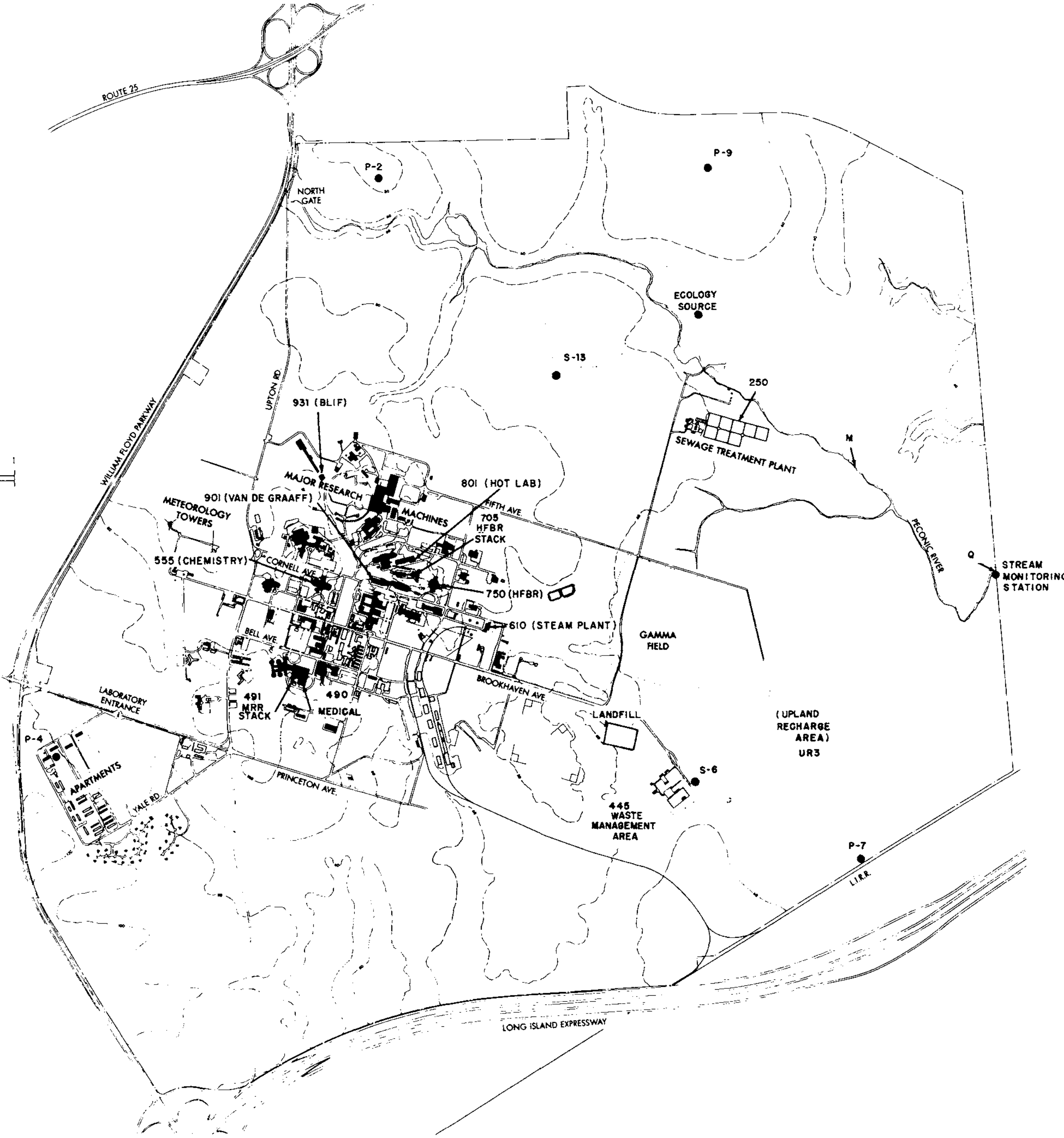
TABLE 1

1979 BNL Environmental Monitoring Resident Population (1979)[a]
Distribution Within 80 km Radius of BNL

Sector	0- 16 km (10 mi)	16- 32 km (20 mi)	32- 48 km (30 mi)	48- 64 km (40 mi)	64- 80 km (50 mi)	Total	Remarks
SSW	19,496	998	0	0	0	20,494	Beyond 32 km - Atlantic Ocean
SW	38,388	59,698	3,165	0	0	101,251	Beyond 48 km - Atlantic Ocean
WSW	34,619	132,802	327,784	426,904	764,169	1,686,278	Beyond 80 km - Part of New York City
W	45,216	122,556	220,678	227,073	369,930	985,453	Beyond 80 km - New York City
WNW	38,103	53,083	100	201,804	121,881	414,971	Between 32 km & 48 km - Long Island Sound and beyond 48 km - Connecticut and New York States.
NW	16,413	1,425	127,910	115,460	105,044	366,252	Same as WNW
NNW	6,995	0	197,286	101,199	51,197	356,677	Between 16 km and 32 km - Long Island Sound, beyond 20 km - Connecticut.
N	4,143	0	88,352	234,167	244,355	571,017	Same as NNW
NNE	6,905	0	6,526	41,783	61,738	116,952	Same as NNW
NE	2,685	682	0	12,625	30,869	46,861	Between 32 km and 48 km - Long Island Sound, beyond - Connecticut
ENE	2,275	6,408	11,849	13,450	2,022	36,004	North Fork of Long Island
E	2,755	14,424	15,702	8,192	501	41,574	South Fork on Long Island and Atlantic Ocean.
ESE	5,608	6,945	0	0	0	12,553	Long Island and Beyond 32 km - Atlantic Ocean.
SE	8,270	0	0	0	0	8,270	Beyond 18 km - Atlantic Ocean
SSE	20,414	0	0	0	0	20,414	Same as SE
S	15,107	18	0	0	0	15,125	Beyond 32 km - Atlantic Ocean
Total	267,392	399,039	999,352	1,382,657	1,751,706	4,800,146	

[a]Population data estimated from information supplied by Ms. Peggy Wagner, Research Analyst, Long Island Regional Planning Board [3,4].





Environmental Monitoring Stations

<u>Air</u>
P-2 Northwest perimeter
P-4 Southwest perimeter
P-7 Southeast perimeter
P-9 Northeast perimeter
S-6 Waste Management Area
S-13 SW Corner, Ecology Field

<u>Water</u>
250 Sewage Treatment Plant
M Peconic River, 0.5 mi. downstream
Q Site Boundary
UR-3 Upland Recharge Project

Figure 2. Brookhaven National Laboratory Site

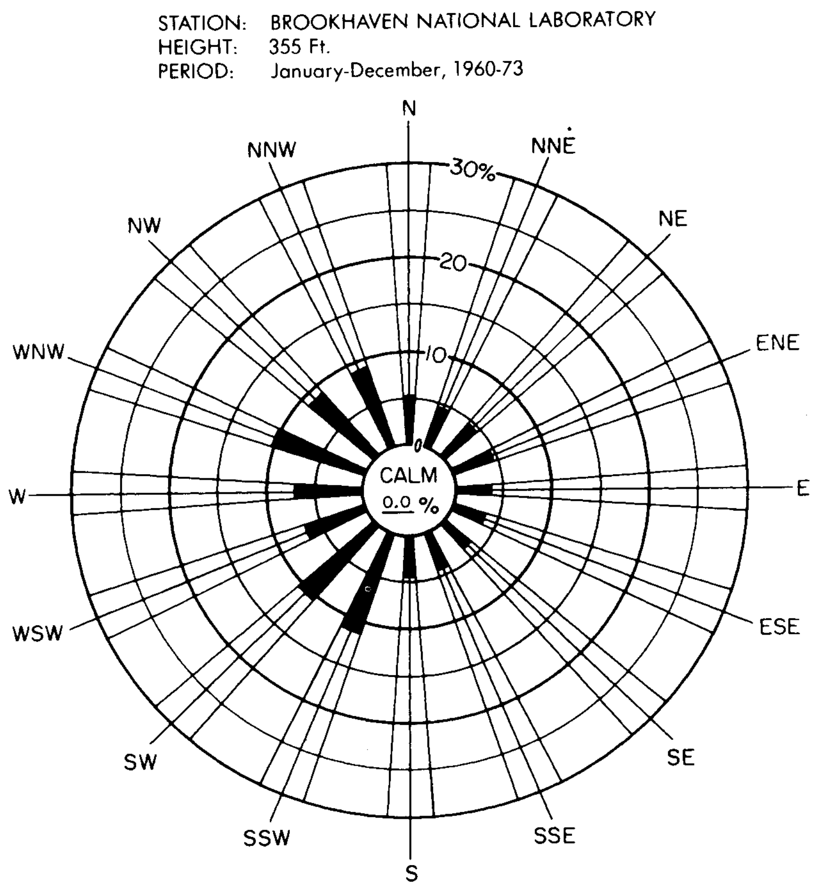


Figure 3. Annual Wind Rose. The Wind Rose also Represents the Period 1973-1979

Studies of the hydrology and geology (5-7) of Long Island in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are locally between 31-61 m thick, are generally sandy and highly permeable. Water penetrates them readily and there is little direct run-off into surface streams except during periods of intense precipitation. The average annual precipitation is 122 cm and the annual total for 1979 was 142.5 cm. About half of it is lost to the atmosphere through evapotranspiration and the other half percolates to recharge ground water. As indicated in Figure 4 (7), the ground water in the vicinity of the Laboratory moves predominantly in a horizontal direction to the Great South Bay. This is modified toward a more easterly direction in the Peconic River watershed portions of the site. The estimated rate of movement at the ground water surface is about 16.2 cm d^{-1} (7).

1.3 Existing Facilities:

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

1) the fundamental structure and properties of matter,

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

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

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

5) energy and nuclear-related technology,

6) energy sources, transmission and use 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, moderated and cooled by heavy water, and which operates at a routine power level of 40 MW(th). Recently, modifications to the primary water cooling system have been made to allow the power level to be raised to 60 MW(th) in the immediate future,

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

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

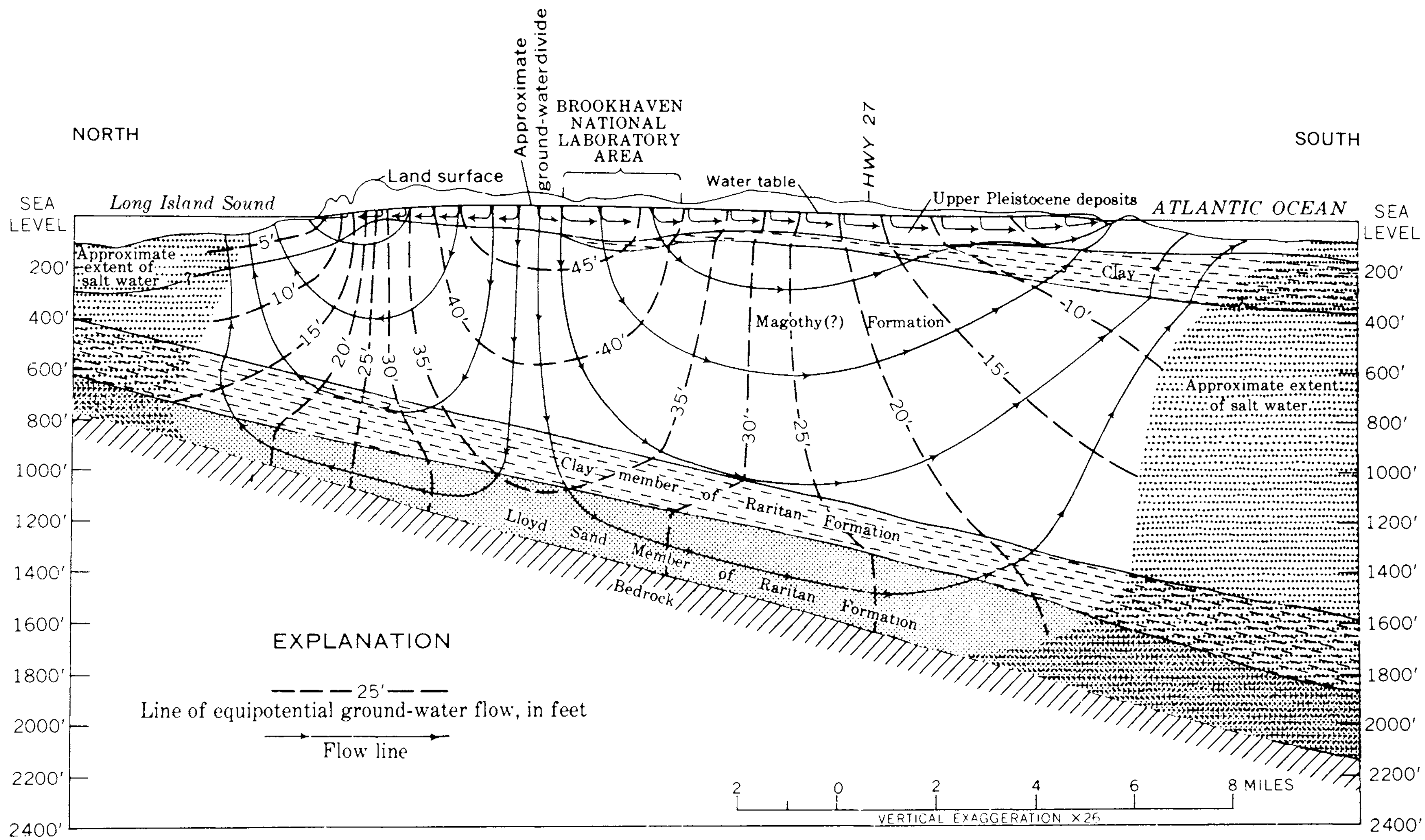


Figure 4. Schematic Ground-Water Flow Lines, Central Upton Area

4) the 200 MeV Proton Linac, which serves as an injector for the AGS, also supplies continuous currents of protons for radionuclide production by spallation reactions in the Brookhaven Linac Isotopes Production Facility (BLIP) and in the Chemistry Linac Irradiation Facility (CLIF),

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

6) To facilitate advanced studies in high energy physics, a new facility, "ISABELLE," which will be a colliding-beam machine with two proton beams of 400 GeV each and whose collision will make available energies up to 800 GeV, is proposed for completion by 1983 (8).

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 a high activity gamma irradiation source), the Chemistry Department, and the Department of Energy and Environment (DEE). At the Hot Laboratory special purpose radionuclides are developed and processed for on- and off-site use under the joint auspices of the DEE and the Medical Department. This facility also contains a radioactive waste treatment center, which includes an evaporator for volume reduction 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 wastes, with additional significant contributions originating from the Medical Research Center, the Hot Laboratory complex, as well as from decontamination and laundry operations.

2.0 SUMMARY

The environmental levels of radioactivity and other pollutants found in the vicinity of Brookhaven National Laboratory (BNL) during 1979 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 and the water 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 water quality of ground waters underlying the Laboratory; and concentrations of radioactivity in milk samples obtained in the vicinity of the Laboratory.

The external radiation dose for 1979 at the north boundary of the Laboratory attributable to an ecology forest irradiation source was 1.43 mRem a^{-1} (1.43×10^{-5} Sv a^{-1}) or 0.4% of the applicable Radiation Protection Standard.*

At the boundary of the Laboratory, about 1.0 km northwest of the Alternating Gradient Synchrotron (AGS), the calculated dose due to skyshine (scattered radiation) was about 0.88 mRem a^{-1} (0.88×10^{-5} Sv a^{-1}), or 0.16% of the Standard. This was too small to be measured. Due to their limited range, the external radiation 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, 7 pCi m^{-3} (0.7×10^{-2} μCi ml^{-1} or 0.26×10^{-5} Bq ml^{-1}) was <0.01% of the Radiation Concentration Guide (RCG). The largest average concentration of tritium in precipitation was at or below the Minimum Detection Limit (MDL) which was 160 pCi l^{-1} (1.6×10^{-7} μCi ml^{-1} or 5.9×10^{-3} Bq ml^{-1}). The MDL represents about 0.01% of the RCG for drinking water.

At the Central Steam Plant, the most recent measurement of the stack emission of air particulates indicated that the average rate was 0.078 lb/10^6 Btu. A calculation based on meteorological parameters indicates that at the site boundary, their concentration was 0.35 μg m^{-3}, 0.48% of the yearly average ambient Air Quality Standard (12). At the site boundary the calculated concentrations of SO_2, NO_x, Lead (Pb) and Cadmium (Cd) emitted from the plant were 1.1×10^{-3}, 6×10^{-4}, 5×10^{-9} and 7.6×10^{-12} ppm, respectively, which were 4.7, 1.6, 0.3 and < 0.01% of their respective ambient air quality standards.

Of the sewage effluent released onto the sand filter beds of the Laboratory sewage treatment plant 78% flowed directly into the Peconic River. The balance was assumed to have percolated into the ground water underlying the beds. The gross beta concentration of the output from them was 28.5 pCi l^{-1} (2.85×10^{-8} μCi ml^{-1} or 1.06×10^{-3} Bq ml^{-1}), or < 1% of the RCG. The tritium concentration was 11.9 nCi l^{-1} (11.9×10^{-6} μCi ml^{-1} or 4.4×10^{-1} Bq ml^{-1}), or 0.6% of the RCG. The same concentration was assumed for the infiltration into groundwater.

Downstream about 3.5% of the combined flow from the sand filter beds and from upstream of the Peconic River also percolated into the groundwater. This occurred 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 11.7 pCi l^{-1} (1.17×10^{-8} μCi ml^{-1} or 4.3×10^{-4} Bq ml^{-1}), or <1% of the RCG, and the tritium concentration was 4.9 nCi l^{-1} (4.9×10^{-6} μCi ml^{-1}), or 0.1% of the RCG. At the site boundary, the gross beta concentration was 15.4 pCi l^{-1} (1.54×10^{-8} μCi ml^{-1} or

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

0.53×10^{-3} Bq ml^{-1}), or 0.5% of the RCG, and the tritium concentration was 5.4 nCi l^{-1} (5.4×10^{-6} μCi ml^{-1} or 2×10^{-1} Bq ml^{-1}), or 0.17% of the RCG.

Except for 35 daily pH levels which were "out of limit," all reportable non-radiological parameters of the Laboratory sewage effluent 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 at the point of discharge was at or within water quality standards for the receiving body of water.

Bimonthly sampling of the Peconic River water downstream of the sewage treatment plant outfall has indicated a decrease of concentrations of radioactivity. At a location 4.8 km downstream, the average gross beta concentration as established by bimonthly "grab" sampling was 8 pCi l^{-1} (8×10^{-9} μCi ml^{-1} or 3×10^{-4} Bq ml^{-1}), or 0.20% of the RCG and the tritium concentration less than 0.57 pCi l^{-1} (<0.57×10^{-6} μCi ml^{-1} or <2.1×10^{-2} Bq ml^{-1}), or 0.01% of the RCG. About 24 km downstream, at the river's mouth, the flow was about 19 times that at the Laboratory's site boundary (USGS-1979 data), the average concentration of gross beta activity being 6.7 pCi l^{-1} (6.7×10^{-9} μCi ml^{-1} or 2.5 x 10^{-1} Bq ml^{-1}) and that of tritium being 0.8 nCi l^{-1} (8×10^{7} μCi ml^{-1} or 2.8 x 10^{-2} Bq ml^{-1}). Thus, it was apparent that the total gross beta activity in the river at that location exceeded that at the Laboratory's site boundary. This difference is attributed to the fact that the total flow at the river's mouth is increased due to tributary additions which in turn have added fallout radionuclides that were present in the drainage area of the tributaries.

Seasonal sampling of Peconic River bottom sediments, stream vegetation and of miscellaneous aquatic fauna was conducted. The data indicated that concentration 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, which may also represent fallout contributions, were below the Minimum Detection Limits (MDL) of the system used and as such were not reported. The data on fish obtained from the river at the site boundary suggested the presence of small amounts of radioactivity attributable to the Laboratory's past releases. The concentration of ^{137}Cs ranged from 1036 to 1113 pCi kg^{-1} (4×10^{1} to 37 Bq kg^{-1}). This concentration was 0.03 to 0.02% of the RCG, based on an assumed ingestion of 50 g d^{-1}.

About 19 million liters of water per day obtained from on-site supply wells were used for "once through" cooling and returned to groundwater in on-site recharge basins. The concentration of gross beta activity in them was about five to ten times greater than that of the supply wells, and was less than 0.1% of the RCG. The tritium concentrations were less than the MDL, which is about 0.1% of the RCG.

Groundwater surveillance was conducted in a network of some 87 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 contaminants in groundwater. 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 have been decreasing, when compared to those observed during previous years. This reflects the decrease in the concentrations due to decay and dilution. They were not more than a few percent of the EPA Drinking Water Standards. The largest average gross alpha concentration, 6 pCi l^{-1} (6 x 10^{-9} μCi ml^{-1} or 2.1 x 10^{-4} Bq ml^{-1}) was 40% of the EPA Drinking Water Standard for unidentified mixtures containing alpha activity other than ^{226}Ra. It was not directly relatable to any known Laboratory effluent releases. The largest average gross beta concentration was 20 pCi l^{-1} 2 x 10^{-8} μCi ml^{-1} or 0.7 x 10^{-3} Bq ml^{-1}). The largest average tritium concentration, 3.1 nCi l^{-1} (3.1 x 10^{-6} μCi ml^{-1} or 1.2 x 10^{-1} Bq ml^{-1}) was 21% of the EPA Drinking Water Standard.

Concentrations of gross alpha, gross beta and ^{90}Sr radioactivity were found to be slightly higher in a sampling well about 0.35 km east of the site boundary, than in wells at the boundary itself. The gross alpha concentration, 3.3 pCi l^{-1} (3.3 x 10^{-9} μCi ml^{-1} or 12.3 x 10^{-6} Bq ml^{-1}) was 22% of the EPA Drinking Water Standard. However, this was not directly relatable to any known Laboratory effluent. The gross beta concentration was 15.2 pCi l^{-1} (15.2 x 10^{-9} μCi ml^{-1} or 5.7 x 10^{-4} Bq ml^{-1}), and the ^{90}Sr concentration was 2 pCi l^{-1} (2 x 10^{-9} μCi ml^{-1} or 0.8 x 10^{-4} Bq ml^{-1}). The latter was 25% of the EPA Drinking Water Standard.

Except for pH levels slightly lower 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 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 their respective water quality standards. These levels exceeded those found in recent Laboratory liquid effluents, and may be an artifact produced by the sampling well casing rather than being present in groundwater itself.

On-site, adjacent to the Solid Waste Management area, the landfill, the former open dump, and the decontamination facility storm sewer sump, above ambient background concentrations of gross beta activity, ^{90}Sr, and tritium were found in a number of nearby groundwater 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, 107 pCi l^{-1} (10.7 x 10^{-10} μCi ml^{-1} or 4.0 x 10^{-3} Bq ml^{-1}), or 13 times the EPA Drinking Water Standard, was found in a well 175 m south of the area. This level reflects the effects of a known inadvertent injection into groundwater which occurred in 1960.

At the landfill, a gross alpha concentration of 42.5 pCi l^{-1} (4.25 x 10^{-8} μCi ml^{-1} or 1.8 x 10^{-6} Bq ml^{-1}), or 300% of the EPA Drinking Water Standard [18], a gross beta concentration of 119 pCi l^{-1} (1.19 x 10^{-7} μCi ml^{-1} or 4.4 x 10^{-3} Bq ml^{-1}), or 6% of the RCG, and a tritium concentration of 427 x 10^{-6} μCi ml^{-1} (1.5 x 10^{1} Bq ml^{-1}), or 21 times the EPA Drinking Water Standard, were the largest found. They were found in wells between the landfill and locations 80 m south of the perimeter of the working area.

At the decontamination facility storm sewer sump, a ^{90}Sr concentration of 57.1 pCi l^{-1} (5.71 x 10^{-8} μCi ml^{-1} or 20.7 x 10^{-3} Bq ml^{-1}), or 650 times the EPA

Drinking Water Standard, was found in a surveillance well about 50 m southeast of the sewer outfall into the sump.

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 49 ppm, or 86 times the standard, and that of Zn was 2.7 ppm, or 4.3 times the standard.

In all cases, the on-site levels of radioactivity or of other agents which were found in above ambient background in ground water appeared to be confined to within a hundred meters of their origin. They 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 the EPA Drinking Water Standards (18).

A study conducted in 1979, with the collaboration of the Suffolk County Department of Health Services (SCDHS), on the distribution of ^{90}Sr in surveillance wells throughout the county wells indicated that they were related to depth of water table. The largest concentrations, in four of 43 samples, ranged from 1.1 to 2.75 pCi l^{-1}. There was no apparent correlation between the presence of ^{90}Sr in these wells and their proximity to the Laboratory. In the remaining wells the concentrations of ^{90}Sr were below 0.5 pCi l^{-1}.

The collective average dose equivalent rate (total population dose) attributable to Laboratory sources, for the population up to a distance of 80 km, was calculated to be 5.46 rem a^{-1} (person-rem a^{-1}), as compared to a natural background dose equivalent rate to the same population of about 278,405 rem a^{-1} (person-rem a^{-1}).

3.0 MONITORING DATA COLLECTION, ANALYSIS AND EVALUATION

3.1 External Radiation Monitoring:

Dose equivalent rates at the site boundary, including natural background (as influenced by fallout) and the increments attributable to Laboratory activity, were routinely measured by the use of CaF_2:Dy thermoluminescent dosimeters (TLD) 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 weekly average dose equivalent rates for external radiation resulting from gamma activity only (9,10) are given in Table 2. There was no measurable 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 5883 curies (2.18×10^{14} Bq) of ^{137}Cs (as of 1/1/79), produced a dose equivalent rate of 1.43 ± .08 mRem a^{-1} ($1.43 \times 10^{-5} \pm 8 \times 10^{-7}$ Sv a^{-1}) or 0.4% of the Radiation Protection Standard for a hypothetical individual member of the general public at this location on the Laboratory perimeter. The average external background radiation level was 57.7 mRem a^{-1} (5.77×10^{-4} Sv a^{-1}). As of September 28, 1979, the Ecology Forest

TABLE 2

1979 BNL Environmental Monitoring
Weekly External Dose Equivalent Rates from Background and BNL Operations
(mRem/week)

Month	P-2	P-4	P-7	Northeast Perimeter P-9	Source[a]	Average Background[b]
January/February	1.05	1.08	1.08	1.06	<0.00	1.07
March	1.14	1.13	1.13	1.09	<0.00	1.13
April	1.15	1.18	1.24	1.19	<0.00	1.19
May	1.09	1.12	1.12	1.14	0.03	1.11
June	1.05	1.14	1.14	1.18	0.07	1.11
July	1.17	1.19	1.18	1.27	0.09	1.18
August	1.13	1.20	1.20	1.27	0.09	1.18
September	1.26	1.29	1.30	1.31	0.03	1.28
October	1.12	1.13	1.16	1.09	<0.00	1.14
November	1.28	1.30	1.28	1.25	<0.00	1.29
December	1.04	1.13	1.11	1.09	<0.00	1.09
Total (mRem/year) (50 weeks)	56.42	58.26	58.51	58.53	1.43	57.74
Average (mRem/week)	1.13	1.17	1.18	1.18	0.03	1.16
Standard deviation (2σ)	0.16	0.14	0.14	0.18	0.08	0.14

Locations of monitoring stations indicated on Figure 2

[a] ^{137}Cs Ecology Forest Irradiation Source radiation level derived by subtracting average background at other stations from total measured level at northeast perimeter. This source has been decommissioned as of September 28, 1979 and was removed from the Ecology Forest area on October 29, 1979.

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

Data for this table supplied by J. Gilmartin (S&EP) using CaF_2 (Dy) environmental monitoring TLDs which were placed in the above locations by E. Hartmann (S&EP).

mRem = 0.00001 Sv.

source was decommissioned. It was removed from the Ecology Forest area on October 29, 1979. The TLD readings at the northeast perimeter (P-9), during the last quarter of the year, confirm the absence of the source. It is to be noted that the source radiation (photons) were less penetrating during winter months relative to the summer months as the density of air increases with the drop in temperature during winter [9,10], which accounts for the increases in radiation levels noted at the northeast perimeter during the summer months.

3.2 Airborne Effluents and Ground-Level Air Particulates, Tritium and Radioiodine Monitoring:

3.2.1 Facilities and Effluents

The principal Laboratory facilities which currently discharge radioactive effluents to the atmosphere are listed in Table 3. The installed on-line effluent monitoring and sampling devices are also indicated. The location of these facilities on the Laboratory site are shown in Figure 2. The types and amounts of these effluents released during 1979 are shown in Table 4.

Oxygen-15 (^{15}O), Argon-41 (^{41}Ar) and Xenon-127 (^{127}Xe) are radioactive gases. Since they have relatively short half-lives, they have the potential of being environmentally significant as sources of increased external radiation only at or relatively near the point of release. ^{127}Xe is produced at the BLIP facility for commercial use. ^{15}O, which has a half-life of two minutes, is produced by the interaction of protons and water in the BLIP facility and evolved at an estimated rate of 0.21 Ci μA^{-1} h^{-1} (7.8 x 10^9 Bq μA^{-1} h^{-1}). When this facility is operated at the full beam current of 180 μA, the equilibrium activity of ^{15}O at the point of generation is 1.8 Ci (6.6 x 10^{10} Bq). Argon-41, which has a half-life of 110 minutes, is produced by the interaction of neutrons and ventilating air in the Medical Reactor and released form its stack at a rate of 1 Ci $MW(th)^{-1}h^{-1}$ (3.7 x 10^{10} Bq $MW(th)^{-1}h^{-1}$) when it is operated at full power of 3 MW(th). Assuming equilibrium is attained, a conservative assumption, the equilibrium activity is 8 Ci (2.96 x 10^{11} Bq) at the reactor stack. In reviewing the airborne effluent data (Table 4) over the past six years (1974-1979), it is to be observed that, except for ^{127}Xe, the radioactive gases released are a function of operational time and power level of the facility. Two factors have served to reduce the quantities of radioactivity released to the atmosphere from BNL facilities. At the Hot Laboratory complex (Bldg. 801), an experiment which utilized about 1000 Ci (3.7 x 10^{10} Bq) of tritium (as vapor) was discontinued during 1979. This has reduced the release of tritium from this complex by 50 times when compared with the releases during the operation of the experiment in 1978. The decrease in tritium gas released at the Van de Graaf facility from 1263 Ci (4.67 x 10^{13} Bq) in 1978 to 80 Ci (2.96 x 10^{12} Bq) in 1979 is the result of improved decontamination techniques such as scrubbing which has reduced the quantities released to the environment. A second order effect which has contributed to the decrease is the accurate calibration of the Kanne chamber resulting in the increased reliability of data collection and improving the confidence in the reported tritium releases.

