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Office of Environmental Audit

Environmental Survey
Preliminary Report

Brookhaven National Laboratory
Upton, New York

June 1988

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U.S. Department of Energy
Washington, DC 20585

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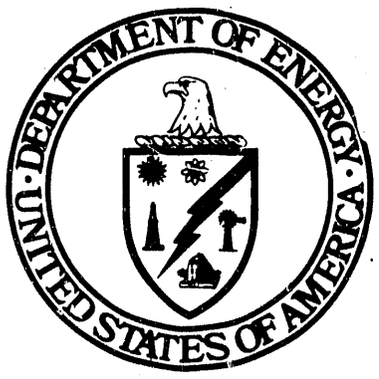

Environmental Survey
Preliminary Report

Brookhaven National Laboratory
Upton, New York

June 1988

PREFACE
TO
THE DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains the preliminary findings based on the first phase of an Environmental Survey at the Department of Energy (DOE) Brookhaven National Laboratory (BNL), located at Upton, New York. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The BNL Survey is a portion of the larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary of Energy, John S. Herrington, to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no-fault" baseline Survey of all the Department's major operating facilities, environmental problems and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1989.

The findings in this report are subject to modification based on the results from the Sampling and Analysis phase of the Survey. The findings are also subject to modification based on comments from the Chicago Operations Office concerning the technical accuracy of the findings. The modified preliminary findings and any other appropriate changes will be incorporated into an Interim Report. The Interim Report will serve as the site-specific source for environmental information generated by the Survey and, ultimately, as the primary source of information for the DOE-wide prioritization of environmental problems in the Survey Summary Report.

June 1988
Washington, D.C.

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EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings from the first phase of the Environmental Survey of the United States Department of Energy (DOE) Brookhaven National Laboratory (BNL) conducted April 6 through 17, 1987.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team components are being supplied by a private contractor. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with BNL. The Survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. This phase of the Survey involves the review of existing site environmental data, observations of the operations carried on at BNL, and interviews with site personnel.

The Survey team developed a Sampling and Analysis Plan to assist in further assessing specific environmental problems identified during its on-site activities. The Sampling and Analysis Plan will be executed by Oak Ridge National Laboratory. When completed, the results will be incorporated into the BNL Environmental Survey Interim Report. The Interim Report will reflect the final determinations of the BNL Survey.

Site Description

BNL is a multidisciplinary research facility located on 21.3 km^2 of Federally owned property in Suffolk County on Long Island, approximately 97 km, east of New York City. BNL has been operated by Associated Universities, Inc., since its inception in 1947. BNL conducts a variety of scientific research and development programs in the areas of high-energy, nuclear, and solid-state physics; fundamental material structure properties and interactions of matter; nuclear medicine; and the biological and chemical effects of radiation as well as chemical substances involved in the use and production of energy.

The Survey team met with representatives of local, state, and Federal regulatory agencies. These representatives expressed concern over a wide variety of actual and potential environmental problems. The majority of the issues involved past and present discharges of hazardous and

radioactive wastes to groundwater and surface water, the extent of on-site and off-site groundwater contamination, past and present land disposal practices, and the adequacy of the environmental monitoring program. All of the environmental concerns identified by the regulatory agencies are addressed in this report.

Summary of Findings

The major preliminary findings of the Environmental Survey of BNL are as follows:

- Off-site groundwater is contaminated with tritium and volatile organic compounds (VOCs). BNL is the source of the tritium contamination and may be the source of VOC contamination. Two residential wells are contaminated with tritium, and VOCs are at levels below drinking water standards.

- Groundwater in several areas on-site is contaminated with tritium, strontium, and VOCs; concentrations in some areas exceed either state and/or federal drinking water standards. Groundwater remediation (air stripping), to remove VOCs, is currently under way at one area of the site.

- The groundwater monitoring program has a number of deficiencies, making it difficult to characterize the nature and extent of groundwater contamination both on-site and off-site.

- There are numerous areas on-site that are actual and/or potential sources of soil, surface water, and groundwater contamination. The actual and/or potential sources include active and inactive disposal areas, cesspools, abandoned drums, and stained soils.

- There is a potential for mismanaging mixed wastes because BNL has not routinely characterized its radioactive wastes for hazardous properties.

Overall Conclusions

The Survey found no environmental problems at BNL that represent an immediate threat to human life. The preliminary findings identified at BNL by the Survey do indicate that the site has some potentially significant environmental problems, which are predominantly a result of past practices. The most pressing problem facing the site, at present, is contamination of the groundwater with radionuclides and volatile organic compounds. This problem is further exacerbated by the presence

of numerous actual and potential sources of groundwater contamination on-site as well as inadequacies in the groundwater monitoring program, both of which make it difficult to characterize the nature and extent of contamination. In addition, BNL overlies a designated sole-source aquifer (i.e., an aquifer that provides 50 percent or more of the drinking water for an area) that is extremely susceptible to contamination because of its proximity to the surface and the high permeability of the overlying strata.

The environmental problems described in this report vary in terms of their magnitude and risk. Although the Survey-related sampling and analysis to be performed at BNL will assist in further identifying environmental problems at the site, a complete understanding of the significance of some of the environmental problems identified requires a level of study and characterization that is beyond the scope of the Survey. Actions currently under way or planned at the site (particularly the groundwater investigation and site remediation activities) will contribute toward meeting this requirement.

Transmittal and Follow-up of Findings

The findings of the Environmental Survey of BNL were shared with the DOE Chicago Operations Office, the DOE Area Office, and the site contractor at the Survey closeout briefing held on April 17, 1987. The site contractor submitted an Implementation Plan to address the Survey preliminary findings to the Operations Office on September 15, 1987. A final action plan addressing all the Survey findings cited herein will be prepared by the Chicago Operations Office within 45 days of receiving this Preliminary Report. Those findings that involve extended studies and multiyear budget commitments will also be the subject of the Environmental Survey Summary Report and DOE-wide prioritization.

Within the Office of Environment, Safety and Health, the Office of Environmental Guidance and Compliance has immediate responsibility for monitoring environmental compliance and the status of BNL findings. The Office of Environmental Audit will continue to assess the environmental problems through a program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1989.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings of an Environmental Survey, conducted April 6 through 17, 1987, at the Department of Energy's (DOE's) Brookhaven National Laboratory (BNL), in Upton, New York. BNL is a multiprogram laboratory involved in research in high energy and nuclear physics, chemistry, biology, and energy-related life and environmental sciences. The BNL facility is owned by DOE and operated by Associated Universities, Incorporated, a consortium of nine sponsoring universities--Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Princeton, University of Pennsylvania, University of Rochester, and Yale. The major functions and mission of BNL, as well as the major BNL facilities used to accomplish the mission, are outlined in Section 2.2.

The BNL Survey is part of the DOE-wide Environmental Survey announced by Secretary John S. Herrington on September 18, 1985. The purpose of the overall effort is to identify, via "no fault" baseline Surveys, existing environmental problems and areas of environmental risk at DOE facilities and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and to allocate the resources necessary to correct these problems. Because the Survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The BNL Environmental Survey was conducted by an interdisciplinary team of technical specialists headed and managed by a Team Leader and Assistant Team Leader from DOE's Office of Environmental Audit. A complete list of Survey participants and their affiliations is provided in Appendix A.

The Survey team focused on all environmental media and used Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols in the DOE Environmental Survey Manual (DOE, 1987). Substantial use of existing information, plus interviews with knowledgeable field office and site-contractor personnel, accounted for a large part of the on-site effort. A summary of the site-specific Survey activities is presented in Appendix B.

The preliminary Survey findings are presented in Sections 3 and 4 in the form of existing and potential environmental problems. Section 3 includes those findings that pertain to a specific

environmental medium (e.g., air or soil), whereas Section 4 includes those that are non-media-specific (e.g., waste management, direct radiation, and quality assurance). Because the findings vary greatly in terms of magnitude, risk, and characterization and consequently require different levels of management attention and response, they are further divided into four categories within each of the sections in Sections 3 and 4.

The criteria for placing a finding into one or more of the four categories are as follows:

Category I includes only those findings which, based upon the information available to the Team Leader, involve an immediate threat to human life. Findings of this type shall be immediately conveyed to the responsible Environmental Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are those environmental problems wherein the potential risk is highest; the confidence in the finding, based on the information available, is the strongest, and the appropriate response to the finding, in terms of alternatives, is the most restrictive.

Category II findings encompass one or more of the following situations:

- Multiple or continuing exceedances (past or present) of a health-based environmental standard, where there is immediate potential for human population exposure, or a one-time exceedance, wherein residual impacts pose an immediate potential for human population exposure.

- Evidence that a health-based environmental standard may be exceeded, as discussed in the preceding situation, within the time frame of the DOE-wide Survey.

- Evidence that the likelihood is high for an unplanned release as the result, for example, of the condition or design of pollution abatement, monitoring equipment, or other management practices.

- Noncompliance with significant regulatory procedures (i.e., those substantive technical regulatory procedures designed to directly or indirectly minimize or prevent risks, such as inadequate monitoring or failure to obtain required permits).

Category II findings include those environmental problems where the risk is high, but the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to identify the problem, but may be insufficient to fully characterize it. Finally, in this category, more

discretion is available to the Operations Offices and Program Offices for an appropriate response. However, the need for that response is such that management should not wait for completion of the entire DOE-wide Survey to respond. Unlike Category I findings, a sufficient, near-term response by the Operations Office may include further problem characterization prior to any action taken to rectify the situation.

Category III findings encompass one or both of the following criteria:

- The existence of pollutants or hazardous materials in the air, water, groundwater, or soil, resulting from DOE operations that pose or may pose a hazard to human health or the environment.

- The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

Category III findings are those environmental problems for which the broadest definition of risk is used. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problem. Under this category, the range of alternatives available for response and the corresponding time frames for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases as well as multiyear budget commitments. These problems will be included in the DOE-wide prioritization effort to ensure that DOE's limited resources are used effectively.

In general, the levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, state, or local regulation for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the presence of some nonregulated material is in a concentration that presents a concern for local populations or the environment and, hence, warrants inclusion as an environmental problem. Likewise, the presence of regulated materials in concentrations below those established by regulatory authorities, but which present a potential for hazard or concern, may be classified as an environmental problem. In general, however, conditions that meet regulatory or other requirements (where such exist) would not present a potential hazard and would not be identified as an environmental problem.

Conditions that pose or may pose a hazard are generally those which are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazardous threat to human health and the environment and should be identified

as an environmental problem. Additionally, potentially hazardous conditions are those in which the likelihood of the occurrence of release is high.

The definition of the term "environmental problem" is broad and flexible to allow for the wide differences among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

Category IV findings include instances of administrative noncompliance and management practices that are indirectly related to environmental risk, but are not appropriate for inclusion in Categories I-III. Such findings can be based upon any level of information available to the Team Leader, including direct observation by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Operations Offices and Program Office for appropriate action.

Based on the professional judgment of the Team Leader, the findings within categories in each section are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report are only the first step in a multistep, iterative process to prioritize DOE's problems.

The next phase of the BNL Survey is Sampling and Analysis (S&A). Oak Ridge National Laboratory (ORNL), the S&A team for BNL collected samples over a 2-week period in April 1988. Prior to sampling, an S&A Plan was prepared by DOE and ORNL in accordance with the protocols in the DOE Environmental Survey Manual. The results generated by the S&A effort will be used to assist the Survey team in further defining the existence and extent of potential environmental problems identified during the Survey.

An Interim Report will be prepared 8 to 12 weeks after the completion of the S&A effort. The Interim Report will incorporate the results of the S&A effort as well as any changes or comments resulting from the review of the Preliminary Report. Based on the S&A results, the preliminary findings and observations made during the on-site Survey may be modified, deleted, or moved within or between categories. The Interim Report will serve both as the site-specific repository for information generated by the Survey and, ultimately, as the site-specific source of information for the DOE-wide prioritization of environmental problems.

It is clear that certain of the findings and observations contained in this report, especially those in Category II, can and should be addressed in the near-term (i.e., prior to the DOE-wide prioritization effort). It is also clear that the findings and observations in this report vary greatly in terms of magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses will require careful planning to ensure appropriate and effective application. The information in this Preliminary Report will assist the Chicago Operations Office in the planning of these near-term responses.

The Chicago Operations Office submitted a draft action plan dated September 15, 1987, in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the BNL Survey Status Report dated June 2, 1987. The draft action plan for the BNL Survey has been reviewed by the Office of Environmental Guidance and Compliance (OEG). OEG has immediate responsibility for monitoring the status and overseeing the adequacy of corrective actions taken by the Operations Office in response to the Survey findings.

As required in the December 2, 1987, memorandum from the Assistant Secretary for Environment, Safety and Health to the Operations Office Managers entitled, Follow-up of Environmental Survey Findings, the Chicago Operations Office will prepare and submit a final action plan to the Deputy Assistant Secretary (DAS) for Environment within 45 days of receiving this Preliminary Report. The final action plan for the BNL Survey will address all of the preliminary findings, cited herein, and will incorporate OEG's comments on the draft action plan.

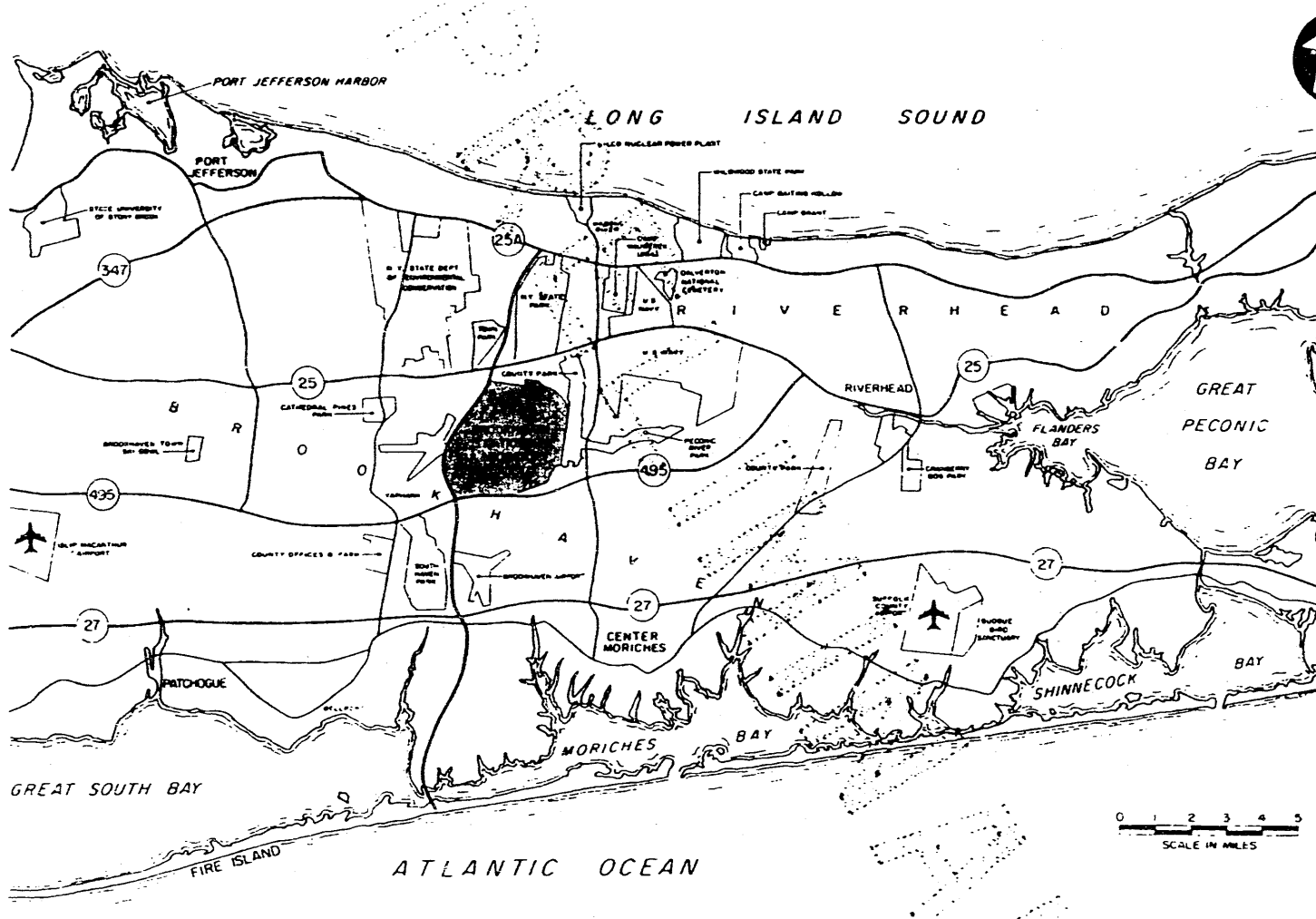
2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Brookhaven National Laboratory (BNL) occupies 2,130 hectares (5,263 acres) of gently rolling land in Suffolk County on Long Island, New York. Most of the site is wooded, except for a developed area of about 680 hectares (1,680 acres). Its location, at about 97 kilometers (60 miles) east of New York City, places BNL at the approximate geographical center of Long Island. Neighboring communities include Brookhaven Township (in which BNL is situated), Patchogue 16 km (10 miles) WSW, Bellport 13 km (8 miles) SW, Center Moriches 11 km (7 miles) SE, Riverhead 21 km (13 miles) due east, Wading River 11 km (7 miles) NNE, and Port Jefferson 18 km (11 miles) northwest. Refer to Figure 2-1 for site location and neighboring communities.

Suffolk County has a total population of 1,300,000, of which 380,000 live in Brookhaven Township. Even though the township has the largest population in Suffolk County, its large area yields a population density of only 540 persons per square kilometer (1,400 persons per square mile). The neighboring eastern townships of Riverhead and Southhampton have even lower densities at <120 persons per square kilometer (<300 persons per square mile). There has been a continuing development of suburban housing and shopping centers just west of the BNL site in recent years (BNL, 1985a).

The climate of Long Island is coastal, with extremes being moderated in summer by southerly ocean breezes and in winter by the large water masses of Long Island Sound and the Atlantic Ocean. Severe local thunderstorms and tornadoes are virtually nonexistent, but occasional hurricanes do wreak havoc on the island, causing wind damage and localized flooding. Precipitation is evenly distributed throughout all seasons, averaging 107 centimeters (42 inches) per year. This rainfall pattern is especially important because precipitation is the only source of potable water throughout Long Island. Rainfall, which is absorbed into and through the soils, filters down into the aquifer to form a primary water reserve, whose maximum natural yield is estimated to be 4.35 billion liters (1.15 billion gallons) per day. The U.S. Environmental Protection Agency (EPA) has designated this aquifer to be a sole-source aquifer (i.e., an aquifer that provides 50 percent or more of the drinking water for an area). Management and protection of this irreplaceable resource has led the Township of Brookhaven to adopt a master plan that zones land use to preserve the aquifer. Brookhaven is the first Long Island community to take this step.



SOURCE BNL, 1985a

FIGURE 2-1

MAP SHOWING SITE LOCATION
BNL - UPTON, NY

The BNL site, along with most of Suffolk County, is covered with scrub oak and pine. Most of the vegetation is secondary growth, although the only virgin white pine grove (the Prosser Pines at Yaphank) lies 3 km (2 miles) west of the BNL property line. As surrounding areas have been cleared for development, the laboratory site is becoming increasingly important as a refuge for wildlife. BNL shelters about 30 species of mammals, including an ever-increasing herd of white-tailed deer. Also, about 180 species of birds have been recorded on-site. About 33 of these species are year-round residents, whereas the remainder are transients, using the Atlantic Flyway in their migration routes north and south. The preservation of wetlands and feeding areas will continue to encourage breeding and flock expansion, not only at BNL but all over Long Island.

The site was used by the U.S. Army during World Wars I and II, when it was called Camp Upton. The name Upton is still used as the official post office address. The Atomic Energy Commission was given title to the property in 1947, then transferred ownership; first to the Energy Research and Development Administration in 1975, then to DOE in 1977. The gradual transition from army camp to campus-style research facility has been a continuous process at BNL. Many of the older wooden frame buildings have been modified and are still in use and stand as a contrast to the new, permanent buildings.

2.2 Overview of Major Operations

As one of the DOE's multiprogram laboratories, BNL has three major functions:

- Design, construct, and operate large research facilities such as particle accelerators, nuclear reactors, and synchrotron storage rings for research in high energy and nuclear physics, chemistry, biology, and energy-related life and environmental sciences.

- Carry out long-term, high-risk programs in the basic sciences (using the unique facilities mentioned above) which have a potential long-term payoff.

- Expand the technology base of the nation, especially in areas where work is best performed in an institutional setting that is independent of all proprietary interests.

To carry out this mission, BNL has maintained a full-time staff of 3,300 to 4,000, plus about 1,500 "outsiders" who, each year, participate in research on shorter-term projects as collaborators, consultants, or students. Operations are currently housed in 334 buildings with a total floor space of 335,335 meters^2 (3,609,500 feet^2), including trailers and modular buildings.