TABLE 3

1979 BNL Environmental Monitoring Gaseous Effluent
Release Locations and On-Line Monitoring and Sampling Devices

Building[a]	Facility and release point radioactive effluents	Release height (m)	Principal nuclide(s)	On-Line monitoring	Sampling devices
490	Medical Research Center Roof Stack	13.7	Tritium (vapor)	None	Dessicant for tritium vapor
491	Medical Research Reactor	45.7	Argon-41	Moving tape for radio-particulates	Charcoal for radioiodines
555	Chemistry Building Roof	16.8	Tritium (vapor)	None	Dessicant for tritium vapor
750 801	High Flux Beam Reactor/ Hot Laboratory Stack	97.5	Tritium (vapor)	Beta scintillator for radioactive gases; Kanne chamber for tritium (gas+vapor)	Dessicant for tritium vapor; particulate filter for gross beta; charcoal cartridge for radioiodines
901	Van de Graaff Accelerator	18.3	Tritium (gas+ vapor)	Kanne chamber for tritium (gas+vapor)	Dessicant for tritium vapor
931	Linac Isotope Facility	18.3	Tritium (vapor) Oxygen-15	G-M detector for radiogases	Dessicant for tritium vapor
Steam Plant Effluents					
610	Central Steam Plant Stack	19.8	Particulates; SO_2; NO_x	None	None

[a]Locations given in Figure 2

TABLE 4

1979 BNL Environmental Monitoring Airborne Effluent Data
Radioactive Effluents

Building	Facility and release point	Elevation[a] (m)	Nuclide	Activity released (Ci)
491	Medical Research Reactor Stack	45.7	^{41}Ar	314.9[b]
490	Medical Research Center Stack	13.7	^{3}H (vapor)	1.8
555	Chemistry Building Stack	16.8	^{3}H (vapor)	15.3
750	High Flux Beam Reactor	97.5	^{3}H (vapor)	119.2
801	Hot Laboratory Stack		^{3}H (vapor)	0.8×10^{-3}
			Gross Beta (Particulate)	1.7×10^{-4}
			^{123}Xe	0.6
			^{127}Xe	1.0
901	Van de Graaff Accelerator	18.3	^{3}H (gas)	79.5
			^{3}H (vapor)	9.3
931	Linac Isotope Production	18.3	^{3}H (vapor)	24.7×10^{-3}
	Facility		^{15}O	27483[c]

[a] Above ground level.

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

[c] Calculated from reported operating time and estimated production rate at 180 μamp full beam current.

Ci = 3.7×10^{10} Bq.

The slight increase in tritium (as vapor) released from the HFBR resulted principally from the purging of the heat exchanger system, preparatory for modifications to increase the power level of the facility from 40 MW to 60 MW.

Considerable dilution with the ambient air occurs between the point of generation and release of these sources of radioactivity and the site boundary. Additionally, radioactive decay decreases the air activity concentrations of shorter lived radionuclides during the transit time between the source and the site boundary. After dilution and decay, concentrations of airborne radioactivity at the site boundary was reduced to such a level that they produced no detectable increase in the dose equivalent rate (as resulting from the discharge of radioactive effluents to the atmosphere - Table 3) during 1979.

Tritium (^3H) has a half-life of 12.3 years, and is a very low energy beta emitter ($T_{\beta(max)}$ = 18.6 KeV). Its principal environmental significance is as tritiated water vapor (HTO), when it is taken up and utilized by living systems as water. Of the 225 Ci (8.4 x 10^{12} Bq) of tritium released from the Laboratory facilities during 1979, 79.5 Ci (2.96 x 10^{12} Bq) (35%) was in gaseous form, and 145.5 Ci (5.4 x 10^{12} Bq) (65%) was released as tritiated water vapor (HTO). As Low as Reasonably Achievable (ALARA) practices have reduced HTO releases from the HFBR by 70% since 1974. These include replacing a portion of the heavy water (moderator and coolant) at frequent intervals (once a year) and an effective program to detect tritium and prevent its leak.

The amounts of conventional pollutants released from the central steam plant are shown in Table 5. Those for sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are estimated from reported emission factors for comparable plants (11), supplemented by analysis for sulfur 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 steam boiler units in a series of tests conducted during 1977 by an Environmental Protection Agency (EPA) approved laboratory. Their results indicate the average emission rate of particulates, 0.078 lb $MBTU^{-1}$, was below the emission limit of 0.1 lb $MBTU^{-1}$ as set forth by the New York State Department of Environmental Conservation (Part 227, Stationary Combustion Installations).

A review of the stack emission data over the past six years (1974-1979) has indicated reductions in SO_2, NO_x and particulates. This is especially noticeable since 1976 when the Laboratory initiated the utilization of alternate liquid fuels (ALF), such as mineral spirits, alcohol, jet fuel and reconstituted fuels. The amount of ALF relative to total fuel consumption at the steam plant has increased from zero in 1976 to 6% in 1977, 23% in 1978 and 49% in 1979. These alternate fuels typically have a weighted average sulfur content of 0.5% or less, as compared to the typical 1% sulfur content of the #6 oil. Thus, though the total volume of fuel consumed has gone up, the amount of fuel, if weighted to 1% sulfur content, has been reduced by 32% which, in turn, is reflected in the reduction of pollutants. Because of the uncertainties in the potential releases to the environment resulting from the combustion of these fuels, 28 samples of these alternate fuels were analyzed for cadmium (Cd) and lead (Pb). The results, tabulated below indicate that the burning of ALF does not constitute a health hazard.

TABLE 5

1979 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[a]	EPA Primary Air Quality Standard (12)
SO_2	3.25×10^5 [b]	270 ppm	1.06×10^{-3} ppm	0.03 ppm
NO_x	1.44×10^5	156 ppm	6.33×10^{-4} ppm	0.05 ppm
Particulates	3.1×10^4 [c]	$0.09\ g\ m^{-3}$	$0.35\ \mu g\ m^{-3}$	$75\ \mu g\ m^{-3}$

[a] Based on average X/Q of 2.4×10^{-7} sec m^{-3} calculated by BNL Meteorology Group (1979).

[b] Based on average 1.0% sulfur content.

[c] Based on measured average value during February 1977 stack sampling conducted on main steam boiler unit (New York Testing Laboratories, Inc., Westbury, N.Y., 11590).

Table based on data supplied by Plant Engineering (E.E. Shelton).

	Lead (Pb)		Cadmium (Cd)	
	Minimum	Maximum	Minimum	Maximum
Concentration in ALF Sample (ppm)	<1	273	<0.1	4
Concentration at Site Boundary ($\mu g\ m^{-3}$)				
a) if only ALF was burned	$<3.8\times10^{-6}$	1.04×10^{-3}	$<0.38\times10^{-6}$	1.52×10^{-5}
b) if burned at the maximum possible mixture - 50% ALF/50% #6	$<1.9\times10^{-6}$	0.52×10^{-3}	$<0.19\times10^{-6}$	0.76×10^{-5}
Standard ($\mu g\ m^{-3}$)		1.5*	39,000**	

*EPA (12)
**British Standard, no U.S. standard as yet promulgated.

As indicated in the 1978 Environmental Monitoring Report and as estimated from the fuel consumed in 1979, the mercury (Hg) concentration in ALF samples was approximately 100 times below the EPA limit of 4.65 kg day^{-1} (12). An analysis for chlorinated hydrocarbons was negative although small traces of chlorine were detected. Additionally, the resulting low ash content (<20 ppm) after burning ALF indicates negligible quantities of trace metals which has been confirmed by our analysis for Cd and Pb. Therefore, even if the most liberal estimates of usage are employed, the environmental consequences of burning these alternate fuels with #6 fuel oil are not significant.

3.2.2 Sampling and Analysis

The Brookhaven environmental monitoring air sampling program is designed to identify airborne radioactivity attributable to natural sources, to activities remote from the Laboratory (e.g., above ground nuclear weapons tests) and to Laboratory activities. Most of the air concentrations of radioactivity detected during 1979 could be attributable to the first two sources. Fallout from the Chinese nuclear test which took place on December 14, 1978 was also detected.

3.2.3 Air Samples

High volume (500 l min^{-1}) positive displacement air pumps (Gast 3040) were operated at a monitoring station southeast of the solid waste management areas (Fig. 2, S-6), and at the northeast and the 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 collection of radiohalogens. In parallel to this system is a 7.6 cm diameter air particulate filter (Gelman type G) followed by a 250 cm^3 impregnated charcoal filter and sampled at a flow rate of two $ft^3 min^{-1}$. The rationale for this latter sampling system is to assure the collection of all species of radioiodines at a suitable flow rate. Short term fluctuations in airborne radioactive particulate concentrations are generally indicative of the presence of recent weapons tests debris. To distinguish between debris from nuclear weapon tests and that which might result from activities of the waste management operations, the air particulate filters at station S-6 were changed and counted on a daily basis during the work week. The air particulate filters at the other stations were changed and counted on a weekly basis.

After allowing several days (> seven days) for the decay of short lived natural radioactivity, the air particulate samples from the solid waste management area station were analyzed for gross alpha activity using a 12.7 cm diameter Zn-S coated detector optically coupled to a photomultiplier tube, and the air particulate samples from all locations were analyzed for gross beta activity using a 12.7 cm beta scintillator. These data are shown in Table 6. This table also includes data from a source point--the HFBR stack. The sampling point is located in the stack in such a manner that it samples the exhaust air from the Hot Lab (Bldg. 801) and the HFBR after it passes through absolute filters. The data, therefore, represent the concentration at the HFBR stack. The seasonal trend of an early spring maximum, as observed for both gross alpha and gross beta activity in 1975, shifted toward late spring in 1976, early summer in 1977, and for 1978 and 1979 has returned to late spring and early summer maximum. An increase in gross beta and alpha activity observed during previous years has been slightly decreased. In general, the gross beta activity at the Waste Management area was about three times that of the SW and NE Perimeter areas, the latter two being usually similar in value. These differences indicate the presence of Laboratory-produced radionuclides in air particulate samples. However, the gross beta activity at all monitoring stations had shown a significant increase in March 1978 and to a slight extent in December 1978 following the Chinese nuclear tests. This increase was not seen in the early part of 1979 indicating the rapid dispersal of fallout activity.

In addition to the daily and/or weekly gross beta counts indicated above, analyses for gamma emitting nuclides were performed on a monthly composite of all individual air particulate samples shortly after the end of each month. The charcoal samples were analyzed at one month post-collection to determine ^{131}I by decay in its full energy peak region during this time. These data are reported in Table 7. Gross beta activity in air that had increased following the Chinese nuclear test in late 1976 began to decline in early 1977 with a slight increase in 1978 due to scavenging by heavy precipitation. The decline continued in 1979. When compared to data from 1976 to 1979, it seems that there is evidence of an early or late spring maximum, which for 1979 indicates a late arrival of the maximum. The increase in December 1978 following the Chinese nuclear test did not follow through in early 1979. Fission product nuclides such as ^{103}Ru, ^{106}Ru, ^{137}Cs, ^{141}Ce, and ^{144}Ce were at or below Minimum Detection Limit (MDL) for the counting system used (Table 29). Although statistically significant levels of ^{131}I were noted during the earlier Chinese nuclear tests in 1976 and 1977 it was not detected during 1979. Naturally occurring ^{7}Be was present in low but near uniform concentration throughout the year. These data indicate

Table 6

1979 BNL ENVIRONMENTAL MONITORING AVERAGE GROSS ALPHA, AND GROSS BETA CONCENTRATIONS, AIR PARTICULATE FILTERS (PCI/M3 OR 1.03E-12 UCI/CM3)

	LOCATION	NO.	ALPHA AVERAGE	ALPHA MAXIMUM	ALPHA MINIMUM	NO.	BETA AVERAGE	BETA MAXIMUM	BETA MINIMUM	TL FLOW(M3)
JANUARY	WASTE AREA	22	.0010	.0032	.0001	22	.0703	.1610	.0254	2.100E+04
	S.W. PERIM					5	.0589	.1060	.0182	1.753E+04
	N.E. PERIM					4	.0701	.1120	.0479	1.461E+04
	STACK					5	.2620	1.0000	.0427	9.049E+02
FEBRUARY	WASTE AREA	19	.0013	.0027	.0001	19	.0692	.1350	.0229	1.807E+04
	S.W. PERIM					4	.0558	.0668	.0257	1.458E+04
	N.E. PERIM					3	.0695	.0721	.0667	8.831E+03
	STACK					4	.2965	.8620	.0526	7.245E+02
MARCH	WASTE AREA	22	.0010	.0025	.0002	22	.0708	.2070	.0351	1.728E+04
	S.W. PERIM					4	.0558	.0727	.0416	1.258E+04
	N.E. PERIM					4	.0530	.0842	.0294	1.619E+04
	STACK					4	.0420	.0548	.0270	7.121E+02
APRIL	WASTE AREA	19	.0009	.0019	.0000	19	.1481	.4110	.0632	2.284E+04
	S.W. PERIM					5	.0614	.1540	.0040	1.451E+04
	N.E. PERIM					5	.0980	.1620	.0490	1.203E+04
	STACK					5	.1735	.5680	.0289	7.818E+02
MAY	WASTE AREA	22	.0006	.0017	.0000	22	.1965	.4900	.0854	1.762E+04
	S.W. PERIM					4	.1087	.1280	.0692	1.624E+04
	N.E. PERIM					4	.1210	.1430	.0825	1.366E+04
	STACK					4	.0393	.4430	.0208	6.545E+02
JUNE	WASTE AREA	20	.0005	.0019	.0000	20	.1853	.4120	.0956	1.660E+04
	S.W. PERIM					4	.1188	.1540	.0943	1.583E+04
	N.E. PERIM					4	.1276	.1670	.0975	1.380E+04
	STACK					4	.0282	.0345	.0113	4.563E+03
JULY	WASTE AREA	18	.0007	.0017	.0001	18	.1628	.2960	.0865	1.602E+04
	S.W. PERIM					8	.1156	.2100	.0918	1.612E+04
	N.E. PERIM					5	.1319	.2270	.0835	1.298E+04
	STACK					5	.0735	.1420	.0209	8.412E+02
AUGUST	WASTE AREA	23	.0040	.1010	.0002	23	.2106	.5930	.0106	1.774E+04
	S.W. PERIM					4	.0944	.1120	.0785	1.317E+04
	N.E. PERIM					4	.0838	.0944	.0730	1.437E+04
	STACK					5	.0547	.0865	.0219	9.323E+02
SEPTEMBER	WASTE AREA	13	.0006	.0013	.0001	13	.2640	.7600	.0976	1.027E+04
	S.W. PERIM					4	.0717	.0852	.0634	1.303E+04
	N.E. PERIM					4	.0733	.0970	.0546	1.288E+04
	STACK					4	.1494	.3470	.0213	6.932E+02
OCTOBER	WASTE AREA	19	.0018	.0309	.0002	21	.0870	.3190	.0257	1.815E+04
	S.W. PERIM					6	.0619	.0900	.0418	1.489E+04
	N.E. PERIM					5	.0600	.0792	.0451	1.383E+04
	STACK					4	.0599	.0690	.0419	8.378E+02
NOVEMBER	WASTE AREA	18	.0012	.0022	.0003	18	.1063	.1800	.0554	1.664E+04
	S.W. PERIM					4	.0839	.1350	.0575	1.067E+04
	N.E. PERIM					3	.0654	.1100	.0441	1.209E+04
	STACK					4	.0361	.0565	.0192	6.123E+02
DECEMBER	WASTE AREA	19	.0008	.0023	.0002	18	.1112	.3010	.0373	1.887E+04
	S.W. PERIM					4	.0571	.1260	.0416	1.357E+04
	N.E. PERIM					4	.0478	.0510	.0403	1.535E+04
	STACK					3	.0229	.0324	.0041	4.054E+02
YTD	WASTE AREA	234	.0012	.1010	.0000	235	.1340	.7600	.0106	2.119E+05
	S.W. PERIM					56	.0794	.2100	.0040	1.727E+05
	N.E. PERIM					49	.0828	.2270	.0294	1.606E+05
	STACK					51	.0845	1.0000	.0041	1.266E+04
FIRST QTR	WASTE AREA	63	.0011	.0032	.0001	63	.0701	.2070	.0229	5.634E+04
	S.W. PERIM					13	.0570	.1060	.0182	4.468E+04
	N.E. PERIM					11	.0630	.1120	.0294	3.963E+04
	STACK					13	.2058	1.0000	.0270	2.342E+03
SECND QTR	WASTE AREA	61	.0007	.0019	.0000	61	.1739	.4900	.0632	5.707E+04
	S.W. PERIM					13	.0974	.1540	.0040	4.658E+04
	N.E. PERIM					13	.1163	.1670	.0490	3.950E+04
	STACK					13	.0483	.5680	.0113	6.000E+03
THIRD QTR	WASTE AREA	54	.0020	.1010	.0001	54	.2056	.7600	.0106	4.402E+04
	S.W. PERIM					16	.0955	.2100	.0634	4.232E+04
	N.E. PERIM					13	.0959	.2270	.0546	4.023E+04
	STACK					14	.0877	.3470	.0209	2.467E+03
LAST QTR	WASTE AREA	56	.0012	.0309	.0002	57	.1005	.3190	.0257	5.447E+04
	S.W. PERIM					14	.0662	.1350	.0416	3.913E+04
	N.E. PERIM					12	.0570	.1100	.0403	4.127E+04
	STACK					11	.0440	.0690	.0041	1.856E+03

YTD: Yearly total
Reference Standards: Table 29

TABLE 7

1979 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 Gross β	Sample Volume (m^3)	NUCLIDES ^{7}Be	NUCLIDES $^{140}Ba\text{-}La$
January	0.066	53140	-	-
February	0.065	41481	.009	-
March	0.060	46050	.07	-
April	0.110	49380	.06	-
May	0.145	47520	.10	.003
June	0.145	46230	.08	-
July	0.137	45120	.08	.002
August	0.137	45280	.09	-
September	0.127	36180	.06	-
October	0.071	46870	.09	.003
November	0.088	39400	.08	.002
December	0.075	47790	-	-
Average	0.102		.07	
Radiation Concentration Guide [13]	100		$4x10^4$	1000

Error of the counting of samples is estimated to be about 15%.

Radionuclides such as ^{131}I, ^{137}Cs, ^{144}Ce all below MDL. (Table 29)

See Figure 2 for location of sampling stations: P-2, P-4, P-7, P-9, S-6 and S-13.

pCi = 3.7×10^{-2} Bq.

the absence of Laboratory effluent contributions at concentrations 1/100,000 or less than radiation protection guide levels.

Sampling for tritium vapor was performed at the same air sampling stations by drawing a small side stream of air ($\sim$100 cm^3 min^{-1}) through silica gel cartridges which were generally changed on a monthly basis. During colder months, the sampling cycle was lengthened due to low humidity. The collected vapor was subsequently removed from the gel by heating, then condensed and assayed by liquid scintillation counting. The tritium air concentration data obtained during 1979 is shown in Table 8. The measured yearly average concentration (including background) at the site boundary, about 6.5 pCi m^{-3} (0.065 x 10^{-10} µCi cm^{-3} or 0.24 x 10^{-6} Bq cm^{-3}), was 0.004% of the applicable Radiation Concentration Guide (RCG).

The current Laboratory environmental monitoring program does not include air sampling for nonradioactive substances. The calculated annual average concentrations at the site boundary of the conventional pollutants released from the central steam plant are listed in Table 5. All were less than 2% of the EPA Primary Air Quality Standard for the reported constituents. As discussed earlier in this Section, the use of ALF with #6 fuel oil does not represent a significant impact on the environment.

About 250 kg of various pesticides, chiefly organo-phosphates, Thiodan, Diazinon, Carbaryl and Parathion, were applied on site during 1978, principally to protect crops which were grown for biological research purposes. All of these pesticides are considered biodegradable, with persistence times in the order of a week (14). Furthermore, they were applied with a "sticker" additive to minimize becoming airborne subsequently.

3.2.4 Precipitation

Two pot-type rain collectors each with a surface area of 0.33 m^2, are situated adjacent to the sewage treatment plant (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) by washing down the rain collector with a known volume of water. Part of each collection was evaporated for gross beta counting, a small fraction was composited for monthly tritium analysis, and the balance was put through ion exchange columns for subsequent quarterly ^{90}Sr and gamma analyses. The data for 1979 (with the exception of tritium) are reported in Table 9. There was no detectable indication of Laboratory released airborne radioactivity in precipitation collected on site. The gross beta activity does reflect rainfall scavenging of radioactive fallout from the last Chinese nuclear test of December 14, 1978. The amounts of naturally produced gamma emitters, such as ^{7}Be and ^{22}Na, which have been slightly higher each year since 1975, especially during 1977 and 1978 (see EM Reports 1975-1978) were reduced by more than 50% in 1979. Fission and activation products, such as ^{54}Mn, ^{65}Zn, ^{95}Zr-Nb and ^{131}I, were all below their MDL (Table 29).

TABLE 8

1979 BNL Environmental Monitoring Average Tritium Vapor Concentration in Air

(pCi/m^3 or 10^{-12} µCi/ml)

Period	Waste Management Area	Southwest Perimeter	Northeast Perimeter
1/ 5 - 4/13	17	12	6
4/13 - 7/18	46	7*	6
7/18 - 9/21	672	6*	7*
9/21 - 12/28	9	4*	3*
Average	186	7	6
Radiation Concentration Guide {13}	. . . .	2×10^5	. . . .

* Less than MDL.

µCi = 3.7×10^4 Bq.

pCi = 3.7×10^{-2} Bq.

TABLE 9

1979 Monthly Average Gross Beta Concentration,
Total Gross Beta Activity and Individual Nuclide Activity in Precipitation[a]

Month	Rainfall (cm)	Average Gβ (pCi/liter or 10^{-9} μCi/ml)	(nCi/m^2)							
			Gβ	^{7}B	^{22}Na	^{65}Zn	^{90}Sr	^{131}I	^{137}Cs	^{144}Ce
January	33.0	1.6	0.53							
February	13.4	23.6	3.16	35.4	0.71	-	.07	-	9.20	-
March	9.0	6.2	0.56							
April	12.6	13.3	1.68							
May	10.4	10.0	1.04	11.6	0.10	-	0.11	-	0.10	-
June	5.5	10.3	0.57							
July	1.5	45.8	0.69							
August	19.7	5.3	1.04	8.5	0.04	-	0.04	-	0.02	-
September	8.1	3.2	0.26							
October	11.6	9.6	1.11							
November	10.0	3.4	0.34	7.0	0.05	-	0.04	-	-	-
December	7.7	4.1	0.32							
Total	142.5	(136.4)	11.39	62.6	0.89	-	.26	-	9.32	-
Average	11.9	11.4	(11.30)	(62.5)	(0.90)					
Average Radiation Concentration Guide [13]		$3x10^3$	$3x10^3$	$8x10^2$	$1x10^4$	$3x10^4$	$8x10^1$	$8x10^1$	$5x10^3$	$3x10^3$

nCi = 3.7×10^{1} Bq.

pCi = 3.7×10^{-2} Bq.

[a]There were two Chinese nuclear tests; one on March 14, 1978 and the other on December 14, 1978. Some fallout activity was detected at BNL as a result of the tests.

[b]Below the Minimum Detection Limit (MDL) of the system used in analyzing the sample (Table 29)

To obtain an indication of the washout of tritium from local airborne releases in addition to the pot-type collectors, small precipitation collectors were installed at the perimeter stations (P-2, P-4, P-7, P-9) and at Blue Point, some 20 km southwest of the Laboratory site. 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) and at other collectors, were all reduced significantly when compared to 1974, 1975, 1976, 1977 and 1978. The levels detected were, however, at or below the MDL (Table 29). The average concentration (on site) was less than 0.01% of the RCG for drinking water. The estimated total deposition of tritium on the Laboratory site during 1979 was <5.3 Ci (1.96×10^{11} Bq) (using the yearly totals of on-site and perimeter concentrations). The washout of Laboratory effluent appears to have been less than 3 Ci (<1×10^{11} Bq) or about 2% of the reported stack release of tritium vapor.

3.3 Liquid Effluent Monitoring

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

The primary water cooling systems of such facilities as the High Flux Beam Reactor, and the Medical Research Reactor, each of which contain multicurie (terabecquerel) 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 of generation in small containers, collected by the Laboratory waste management group, and subsequently packaged 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 by tank truck to storage tanks adjacent to the Laboratory liquid waste evaporator. At this facility, liquids are concentrated about a hundred 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, depending on the results of analysis, are routed directly to the Laboratory sanitary waste system, where they are diluted by large quantities (approaching 4,000,000 l d^{-1}) of cooling

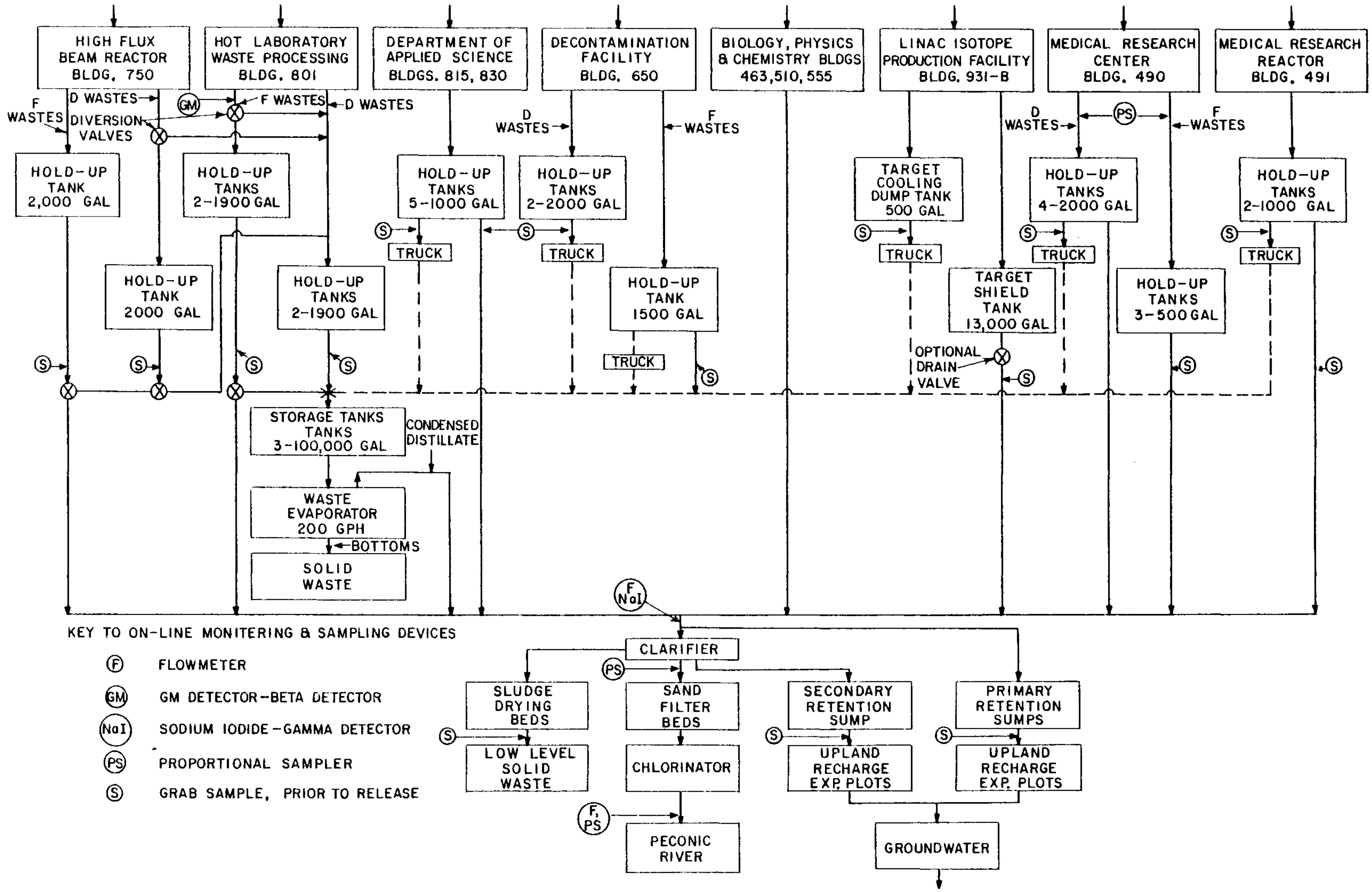


Figure 5. BNL Liquid Effluent Systems

and other uncontaminated water routinely produced by diverse Laboratory operations. Sampling and analysis of facility holdup tanks is done to facilitate waste management; while effluent sampling is performed at the sewage treatment plant to establish the concentration and amounts of environmental releases.

The small amounts of low level radioactive waste effluents that may be routinely disposed of by release into the Laboratory sanitary waste system are established by administrative limits (15), which correspond to those applicable to sewage systems. Within these limits, individual releases are kept as low as practicable.

3.3.1 National Pollutant Discharge Elimination System (NPDES) Permit

As of January 31, 1975, the effluent from the Laboratory sewage treatment plant was subject to the conditions of The National Pollutant Discharge Elimination System (NPDES) Permit No. NY 000 5835. Quarterly reports have been prepared in accordance with this permit using data obtained by the sewage treatment plant operators. A yearly summary of these data is shown in Table 10, which includes a specification of the permit conditions. The Laboratory effluent was within these conditions, with the exception of some daily pH levels which were "out of limit," as set by the permit.

These pH levels were below the lower limit of 5.8 on 35 occasions. However, these were within the local natural range of ground water (pH 4.5-5.5). A study has been made to determine the causative factors behind these low pH values. It indicates that the low pH of rainfall (pH 2.5-4.9) on Long Island is a significant factor in lowering the pH of the Laboratory effluent as it passes through the sand filter beds. The U.S. EPA has been asked to consider the lowering of BNL's permit standard on this parameter (pH).

3.3.2 Meadow-Marsh Project

The Meadow-Marsh Project (16), which was conducted by the Department of Energy and Environment (DEE) since 1972 was discontinued on December 31, 1978. Since there was no effluent leaving the project sampling was also discontinued.

3.3.3 Peconic River

Primary treatment of the liquid stream collected by the sanitary waste system to remove suspended solids is provided by a 950,000 liter clarifier. The liquid effluent from it then flows onto sand filter beds, from which about 78% of the water is recovered by an underlying tile field. This recovered water is chlorinated and then 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 illustrated 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 lo-

TABLE 10

1979 BNL Environmental Monitoring National Pollution Discharge Elimination System
Summary of Data

Parameter	Status	Quantity Minimum	Quantity Average	Quantity Maximum	Quantity Units	Quantity No. ex.[a]	Concentration Minimum	Concentration Average	Concentration Maximum	Concentration Units	Concentration No. ex.	Frequency of analysis	Sample type
Flow	Sample measurement	0.55	0.87	1.42	MGD	-	XX	XX	XX			Cont.	NA
	Permit requirement						XX	XX	XX	-	-	Cont.	NA
pH Influent	Sample measurement	6.3	6.8	9.2	Std.		XX	XX	XX			5/7	Grab
	Permit requirement	XX	XX	XX	Units	-	XX	XX	XX	-	-	Daily	Grab
pH Effluent	Sample measurement	5.5	5.9	6.5	Sts.		XX	XX	XX			5/7	Grab
	Permit requirement	5.8	XX	9.0	Units	35	XX	XX	XX	-	-	Daily	Grab
BOD_5 Influent	Sample measurement	90.9	149.8	218.4	Kg/		22.0	33.2	50.5	mg/l		Weekly	8 hr.
	Permit requirement	XX	XX	XX	day	-	XX	XX	XX		-	Monthly	8 hr.
BOD_5 Effluent	Sample measurement	6.6	13.2	24.6	Kg/		2.2	4.0	7.2	mg/l		Weekly	8 hr.
	Permit requirement	XX	262.0	391.0	day	0	XX	30.0	45.0		0	Monthly	8 hr.
Percent removal, BOD_5	Sample measurement	XX	XX	XX			85.1	91.0	95.0	%		Weekly	-
	Permit requirement	XX	XX	XX	-	-	XX	XX	XX		0	Monthly	-
Suspended solids, Influent	Sample measurement	53.4	125.1	207.5	Kg/		10.5	26.7	53.9	mg/l		Biweekly	8 hr.
	Permit requirement	XX	XX	XX	day	-	XX	XX	XX		-	Monthly	8 hr.
Suspended solids, Effluent	Sample measurement	0.0	1.5	8.0	Kg/		0.0	0.4	2.0	mg/l		Biweekly	8 hr.
	Permit requirement	XX	262.0	391.0	day	0	XX	30.0	45.0		0	Monthly	8 hr.
Percent removal, Suspended solids	Sample measurement	XX	XX	XX			95.0	98.8	100.0	%		Weekly	-
	Permit requirement	XX	XX	XX	-	-	85.0	XX	XX		0	Monthly	-
Settleable solids, Influent	Sample measurement	XX	XX	XX			0.3	1.8	5.0			5/7	Grab
	Permit requirement	XX	XX	XX	-	-	XX	XX	XX	-	-	Daily	Grab
Settleable solids, Effluent	Sample measurement	XX	XX	XX			0.0	0.0	0.0			5/7	Grab
	Permit requirement	XX	XX	XX	-	-	XX	XX	XX	-	-	Daily	Grab
Residual Chlorine, Effluent	Sample measurement	XX	XX	XX			0.5	1.0	1.7			5/7	Grab
	Permit requirement	XX	XX	XX	-	-	XX	XX	XX	-	-	Daily	Grab
Temperature, Effluent	Sample measurement	6.0	15.1	23	^{o}C		XX	XX	XX			5/7	Grab
	Permit requirement	XX	XX	XX		-	XX	XX	XX	-	-	Daily	Grab
Fecal coliform, Effluent	Sample measurement		XX	XX			0.0	0.0	0.0			Weekly	Grab
	Permit requirement		XX	XX	-	-	XX	200.0	400.0	n/100 ml	0	Monthly	Grab

XX Indicates not required.