To carry out the multifaceted studies, BNL must perform to fulfill its mission, a number of major scientific facilities have been provided for staff use. The following is a brief summary of these operations (BNL, 1985a):

- The High Flux Beam Reactor (HFBR) is fueled with enriched uranium, moderated and cooled by heavy water, and is operating at a routine power level of 60 megawatts (MW) thermal. This domed, 8,760-meter^2 (94,300-foot^2) facility (Building 750), is utilized for projects in Physics (60 percent), Chemistry (23 percent), Biology (16 percent), and other areas (1 percent). Multiple beam lines are available for simultaneous experiments by a number of research teams.

- The Medical Research Reactor (MRR) is fueled with enriched uranium, moderated and cooled by light water, and operates intermittently at power levels up to 3 MW thermal. This 1,050-meter^2 (11,300-foot^2) structure (Building 491) provides irradiation services for the Medical Department (33 percent), Chemistry (8 percent), Safety and Environmental Protection (8 percent), Reactor Division (4 percent), Physics (1 percent), and to outside organizations for research (46 percent).

- The Alternating Gradient Synchrotron (AGS), a proton accelerator, operates at energies of up to 33 giga-electron volts (GeV) in studies involving high-energy physics research and particle detection. The machine complex has a diameter of 256 meters (840 feet) and was upgraded in 1969 to permit operation at higher intensities. The Physics Department and outside universities are the largest users.

- The 200 million electron volts (MeV) Linear Accelerator (LINAC-Building 930) serves as an injector for the AGS described above. It also supplies a continuous beam of protons for producing radioisotopes by spallation reactions in the Brookhaven Linac Isotope Production Facility (BLIP-Building 931B) and in the Chemistry Linac Irradiation Facility (CLIF-Building 931A).

- The Tandem Van de Graaff, Vertical Accelerator, and Research Van de Graaff Generator are operated by the Physics Department for use in medium-energy physics research, as well as special nuclide production. Housed in Building 901A, the Tandem Van de Graaff is connected to the AGS by a 610-meter (2,000-foot) tunnel. This interconnection of the two facilities permits the injection of intermediate-mass ions into the AGS, where such ions can be accelerated to energies of up to 15 GeV atomic mass unit (amu). Ions can then be extracted and sent to AGS experimental halls for physics research.

- The National Synchrotron Light Source (NSLS-Building 725) utilizes a linear accelerator and a booster synchrotron as an injection system for two electron storage rings:

  - A 2.5-GeV x-ray ring used for x-ray diffraction studies.
  - A 700-MeV vacuum ultraviolet ring for spectroscopy studies.

Usage rates for these two rings are as follows:

	Percentage of Active Use Time	
	X-ray Ring	Vacuum UV Ring
BNL Biology, Chemistry, and Physics Depts.	12	15
BNL NSLS	--	12
Industry	30	35
Universities	28	37
Government Agencies	18	--
Others	12	1

Besides these major laboratory facilities, many other programs involve the use of radionuclides or irradiation for scientific purposes. For example, the Department of Applied Science and the Medical Department develop and process special-purpose radionuclides jointly for general use. Other similar programs are carried out in the Chemistry Department and in the Biology Department. The foregoing overview summarizes those activities that can generate most of BNL's environmental problems. For example, nearly all of the BNL's airborne radioactive effluents are generated at the High Flux Beam Reactor (HFBR), the Brookhaven Linear Isotope Producer (BLIP), and the Research Van de Graaff Generator, with minor contributions from the Medical Research Center and the Chemistry Department. The HFBR and BLIP are the major generators of liquid radioactive wastes, with smaller contributions coming from the "hot" wastewaters at the Hot Laboratory, the Decontamination and Hot Laundry Facility, and the Waste Concentration Facility. All of the facilities discussed here will be addressed in greater detail in subsequent sections of the report.

2.3 State/Federal/Local Concerns

Representatives of the Survey team met with EPA and the New York State Department of Environmental Conservation (NYSDEC) on March 10, 1987. The purpose of this meeting was to

EPA, NYSDEC, Suffolk County, and Brookhaven town are addressed in either the body or the findings sections of this report.

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, water, and groundwater media. The discussions include a summary of the available background environmental information related to each medium, a description of the sources of pollution and control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems found by the Survey team related to each medium.

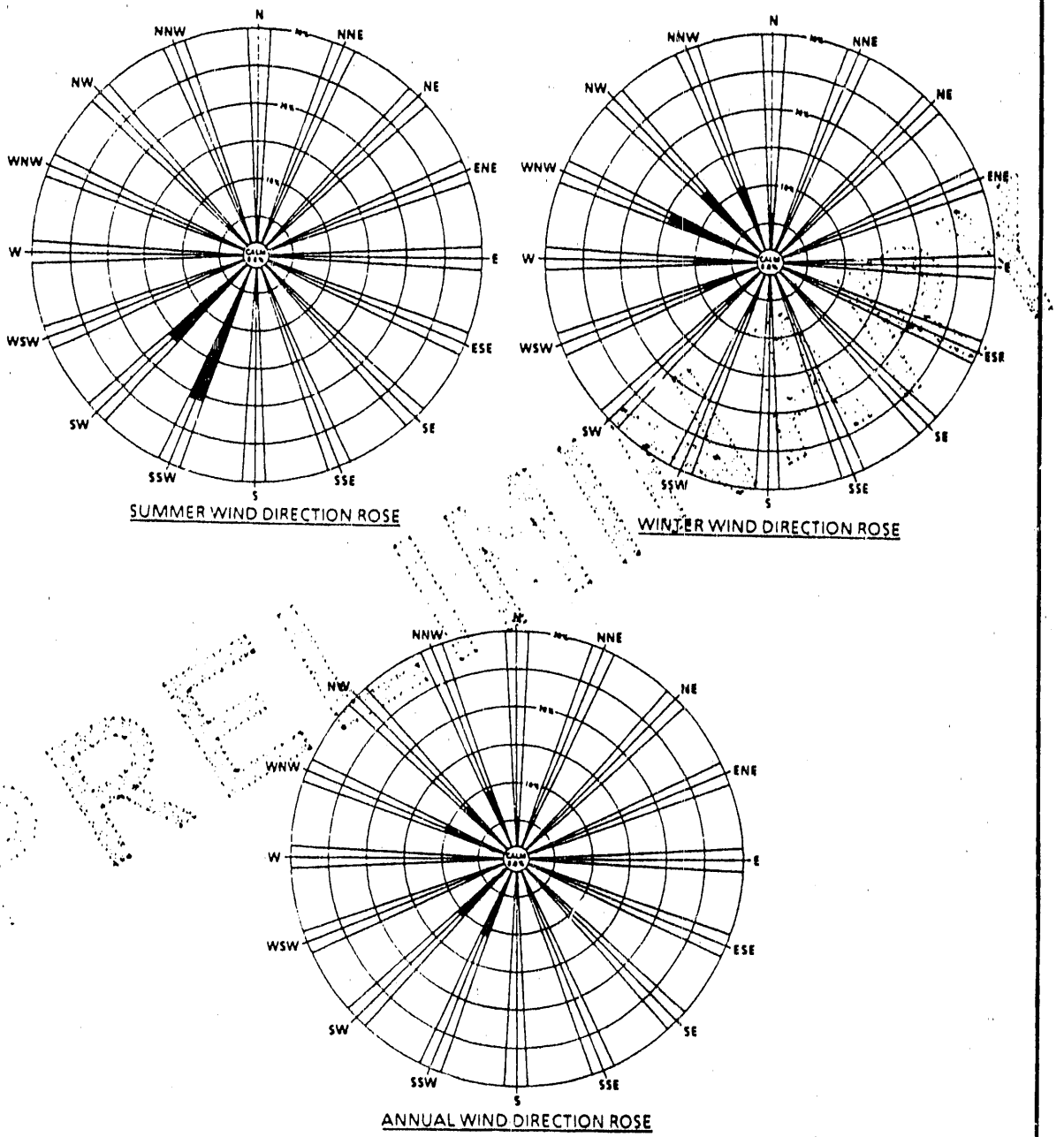
3.1 Air

3.1.1 Background Environmental Information

BNL is located in one of the most populated and heterogeneous air-quality control regions (AQCR) in the nation, the New Jersey/New York/Connecticut Interstate AQCR. This region is made up of New York City and Long Island and those counties in northeastern New Jersey and southwestern Connecticut closest to New York City (BNL, 1985a).

Because of its size and nonhomogeneity, the region is subdivided into many parts. The portion in New York State is subdivided into (1) Manhattan Island, (2) Staten Island, (3) portions of the Bronx, Brooklyn, and Queens (other than the easternmost portions), and (4) the remainder of the AQCR in New York State. The last of these subdivisions, in which BNL is located, consists of Nassau and Suffolk counties and the easternmost sections of New York City. This subdivision of the AQCR is classified "better than national standards" for particulates and sulfur dioxides. For nitrogen oxides, it is classified "cannot be classified or better than national standards." For carbon monoxide, a slightly different boundary has been chosen in which a subdivision consisting of Suffolk County and eastern Nassau County is classified as "cannot be classified or better than national standards." For ozone the entire AQCR is "cannot be classified." This is equivalent to a nonattainment status. It is probable that if a monitoring station were located near BNL, a portion of Suffolk County might show measurements of ozone in compliance with national standards. A new station is unlikely, however, and the nearest station (which is located near the Nassau-Suffolk County border) is frequently out of compliance. An exception to this occurred during calendar year 1984, during which no violations were found (NYSDEC, 1986).

As shown on the attached wind roses (Figure 3-1), the predominant wind directions vary throughout the year. During the summer, winds from the SSW and SW sectors dominate, with these two sectors accounting for more than 35 percent of the observed winds. During the winter, the NW and WNW



Source: Liverman, 1977

FIGURE 3-1

WIND ROSE DIAGRAMS
BNL - UPTON, NY

sectors dominate, accounting for 27 percent of the winds. During the spring and fall, wind patterns are intermediate between these sectors. On the average, winds from the west (which include 7 of the 16 compass sectors ranging from the SSW through NNW) account for more than 64 percent of the wind frequencies. Therefore, air quality of the heavily populated western section of the AQCR influences air quality near BNL (and is at least partially responsible for the nonattainment designation with respect to ozone).

Air quality immediately upwind (west) and downwind (east) of BNL, with respect to radionuclides, is excellent. Background radiation concentrations near BNL are primarily the result of worldwide atomic weapons testing and other nuclear explosions. Background tritium concentrations are so low that higher-than-normal measured values are thought to result from laboratory contamination of ambient air samples (see Finding 3.1.4.4.1). There are no other large sources of radionuclide emissions in Suffolk County, with the exception of the Shoreham Power Plant. This controversial facility is currently not operating because of strong public opposition. If the facility operates in the future, it is not expected to affect BNL's background air quality because of its location (directly north of BNL) and because the prevailing winds are from the west. Three of the off-site thermoluminescent dosimeters (TLDs) used by BNL are located close to the Shoreham Station in the eastern, southern, and western directions. In addition, a background tritium monitor located close to Shoreham was in operation until 1987. Thus, if Shoreham begins to operate, BNL will have a good comparison with gamma and tritium levels found during the preoperational years.

3.1.2 General Description of Pollution Sources and Controls

Permitted Sources

A total of 27 air permits are currently issued to BNL. These were reissued during 1986 and all are in effect until November 29, 1991. These sources, along with contaminants released and pollution controls, are summarized in Table 3-1.

To date, no comprehensive air emissions inventory has ever been developed at BNL (see Finding 3.1.4.4.4). The Blass Task Force (Blass, 1986) report (see Section 2.3) contained the finding that "no building-by-building survey of air emissions has been conducted." Each permit, however, contains an estimate of emissions under the maximum rate of operation, which can be summed to a partial inventory. The summary of the permitted emissions is shown in Table 3-2. Emissions from the package boilers and incinerators were not included because of the attainment status of this portion of the AQCR with respect to nitrogen oxides,(NO_X), sulfur dioxide (SO_2), and particulates.

TABLE 3-1

PERMITTED AIR SOURCES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Pollution Source	Airborne Contaminants	Controls
Package boilers, (7 Total) (Buildings 423, 452, 457, 479, 493, 835, & T30)	Particulates Sulfur dioxide Nitrogen oxides	None Sulfur content of fuel None
Incinerator (Building 493)	Particulates Sulfur dioxide	None (secondary burner) Sulfur content of fuel
Pathological Incinerator (Building 444)	Particulates Sulfur dioxide	Secondary burner Thermal afterburner Baffle chamber Sulfur content of fuel
Blueprint machines (6 Total) (Buildings 134, 197, 510, 515, 903, 911)	Ammonia	None Limited by throughput
Vapor degreaser (Building 208)	1,1,1-trichloroethane	Cover, condenser, operating procedures
Paint spray booths (2) (Building 422)	Particulates Paint thinner	Wet filter None
Lathes and Grinders (Building 462)	Particulates (non-rad)	Bag Filter
Lathes and Grinders (Building 462)	Radioactive solids	HEPA filter
Woodworking machines (20 Total) (Building 422)	Particulates	Cyclones (2)
Sandblasters (Building 208)	Particulates	Bag filters (2)
Shot blaster (Building 650)	Radioactive solids	HEPA filter
Scrap lead recycle	Particulates	HEPA filter
Lead melting pots (Building 208)	Particulates	None

Source: Adapted from BNL permits by Survey team.
HEPA: High Efficiency Particulate Air.

TABLE 3-2

ESTIMATED AIR EMISSIONS (PERMITTED SOURCES)
BROOKHAVEN NATIONAL LABORATORY,
UPTON, NEW YORK

	Pounds/Year
Volatile Organic Compounds	26,490
Lead	12.8
Radioactive Solids	nil
Ammonia	18,000

Source: Adapted from BNL permits by Survey team.

The degreaser in Building 208, if operated at its permit maximum, would volatilize 17,850 pounds (8100 kg) per year of 1,1,1-trichloroethane. Actual use is estimated by Building 208 management (Rosenka, 1987) to be a maximum of 9,000 pounds (4085 kg) per year, some of which is contained in the waste sludge. Nevertheless, this is probably the largest single source of volatile organic emissions at BNL. The new degreaser in Building 905 will be a comparable source in the future. In past years, the degreaser in Building 197 was one of the largest users of this solvent at BNL. With the installation of a recovery still, use has been reduced to about 2,500 pounds (1135 kg) per year.

Nonpermitted Sources

During the Survey, a number of sources were noted without proper permits (see Finding No. 3.1.4.4.3). These sources are listed in Table 3-3. The package boilers and the fume scrubber are administrative problems only, since they do not contribute significantly to air emissions inventories. Current permits have not been issued for the central steam plant, although these are anticipated in the near future. The Survey observed a number of unpermitted vapor degreasers and parts cleaners, which are contributors to the volatile organic compounds emissions. It is likely that there are many other parts cleaners at BNL without permits.

Organic Air Emissions

An attempt was made to estimate, from purchasing records, the volume of volatile solvents evaporated each year. The estimated volumes for solvents purchased in the largest quantities are shown in Table 3-4. The volumes shown for isopropyl alcohol, methyl alcohol, acetone, and chloroform are the average amounts purchased in the 1982 to 1986 period. For 1,1,1-trichloroethane, this average was adjusted to take into account a recovery still installed in November 1985, in Building 197. Operation of this still has reduced purchases of 1,1,1-trichloroethane, by the National Synchrotron Light Source Department, by approximately 1,000 gallons per year.

The estimate used by the Survey team, that 90 percent of the solvents are lost by evaporation, is consistent with EPA estimates. However, even an estimate of a smaller quantity lost by evaporation would indicate that large quantities are evaporated each year. While the compiling of a building-by-building air emissions inventory may be overly cumbersome, purchasing records can be used to clarify which departments are the major users of solvents. Table 3-5 shows the amounts of these solvents purchased by departments using the largest quantities from 1982 through 1986. Most of the large uses are for vapor degreasers and cold parts cleaners. The new degreaser in Building 905

TABLE 3-3

UNPERMITTED AIR SOURCES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Source Description	Emissions
422	Steam Boilers 2.2 M BTU/hour	Particulate SO_X and NO_X
244	Steam Boilers 1.2 M BTU/hour	Particulate SO_X and NO_X
905	Vapor Degreaser (>185 gallon)	1,1,1-trichloroethane
197C	Water Scrubber - Fumes from HF/HNO_3 pickling	HF and HNO_3
924	Vapor Degreaser (30 gallon)	1,1,1-trichloroethane
423	Parts Cleaners (three; 200 gallon, 200 gallon, 50 gallon)	1,1,1-trichloroethane
452	Parts Cleaners (two; 150 gallon and 100 gallon)	1,1,1-trichloroethane

Source: DOE Survey team.

TABLE 3-4

VOLATILE AIR EMISSIONS (1982 – 1986)
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Compound	Purchases Gallons/Year	Purchases Pounds/Year	Air Emissions (1) Pounds/Year
1,1,1-Trichloroethane	3,833 (2)	42,815 (2)	38,533
Isopropyl Alcohol	1,066	6,990	6,290
Methyl Alcohol	772	5,098	4,590
Acetone	568	3,745	3,370
Chloroform	281	3,475	3,130

Source: Adapted from BNL Purchasing Records by Survey team.

(1) Estimated by assuming that 90 percent of amounts purchased were volatilized.

(2) Assumes that the solvent-still, which was purchased and installed in November 1985, was in operation during the entire period.

TABLE 3-5

SOLVENT PURCHASES BY DEPARTMENT (1982 - 1986) – GALLONS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Department	1,1,1-Trichloroethane	Isopropyl Alcohol	Methyl Alcohol	Acetone	Chloroform
Accelerator Department	1,571	240	414	309	
Alternating Gradient Synchrotron	3,561		2	2	
Biology Department	104	332	814	387	51
Chemistry Department	1,655	16	290	604	318
Applied Science	1,256	2,352	377	310	1,014
Plant Engineering	1,449	66	42		
Collider Beam Accelerator	345	13	250	205	2
National Synchrotron Light Source	8,437	650	80	82	
Medical Department	72	32	506	115	13
Physics Department	873	185	257	352	
Reactor Department	756			4	
Supply and Materials	2,238	977	408	263	5
Others	1,249	468	422	209	2
TOTAL	**23,566**	**5,331**	**3,862**	**2,842**	**1,405**

Source: Adapted from BNL Purchasing Records by Survey team.

is expected to use a similar quantity of solvent as the degreaser in Building 208, since the two are identical in size.

Radionuclide Sources and Controls

The major sources of radionuclide air releases for 1985 are summarized in Table 3-6. The most significant release, from the standpoint of total curies released from stacks, is oxygen-15. In 1985, this accounted for 57 percent of the total curies released. The amount varies significantly from year to year. (In 1981, oxygen-15 accounted for 81 percent of the total). However, because of the extremely short half-life (122 seconds), oxygen-15 does not pose an off-site problem, since little of the material released reaches the site boundary.

In terms of dose, argon-41 accounts for virtually all (e.g., more than 99 percent) of the collective population airborne dose (i.e., the dose to the population living within 80 km). In 1985, argon-41 contributed 4.77 man rems and tritium 0.02 man rem, so that the BNL airborne releases comprised 0.0016 percent of the total dose due to natural background (300,000 man rems).

Tritium Sources

Tritium is released in smaller amounts (curies) than oxygen-15 or argon-41. However, because of its slower decay (half life = 12 years) and greater persistence (as tritiated water, HTO), tritium is the radionuclide found in largest quantity in ambient air samples taken at the site boundary. It is also the radionuclide that receives the most attention from the standpoint of installed controls.

A project will be implemented in early 1988 in which condensate from the liquid waste evaporator, described in Section 4.1.1.2, will be vaporized and exhausted through the High Flux Beam Reactor (HFBR) stack. Prior to 1986, this condensate was discharged to the sewage treatment plant. This addition is expected to increase the amount of tritium (as HTO) discharged from the HFBR by about 20 curies per year, although additions of up to 50 curies per year may occur as the inventory of condensate accumulated during 1986 and 1987 is worked off.

Considerable care will be needed to avoid downdraft from the stack because of the extremely low escape velocity.* The normal escape velocity at present is about 0.5 meters per second (1.6 feet/second) compared to a design velocity of approximately 5.0 meters per second (16 feet/second).

* Some downdraft is occurring at the present and is apparently the cause of high concentrations of tritium in the laboratory and nearby. A crude estimate developed by the Survey team indicates that up to 20 percent of the tritiated water from the HFBR stack is deposited on-site.

TABLE 3-6

RADIATION SOURCES - BNL 1985
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Building No.	Facility	Principal Radionuclide	1985 Release (Ci)
491	Medical Reactor Reactor Stack	Ar-41	1.1×10^{3}
931	LINAC Isotope Facility	O-15	1.9×10^{3}
901	Van de Graaff Accelerator	H-3	2.0×10^{2} (HT) 2.4×10^{0} (HTO)
490	Medical Research Center Roof Stack	H-3	4.2×10^{1}
750	HFBR	H-3	9.3×10^{1}
555	Chemistry Roof Stack	H-3	2.6×10^{-1}

Source: Day et al., 1986.

The stack, as designed, carried a far higher air flow (>100,000 cubic feet per minute) during the years prior to 1969 when the old (air-cooled) reactor was in operation. Normal flow at present is 10,000 cubic feet (283 m^3) per minute. Condensation inside the stack is also a potential problem. Process design calculations indicate that the relative humidity within the stack will be increased only from the present 65 percent to 81 percent. If either downdraft or condensation occurs, some corrective action will be required. The effect of operating at a room evacuation rate of 20,000 cubic feet (566 m^3) per minute at the HFBR will be evaluated as well as alternative disposal schemes.