[a] Total for the year.

Data collected by R. Richards and G. Yengel (Sewage Treatment Plant) and forwarded by H. Haller (Plant Engineering) to Safety and Environmental Protection Division.

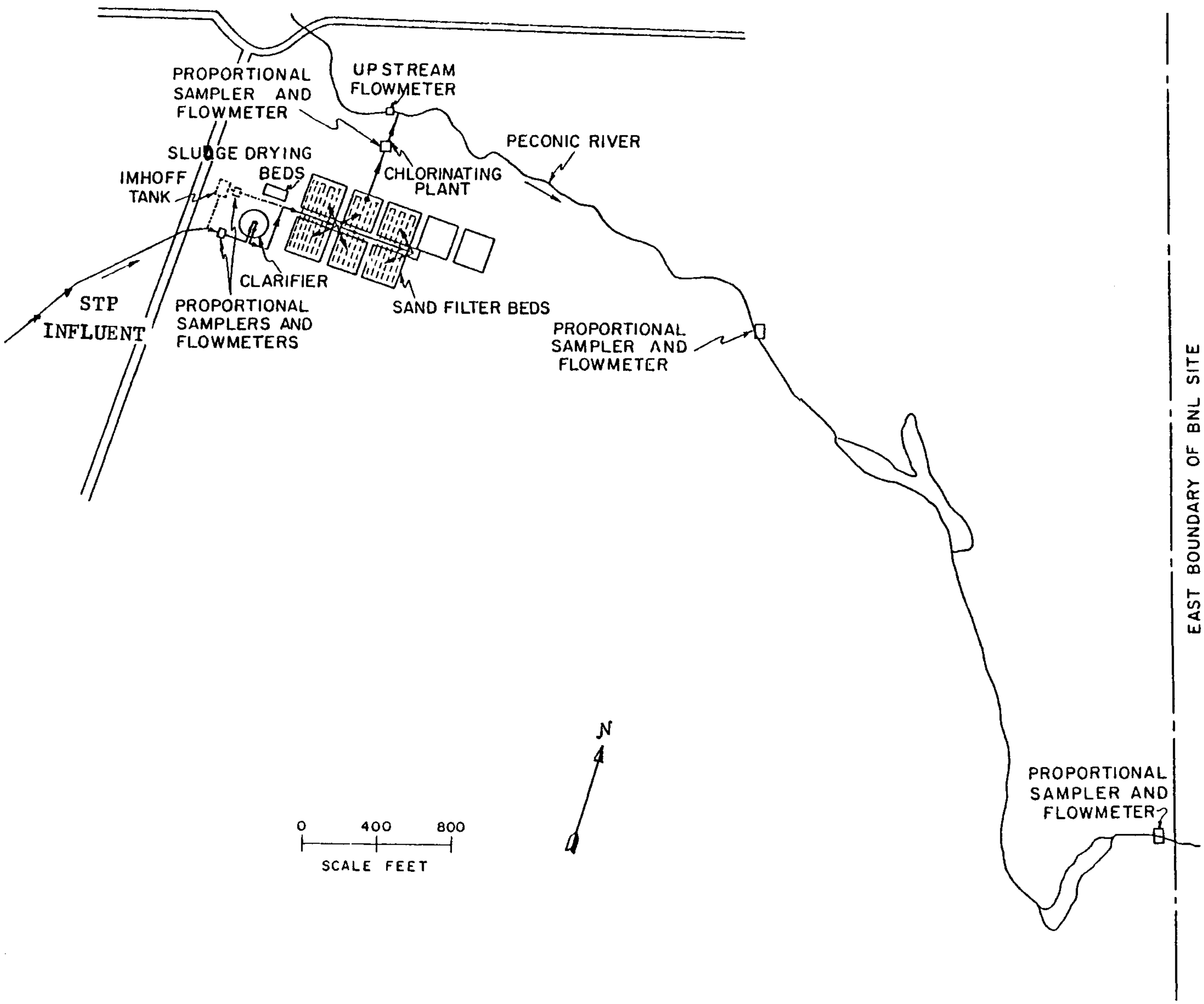


Figure 6. Sewage Treatment Plant

cated 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.

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 analyzed for gross beta, alpha, and for tritium. Another aliquot, proportional to the measured flow during the sampling period, was passed through ion exchange columns for subsequent analysis as an integrated sample. If the gross beta count at each location did not indicate the need for immediate radionuclide identification, then one set of these columns was analyzed directly on a monthly or quarterly basis for gamma emitting nuclides and the other 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 11. Yearly totals and average concentrations are indicated. The average monthly flow at the clarifier which had decreased from previous years, during 1976 and 1977, increased in 1978 and 1979 an increase over the 1977 flows by 14% and 22% respectively. The output at the chlorine house has shown a similar increase. The loss to ground water through the sand filter beds, however, has apparently increased when compared to 1978, and could be the result of a combination of events, such as, calibration of flowmeters, loss of efficiency of filter beds, etc. This is being investigated. About 78% of the total flow into the clarifier appeared in the output at the chlorine house after passing through the sand filter beds. The balance was assumed to have percolated to the ground water flow under the beds. Estimates of the amount of radioactivity released to the ground water in this manner during 1979 are shown in Table 11. 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.

An analysis of the radionuclide concentrations at the chlorine house over the past six years (1974-1979) has indicated that the fluctuations observed appear to be relatable to sand filter beds. It also indicates that a time lag between input and output from from the sand filter beds is evident. This lag appears to be greater for ^{134}Cs and ^{137}Cs than for ^{90}Sr. During 1979, radionuclides such as ^{51}Cr, ^{65}Zn, ^{95}Zr-Nb, ^{125}Sb, ^{131}I and ^{144}Ce, which have been detected in previous years, were all at or below MDL (see Appendix B) and as such were not reported in the Table 11. The Laboratory releases of radionuclides have been on the decrease over the years as a result of the ALARA approach.

Flow and activity 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 12. The climatic conditions, which in 1977 had resulted in decreased flows when compared to previous years, were reversed in 1978 and 1979. Above average rainfall (143 cm) has resulted in a flow at the site perimeter which was nine times greater than that recorded in 1977. It must be noted, however, that the flows recorded in 1979 were estimated on the basis of chloride

TABLE 11

1979 BNL Environmental Monitoring Total Activities and Concentrations of Identifiable Nuclides in Liquid Effluents
Sewage Treatment Plant

Month	Flow 10^{10} ml	Gα	Gβ	Gβ + γ only[a]	^{3}H	^{7}Be	^{22}Na	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{90}Sr	^{134}Cs	^{137}Cs
						Clarifier (mCi)								
January	12.59	0.46	21.8	33.41	1305	1.9	0.41	b	b	b	b	0.038	3.40	5.7
February	10.61	0.21	8.4	10.93	467	0.2	0.05	.03	b	b	b	0.017	0.63	1.6
March	12.12	0.14	3.5	4.84	760	0.2	0.01	b	b	.02	.02	0.027	0.09	.22
April	13.22	0.20	6.1	6.37	1553	0.15	0.001	.003	.02	.05	b	0.033	.05	.08
May	14.79	0.22	3.4	3.58	636	0.09	b	.01	.02	b	.04	0.050	.02	b
June	14.42	0.21	2.8	2.94	1177	.04	b	.01	.02	b	.04	0.023	.02	.007
July	16.66	0.22	4.3	4.47	2523	.05	b	.02	.02	b	.05	0.017	.02	.008
August	15.49	0.20	3.3	3.42	4114	.06	.01	.01	.01	b	.02	0.020	b	.01
September	11.74	0.15	10.3	11.41	1769	b	b	b	.06	b	1.05	0.024	b	b
October	16.92	0.20	4.3	4.64	3823	0.16	b	b	b	b	0.16	0.036	.02	b
November	13.29	0.17	4.0	4.68	2551	0.20	b	b	b	b	0.44	0.017	.04	b
December	10.96	0.17	2.9	3.47	1135	0.19	b	b	b	b	0.3	0.045	0.06	0.02
Total	162.81	2.58	75.2	94.16	21810	1.27	0.41	.092	0.18	.07	2.22	0.347	5.11	7.60
						Average concentration (pCi/liter or 10^{-9} μCi/ml)								
		1.58	46.19	57.80	13400	0.78	0.25	.06	0.10	.04	1.36	0.21	3.14	4.67
						Groundwater (Sand-Filter Beds) (mCi)								
Total	36.17	0.51	10.3	12.61	4310	0.43	0.13	.06	0.03	b	0.09	0.19	0.57	1.00
						Average concentration (pCi/liter or 10^{-9} μCi/ml)								
		1.4	28.5	34.86	11910	1.20	0.37	0.17	0.09	b	0.26	0.53	1.58	2.77
						Chlorine House (mCi)								
January	10.41	0.19	3.6	4.94	887	0.75	0.27	0.03	b	b	.005	0.072	0.21	0.28
February	7.74	0.12	1.8	2.93	256	0.40	0.09	b	0.02	b	0.03	0.070	0.23	0.36
March	10.12	0.16	2.1	2.81	624	0.14	0.02	0.05	0.01	b	0.04	0.073	0.16	0.34
April	10.46	0.16	3.8	4.19	1669	b	0.01	0.04	0.02	b	0.06	0.061	0.18	0.24
May	11.80	0.18	3.0	3.13	506	b	0.001	0.02	b	b	0.02	0.063	0.08	0.12
June	14.78	0.22	3.5	3.62	860	b	b	0.02	0.02	b	0.05	0.096	0.02	0.20
July	12.46	0.16	2.8	3.51	1957	b		0.03	b	b	b	0.062	0.23	0.45
August	11.57	0.14	2.2	3.11	2903	0.16	0.03	0.02	b	b	b	0.031	0.23	0.47
September	8.22	0.09	6.5	7.66	823	b	b	b	b	b	0.003	0.029	0.16	0.27
October	10.20	0.12	3.1	3.71	2382	0.10	0.02	0.01	0.01	b	0.01	0.048	0.15	0.29
November	12.25	0.16	2.5	2.99	1597	b	0.01	0.01	0.01	b	0.05	0.047	0.14	0.27
December	6.97	0.08	1.3	1.67	653	b	0.01	0.01	b	b	0.04	0.024	0.11	0.20
Total	127.0	1.78	36.2	44.27	15120	1.52	0.47	0.22	0.12	b	0.33	0.676	2.01	3.52
						Average concentration (pCi/liter or 10^{-9} μCi/ml)								
EPA-Drinking water regulations [18] and Radiation Concentration Guide [17]		1.4	28.5	34.86	11910	1.20	0.37	0.17	0.09	b	0.26	0.53	1.58	2.77
				$3x10^{3}$ c	$2x10^{4}$	$2x10^{6}$	$4x10^{4}$	$1x10^{5}$	$5x10^{4}$	$1x10^{5}$	$5x10^{4}$	8	$9x10^{3}$	$2x10^{4}$

[a]Includes gamma (only) emitters but excludes tritium.

[b]Below the Minimum Detection Limit (MDL) of the system used in estimating the activity. Other radionuclides such as ^{51}Cr, ^{65}Zn, $^{95}ZrNb$, ^{125}Sb, ^{131}I, $^{140}BaLa$, ^{144}Ce were all below MDL.

[c]For mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$, or long lived alpha emitters. The concentration guides for unknown mixtures depend, within the range given, on whether certain radionuclides are know to be present in concentrations less than 0.1 of their CGs, and the sum of the fractions of the CGs for all such nuclides is less than 0.25.

mCi = 3.7×10^{7} Bq.

μCi = 3.7×10^{4} Bq.

pCi = 3.7×10^{-2} Bq.

TABLE 12

1979 BNL Environmental Monitoring Total Activities and Concentrations of Identifiable Nuclides in Liquid Effluents
Peconic River

Month	Flow $\times 10^{10}$ ml	Gross α	Gross β	Gβ + γ only[a]	^{3}H	^{7}Be	^{22}Na	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{90}Sr	^{134}Cs	^{137}Cs
							Former Perimeter (mCi)							
January	33.30	0.50	4.40	5.56	847	0.53	0.12	0.04	b	b	0.03		0.18	0.26
February	75.70	1.21	8.89	12.83	3689	1.33	0.38	0.13	b	b	0.13	1.22	0.57	1.40
March	76.50	0.97	4.90	7.84	1124	1.15	0.22	0.11	0.07	b	0.12		0.43	0.84
April	105.00	1.57	8.12	10.27	2241	0.51	0.04	0.11	0.06	b	0.16		0.43	0.84
May	65.00	1.08	7.28	8.89	1484	0.59	0.08	0.03	0.03	b	0.06	1.52	0.32	0.50
June	32.70	0.50	5.37	5.93	1217	0.14	0.03	0.02	0.01	b	b		0.12	0.24
July	28.50	0.40	3.05	3.84	2491	0.18	0.04	0.03	b	b	b		0.17	0.37
August	21.50	0.31	2.50	3.06	2898	0.12	0.02	0.01	b	b	b	0.49	0.13	0.28
September	16.00	0.17	6.90	7.29	1009	b	0.02	0.02	b	b	0.02		0.12	0.21
October	23.20	0.13	1.38	1.98	1353	0.16	0.02	0.01	b	b	b		0.14	0.27
November	12.50	0.18	1.50	1.76	1188	0.04	b	b	b	b	0.03	0.19	0.07	0.12
December	11.50	0.14	1.90	2.27	1015	0.07	0.01	0.01	b	b	0.01		0.09	0.18
Total	501.40	7.16	56.19	71.52	20556	4.82	0.98	0.52	0.17	b	0.56	3.42	2.77	5.51
							Average Concentration (pCi/liter or 10^{-9} μCi/ml)							
		1.43	11.21	14.26	4100	0.96	0.20	0.10	.03	b	0.11	0.68	0.55	1.10
							Groundwater (Stream Bed) (mCi)							
Total	17.4	0.28	2.04	1.78	848	0.31	0.09	0.03	b	b	0.03	0.28	0.13	0.32
							Average Concentration (pCi/liter or 10^{-9} μCi/ml)							
		1.60	11.74	10.25	4873	1.76	0.50	0.17	b	b	0.17	1.61	0.75	1.85
							Site Boundary (mCi)							
January	36.40	0.54	4.40	4.88	847	0.23	0.03	0.01	0.01	b	0.01		0.08	0.11
February	58.30	0.87	5.60	8.19	960	1.69	0.26	0.05	0.03	b	0.01	1.43	0.11	0.44
March	77.80	1.00	5.00	9.96	10090	1.01	0.36	0.09	b	b	0.18		0.28	0.63
April	112.00	1.62	21.20	25.03	3479	0.43	b	0.21	b	b	0.10		0.03	0.10
May	68.90	1.04	7.38	8.43	2022	0.39	0.05	0.05	0.05	b	b	0.44	0.02	0.49
June	34.10	0.46	7.70	8.0	648	0.11	0.01	b	b	b	b		0.06	0.12
July	29.20	0.40	16.60	17.17	1216	0.11	0.02	0.03	0.01	b	0.02		0.12	0.26
August	23.30	0.31	2.70	3.12	2368	0.09	0.01	0.01	b	b	b	0.27	0.10	0.21
September	23.30	0.26	3.30	3.74	1067	b	0.02	0.02	0.05	b	0.02		0.12	0.21
October	25.10	0.30	2.33	2.83	2774	0.14	0.02	0.01	b	b	b		0.10	0.23
November	16.20	0.21	1.70	1.95	1834	0.06	b	b	b	b	b	0.33	0.07	0.12
December	14.99	0.18	1.80	1.84	739	b	b	b	b	b	b		0.01	0.03
Total	519.49	7.19	79.71	95.14	28044	4.26	0.78	0.48	0.15	b	0.34	2.47	1.10	2.95
							Average Concentration (pCi/liter or 10^{-9} μCi/ml)							
		1.38	15.35	18.31	5399	0.82	0.15	0.10	0.03	b	0.07	0.48	0.21	0.57
EPA-Drinking Water Regulations [18] and Radiation Conc Guides [17]			3×10^{3}[c]		2×10^{4}	2×10^{6}	4×10^{4}	1×10^{5}	5×10^{5}	1×10^{5}	5×10^{4}	8	9×10^{3}	2×10^{4}

[a]Includes gamma (only) emitters but excludes tritium.

[b]Below the Minimum Detection Limit (MDL) of the system used in estimating the activity. Other radionulcides such as ^{51}Cr, ^{65}Zn, $^{95}ZrNb$, ^{125}Sb, ^{131}I, ^{140}Ce were all below MDL.

[c]For mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$, or long lived alpha emitters. The concentration guides for unknown mixtures depend, within the range given, on whether certain radionulcides are known to be present in concentrations less than 0.1 of their CGs, and the sum of the fractions of the CGs for all such nuclides is less than 0.25.

mCi = 3.7 c 10^{7} Bq.

μCi = 3.7 x 10^{4} Bq.

pCi = 3.7 x 10^{-2} Bq.

concentrations, since the flows exceeded the capability of the measuring system. A review of the flow measuring system is in progress. Such changes in flow do affect the amount of water that percolates into the ground water system; for example, 16% of the flow between the former perimeter and the present site boundary was lost to the ground water in 1975, 30% in 1976, 60% in 1977 less than 1% in 1978 and about 3% in 1979. Such fluctuations can result in changes in radionuclide activity concentrations between the former and present site boundary but this is related to total flow since the total activity essentially remains almost constant. This is true for radionuclides, such as ^{7}Be, ^{22}Na, and ^{137}Cs, which have remained in solution and therefore have not significantly precipitated out of the water body. Upper limit estimates of the total activity that may have percolated to the underlying aquifier is also shown in Table 12. These are based on the decrease in total flow between the former site boundary and the perimeter during October and November.

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, 4% of the annual total activity (excluding tritium) consisted of ^{90}Sr and that no appreciable amounts of long-lived radioactive iodine or other bone-seeking nuclides such as radium were present. It must be noted that the 4% indicated above would decrease if other radionuclides were present. Under these circumstances, the applicable RCG was 3000 pCi l^{-1} (3.0×10^{-6} μCi ml^{-1} or 1.1×10^{-1} Bq ml^{-1}). The gross beta concentration in the portion which is assumed to have percolated to ground water was 11.7 pCi l^{-1} (1.17×10^{-8} μCi ml^{-1} or 4.32×10^{-4} Bq ml^{-1}) or <1% of the RCG.

At the Laboratory perimeter (2.6 km downstream from the chlorine house), 3% of the annual total activity was ^{90}Sr. The applicable RCG was also 3000 pCi l^{-1} (1.1×10^{-1} Bq ml^{-1}). The observed gross beta concentration of the water released downstream was 15.4 pCi l^{-1} (1.54×10^{-8} μCi ml^{-1} or 5.7×10^{-4} Bq ml^{-1}) or <1% of the RCG.

In addition to the above measurements, the Safety and Environmental Protection Division conducts routine measurements of water quality and purity of the filter beds 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 1979 is shown in Table 13. The outflow from the sand filter beds (EA) into the Peconic River complied with water quality standards for minimum dissolved oxygen (DO) (12, 19), except at upstream of the outfall (HE) and at the perimter (HM). During the severe winter of 1977/1978 there was heavy snowfall. This and the subsequent rise in water table in 1979 resulted in heavy decomposition of vegetation due to water logging in the Peconic River drainage area. This would lead to a high content of humic acid in the river water, which in turn would increase the biological oxygen demand and thereby lead to reductions in dissolved oxygen content, as indicated (20). Although occasionally below the standard (19), the effluent pH was within the range of local ambient levels. After mixing with the upstream flow, the temperature increment was within the standard (21) at the Laboratory perimeter. Yearly average concentrations of most metals were, before dilution, at or within the standard for the receiving body of water (12, 19) except iron (Fe) and occasionally copper (Cu), and lead (Pb). From past studies, iron (Fe)

TABLE 13

1979 BNL ENVIRONMENTAL MONITORING LIQUID EFFLUENT WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
EA	MEAN	16	5.5	8.0	27.5	4.09	0.89	119	159	1	2
	MINIMUM	3	4.6	0.9	20.3	0.26	0.36	100	59	0	0
	MAXIMUM	27	6.4	10.8	38.3	5.93	1.60	160	250	90	137
	NUMBER	246	245	244	53	53	53	11	247	241	238
HE	MEAN	11	5.4	6.6	7.5	0.26	0.04	61	56	31	109
	MINIMUM	0	4.0	3.6	0.9	0.01	0.01	39	41	0	0
	MAXIMUM	24	7.6	9.6	11.0	0.67	0.11	112	149	* 8	452
	NUMBER	97	97	96	11	11	11	11	97	93	89
HM	MEAN	13	5.3	7.8	16.3	1.56	0.37	79	96	30	252
	MINIMUM	0	3.8	4.4	10.6	0.42	0.08	62	6	0	0
	MAXIMUM	26	6.3	11.2	24.0	3.04	1.76	99	162	960	1600
	NUMBER	142	141	136	51	51	51	10	143	137	131
HQ	MEAN	12	5.8	6.3	15.9	0.89	0.28	81	98	51	185
	MINIMUM	0	4.7	1.2	11.1	0.13	0.09	12	62	0	1
	MAXIMUM	28	7.6	13.0	31.2	2.13	0.71	136	159	720	680
	NUMBER	147	146	142	52	53	53	11	147	135	131

METALS (IN PPM)

		AG	CD	CR	CU	FE	HG	PB	ZN
EA	MEAN	.003	.0013	.004	.071	.144	.0005	.005	.202
	MINIMUM	.001	.0009	.002	.033	.045	.0003	.002	.130
	MAXIMUM	.008	.0019	.026	.220	.350	.0008	.009	.285
	EXCEPTION	0	0	6	0	0	0	8	0
	NUMBER	12	12	12	12	12	12	12	12
HE	MEAN	.001	.0005	.002	.010	1.315		.004	.015
	MINIMUM	.001	.0003	.002	.002	.420		.002	.005
	MAXIMUM	.001	.0006	.003	.024	2.680		.005	.028
	EXCEPTION	3	3	2	1	0	0	3	0
	NUMBER	3	3	3	3	3	0	3	3
HM	MEAN	.001	.0006	.002	.038	.861	.0002	.020	.083
	MINIMUM	.000	.0003	.001	.014	.324	.0001	.001	.055
	MAXIMUM	.002	.0009	.002	.094	2.840	.0004	.219	.111
	EXCEPTION	8	7	6	0	0	0	9	0
	NUMBER	12	12	9	12	12	12	13	12

1979 BNL ENVIRONMENTAL MONITORING SEWAGE INFLUENT WATER QUALITY AND PURITY-METALS

METALS (IN PPM)

		AG	CD	CR	CU	FE	PB	ZN
DA	MEAN	.004	.0015	.008	.078	.331	.007	.112
	MINIMUM	.001	.0008	.002	.033	.213	.003	.078
	MAXIMUM	.007	.0025	.019	.181	.510	.011	.197
	EXCEPTION	1	0	2	0	0	1	0
	NUMBER	12	12	12	12	12	12	12

1979 BNL ENVIRONMENTAL MONITORING PRECIPITATION WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
GD	MEAN		4.1								
	MINIMUM		3.0								
	MAXIMUM		5.8								
	NUMBER	0	52	0	0	0	0	0	0	0	0

Reference Standards - Table 29

Exception: No. of samples below Minimum Detection Limit (MDL)

EA: Sand filter beds
HE: Upstream of outfall
HM: Former site boundary
HQ: Site boundary
DA: Sewage Effluent
GD: Precipitation

seems to be ubiquitous at the levels seen in the ground water system. Since the Laboratory derives all of its water from the underlying aquifer, the presence of Fe in our effluents is not surprising. The high value of Cu upstream of the outfall is consistent with the presence of humic acid, which is known to chelate and concentrate transition metals from the water (20).

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 liquids within administrative limits (15). A battery operated fixed flow sampler is operated at Riverhead, at the mouth of the Peconic River, between March and December. Reference "grab" samples were obtained from other nearby streams and bodies of water outside the Laboratory 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 (HA),

B - Peconic River at Wading River-Manorville Road, 7.04 km downstream (HB),

C - Peconic River at Manorville, 10.67 km downstream (HC),

D - Peconic River at Calverton, 14.23 km downstream (HD),

R - Peconic River at Riverhead, 19.35 km downstream (HR),

Controls (Not in the Laboratory drainage area)

E - Peconic River, upstream from the Laboratory effluent outfall (HE),

F - Peconic River, north tributary (independent of the Laboratory (HF) drainage area),

H - Carman River, outfall of Yaphank Lake (HH),

I - Northeast corner of Artist Lake on Route 25 (HI).

Individual monthly and yearly average gross beta, tritium and ^{90}Sr concentrations at downstream and control locations are shown in Table 14. A comparison with the on-site and perimeter concentrations shown in Table 12 indicates 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 over the years has been about 19 times that at the Laboratory perimeter (USGS-1979 data), it was evident that the total amount of radioactivity at this location was much greater than those released into the Peconic River at the Laboratory perimeter. This obviously represents radioactivity washed out of drainage areas and tributary additions, in addition to that from the Laboratory area, by rainfall. During

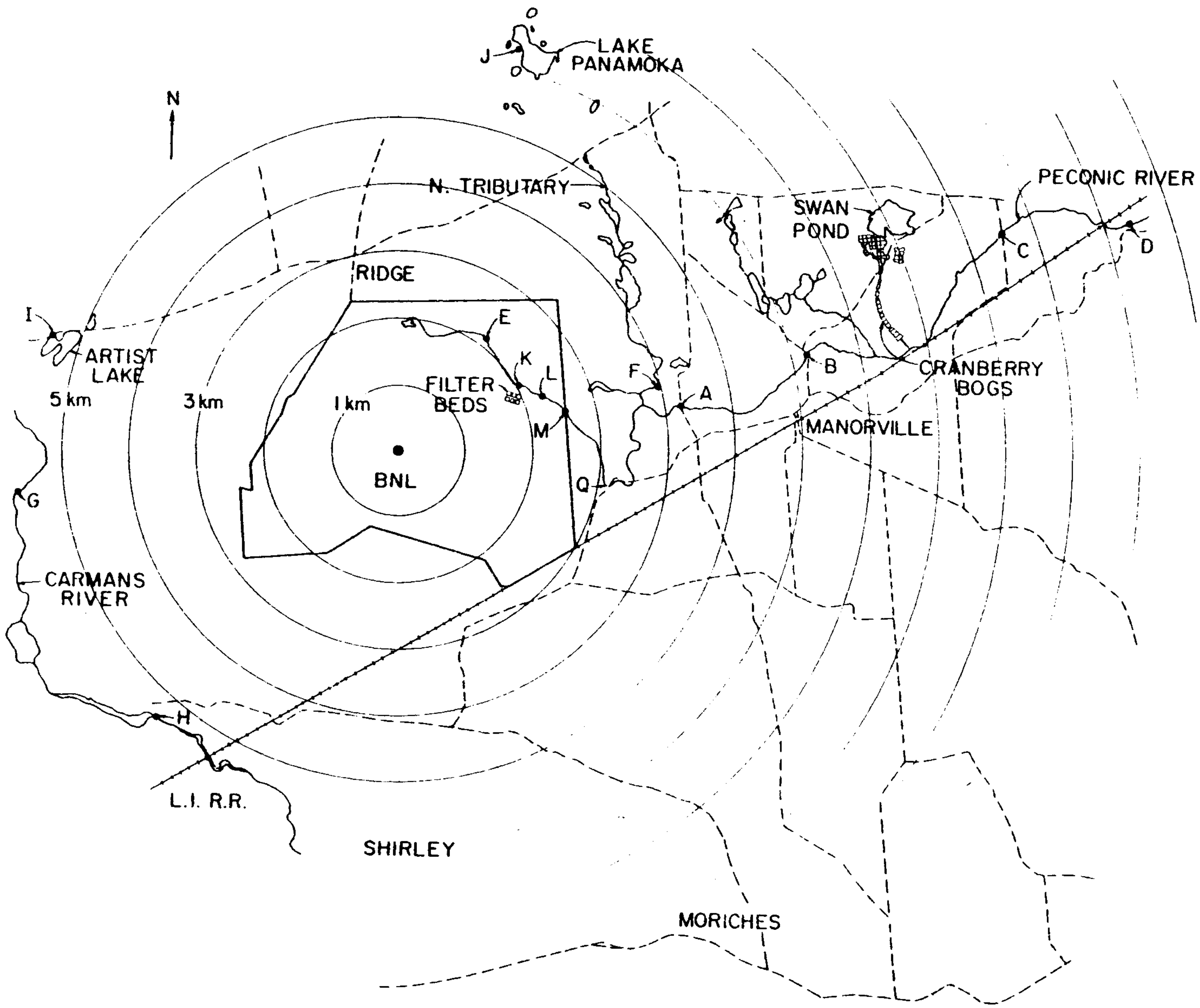


Figure 7. Peconic River, On-site and Downstream Sampling Locations

TABLE 14

1979 BNL DOWNSTREAM AND CONTROL WATER SAMPLES

LOCATION	QUARTER	NO. OF SAMPLES	GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
DOWNSTREAM										
HA	FIRST	1	0.33	0.26	2.99	0.87	0.22	0.22		
	SECOND	1	0.56	0.37	5.38	1.07	0.32	0.32	0.87	0.13
	THIRD	1	0.31	0.23	16.28	1.43	0.86	0.25		
	FOURTH	1	0.26	0.26	7.35	1.13	0.90	0.26	0.62	0.11
SUMMARY		4	0.37	0.14	8.00	0.57	0.57	0.13	0.75	0.09
HB	FIRST	1	0.26	0.26	5.01	1.21	0.22	0.22		
	SECOND	1	0.42	0.36	6.30	1.14	0.32	0.32	0.69	0.13
	THIRD	1	0.22	0.22	4.96	0.99	0.32	0.32		
	FOURTH	1	0.24	0.24	4.14	1.01	0.62	0.26	0.53	0.12
SUMMARY		4	0.29	0.14	5.10	0.55	0.37	0.14	0.61	0.09
HC	FIRST	1	0.31	0.31	3.55	0.90	0.22	0.22		
	SECOND	1	0.37	0.28	6.05	1.07	0.32	0.32	0.97	0.14
	THIRD	1	0.24	0.23	7.95	1.14	0.32	0.32		
	FOURTH	1	0.18	0.18	3.31	0.95	1.18	0.28	0.47	0.11
SUMMARY		4	0.27	0.13	5.21	0.51	0.51	0.14	0.72	0.09
HD	FIRST	1	0.29	0.29	3.18	0.89	0.22	0.22		
	SECOND	1	0.24	0.24	3.48	0.93	0.32	0.32	0.70	0.13
	THIRD	1	0.25	0.25	3.89	0.94	0.32	0.32		
	FOURTH	1	0.18	0.18	4.95	1.20	1.33	0.31	0.46	0.10
SUMMARY		4	0.24	0.12	3.88	0.50	0.55	0.15	0.58	0.08
HL	FIRST	1	0.29	0.29	6.14	1.27	0.22	0.22		
	SECOND	1	0.66	0.40	12.01	1.35	0.32	0.32		
	THIRD	1	0.22	0.22	12.08	1.41	3.59	0.31		
	FOURTH	0	0.00	0.00	0.00	0.00	0.00	0.00		
SUMMARY		3	0.39	0.18	10.08	0.78	1.38	0.16		
HR	FIRST	0	0.00	0.00	0.00	0.00	0.00	0.00		
	SECOND	5	0.52	0.20	8.58	0.63	1.42	0.24	0.45	0.04
	THIRD	6	0.47	0.19	5.39	0.89	0.31	0.11		
	FOURTH	4	0.23	0.11	4.79	0.50	0.30	0.12	0.48	0.05
SUMMARY		15	0.43	0.11	6.65	0.41	0.80	0.12	0.47	0.03
CONTROL										
HE	FIRST	1	0.51	0.30	4.19	0.93	0.22	0.22		
	SECOND	1	0.79	0.41	3.89	0.99	0.32	0.32	0.59	0.12
	THIRD	1	0.16	0.16	1.14	1.14	0.23	0.23		
	FOURTH	1	0.31	0.31	0.89	0.78	0.21	0.21	0.41	0.11
SUMMARY		4	0.44	0.15	2.53	0.48	0.24	0.12	0.50	0.09
HF	FIRST	1	0.50	0.29	2.68	0.85	0.22	0.22		
	SECOND	1	0.16	0.16	1.27	0.79	0.32	0.32	0.91	0.13
	THIRD	1	0.20	0.19	2.41	0.84	0.23	0.23		
	FOURTH	1	0.08	0.08	1.64	0.83	0.21	0.21	0.60	0.12
SUMMARY		4	0.24	0.10	2.00	0.41	0.24	0.12	0.76	0.09
HH	FIRST	1	0.16	0.16	3.05	0.90	0.22	0.22		
	SECOND	1	0.31	0.27	1.34	0.83	0.32	0.32	0.47	0.13
	THIRD	1	0.16	0.16	2.52	0.91	0.23	0.23		
	FOURTH	1	0.24	0.24	2.20	0.90	0.21	0.21	0.32	0.09
SUMMARY		4	0.22	0.11	2.28	0.44	0.24	0.12	0.40	0.08
HI	FIRST	1	0.29	0.29	3.15	1.12	0.22	0.22		
	SECOND	1	0.59	0.34	6.41	1.09	0.32	0.32	0.82	0.14
	THIRD	1	0.20	0.20	6.69	1.13	0.23	0.23		
	FOURTH	1	0.38	0.35	5.08	1.10	0.25	0.25	0.79	0.13
SUMMARY		4	0.37	0.15	5.33	0.55	0.25	0.13	0.81	0.10
HJ	FIRST	0	0.00	0.00	0.00	0.00	0.00	0.00		
	SECOND	0	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.11
	THIRD	0	0.00	0.00	0.00	0.00	0.00	0.00		
	FOURTH	1	0.21	0.21	3.68	0.97	0.21	0.21		
SUMMARY		1	0.21	0.21	3.68	0.97	0.21	0.21	0.48	0.11

nCi = 3.7×10^{1} Bq.   pCi = 3.7×10^{-2} Bq.

Note: prefix H applied to facilitate sampling designation.

1979, 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 13). These limited "grab" sample data are shown in Table 15. The effect of somewhat elevated levels of some of the parameters downstream results from other activities, residential and industrial, along the length of the Peconic River. This is based on the observation that the increased levels are not uniform but seem to be localized.

3.3.4 Recharge Basin

After use in "once through" heat exchangers and process cooling, about 19 million 1 d^{-1} (MLD) of water (data provided by Plant Engineering) was returned to the aquifer through on-site recharge basins: about 6.9 MLD to basin N located about 610 m northeast of the AGS; about 5.8 MLD to basin O about 670 m east of the HFBR; and about 6.3 MLD to basin P located 305 m south of the MRR (see Fig. 8). An organic phosphate is added to the AGS cooling and process water supply, which is independent of the Laboratory's potable supply, to establish a PO_4^{-3} concentration of about 2 ppm in order to maintain the ambient iron in solution. Of the total AGS pumpage, about 4.3 MLD was discharged to the N basin, and 4.3 MLD to the O basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and is treated to control corrosion and deposition of solids. Blowdown from this system, about 1.5 MLD, which contains about 6-8 ppm PO_4 and 3-4 ppm benzotriazole is also discharged to the O sump. The MRR-MRC "once through" coolant which amounts to 6.3 MLD is not routinely treated and is discharged to the P basin. Concentrations of radioactivity and other agents in the water discharged into these basins are monitored by routine weekly grab sampling. The average gross beta and tritium activity concentrations are shown in Table 16. The average gross beta activity concentration in the sump north of the AGS (N) and LINAC (T) are slightly above background since this water cools beam stops where activation products are formed and was 0.4% to 1% of the applicable RCG. However, in the Linac (T) sump the gross beta activity was found to be about 1858 pCi/l in September. Investigations conducted at that time revealed that the increase in activity was due to a leak from the BLIP tank water which ultimately entered into the LINAC sump. The leak has been corrected and a significant amount of the contaminated water has been contained and will be disposed of in an appropriate manner. In the case of the sump east of the steam plant (U), the gross beta activity has continued to show levels approaching 3 to 8% of the RCG. However, wells used to monitor these sumps have not shown any increase in gross beta activity above background (gross beta activity in wells located upstream). Sampling frequency of these wells was increased in 1979 to investigate ground water contamination and no significant increases were noted in relation to previous years. Sampling frequency of the steam plant sump (U) will be increased in 1980 and analysis of these samples for specific radionuclides will be made. In general, the average concentration of gross beta and tritium activity concentrations in the other basins were slightly increased above those in the Laboratory supply wells and were about 0.1% of the applicable RCG for unidentified gross beta emitters and tritium.

TABLE 15

1979 BNL ENVIRONMENTAL MONITORING DOWNSTREAM AND CONTROL
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
HA	MEAN	14	5.7	6.7	10.1	0.29	0.07	55	63	35	175
	MINIMUM	6	5.1	1.8	8.6	0.11	0.05	45	52	0	16
	MAXIMUM	21	6.2	10.6	12.1	0.45	0.10	64	69	100	392
	NUMBER	4	4	4	4	4	4	4	4	4	4
HB	MEAN	12	5.6	7.0	9.9	0.30	0.06	57	62	29	144
	MINIMUM	6	5.4	1.4	9.1	0.21	0.03	55	59	1	54
	MAXIMUM	18	6.0	12.0	11.6	0.41	0.14	59	67	68	300
	NUMBER	4	4	4	4	4	4	4	4	4	4
HC	MEAN	14	6.8	9.8	9.6	0.13	0.05	59	86	6	97
	MINIMUM	6	5.5	6.6	9.1	0.04	0.02	51	54	0	32
	MAXIMUM	22	8.9	12.2	10.6	0.22	0.11	73	164	12	176
	NUMBER	4	4	4	4	4	4	4	4	4	4
HD	MEAN	13	6.2	10.6	12.0	0.31	0.04	72	101	35	127
	MINIMUM	6	5.6	8.2	9.1	0.08	0.01	47	56	0	10
	MAXIMUM	21	6.6	12.6	19.2	0.64	0.09	116	172	104	190
	NUMBER	4	4	4	4	3	4	3	4	4	3
HF	MEAN	14	5.3	6.8	6.9	0.21	0.04	44	45	28	133
	MINIMUM	5	4.5	1.4	6.6	0.03	0.01	36	42	0	10
	MAXIMUM	23	5.7	10.4	7.1	0.67	0.10	52	48	104	270
	NUMBER	4	4	4	4	4	4	4	4	4	4
HH	MEAN	13	6.3	10.8	13.0	1.09	0.02	84	106	17	58
	MINIMUM	5	6.0	9.6	9.6	0.82	0.01	70	94	4	18
	MAXIMUM	21	6.4	12.6	19.2	1.32	0.04	110	134	36	100
	NUMBER	4	4	4	4	4	4	4	4	4	4
HI	MEAN	14	6.6	10.3	19.5	0.17	0.02	74	105	67	115
	MINIMUM	4	6.3	8.4	18.2	0.10	0.01	60	98	5	22
	MAXIMUM	24	6.8	12.6	21.7	0.31	0.03	84	112	180	240
	NUMBER	4	4	4	4	4	4	4	4	4	4
HJ	MEAN	3	7.0	12.4	9.1	0.38	0.04	52	68	0	0
	MINIMUM	3	7.0	12.4	9.1	0.38	0.04	52	68	0	0
	MAXIMUM	3	7.0	12.4	9.1	0.38	0.04	52	68	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
HL	MEAN	17	5.4	7.6	19.1	3.55	0.36	92	112	0	133
	MINIMUM	6	4.9	6.2	12.6	1.15	0.15	62	73	0	120
	MAXIMUM	22	6.0	9.2	22.4	7.40	0.47	126	156	0	146
	NUMBER	3	3	3	3	3	3	3	3	3	2
HR	MEAN	17	6.1	8.8	12.6	0.35	0.08	86	98	80	219
	MINIMUM	5	5.3	7.4	9.6	0.03	0.05	60	74	1	16
	MAXIMUM	26	6.6	11.6	16.1	0.81	0.19	189	185	358	950
	NUMBER	17	17	17	8	8	8	8	17	16	16

TABLE 15 (Continued)

1979 BNL ENVIRONMENTAL MONITORING DOWNSTREAM AND CONTROL
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
HA	MEAN	.001	.0004	.009	.006	.899	.007	.012
	MINIMUM	.001	.0002	.002	.003	.310	.002	.004
	MAXIMUM	.001	.0006	.029	.015	2.250	.017	.022
	EXCEPTION	3	4	3	0	0	3	0
	NUMBER	4	4	4	4	4	4	4
HB	MEAN	.001	.0004	.002	.003	1.539	.003	.010
	MINIMUM	.001	.0002	.001	.002	.310	.002	.003
	MAXIMUM	.001	.0006	.002	.004	3.600	.005	.018
	EXCEPTION	3	4	4	0	0	4	0
	NUMBER	4	4	4	4	4	4	4
HC	MEAN	.001	.0004	.002	.002	.907	.004	.006
	MINIMUM	.001	.0002	.001	.001	.380	.002	.002
	MAXIMUM	.001	.0006	.002	.002	1.980	.005	.013
	EXCEPTION	4	4	4	1	0	4	0
	NUMBER	4	4	4	4	4	4	4
HD	MEAN	.001	.0005	.002	.003	.655	.004	.005
	MINIMUM	.001	.0003	.001	.001	.285	.002	.002
	MAXIMUM	.001	.0006	.002	.006	1.310	.005	.011
	EXCEPTION	4	3	4	0	0	4	0
	NUMBER	4	4	4	4	4	4	4
HF	MEAN	.001	.0004	.002	.001	1.689	.004	.005
	MINIMUM	.001	.0002	.001	.001	.255	.002	.002
	MAXIMUM	.001	.0006	.002	.002	5.250	.005	.007
	EXCEPTION	4	4	4	1	0	3	0
	NUMBER	4	4	4	4	4	4	4
HH	MEAN	.001	.0004	.002	.001	.157	.004	.002
	MINIMUM	.001	.0002	.001	.001	.015	.002	.001
	MAXIMUM	.001	.0006	.002	.002	.267	.005	.003
	EXCEPTION	4	4	4	1	1	4	2
	NUMBER	4	4	4	4	4	4	4
HI	MEAN	.001	.0004	.004	.002	.046	.008	.005
	MINIMUM	.001	.0002	.002	.002	.046	.004	.002
	MAXIMUM	.001	.0006	.011	.002	.046	.016	.009
	EXCEPTION	4	4	3	0	0	1	0
	NUMBER	4	4	4	4	1	4	4
HJ	MEAN	.001	.0002	.002	.002	.076	.002	.013
	MINIMUM	.001	.0002	.002	.002	.076	.002	.013
	MAXIMUM	.001	.0002	.002	.002	.076	.002	.013
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
HL	MEAN	.002	.0008	.002	.027	.870	.008	.054
	MINIMUM	.001	.0003	.001	.007	.400	.005	.009
	MAXIMUM	.003	.0013	.002	.053	1.510	.014	.090
	EXCEPTION	2	1	3	0	0	1	0
	NUMBER	3	3	3	3	3	3	3
HR	MEAN	.001	.0005	.002	.002	.597	.004	.004
	MINIMUM	.001	.0003	.001	.001	.405	.002	.001
	MAXIMUM	.001	.0006	.002	.002	.767	.005	.008
	EXCEPTION	3	3	3	1	0	3	0
	NUMBER	3	3	3	3	3	3	3

Reference Standard - Table 29

Note: prefix H applied to
facilitate sampling designation.

TABLE 16

1979 BNL MONTHLY SUMP SAMPLES

LOCATION	MONTH	NO. OF SAMPLES	GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR
HN	JANUARY	4	0.40	0.18	8.75	0.63	0.83	0.46
	FEBRUARY	4	0.50	0.17	37.11	1.01	1.66	0.65
	MARCH	4	0.35	0.14	11.22	0.63	1.29	0.64
	APRIL	4	0.34	0.16	11.67	0.74	1.37	0.72
	MAY	3	0.51	0.19	3.65	0.56	1.24	0.72
	JUNE	2	0.23	0.16	10.94	0.90	1.22	0.86
	JULY	3	0.43	0.18	3.55	0.54	1.32	0.81
	AUGUST	4	0.41	0.23	3.56	1.10	0.89	0.49
	SEPTEMBER	1	0.48	0.48	7.51	1.36	1.22	1.22
	OCTOBER	2	0.44	0.20	51.05	1.71	1.58	1.15
	NOVEMBER	3	0.23	0.14	3.05	0.51	1.65	0.96
	DECEMBER	1	0.26	0.26	1.49	0.84	0.00	0.00
SUMMARY		35	0.39	0.06	12.94	0.26	1.25	0.22
HO	JANUARY	4	0.45	0.19	3.03	0.50	0.83	0.46
	FEBRUARY	4	0.30	0.15	1.94	0.42	1.26	0.63
	MARCH	4	0.27	0.13	3.23	0.46	1.29	0.64
	APRIL	4	0.21	0.11	2.88	0.58	1.37	0.72
	MAY	4	0.23	0.12	1.91	0.44	1.68	0.92
	JUNE	5	0.31	0.12	2.51	0.41	1.21	0.54
	JULY	4	0.24	0.12	2.53	0.46	1.29	0.67
	AUGUST	4	0.46	0.21	4.11	1.11	1.11	0.56
	SEPTEMBER	3	0.45	0.22	2.96	0.58	1.93	0.86
	OCTOBER	3	0.27	0.12	2.81	0.72	1.09	0.64
	NOVEMBER	3	0.19	0.11	2.51	0.51	1.62	0.95
	DECEMBER	2	0.26	0.18	1.21	0.75	0.55	0.55
SUMMARY		44	0.30	0.04	2.69	0.17	1.28	0.20
HP	JANUARY	2	0.63	0.32	3.23	0.72	1.09	0.79
	FEBRUARY	2	0.45	0.24	2.87	0.66	1.25	0.88
	MARCH	2	0.23	0.17	2.15	0.70	1.30	0.92
	APRIL	4	0.34	0.17	8.30	0.66	1.37	0.72
	MAY	4	0.30	0.14	3.32	0.49	1.68	0.92
	JUNE	5	0.40	0.15	2.36	0.42	1.00	0.49
	JULY	4	0.43	0.17	2.75	0.49	1.29	0.67
	AUGUST	5	0.27	0.13	2.12	0.85	0.93	0.45
	SEPTEMBER	3	0.36	0.20	1.98	0.56	1.42	0.83
	OCTOBER	3	0.38	0.17	6.44	0.74	1.09	0.64
	NOVEMBER	3	0.28	0.16	4.70	0.59	2.02	0.96
	DECEMBER	1	0.26	0.26	1.75	0.94	0.00	0.00
SUMMARY		38	0.36	0.05	3.62	0.19	1.26	0.22
HT	JANUARY	4	0.28	0.14	2.33	0.49	0.83	0.46
	FEBRUARY	4	0.27	0.14	2.55	0.45	1.26	0.63
	MARCH	4	0.24	0.12	1.35	0.37	1.29	0.64
	APRIL	4	0.32	0.17	6.44	0.65	1.37	0.72
	MAY	4	0.32	0.14	4.60	0.52	1.68	0.92
	JUNE	5	0.32	0.13	2.61	0.42	3.15	0.57
	JULY	4	0.22	0.11	1.39	0.44	1.29	0.67
	AUGUST	5	0.24	0.11	1.89	0.84	0.93	0.45
	SEPTEMBER	4	2.20	0.65	1858.13	16.51	25.59	1.00
	OCTOBER	3	0.30	0.14	38.17	1.27	1.08	0.64
	NOVEMBER	3	0.25	0.14	2.60	0.51	1.69	0.94
	DECEMBER	2	0.20	0.14	1.17	0.74	0.55	0.55
SUMMARY		46	0.44	0.07	166.40	1.45	3.54	0.20
HU	JANUARY	4	0.28	0.15	7.26	0.73	0.86	0.46
	FEBRUARY	4	0.29	0.15	10.85	0.81	1.26	0.63
	MARCH	4	2.39	0.64	68.36	1.52	1.29	0.64
	APRIL	4	1.96	0.76	154.58	6.50	1.37	0.72
	MAY	4	0.21	0.10	12.71	0.82	1.68	0.92
	JUNE	5	0.65	0.37	164.69	6.01	1.21	0.54
	JULY	4	0.21	0.11	10.98	0.76	1.29	0.67
	AUGUST	5	0.60	0.38	8.08	1.07	0.93	0.45
	SEPTEMBER	3	0.19	0.11	7.40	0.85	1.55	0.84
	OCTOBER	3	0.26	0.14	7.89	0.97	1.40	0.65
	NOVEMBER	3	0.24	0.14	9.94	0.94	1.62	0.95
	DECEMBER	2	0.17	0.12	4.68	0.87	0.55	0.55
SUMMARY		45	0.67	0.11	44.62	0.92	1.26	0.20
Radiation Con. Guide [17] and EPA Drinking Water Standard [18]			15		3000		20	

nCi = 3.7×10^{1} Bq.

pCi = 3.7×10^{-2} Bq.

Error: Standard dev.
Summary: Avg. for the year.

Location

HN: North of AGS
HO: East of HFBR
HP: South
HT: Linac
HU: East of Steam Plant

Water quality data obtained during 1979 from periodic (approximately monthly) analyses of "grab" samples from the recharge basins, from a culvert which conducts some air conditioning tower blowdown and 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. 3) is shown in Table 17. All were within established standards for ground water quality except at sump HU where washout from recharging of ion exchange resins (used in softening water) increased the concentrations of cations and anions, thereby increasing conductivity. Excess metal concentrations, such as for Cd, Cr, Cu, Fe, Pb and Zn, indicate effects of chemical treatment for keeping iron in solution and steam plant condensates and boiler washings (Pb and Zn from pipes). Investigations are in progress to pinpoint the sources of these elements and examine the area in the vicinity of this sump for possible location of cesspools and/or irregularities in the sanitary system.

3.3.5 Aquatic Biological Studies

During the summers of 1977, 1978, and 1979, a comprehensive program aimed at understanding the effect of the Laboratory effluent on the Peconic River biological system over the years was initiated. This study, which is expected to take three to four years, will be phased in gradually. In 1977, 1978 and 1979, the program was exploratory, wherein sampling stations, sampling techniques and analytical procedures and their limitations were investigated. The results so obtained will be used to develop an adequate program to be implemented in 1981 when it is hoped that the data so obtained would be amenable to modeling for predictive purposes. Additional data from previous years will also be used. Figure 7 indicates some of the sampling locations. These are:

E - Reference point-headwaters of the Peconic River-Control Station,

K - 0.045 km, no vegetation, significant influence of chlorine.

L - 0.106 km,

M - 0.798 km, referred to as the former site boundary,

Q - 2.11 km, the present site boundary, fish collected from here,

A - 4.85 km,

S - 7.05 km,

T - 10.82 km,

U - 14.23 km

W - 18.18 km, mussel bed,

Y - 22.21 km, salt water meets fresh water.

TABLE 17

1979 BNL ENVIRONMENTAL MONITORING RECHARGE BASINS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUC-TIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
HN	MEAN	15	6.5	9.6	15.0	0.21	0.19	72	102	1	98
	MINIMUM	8	5.0	8.2	0.0	0.08	0.02	65	64	0	14
	MAXIMUM	26	7.2	11.2	20.2	0.46	0.58	86	215	4	210
	NUMBER	35	35	35	10	10	10	9	35	5	5
HO	MEAN	16	6.6	9.7	19.2	0.26	0.22	70	114	1	50
	MINIMUM	9	5.7	9.0	15.6	0.03	0.01	63	88	0	0
	MAXIMUM	27	7.4	12.0	23.2	0.65	0.57	77	166	3	120
	NUMBER	44	44	44	11	11	11	9	44	5	5
HP	MEAN	15	6.1	6.5	29.5	1.43	0.02	115	176	0	1
	MINIMUM	11	5.3	0.6	23.7	0.91	0.01	104	151	0	0
	MAXIMUM	28	7.0	13.2	34.8	1.72	0.04	133	259	0	4
	NUMBER	38	38	38	11	11	11	11	38	3	3
HS	MEAN	16	6.7	9.4	23.3	0.74	0.28	111	139	63	242
	MINIMUM	8	5.4	7.0	6.5	0.08	0.02	72	18	0	0
	MAXIMUM	26	9.8	10.8	42.3	10.94	1.96	213	380	336	890
	NUMBER	50	50	50	49	49	49	9	50	45	41
HT	MEAN	19	6.7	8.9	22.5	0.39	0.04	96	130	0	2
	MINIMUM	12	5.7	6.6	16.6	0.12	0.01	80	100	0	0
	MAXIMUM	31	7.6	10.6	28.1	0.67	0.11	139	160	0	8
	NUMBER	45	45	45	11	11	11	9	45	5	5
HU	MEAN	21	9.6	6.6	976.2	0.89	0.34	1883	1436	7	13
	MINIMUM	1	2.7	2.6	27.7	0.24	0.01	190	153	0	0
	MAXIMUM	32	11.3	10.8	•00.0	2.25	0.71	6562	• 0	40	80
	NUMBER	44	44	39	12	12	12	10	44	6	6

*10000

1979 BNL ENVIRONMENTAL MONITORING RECHARGE BASINS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
HS	MEAN	.001	.0006	.002	.013	2.460	.005	.197
	MINIMUM	.001	.0006	.002	.013	2.460	.005	.197
	MAXIMUM	.001	.0006	.002	.013	2.460	.005	.197
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
HU	MEAN	.007	1.5200	8.100	16.100	747.000	5.320	95.600
	MINIMUM	.007	1.5200	8.100	16.100	747.000	5.320	95.600
	MAXIMUM	.007	1.5200	8.100	16.100	747.000	5.320	95.600
	EXCEPTION	1	0	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1

Reference Standards - Table 29

HN: North of AGS
HO: East of HFBR
HP: South of MRR
HS: South of Warehouse
HT: North of LINAC
HU: East of Steam Plant

Exception: Below Minimum Detection Limit (MDL)

These locations were sampled for sediment and vegetation common to most of the sites. A significant improvement from previous sediment sampling techniques was the use of coring to collect river bottom sediments. This procedure will enable determination of both vertical and horizontal migration of radionuclides in the bottom sediments. Fish samples were limited by availability to Station Q. Mussel samples were available only from Stations T and W. Intensive sampling of the aquatic environment will be done in 1980 and 1981, especially for stations beyond the influence of the Peconic River.

The data in Table 18 are restricted to ^{90}Sr and ^{137}Cs. These radionuclides were found in detectable concentrations above the MDL and can be considered as principal contributors to body burden estimates in man. Other nuclides such as ^{60}Co, which are attributable to Laboratory effluents, were present but were either less than or equal to the MDL for the counting system used (Table 29 and Appendix B). In analyzing the data, it was noted that beyond Station Q, most of the radionuclides were at or below MDL. Also, since Station Q represents the site boundary, a proper documentation of all releases is critical for the evaluation of Laboratory releases. The table, therefore, is also restricted to Station Q on the above basis.

Looking at the concentration factors on a unit weight basis for ^{90}Sr and ^{137}Cs at Station Q, it is noted that there is an increase in unit activity across the food chain: water-vegetation-fish. For ^{90}Sr, the concentration factor for fish ranges from 69 to 103 in flesh. In the case of ^{137}Cs, the concentration factor for fish ranged from 1190-1280. These results are in accordance with observations in aquatic environments (22, 23). Using an assumed intake of 1.36 kg/yr of fish flesh (edible portions) for persons fishing along the Peconic River and the indicated range of concentrations of ^{90}Sr and ^{137}Cs in fish flesh (edible portions), one can compute for an adult, body burdens for these radionuclides in man to be ranging from 0.05% to 0.15% respectively of the doses permissible by the Regulatory Guide (24).

3.3.6 Surveillance Wells

3.3.6.1 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. These wells (Fig. 8) are located generally west to northwest of the Laboratory's principal facilities and 'upstream' of the local ground water flow pattern. An average of about 28.4 MLD 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 ($<1 \times 10^{-9}$ μCi ml^{-1} or 3.7×10^{-5} Bq ml^{-1}), and almost all tritium concentrations were <1.0 nCi/liter ($<10^{-6}$ μCi/ml or 3.7×10^{-2} Bq ml^{-1}). The gross beta and tritium results are listed in Table 19. There are some differences in the gross beta concentrations among these wells. However, these differences are not corraborated by tritium concentrations indicating that the sources of gross beta are not related to Laboratory activities. In general,

TABLE 18

1979 BNL Environmental Monitoring Concentration of ^{90}Sr and ^{137}Cs in Water, Sediment, Vegetation and Fish Obtained from the Peconic River at the Site Perimeter as Observed During 1974-1979

Year	Water ^{90}Sr (pCi/l)	Water ^{137}Cs (pCi/l)	Sediment ^{90}Sr (pCi/Kg-wet)[a]	Sediment ^{137}Cs (pCi/Kg-wet)[a]	Vegetation ^{90}Sr (pCi/Kg-wet)[a]	Vegetation ^{137}Cs (pCi/Kg-wet)[a]	Fish ^{90}Sr Flesh (pCi/Kg-wet)[a]	Fish ^{137}Cs Flesh (pCi/Kg-wet)[a]
1974	1.23	1.13	-	306	-	220	-	112-326
1975	1.74	4.46	-	525	-	1010	-	397
1976	1.37	1.86	-	440	-	257	-	700
1977	1.09	1.60	-	1656	-	1128	25-30	772-3400
1978	1.11	0.79	-	920	-	990	27-34	536-1192
1979	0.58	0.87	19	188	86	585	40-60	1036-1113

[a]Original results given in dry weight; the results shown in Table are corrected to wet weight which facilitates estimation of concentration factors.

these values have been consistent over many years. Well #3 which had previously showed larger than average concentrations in gross beta activity and in other parameters such as coliform content, suggesting possible leakage in the well casing, has been discontinued.

3.3.6.2 Ground Water Surveillance

Samples of ground water were obtained from a network of shallow surveillance wells previously installed in the vicinity of several areas where a potential existed for the percolation of radioactivity from the surface downward into the saturated zone of ground water. They include areas adjacent to on-site recharge basins, sand filter beds, downstream Peconic River, solid waste management area, former open dump, sanitary landfill, decontamination facility sump, and to the Meadow-Marsh Project area. The locations of most of these ground water surveillance wells are shown in Figure 9. The locations of the several wells installed at the landfill and solid waste management area are shown in Figure 10.

For convenience in assessing the data, the wells have been divided into several groups. Yearly average gross alpha, gross beta, and tritium activity concentrations of the wells adjacent to the sand filter beds, and downstream on the Peconic River are summarized in Table 20. During the year, at least one sample from locations adjacent to the recharge basins and from locations immediately adjacent to the sand filter beds and the Peconic River were analyzed for ^{90}Sr and ^{137}Cs (by gamma analysis) and are included in the table. Corresponding information for wells downstream (with reference to ground water movement) of the solid waste management area, the landfill and former dump zones, and the decontamination facility sump (about 1 km east of the HFBR) is summarized in Table 21. Since the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" (25), the EPA Drinking Water Standard is applicable (18). The data, therefore, is evaluated in terms of the EPA standard and not the RCG's, as was done in previous years.

In analyzing the data over the last six years (1974-1979), it has been observed that the spread of radioactivity in the ground water from Laboratory operations remained limited to within a few hundred meters of the identifiable foci. Above background activity concentrations of gross beta emitters, tritium and ^{90}Sr were found on-site adjacent to the sand filter beds and the Peconic River at small fractions of the Drinking Water Standards. In 1979, the activity concentrations were generally less than those noted in 1974 and 1975, but were similar to that of 1976, 1977 and 1978, indicating that radionuclides had not moved significantly since 1976. Wells XH and XZ which had shown a significant increase in gross beta activity in 1978 were reduced by more than 60% in 1979. It must be noted, however, that these increases in 1978 were not accompanied by a similar increase in ^{90}Sr activity. Wells XK, XL, XN, XX and XY in proximity to the Peconic River did show slight increases in gross beta activity indicating the influence of the Peconic River. A similar influence was also seen in the gross alpha activity in wells XM and XN. Adjacent to the Peconic River at the site boundary all activity concentrations (gross beta and tritium) were less than or equal to 4% of the Drinking Water Standards. Samples of well water collected from homes (Stations A, B, C and D - Figure 9) and well WS downstream

TABLE 19

1979 BNL POTABLE WATER AND COOLING WATER WELLS

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR
FB	MEAN	0.31	0.13	2.55	0.46	0.26	0.13
	MINIMUM	0.19	0.19	2.14	0.90	0.20	0.20
	MAXIMUM	0.58	0.35	2.83	0.96	0.31	0.31
	NUMBER	4		4		4	
FD	MEAN	0.30	0.14	1.23	0.41	0.26	0.13
	MINIMUM	0.23	0.23	0.87	0.85	0.20	0.20
	MAXIMUM	0.38	0.28	1.55	0.79	0.31	0.31
	NUMBER	4		4		4	
FE	MEAN	0.24	0.12	0.93	0.45	0.26	0.13
	MINIMUM	0.17	0.17	0.75	0.72	0.20	0.20
	MAXIMUM	0.32	0.32	1.22	1.22	0.31	0.31
	NUMBER	4		4		4	
FF	MEAN	0.35	0.15	1.42	0.47	0.26	0.13
	MINIMUM	0.24	0.24	1.19	1.19	0.20	0.20
	MAXIMUM	0.44	0.32	1.84	0.83	0.31	0.31
	NUMBER	4		4		4	
FG	MEAN	0.30	0.13	0.97	0.54	0.27	0.16
	MINIMUM	0.17	0.17	0.82	0.75	0.20	0.20
	MAXIMUM	0.56	0.31	1.20	1.20	0.31	0.31
	NUMBER	3		3		3	
FH	MEAN	0.27	0.19	3.37	0.66	0.26	0.19
	MINIMUM	0.26	0.26	2.40	0.84	0.21	0.21
	MAXIMUM	0.28	0.28	4.34	1.01	0.31	0.31
	NUMBER	2		2		2	
FI	MEAN	0.28	0.16	3.26	0.53	0.24	0.14
	MINIMUM	0.28	0.28	1.97	0.90	0.20	0.20
	MAXIMUM	0.28	0.28	5.76	1.04	0.31	0.31
	NUMBER	3		3		3	
FJ	MEAN	0.55	0.19	2.40	0.51	0.24	0.14
	MINIMUM	0.28	0.28	2.27	0.85	0.20	0.20
	MAXIMUM	0.95	0.41	2.47	0.86	0.31	0.31
	NUMBER	3		3		3	
FL	MEAN	0.24	0.14	2.47	0.54	0.27	0.16
	MINIMUM	0.16	0.16	2.16	0.92	0.21	0.21
	MAXIMUM	0.32	0.32	2.91	0.91	0.31	0.31
	NUMBER	3		3		3	

EPA-Drinking
Water [18] and
Radiation Concentration
Guides [17]

3000 pCi/liter for unidentified nuclides in the absence of ^{90}Sr, ^{228}Ra or ^{129}I; 15 pCi/liter in the presence of ^{90}Sr, ^{228}Ra or ^{129}I.