Tritium releases from 1981 through 1985 from major sources at BNL are shown in Table 3-7. During this period, 56 percent of the total tritium was discharged in the form of tritiated water (HTO) from the HFBR stack. Process control devices at the HFBR consist of high-efficiency particulate air (HEPA) filters to remove radioactive particulates. Control of tritium consists of administrative procedures to detect tritium and prevent its release. In addition, since 1977, annual replacement of a portion of the heavy water (used as a moderator and coolant) has reduced the release of tritiated water by about 50 percent of pre-1977 levels.

The other major source of tritium releases at BNL is the Van de Graaff accelerator. From 1981 through 1985, 40 percent of the BNL total tritium release was from the Van De Graaff, 31.25 percent of which was in the form of tritium gas (HT). Release of tritium (tritium gas plus tritiated water) during experiments with the accelerators is controlled by passing the exhaust gases through a catalytic oxidation unit, which converts tritium gas (HT) to tritiated water (HTO), and then passing the gases over a silica gel desiccant to remove water (including HTO). Tritium releases occur when (1) the control units are by-passed during periods of high-vent gas pumping rates; (2) the catalytic oxidation catalyst is fouled and thus tritium gas is vented; and (3) the silica gel is saturated and thus tritiated water is vented. Table 3-7 shows that releases in 1985 were principally due to fouled catalyst (since HT was 99 percent of the release). Prior to 1985, tritium releases from the Van de Graaff resulted from a combination of the three problems cited above. (In 1983 catalyst fouling was responsible for 90 percent of the total.) Procedural controls now prohibit starting experiments when the effectiveness of the oxidation catalysts or the silica gel capacity is suspect. However, fouling of the catalyst while an experiment is in progress can result in lack of detection of a tritium release until the experiment has been completed.

Releases of tritium gas are not viewed as equivalent to releases of the same amounts (curies) of tritiated water. The dose conversion factor of tritium in tritiated water is 400 times that of tritium gas (ICRP, 1959). The rate of oxidation of tritium (HT) in the atmosphere is so slow that this conversion can be ignored (Eakins & Hutchinson, 1973).

TABLE 3-7

TRITIUM RELEASES AT BNL - CURIES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Building	Van de Graaff 901		HFBR 750	Medical Research 490	BNL Total(1)
1981	410	(HT 300) (HTO 110)	240	1.1	655
1982	29	(HT 15) (HTO 13)	330	1.5	361
1983	130	(HT 118) (HTO 12)	270	7.9	408
1984	78.4	(HT 20.1) (HTO 58.3)	244	0.4	330
1985	202.4	(HT 200) (HTO 2.4)	93	42	338
5-Year Total	848.8	(HT 653.1) (HTO 195.7)	1,177	52.9	2,092
% of BNL Total	40.6	(HT 31.25) (HTO 9.36)	56.3	2.5	

Source: BNL Annual Environmental Monitoring Reports.
(1) Total includes minor sources.

BNL management concern with releases from the Van De Graaff prompted a study, which recommended an upgrade of the monitoring equipment and reduction of releases through available technology (Balsamo, et al., 1986). These recommendations have not been implemented to date.

Particulate Controls

While radionuclide particulates do not constitute a major concern at BNL, there are numerous sources, all of which are controlled with HEPA filters. For example, Building 490 has about 30 filters, most of which control hood exhausts. Standard procedures at BNL require annual testing of HEPA filters. Most are equipped with devices to monitor pressure drop across the filter when in operation. However, monitoring of pressure drop is not part of standard operating procedures. Finding 3.1.4.4.5 discusses filters that do not have continuous pressure-drop monitors.

Other Sources and Controls

The central steam plant (Building 610) supplies steam (for heating and cooling) to most of the buildings at BNL. The plant consists of 4 boilers, each with a separate stack, with a total capacity of 345,000 pounds of steam/hour (equivalent to about 390 million BTU/hour). The plant was designed to burn No. 6 fuel oil. Current New York regulations (Part 225, Fuel Consumption and Use) restrict such units in Suffolk County to a maximum sulfur content of 1.0 wt percent. While some regions in New York state will require lower sulfur limitations beginning January 1, 1988, no changes are being implemented in Suffolk County or neighboring areas.

Prior to 1973, use of lower quality, higher sulfur (to 2.2 wt percent) fuels resulted in some exceedances of the particulate standards. The BNL environmental impact statement (Liverman, 1977) reports 1974 results for particulates from the No. 5 boiler of 5.7 times the New York limit of 0.1 pound/10^6 BTU. Improvements, consisting of high-quality, lower ash fuels; soot blowers; and air preheating equipment have eliminated this problem. Short puffs of black smoke are seen infrequently, such as during soot blowing. The appearance of the stack during the Survey was exemplary.

In the early 1970s, BNL began the practice of burning waste petroleum products as a cost-reducing measure. Early problems with lead, a contaminant in automotive lubricants, were controlled by limiting the quantities utilized.

Combustion of off-specification fuels, called alternate liquid fuels (ALFs), became a major program at BNL in the 1970s and early 1980s. The definition of ignitable wastes under the Resource

Conservation and Recovery Act (RCRA) brought many administrative problems, since all of the ALFs were categorized as hazardous wastes because they are ignitable. Problems with permitting of storage tanks are discussed in Section 4.1.2. Air permits for burning ALFs have been a constant problem. New York state has, to date, never issued BNL a permit to burn ALFs.

Samples of all materials used in the preparation of ALFs are routinely analyzed for polychlorinated biphenyls (PCBs) to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations. In October of 1984, 300,000 gallons of off-specification military fuel that contained PCBs, at a concentration of 80 ppm, were received at BNL. The EPA and NYSDEC were notified, and the laboratory applied for a provisional EPA permit (in accordance with 40 CFR 761) to burn the fuel. A 10 percent fuel-firing rate (10 percent of this fuel blended with PCB-free fuel) is planned to ensure that the concentration will be well below the EPA limit of 50 parts per million (ppm). The satisfactory destruction and combustion efficiencies have been demonstrated and additional monitoring equipment was installed, during 1985, so that all EPA requirements should be satisfied.

The cost attractiveness of burning ALFs has deteriorated since the time of oil shortages. The combination of permitting problems and poor cost attractiveness has caused BNL to propose a termination of the ALF combustion program during 1987. This is expected to remove the obstacles in obtaining current air permits.

As mentioned in the section on nonpermitted sources, several remote package boilers are without operating permits. However, these and the seven permitted units (Buildings 423, 452, 457, 479, 493, 835, and T30) require fueling with low-sulfur, No. 4 fuel oil, which tends to give a clear stack and no problems with SO_2 or NO_X emissions.

3.1.3 Environmental Monitoring Program

The ambient-air monitoring programs focus very heavily on tritium. This is because the perimeter concentrations of all other radionuclides are so low that measurements are usually below detection limits. This reasoning is consistent with measurements of gross-alpha and gross-beta activity from TLDs mounted at the site perimeter, and with measurement of radionuclide concentrations in precipitation collected on-site. The 1985 values for precipitation samples are shown in Table 3-8. Concentrations as percentages of the derived concentration (in air) guide (DCG) are 0.002 percent for beryllium-7, 0.0005 percent for cesium-137, 0.056 percent for strontium-90, and 0.002 percent for tritium.

TABLE 3-8

1985 QUARTERLY AVERAGE RADIONUCLIDE ACTIVITY IN PRECIPITATION BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

	^{3}H	^{7}Be	^{137}Cs	^{90}Sr - 1984	^{90}Sr - 1985
1985 Average nCi/m^2	19.7	10.9	0.025	0.045	0.007*
Radiation Concentration Guide	8×10^5	5×10^5	5×10^3	8×10^1	8×10^1

Source: Day et al., 1986.

* 1985 average not representative because of loss of some samples.

Tritiated water concentrations in ambient air are also very low. This is corroborated by the low concentrations of tritium in precipitation (Table 3-8). However, this subject has received much attention at BNL for several reasons: (1) tritium is the radionuclide found in the highest concentration in ambient-air samples; (2) tritium is the only radionuclide found in ambient-air samples known to be present because of BNL's effluents; and (3) monitoring prior to 1985 provided somewhat anomalous results.

Suspicions about tritium results occurred when, after several years of steadily decreasing concentrations at the ambient-air monitoring stations, the results at station P-4 (the southwest station) showed an unexpected increase in 1981. Because this station is upwind of potential BNL releases 85 percent of the time, the anomalous results were eliminated from the calculation of the collective dose equivalent for 1981. The conclusion, drawn by a task force reviewing the data, was that the anomalous results were due to contamination in the laboratory of several samples during analysis.

A second task force was convened in mid-1983 to determine the validity of measured environmental release data for tritium. The report issued by this second task force (Miltenberger et al., 1984) tended to support the conclusion of contamination during sample analysis but also established that ambient concentrations were consistently two to five times the stack concentrations predicted by modeling (see Finding No. 3.1.4.4.1).

During August and September 1983, a total of 16 perimeter monitors were operated for tritium to provide the task force with better data. A decision was made to continue sampling at the 16 compass sectors in 1985. This practice continued during 1986, and it appears that it will continue for the foreseeable future. BNL also monitors an additional eight points within the site, and two monitoring stations have been set up as background (control) stations. These background stations are located at residences of two BNL employees in Patchogue and Rocky Point, approximately 17 kilometers southeast and 10 kilometers northeast of BNL, respectively. Operation of the latter station (at Rocky Point) was terminated in 1987.

The BNL system is one of the most comprehensive systems in existence for detecting releases of tritium. Larger sites (e.g., the Nevada Test Site and Savannah River) have more comprehensive systems, but also handle larger quantities. Two types of ambient-air monitoring stations are in use at BNL. Four of the perimeter stations are equipped to collect particulate samples as well as tritium samples. The oldest of these stations, P-9 (the NE compass point) and P-4 (SW), have been in use since 1972. These two points were selected as being representative of upwind and downwind conditions. Station P-4 is upwind of BNL 85 percent of the time, whereas P-9 is downwind 30 percent

of the time. A third station, P-7 (ESE), was added in 1980 and the fourth, P-2 (NNW), was added in 1981. A duplicate train is in use at P-7 as a quality control check, and Suffolk County also operates a sampling train at P-7. These stations are commonly referred to as AC stations, since they operate on alternating current.

The remaining monitors are battery-operated (the so-called DC stations) and utilize a small pump powered by a 6-volt battery. The pump sends a stream of air (10 to 100 cc/minute) through a silica gel tube to collect water. Each week the silica gel tubes are collected, the water (including tritiated water) is removed by distillation, and the tritium concentration of the distillate is determined by liquid scintillation counting.

With respect to tritiated water monitoring, 1985 is the first year with complete (16 compass points) perimeter monitoring. Annual averages ranged from a low of 2.09 pCi/m^3 at station 16 (the NNW compass point) to a high of 21.1 pCi/m^3 at station 8 (the SSE point), compared to an average of 4.5 pCi/m^3 at the control stations. The 16 compass points averaged 7.98 pCi/m^3, which is less than 2 times the average measured at the control stations and less than 0.01 percent of the Derived Concentration Guidelines (DCG) of 2 x 10^5 pCi/m^3.

A tritium sampler operated in the analytical laboratory building (Building 705) averaged 54.8 pCi/m^3 for 1985, or 6.8 times the perimeter average. The high concentrations are attributable to the sampler's location, which is near several airborne effluent release points. Apparently, all BNL management are not in agreement with the first task force's conclusion that the high tritium concentrations of ambient air are a result of laboratory contamination. The 1985 Environmental Monitoring Report (Day et al., 1986) states that "although these levels (i.e., the laboratory and station 17 outside the laboratory) are substantially in excess of the control stations, contamination of environmental samples is not apparent."

As indicated above, all airborne doses calculated at BNL are extremely low. BNL has, for many years, used an internally developed model called the BNL Wind Rose Dispersion Model. During 1986, an agreement was reached with EPA that use of the BNL model would be satisfactory for the 1986 environmental monitoring report (Welty, 1986). The EPA is developing another model, called CRRIS, which has some advantages over AIRDOS. When fully developed, EPA may require that CRRIS be used. Until a decision is reached, EPA is considering the interim use of other models, such as the BNL Wind Rose Dispersion Model.

3.1.4 Findings and Observations

3.1.4.1 Category I

None.

3.1.4.2 Category II

None.

3.1.4.3 Category III

None.

3.1.4.4 Category IV

1. Laboratory Contamination of Tritium-in-Air Samples. Measured levels of tritiated water (in air) at the BNL perimeter may be inaccurate. Levels of tritiated water at the perimeter are 2 to 5 times the levels predicted by the atmospheric modeling of the BNL stack releases (Miltenberger et al., 1984). The low levels of background tritium concentrations, which are monitored at two remote stations, do not fully explain the discrepancy. Possible explanations include (1) inaccurate measurements at the perimeter, (2) inaccurate modeling, or (3) an unknown source of tritium not included in the models or a combination of these. According to BNL, contamination of samples in the laboratory is responsible for the higher than predicted concentrations.

   Based on a recommendation from the 1985 Environmental Audit (NUS, 1985), BNL initiated additional in-laboratory monitoring to ensure that sample contamination is avoided. This program has proved unsuccessful because high laboratory tritium-in-air concentrations are not consistent with suspect levels at the BNL perimeter. Relocation of a portion of the radiological laboratory to an uncontaminated area to avoid such contamination has been under consideration by BNL for several years.

2. Tritium Releases. Lack of real-time, on-line tritium detection and adequate emission control equipment at the Van de Graaff allows tritium gas to be vented to the atmosphere. Purge gas containing tritium from the research Van de Graaff generator (B-901) is vented through control equipment consisting of a single catalytic recombination unit and a desiccant. The

recombination unit catalytically oxidizes tritium gas to tritiated water, which is absorbed by the desiccant. According to BNL, more than half of the atmospheric venting of tritium gas, in recent years, occurred as a result of fouling of the recombination unit. In the 5 years from 1981 to 1985, 31.3 percent (653.1 curies) of the total tritium (gas and water) released from BNL (2,090.0 curies) was released as tritium gas from the Van de Graaff (see Table 3-7). Tritium gas has a dose conversion factor that is 1/400 that of tritiated water, so that the Van de Graaff emissions contribute little to the off-site dose.

More efficient catalytic oxidation units and more efficient monitoring equipment were recommended in an interim BNL report issued in February 1986 (Balsamo, et al., 1986).

3. Unpermitted Sources. BNL has a number of air emission sources that are operating without the required state permits. These include two steam boilers, several vapor degreasers and parts cleaners, and an acid cleaner controlled by an aqueous scrubber (see Table 3-3). In addition, the permit for the central steam plant (Building 610) has not been reissued. Since the controversy surrounding the use of alternate liquid fuels has been resolved, it is expected that this permit will be issued in the near future.

4. Volatile Organic Emissions Inventory. The lack of a comprehensive inventory of volatile organic emissions precludes assessment of the need, if any, for source controls. Emissions of volatile organic compounds occur at BNL as a result of the use of solvents in vapor degreasers, parts cleaners, and a variety of small research experiments conducted in laboratory hoods. The maximum allowable release rate from permitted sources (see Table 3-2) is 26,490 pounds per year. Annual purchases of the solvents used at BNL in large volumes are shown in Table 3-4, along with preliminary estimates (made by the Survey team) of the amounts lost by volatilization. Total emissions are estimated to be in excess of 50,000 pounds per year.

Because of the large number of solvents in use at BNL, it is virtually impossible to construct a building-by-building air emissions inventory. In addition, the utility of such an inventory would be questionable because of variation from year to year in the type and quantity of solvents used. A use pattern by department is shown in Table 3-5 for the five large-volume solvents used at BNL. This information could serve as a substitute for a more cumbersome air emissions inventory.

In general, BNL has installed control equipment on many of the air emission sources. However, this is not the rule for most sources of organic emissions. It must be stressed that

individual sources are likely to be small and, unless the material is particularly toxic or hazardous, there may not be a compelling reason to install such devices.

5. Performance Monitoring of HEPA Filters. Lack of monitoring for pressure differential across the high efficiency particulate air (HEPA) filters can result in a potential release of particulate radionuclides. BNL conducts annual tests of efficiency after a HEPA filter has been installed. On those HEPA filters without in-line pressure differential monitors, there is no way to determine if the filter becomes torn, loaded, or otherwise inefficient, until the next annual test. Although most HEPA filters at BNL have in-line pressure-drop monitors, the Survey identified 14 filters in B-801 and 3 in B-490 that did not.

6. Control of Emissions From Degreasers. Lack of an effective cover on the vapor degreaser in B-208, when not in use, results in an increased rate of evaporation of solvent (trichloroethane). According to BNL, because of improper design, the evaporation rate of solvent is actually increased when the cover is in place. BNL plans to construct a more efficient cover. Nevertheless, loss of solvent [estimated by BNL to be less than 9,000 pounds per year(Rosenka, 1987)] is well below the limit of 17,000 pounds per year set in the state operating permit.

7. Air Quality Surveillance. Dose assessment calculations and air monitoring results may be inaccurate because of the lack of integrated flow measurement devices at the perimeter air monitoring stations. An undetected interruption of flow through the sample trains during a sample period (weekly, in most cases) would result in a smaller-than-normal sample being collected. This could result in a low (inaccurate) calculation of the air component of dose assessment and other monitored air parameters.

   Suffolk County Bureau of Air Pollution Control maintains an air monitoring station at BNL, located adjacent to BNL's Station P-7. The Suffolk County unit contains an integrated gas flow meter. Thus, in the event of a dispute, the county result would be considered more reliable.

   BNL is in the process of installing gas flow meters (and critical orifices). Installation is anticipated during 1988.

8. Dose Assessment Modeling. The BNL procedures used to determine the reported off-site dose impact may not be in conformance with regulatory requirements under NESHAP. At the time of the Survey, BNL used its own computer model, called the "BNL Wind Rose Dispersion" model, to estimate the airborne radiation dose. EPA requires use of the AIRDOS model, unless

a formal waiver is obtained. BNL received verbal permission from EPA to use the Wind Rose Dispersion model for the 1985 calendar year. BNL has obtained neither written nor verbal approval to continue using its own model. The 1985 reported dose impacts from BNL are quite low, or about 1 percent of the NESHAP whole-body standard.

3.2 Soil

3.2.1 Background Environmental Information

The natural soils found at Brookhaven National Laboratory (BNL) are derived from loess and from outwash sand and gravel. The eastern third of the site has a thin, near-surface deposit of silt and clay. This unit is generally 5- to 10-feet thick, discontinuous, and unevenly distributed. These deposits are sufficiently fine-grained so that they appreciably impede infiltration. In doing so, they hold water at or near the land surface and, thus, locally form swampy areas or ponds. The balance of the site is covered with outwash sand and gravel deposited by streams from the melting Ronkonkoma ice sheet. These materials are crudely stratified and consist of clean sand, gravel, and little clay or silt. Few boulders occur. Cores from test holes reveal thin layers of silt or clay, which at most are 1- to 2-inches thick. Thicker lenses of clay are absent in the vicinity of the site. These lenses of silt and clay were probably deposited in small lakes formed between the retreating face of the Harbor Hill ice sheet and the Harbor Hill moraine (De Laguna, 1963).

Surface soils mapped by the U.S. Department of Agriculture range from the coarse Duke's sand in the north and east to finer Sassafras sandy loam in the southwest. The soil types on-site, in order of increasing coarseness, are (1) Sassafras loam, (2) Sassafras fine sandy loam, (3) Sassafras sandy loam, (4) Plymouth sand loam, (5) Duke's loamy sand, (6) Plymouth sand, and (7) Duke's sand. Babylon sand and meadows soil are associated with wet sites where texture is not an important consideration (Liverman, 1977). Figure 3-2 is a soil map of the BNL site. In many places, either the natural soils are covered with fill or were removed during facility construction.

Soils, grass, and milk from two to five dairy farms off-site have been sampled since the early 1970s by the Suffolk County Department of Health Services. The samples were analyzed by BNL for selected radionuclides only. Results for soil and grass published in the Final Environmental Impact Statement (Liverman, 1977) for the site are presented in Table 3-9. Non-radionuclide contamination was not analyzed. Of the eight nuclides reported, Be-7 is generated by cosmic radiation; Zn-65, Zr-95/Nb-95, Cs-137, and Ce-144 are from deposition of global fallout from nuclear weapons tests; and U, Th, and K are naturally occurring terrestrial components (Liverman, 1977).