20 nCi/liter - for Tritium (^{3}H)

nCi = 3.7×10^{1} Bq.

pCi = 3.7×10^{-2} Bq.

FA:1	FE:5	FI:102
FB:2	FF:6	FJ:103
FC:3	FG:7	FK:104
FD:4	FH:101	FL:105

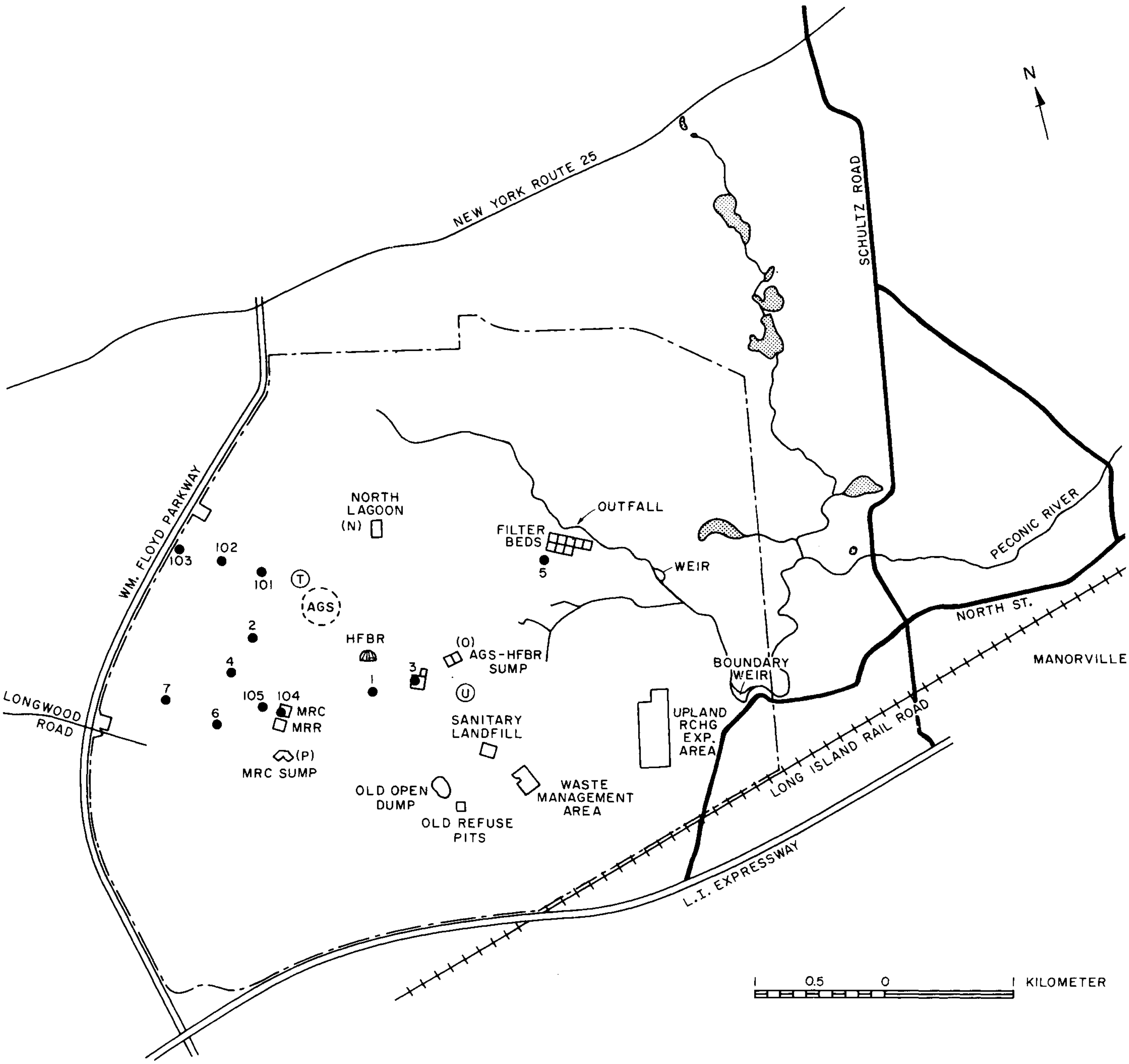


Figure 8. On-site Potable and Supply Wells

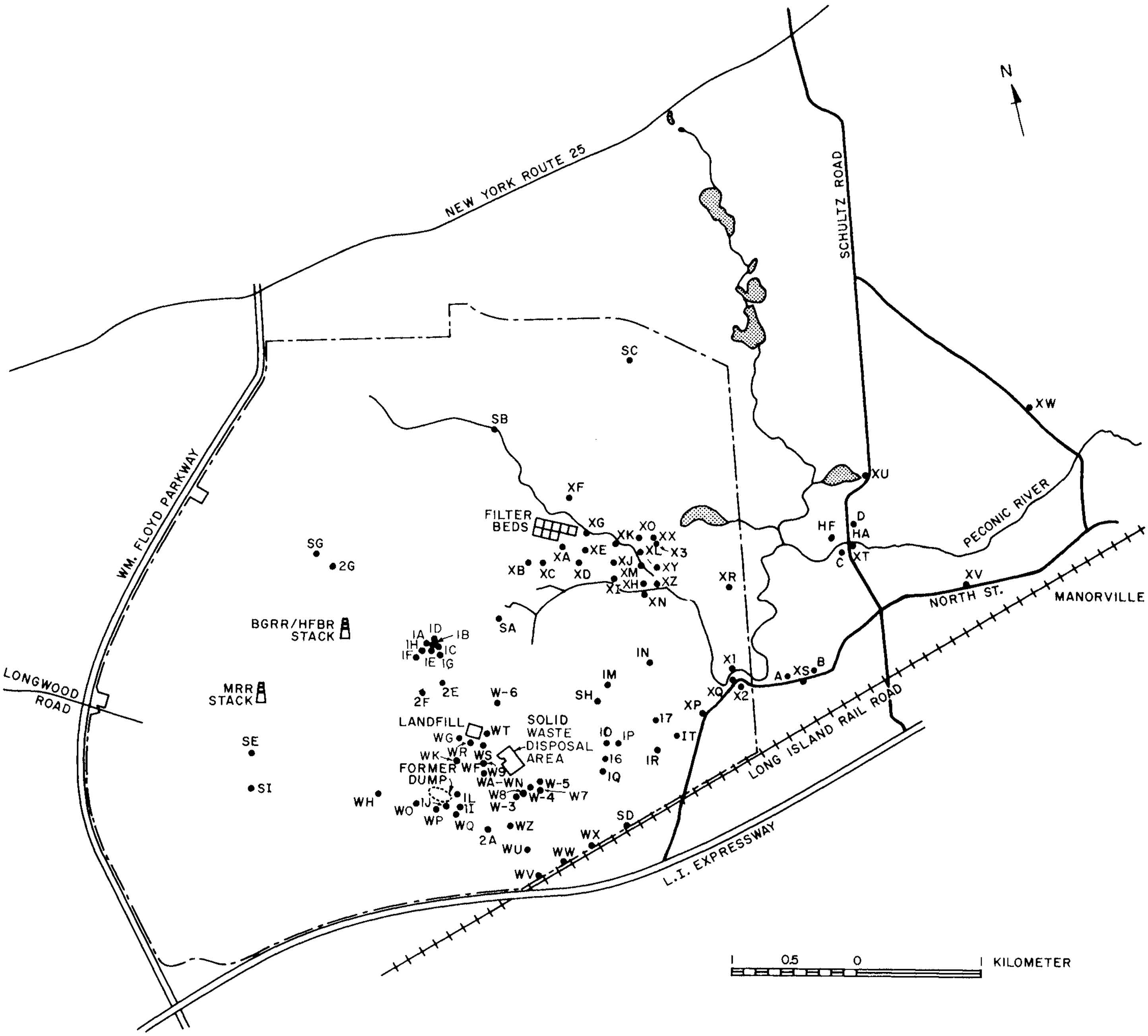


Figure 9. Location of Groundwater Surveillance Wells

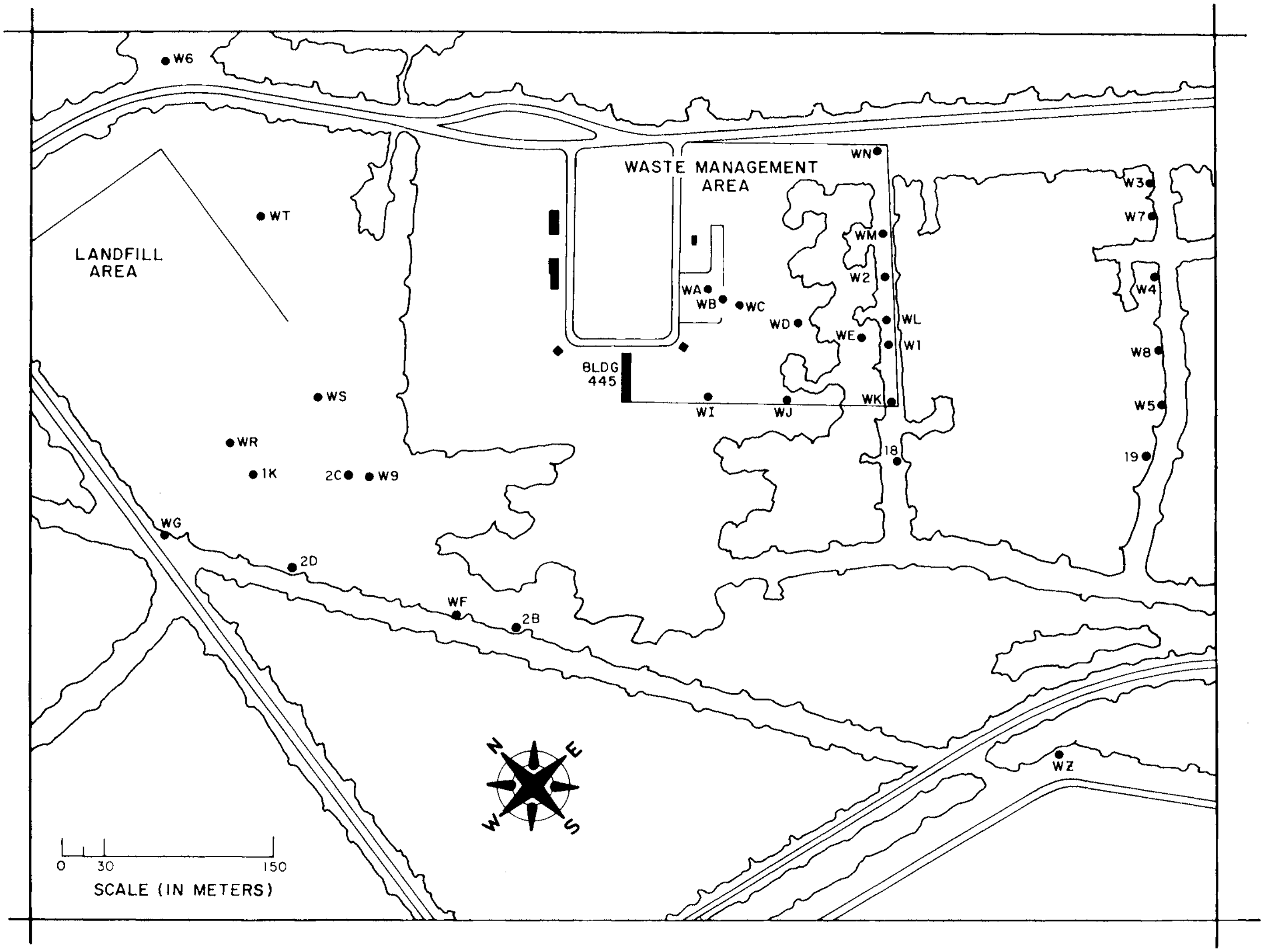


Figure 10. Landfill and Waste Management Area Surveillance Wells

Table 20

1979 BNL SAND FILTER BED AND PECONIC RIVER AREA

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
XA	MEAN	0.51	0.19	11.41	0.52	8.59	0.15	1.89	0.09
	MINIMUM	0.20	0.20	6.83	1.16	0.50	0.29	1.76	0.17
	MAXIMUM	1.76	1.34	15.45	1.48	20.00	0.60	1.98	0.19
	NUMBER	8		8		8		3	
XB	MEAN	0.32	0.32	2.84	0.84	0.22	0.22	0.21	0.12
	MINIMUM	0.32	0.32	2.84	0.84	0.22	0.22	0.21	0.12
	MAXIMUM	0.32	0.32	2.84	0.84	0.22	0.22	0.21	0.12
	NUMBER	1		1		1		1	
XC	MEAN	0.61	0.32	5.78	0.98	0.22	0.22	1.91	0.17
	MINIMUM	0.61	0.32	5.78	0.98	0.22	0.22	1.91	0.17
	MAXIMUM	0.61	0.32	5.78	0.98	0.22	0.22	1.91	0.17
	NUMBER	1		1		1		1	
XD	MEAN	0.21	0.21	1.71	0.76	0.22	0.22	0.11	0.08
	MINIMUM	0.21	0.21	1.71	0.76	0.22	0.22	0.11	0.08
	MAXIMUM	0.21	0.21	1.71	0.76	0.22	0.22	0.11	0.08
	NUMBER	1		1		1		1	
XE	MEAN	0.22	0.21	1.77	0.80	0.20	0.20	0.33	0.11
	MINIMUM	0.22	0.21	1.77	0.80	0.20	0.20	0.33	0.11
	MAXIMUM	0.22	0.21	1.77	0.80	0.20	0.20	0.33	0.11
	NUMBER	1		1		1		1	
XF	MEAN	0.20	0.20	1.13	1.13	0.20	0.20		
	MINIMUM	0.20	0.20	1.13	1.13	0.20	0.20	<MDL	
	MAXIMUM	0.20	0.20	1.13	1.13	0.20	0.20		
	NUMBER	1		1		1		1	
XG	MEAN	0.40	0.10	3.83	0.35	0.24	0.08	0.89	0.07
	MINIMUM	0.19	0.19	2.26	0.86	0.22	0.22	0.40	0.10
	MAXIMUM	0.89	0.47	7.30	1.23	0.37	0.37	1.67	0.17
	NUMBER	9		9		9		4	
XH	MEAN	0.32	0.23	0.98	0.75	0.22	0.22		
	MINIMUM	0.32	0.23	0.98	0.75	0.22	0.22		
	MAXIMUM	0.32	0.23	0.98	0.75	0.22	0.22		
	NUMBER	1		1		1			
XI	MEAN	0.47	0.28	7.03	1.06	0.23	0.23	0.81	0.16
	MINIMUM	0.47	0.28	7.03	1.06	0.23	0.23	0.17	0.04
	MAXIMUM	0.47	0.28	7.03	1.06	0.23	0.23	1.45	0.16
	NUMBER	1		1		1		2	
XJ	MEAN	0.26	0.22	3.75	0.90	0.20	0.20	1.08	0.14
	MINIMUM	0.26	0.22	3.75	0.90	0.20	0.20	1.08	0.14
	MAXIMUM	0.26	0.22	3.75	0.90	0.20	0.20	1.08	0.14
	NUMBER	1		1		1		1	
XK	MEAN	0.65	0.15	10.46	0.49	1.45	0.09	2.53	0.07
	MINIMUM	0.16	0.16	7.80	1.25	0.37	0.37	2.14	0.18
	MAXIMUM	1.49	0.93	17.22	2.40	3.18	0.30	2.97	0.22
	NUMBER	9		9		9		5	
XL	MEAN	1.07	0.20	24.28	0.73	1.92	0.22	5.88	0.16
	MINIMUM	0.68	0.38	15.16	1.41	1.03	0.39	5.69	0.28
	MAXIMUM	1.61	0.54	31.26	2.01	3.03	0.37	7.19	0.31
	NUMBER	6		6		6		3	
XM	MEAN	6.10	0.74	14.63	0.52	2.09	0.17	1.84	0.13
	MINIMUM	1.45	0.53	11.32	1.31	0.22	0.22	1.51	0.15
	MAXIMUM	27.28	5.54	17.76	1.84	5.45	0.35	2.16	0.20
	NUMBER	8		8		8		2	
XN	MEAN	6.52	2.03	20.93	4.75	0.21	0.21	0.14	0.09
	MINIMUM	6.52	2.03	20.93	4.75	0.21	0.21	0.14	0.09
	MAXIMUM	6.52	2.03	20.93	4.75	0.21	0.21	0.14	0.09
	NUMBER	1		1		1		1	
XQ	MEAN	0.45	0.17	6.40	0.52	0.98	0.13	1.18	0.10
	MINIMUM	0.16	0.16	3.78	1.03	0.23	0.23	1.09	0.14
	MAXIMUM	0.80	0.44	9.10	1.23	2.07	0.28	1.29	0.15
	NUMBER	5		5		5		2	
XR	MEAN	0.70	0.31	5.23	0.98	0.23	0.23	1.80	0.17
	MINIMUM	0.70	0.31	5.23	0.98	0.23	0.23	1.80	0.17
	MAXIMUM	0.70	0.31	5.23	0.98	0.23	0.23	1.80	0.17
	NUMBER	1		1		1		1	
XS	MEAN	2.32	0.22	12.32	0.43	0.25	0.08	1.91	0.07
	MINIMUM	1.38	0.57	9.34	1.29	0.22	0.22	1.92	0.19
	MAXIMUM	3.31	0.89	15.18	1.48	0.32	0.32	2.01	0.18
	NUMBER	10		10		10		4	

Table 20 (continued)

1979 BNL SAND FILTER BED AND PECONIC RIVER AREA

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
XW	MEAN	0.19	0.19	1.83	0.80	0.22	0.22	0.15	0.08
	MINIMUM	0.19	0.19	1.83	0.80	0.22	0.22	0.15	0.08
	MAXIMUM	0.19	0.19	1.83	0.80	0.22	0.22	0.15	0.08
	NUMBER	1		1		1		1	
XX	MEAN	0.90	0.13	12.09	0.43	2.19	0.09	3.34	0.11
	MINIMUM	0.68	0.37	7.80	1.12	0.24	0.24	2.12	0.18
	MAXIMUM	1.18	0.50	17.51	1.63	11.20	0.40	4.56	0.26
	NUMBER	10		10		10		4	
XY	MEAN	0.23	0.23	11.81	1.28	2.01	0.25	2.68	0.19
	MINIMUM	0.23	0.23	11.81	1.28	2.01	0.25	2.68	0.19
	MAXIMUM	0.23	0.23	11.81	1.28	2.01	0.25	2.68	0.19
	NUMBER	1		1		1		1	
XZ	MEAN	0.27	0.27	3.60	0.88	0.22	0.22	0.55	0.11
	MINIMUM	0.27	0.27	3.60	0.88	0.22	0.22	0.55	0.11
	MAXIMUM	0.27	0.27	3.60	0.88	0.22	0.22	0.55	0.11
	NUMBER	1		1		1		1	
X1	MEAN	0.39	0.24	2.51	0.84	0.23	0.23		
	MINIMUM	0.39	0.24	2.51	0.84	0.23	0.23		
	MAXIMUM	0.39	0.24	2.51	0.84	0.23	0.23		
	NUMBER	1		1		1			
X2	MEAN	0.17	0.17	1.09	1.09	0.33	0.21		
	MINIMUM	0.17	0.17	1.09	1.09	0.33	0.21	<MDL	
	MAXIMUM	0.17	0.17	1.09	1.09	0.33	0.21		
	NUMBER	1		1		1		1	

TABLE 20 (Continued)

1979 BNL MISCELLANEOUS ON SITE

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
SA	MEAN	0.23	0.23	2.48	0.92	0.22	0.22		
	MINIMUM	0.23	0.23	2.48	0.92	0.22	0.22		
	MAXIMUM	0.23	0.23	2.48	0.92	0.22	0.22		
	NUMBER	1		1		1			
SC	MEAN	0.23	0.23	1.20	1.20	0.22	0.22		
	MINIMUM	0.23	0.23	1.20	1.20	0.22	0.22		
	MAXIMUM	0.23	0.23	1.20	1.20	0.22	0.22		
	NUMBER	1		1		1			
SD	MEAN	0.17	0.17	4.15	0.93	0.22	0.22		
	MINIMUM	0.17	0.17	4.15	0.93	0.22	0.22		
	MAXIMUM	0.17	0.17	4.15	0.93	0.22	0.22		
	NUMBER	1		1		1			
SE	MEAN	0.18	0.10	3.59	0.59	0.34	0.10		
	MINIMUM	0.17	0.17	2.11	0.99	0.22	0.22		
	MAXIMUM	0.19	0.19	6.27	1.13	0.58	0.02		
	NUMBER	3		3		3			
SG	MEAN	0.27	0.27	6.74	1.22	0.23	0.23	1.39	0.15
	MINIMUM	0.27	0.27	6.74	1.22	0.23	0.23	1.39	0.15
	MAXIMUM	0.27	0.27	6.74	1.22	0.23	0.23	1.39	0.15
	NUMBER	1		1		1		1	
SI	MEAN	0.20	0.20	1.41	0.81	0.23	0.23	0.13	0.08
	MINIMUM	0.20	0.20	1.41	0.81	0.23	0.23	0.13	0.08
	MAXIMUM	0.20	0.20	1.41	0.81	0.23	0.23	0.13	0.08
	NUMBER	1		1		1		1	
16	MEAN	0.30	0.30	4.79	1.04	0.22	0.22		
	MINIMUM	0.30	0.30	4.79	1.04	0.22	0.22		
	MAXIMUM	0.30	0.30	4.79	1.04	0.22	0.22		
	NUMBER	1		1		1			
17	MEAN	0.17	0.17	2.96	0.87	0.22	0.22		
	MINIMUM	0.17	0.17	2.96	0.87	0.22	0.22		
	MAXIMUM	0.17	0.17	2.96	0.87	0.22	0.22		
	NUMBER	1		1		1			
2E	MEAN	0.25	0.17	8.05	0.91	0.22	0.16	1.18	0.14
	MINIMUM	0.21	0.21	4.98	1.24	0.22	0.22	1.18	0.14
	MAXIMUM	0.30	0.26	11.11	1.34	0.23	0.23	1.18	0.14
	NUMBER	2		2		2		1	
2F	MEAN	0.36	0.26	8.07	0.86	0.30	0.22	0.81	0.12
	MINIMUM	0.25	0.25	2.49	0.88	0.23	0.23	0.81	0.12
	MAXIMUM	0.47	0.46	13.66	1.48	0.37	0.37	0.81	0.12
	NUMBER	2		2		2		1	
2G	MEAN	0.43	0.35	7.53	1.21	0.22	0.22		
	MINIMUM	0.43	0.35	7.53	1.21	0.22	0.22		
	MAXIMUM	0.43	0.35	7.53	1.21	0.22	0.22		
	NUMBER	1		1		1			
EPA-Drinking Water Regulations [18] and Radiation Concentration Guides [17]		15		3000[a]		20		8	

[a] If $^{125-133}I$ and ^{90}Sr not present. Number: samples analyzed per year

nCi = 3.7×10^{1} Bq.

pCi = 3.7×10^{-2} Bq.

TABLE 21

1979 BNL WASTE MANAGEMENT AREA PART 1

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
WB	MEAN	0.72	0.21	204.67	2.68	10.00	0.27	40.97	0.72
	MINIMUM	0.61	0.35	42.54	2.17	1.69	0.38	40.97	0.72
	MAXIMUM	0.81	0.37	477.60	7.07	20.00	0.60	40.97	0.72
	NUMBER	3		3		3		1	
WC	MEAN	0.77	0.41	157.00	4.08	21.90	0.60	60.18	0.84
	MINIMUM	0.77	0.41	157.00	4.08	21.90	0.60	60.18	0.84
	MAXIMUM	0.77	0.41	157.00	4.08	21.90	0.60	60.18	0.84
	NUMBER	1		1		1		1	
WD	MEAN	0.44	0.14	27.07	0.80	20.60	0.39	9.47	0.36
	MINIMUM	0.25	0.25	16.77	1.46	2.75	0.30	8.97	0.40
	MAXIMUM	0.67	0.36	39.07	2.09	52.10	1.70	10.01	0.28
	NUMBER	5		5		5		3	
WE	MEAN	0.25	0.25	15.36	1.36	0.23	0.23	5.83	0.27
	MINIMUM	0.25	0.25	15.36	1.36	0.23	0.23	5.83	0.27
	MAXIMUM	0.25	0.25	15.36	1.36	0.23	0.23	5.83	0.27
	NUMBER	1		1		1		1	
WJ	MEAN	0.61	0.34	9.01	1.16	1.82	0.28	0.84	0.13
	MINIMUM	0.61	0.34	9.01	1.16	1.82	0.28	0.84	0.13
	MAXIMUM	0.61	0.34	9.01	1.16	1.82	0.28	0.84	0.13
	NUMBER	1		1		1		1	
WK	MEAN	1.51	0.51	148.66	2.05	5.39	0.23	66.17	0.49
	MINIMUM	0.20	0.20	79.49	2.87	2.62	0.21	34.70	0.63
	MAXIMUM	2.23	0.61	228.70	4.69	9.05	0.43	106.90	1.20
	NUMBER	6		6		6		3	
WL	MEAN	0.88	0.18	129.13	1.62	3.11	0.26	57.92	0.58
	MINIMUM	0.34	0.27	69.28	2.70	0.55	0.25	35.69	0.71
	MAXIMUM	1.80	0.55	188.00	4.51	5.52	1.15	79.70	1.03
	NUMBER	5		5		5		3	
WM	MEAN	0.61	0.38	26.93	1.82	4.11	0.34	2.22	0.18
	MINIMUM	0.61	0.38	26.93	1.82	4.11	0.34	2.22	0.18
	MAXIMUM	0.61	0.38	26.93	1.82	4.11	0.34	2.22	0.18
	NUMBER	1		1		1		1	
WN	MEAN	0.23	0.23	1.84	0.83	0.58	0.25	0.11	0.08
	MINIMUM	0.23	0.23	1.84	0.83	0.58	0.25	0.11	0.08
	MAXIMUM	0.23	0.23	1.84	0.83	0.58	0.25	0.11	0.08
	NUMBER	1		1		1		1	
WU	MEAN	0.27	0.27	1.00	0.75	0.20	0.20	0.12	0.08
	MINIMUM	0.27	0.27	1.00	0.75	0.20	0.20	0.12	0.08
	MAXIMUM	0.27	0.27	1.00	0.75	0.20	0.20	0.12	0.08
	NUMBER	1		1		1		1	
WV	MEAN	0.27	0.27	0.98	0.73	0.20	0.20		
	MINIMUM	0.27	0.27	0.98	0.73	0.20	0.20	<MDL	
	MAXIMUM	0.27	0.27	0.98	0.73	0.20	0.20		
	NUMBER	1		1		1.		1	
WW	MEAN	0.13	0.13	1.72	0.82	0.20	0.20		
	MINIMUM	0.13	0.13	1.72	0.82	0.20	0.20	<MDL	
	MAXIMUM	0.13	0.13	1.72	0.82	0.20	0.20		
	NUMBER	1		1		1		1	

TABLE 21 (Continued)

1979 BNL WASTE MANAGEMENT AREA PART 2

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
WX	MEAN	0.30	0.30	1.14	0.76	0.20	0.20		
	MINIMUM	0.30	0.30	1.14	0.76	0.20	0.20		
	MAXIMUM	0.30	0.30	1.14	0.76	0.20	0.20		
	NUMBER	1		1		1			
WZ	MEAN	1.38	1.38	5.60	5.60	0.20	0.20		
	MINIMUM	1.38	1.38	5.60	5.60	0.20	0.20		
	MAXIMUM	1.38	1.38	5.60	5.60	0.20	0.20		
	NUMBER	1		1		1			
W1	MEAN	0.33	0.11	18.29	0.66	1.16	0.24	7.64	0.24
	MINIMUM	0.20	0.20	10.04	1.17	0.36	0.25	4.30	0.25
	MAXIMUM	0.49	0.28	27.03	1.74	1.76	1.10	10.98	0.41
	NUMBER	5		5		5		2	
W3	MEAN	0.15	0.15	1.44	0.93	0.31	0.31		
	MINIMUM	0.15	0.15	1.44	0.93	0.31	0.31	<MDL	
	MAXIMUM	0.15	0.15	1.44	0.93	0.31	0.31		
	NUMBER	1		1		1		1	
W4	MEAN	0.18	0.15	3.78	1.13	0.22	0.22	0.13	0.09
	MINIMUM	0.18	0.15	3.78	1.13	0.22	0.22	0.13	0.09
	MAXIMUM	0.18	0.15	3.78	1.13	0.22	0.22	0.13	0.09
	NUMBER	1		1		1		1	
W5	MEAN	0.36	0.21	2.36	1.06	0.22	0.22		
	MINIMUM	0.36	0.21	2.36	1.06	0.22	0.22		
	MAXIMUM	0.36	0.21	2.36	1.06	0.22	0.22		
	NUMBER	1		1		1			
W7	MEAN	0.24	0.24	1.62	0.88	0.31	0.31		
	MINIMUM	0.24	0.24	1.62	0.88	0.31	0.31	<MDL	
	MAXIMUM	0.24	0.24	1.62	0.88	0.31	0.31		
	NUMBER	1		1		1		1	
W8	MEAN	0.15	0.14	2.84	1.10	0.22	0.22		
	MINIMUM	0.15	0.14	2.84	1.10	0.22	0.22		
	MAXIMUM	0.15	0.14	2.84	1.10	0.22	0.22		
	NUMBER	1		1		1			
18	MEAN	1.11	0.51	3.95	0.99	0.39	0.24	0.12	0.08
	MINIMUM	1.11	0.51	3.95	0.99	0.39	0.24	0.12	0.08
	MAXIMUM	1.11	0.51	3.95	0.99	0.39	0.24	0.12	0.08
	NUMBER	1		1		1		1	
19	MEAN	0.43	0.28	21.88	1.62	0.23	0.23	0.40	0.10
	MINIMUM	0.43	0.28	21.88	1.62	0.23	0.23	0.40	0.10
	MAXIMUM	0.43	0.28	21.88	1.62	0.23	0.23	0.40	0.10
	NUMBER	1		1		1		1	

TABLE 21 (Continued)