Currently no Federal or state regulations limit the concentration of uranium or thorium in soils. However, there is some guidance available from both the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE). The NRC, in a memorandum pertaining to a Branch Technical Position on the disposal or on-site storage of residual thorium or uranium, established

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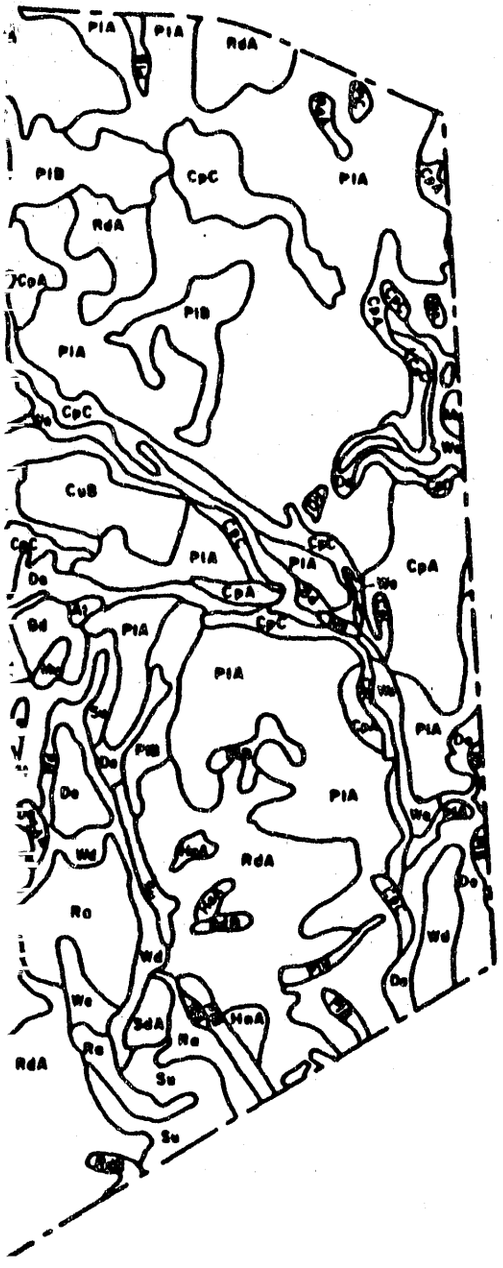
Source: Adapted from Liverman, 1977.



N

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E, shows the slope. Most symbols without a slope letter are those of nearly level soils but some are for land types that have a considerable range of slope.

SYMBOL	NAME
At	Atsion sand
Bd	Berryland mucky sand
CpA	Carver and Plymouth sands, 0 to 3 percent slopes
CpC	Carver and Plymouth sands, 3 to 15 percent slopes
CpE	Carver and Plymouth sands, 15 to 35 percent slopes
CuB	Cut and fill land, gently sloping
CuC	Cut and fill land, sloping
CuE	Cut and fill land, steep
De	Deerfield sand
HoA	Haven loam, 0 to 2 percent slopes
HoB	Haven loam, 2 to 6 percent slopes
Ma	Made land
Mu	Muck
Ra	Raynham loam
Rc	Recharge basin
RdA	Riverhead sandy loam, 0 to 3 percent slopes
RbB	Riverhead sandy loam, 3 to 8 percent slopes
RdC	Riverhead sandy loam, 8 to 15 percent slopes
RhB	Riverhead and Haven soils, graded, 0 to 8 percent slopes
SdA	Scio silt loam, sandy substratum, 0 to 2 percent slopes
Su	Sudbury sandy loam
Wd	Walpole sandy loam
We	Wareham loamy sand

FIGURE 3-2

SOIL MAP OF BNL SITE
BNL - UPTON, NY

TABLE 3-9

OFF-SITE SOIL AND GRASS ACTIVITY, 1972-1973
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Isotope	Soil Activity pCi/Kg (wet weight)	Grass Activity pCi/Kg (wet weight)
Be-7	< 500	1,175 ± 275
Zn-65	380 ± 190	< 50
Zr-95/Nb-95	360 ± 90	240 ± 60
Cs-137	1,425 ± 360	85 ± 20
Ce-144	1,075 ± 270	250 ± 65
U (All)	1,080 ± 270	Not Reported
Th (All)	1,270 ± 320	Not Reported
K-40	5,656 ± 1,410	4,250 ± 1,060

Source: Liverman, 1977

derived concentration limits for various disposal options (NRC, 1981). One of these options applies to wastes with sufficiently low concentrations of uranium or thorium, so that they would present no health risk and may be disposed of in any manner. The acceptable concentrations for this disposal option were derived by the NRC using radiation dose guidelines recommended by the U.S. Environmental Protection Agency (EPA) for protection against transuranium elements present in the environment (EPA, 1977). The derived concentration limits are natural thorium, 10 pCi/g; depleted uranium, 35 pCi/g; enriched uranium, 30 pCi/g; and natural uranium, 10 pCi/g. The concentration limits for natural thorium and natural uranium are based on the assumption that all the daughter products of these elements are present in secular equilibrium. The radium isotopes are the daughter products that are used to establish the limits.

The only radionuclide-specific guidelines are for residual radioactivity at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985; Gilbert et al. 1985). These guidelines specify concentrations for thorium-232, thorium-230, radium-228, and radium-226 of 5 pCi/g averaged over the first 15 cm of soil below the surface. They also take into account the in-growth of the daughters and assume secular equilibrium. For other radionuclides or mixtures, the soil concentration guidelines must be derived, on a site-specific basis, from a basic dose limit of 100 mrem/yr to an individual, from all pathways.

There are no regulatory standards for nonradiological contaminant concentrations in soil as there are for drinking water supplies or for air. A determination of "safe" or "acceptable" levels in soils depends on contaminant migration pathways (e.g., wind or water erosion or leaching to the groundwater) and potential human exposure routes (e.g., ingestion of soils by children or farm animals, ingestion of contaminated groundwater, or inhalation of fugitive dust containing contaminants). Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis.

3.2.2 General Description of Pollution Sources and Controls

Soils can become contaminated by air emissions, runoff, storage and disposal activities, spills, and resuspension of contaminated materials from other areas. On-site soil sampling at BNL typically has been limited to areas of known or suspected contamination (e.g., Hazardous Waste Management Area [HWMA], construction sites, decommissioning and decontamination sites, and sites identified in the EG&G aerial radiation survey) (see Figure 4-4). BNL is currently the only potential source of radionuclides in soils in the immediate area, except for naturally occurring radionuclides and fallout. Consequently, the focus of soil sampling has been area-specific, as opposed to routine, site-wide monitoring, and has been limited to radiation and radioactive contaminants. Because soil

monitoring is limited in terms of areas sampled and constituents analyzed, the Survey team, in some cases, utilized process information and physical evidence of contamination to identify a number of potential soil contamination sources and areas of known soil contamination.

Actual and potential sources of soil contamination from experiments, operations, and airborne emissions, both past and present, are described below. These areas primarily consist of diffuse and/or large areas where soils have been contaminated. Discrete areas of soil contamination resulting, for example, from isolated small spills or deteriorated drums, are addressed in Section 4.5. Soil contamination, if any, associated with active and inactive waste disposal sites (e.g., the present and former landfills) is addressed in Sections 4.1 and 4.5, respectively. The exception to this idea is the Meadow Marsh Project discussed below, which involved the use of in-place soils as a filter medium for radioactive and nonradioactive contaminants. Supporting data and a complete discussion the following sources or areas of soil contamination are provided in Finding 3.2.4.3.1.

- Hazardous Waste Management Area (HWMA) - Soils within and adjacent to the HWMA have been or may be contaminated with radionuclides, organics, and inorganics, as a result of past and present activities/operations.

- AGS Steel Storage Scrap Yard - The AGS Department presently maintains two scrap steel storage yards. Radioactive particles from rusting steel may have contaminated the soil.

- Air Stripping Area - Air stripping was initiated in 1985 to remove volatile degreaser solvents (chloroform, trichloroethylene, tetrachloroethylene, and 1,1,1-trichlorethane) from the groundwater at BNL. The air stripping operation represents a potential source of soil contamination.

- Meadow Marsh Project - Also known as the Upland Recharge Experiment, this project, which was initiated in mid-1973, involved the land application of liquid effluent from residential cesspools and the BNL sewage treatment plant. The soil in this area was used as a medium to filter out various radioactive, organic, and inorganic contaminants. The extent to which the soil is contaminated is unknown.

- Landfill Leachate - Soils adjacent to the current landfill may be becoming contaminated by leachate.

- Cs-137-Contaminated Landscaping Soil - An aerial radiological survey of the BNL site performed in 1980 (Hobaugh, 1984) indicated that above-background radiation levels,

possibly indicative of soil contamination, existed on the site. These areas were investigated, and the radionuclide of concern in several areas was determined to be Cs-137. It was concluded that the Cs-137 contamination was an isolated incident and not indicative of sitewide contamination.

The sources and areas of soil contamination described above have the potential to affect other environmental media such as air, surface water, and groundwater. The major threat posed by soil contamination at BNL is primarily migration of contaminants to surface water and groundwater. The extent to which soil contamination has affected surface water or groundwater is addressed in Sections 3.3. and 3.4, respectively.

3.2.3 Environmental Monitoring Program

BNL conducts soil sampling both on-site and off-site. The on-site soil sampling program is limited in terms of the sampling frequency, the constituents analyzed, and the areas sampled (i.e., it is not performed sitewide on a routine basis, and the focus is on radionuclides). Typically on-site sampling for radionuclides is conducted in response to on-site construction projects, decommissioning and decontamination projects, and in response to suspected contamination (as was indicated by the 1980 EG&G aerial radiological survey). Since there is no program (past or present) to assess the overall environmental impacts of BNL's operations on soils and vegetation (on a sitewide basis), there is little environmental monitoring data available for on-site soils and vegetation.

The levels of off-site radioactive contamination are monitored annually by measuring radioactivity in vegetation, milk, and soil at five dairy farms in the vicinity of the site. The samples are collected by the Suffolk County Department of Health Services (SCDHS) and analyzed by BNL. Table 3-10 presents results of the vegetation and soil analyses performed in 1985. The radionuclides reported are K-40, Cs-137, Be-7, Th-228, Ra-226, and Hg-203 (Day et al., 1986). One milk sample was collected at a dairy farm in the vicinity of the laboratory site. The only radionuclide detected was naturally occurring K-40 at a concentration of 1.5×10^{-6} µCi/ml (Day et al., 1986). The data from one year to the next may not be comparable because it is not known if the sampling locations and methodology are standardized for the media (animal products, vegetation, and soil) sampled. In addition, the validity of the data may be suspect because the sampling methods, protocols, and quality assurance (QA) measures used by Suffolk County are unknown (see Finding 3.2.4.4.1).

TABLE 3-10

RADIONUCLIDE CONCENTRATIONS IN SOIL AND VEGETATION, 1985
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

	Radionuclide					
Sample Matrix	K-40 pCi/Kg	Cs-137 pCi/Kg	Be-7 pCi/Kg	Th-228 pCi/Kg	Ra-226 pCi/Kg	Hg-203 pCi/Kg
Grass	4,800	101	1,700	72	ND	ND
Grass	4,960	12	230	ND	ND	ND
Grass	2,900	ND	410	ND	ND	ND
Grass	4,860	ND	1,340	33	ND	ND
Grass	4,440	111	2,030	20	ND	ND
Strawberries	1,340	ND	140	ND	ND	ND
Soil	2,740	275	ND	248	201	ND
Soil	3,890	657	ND	295	89	ND
Soil	4,500	216	ND	ND	500	ND
Soil	6,100	178	ND	869	657	ND
Soil	5,650	924	740	873	622	70

Source: Adapted from Day et al., 1986.

ND: Not detected.
Note: Sample locations listed in the source document were not detailed enough to provide geographic locations.

3.2.4 Findings and Observations

3.2.4.1 Category I

None.

3.2.4.2 Category II

None.

3.2.4.3 Category III

1. On-site soil contamination - Actual and potential areas of on-site soil contamination have not been fully identified and characterized. The Survey identified the following specific areas that are or may be contaminated with hazardous constituents or radionuclides:

   a. Hazardous Waste Management Area (HWMA) - Soils within and adjacent to the HWMA have been or may be contaminated with radionuclides, organics, and inorganics, as a result of past and/or present activities/operations. These activities/operations include the following:

      - Containers of radioactive oil, radioactive solidified evaporator sludge, and oil spill cleanup debris are stored outdoors. The containers, some of which were deteriorating, may eventually release their contents to the environment [see Findings 4.1.2.3.1(a) and 4.5.2.3.1(d)].

      - Spills from the past practice of neutralizing acids and bases and dumping the acid/base neutralization supernatant on the ground [see Findings 4.1.2.3.1(b) and 4.5.2.3.1(d)].

      - Long-term storage of activated parts from the Alternating Gradient Synchrotron (AGS). These parts are stored outdoors directly on the ground (see Finding 4.1.2.3.1(c)).

      - Long-term storage of gas cylinders, neutralization salts, and activated equipment (other than AGS equipment). These materials are stored outdoors directly on the ground [see Findings 4.1.2.3.1(d) and 4.5.2.3.1(d)].

b. A S Steel Storage Scrap Yard - The AGS Department currently maintains two steel storage scrap yards. One yard is intended for the storage of steel contaminated by radioactivity and the other yard to store "clean steel." During the Survey it was noted that clean steel and radioactive steel were not separated, but stored in either yard. Some of the steel has been stored in the yards for more than 20 years and has rusted. The rust flakes have fallen to the ground, and as a result, radioactive particles of steel may have contaminated the soil. Additionally, surface water has ponded in the yards during rainfall events. The result is the downward migration of the radioactive particles and any soluble constituents into the soil (see Finding 4.1.2.3.3).

c. Air Stripping Area - Air stripping was initiated in 1985 to remove volatile degreaser solvents (chloroform, trichloroethylene, tetrachloroethylene, and 1,1,1-trichlorethane) from the groundwater at BNL (see Finding 3.4.4.3.1(a)). Continual operation of the air strippers is planned until the level of volatile organics is acceptable to the State of New York. The air stripping operation represents a potential source of soil contamination. The groundwater that is being pumped and sprayed contains other contaminants besides chlorinated organics. These include gross alpha and beta emitters, Cs-137, Co-60, H-3, Na-22, Sr-90, Fe, Mn, Na, Pb, Zn, chlorides, and sulphates.

d. Meadow Marsh Project - Also known as the Upland Recharge Experiment, this project, which was initiated in mid-1973, involved the land application of liquid effluent from residential cesspools and the BNL sewage treatment plant. The soil in this area was used as a medium to filter out various radioactive, organic, and inorganic contaminants. The types and concentrations of contaminants in the effluent are not fully known. The only radionuclides present (and analyzed for) were tritium, Sr-90, gross alpha, and gross beta. Inorganics included copper, zinc, and iron. Chemical analysis of samples taken in December 1973 from wells in the area showed that, except for nitrate, the impacts on groundwater were negligible (see Finding 3.4.4.3.1(e)). Tritium was found in the groundwater 3 months after the project started. Application of effluents continued until December 1978. The extent to which the soil is contaminated is unknown [see also Finding 4.5.2.3.1(n)].

e. Landfill Leachate - Soils adjacent to the current landfill may be being contaminated by leachate. Several discrete leachate streams are emanating from the northeastern and eastern sides of the landfill. The leachate is flowing across the surface of the soil and ponding. Ultimately the leachate percolates into the soil toward groundwater (see Findings 4.1.2.2.2 and 4.5.2.3.1(f)).

f. Cs-137 Contaminated Landscaping Soil - An aerial radiological survey of the BNL site performed in 1980 (Hobaugh, 1984) indicated that radiation levels possibly indicative of soil contamination existed on the site. These areas were investigated, and the radionuclide of concern in several areas was determined to be Cs-137. The source of the contaminated soil is believed to have resulted from spills of aged fission products stored (and subsequently removed) in the HWMA. Soils from that area were scraped to a depth of 15 to 20 cm in 1954-1955, 1958, and the mid-1960s and "banked" at the former landfill (Miltenberger, Undated). The contaminated soil subsequently was used for on-site landscaping at Buildings 30, 355, 490, 510, 555, and 930. The levels of radiation in those areas ranged from 7 to 60 μR/hr. The only remedial action recommended was to identify the locations on the Plant Engineering maps and do periodic monitoring (Miltenberger, undated). The Cs-137 contamination was an isolated incident and not indicative of sitewide radionuclide soil contamination.

3.2.4.4 Category IV

1. Inadequate routine soil-monitoring program. The lack of an adequate program for routinely monitoring on-site and off-site soils may result in lack of detection environmental contamination of these soils.

BNL does not perform routine, on-site soil monitoring to determine whether laboratory activities are contaminating soils on a site-wide basis. Although on-site soil monitoring is performed, it is not performed on a routine basis and is limited to specific areas (of known or suspected contamination) and the preponderance of constituents analyzed are typically radionuclides (see Finding 3.2.4.3.1).

Routine, off-site monitoring of soils, vegetation, and milk is performed annually by SCDHS. BNL's role is limited to sample analysis. Although the results to date indicate that BNL activities do not significantly affect off-site soils, the effectiveness of the program and quality of the data are unknown. BNL does not have SCDHS's procedures on file, nor does BNL have control over the sampling program. The validity of the data generated by the SCDHS program is suspect because the sampling methods, protocols, and quality assurance measures used by SCDHS are unknown.

Because of the nature of the activities conducted at BNL, site-wide soil contamination, either on-site or off-site, is not expected to be a problem; however, there are insufficient analytical data to empirically support this contention.

2. Limited monitoring of soil excavations - The lack of a program to monitor excavated site areas for nonradiological constituents may result in failure to identify possible contamination. Currently, radiological concerns associated with excavations are evaluated by Health Physics personnel. Where decommissioning and decontamination is involved, soil is cleaned to a penetrating radiation level equivalent to background (6-10 μR/hr). However, no data are routinely collected to evaluate potential nonradiological contamination. It is not known whether there are nonradiological contaminants in the soil column, even though it is known that several potential contaminants are used and have been released on the site.

3.3 Surface Water

3.3.1 Background Environmental Information

Brookhaven National Laboratory occupies 2,130 hectares (5,265 acres) of gently rolling land in Suffolk County, New York. All but about 680 hectares (1,680 acres) are relatively undeveloped, wooded, natural terrain ranging from 13.3 to 36.6 meters (44 to 120 feet) above sea level. The site lies on the western rim of the shallow Peconic River watershed, with a principal tributary of the river rising within the marshes of the north and east sections of the site. Refer to Figure 3-3. The river itself rises north and east of BNL, then flows due east into Flanders Bay, an arm of Great Peconic Bay. Under natural conditions, precipitation is the source of all fresh water on Long Island, averaging 122 centimeters (48 inches) per year. An interesting feature of the precipitation pattern is its relatively narrow range of average monthly values, from about 6 to 13 centimeters (2.4 to 5.2 inches) per month. As a result, there is a noticeable absence of long wet or dry seasons found in most other parts of the country (Liverman, 1977).

There is relatively little direct runoff into surface streams because the sandy, highly permeable soils allow rapid water penetration. As a result, 95 percent of all surface stream flows are derived from groundwater seepage. About 44 percent of the total precipitation that falls on Suffolk County is consumed by evapotranspiration, while about 50 percent penetrates the soil quickly and recharges the groundwater reservoir. This pool of freshwater, which is estimated to contain 11×10^{12} to 23×10^{12} liters (3×10^{12} to 6×10^{12} gallons) underlying Suffolk and Nassau Counties, is the sole source of fresh water for the 2.6 million people living in those two counties.

Because of BNL's location at the headwaters of the Peconic and its tributaries, flooding is not a major problem. The porous soil, the distance to the water table, and the evenly distributed rainfall frequencies, all tend to minimize the chance for serious flooding. Exceptions do occur during hurricanes, when intense rainfall can accumulate more rapidly than it can penetrate or run off. Hurricane Edna produced 22.9 centimeters (9.02 inches) of rain in a single storm on September 10 and 11, 1954. During the peak of that storm, 5.3 centimeters (2.1 inches) fell in a single hour. But even these volumes of water were soon absorbed once the storm passed.