1979 BNL LAND FILL AREA

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90	ERROR
WF	MEAN	0.25	0.18	2.28	0.61	1.21	1.11	0.47	0.10
	MINIMUM	0.24	0.24	2.14	0.82	0.22	0.22	0.47	0.10
	MAXIMUM	0.25	0.25	2.42	0.89	2.20	2.20	0.47	0.10
	NUMBER	2		2		2		1	
WG	MEAN	0.27	0.17	1.64	0.60	0.22	0.15	0.17	0.10
	MINIMUM	0.23	0.23	0.97	0.76	0.22	0.22	0.17	0.10
	MAXIMUM	0.30	0.24	2.30	0.92	0.22	0.22	0.17	0.10
	NUMBER	2		2		2		1	
WR	MEAN	5.74	3.32	86.68	8.19	15.60	0.50	5.29	0.29
	MINIMUM	5.74	3.32	86.68	8.19	15.60	0.50	5.29	0.29
	MAXIMUM	5.74	3.32	86.68	8.19	15.60	0.50	5.29	0.29
	NUMBER	1		1		1		1	
WS	MEAN	4.77	1.17	54.91	3.29	133.25	0.82	2.73	0.21
	MINIMUM	2.27	1.53	47.87	6.25	12.20	0.50	2.73	0.21
	MAXIMUM	8.55	2.95	65.28	6.71	427.00	3.00	2.73	0.21
	NUMBER	4		4		4		1	
WT	MEAN	5.44	1.47	72.35	2.06	0.29	0.19	0.10	0.07
	MINIMUM	0.85	0.36	57.15	2.44	0.26	0.20	0.10	0.07
	MAXIMUM	10.03	2.92	87.55	3.33	0.32	0.32	0.10	0.07
	NUMBER	2		2		2		1	
W9	MEAN	10.26	3.12	72.19	3.84	45.45	0.47	6.34	0.21
	MINIMUM	5.19	2.88	50.02	6.84	0.22	0.22	4.13	0.24
	MAXIMUM	20.23	11.23	88.06	8.72	85.20	1.10	8.54	0.34
	NUMBER	4		4		4		2	
1K	MEAN	19.46	3.95	78.95	4.62	20.70	0.39	5.10	0.33
	MINIMUM	7.19	3.62	52.27	6.79	4.69	0.33	5.10	0.33
	MAXIMUM	42.45	10.72	116.80	9.34	39.60	0.80	5.10	0.33
	NUMBER	3		3		3		1	
2A	MEAN	0.22	0.16	2.54	0.62	0.26	0.19	0.44	0.10
	MINIMUM	0.19	0.19	1.83	0.80	0.20	0.20	0.44	0.10
	MAXIMUM	0.25	0.25	3.24	0.96	0.32	0.32	0.44	0.10
	NUMBER	2		2		2		1	
2B	MEAN	0.17	0.13	7.99	0.83	0.26	0.19	<MDL	
	MINIMUM	0.12	0.12	4.54	1.09	0.20	0.20		
	MAXIMUM	0.23	0.23	11.44	1.26	0.32	0.32		
	NUMBER	2		2		2			
2C	MEAN	4.34	1.98	56.74	4.55	48.20	0.64	7.44	0.34
	MINIMUM	0.73	0.35	1.17	1.17	27.60	0.90	7.44	0.34
	MAXIMUM	7.95	3.95	112.30	9.03	68.80	0.90	7.44	0.34
	NUMBER	2		2		2		1	
2D	MEAN	18.48	5.14	86.34	5.95	32.45	0.67		
	MINIMUM	16.45	5.74	53.78	7.03	6.09	0.35		
	MAXIMUM	20.51	8.52	118.90	9.61	58.80	1.30		
	NUMBER	2		2		2			

TABLE 21 (Continued)

1979 BNL 650 SUMP AREA AND FORMER DUMP AREA

		GROSS ALPHA (PCI/L)	ERROR	GROSS BETA (PCI/L)	ERROR	TRITIUM (NCI/L)	ERROR	SR90 (PCI/L)	ERROR
650 SUMP AREA									
1A	MEAN	0.44	0.29	106.00	3.31	0.23	0.23	53.08	0.80
	MINIMUM	0.44	0.29	106.00	3.31	0.23	0.23	53.08	0.80
	MAXIMUM	0.44	0.29	106.00	3.31	0.23	0.23	53.08	0.80
	NUMBER	1		1		1		1	
1C	MEAN	0.13	0.13	1.55	0.84	0.21	0.21	0.54	0.14
	MINIMUM	0.13	0.13	1.55	0.84	0.21	0.21	0.54	0.14
	MAXIMUM	0.13	0.13	1.55	0.84	0.21	0.21	0.54	0.14
	NUMBER	1		1		1		1	
1D	MEAN	0.23	0.23	1.84	0.81	0.23	0.23	0.87	0.12
	MINIMUM	0.23	0.23	1.84	0.81	0.23	0.23	0.87	0.12
	MAXIMUM	0.23	0.23	1.84	0.81	0.23	0.23	0.87	0.12
	NUMBER	1		1		1		1	
1E	MEAN	0.23	0.23	117.40	3.46	0.21	0.21	57.11	0.81
	MINIMUM	0.23	0.23	117.40	3.46	0.21	0.21	57.11	0.81
	MAXIMUM	0.23	0.23	117.40	3.46	0.21	0.21	57.11	0.81
	NUMBER	1		1		1		1	
1F	MEAN	0.23	0.23	1.57	0.84	0.23	0.23	0.23	0.09
	MINIMUM	0.23	0.23	1.57	0.84	0.23	0.23	0.23	0.09
	MAXIMUM	0.23	0.23	1.57	0.84	0.23	0.23	0.23	0.09
	NUMBER	1		1		1		1	
1H	MEAN	0.25	0.25	61.87	2.58	0.21	0.21		
	MINIMUM	0.25	0.25	61.87	2.58	0.21	0.21		
	MAXIMUM	0.25	0.25	61.87	2.58	0.21	0.21		
	NUMBER	1		1		1			
FORMER DUMP AREA									
WO	MEAN	0.16	0.16	3.20	0.94	0.22	0.22		
	MINIMUM	0.16	0.16	3.20	0.94	0.22	0.22		
	MAXIMUM	0.16	0.16	3.20	0.94	0.22	0.22		
	NUMBER	1		1		1			
WP	MEAN	0.19	0.19	1.94	0.88	2.15	0.35		
	MINIMUM	0.19	0.19	1.94	0.88	2.15	0.35		
	MAXIMUM	0.19	0.19	1.94	0.88	2.15	0.35		
	NUMBER	1		1		1			
WQ	MEAN	0.26	0.26	1.26	0.82	0.22	0.22		
	MINIMUM	0.26	0.26	1.26	0.82	0.22	0.22		
	MAXIMUM	0.26	0.26	1.26	0.82	0.22	0.22		
	NUMBER	1		1		1			
1I	MEAN	0.23	0.23	1.19	1.19	0.22	0.22	0.11	0.08
	MINIMUM	0.23	0.23	1.19	1.19	0.22	0.22	0.11	0.08
	MAXIMUM	0.23	0.23	1.19	1.19	0.22	0.22	0.11	0.08
	NUMBER	1		1		1		1	
1J	MEAN	0.26	0.26	0.91	0.79	0.22	0.22	0.11	0.10
	MINIMUM	0.26	0.26	0.91	0.79	0.22	0.22	0.11	0.10
	MAXIMUM	0.26	0.26	0.91	0.79	0.22	0.22	0.11	0.10
	NUMBER	1		1		1		1	
EPA-Drinking Water Regualtions [18] Radiation Concentration Guides [17]			15	3000[a]		20		8	

[a] If $^{125-133}I$ and ^{90}Sr not present.

nCi = 3.7×10^{1} Bq.   pCi = 3.7×10^{-2} Bq.   Number: samples analyzed per year (with reference to ground water movement) of the Laboratory and the Peconic River, which had in 1978 indicated ^{90}Sr concentrations approaching one to two pCi ℓ^{-1}, showed a slight decrease in concentration. Whether the ^{90}Sr present in these wells result from Laboratory operations or not, the above values confirm that the EPA drinking water limit of 8 pCi ℓ^{-1} (18) has not been exceeded. In order to establish "background" levels of ^{90}Sr in local ground water remote from the possible influence of any BNL effluent, this Laboratory collaborated with the Suffolk County Department of Health Services (SCDHS) during July/August 1979, in the collection and analysis of a number of samples from the county-wide network of test wells. Twenty three samples were collected from wells located from Babylon to Southhampton and having depths ranging from 8 m (shallow) to 86 m (deep). In addition, samples were collected from 20 private wells which are used as supply of drinking water in homes, schools and fire stations located primarily east of the Laboratory. All 43 samples were analyzed for ^{90}Sr by this Laboratory. The results, based on a minimum level of detection of 0.1 pCi ℓ^{-1} ^{90}Sr, indicated that the largest concentration was found in four of the test wells and ranged from 1.1 to 2.75 ℓ^{-1} pCi while the rest of the wells were below 0.5 pCi ℓ^{-1}. When the ^{90}Sr concentrations were related to the depth of the water table, it was apparent that the largest concentrations were present in the shallow wells regardless of their proximity to the Laboratory. This observation casts doubt on the assumption made in the 1978 Environmental Monitoring Report that the presence of ^{90}Sr, in concentration of 1-2 pCi ℓ^{-1}, in samples collected from shallow private wells located a short distance east of the Laboratory site and adjacent to the Peconic River was entirely the result of past releases by the Laboratory into the Peconic River. It now appears that most, if not all, of the ^{90}Sr concentrations found in these wells is most likely from fallout from past nuclear weapon tests. A review of the data on the levels of fallout-related ^{90}Sr in precipitation shows that it was present in yearly average concentrations of more than 2 pCi ℓ^{-1} from 1953 to 1965, with the exception of 1959. The maximum concentration measured locally was 26 pCi ℓ^{-1} in 1963.

According to local and state radiological health authorities, the health significance of these small amounts of ^{90}Sr is minimal. The EPA limit for ^{90}Sr in a community water supply (applicable to the ground water in Suffolk as a "sole source" of drinking water (25)) is 8 pCi ℓ^{-1} (18). This would correspond to a yearly dose commitment of four millirems.

The current average concentration of past weapons testing related ^{90}Sr in milk from a local dairy is about 14 pCi ℓ^{-1} while the average total dietary intake of ^{90}Sr in the New York area is about 8 pCi d^{-1}. A yearly dose commitment of four millirems is within the local fluctuations of external background radiation, which averages about 70 millirems per year on Long Island.

Compared with the values detected in 1974-1978, the gross beta, tritium and ^{90}Sr activity concentrations for 1979 have, in most cases, decreased to 50% of the values in 1977 in several wells adjacent to the solid waste management area. The elevated ^{90}Sr activity concentrations, exceeding Drinking Water Standards, in wells WK, WL, WB and WC continue to reflect the inadvertent injection in 1960 of approximately 1 Ci (3.7×10^{10} Bq) of this nuclide into ground water at well WA. The concentrations in wells WK and WL, which had decreased by 20 to 30% of the 1977 levels, remained at the level seen in 1978, while well WB, which is adjacent to WA, has decreased by a factor of 2, but well WC has increased to 12 times the 1978 level. Other wells, such as WD, WE, WM, Wl and 19 have all shown decreases in gross beta and ^{90}Sr activity when compared to 1978 levels. Such fluctuations represent the complex interaction of ground water movement rates and distribution coefficients of the elements in the soil matrix. The gross beta and tritium activity concentrations, which had shown an increasing trend since 1974, decreased in several wells immediately adjacent to the landfill area and reflects movement and dilution through ground water. A further decrease in activity concentrations was apparent in wells adjacent to the former open dump when compared to the years 1974-1978. The gross beta and ^{90}Sr values in wells 1A and 1H, monitoring the decontamination facility (Bldg. 650) sump, which had increased by a factor of two in 1978 showed significant reductions in activity in 1979 but well 1E has increased twofold without a similar increase in ^{90}Sr concentration, while the other wells around this sump area have further decreased when compared to the concentrations during 1974-1978. In view of the new standards that are applicable to ground water systems, the gross beta and ^{90}Sr indeed exceed the limits. However, in the case of ^{90}Sr, calculations based on ground water travel times, ^{90}Sr distribution coefficient for ion-exchange and distance to potential user (as drinking water) indicate travel time greater than two ^{90}Sr half-lives (approximately 60 years) to reach areas where exposure can occur. Based on the existing levels in the above wells, the Laboratory does not foresee this inadvertent dumping of ^{90}Sr in well WA and the 650 sump area will cause the concentrations of ^{90}Sr in wells off-site to exceed EPA drinking water limits. A study on ^{90}Sr in groundwater discussed elsewhere in this section further substantiates the above observation.

Several water quality and purity parameters were evaluated for all ground water surveillance wells. The data for those wells nearby to on-site sumps, the sand filter beds, and downstream of the Peconic River on- and off-site, are shown in Table 22. Similarly, the data for wells nearby to the solid waste management area, the landfill, the dump area and the 650 sump, are shown in Table 23. Table 24 presents similar data for potable and cooling water supply wells. This data is further compared with tap water, for a few of the parameters, in the same table. In all cases, the ground water quality parameters were within standard limits. Analyses for selected metals were conducted for a few wells immediately adjacent to the sand filter beds, to the Peconic River, to the waste management, landfill and former dump areas. These data are shown in Table 25. Results of trace element analyses for potable and cooling water supply wells, and tap water are given in Table 26.

In general, the data were comparable to that observed during 1974-1978. With the exception of pH, all analyzed water quality parameters were within New York State Water Quality Standards (13). The somewhat lower pH levels appear to reflect natural ambient levels, since higher pH levels were present in the input to and output from the sewage treatment plant (see Table 10). Concentrations of Fe, Zn and Pb in excess of water quality standards were found in some of the wells immediately adjacent to the sand filter beds, the Peconic River, 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 reflect the leaching of accumulations of these metals from past Laboratory releases. A program to compare effects of well casings has been instituted in 1980. Tracing the levels of these

TABLE 22

1979 BNL ENVIRONMENTAL MONITORING SAND FILTER BEDS AND PECONIC RIVER AREA WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN .(PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUC-TIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
XA	MEAN	17	5.5	4.4	27.0	6.41	0.03	131	175	0	0
	MINIMUM	14	5.2	2.0	22.3	3.33	0.01	117	154	0	0
	MAXIMUM	22	5.8	7.2	32.8	11.47	0.12	142	198	0	0
	NUMBER	8	8	8	8	8	8	7	8	8	8
XB	MEAN	10	6.3	7.8	31.5	0.03	0.01	157	160	0	0
	MINIMUM	10	6.3	7.8	31.5	0.03	0.01	157	160	0	0
	MAXIMUM	10	6.3	7.8	31.5	0.03	0.01	157	160	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XC	MEAN	10	6.3	3.8	13.5	0.03	0.01	65	87	0	0
	MINIMUM	10	6.3	3.8	13.5	0.03	0.01	65	87	0	0
	MAXIMUM	10	6.3	3.8	13.5	0.03	0.01	65	87	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XD	MEAN	10	5.6	2.6	11.5	0.06	0.01	48	64	0	0
	MINIMUM	10	5.6	2.6	11.5	0.06	0.01	48	64	0	0
	MAXIMUM	10	5.6	2.6	11.5	0.06	0.01	48	64	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XE	MEAN	12	5.3	6.6	8.2	0.54	0.03	1	63	0	0
	MINIMUM	12	5.3	6.6	8.2	0.54	0.03	1	63	0	0
	MAXIMUM	12	5.3	6.6	8.2	0.54	0.03	1	63	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XF	MEAN	11	5.4	4.2	11.7	0.02	0.01	54	72	0	0
	MINIMUM	11	5.4	4.2	11.7	0.02	0.01	54	72	0	0
	MAXIMUM	11	5.4	4.2	11.7	0.02	0.01	54	72	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XG	MEAN	13	5.5	7.5	7.5	0.14	0.04	72	72	0	0
	MINIMUM	9	5.1	6.4	4.0	0.01	0.01	58	58	0	0
	MAXIMUM	16	6.0	8.6	11.1	0.40	0.09	100	91	0	0
	NUMBER	9	9	9	9	9	9	9	9	6	6
XH	MEAN	11	5.1	3.0	9.2	0.04	0.01	69	53	0	0
	MINIMUM	11	5.1	3.0	9.2	0.04	0.01	69	53	0	0
	MAXIMUM	11	5.1	3.0	9.2	0.04	0.01	69	53	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XI	MEAN	9	5.6	6.6	13.5	0.03	0.01	35	54	0	0
	MINIMUM	9	5.6	6.6	13.5	0.03	0.01	35	54	0	0
	MAXIMUM	9	5.6	6.6	13.5	0.03	0.01	35	54	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XJ	MEAN	11	5.1	1.6	6.1	0.02	0.03	40	47	0	0
	MINIMUM	11	5.1	1.6	6.1	0.02	0.03	40	47	0	0
	MAXIMUM	11	5.1	1.6	6.1	0.02	0.03	40	47	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XK	MEAN	12	5.6	2.0	17.5	0.07	0.05	109	128	0	0
	MINIMUM	9	5.2	1.5	14.4	0.03	0.01	84	111	0	0
	MAXIMUM	15	6.2	2.4	24.2	0.24	0.12	161	159	0	0
	NUMBER	9	9	9	9	7	9	9	9	8	8
XL	MEAN	13	5.6	3.0	23.0	0.16	0.03	120	142	0	0
	MINIMUM	4	5.0	2.0	17.3	0.01	0.01	86	115	0	0
	MAXIMUM	16	6.3	4.4	41.9	0.65	0.07	190	210	0	3
	NUMBER	7	7	7	7	7	7	7	7	6	7
XM	MEAN	18	5.5	6.6	18.4	0.07	0.10	93	108	0	0
	MINIMUM	16	5.0	1.2	10.1	0.02	0.01	71	86	0	0
	MAXIMUM	19	6.2	8.0	26.0	0.13	0.38	130	132	0	3
	NUMBER	8	8	8	8	8	8	8	8	7	7
XN	MEAN	13	5.0	1.6	20.9	0.02	0.03	123	96	0	0
	MINIMUM	13	5.0	1.6	20.9	0.02	0.03	123	96	0	0
	MAXIMUM	13	5.0	1.6	20.9	0.02	0.03	123	96	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XQ	MEAN	13	5.9	2.7	25.4	0.08	0.02	103	136	0	0
	MINIMUM	12	5.7	2.0	21.4	0.01	0.01	75	116	0	0
	MAXIMUM	15	6.0	5.0	32.7	0.29	0.04	140	147	0	0
	NUMBER	5	5	5	5	5	5	5	5	5	4
XR	MEAN	10	5.3	7.2	7.4	0.03	0.06	26	45	0	0
	MINIMUM	10	5.3	7.2	7.4	0.03	0.06	26	45	0	0
	MAXIMUM	10	5.3	7.2	7.4	0.03	0.06	26	45	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XS	MEAN	12	5.4	8.6	11.4	0.92	0.08	101	126	0	0
	MINIMUM	11	4.8	7.8	0.0	0.13	0.01	71	106	0	0
	MAXIMUM	13	5.8	9.4	25.0	1.47	0.46	155	151	0	0
	NUMBER	10	10	10	10	10	7	10	10	8	9

TABLE 22 (Continued)

1979 BNL ENVIRONMENTAL MONITORING MISCELLANEOUS ON SITE WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
XW	MEAN	11	5.0	5.0	33.7	0.03	0.01	90	144	0	0
	MINIMUM	11	5.0	5.0	33.7	0.03	0.01	90	144	0	0
	MAXIMUM	11	5.0	5.0	33.7	0.03	0.01	90	144	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XX	MEAN	12	5.4	2.5	17.6	0.08	0.56	84	98	0	0
	MINIMUM	11	5.0	1.6	13.1	0.00	0.01	53	86	0	0
	MAXIMUM	14	6.2	4.6	22.4	0.43	6.01	186	114	0	0
	NUMBER	11	11	10	10	10	11	10	10	9	9
XY	MEAN	14	5.3	1.8	20.9	0.02	0.01	84	102	0	0
	MINIMUM	14	5.3	1.8	20.9	0.02	0.01	84	102	0	0
	MAXIMUM	14	5.3	1.8	20.9	0.02	0.01	84	102	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
XZ	MEAN	11	5.8	4.6	27.5	0.26	0.02	146	149	0	0
	MINIMUM	11	5.8	4.6	27.5	0.26	0.02	146	149	0	0
	MAXIMUM	11	5.8	4.6	27.5	0.26	0.02	146	149	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
X1	MEAN	8	5.0	6.4	6.9	0.03	0.03	97	45	0	0
	MINIMUM	8	5.0	6.4	6.9	0.03	0.03	97	45	0	0
	MAXIMUM	8	5.0	6.4	6.9	0.03	0.03	97	45	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
X2	MEAN	11	5.2	2.0	9.1	0.02	0.02	145	141	0	0
	MINIMUM	11	5.2	2.0	9.1	0.02	0.02	145	141	0	0
	MAXIMUM	11	5.2	2.0	9.1	0.02	0.02	145	141	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
X5	MEAN	10	5.6	8.0	9.3	0.47	0.02	54	79	0	0
	MINIMUM	10	5.6	8.0	9.3	0.47	0.02	54	79	0	0
	MAXIMUM	10	5.6	8.0	9.3	0.47	0.02	54	79	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
SA	MEAN	14	5.5	6.4	46.0	2.51	0.01	139	212	0	0
	MINIMUM	14	5.5	6.4	46.0	2.51	0.01	139	212	0	0
	MAXIMUM	14	5.5	6.4	46.0	2.51	0.01	139	212	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
SC	MEAN	12	6.1	7.2	8.1	0.01	0.02	44	56		
	MINIMUM	12	6.1	7.2	8.1	0.01	0.02	44	56		
	MAXIMUM	12	6.1	7.2	8.1	0.01	0.02	44	56		
	NUMBER	1	1	1	1	1	1	1	1	0	0
SD	MEAN	12	5.2	9.2	8.6	0.01	0.01	41	67	0	0
	MINIMUM	12	5.2	9.2	8.6	0.01	0.01	41	67	0	0
	MAXIMUM	12	5.2	9.2	8.6	0.01	0.01	41	67	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
SE	MEAN	14	6.0	9.1	35.7	1.39	0.03	152	197	0	0
	MINIMUM	13	5.6	8.6	28.7	1.31	0.01	119	178	0	0
	MAXIMUM	14	6.3	10.0	44.9	1.46	0.07	169	225	0	0
	NUMBER	3	3	3	3	3	3	3	3	2	2
SG	MEAN	12	5.4	10.0	63.4	0.45	0.01	82	236	0	0
	MINIMUM	12	5.4	10.0	63.4	0.45	0.01	82	236	0	0
	MAXIMUM	12	5.4	10.0	63.4	0.45	0.01	82	236	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
SI	MEAN	13	5.7	10.0	22.3	0.62	0.01	87	114	0	0
	MINIMUM	13	5.7	10.0	22.3	0.62	0.01	87	114	0	0
	MAXIMUM	13	5.7	10.0	22.3	0.62	0.01	87	114	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
16	MEAN	12	4.7	2.6	11.6	2.29	0.01	121	112	0	0
	MINIMUM	12	4.7	2.6	11.6	2.29	0.01	121	112	0	0
	MAXIMUM	12	4.7	2.6	11.6	2.29	0.01	121	112	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
17	MEAN	11	5.8	9.8	12.1	0.01	0.01	100	68	0	0
	MINIMUM	11	5.8	9.8	12.1	0.01	0.01	100	68	0	0
	MAXIMUM	11	5.8	9.8	12.1	0.01	0.01	100	68	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
2E	MEAN	11	5.4	7.3	56.7	0.13	0.03	132	202	0	0
	MINIMUM	8	4.8	5.6	22.2	0.01	0.02	92	123	0	0
	MAXIMUM	14	6.0	9.0	91.1	0.26	0.04	171	281	0	0
	NUMBER	2	2	2	2	2	2	2	2	2	2
2F	MEAN	15	6.0	9.3	45.2	0.23	0.01	142	193	0	0
	MINIMUM	15	6.0	9.2	12.4	0.19	0.01	91	88	0	0
	MAXIMUM	15	6.0	9.4	78.0	0.27	0.01	192	298	0	0
	NUMBER	2	2	2	2	2	2	2	2	2	2
2G	MEAN	21	5.7	2.6	26.2	0.09	0.26	101	143	0	0
	MINIMUM	21	5.7	2.6	26.2	0.09	0.26	101	143	0	0
	MAXIMUM	21	5.7	2.6	26.2	0.09	0.26	101	143	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1

Reference Standards - Table 29

Number: samples analyzed per year

TABLE 23

1979 BNL ENVIRONMENTAL MONITORING WASTE MANAGEMENT AREA WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUC-TIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
WB	MEAN	14	5.4	6.0	8.2	2.61	2.01	50	105	0	0
	MINIMUM	13	5.2	4.8	7.6	0.51	0.01	1	74	0	0
	MAXIMUM	15	5.5	7.0	8.6	5.25	6.01	94	124	0	0
	NUMBER	3	2	3	3	3	3	3	3	2	2
WC	MEAN	15	5.2	7.4	6.6	4.85	0.02	75	104	0	0
	MINIMUM	15	5.2	7.4	6.6	4.85	0.02	75	104	0	0
	MAXIMUM	15	5.2	7.4	6.6	4.85	0.02	75	104	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WD	MEAN	12	5.2	8.8	5.7	1.03	0.07	78	111	0	0
	MINIMUM	10	4.8	8.4	4.0	0.66	0.02	70	100	0	0
	MAXIMUM	14	5.6	9.4	7.1	1.70	0.20	98	120	0	0
	NUMBER	5	5	5	5	5	5	5	5	1	1
WE	MEAN	13	5.7	8.4	2.5	0.01	0.02	39	44		
	MINIMUM	13	5.7	8.4	2.5	0.01	0.02	39	44		
	MAXIMUM	13	5.7	8.4	2.5	0.01	0.02	39	44		
	NUMBER	1	1	1	1	1	1	1	1	0	0
WJ	MEAN	13	5.2	7.0	9.1	0.60	0.02	70	95		
	MINIMUM	13	5.2	7.0	9.1	0.60	0.02	70	95		
	MAXIMUM	13	5.2	7.0	9.1	0.60	0.02	70	95		
	NUMBER	1	1	1	1	1	1	1	1	0	0
WK	MEAN	11	5.4	8.5	7.9	1.04	0.03	66	94	0	0
	MINIMUM	10	5.2	8.0	5.6	0.62	0.01	58	86	0	0
	MAXIMUM	12	5.7	9.4	9.2	1.54	0.06	90	109	0	0
	NUMBER	5	5	5	4	5	5	5	5	4	4
WL	MEAN	11	5.3	9.5	3.5	1.66	0.03	75	94	0	0
	MINIMUM	10	4.8	9.0	1.5	0.25	0.01	63	80	0	0
	MAXIMUM	13	5.8	9.8	4.5	2.42	0.05	83	104	0	0
	NUMBER	5	5	5	5	5	5	4	5	1	1
WM	MEAN	14	6.1	6.4	8.1	0.44	0.02	101	153		
	MINIMUM	14	6.1	6.4	8.1	0.44	0.02	101	153		
	MAXIMUM	14	6.1	6.4	8.1	0.44	0.02	101	153		
	NUMBER	1	1	1	1	1	1	1	1	0	0
WN	MEAN	13	5.9	7.0	9.1	0.13	0.02	95	148		
	MINIMUM	13	5.9	7.0	9.1	0.13	0.02	95	148		
	MAXIMUM	13	5.9	7.0	9.1	0.13	0.02	95	148		
	NUMBER	1	1	1	1	1	1	1	1	0	0
WU	MEAN	10	5.6	8.0	8.6	0.01	0.02	40	56	0	0
	MINIMUM	10	5.6	8.0	8.6	0.01	0.02	40	56	0	0
	MAXIMUM	10	5.6	8.0	8.6	0.01	0.02	40	56	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WV	MEAN	11	6.0	7.6	2.0	0.01	0.02	28	39	0	0
	MINIMUM	11	6.0	7.6	2.0	0.01	0.02	28	39	0	0
	MAXIMUM	11	6.0	7.6	2.0	0.01	0.02	28	39	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WW	MEAN	11	5.6	8.8	14.6	0.01	0.02	70	95	0	0
	MINIMUM	11	5.6	8.8	14.6	0.01	0.02	70	95	0	0
	MAXIMUM	11	5.6	8.8	14.6	0.01	0.02	70	95	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WX	MEAN	12	5.9	8.0	9.6	0.05	0.02	54	69	0	0
	MINIMUM	12	5.9	8.0	9.6	0.05	0.02	54	69	0	0
	MAXIMUM	12	5.9	8.0	9.6	0.05	0.02	54	69	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WZ	MEAN	11	5.7	7.4	6.6	0.01	0.02	54	81	0	
	MINIMUM	11	5.7	7.4	6.6	0.01	0.02	54	81	0	
	MAXIMUM	11	5.7	7.4	6.6	0.01	0.02	54	81	0	
	NUMBER	1	1	1	1	1	1	1	1	1	0
W1	MEAN	11	5.4	9.3	3.9	0.83	0.02	59	55	0	0
	MINIMUM	10	5.0	8.0	3.3	0.13	0.01	38	46	0	0
	MAXIMUM	13	5.8	9.8	4.5	1.49	0.04	92	62	0	0
	NUMBER	5	5	5	5	5	5	3	5	1	1
W3	MEAN	11	5.1	7.0	7.9	3.82	0.01	83	101	0	0
	MINIMUM	11	5.1	7.0	7.9	3.82	0.01	83	101	0	0
	MAXIMUM	11	5.1	7.0	7.9	3.82	0.01	83	101	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
W4	MEAN	11	5.3	10.0	4.0	0.05	0.01	49	39	0	0
	MINIMUM	11	5.3	10.0	4.0	0.05	0.01	49	39	0	0
	MAXIMUM	11	5.3	10.0	4.0	0.05	0.01	49	39	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
W5	MEAN	11	5.0	10.0	5.4	0.05	0.01	40	46		
	MINIMUM	11	5.0	10.0	5.4	0.05	0.01	40	46		
	MAXIMUM	11	5.0	10.0	5.4	0.05	0.01	40	46		
	NUMBER	1	1	1	1	1	1	1	1	0	0

TABLE 23 (Continued)

1979 BNL ENVIRONMENTAL MONITORING LANDFILL AREA WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUC-TIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
W7	MEAN	11	5.1	7.0	10.9	0.64	0.01	60	89	0	0
	MINIMUM	11	5.1	7.0	10.9	0.64	0.01	60	89	0	0
	MAXIMUM	11	5.1	7.0	10.9	0.64	0.01	60	89	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
W8	MEAN	11	5.0	9.2	5.0	0.05	0.01	43	47		
	MINIMUM	11	5.0	9.2	5.0	0.05	0.01	43	47		
	MAXIMUM	11	5.0	9.2	5.0	0.05	0.01	43	47		
	NUMBER	1	1	1	1	1	1	1	1	0	0
18	MEAN	12	4.8	10.0	6.4	0.05	0.01	44	61	0	0
	MINIMUM	12	4.8	10.0	6.4	0.05	0.01	44	61	0	0
	MAXIMUM	12	4.8	10.0	6.4	0.05	0.01	44	61	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
19	MEAN	12	5.0	10.0	8.4	0.05	0.01	46	68	0	0
	MINIMUM	12	5.0	10.0	8.4	0.05	0.01	46	68	0	0
	MAXIMUM	12	5.0	10.0	8.4	0.05	0.01	46	68	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WF	MEAN	12	5.3	8.2	13.1	0.34	0.02	60	83	0	0
	MINIMUM	12	4.8	8.0	8.6	0.05	0.01	47	76	0	0
	MAXIMUM	12	5.7	8.4	17.6	0.63	0.02	73	90	0	0
	NUMBER	2	2	2	2	2	2	2	2	1	1
WG	MEAN	13	5.4	5.8	7.3	0.17	0.03	41	68	0	0
	MINIMUM	13	5.4	3.6	6.0	0.03	0.01	38	54	0	0
	MAXIMUM	13	5.4	8.0	8.6	0.31	0.04	43	81	0	0
	NUMBER	2	2	2	2	2	2	2	2	2	2
WR	MEAN	15	6.4	2.6	9.6	0.39	0.02	445	1108	0	0
	MINIMUM	15	6.2	2.2	1.5	0.26	0.02	354	1085	0	0
	MAXIMUM	15	6.5	3.0	17.7	0.51	0.02	536	1130	0	0
	NUMBER	2	2	2	2	2	2	2	2	1	1
WS	MEAN	12	5.1	1.8	27.7	0.23	0.02	378	738	0	0
	MINIMUM	10	1.4	1.6	2.6	0.05	0.01	253	670	0	0
	MAXIMUM	14	6.7	2.0	46.9	0.55	0.02	449	839	0	0
	NUMBER	4	4	2	4	4	4	4	4	3	2
WT	MEAN	12	6.2	3.3	9.9	0.11	0.02	64	87	0	0
	MINIMUM	11	6.0	2.2	9.1	0.01	0.01	56	84	0	0
	MAXIMUM	13	6.4	4.4	10.6	0.20	0.02	71	90	0	0
	NUMBER	2	2	2	2	2	2	2	2	2	2
W9	MEAN	12	6.2	2.5	16.8	0.30	0.02	419	934	0	0
	MINIMUM	11	5.6	1.5	3.6	0.12	0.01	333	815	0	0
	MAXIMUM	13	6.7	3.2	52.0	0.63	0.02	562	1005	0	0
	NUMBER	4	4	4	4	4	4	4	4	4	4
1K	MEAN	14	6.3	1.3	33.7	0.30	0.01	474	983	0	0
	MINIMUM	13	6.2	1.0	2.0	0.25	0.01	454	905	0	0
	MAXIMUM	15	6.6	1.4	93.4	0.36	0.01	496	1049	0	0
	NUMBER	3	3	3	3	3	3	3	3	2	2
2A	MEAN	11	5.6	9.9	6.9	0.02	0.01	40	55	0	1
	MINIMUM	11	5.5	9.8	5.1	0.01	0.01	37	50	0	0
	MAXIMUM	11	5.7	10.0	8.6	0.03	0.01	43	59	0	1
	NUMBER	2	2	2	2	2	2	2	2	2	2
2B	MEAN	11	5.3	10.1	8.6	0.06	0.03	46	69	0	0
	MINIMUM	10	5.0	10.0	5.6	0.02	0.02	44	62	0	0
	MAXIMUM	11	5.5	10.2	11.6	0.09	0.03	47	75	0	0
	NUMBER	2	2	2	2	2	2	2	2	1	1
2C	MEAN	13	6.3	2.0	2.0	0.34	0.05	639	1213	0	0
	MINIMUM	13	6.2	1.6	1.5	0.29	0.03	639	1170	0	0
	MAXIMUM	13	6.3	2.4	2.5	0.38	0.07	639	1255	0	0
	NUMBER	2	2	2	2	2	2	1	2	2	2
2D	MEAN	13	6.2	2.0	25.9	0.21	0.04	326	870	0	0
	MINIMUM	13	6.0	2.0	23.7	0.19	0.01	326	800	0	0
	MAXIMUM	13	6.4	2.0	28.0	0.23	0.06	326	940	0	0
	NUMBER	2	2	2	2	2	2	1	2	2	2