All of the process and potable water used at BNL is withdrawn from a series of private wells on-site. Two basic types of distribution systems exist. One provides well water that is chlorinated for use throughout the site for all cooling water, process, and domestic needs, including potable water for human consumption. The other system provides cooling and air conditioning water only for selected large volume users. Both systems provide treatment (iron removal and pH adjustment) for those

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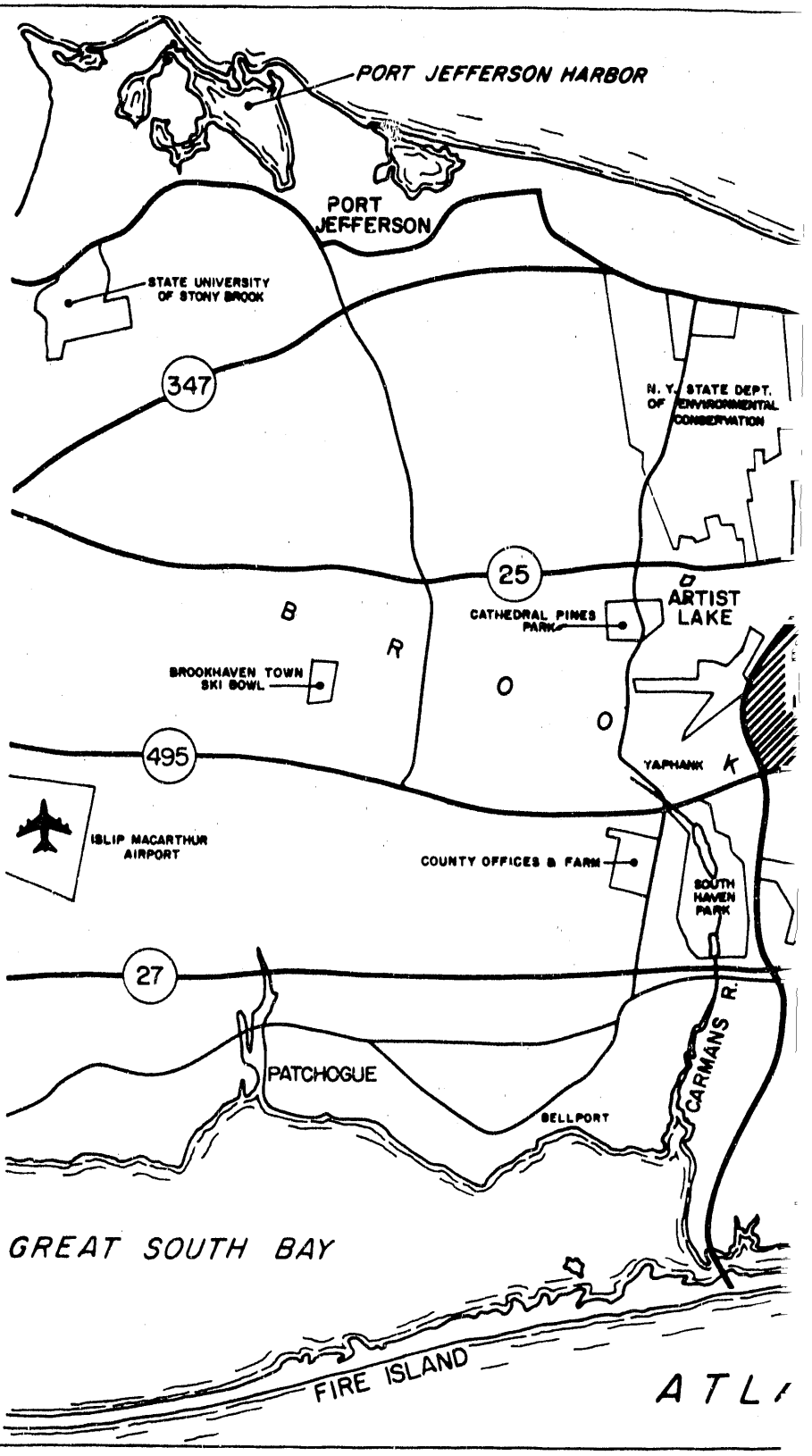


Source: BNL, 1985.

MAP SI

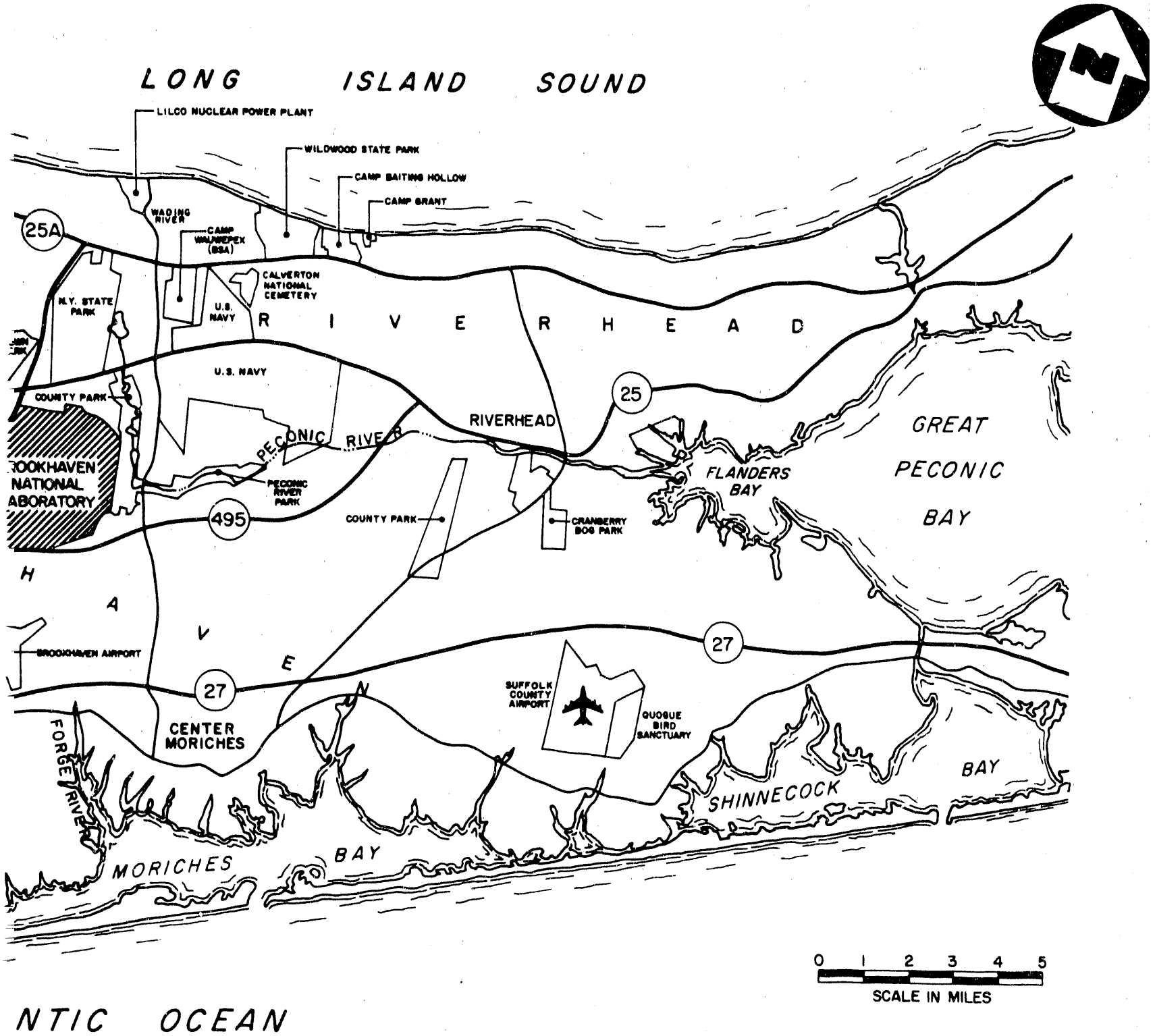


FIGURE 3-

OWING SURFACE WATER FEATURES
BNL - UPTON, NY

wells known to be high in iron content and acidity.

Considerable flexibility exists, depending on which wells are used to meet BNL's normal water requirements. During the Survey the water distribution in effect can be summarized as follows:

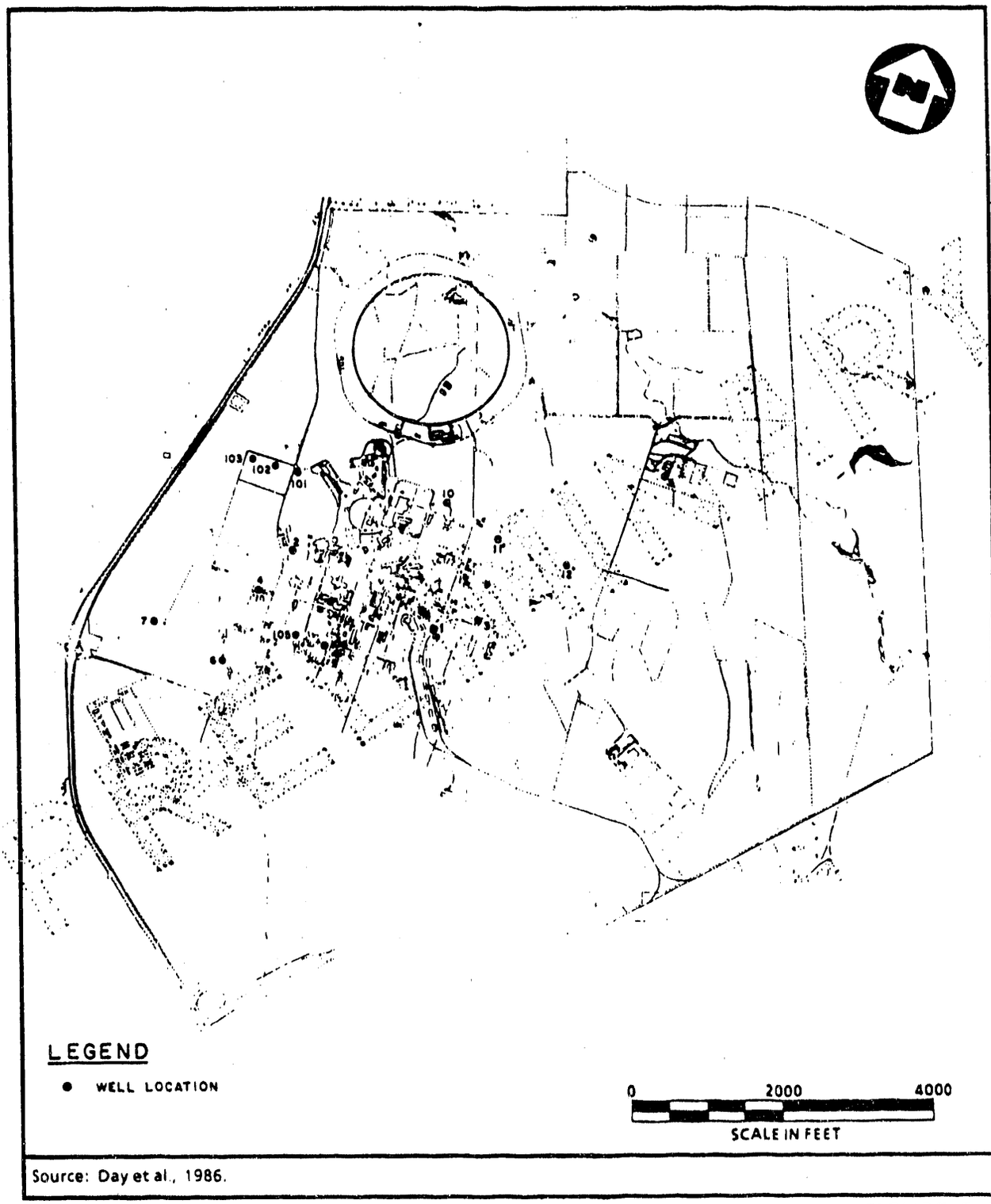
- Potable water sources: Wells 7, 6, and 4 (in that sequence) provided iron-laden water to the Water Treatment Plant (Building 624) for iron removal and chlorination. Well 2 was placed out of service in August 1985 because of contamination from volatile organics. Wells 10, 11, and 12 alternated lead positions to provide additional potable water (following chlorination at the well head). Treated water flows were blended and distributed throughout BNL. Wells 1 and 3 were placed out of service, the former in September 1986 due to high volatile organics, the latter in December 1986 to prevent migration of a suspected contaminant plume toward the well.

- Process (nonpotable) water sources: Wells 101, 102, and 103 provided iron-laden water to treatment, followed by distribution to the Alternating Gradient Synchrotron (AGS) (Building 911 Complex) for use in cooling the main ring heat exchangers and for air conditioning the entire AGS facility. Wells 104 and 105 provided clean water for reactor cooling and air conditioning uses at the Medical Research Center (Building 490) and the Medical Research Reactor (Building 491). Locations of all supply wells are shown in Figure 3-4.

Typical flows for the systems described above are given in Figure 3-5 in million liters per day (MLD) and gallons per minute (GPM). A water balance summarizing the typical daily flows is provided below:

	MLD	GPM	% of Total
Fresh water withdrawn from aquifer:			
Potable	14.80	2,715	61.8
Nonpotable	9.16	1,681	38.2
Total Volume Withdrawn	23.96	4,396	100.0
Water distribution and disposal:			
• Evaporative losses:			
Cooling towers	1.70	312	7.1
Atmospheric and windage	1.05	193	4.4
Steam generation	0.10	18	0.4
Subtotal Evaporated	2.85	523	11.9
• Recharged to aquifer:			
Deliberate	15.61	2,864	65.2
Inadvertent	2.88	528	12.0
Subtotal Recharged	18.49	3,392	77.2
• Released to the Peconic River	2.62	481	10.9
• Total Distributed and Disposed	23.96	4,396	100.0

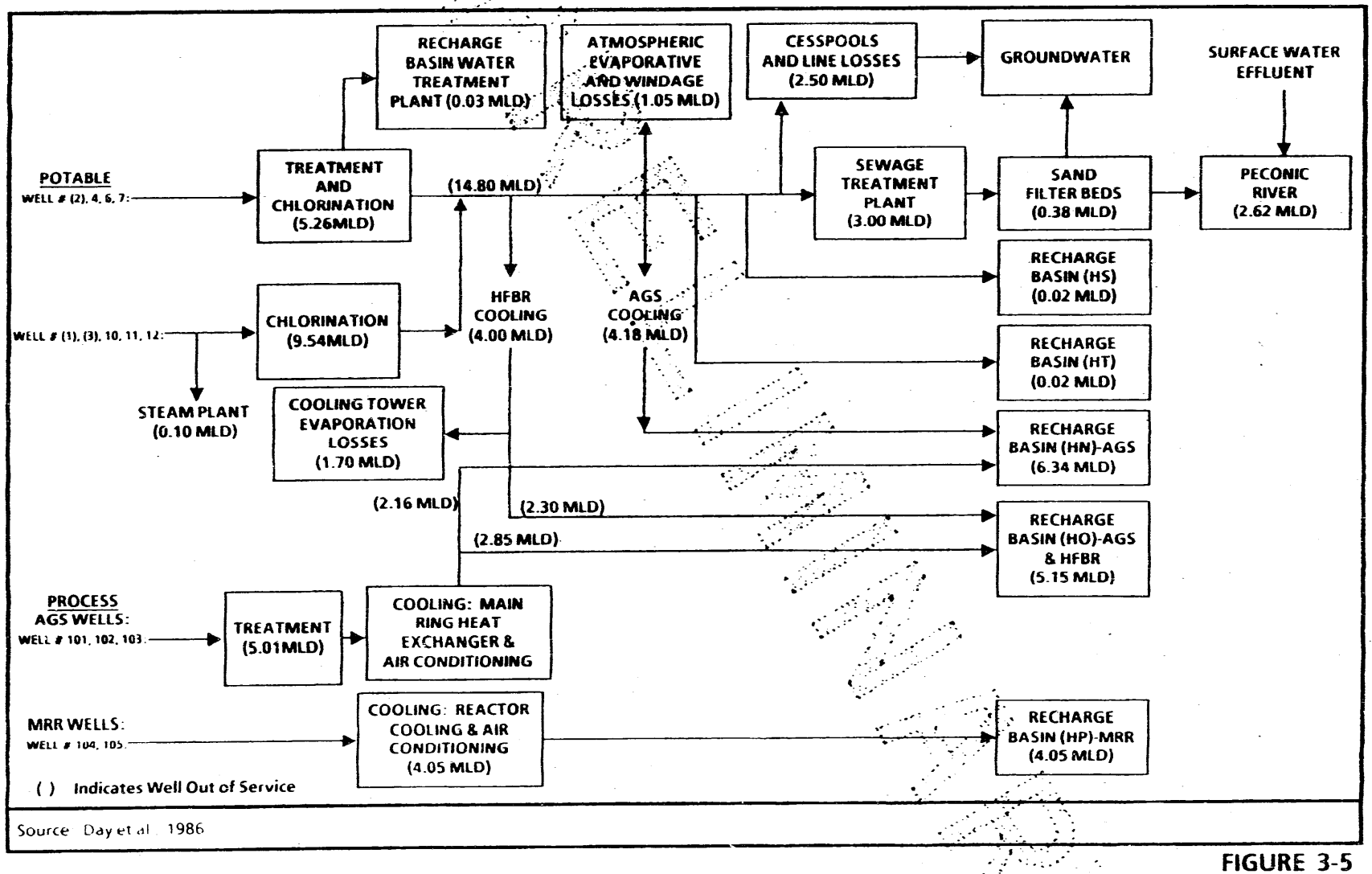
Sources: Adapted from Day et al., 1986



Source: Day et al., 1986.

FIGURE 3-4

LOCATION OF POTABLE AND SUPPLY WELLS
BNL - UPTON, NY



Source: Day et al., 1986

FIGURE 3-5

SCHEMATIC OF WATER USE & FLOW
BNL - UPTON, NY

From the above summary, it becomes obvious that more than three-fourths of all water withdrawn from the aquifer is returned to the aquifer, either deliberately by means of recharge basins and cesspools designed to encourage percolation into the soil, or inadvertently through line losses in the sanitary sewer system and sand filtration operations at the sewage treatment plant. Moreover, a significant portion of the 10.9 percent released to the Peconic will also percolate through the stream bed to recharge the aquifer before the river merges with the salt waters of Flanders Bay and Great Peconic Bay (Liverman, 1977).

3.3.2 General Description of Pollution Sources and Controls

All major sources of polluted or contaminated wastewaters have been identified at BNL, and appropriate controls are being applied. BNL has adopted a basic principle of confining and concentrating its liquid wastes to minimize the volumes requiring decontamination or treatment. Liquids are segregated at their point of origin on the basis of their expected concentrations of radioactivity or other potentially hazardous nature. Nontoxic solutions are released to the sanitary sewer system along with low volumes of cooling waters, general laboratory rinsewaters, sink discharges, and domestic wastes. Every attempt is made to minimize the wastewater flows entering the system. Rather than acting as diluents, large volumes of cooling water from heat exchangers and air conditioning units at the Alternating Gradient Synchrotron (AGS), the High Flux Beam Reactor (HFBR), and the Medical Research Reactor (MRR) are pumped to recharge basins and allowed to infiltrate the ground to recharge the aquifer. These basins lie a considerable distance from the cooling-water sources. Part of the AGS flow is pumped to basins 610 meters (2,000 feet) northeast of the AGS, while the rest of the AGS flow is mixed with HFBR cooling waters and released to basins 670 meters (2,200 feet) east of the HFBR. MRR cooling waters are transferred 305 meters (1,000 feet) due south of the medical reactor and research complex. Refer to Figure 3-6 for details.

Where small volumes (up to 100 liters) of liquid radioactive effluent are generated from laboratory operations, arrangements are made to collect wastewaters at their point of origin prior to mixing with other liquid wastes. Those BNL facilities which produce larger volumes of radioactive liquids are equipped with dual waste-handling retention systems, one for "active" (D) wastes and the other for "inactive" (F) wastes. Facilities so equipped include the HFBR (Building 750), the Hot Laboratory Waste Processing Operation (Building 801), the Decontamination Facility (Building 650), and the Medical Research Center (Building 490). Wastewaters from these operations are retained in holdup tanks ranging in size from 1,900 liters (500 gallons) to 7,600 liters (2,000 gallons) while sampling and analyses are conducted to quantify wastewater characteristics. Radioactivity criteria used to define

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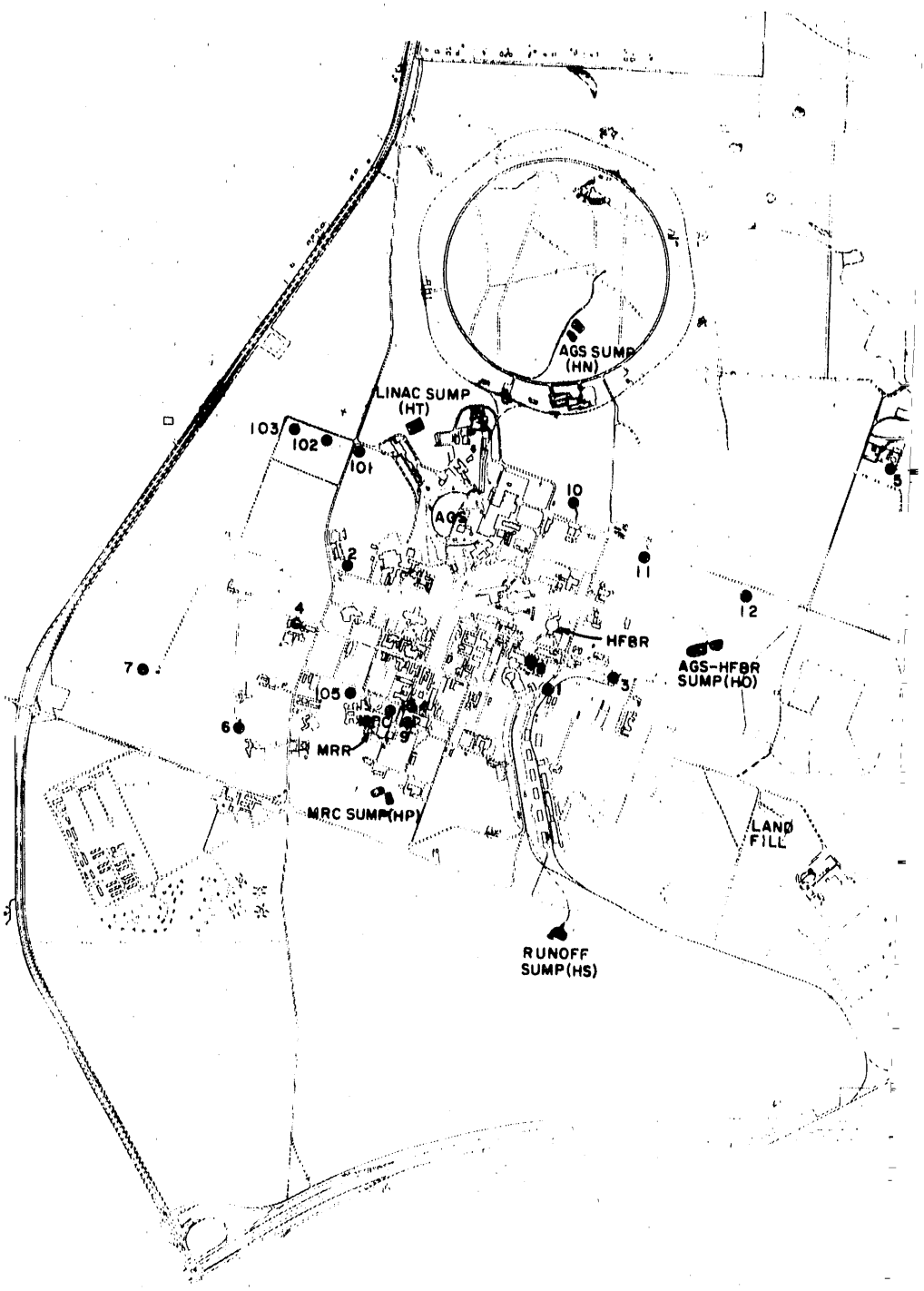
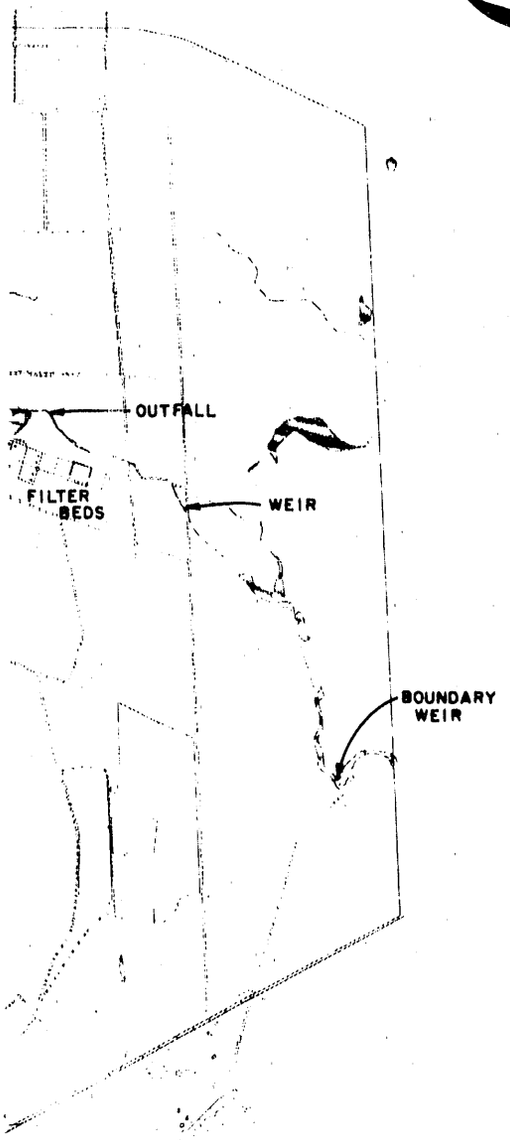


Source: Day et al., 1986.

POTABI



LEGEND

- WELL LOCATION
- SUMP LOCATION

0 2500 5

SCALE IN FEET

FIGURE

E & SUPPLY WELLS AND RECHARGE SUMPS
BNL - UPTON, NY

wastewater that can be released directly to the sanitary sewer as opposed to wastewater that must be handled as radioactive wastes are as follows:

Gross alpha activity	< 100 pCi total
Gross beta activity	< 1 mCi total
Tritium	< 100 mCi total

The tritium cut-off point was changed, effective June 3, 1985, to <5 mCi total as part of a sitewide response to concerns about tritium releases to the Peconic River. Certain other nonradioactivity criteria are also defined in BNL guidelines for use on a case-by-case basis, as needed. These criteria have only been applied very rarely. No wastewater subject to the nonradioactivity criteria has ever failed to be acceptable for release (BNL, 1984).

Depending upon the results obtained, the wastewaters are either discharged directly to the sanitary sewer system for treatment at the Sewage Treatment Plant (STP), if compatible with that operation, or transferred to the Waste Concentration Facility (WCF) at Building 811 for special handling. This transfer is accomplished by dedicated underground pipelines from Buildings 750 and 801, or via tank trucks from the other operations.

Other sources of radioactive wastewaters that are delivered to the WCF for treatment include the following:

- Department of Applied Science (DAS) laboratories in Buildings 815 and 830.
- Biology, Chemistry, and Physic laboratories in Buildings 463, 555, and 510, respectively.
- The LINAC Isotope Production Facility in Building 931B.
- The Medical Research Reactor in Building 491.
- Small-volume containers of liquid wastes from individual laboratories throughout BNL.

The WCF is designed to provide temporary storage for the incoming wastes; distillation to separate volatiles (including water) from particulates, suspended, and dissolved solids; and temporary storage of distillates. The evaporator is a vapor compression unit that reduces the total liquid volume by a factor of ~100. Distillates were formerly allowed to trickle into the sanitary sewer system after monitoring for radioactivity, but this practice was discontinued in December 1984. Since then, distillates have been allowed to accumulate in underground holding tanks, which are now full. As a result, the WCF has not been able to process any additional wastes for over a year, while a decision is made regarding an acceptable disposal method for the distillates. Refer to Finding 4.1.2.2.1 for further information on this disposal problem.

The slurry remaining after distillation contains a concentrated form of the radioactive metals originally present in the solutions. This slurry is mixed with concrete, solidified in drums, and stored at the HWMA awaiting shipment to ultimate disposal off-site. Concern exists about the possibility of some of the solidified slurries being considered mixed wastes because of the presence of hazardous metals and radioactivity. Refer to Finding 4.1.1.2.2 for a more complete discussion on this mixed waste issue.

In addition to the sources of contaminated wastewater described above, several other smaller sources exist on-site at BNL. Those which regularly generate liquid effluents are summarized below:

- The Hot Laundry - Building 650. In addition to the previously addressed Decontamination Facility, Building 650 also houses BNL's laundry facilities. As soiled laundry is delivered to the building, any potentially radioactive laundry is segregated from routine laundry. Dedicated equipment for contaminated laundry only, is equipped with its own isolated drains and a sump for holding washwater until it can be monitored for radioactivity. Depending on results of analysis, these wastewaters are then routed to the WCF or to the sanitary sewer system. The nonradioactive laundry is cleaned in other washers, from which all wastewaters routinely are released to the sewage treatment plant without holdup.

- Photography and Graphic Arts - Building 118, 197, and 493. Film processing, printing, and developing, rinsewaters and spent solutions are handled in accordance with the latest manufacturer's recommendations. Solutions requiring pretreatment are treated via ion-exchange cartridges prior to release to the sanitary sewer system. Waste minimization through reuse/recycle is practiced. For example, continuous electrolytic removal of silver allows fixer solutions to be used for several process cycles instead of once. Even trace amounts of silver are removed galvanically, using a process which releases a totally biodegradable wastewater to the STP.

- Component Cleaning, Degreasing, and Parts Washing Lines - Buildings 197, 208, 423, 452, 905, 924, and possibly other buildings. Metal parts are degreased in solvents and chemically cleaned in a series of solution and rinse tanks. Typical solutions include 1,1,1-trichloroethane as the degreasing solvent and hydrofluoric/nitric acids, sodium hydroxide, sulfuric acid, acetone, and clean rinse water. Metal parts subjected to cleaning are made of stainless steel and aluminum for the most part, but a lesser amount of copper, brass, and titanium is also cleaned. At Building 197, the system operates currently with a

new solvent recovery arrangement, generating 208 liters (55 gallons) of reclaimed solvent every two or three weeks. Formerly, spent solvent was released to a nearby cesspool, which also received rinsewaters from the other sections of the cleaning line. The cleaning room at Building 208 consists of seven tanks with automatic level sensors and makeup water addition. This system was built in 1984, operated for about 18 months, then shut down to repair leaks in the system. Spent solutions drain to a sump at one end of the line, from where they are pumped to tank trucks and handled as hazardous wastes. The other buildings contain solvent tanks ranging in size from 110 to 760 liters (30 to 200 gallons). Buildings 423 and 452 have three and two tanks, respectively.

- Central Steam Plant - Building 610. The BNL steam generating system consists of four boilers whose total capacity is 340,000 pounds of steam/hour. This capacity is more than two times recent peak demands of 160,000 pounds/hour. Plans exist to further upgrade the system so that it would be capable of producing 250,000 pounds/hour even if the two largest boilers were off-line. The plant operates continuously, burning a blend of fuels ranging from pure No. 6 virgin fuel oil to a 50/50 mixture blend of light feedstocks and No. 6 fuel oil. Steam is distributed throughout BNL at 125 psig via a 10-mile-long underground distribution system. Condensate is collected and routed back to the boilers following deaeration. Approximately 85 percent of all condensates are recovered. Softened water is used as makeup to the boilers, and all blowdown flows are directed to the sanitary sewer system.

- Cesspools and Septic Tanks at numerous buildings. Although BNL has expanded its sanitary sewer system to allow for tie-in of most of the laboratory operations, at least 24 active cesspools and septic tanks remain in use, without including those in the housing areas. The latter would handle domestic wastewaters only. However, many of the other 24 facilities have a potential for receiving contaminated wastewaters from machine shops, cleaning operations, assembly areas, craft shops, and other laboratory-related processes. About 75 percent of the cesspools are included in a planned phase-out program, including five buildings scheduled for tie-in in FY 1987. The remaining sites have not yet been included in any tie-in plans. Refer to Section 4.5.1.3 and Finding 4.5.2.3.2 for additional information on cesspools.

- Sanitary Sewage Treatment Plant (STP). The major control for liquid effluents is the primary and secondary treatment given to all sanitary wastewater delivered to the STP. A 950,000 liter (250,000 gallon) clarifier removes suspended solids from the inlet stream, while a series of sand filter beds provides secondary treatment. The filtrate is recovered

through an underground tile field and released to the Peconic River's headwaters, often making up the major portion of the flow downstream of the effluent release point. The effluent discharge is regulated by New York State's SPDES Permit No. 0005835 (NYSDEC, 1983). Refer to Section 3.3.3 for more details. The sludge and skimmings from the clarifier are routed to an anaerobic digester for reduction of volume. The sludge from the digester is dried on sludge drying beds prior to testing and disposal at on-site landfills. In addition, the sand used in the series of filter beds to provide secondary treatment of effluents has been dredged out of the beds and replaced on at least two occasions. Some of this sand was placed alongside the filter beds on the north and south sides, while the remainder was used as fill or transferred to the former landfill. These solid materials contained radioactive metals and other pollutants, which may still be contaminating groundwater. Refer to Finding 3.4.4.3.1.c for additional information on known groundwater contamination from this source.

- Sanitary Sewer Mains and Pipelines. As outlined in Section 3.3.1, 2.88 million liters per day (761,000 gpd) of BNL's water are recharged to groundwater via cesspools, line losses from the collection system, and percolation downward from the sand filter beds at the STP. About 1.2 million liters per day (317,000 gpd) of this total are lost inadvertently through leaks in sewer pipes and joints enroute to the STP (ERDA, 1977). Cesspools were discussed above. The water recharged from the sand filter bottoms is of the same quality as surface water released to the Peconic River, both having received the same treatment. But the water lost through leaking pipes and joints has not yet been treated, and contains raw sewage plus any laboratory-generated contaminants. The sewer system dates back as far as 1917, with major repairs in 1970 when the original STP was erected. Since then, the collection system has been extended and modified to its present 50 km (31-mile) length. Because of its size, age and complexity, the sanitary sewer system is probably one of the major nondeliberate sources of recharge to the groundwater below BNL. Refer to Finding 3.3.5.3.2 for additional information on this subject.

In addition to the above sources of contaminated wastewater that generate liquid effluents on a regular basis, BNL also has a few other actual or potential sources that can produce contaminated wastewaters only if certain conditions exist. For example, storm events produce excess water, which can run off into areas where soil contamination may exist, and thus transfer soluble, radioactive pollutants to the water. BNL has provided a system of catch basins, culverts, and storm sewers to collect stormwater in the developed portions of the site. This collection system discharges at headwalls into swales and recharge lagoons outside the developed areas. This method of controlling stormwater

maximizes the percolation of water into the ground and is the standard method of stormwater disposal throughout Long Island. Because of the high flow and large volume of such water during storm events, concentrations of pollutants are diluted to low levels, typically below limits of detection.

However, in the Hazardous Waste Management Area (HWMA), runoff is much more likely to contain elevated levels of contamination. Runoff from the materials handling and segregation areas is diverted to an unlined pond just northwest of HWMA operations, and partially outside the fenced-in, secure area. Neither the runoff nor the receiving pond have been characterized for hazardous or radioactive pollutants. Refer to Finding 3.3.5.2.1 in this section and to related Findings 3.2.4.3.1(a), 3.4.4.3.1(a), and 4.1.2.3.1 in other sections of this report.

There have been efforts made to control runoff in certain other areas where potential contamination exists. For example, the Central Steam Facility (CSF) has enclosed its fuel storage tanks within containment dikes, some of which are impervious. Runoff collected within CSF's mini-tank farm containment area is checked for visible oil sheen. If sheen is absent, runoff is pumped to the sanitary sewer collection system for treatment at the STP. If sheen is visible, samples are collected and analyzed to determine whether the runoff must be treated as a hazardous waste or can be released to the STP.

BNL describes other methods for eliminating the discharge or release of oil in its Spill Prevention, Control, and Countermeasures Plan (Mahlmann, 1985). Preplanned procedures are given in the plan to minimize any impact from casualties to any storage tank or associated pipelines on the sole-source aquifer below BNL or on any surface water receptors. The SPCC Plan has undergone three revisions since it was first prepared and is reviewed regularly to make certain that necessary changes are made as quickly as possible.

3.3.3 Environmental Monitoring Program

BNL publishes an annual Environmental Monitoring Report (EMR) for distribution internally and externally. Topics covered include airborne and liquid effluents, radioactivity, potable water, groundwater, off-site dose assessments, and impacts on the Peconic River.

One of the critical measurements in the EMR is the degree of compliance with BNL's SPDES permit covering releases to the Peconic River from the Sanitary Sewage Treatment Plant (STP) and to the groundwater from each of five permitted recharge basins. SPDES Permit No. NY-0005385 became

effective on May 1, 1983 and has an expiration date of May 1, 1988. The original permit listed six recharge basins, including one at the water treatment plant (Building 624) for handling filter backwash wastewaters. On December 21, 1983, this release point was deleted from permit requirements, and iron limits at outfall 001 (the STP effluent) were modified. The current SPDES requirements are given in Table 3-11.

Note that outfall 001, the STP effluent, has specific numerical limitations on 18 parameters, plus a requirement that the receiving stream's dissolved oxygen content must not be depressed to less than 3 mg/l downstream of the effluent release point. Sampling frequencies vary from continuously for flow rates, to daily for 6 parameters, to monthly for the remaining 11 parameters. Despite the large list of requirements, BNL monitoring indicates a very high level of compliance with SPDES limitations, consistently meeting specified numerical limits 99 percent of the time. The only parameters that occasionally exceed compliance are total iron, pH, and radium-226. Total iron problems originate with the well water used on-site. Wells 4, 6, and 7 are high in iron content, but are treated to less than 0.2 mg/l prior to use. However, even minor additions of 0.5 mg/l of iron will cause exceedance of the 0.6 mg/l daily maximum limitation. But even when exceedances occur, they tend to be minimal. For example, the only 1986 iron exceedance occurred on the 24-hour composite collected in October, when the measured total iron concentration was 0.64 mg/l versus the SPDES limitation of 0.6 mg/l.

Similarly, for pH, the limitation specifies a range of 5.8 to 9.0 pH units for the BNL effluent from the STP. The range was missed by a narrow margin - pH 5.7 for one day in September 1986. All other pH readings ranged from 5.8 to 6.8. Considering that pH readings are made daily, compliance was obtained 99.5 percent of the time. The lower pH values are consistent with typical Long Island groundwater.

BNL monitors gross alpha activity readings daily at outfall 001 to assess compliance with the SPDES limitation on Radium-226. Through an understanding with the State of New York, specific analysis for Ra-226 is not required unless gross alpha concentration levels exceed 5 pCi/l as a daily maximum. BNL monitoring data show very few occasions when this limit is exceeded in the STP effluent, none within the last 2 years. Maximum daily gross alpha concentrations for 1986 and 1987 were reported as 4.52 and 3.40 pCi/l respectively. These maximum readings occurred in January of each year. The long-term average of all monthly maximum gross alpha readings is 2.3 pCi/l, and the 95 percent confidence range for maximum concentrations is 0.8 to 3.8 pCi/l. The overall average for all daily gross alpha concentrations (not just the monthly maximum) is 0.6 pCi/l, or 12 percent of the concentration used to require specific isotope analyses for Ra-226. For this reason, exceedance of the

TABLE 3-11

SPDES EFFLUENT MONITORING REQUIREMENTS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

OUTFALL 001 (SANITARY SEWAGE TREATMENT PLANT EFFLUENT)

Parameter	Sample Type	Frequency	Limitations	
			Daily Average	Daily Maximum
Flow	Automatic Record	Continuous	1.86 x 10^6 GPD	–
Temperature	Grab	Daily	–	90°F
pH	Grab	Daily	–	5.8 to 9.0
Chlorine	Grab	Daily	–	0.05 mg/l
Settleable Solids	Grab	Daily	–	0.1 ml/l
BOD_5	24-hour Composite	Monthly	10.0 mg/l	20 mg/l
Suspended Solids	24-hour Composite	Monthly	5 mg/l	10 mg/l
Copper	24-hour Composite	Monthly	3.0 lbs./day	0.4 mg/l(1)
Lead	24-hour Composite	Monthly	0.75 lbs./day	0.067 mg/l(1)
Zinc	24-hour Composite	Monthly	4.5 lbs./day	0.300 mg/l(1)
Iron (Dissolved)	24-hour Composite	Monthly	9 lbs./day	0.6 mg/l x 9 lbs./day
Silver	24-hour Composite	Monthly	0.75 lbs./day	0.05 mg/l(1)
Ammonia-Nitrogen	Grab	Monthly	–	2.0 mg/l
Total Coliform	Grab	Monthly	–	10,000/100 ml(2)
Fecal Coliform	Grab	Monthly	–	2,000/100 ml(2)
Gross Beta	Grab	Daily	–	1,000 pCi/l(3)
Radium 226	Grab	Daily	–	3 pCi/l
Strontium 90	Grab	Monthly	–	10 pCi/l

OUTFALL 002 (DISCHARGE TO HN RECHARGE BASIN)*

Flow	Instantaneous	Monthly	1.86 x 10^6 GPD	–
pH	Grab	Monthly	–	6.5 to 8.5

TABLE 3-11
SPDES EFFLUENT MONITORING REQUIREMENTS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

OUTFALL 003 (DISCHARGE TO HO RECHARGE BASIN)*

Parameter	Sample Type	Frequency	Limitations	
			Daily Average	Daily Maximum
Flow	Instantaneous	Monthly	1.5×10^6 GPD	–
pH	Grab	Monthly	–	6.5 to 8.5

OUTFALL 004 (DISCHARGE TO HP RECHARGE BASIN)*

Flow	Instantaneous	Monthly	1.7×10^6 GPD	–
pH	Grab	Monthly	–	6.5 to 8.5

OUTFALL 005 (DISCHARGE TO HS RECHARGE BASIN)*

Flow	Instantaneous	Weekly	5.0×10^3 GPD	–
pH	Grab	Weekly	–	6.5 to 8.5

OUTFALL 006 (DISCHARGE TO HT RECHARGE BASIN)*

Flow	Instantaneous	Monthly	5.0×10^3 GPD	
pH	Grab	Monthly	–	6.5 to 8.5

Source: NYSDEC, 1983

GPD - Gallons Per Day.
(1) Instantaneous Maximum.
(2) Monthly Mean Geometric.
(3) In the absence of Sr^{90} and alpha emitters.
* Records maintained at each discharging facility.

Additional Requirements:

- The 001 discharge shall not lower the dissolved oxygen of the receiving waters to less than 3 mg/l at any time.
- Water treatment chemicals listed in the permit application are under review for water quality effects. Application must be made to NYSDEC if other chemicals are contemplated.
- The effluent shall meet the requirements of the Nuclear Regulatory Commission.

3 pCi/l limit on Ra-226 concentrations in STP effluents is very unlikely, as is the need to analyze specifically for Ra-226.

All other pollutants are consistently below the limits cited in the permit requirements, most by a comfortable margin, with long-term average values at 10 to 30 percent of the SPDES limitations. Only temperature and total suspended solids yielded long-term averages and standard deviations large enough that the high end of their 95 percent confidence range would begin to approach permit limits. The range for temperature is 50 to 85°F, with a permitted maximum of 90°F. For total suspended solids the expected range is 0 to 4.4 mg/l, while the daily average limitation is 5.0 mg/l. Data for lead are difficult to assess, since analytical results sometimes include concentrations expressed as <0.1 mg/liter. The permitted daily maximum concentration is only 0.067 mg/liter, so it is not possible to state with certainty that a <0.1 mg/liter measurement is in or out of compliance. BNL has made improvements in its analytical capabilities for metals to eliminate this uncertainty. The most recent analyses show a daily maximum lead concentration of only 0.013 mg/l, well within lead's limits.