TABLE 23 (Continued)

1979 BNL ENVIRONMENTAL MONITORING FORMER DUMP AREA WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
WO	MEAN	11	5.0	11.0	6.5	0.01	0.01	51	56	0	0
	MINIMUM	11	5.0	11.0	6.5	0.01	0.01	51	56	0	0
	MAXIMUM	11	5.0	11.0	6.5	0.01	0.01	51	56	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WP	MEAN	11	4.5	7.8	7.0	0.77	0.01	63	67	0	0
	MINIMUM	11	4.5	7.8	7.0	0.77	0.01	63	67	0	0
	MAXIMUM	11	4.5	7.8	7.0	0.77	0.01	63	67	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
WQ	MEAN	11	4.9	9.7	6.5	0.12	0.01	50	52	0	0
	MINIMUM	11	4.9	9.7	6.5	0.12	0.01	50	52	0	0
	MAXIMUM	11	4.9	9.7	6.5	0.12	0.01	50	52	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1I	MEAN	12	5.0	8.6	10.1	0.01	0.01	41	74	0	0
	MINIMUM	12	5.0	8.6	10.1	0.01	0.01	41	74	0	0
	MAXIMUM	12	5.0	8.6	10.1	0.01	0.01	41	74	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1J	MEAN	12	5.2	11.0	6.0	0.01	0.01	33	48	0	0
	MINIMUM	12	5.2	11.0	6.0	0.01	0.01	33	48	0	0
	MAXIMUM	12	5.2	11.0	6.0	0.01	0.01	33	48	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1

1979 BNL ENVIRONMENTAL MONITORING BUILDING 650 SUMP AREA WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
1A	MEAN	16	5.7	6.2	20.8	0.38	0.08	82	181	0	0
	MINIMUM	16	5.7	6.2	20.8	0.38	0.08	82	181	0	0
	MAXIMUM	16	5.7	6.2	20.8	0.38	0.08	82	181	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1C	MEAN	15	6.0	7.2	23.0	0.05	0.23	97	104	0	0
	MINIMUM	15	6.0	7.2	23.0	0.05	0.23	97	104	0	0
	MAXIMUM	15	6.0	7.2	23.0	0.05	0.23	97	104	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1D	MEAN	16	6.0	6.2	15.8	0.27	0.01	16	121	0	0
	MINIMUM	16	6.0	6.2	15.8	0.27	0.01	16	121	0	0
	MAXIMUM	16	6.0	6.2	15.8	0.27	0.01	16	121	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1E	MEAN	14	5.7	6.6	14.3	0.69	0.03	14	100	0	0
	MINIMUM	14	5.7	6.6	14.3	0.69	0.03	14	100	0	0
	MAXIMUM	14	5.7	6.6	14.3	0.69	0.03	14	100	0	0
	NUMBER	1	1	1	1	1	1	1	1	1	1
1H	MEAN	15	6.0	5.8	7.7	0.31	0.03	75	79		
	MINIMUM	15	6.0	5.8	7.7	0.31	0.03	75	79		
	MAXIMUM	15	6.0	5.8	7.7	0.31	0.03	75	79		
	NUMBER	1	1	1	1	1	1	1	1	0	0

Reference Standards - Table 29

Number: samples analyzed per year

TABLE 24

1979 BNL ENVIRONMENTAL MONITORING COOLING WATER WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
FH	MEAN	13	5.8	7.4	17.9	0.10	0.18	93	113	0	0
	MINIMUM	13	5.7	7.0	13.5	0.05	0.01	71	88	0	0
	MAXIMUM	13	5.8	7.8	22.4	0.15	0.36	115	137	0	0
	NUMBER	2	2	2	2	2	2	2	2	1	1
FI	MEAN	11	5.8	7.5	12.2	0.02	0.52	64	78	0	0
	MINIMUM	10	5.6	7.0	10.7	0.02	0.01	53	73	0	0
	MAXIMUM	11	6.1	8.2	13.3	0.02	1.28	74	84	0	0
	NUMBER	3	3	3	3	1	3	3	3	1	1
FJ	MEAN	11	5.7	4.5	16.9	0.28	0.24	70	93	0	0
	MINIMUM	10	5.5	4.0	15.8	0.27	0.03	66	89	0	0
	MAXIMUM	11	6.0	5.4	18.0	0.31	0.40	76	96	0	0
	NUMBER	3	3	3	3	3	3	3	3	2	2
FL	MEAN	14	5.7	6.9	29.3	1.44	0.02	123	165	0	0
	MINIMUM	14	5.6	5.6	28.5	1.41	0.01	114	156	0	0
	MAXIMUM	14	5.8	7.6	30.2	1.49	0.04	131	175	0	0
	NUMBER	3	3.	3	3	3	3	2	3	2	2

1979 BNL ENVIRONMENTAL MONITORING TAP WATER
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
FN	MEAN		5.3		19.9.	0.42	0.05	86			
	MINIMUM		5.3		16.7	0.03	0.01	71			
	MAXIMUM		5.3		24.5	3.34	0.25	126			
	NUMBER	0	1	0	53	53	52	12	0	0	0

1979 BNL ENVIRONMENTAL MONITORING POTABLE SUPPLY WELLS
WATER QUALITY AND PURITY

LOCATION	SAMPLE	TEMPERATURE	PH	DISSOLVED OXYGEN (PPM)	CHLORIDES (PPM)	NITRATE NITROGEN (PPM)	TOTAL PHOSPHOROUS (PPM)	DISSOLVED SOLIDS (PPM)	CONDUCTIVITY MICROMHO/CM	COLIFORM FECAL (/100 ML)	COLIFORM TOTAL (/100 ML)
FB	MEAN	13	5.9	7.0	21.7	0.73	0.04	112	134	0	0
	MINIMUM	12	5.7	6.4	18.5	0.57	0.01	92	122	0	0
	MAXIMUM	13	6.0	7.4	28.6	0.81	0.06	148	162	0	0
	NUMBER	4	4	4	4	4	4	3	4	4	4
FD	MEAN	11	5.8	7.7	17.8	0.25.	0.04	71	97	0	0
	MINIMUM	10	5.7	7.0	16.8	0.11	0.01	68	91	0	0
	MAXIMUM	12	6.0	8.0	19.3	0.40	0.06	74	104	0	0
	NUMBER	4	4	4	4	4	4	3	4	4	4
FE	MEAN	13	5.8	8.3	6.2	0.08	0.03	38	74	0	0
	MINIMUM	10	5.4	4.0	5.4	0.01	0.01	35	46	0	0
	MAXIMUM	19	6.1	10.8	7.7	0.23	0.05	42	154	0	0
	NUMBER	3	4	4	4	4	4	3	4	4	4
FF	MEAN	12	5.7	8.6	17.5	0.50	0.03	86	118	0	0
	MINIMUM	11	5.5	8.6	6.6	0.37	0.01	80	114	0	0
	MAXIMUM	12	6.0	8.6	23.0	0.60	0.05	90	124	0	0
	NUMBER	4	4	4	4	4	4	3	4	4	3
FG	MEAN	10	5.8	8.2	11.4	0.05	0.03	59	71	0	0
	MINIMUM	10	5.5	8.0	9.5	0.01	0.01	58	69	0	0
	MAXIMUM	11	6.2	8.6	13.3	0.08	0.05	60	74	0	0
	NUMBER	3	3	3	3	3	3	2	3	3	3

Reference Standards - Table 29

Locations indicated on Fig. 8 & identified as: Potable - FA: 1, FB: 2, FC: 3, FD: 4, FE: 5, FF: 6, FG: 7.
Cooling - FH: 101, FI: 102, FJ: 103, FK: 104, FL: 105.

Number: samples analyzed per year

TABLE 25

1979 BNL ENVIRONMENTAL MONITORING SAND FILTER BEDS AND PECONIC RIVER AREA WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
XA	MEAN	.001	.0009	.015	.007	.516	.004	.284
	MINIMUM	.001	.0009	.002	.005	.110	.002	.262
	MAXIMUM	.001	.0010	.054	.009	1.650	.005	.319
	EXCEPTION	4	0	3	0	0	4	0
	NUMBER	4	4	4	4	4	4	3
XB	MEAN	.001	.0003	.001	.003	.200	.011	3.930
	MINIMUM	.001	.0003	.001	.003	.200	.011	3.930
	MAXIMUM	.001	.0003	.001	.003	.200	.011	3.930
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XC	MEAN	.001	.0003	.001	.007	1.610	.002	.610
	MINIMUM	.001	.0003	.001	.007	1.610	.002	.610
	MAXIMUM	.001	.0003	.001	.007	1.610	.002	.610
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
XD	MEAN	.001	.0003	.023	.003	.720	.006	.204
	MINIMUM	.001	.0003	.023	.003	.720	.006	.204
	MAXIMUM	.001	.0003	.023	.003	.720	.006	.204
	EXCEPTION	1	1	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XE	MEAN	.001		.002	.006	.450	.002	.953
	MINIMUM	.001		.002	.006	.450	.002	.953
	MAXIMUM	.001		.002	.006	.450	.002	.953
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	0	1	1	1	1	1
XF	MEAN	.001		.005	.009	.083	.027	2.430
	MINIMUM	.001		.005	.009	.083	.027	2.430
	MAXIMUM	.001		.005	.009	.083	.027	2.430
	EXCEPTION	1	0	0	0	0	0	0
	NUMBER	1	0	1	1	1	1	1
XG	MEAN	.001	.0005	.002	.005	3.328	.004	.094
	MINIMUM	.001	.0002	.001	.003	1.190	.002	.064
	MAXIMUM	.001	.0006	.002	.013	6.600	.005	.126
	EXCEPTION	5	5	5	0	0	5	0
	NUMBER	5	5	5	5	5	5	5
XH	MEAN	.001	.0005	.001	.005	3.750	.005	.823
	MINIMUM	.001	.0005	.001	.005	3.750	.005	.823
	MAXIMUM	.001	.0005	.001	.005	3.750	.005	.823
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XI	MEAN	.001	.0003	.015	.005	.100	.011	.460
	MINIMUM	.001	.0003	.015	.005	.100	.011	.460
	MAXIMUM	.001	.0003	.015	.005	.100	.011	.460
	EXCEPTION	1	1	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XJ	MEAN	.001	.0002	.002	.003	1.100	.002	.511
	MINIMUM	.001	.0002	.002	.003	1.100	.002	.511
	MAXIMUM	.001	.0002	.002	.003	1.100	.002	.511
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
XK	MEAN	.001	.0005	.002	.003	2.004	.004	1.119
	MINIMUM	.001	.0002	.002	.002	1.610	.002	.563
	MAXIMUM	.001	.0009	.003	.004	2.480	.005	2.320
	EXCEPTION	5	5	3	1	0	5	0
	NUMBER	5	5	5	3	5	5	5
XL	MEAN	.001	.0005	.002	.003	2.888	.004	.577
	MINIMUM	.001	.0003	.002	.002	1.650	.002	.288
	MAXIMUM	.001	.0006	.002	.004	5.890	.005	.840
	EXCEPTION	4	4	3	0	0	3	0
	NUMBER	4	4	4	4	4	4	4
XM	MEAN	.001	.0007	.003	.015	3.530	.007	.935
	MINIMUM	.001	.0006	.002	.011	2.310	.005	.718
	MAXIMUM	.001	.0010	.005	.016	5.520	.011	1.160
	EXCEPTION	3	3	3	0	0	3	0
	NUMBER	3	4	4	4	4	4	4
XN	MEAN	.001	.0002	.003	.009	9.050	.010	1.220
	MINIMUM	.001	.0002	.003	.009	9.050	.010	1.220
	MAXIMUM	.001	.0002	.003	.009	9.050	.010	1.220
	EXCEPTION	1	1	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XQ	MEAN	.001	.0032	.003	.003	15.100	.122	.237
	MINIMUM	.001	.0003	.002	.003	6.600	.005	.215
	MAXIMUM	.001	.0060	.003	.003	23.600	.238	.260
	EXCEPTION	2	2	1	0	0	1	0
	NUMBER	2	2	2	1	2	2	2

TABLE 25 (Continued)

1979 BNL ENVIRONMENTAL MONITORING LANDFILL AREA WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
XR	MEAN	.001	.0003	.001	.006	.020	.009	1.210
	MINIMUM	.001	.0003	.001	.006	.020	.009	1.210
	MAXIMUM	.001	.0003	.001	.006	.020	.009	1.210
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XS	MEAN	.002	.0004	.002	.016	3.958	.004	.143
	MINIMUM	.001	.0002	.001	.014	3.210	.002	.126
	MAXIMUM	.007	.0006	.002	.018	4.500	.005	.189
	EXCEPTION	4	4	4	0	0	4	0
	NUMBER	4	4	4	4	4	4	4
XW	MEAN	.001	.0003	.001	.005	.560	.002	.192
	MINIMUM	.001	.0003	.001	.005	.560	.002	.192
	MAXIMUM	.001	.0003	.001	.005	.560	.002	.192
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
XX	MEAN	.001	.0005	.002	.003	5.656	1.204	.184
	MINIMUM	.001	.0002	.002	.002	4.930	.002	.133
	MAXIMUM	.001	.0006	.002	.003	6.410	6.005	.230
	EXCEPTION	5	5	4	0	0	3	0
	NUMBER	5	5	5	5	5	5	5
XY	MEAN	.001	.0003	.002	.004	.281	.007	.600
	MINIMUM	.001	.0003	.002	.004	.281	.007	.600
	MAXIMUM	.001	.0003	.002	.004	.281	.007	.600
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
XZ	MEAN	.001	.0003	.001	.003	.010	.002	.236
	MINIMUM	.001	.0003	.001	.003	.010	.002	.236
	MAXIMUM	.001	.0003	.001	.003	.010	.002	.236
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
X1	MEAN	.001	.0003	.002	.004	.020	.002	.973
	MINIMUM	.001	.0003	.002	.004	.020	.002	.973
	MAXIMUM	.001	.0003	.002	.004	.020	.002	.973
	EXCEPTION	1	1	0	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
X2	MEAN	.001	.0002	.005	.003	.050	.002	1.450
	MINIMUM	.001	.0002	.005	.003	.050	.002	1.450
	MAXIMUM	.001	.0002	.005	.003	.050	.002	1.450
	EXCEPTION	1	1	0	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WF	MEAN	.001	.0004	.000	.005	.452	.006	.407
	MINIMUM	.001	.0002	.000	.003	.226	.005	.399
	MAXIMUM	.001	.0006	.000	.008	.679	.007	.414
	EXCEPTION	2	2	2	0	0	1	0
	NUMBER	2	2	2	2	2	2	2
WG	MEAN	.001	.0004	.002	.004	8.200	.004	.169
	MINIMUM	.001	.0002	.002	.003	7.420	.002	.139
	MAXIMUM	.001	.0006	.002	.005	8.980	.005	.199
	EXCEPTION	2	2	2	0	0	2	0
	NUMBER	2	2	2	2	2	2	2
WR	MEAN	.003	.0006	.002	.007	46.230	.005	.103
	MINIMUM	.003	.0006	.002	.007	46.230	.005	.103
	MAXIMUM	.003	.0006	.002	.007	46.230	.005	.103
	EXCEPTION	0	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WS	MEAN	.001	.0006	.002	.005	22.600	.007	.358
	MINIMUM	.001	.0006	.002	.005	22.600	.007	.358
	MAXIMUM	.001	.0006	.002	.005	22.600	.007	.358
	EXCEPTION	1	1	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WT	MEAN	.001	.0005	.002	.004	.797	.004	2.495
	MINIMUM	.001	.0003	.002	.002	.717	.003	2.320
	MAXIMUM	.001	.0006	.002	.006	.876	.005	2.670
	EXCEPTION	2	1	2	0	0	1	0
	NUMBER	2	2	2	2	2	2	2
W9	MEAN	.002	.0004	.004	.006	38.300	.004	.192
	MINIMUM	.001	.0002	.002	.006	19.300	.002	.063
	MAXIMUM	.004	.0006	.005	.006	57.300	.006	.321
	EXCEPTION	1	2	1	0	0	1	0
	NUMBER	2	2	2	1	2	2	2
IK	MEAN	.003	.0006	.002	.005	42.900	.005	.950
	MINIMUM	.003	.0006	.002	.005	42.900	.005	.950
	MAXIMUM	.003	.0006	.002	.005	42.900	.005	.950
	EXCEPTION	0	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1

TABLE 25 (Continued)

1979 BNL ENVIRONMENTAL MONITORING MISCELLANEOUS ON SITE WELLS -
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
2A	MEAN	.001	.0004	.002	.005	.064	.018	.476
	MINIMUM	.001	.0002	.002	.001	.029	.014	.433
	MAXIMUM	.001	.0006	.002	.009	.099	.023	.518
	EXCEPTION	2	2	2	1	0	0	0
	NUMBER	2	2	2	2	2	2	2
2B	MEAN	.001	.0004	.002	.002	.034	.007	.007
	MINIMUM	.001	.0002	.002	.001	.017	.005	.005
	MAXIMUM	.001	.0006	.002	.003	.052	.008	.009
	EXCEPTION	2	2	2	0	0	1	0
	NUMBER	2	2	2	2	2	2	2
2C	MEAN	.002	.0004	.002	.006	30.850	.004	.033
	MINIMUM	.001	.0002	.002	.002	25.400	.002	.032
	MAXIMUM	.004	.0006	.002	.010	36.300	.005	.035
	EXCEPTION	1	2	2	0	0	2	0
	NUMBER	2	2	2	2	2	2	2
2D	MEAN	.001	.0031	.002	.007	37.050	.004	.004
	MINIMUM	.001	.0002	.002	.005	24.700	.002	.001
	MAXIMUM	.001	.0060	.002	.008	49.400	.005	.008
	EXCEPTION	2	2	2	0	0	2	0
	NUMBER	2	2	2	2	2	2	2
SA	MEAN	.001	.0021	.002	.009	.380	.007	1.817
	MINIMUM	.001	.0021	.002	.009	.380	.007	1.817
	MAXIMUM	.001	.0021	.002	.009	.380	.007	1.817
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
SC	MEAN	.001	.0008	.002	.009	.125	.032	1.160
	MINIMUM	.001	.0008	.002	.009	.125	.032	1.160
	MAXIMUM	.001	.0008	.002	.009	.125	.032	1.160
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
SD	MEAN	.001	.0009	.002	.006	1.370	.005	.730
	MINIMUM	.001	.0009	.002	.006	1.370	.005	.730
	MAXIMUM	.001	.0009	.002	.006	1.370	.005	.730
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
SE	MEAN	.001	.0002	.002	.042	28.400		.168
	MINIMUM	.001	.0002	.002	.042	28.400		.168
	MAXIMUM	.001	.0002	.002	.042	28.400		.168
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	0	1
SG	MEAN	.001	.0011	.002	.015	14.000	.002	.715
	MINIMUM	.001	.0011	.002	.015	14.000	.002	.715
	MAXIMUM	.001	.0011	.002	.015	14.000	.002	.715
	EXCEPTION	1	0	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
SI	MEAN	.001	.0002	.002	.006	11.400	.002	.015
	MINIMUM	.001	.0002	.002	.006	11.400	.002	.015
	MAXIMUM	.001	.0002	.002	.006	11.400	.002	.015
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
16	MEAN	.001	.0006	.002	.009	.295	.019	.008
	MINIMUM	.001	.0006	.002	.009	.295	.019	.008
	MAXIMUM	.001	.0006	.002	.009	.295	.019	.008
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
17	MEAN	.001	.0006	.002	.002	.202	.017	.010
	MINIMUM	.001	.0006	.002	.002	.202	.017	.010
	MAXIMUM	.001	.0006	.002	.002	.202	.017	.010
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
2E	MEAN	.001	.0006	.002	.005	.089	3.005	.006
	MINIMUM	.001	.0006	.002	.003	.064	.005	.005
	MAXIMUM	.001	.0006	.002	.006	.114	6.005	.006
	EXCEPTION	2	2	1	0	0	1	0
	NUMBER	2	2	1	2	2	2	2
2F	MEAN	.001	.0004	.002	.003	.988	.004	.008
	MINIMUM	.001	.0002	.002	.002	.927	.002	.008
	MAXIMUM	.001	.0006	.002	.003	1.050	.005	.008
	EXCEPTION	2	2	2	0	0	2	0
	NUMBER	2	2	2	2	2	2	2
2G	MEAN	.001	.0006	.002	.002	.053	.005	.089
	MINIMUM	.001	.0006	.002	.002	.053	.005	.089
	MAXIMUM	.001	.0006	.002	.002	.053	.005	.089
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1

TABLE 25 (Continued)

1979 BNL ENVIRONMENTAL MONITORING WASTE MANAGEMENT AREA WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
WB	MEAN	.001	.0005	.002	.005	.123	.006	.534
	MINIMUM	.001	.0002	.002	.002	.039	.005	.383
	MAXIMUM	.001	.0006	.002	.010	.258	.006	.791
	EXCEPTION	3	3	3	0	0	1	0
	NUMBER	3	3	3	3	3	3	3
WC	MEAN	.001		.002	.006	.546	.002	.481
	MINIMUM	.001		.002	.006	.546	.002	.481
	MAXIMUM	.001		.002	.006	.546	.002	.481
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	0	1	1	1	1	1
WD	MEAN	.001	.0005	.002	.008	.156	.013	.897
	MINIMUM	.001	.0003	.001	.007	.068	.011	.794
	MAXIMUM	.001	.0006	.002	.009	.260	.016	1.100
	EXCEPTION	3	2	3	0	0	0	0
	NUMBER	3	3	3	3	3	3	3
WE	MEAN	.001	.0002	.002	.003	.068	.002	.407
	MINIMUM	.001	.0002	.002	.003	.068	.002	.407
	MAXIMUM	.001	.0002	.002	.003	.068	.002	.407
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WJ	MEAN	.001	.0002	.002	.004	.759	.011	.511
	MINIMUM	.001	.0002	.002	.004	.759	.011	.511
	MAXIMUM	.001	.0002	.002	.004	.759	.011	.511
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WK	MEAN	.001	.0004	.002	.004	.080	.003	.656
	MINIMUM	.001	.0002	.001	.004	.047	.002	.430
	MAXIMUM	.001	.0006	.002	.005	.122	.005	.860
	EXCEPTION	3	3	3	0	0	2	0
	NUMBER	3	3	3	3	3	3	3
WL	MEAN	.001	.0004	.002	.021	.173	.003	.302
	MINIMUM	.001	.0002	.001	.003	.068	.002	.241
	MAXIMUM	.001	.0006	.002	.056	.342	.005	.375
	EXCEPTION	3	3	3	0	0	2	0
	NUMBER	3	3	3	3	3	3	3
WM	MEAN	.001	.0002	.002	.003	.372	.002	.159
	MINIMUM	.001	.0002	.002	.003	.372	.002	.159
	MAXIMUM	.001	.0002	.002	.003	.372	.002	.159
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WN	MEAN	.001	.0002	.002	.004	.569	.010	.113
	MINIMUM	.001	.0002	.002	.004	.569	.010	.113
	MAXIMUM	.001	.0002	.002	.004	.569	.010	.113
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WU	MEAN	.001	.0064	.002	.005	.471	.002	2.210
	MINIMUM	.001	.0064	.002	.005	.471	.002	2.210
	MAXIMUM	.001	.0064	.002	.005	.471	.002	2.210
	EXCEPTION	1	0	0	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WV	MEAN	.001	.0006	.002	.006	.205	.005	2.100
	MINIMUM	.001	.0006	.002	.006	.205	.005	2.100
	MAXIMUM	.001	.0006	.002	.006	.205	.005	2.100
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WW	MEAN	.001	.0004	.002	.004	.049	.008	1.050
	MINIMUM	.001	.0004	.002	.004	.049	.008	1.050
	MAXIMUM	.001	.0004	.002	.004	.049	.008	1.050
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WX	MEAN	.001	.0002	.002	.004	.159	.007	1.730
	MINIMUM	.001	.0002	.002	.004	.159	.007	1.730
	MAXIMUM	.001	.0002	.002	.004	.159	.007	1.730
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WZ	MEAN	.001	.0039	.002		4.450	.142	2.820
	MINIMUM	.001	.0039	.002		4.450	.142	2.820
	MAXIMUM	.001	.0039	.002		4.450	.142	2.820
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	0	1	1	1
WI	MEAN	.001	.0004	.002	.012	.134	.003	.440
	MINIMUM	.001	.0002	.001	.003	.078	.002	.360
	MAXIMUM	.001	.0006	.002	.038	.190	.005	.520
	EXCEPTION	3	3	2	0	0	1	0
	NUMBER	3	3	3	4	2	3	3

TABLE 25 (Continued)

1979 BNL ENVIRONMENTAL MONITORING FORMER DUMP AREA WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
W3	MEAN	.001	.0006	.002	.002	.016	.005	.451
	MINIMUM	.001	.0006	.002	.002	.016	.005	.451
	MAXIMUM	.001	.0006	.002	.002	.016	.005	.451
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
W4	MEAN	.001	.0002	.002	.001	.182	.002	1.220
	MINIMUM	.001	.0002	.002	.001	.182	.002	1.220
	MAXIMUM	.001	.0002	.002	.001	.182	.002	1.220
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
W5	MEAN	.001	.0002	.002	.003	.015	.002	1.080
	MINIMUM	.001	.0002	.002	.003	.015	.002	1.080
	MAXIMUM	.001	.0002	.002	.003	.015	.002-	1.080
	EXCEPTION	1	1	1	0	1	1	0
	NUMBER	1	1	1	1	1	1	1
W7	MEAN	.001	.0006	.002	.002	.065	.009	.462
	MINIMUM	.001	.0006	.002	.002	.065	.009	.462
	MAXIMUM	.001	.0006	.002	.002	.065	.009	.462
	EXCEPTION	1	1	1	1	0	0	0
	NUMBER	1	1	1	1	1	1	1
W8	MEAN	.001	.0002	.002	.003	.137	.015	1.070
	MINIMUM	.001	.0002	.002	.003	.137	.015	1.070
	MAXIMUM	.001	.0002	.002	.003	.137	.015	1.070
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
18	MEAN	.001	.0002	.002	.003	.349	.025	.975
	MINIMUM	.001	.0002	.002	.003	.349	.025	.975
	MAXIMUM	.001	.0002	.002	.003	.349	.025	.975
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
19	MEAN	.001	.0002	.002	.004	.144	.059	.029
	MINIMUM	.001	.0002	.002	.004	.144	.059	.029
	MAXIMUM	.001	.0002	.002	.004	.144	.059	.029
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
WO	MEAN	.001	.0011	.002	.088	3.200	.005	.019
	MINIMUM	.001	.0011	.002	.088	3.200	.005	.019
	MAXIMUM	.001	.0011	.002	.088	3.200	.005	.019
	EXCEPTION	1	0	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WP	MEAN	.001	.0012	.002	.008	2.450	.005	.007
	MINIMUM	.001	.0012	.002	.008	2.450	.005	.007
	MAXIMUM	.001	.0012	.002	.008	2.450	.005	.007
	EXCEPTION	1	0	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
WQ	MEAN	.001	.0006	.007	.003	1.220	.005	.003
	MINIMUM	.001	.0006	.007	.003	1.220	.005	.003
	MAXIMUM	.001	.0006	.007	.003	1.220	.005	.003
	EXCEPTION	1	1	0	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
1I	MEAN	.001	.0026	.002	.007	2.010	.005	038
	MINIMUM	.001	.0026	.002	.007	2.010	.005	.038
	MAXIMUM	.001	.0026	.002	.007	2.010	.005	.038
	EXCEPTION	1	0	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1
1J	MEAN	.001	.0006	.002	.003	1.790	.005	.008
	MINIMUM	.001	.0006	.002	.003	1.790	.005	.008
	MAXIMUM	.001	.0006	.002	.003	1.790	.005	.008
	EXCEPTION	1	1	1	0	0	1	0
	NUMBER	1	1	1	1	1	1	1

TABLE 25 (Continued)

1979 BNL ENVIRONMENTAL MONITORING BUILDING 650 SUMP AREA WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
1A	MEAN	.001	.0002	.002	.003	.250	.006	.845
	MINIMUM	.001	.0002	.002	.003	.250	.006	.845
	MAXIMUM	.001	.0002	.002	.003	.250	.006	.845
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
1C	MEAN	.001	.0002	.002	.004	.481	.033	.953
	MINIMUM	.001	.0002	.002	.004	.481	.033	.953
	MAXIMUM	.001	.0002	.002	.004	.481	.033	.953
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
1D	MEAN	.001	.0002	.002	.004	.068	.009	.858
	MINIMUM	.001	.0002	.002	.004	.068	.009	.858
	MAXIMUM	.001	.0002	.002	.004	.068	.009	.858
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
1E	MEAN	.001	.0008	.002	.011	.263	.035	2.900
	MINIMUM	.001	.0008	.002	.011	.263	.035	2.900
	MAXIMUM	.001	.0008	.002	.011	.263	.035	2.900
	EXCEPTION	1	0	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1
1H	MEAN	.001	.0002	.002	.076	.263	.036	3.160
	MINIMUM	.001	.0002	.002	.076	.263	.036	3.160
	MAXIMUM	.001	.0002	.002	.076	.263	.036	3.160
	EXCEPTION	1	1	1	0	0	0	0
	NUMBER	1	1	1	1	1	1	1

Reference Standards - Table 29

Number: samples analyzed per year
Exception: sample concentration
<MDL

TABLE 26

1979 BNL ENVIRONMENTAL MONITORING POTABLE SUPPLY WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
FB	MEAN	.001	.0004	.002	.018	2.463	.004	.007
	MINIMUM	.001	.0002	.002	.015	1.340	.002	.005
	MAXIMUM	.001	.0006	.002	.023	5.630	.005	.012
	EXCEPTION	4	4	3	0	0	4	0
	NUMBER	4	4	4	4	4	4	4
FD	MEAN	.001	.0011	.002	.015	2.913	.004	.004
	MINIMUM	.001	.0002	.002	.003	.533	.002	.001
	MAXIMUM	.001	.0030	.003	.036	5.000	.005	.007
	EXCEPTION	4	4	3	0	0	4	1
	NUMBER	4	4	4	4	4	4	4
FE	MEAN	.001	.0004	.002	.006	.419	.003	.100
	MINIMUM	.001	.0002	.001	.002	.129	.002	.069
	MAXIMUM	.001	.0006	.002	.011	.812	.005	.133
	EXCEPTION	4	4	4	0	0	4	0
	NUMBER	4	4	4	4	4	4	4
FF	MEAN	.001	.0011	.002	.006	5.140	.005	.002
	MINIMUM	.001	.0002	.002	.002	3.830	.002	.001
	MAXIMUM	.001	.0030	.002	.015	6.910	.010	.005
	EXCEPTION	3	3	3	0	0	3	2
	NUMBER	4	4	4	4	4	4	4
FG	MEAN	.001	.0004	.008	.004	1.823	.003	.008
	MINIMUM	.001	.0002	.002	.003	1.730	.002	.007
	MAXIMUM	.001	.0006	.021	.006	2.000	.005	.010
	EXCEPTION	3	3	2	0	0	3	0
	NUMBER	3	3	3	3	3	3	3

1979 BNL ENVIRONMENTAL MONITORING COOLING WATER WELLS
WATER QUALITY AND PURITY-METALS

		METALS (IN PPM)						
		AG	CD	CR	CU	FE	PB	ZN
FH	MEAN	.001	.0006	.002	.003	1.340	.005	.009
	MINIMUM	.001	.0006	.002	.002	1.340	.005	.008
	MAXIMUM	.001	.0006	.002	.004	1.340	.005	.009
	EXCEPTION	2	2	2	0	0	2	0
	NUMBER	2	2	2	2	2	2	2
FI	MEAN	.001	.0005	.002	.010	4.600	.004	.048
	MINIMUM	.001	.0002	.002	.006	3.040	.002	.009
	MAXIMUM	.001	.0006	.002	.014	6.830	.005	.115
	EXCEPTION	3	3	3	0	0	3	0
	NUMBER	3	3	3	3	3	3	3
FJ	MEAN	.001	.0005	.002	.121	5.617	.004	.044
	MINIMUM	.001	.0002	.002	.009	5.160	.003	.018
	MAXIMUM	.001	.0006	.002	.340	5.880	.005	.090
	EXCEPTION	3	3	3	0	0	2	0
	NUMBER	3	3	3	3	3	3	3
FL	MEAN	.001	.0005	.002	.027	.643	.004	.004
	MINIMUM	.001	.0003	.002	.021	.510	.002	.003
	MAXIMUM	.001	.0006	.002	.032	.750	.005	.007
	EXCEPTION	3	3	2	0	0	3	0
	NUMBER	3	3	3	3	3	3	3

Reference Standards - Table 29
Locations indicated on Fig. 8 & identified as:

Number: samples analyzed per year
Exception: sample concentration <MDL

Potable	Cooling
FA: 1	FH: 101
FB: 2	FI: 102
FC: 3	FJ: 103
FD: 4	FK: 104
FE: 5	FL: 105
FF: 6	
FG: 7	

elements in the ground water system by means of the Laboratory surveillance wells downstream in the direction of the ground water flow, has indicated significant decreases as we proceed away from the Laboratory, such as 60% along the Peconic River, 25 to 30% in the waste management area and 50% in the 650 sump area. Investigations into the Laboratory wide use of zinc-containing chemicals focused our attention on a compound used as a cleaning agent for cooling towers in the past. A recent Laboratory analysis of this compound indicated a concentration of zinc to be about 3 mg/ml. It was gathered from discussions with Plant Engineering that the washings were discharged into the sewage system. It seems possible that this input may be retained in the sand filter beds and leached into the ground water system, thereby contributing to the increases noted. The Industrial Hygiene Group of the Safety and Environmental Protection Division has instituted a program whereby purchases of chemical compounds that have the potential of polluting the river water are flagged and the user is notified of the proper disposal method. This program has helped the Safety and Environmental Protection Division to identify and advise the users on a score of such compounds since 1978. In addition, a Laboratory wide notification program has been put into effect whereby permission is required from Safety and Environmental Protection Division before any chemical that is defined as toxic is discharged into the sanitary system.