With respect to monitoring stations 002 through 006, numerical limitations are provided only for pH and flow rate. Radioactivity is routinely monitored for comparison with applicable Radiation Concentration Guides (RCG) in effect in 1985. Heavy metals, chlorides, sulfates, specific conductance, and temperature are also routinely monitored, at least on a quarterly basis. Filtrate analyses are conducted annually. The most difficult compliance problem is the low pH typically discharged to these basins. In 1986, 15 of 25 pH measurements were below the pH 6.5 level specified in the limitations. Outfall 002 pH readings varied widely from pH 5.0 to 10.1 (the only pH outside the high end of the range). This recharge basin receives flows from the AGS and the main ring heat exchanger and is subject to wider variations in flow rate and chemical composition. All four samples for outfall 004 were out of range, varying from a low of 5.0 to a high of 6.0. No 1986 pH or flow data were given for outfall 005, but 1985 monitoring data indicated pH levels as low as 5.9. Average and maximum values for water quality during 1986 are given in Table 3-12. There is some question whether the typically low pH values constitute an environmental problem for other users. SPDES limitations specify a pH range of 6.5 to 8.5 for water discharged to outfalls 002 through 006, but the State of New York has not cited BNL for its repeated nonconformances. No chemical changes occur to these waters through their use by BNL prior to recharge. The low pH is the "as received" condition for most of Long Island's groundwater sources. Addition of chemicals (lime, caustic soda, or soda ash) prior to recharge may be more detrimental to further use of the groundwater than returning it to the recharge basins at the low pH. SPDES permits for outfall 001, the STP effluent, provide for a pH range of 5.8 to 9.0 units to be considered in compliance, even though much of the total volume will percolate to the groundwater aquifer. This wider range seems more representative of acceptable conditions for recharge basins also.

TABLE 3-12

WATER QUALITY IN RECHARGE BASINS IN 1986
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

	SPDES Outfall Number				
	002	003	004	005	006
pH, units	5.0 - 10.1	5.0 - 7.4	5.0 - 6.0	No Data	5.3 - 7.6
Conductivity, μmhos/cm	126	170	177	No Data	167
Temperature, C°, average	16	14	16	No Data	17
Temperature, C°, maximum	24	22	18	No Data	25
Chloride, mg/l, average	18.8	21.9	23.6	No Data	15.4
Chloride, mg/l, maximum	19.2	26.8	27.6	No Data	17.8
Sulfate, mg/l, average	12.9	20.8	14.5	No Data	14.3
Sulfate, mg/l, maximum	13.0	22.5	15.5	No Data	15.8
Nitrate, mg/l	<2.5	<2.5	<2.5	No Data	<2.5
Gross α, pCi/l, average	0.183	0.250	0.198	0.604	0.089
Gross α, pCi/l, maximum	0.452	0.565	0.508	6.50	0.226
Gross β, pCi/l, average	13.8	2.48	1.52	3.56	2.61
Gross β, pCi/l, maximum	90.1	3.81	2.30	18.8	3.39
Tritium, pCi/l, average	331	221	147	385	309
Tritium, pCi/l, maximum	1,950	452	290	3,550	467
Silver, mg/l, maximum	<0.02	<0.02	<0.02	No Data	<0.02
Cadmium, mg/l, maximum	<0.005	<0.005	<0.005	No Data	<0.005
Chromium, mg/l, maximum	<0.025	<0.025	<0.025	No Data	<0.025
Copper, mg/l, maximum	0.16	<0.05	<0.05	No Data	<0.05
Iron, mg/l, maximum	1.93	2.90	2.24	No Data	0.08
Manganese, mg/l, maximum	0.27	0.24	0.17	No Data	0.05
Sodium, mg/l, maximum	18.7	24.5	29.1	No Data	25.6
Lead, mg/l, maximum	<0.025	<0.025	<0.025	No Data	<0.025
Zinc, mg/l, maximum	0.07	0.04	<0.01	No Data	0.01

Source: BNL, 1986a.

Even the pollutants, for which no numerical limits are stated, appear to be present at acceptable levels when compared with RCG values or SPDES Permit values given for outfall 001. As discussed above, pH readings were out of the proper range for all basins, but were representative of other Long Island groundwaters. Gross alpha values were a small fraction of the New York State (NYS) drinking water standard of 15.0 pCi/l. Likewise, all average gross beta values and four out of five maximum gross beta values were well below the 50.0 pCi/l compliance level proposed for drinking water. Only outfall 002 reported a gross beta level of 90.1 pCi/l on June 24, 1986. Samples collected in May and July at the same outfall reported gross beta readings of 2.79 and 3.91 pCi/l, respectively. This 3.91 pCi/l level was the second highest reading all year; hence the 90.1 pCi/l level may be an anomalous reading. All tritium measurements observed for the five recharge basins were mere fractions of the NYS drinking water standard of 20,000 pCi/l. The highest maximum level observed, 3,550 pCi/l at outfall 005, is still less than 20 percent of the standard.

With the exception of iron, all metals analyses yielded concentrations well below drinking water standards. Likewise, chlorides, sulfates, and nitrates also were minor fractions of the NYS drinking-water standard levels of 250, 250, and 10 mg/l, respectively.

Besides the required analyses to measure compliance with regulations, BNL also tracks radioactivity up and downstream in the Peconic River. Four background samples are collected upstream and from the north branch of the Peconic and from rivers outside the Peconic drainage area for comparison with samples downstream of the sewage treatment plant effluent discharge point. Refer to Table 3-13 for the most recent results of analysis. Sources along the Peconic River are identified as follows:

Point HM	-	0.3 km (0.2 miles) below outfall 001
Point HQ	-	2.0 km (1.2 miles) below outfall 001 at BNL Boundary
Point HR	-	19.5 km (12 miles) below outfall 001 at Riverhead

All three measured parameters were highest in STP effluents, then gradually abated until the farthest downstream readings represented only slight increases over background. Comparison with NYS drinking water standards (DWS) for gross alpha and beta indicated that all samples (including the STP effluent) could meet the applicable standards and RCGs. For tritium, effluents contained 3,000 pCi/l on the average (equivalent to the RCG), with peak measurements at 3 times that value. The NYS DWS of 20,000 pCi/l is achieved for all samples by a comfortable margin.

TABLE 3-13

RADIOACTIVITY MONITORING OF SURFACE STREAMS BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	pCi/l					
	Gross Alpha		Gross Beta		Tritium	
	Average	Maximum	Average	Maximum	Average	Maximum
Backgrounds: Point HA	0.056	–	0.943	–	296	–
Point HB	0.056	–	0.873	–	189	–
Point HC	0.113	–	0.943	–	215	–
Point HD	0.056	–	1.500	–	80.8	–
Avg. Background	0.070	–	1.065	–	195	–
STP Outfall: Point EA	1.460	4.52	17.1	37.3	3,000	9,070
Peconic River Point HM	0.859	3.93	5.84	15.2	974	3,020
Point HQ	0.141	0.282	7.02	9.95	2,032	3,200
Point HR	0.189	0.565	1.74	3.14	144	509
NYS Drinking Water Standard	15		50		20,000	
Derived Concentration Guide (DCG)	(a)		(a)		2,000,000	

Source: BNL, 1986a.

(a) DOE no longer publishes a DCG for gross alpha and gross beta. Individual radionuclide analyses are preferred, although gross alpha and gross beta determinations are still performed by most facilities as an indicator.

BNL SEP Division staff collect samples of fish from a downstream pond on the Peconic River and from several freshwater background ponds unrelated to BNL operations. The downstream pond, identified as Donahue's Pond, is actively fished by the general public. Specimens taken there represented five different species and two age groups, whereas specimens from background ponds were limited to a single species. Cesium-137 was measured on all fish, and Strontium-90 and tritium were run on those taken from Donahue's Pond. Results are given in Table 3-14.

BNL recognizes that the comparison would be more meaningful if control samples were analyzed for Sr-90 and tritium as well as Cs-137, so future tests will include those analyses. For Cs-137, the downstream samples averaged less than 10 percent higher than control samples when all species were compared, and about 12 percent higher when only chain pickerel were compared. These differences are relatively minor, and could reflect analytical variations alone. The large variations in Sr-90 concentration for all species in Donahue's Pond could be a result of different ages (compare the two brown bullheads), of feeding habits (bottom feeders like the bullheads; predators like the pickerels; and omnivores like the shiner, perch, and sunfish), or of varying skeleton sizes, since Sr-90 tends to concentrate in bone.

Drinking Water Controls

Because of high iron content for water pumped from Wells 4, 6, and 7, the Water Treatment Plant (Building 624) provides treatment, including chlorination and filtration. Iron is precipitated out of solution using lime, flocculated using an organic polymer, and removed in two stages: sedimentation in a 45-minute retention tank, and filtration using dual-media (anthracite coal and sand) filters. The iron sludges from the retention tank and filter backwashes are transferred to the water treatment plant recharge basins for settling and percolating. These basins are dredged every 3 or 4 years and the sludge disposed of by spreading on on-site fire breaks. Wells 10, 11, and 12 are chlorinated to provide potable water for the system without additional treatment. Wells 1, 2, and 3 are currently out of service because of problems with volatile organics. Wells 1 and 2 have elevated levels of 1,1,1-trichloroethane at maximum concentrations of 0.674 and 0.212 parts per million. Well 3 has not yet shown such contamination, but is not being pumped to minimize the possibility of drawing volatile organic plumes into that area. Refer to Section 3.4 for a discussion of organics in groundwater.

Extensive chemical and bacteriological testing is done by NYS-certified operators at the plant. The treatment system has a high degree of flexibility, with automatic alarms to notify operators of malfunctions. An aggressive backflow prevention program is in place, with more than 60 devices already installed. All systems are tested annually and rebuilt every 5 years. All work is done in

TABLE 3-14

RADIONUCLIDE CONCENTRATIONS IN FISH
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Species	pCi/kg wet weight		
		Cs-137	Sr-90	Tritium
Backgrounds: Artist Lake	Chain Pickerel(a)	285	NA	NA
Swan Pond	Chain Pickerel(a)	305	NA	NA
Carmen's River	Chain Pickerel(a)	290	NA	NA
Average		**293**	–	–
Downstream: Donahue's Pond	Chain Pickerel(a)	334	165	709
Donahue's Pond	Golden Shiner(c)	194	2,597	841
Donahue's Pond	Yellow Perch(c)	581	1,025	926
Donahue's Pond	Bluegill Sunfish(c)	195	633	843
Donahue's Pond	Brown Bullhead(b)	253	113	1,742
Donahue's Pond	Brown Bullhead(b)	370	3,328	1,470
Average		**321**	**1,310**	**1,089**

Source: Adapted from Day, et al., 1986.

NA Not Analyzed
(1) Juvenile Fish
(2) Adult Fish
(a) Predator
(b) Bottom feeder
(c) Omnivore

compliance with NYS Department of Health's Public Water Supply Guide on Cross-Connection Control. BNL has also been very successful in identifying service line and appliance problems as they occur. User taste complaints are followed up by sampling and analysis, and components failing these tests are red-tagged to prevent use until repaired or replaced.

Results of BNL's potable water sampling program, routinely analyzed on a monthly basis, indicate no significant problems with the active wells. Radionuclide analyses revealed concentrations of tritium, cobalt-60, cesium-137, chromium-51, sodium-22, and strontium-90 at measurable but low levels, well within NYS Drinking Water Standards, or RCGs. Metals problems were limited to iron, which BNL wells have in common with much of eastern Long Island. The highest concentrations of iron are removed in treatment, and the water distributed throughout the system typically contains <0.2 parts per million.

With respect to organics, except for Wells 1, 2, and 3 cited above, the remaining wells generally show less than detectable or very low levels of organics. Chloroform and 1,1,1-trichloroethane appear in most wellwaters, but at concentrations typically less than 0.01 mg/L. All concentrations observed are well within the NYS Drinking Water Standards or advisory limits.

Bacteriological samples are collected and analyzed monthly, with all results reported to Suffolk County Division of Health Services. In general, no bacteria are detected, a fact which indicates that BNL's potable supply meets all requirements of the EPA, National Primary Drinking Water Standards, and New York State Sanitary Code.

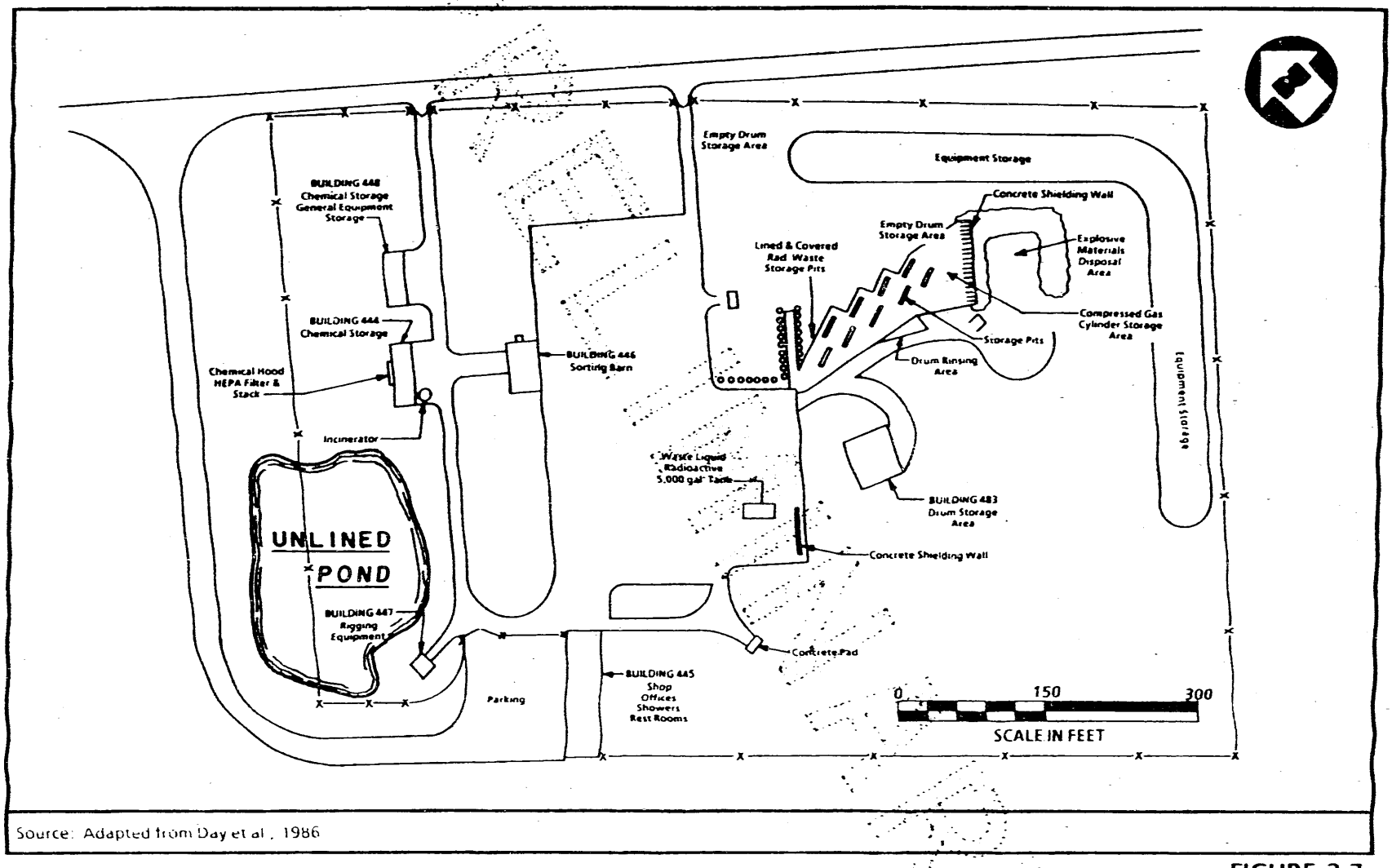
3.3.5 Findings and Observations

3.3.5.1 Category I

None.

3.3.5.2 Category II

1. Unanalyzed Runoff from the HWMA. Potentially contaminated surface-water runoff from the HWMA is diverted to an unlined pond west of and partially outside of the fenced perimeter of the area (Figure 3-7). The unanalyzed runoff, which may contain hazardous and/or radioactive constituents, could be contaminating surface water, soil (refer to Finding 3.2.4.3.1(a)), and groundwater (refer to Finding 3.4.4.3.1(a)). The HWMA is the repository and staging area for both hazardous and radioactive wastes and materials. There is



Source: Adapted from Day et al., 1986

FIGURE 3-7

LOCATION OF UNLINED POND AT HAZARDOUS WASTE MANAGEMENT FACILITY
BNL - UPTON, NY

evidence of past spills and releases in the HWMA (refer to Finding 4.1.2.3.1); hence, it is likely that runoff from the area would contain hazardous and/or radioactive constituents. Although neither runoff nor the receiving pond water have been analyzed, nearby monitoring wells (WR, WS, W9, and 2C) contain above-background levels of several volatile organics (Figure 3-8).

All four groundwater monitoring wells reported the presence of 1,1-dichloroethane; two wells (WR and W9) reported chloroethane; WR also showed benzene and toluene; and 2C contained ethylbenzene. Concentrations of toxic metals were uniformly low, except for zinc, which appeared in wells WS and W9 at 5.4-7.5 mg/l, a level which slightly exceeded the NYS drinking water standard. Iron and manganese were at elevated concentrations, many times higher than drinking water standards (up to 300 times higher for iron and 20 times higher for manganese). These metals are present at concentrations 5 to 20 times greater than those found in other typical Long Island groundwater from off-site locations. Conductivity measurements for well water from these four monitoring wells were typically 10 to 18 times higher than background, a fact which indicated the presence of dissolved contaminants. The groundwater contamination in this area, which is discussed in detail in Section 3.4, may be the result of percolation of contaminated surface water into the ground. Survey-related sampling of surface water and sediment is planned.

3.3.5.3 Category III

1. Disposal of Wastes into Drains of Unsewered Buildings. Hazardous and/or radioactive constituents may be or may have been discharged to active cesspools serving certain process operations. Because of the sensitive nature of Long Island's sole-source aquifer, it is unreasonable to expect that the use of cesspools for disposal of contaminated wastewaters can continue indefinitely. BNL recognizes this problem and has planned to phase-out most of the offending cesspools. A discussion of the consequences of improper cesspool phase-out procedures is presented as part of Finding 4.5.2.3.2.

The Survey team identified process operations which may, owing to the nature of the operation or the materials involved, generate wastewaters contaminated with hazardous and/or radioactive constituents. Wastewaters from these operations are discharged to active cesspools and subsequently percolate into the groundwater. Table 3-15 lists these operations and the potential contaminants.