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. Zn and Fe are considered as nuisance elements and not as a health hazard.

A depiction of the general direction and rate of ground water movement, originally published in the U.S. Geological Survey Study, is shown in Figure 11. The Upland Recharge Project (26) has determined a ground water velocity of 13.4 cm d^{-1} which is in good agreement with the U.S. Geological Survey Study estimate of 16.2 cm d^{-1} (7). 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. The data from all the surveillance wells are reviewed at frequent intervals in order to evaluate the monitoring program and appropriate action is taken, such as, rescheduling the sampling of wells and follow up analysis if required.

3.4 Unusual Occurrences:

3.4.1 Oil Spills

During 1979, the Laboratory experienced six oil spills. They occurred at research facilities and at the steam plant. At the research facilities, the spills were restricted to scintillating fluids, whereas at the steam plant it was mainly #6 oil mixed with ALF. Reporting and clean-up procedures were instituted immediately. The absorbents used to clean up the spills were disposed of according to New York State Department of Environmental Conservation (NYSDEC) approved procedures. Appropriate action pertaining to revegetation is in progress. Followup on the two oil spills that occurred in 1977 has indicated that the actions taken by Plant Engineering (PE) in fertilizing the region and tilling the soil has aided in the biodegradation of the oil. In addition, grass

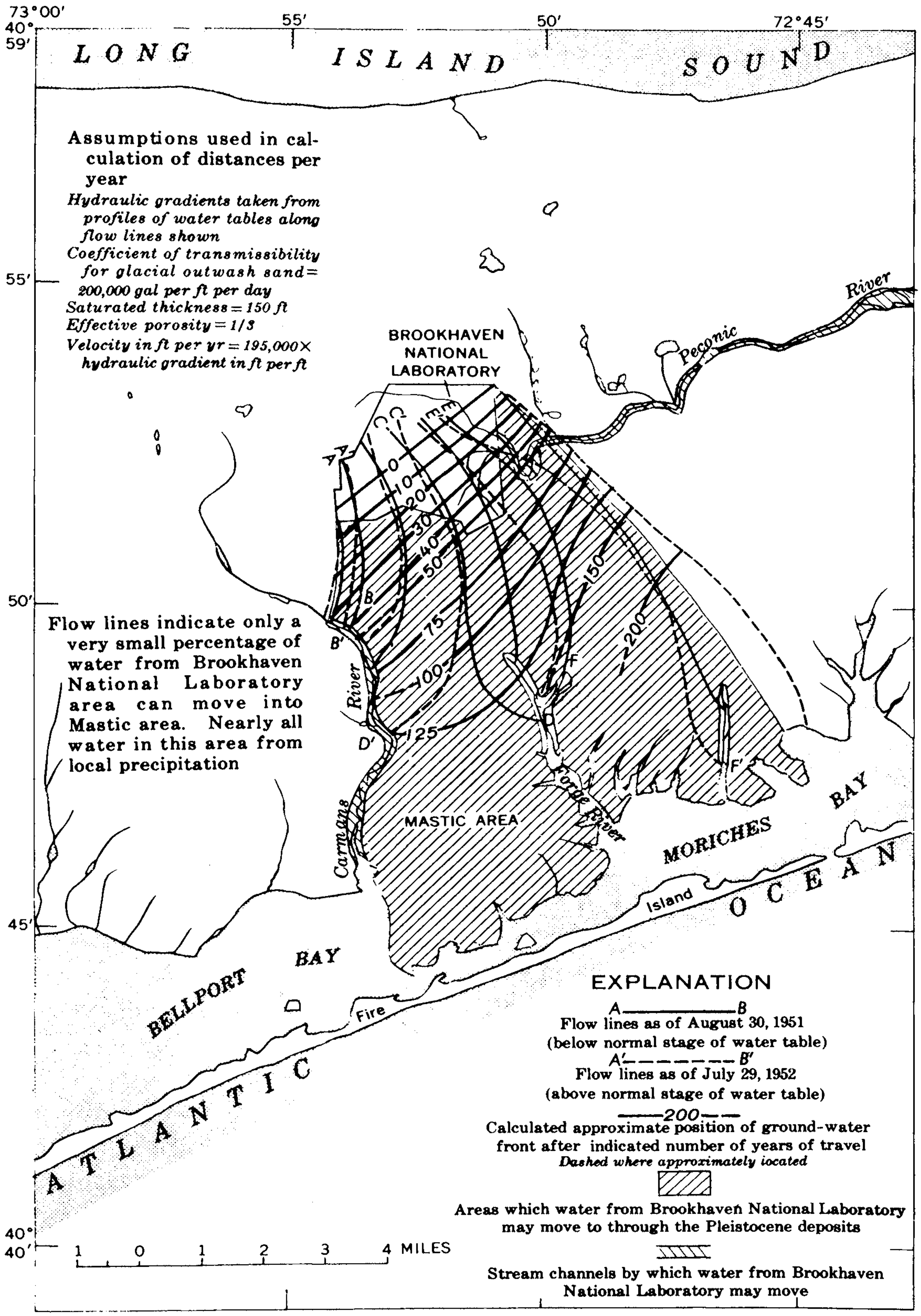


Figure 11. Direction and Time of Travel of Ground Water Laterally in Upper Pleistocene Deposits from the Brookhaven National Laboratory Area to Points of Discharge

seeding has almost returned the surface to normal conditions. Those wells adjoining the steam plant near the recent spills have given no indication that any oil or its compounds have broken through the retaining clay barrier. Monitoring will be continued on a regular basis in order to detect movement of oil, if any, in the ground water system.

3.4.2 Chinese Nuclear Tests

No atmospheric nuclear tests were detonated by the Chinese during 1979. As indicated in Section 3, slight increases in gross beta activity were noted in air samples and precipitation and a very slight increase over the MDL was detected for ^{140}Ba-La in precipitation. Fallout radionuclide concentrations were at or below MDL in milk and grass samples collected from dairy farms in the vicinity of the site. Unlike the previous years, 1976 in particular, the 1979 values may be considered as insignificant in terms of a health hazard.

4.0 OFF SITE DOSE ESTIMATES

Increased levels of radiation and concentrations of radioactivity, in air and water, above ambient background, with resulting increased doses to people, are attributable to the following four Laboratory sources:

1. airborne radioactive effluents, primarily tritium,
2. radioactive liquid effluents,
3. the ^{137}Cs source in the Biology Department Ecology Forest,
4. skyshine from the Alternating Gradient Synchrotron (AGS).

These are discussed below, and the collective dose equivalent rate due to Laboratory operations during 1979 is calculated.

4.1 Annual Average Collective Dose Equivalent Rate Due to Airborne Effluents

As indicated in Table 4, a total of 225 Ci (8.4×10^{12} Bq) of tritium was released from various Laboratory facilities during 1979, making it the largest source of dose equivalent relative to other laboratory released radionuclides, to persons off-site. In using this figure to estimate dose equivalent, it was conservatively assumed that all the tritium released was in the form of tritiated water vapor at the site boundary.

Air activity concentrations of tritium vapor at the site boundary were so low that measurement was difficult. Data given in Table 8 indicate an average concentration (including background) of 6.5 pCi m^{-3} (0.24 Bq m^{-3}) at the site boundary ($\sim$2500 meters from the HFBR stack). Continuous exposure at the Radiation Concentration Guide (2×10^5 pCi m^{-3} or 7.4×10^3 Bq m^{-3}) would result in a per caput annual average dose equivalent rate of 500 mRem a^{-1} (5×10^{-3} Sv person^{-1} a^{-1}). Thus, the per caput annual average dose equivalent rate at this distance attributable to Laboratory air effluent tritium vapor was $(6.5 \times 500)/(2 \times 10^5)$ or 0.02 mRem a^{-1} (0.2×10^{-6} Sv person^{-1} a^{-1}) or 0.005 of the Radiation Protection Standard [17]. Since the individual external background per caput dose equivalent rate (Table 2) in this area was about 57.7 mRem a^{-1} (5.77 x 10^{-4} Sv $person^{-1}$ a^{-1}), the tritium contribution amounts to an increase at the site boundary of about 0.1%, which is within the temporal and spatial variations of the background itself.

As was previously stated, the dose equivalents due to ^{41}Ar, ^{15}O and ^{127}Xe were considered insignificant and as such were not included in the final estimates.

Routine analyses for air particulate radioactivity and for radiohalogens were made throughout 1979 on air samples collected at several locations. Table 27 gives the doses to the general public due to BNL tritium releases. It indicates that beyond the site boundary, the dose rates due to tritium in air effluents from the Laboratory were very small, compared with background and variations in background. The parameter 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 97.5 m release height of the HFBR stack and are averages for a whole year and for all the 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 X/Q values in the direction of major population centers to the west of the Laboratory are lower than the 360° averages. Values of the dose rate due to tritium are derived by multiplying the measured values for the 1.6 to 3.2 km interval (0.019 mRem a^{-1}) by the appropriate ratios of X/Q. The collective average dose equivalent rate (total population dose rate) due to the Laboratory tritium effluent was 4.95 rem a^{-1}, and that due to natural background (57.7 mRem a^{-1}) is estimated to be 278,405 rem a^{-1}.

4.2 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. However, the upper portions of the river are utilized for occasional recreational fishing.

Based on observations, discussions with the New York State Department of Environmental Conservation, and the productivity of the Peconic River, an annual total catch of 500 kg of fish is reasonable. If one assumes that 100 fishermen (who are being treated as maximum individuals) catch the above amount of fish and that their families consume all the fish caught and, furthermore, the breakdown of adults and children (based on an average family of 2 adults and 2 children) to be 354 adults and children above 12 years and 56 infants [3,4], then the annual consumption of fish by the adult group is 1.36 kg/yr and infants is 0.46 kg/yr (as opposed to the USNRC Regulatory Guide [24] value of 21 kg/yr and 6.9 kg/yr), respectively. Using the above more realistic value for consumption of fish, the other assumptions recommended in the NRC Regulatory Guide 1.109 [24] and the maximum observed concentration of ^{90}Sr and ^{137}Cs in fish

Table 27

1979 BNL Environmental Monitoring Collective Annual Average Dose Equivalent Rate Due to BNL Airborne Effluents in Comparison with Background

Distance from HFBR Stack (km)	X/Q[27]	Population[a]	HTO Per Caput Dose Equivalent Rate mRem $Person^{-1}a^{-1}$	HTO Collective Average Dose Equivalent Rate rem a^{-1}	Background Collective Average Dose Equivalent Rate rem a^{-1}
1.6- 3.2	2.4×10^{-7}	1,597	0.019	0.03	93
3.2- 4.8	1.0×10^{-7}	5,540	0.008	0.04	321
4.8- 6.4	6.0×10^{-8}	11,592	0.005	0.06	672
6.4- 8.0	3.9×10^{-8}	20,218	0.003	0.06	1,172
8.0-16.1	1.7×10^{-8}	228,445	0.001	0.23	13,249
16.1-24.2	8.0×10^{-9}	243,809	0.001	0.24	14,140
24.2-32.2	5.5×10^{-9}	155,230	0.001	0.16	9.003
32.2-48.4	3.8×10^{-9}	999,352	0.001	1.00	57,962
48.4-64.5	2.7×10^{-9}	1,382,657	0.001	1.38	80,194
64.5-80.6	2.1×10^{-9}	1,751,706	0.001	1.75	101,599
1.6-80.6	-	4,800,146	-	4.95	278,405

[a]Population data estimated from information supplied by Ms. Peggy Wagner, Research Analyst, Long Island Regional Planning Board [3,4]. See Table 1 for estimated population distribution for 1979.

rem = 0.01 Sv

(Table 18), the estimated maximum individual dose equivalent rate is tabulated below.

Average Maximum Individual Dose Equivalent Rate (mRem a^{-1})

	^{90}Sr		^{137}Cs	
	Infant	Adult	Infant	Adult
Total Body	0.13	0.15	0.02	0.11
Bone	0.51	0.62	0.27	0.12

The collective average dose equivalent rate (total dose) from this indirect pathway, for the above population, can be estimated to be 0.35 rem a^{-1} (1.00 mRem x 354 persons) for adults and 0.05 rem a^{-1} (0.93 mRem x 56 persons) for infants.

Although not directly relatable to the Laboratory liquid effluents during 1979, a ^{90}Sr concentration of 2 pCi l^{-1} (0.73 x 10^{-1} Bq l^{-1}) was found in an off-site surveillance well (XS) about 0.35 km east of the Laboratory site boundary along the Peconic River. This level corresponds to 25% of the EPA Drinking Water Standard [18]. If we assume that during 1979 all the 25 people [3,4] living in the vicinity of this well obtained their drinking water from shallow water supply wells containing ^{90}Sr in a concentration equal to that of the surveillance well then the collective average dose equivalent rate (total dose commitment) will not exceed 0.02 rem a^{-1} (since 8 pCi/l corresponds to 4 mRem). Their collective average dose equivalent rate (total dose) from natural background (including internal radiation) would have been about 2.25 rem a^{-1} (person-rem) during 1979.

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

A 5883 Ci* ^{137}Cs source is located in the northeast part of the Laboratory site, 1010 meters from the north boundary. The dose rate at this boundary during 1979, as determined by the Laboratory Environmental Monitoring Group, was 1.43 mRem a^{-1} (1.43x10^{-5} Sv), or 0.4% of the Radiation Protection Standard.

Population doses beyond the site boundary due to this source have been computed using an estimated 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 28.

Since the dose rate from this source decreases very rapidly with distance, only population segments located within 5 km from the source were considered. The off-site collective average dose equivalent (total dose) is 0.05 rem a^{-1} (person-rem a^{-1}), and appreciable contributions are found only in the NNE and NE sectors.

*As of 1/1/79

TABLE 28

1979 BNL Environmental Monitoring Off-Site Collective Annual Average Dose Equivalent Rate Due to External Radiation Exposure Resulting from the Gamma Forest and AGS Operations

Sector	(km)	Population[a]	Gamma Forest Distance (km)	Gamma Forest Dose Rate (mR a^{-1})	Gamma Forest Person-Rem	AGS Distance (km)	AGS Dose Rate (mR a^{-1})	AGS Person-Rem
SSW	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	263	>4.8	$<10^{-13}$	$<10^{-14}$	4.4	1.73×10^{-4}	4.55×10^{-5}
SW	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	98	>4.8	$<10^{-13}$	$<10^{-14}$	4.3	2.16×10^{-4}	2.12×10^{-5}
WSW	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	342	>4.8	$<10^{-13}$	$<10^{-14}$	4.0	4.00×10^{-4}	1.37×10^{-4}
W	1.6-3.2	278	4.4	1.2×10^{-12}	3.3×10^{-13}	2.5	1.30×10^{-2}	3.61×10^{-3}
	3.2-4.8	866	>4.8	$<10^{-13}$	$<10^{-14}$	3.9	5.62×10^{-4}	4.87×10^{-4}
WNW	1.6-3.2	268	4.2	0.9×10^{-11}	2.4×10^{-12}	2.1	3.03×10^{-2}	8.12×10^{-3}
	3.2-4.8	680	>4.8	$<10^{-13}$	$<10^{-14}$	3.6	8.43×10^{-4}	5.73×10^{-4}
NW	1.6-3.2	204	3.4	6.0×10^{-12}	1.2×10^{-12}	2.0	5.08×10^{-2}	1.04×10^{-2}
	3.2-4.8	243	>4.8	$<10^{-13}$	$<10^{-14}$	3.5	1.30×10^{-3}	3.16×10^{-4}
NNW	1.6-3.2	168	2.8	6.0×10^{-7}	1.0×10^{-7}	2.0	5.08×10^{-2}	8.53×10^{-3}
	3.2-4.8	78	>4.8	$<10^{-13}$	$<10^{-14}$	3.5	1.30×10^{-3}	1.01×10^{-4}
N	1.6-3.2	216	2.1	1.2×10^{-9}	2.6×10^{-10}	2.3	1.95×10^{-2}	4.21×10^{-3}
	3.2-4.8	0	-	-	-	-	-	-
NNE	1.6-3.2	219	1.4	2.0×10^{-2}	4.4×10^{-3}	2.5	1.30×10^{-2}	2.85×10^{-3}
	3.2-4.8	385	2.4	1.2×10^{-5}	4.6×10^{-6}	3.6	8.43×10^{-4}	3.25×10^{-4}
NE	1.6-3.2	132	1.2	3.5×10^{-1}	4.6×10^{-2}	2.9	5.30×10^{-3}	7.00×10^{-4}
	3.2-4.8	197	2.0	2.3×10^{-4}	4.5×10^{-5}	3.5	8.43×10^{-4}	1.66×10^{-4}
ENE	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	0	-	-	-	-	-	-
E	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	351	2.8	6.0×10^{-7}	2.1×10^{-7}	4.0	3.89×10^{-4}	1.37×10^{-4}
ESE	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	335	3.5	0.9×10^{-9}	3.0×10^{-10}	4.4	1.95×10^{-4}	6.53×10^{-5}
SE	1.6-3.2	0	-	-	-	-	-	-
	3.2-4.8	66	2.9	7.5×10^{-11}	5.0×10^{-12}	3.1	1.06×10^{-4}	7.00×10^{-6}
SSE	1.6-3.2	62	4.0	6.0×10^{-11}	3.7×10^{-12}	3.4	1.51×10^{-3}	9.36×10^{-5}
	3.2-4.8	709	>4.8	$<10^{-13}$	$<10^{-14}$	4.5	1.30×10^{-4}	9.22×10^{-5}
S	1.6-3.2	50	4.4	1.2×10^{-12}	6.0×10^{-14}	3.3	1.95×10^{-3}	9.75×10^{-5}
	3.2-4.8	927	>4.8	$<10^{-13}$	$<10^{-14}$	4.5	1.30×10^{-4}	1.21×10^{-4}
Total					0.05			0.041

[a]Population data estimated from information supplied by Ms. Peggy Wagner, Research Analyst, Long Island Regional Planning Board [3,4]. See Table 1 for estimated population distribution for 1979.

4.4 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 penetrate the shield or escape 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.

With the advent of the Isabelle project in 1978, the Safety and Environmental Protection Division has instituted an extensive program to evaluate different neutron detectors in the field and also to determine appropriate sampling locations. These studies should provide data on neutron dose distribution around AGS and Isabelle (when operational) and thus provide a basis for more accurate estimates of off-site doses. Preliminary results, derived by using a neutron monitor (Ludlum 55) at P2 (Figure 2), indicate an annual dose of 6.1 mRem resulting from neutrons other than those generated by the AGS facility. This dose rate has been observed to be similar to levels at other accelerator facilities (28). During 1978 and 1979, the study has been experimental in nature and as such it was felt that the neutron skyshine data for 1979 would not permit a proper evaluation of the doses off-site resulting from AGS operations. Accordingly, it was decided to estimate the dose rate at the site boundary by comparing the total proton flux for 1977 to that for 1978 and 1979 and use this ratio to derive the 1978 and 1979 dose rates from the 1977 values (Table 31 - 1977 E.M. Report). As such, Table 28 gives the derived dose rate (mRem a^{-1}) and the collective average dose equivalent (average doses) rates for each population segment and for each distance from the source.

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 off-site derived collective average dose equivalent (total dose) was 0.04 rem a^{-1} (person-rem a^{-1}) and applicable contributions were found only in the NW and NNW sectors.

4.5 Collective Average Dose Equivalent Rate (Total Population Dose)

The collective average dose equivalent rate (total population dose) beyond the site boundary, within a radius of 80 km, due to Laboratory operations during 1979 is the sum of the values due to the four components discussed above, as shown below:

Pathway		rem a^{-1} (person-rem a^{-1})
Airborne		
Tritium		4.95
Liquid Effluents		
Consuming fish:	Adults	0.35
	Infants	0.05
Well water		0.02
Gamma Forest Source		0.05
AGS Skyshine		0.04
Total		5.46

The collective average dose equivalent (total annual dose) due to external radiation from natural background, to the population within a 80 km radius of the Laboratory, amounts to about 278,405 rem a^{-1}, to which about 85,704 rem a^{-1} (person-rem a^{-1}), should be added for internal radioactivity from natural sources.

TABLE 29

Maximum Permissible Levels of Contaminants in Air and Water With Their Detection Limits

Contaminant Radionuclide		DOE 0524[17] Air	DOE 0524[17] Water	EPA-Drinking Water[18] and NYS Drinking Water Standard[25][a]	NYS Standard[13] Air	NYS Standard[13] Water	Detection Limit[b] Air	Detection Limit[b] Water
Gross α μCi/ml		1×10^{-13}	6×10^{-7}	1.5×10^{-8}	1×10^{-13}	6×10^{-7}	3×10^{-16}	3×10^{-10}
Gross β μCi/ml		1×10^{-10}	1×10^{-7}	1×10^{-7}	1×10^{-10}	1×10^{-7}	1×10^{-15}	1×10^{-9}
^{7}Be μCi/ml	S I	2×10^{-7} 4×10^{-8}	2×10^{-3} 2×10^{-3}	2×10^{-3} 2×10^{-3}	4×10^{-8}	2×10^{-3}	1×10^{-12}	5×10^{-10}
^{3}H μCi/ml		2×10^{-7}	3×10^{-3}	2×10^{-5}	2×10^{-7}	3×10^{-3}	2×10^{-12}[c]	2×10^{-11}
^{60}Co μCi/ml	S I	1×10^{-8} 3×10^{-10}	5×10^{-5} 3×10^{-5}	5×10^{-5} 3×10^{-5}	3×10^{-10}	3×10^{-5}	1×10^{-14}	5×10^{-10}
^{131}I μCi/ml	S I	1×10^{-10} 1×10^{-8}	3×10^{-7} 6×10^{-5}	3×10^{-7} 6×10^{-5}	1×10^{-8}	6×10^{-5}	1×10^{-14}	2×10^{-10}
^{137}Cs μCi/ml	S I	2×10^{-9} 5×10^{-10}	2×10^{-5} 4×10^{-5}	2×10^{-5} 4×10^{-5}	2×10^{-9}	2×10^{-5}	1×10^{-14}	3×10^{-10}
^{54}Mn μCi/ml	S I	1×10^{-8} 1×10^{-9}	1×10^{-4} 1×10^{-4}	1×10^{-4} 1×10^{-4}	1×10^{-8}	1×10^{-6}	1×10^{-14}	3×10^{-10}
^{90}Sr μCi/ml	S I	3×10^{-11} 2×10^{-10}	3×10^{-7} 4×10^{-5}	8×10^{-9}	3×10^{-11}	3×10^{-7}	1×10^{-15}	9×10^{-14}
<u>Non-Radioactive</u>								
Temp °C				$T_{max} < 30$ $\Delta T \leq \pm 2.8$				
pH				6.5-8.5				
Dissolved Oxygen ppm				>4.0				0.2
Chlorides ppm				250		500		0.1
Nitrogen-Nitrate ppm				10		20		.05
Dissolved Solids ppm				500		1000		20.00
Coliform				Zero#/100ml		4#/100ml		0.00
Ag ppm				0.05		0.1		0.001
Cd				0.01		0.2		0.004
Cr				0.05		0.1		0.001
Cu				-		0.2		0.001
Fe				-		0.6		0.02
Hg				0.002		-		0.00007
Pb				0.05		0.1		0.005
Zn				-		0.3		0.002

[a] Aquifer under Long Island declared as "Sole Source" - Applicable Standard is EPA National Interim Primary Drinking Water Regulations [18].

[b] See Appendix B.

[c] As tritiated vapor

S: Soluble
I: Insoluble

APPENDIX A

QUALITY CONTROL

Radioactive Measurements

a. Alpha (α), Beta (β) and Gamma (γ):

Certified radioactive standards from the National Bureau of Standards, U.S. Department of Commerce, are used to standardize radiation measurement instruments. These standards are certified to be at least within 5% of stated values. In some cases, certified standards were also obtained from Amersham/Searle. Daily checks of instrument performances are made using the standards as well as backgrounds. In addition, some samples are counted both in the NaI system and the Ge(Li) system. The Ge(Li) system were calibrated using a new multi-gamma NBS Standard obtained in October 1977. The results from the NaI and Ge(Li) systems agree within 5%. For tritium measurements a number of standards and blanks are included with each run of a liquid scintillator counter which has a programmed automatic sample changer.

The Analytical Laboratory of the Safety and Environmental Protection Division is a participant in the inter-laboratory comparisons of radioactivity in samples of different matrices of water, air filters, soil, vegetation and bone. These samples are distributed by the Department of Energy (DOE) through the Environmental Measurements Laboratory (EML), New York, formerly known as the Health and Safety Laboratory (HASL), on a quarterly basis. The radionucludes assayed were ^{3}H, ^{90}Sr, plutonium isotopes (following wet chemistry) and a number of gamma emitting nuclides. Our results agree within 10% for water samples and within 15% for other sample matrices.

b. TLD Dosimeters

The Dosimetry Services Group of the Safety and Environmental Protection Division participated in the Fourth International Intercomparison of Environmental Dosimeters conducted at Houston, Texas during the late winter and early spring of 1979. There were a total of 122 participants in this test.

The estimated field exposure, as measured by the BNL environmental monitoring TLD dosimeter, agreed within 0.8% of the value measured by a continuously operated recording pressurized ion chamber corrected for energy response. In the laboratory exposure test, the BNL dosimeter agreed within 3.5% for the "high" (∼ 50 mR exposure) and agreed within 6.4% for the "low" (∼ 15 mR exposure).

Nonradioactive Measurements

Procedures for nonradioactive contaminants are those presented in Standard Methods for the Examination of Water and Wastewater (14th edition, 1975). 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 and at least one duplicate and blank is run with each set.

APPENDIX B

Minimum Detectable Limit (MDL)

Some of the values in gamma scans by the NaI detector are not indicated in the tables as these values were at or below MDL. The MDL values are a function of Matrix (efficiency), Count Time (background), etc. Typical tables for NaI and Ge(Li) systems are given below:

Units: 10^{-6} μCi
Detector: Two 4" NaI crystals
Geometry: Planchet and air particulates

Count Time (sec)	^{7}Be	^{144}Ce	^{57}Co	^{58}Co	^{60}Co
4,000	65.7	20.0	4.1	11.5	17.8
8,000	46.2	20.4	2.9	8.1	12.5
40,000	20.5	9.1	1.3	3.6	5.5
60,000	16.7	7.4	1.6	2.9	4.5

Count Time (sec)	^{134}Cs	^{137}Cs	^{59}Fe	^{131}I
4,000	15.9	7.1	3.9	6.0
8,000	11.2	5.0	2.7	4.2
40,000	5.0	2.2	1.2	1.9
60,000	4.0	1.8	1.0	1.5

Count Time (sec)	^{54}Mn	^{22}Na	^{125}Sb	^{65}Zn
4,000	7.0	22.3	30.7	15.9
8,000	4.9	15.6	21.6	11.2
40,000	2.2	6.9	9.2	4.9
60,000	1.8	5.6	7.8	4.0

Units: 10^{-6} μCi
Detector: 145 cc Ge(Li) Detector
Geometry: Filter paper

Count Time (sec)	^{7}Be	^{144}Ce	^{57}Co	^{58}Co	^{60}Co
4,000	18.5	8.2	2.0	4.6	6.2
50,000	7.5	4.1	0.5	1.0	2.0

Count Time (sec)	^{134}Cs	^{137}Cs	^{59}Fe	^{131}I
4,000	7.5	3.2	1.2	2.7
50,000	2.1	1.0	0.6	0.8

Count Time (sec)	^{54}Mn	^{22}Na	^{125}Sb	^{65}Zn
4,000	3.1	8.6	12.8	6.8
50,000	1.0	2.1	3.1	2.3

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