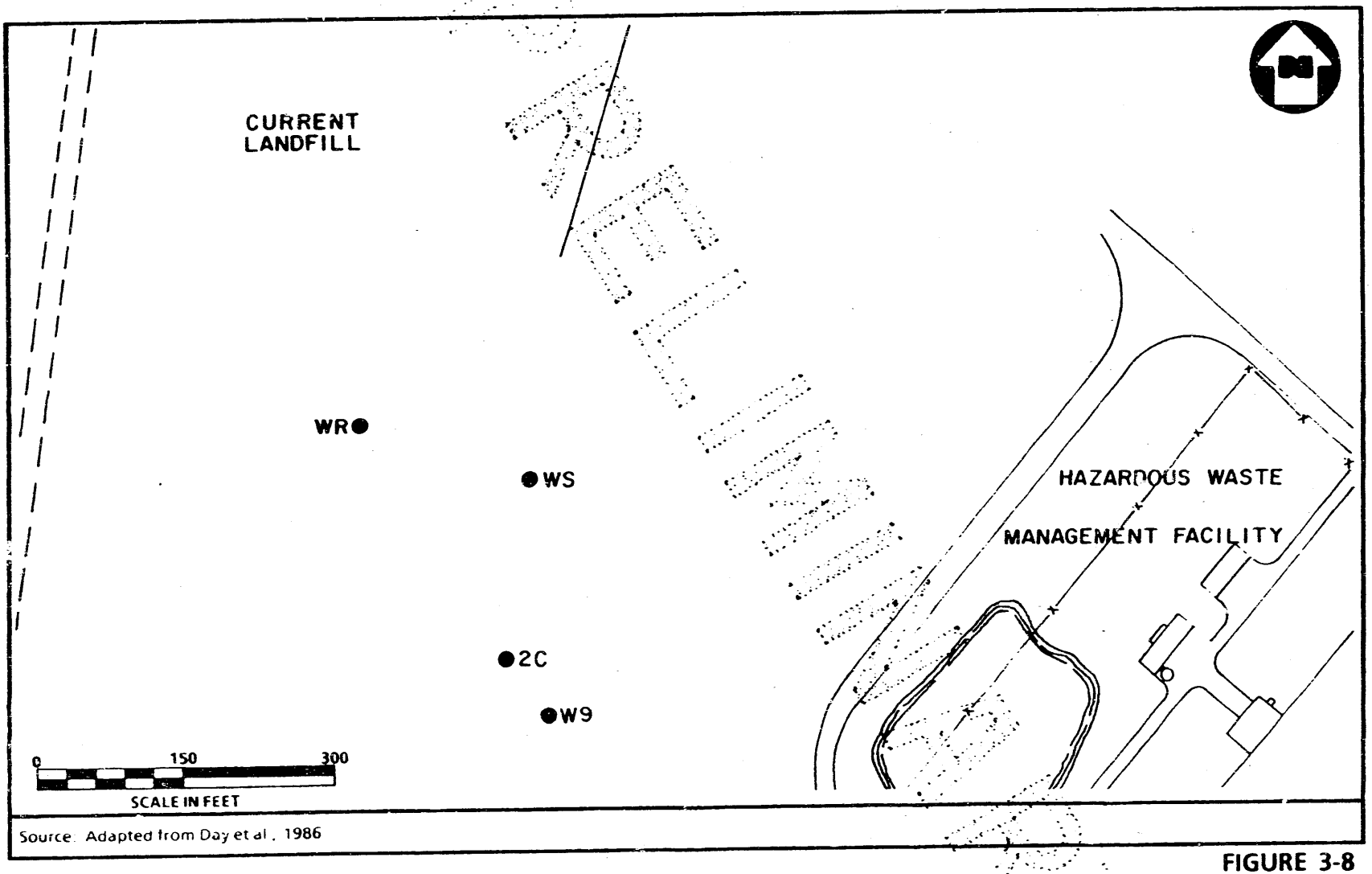


FIGURE 3-8

CONTAMINATED WELLS NEAR HAZARDOUS WASTE MANAGEMENT FACILITY
BNL - UPTON, NY

TABLE 3-15

SOURCE OF POTENTIALLY CONTAMINATED WASTEWATERS
DISCHARGED TO ACTIVE CESSPOOLS OR SEPTIC TANKS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Process	Function	Potential Contaminants
Building 51	Atmospheric Sciences	Light Laboratory	Not known
Building 197	Components Cleaning Line	Light Laboratory	Acids, metals, solvents
Building 244	Carpenter & Paint Shop	Maintenance	Paints, thinners, solvents
Building 348	Calibrations	Light Laboratory	Not known (Rad?)
Building 405	Lumber Shed	Storage	Not known
Building 422	Carpenter & Paint Shop	Maintenance	Paints, thinners, solvents
Building 445	Hazardous Waste Management	Nuclear Waste Processing	Radioactivity, metals, organics
Building 449	Telephone Switch Room	Communications	Not known
Building 479	Machine Shop B	Heavy Machining	Oils, metals, coolants
Building 624	Water Treatment Plant	Utilities	Laboratory reagents
Building 904	Cryogenic Testing	Heavy Laboratory	Not known (Rad?)
Building 905	ADD Coil & Magnet Assembly	Assembly	Acids, cleaners
Building 913A	A.C. House - NE	R&D, Demo and Testing	Not known (Rad?)
Building 913D	A. C. House - SW	R&D, Demo and Testing	Not known (Rad?)
Building 914	AGS Beam Components	R&D, Demo and Testing	Not known (Rad?)
Building 919A	Cryogenic Target Assembly	R&D	Radioactivity, cleaners
Building 919B	ADD Works Area	R&D	Radioactivity, cleaners
Building 926	AGS/ADD Receiving and Storage	Warehouse	Not known (Rad?)
Building 930A	Negative Ion Source Trailer	Light Laboratory	Radioactivity, oils, solvents
Building 935	ADD Magnet Trim Coil Winding	Warehouse	Not known
Building 940	On-line Data Facility	Computing	Not known
Building 945	ADD Magnet Production Hold	Assembly	Cleaners, degreasers
Building 963	R&D Facility	Assembly	Cleaners, degreasers
Building 975	Bubble Area, SPS Storage and Mobile Laboratory	Light Laboratory	Photochemicals, organics

Sources: Carlson & Sweatt, P.C., 1985; BNL, 1986b; BNL Plant Engineering Discussions

The historical analytical data on these wastewaters are too limited to accurately assess impacts from these sources. Even where data exist, they are often contradictory and inconclusive. For example, when BNL and Suffolk County Department of Health Services (SCDHS) sampled cesspools at Buildings 197 and 244, results for organic analyses differed by as many as three orders of magnitude, with SCDHS data showing the higher concentrations. Such discrepancies have not been resolved. Results are as follows:

Location and Organic	Concentrations in µg/l	
	BNL	SCDHS
Building 197 (Components Cleaning Line)		
1,1,1-Trichloroethane	364	43,000
Tetrachloroethene	<10	95
Building 244 (Carpenter & Paint Shop)		
Toluene	15	130
Methylene Chloride	<10	8,000
Trichloroethene	<10	3,800

Source: Analytical Data Report Forms from SCDHS files

BNL has an ongoing plan for phasing out the use of cesspools as a disposal method for laboratory wastewaters, but the environmental risks associated with cesspools will become CERCLA issues unless proper closure methods are practiced. Refer to Section 4.5 for discussion of related findings for inactive or soon to be deactivated cesspools, dry wells, and septic tanks. Survey-related sampling and analysis of cesspool wastewaters and sediments is planned and will include active cesspools that are scheduled for closure and other active cesspools not yet listed as candidates for closure.

2. Integrity of the Sanitary Sewer System. As indicated in Section 3.3.2 on page 3-44, about 12 percent of BNL's total pumped water is recharged to groundwater via the cesspools, line losses in the sanitary sewer system, and percolation through the bottom of the filter beds at the STP. If BNL staff can minimize the release of toxic, hazardous, and radioactive materials to the sanitary sewer system, then any losses will principally be domestic sewage and will pose no more of a threat to the groundwater than do most of Long Island's communities However, if some accidental release of radioactive or hazardous materials occurs and the wastes are diverted to the lined holding pond at the STP, some part of the load will still be lost to

groundwater through the leaks enroute to the holding pond. Depending on the material inadvertently released, the impact on groundwater could be serious.

3.3.5.4 Category IV

1. Unanalyzed Discharge from Building 938. There is a potential for the release of contaminated once-through cooling water from B-938 to the storm or sanitary sewer. (BNL was uncertain where the drain discharged.) The coolant is from the magnets on the Radiation Effects Facility Beam. BNL has not characterized this wastewater source, but has concluded from calculations that maximum potential releases would be limited to 25 µCi/year of beryllium-7 and 1 µCi/year of tritium. BNL is considering conversion of the cooling water system to a closed loop, a step which would minimize any discharge.

2. Unanalyzed Surface-Water Flow Outside Boundaries. BNL's surface-water monitoring program does not account for all water leaving the site as surface-water. A natural surface-water body, identified as Zeek's Pond (sic) on USGS maps, lies just inside BNL's eastern boundary and drains due east into a tributary of the Peconic River, downstream of all surface-water monitoring points except for the one at Riverhead. This discharge is not covered by any existing permit and is not necessarily a pathway for off-site migration of any known contaminants. However, the absence of data could be a problem if questions arose about the characteristics of this source.

3.4 Hydrogeology

3.4.1 Background Environmental Information

3.4.1.1 Geomorphology

The geomorphic features of Long Island are the result of the retreat of the Wisconsin Age ice sheet. The primary features are the Ronkonkoma moraine, which trends along the center of Long Island and passes just south of BNL, and the Harbor Hill moraine, which lies along the north shore of Long Island. The resulting basin between the two moraines is the Manorville basin and forms the upper drainage area of the Peconic River (De Laguna, 1963).

3.4.1.2 Geology

Six principal stratigraphic units have been recognized at BNL, which have been identified in well logs and at exposures in central Suffolk County. The following are descriptions of the principal units (De Laguna, 1963):

Banded Granitic Gneiss: This Precambrian period rock unit is considered the bedrock beneath the BNL site. These gneissic rocks are the oldest rocks beneath the site and are referred to as the basement complex. The approximate depth to this unit is about 1,500 feet below land surface.

Raritan Formation: This Cretaceous period formation lies immediately over bedrock and is divided into two principal stratigraphic units: the Lloyd Sand Member and the upper clay member. The entire formation is about 500 feet thick, and the top of the formation is about 1,000 feet below land surface.

Magothy Formation: The Magothy Formation is also of the Cretaceous period and overlies the Raritan Formation. It primarily consists of alternating layers of sand, gravel, and sandy and silty clays. Beneath BNL this formation is about 800 feet thick, and the top of the formation is about 200 feet below land surface.

Gardiners Clay: This unit of Pleistocene age has a thickness ranging from 10 to 20 feet, and is thought to overlie the Magothy Formation in most of the area of BNL. It is not known if the clay is continuous under the entire BNL area. The clay, where present, is a good marker between the Magothy Formation and the upper Pleistocene deposits.

Glacial Outwash and Moraine: The uppermost stratigraphic unit consists of about 200 feet of unconsolidated sands, gravel, and clay. These Wisconsin age glacial materials are divided into three units, which include

- The basal unit, consisting of a greenish sandy clay containing medium-grained sands.
- The Ronkonkoma Moraine deposits and outwash, which consist of crudely stratified, silica-rich sand with variable amounts of gravel with some silt and clay.
- The surficial silt and clay unit, consisting of a thin sequence of fine-grained materials in the form of discontinuous lenses ranging from 5 to 10 feet in thickness. The relative impermeability of this material in the headwaters area of the Peconic River causes swamps and small lakes to form.

3.4.1.3 Hydrogeology and Groundwater Uses

Groundwater generally occurs in an unconfined condition on Long Island. The water-table generally follows the contours of the land surface. Water-table elevations beneath the site reported for 1951-1952 ranged from approximately 35 to 55 feet mean sea level (msl). The groundwater levels are dependent on the seasonal recharge from precipitation. More recent measurements indicate elevations of 38 to 42 feet msl in the Former Landfill area (C. A. Rich Consultants, Inc., 1985), which appear to be consistent with earlier data. The aquifer beneath BNL is composed of three water-bearing units: the moraine and outwash deposits, the Magothy Formation, and the Lloyd Sand Member of the Raritan Formation. These units are hydraulically connected and make up a single zone of saturation with varying physical properties extending from a depth of 45 feet to 1,500 feet below the land surface. The entire saturated zone consists of stratified, unconsolidated gravel, sand, silt, and clay in various mixtures. The Pleistocene Gardiners clay is discontinuous and partially divides the saturated zone into two major aquifers: the Pleistocene moraine and outwash deposits (the major water-bearing unit) and the Magothy Formation. The Lloyd Sand is a third aquifer but is considered to be minor because of its depth. Table 3-16 summarizes the general hydrogeologic characteristics of the aquifers in the vicinity of the BNL.

The groundwater flow directions are generally south-southeastward and caused by a groundwater divide approximately 1 mile north of the site (Warren et al., 1968). Based on recent pumping test studies, flow rates are calculated to be on the order of 1.7 feet per day in the HWMA (Grosser, 1985), a figure which reasonably agrees with the data in Table 3-16.

TABLE 3-16

AQUIFER CHARACTERISTICS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Aquifer	Pleistocene Deposit Below Water Table	Magothy Formation	Lloyd Sand
Thickness (ft)	145	800	314
Coefficient of lateral permeability (gpd/ft^2)	1,300	100-400	74
Transmissivity of formation (gpd/ft)	190,000	40,000	23,000
Coefficient of vertical permeability (gpd/ft^2)	130-350	--	--
Direction of flow	SE	SE	SE
Undisturbed horizontal velocity of flow (ft/day)	0.5-1.0	0.25-0.1	0.005
Hydraulic gradient	0.0010	0.0006	0.0002
Porosity (%)	35	33	33

Sources: Adapted from Burns and Roe, 1986.

The three aquifers discussed above, which comprise a single zone of saturation beneath most of Long Island, have been designated by the EPA as a "sole-source" aquifer. This aquifer serves as the primary drinking water source for Nassau and Suffolk Counties, population approximately 2.6 million (Blass, 1986). Concerns regarding usage rates and groundwater contamination have prompted Suffolk County to promulgate stringent groundwater use and protection standards.

BNL reportedly pumped approximately 2,560 million gallons for sanitary and process uses in 1985. Approximately 65 percent of the groundwater used by BNL is returned to the aquifer via recharge basins (Blass, 1986). BNL's usage rates do not, at this time, appear to be affecting the water table levels or groundwater flow and direction off-site; primarily because most of the water withdrawn is recharged back into the aquifer (C. A. Rich Consultants, Inc., 1985). The nearest municipal well is located in Shirley, within 3 miles downgradient of BNL. The nearest residential wells are located within one fourth mile of BNL. These wells are sanitary water supplies and draw from the Pleistocene aquifer. The water from annual precipitation has been more than adequate to recharge the aquifer in recent years.

Water quality analyses for some chemicals, as well as alpha and beta activity measurements, were performed in the late 1940s and early 1950s for the U.S. Atomic Energy Commission (De Laguna, 1964). Groundwater from the Pleistocene aquifer, both on- and off-site, was sampled and analyzed as part of those studies. None of the samples showed alpha radioactivity; 14 showed beta activity, with the maximum being 5×10^{-14} Ci/ml. The pollutant of most concern, identified from the chemical analyses, was nitrate. Nitrate concentrations averaged 1.5 ppm. Some wells showed values up to about 70 ppm. The sources cited for the higher values were fertilizer application and cesspools. The detection of highly soluble contaminants, such as nitrate occurring in wells, is consistent with the disposal methods for waste-water--cesspools and recharge basins--coupled with the highly permeable glacial outwash sands in the site area (and Long Island, in general).

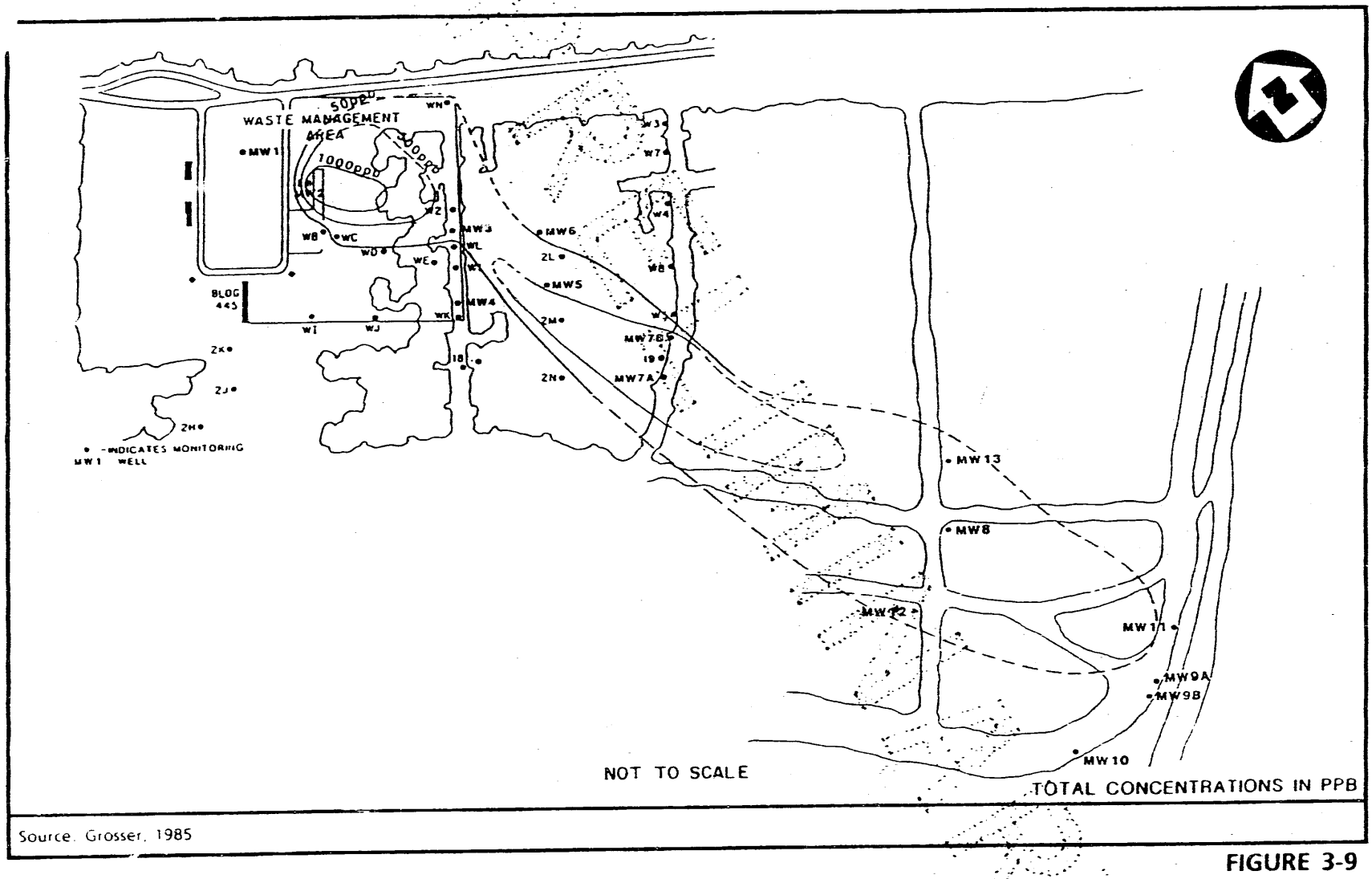
3.4.2 General Description of Pollution Sources and Controls

This section discusses the actual and potential sources of groundwater contamination and the use of institutional or physical controls by BNL. Although this section focuses on sources of groundwater contamination, the Findings in Section 3.4.4 focus on the extent to which these sources have actually affected the groundwater. Additional details and findings related to the physical characteristics of the actual and potential sources of groundwater contamination discussed below can be found in Sections 3.2, 3.3, 4.1, and 4.5. Appropriate cross references are provided.

BNL staff have identified several actual and potential sources of groundwater contamination on-site. In response, a number of groundwater monitoring wells were previously, and are currently, being installed around various areas and facilities. The major sources of actual and potential groundwater contamination and controls, if any, include the following:

- Hazardous Waste Management Area (HWMA) - The HWMA is an ongoing source of groundwater contamination as a result of past and present waste treatment and storage activities. Soils in this area are contaminated with solvents and radionuclides, both of which have migrated into the groundwater. A remedial investigation of that area performed in late 1984 through mid-1985 revealed contamination by volatile organic compounds (VOCs), mainly, chloroform, 193 ppb; 1,1,1-trichloroethane, 900 ppb; trichloroethylene, 120 ppb; and tetrachloroethylene, 2,800 ppb (Grosser, 1985). A second-phase investigation characterized the extent of VOC contamination and provided design for remedial measures. The extent of VOC contamination is shown in Figure 3-9. Since the focus of the investigation was on VOCs, the extent of other contaminants was not characterized. Other known groundwater contaminants in the HWMA include iron, pH, gross alpha and beta radioactivity, tritium, and Sr-90. Table 3-17 presents selected averages of 1985 analytical data from wells in the HWMA. The iron and pH contamination appears to be widespread, and the iron is probably the result of the low pH environment. The cause of the low pH is not well understood; however, acid solutions of both sulfuric and hydrochloric acid were disposed of along with other wastes in the HWMA.

  Physical controls to mitigate groundwater contamination by the VOCs are currently being employed at the HWMA. In 1985, a system of five recovery wells (design discharge capacity of 350 gallons per minute [gpm]) were installed with spray discharge nozzles designed to intercept and remove the VOCs. Based on known contaminant concentration and extent at that time, the projected time required to restore the groundwater quality to below State of New York standards was 75 days. However, pumping time was recommended to be 120 days. Since installation, the air-stripping process has operated intermittently due to unscheduled shutdowns from malfunctions or from freezing during cold weather. The system utilization percentage is currently unknown. Discharge rates observed during the Survey were approximately 350 gpm for three of the wells (PW-1, PW-2, and PW-5), with one other well (PW-3) that appeared to be discharging at less than 350 gpm. Well PW-4 was not observed during the Survey. Monitoring groundwater for changes in the VOC concentration was recommended by the remedial designers to evaluate system effectiveness and to provide data for readjusting pumping rate or nozzle



Source: Grosser, 1985

FIGURE 3-9

VOC PLUME AT THE HAZARDOUS WASTE MANAGEMENT AREA
BNL - UPTON, NY

TABLE 3-17

HAZARDOUS WASTE MANAGEMENT AREA WELLS
AVERAGE RADIOACTIVITY AND WATER QUALITY DATA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Well ID	Gross Alpha (pCi/l)	Gross Beta (pCi/l)	H-3 (pCi/l)	Sr-90 (pCi/l)	pH	Fe (mg/l)
WB	0.55	65.0	8,370	30.1	5.0-6.4	2.14
WC	0.43	18.7	12,900	6.69	4.8-6.2	2.04
WD	0.35	28.0	13,200	20.8	5.3-6.7	0.73
WE	0.14	7.07	4,850	4.0	5.7-6.0	4.96
WI	<0.5	4.49	453	NS	5.4	NA
WK	NS	NS	NS	NS	NS	NS
WL	-0.23	22.8	1,160	13.5 ± 2.4	6.1	0.17
WV	NA	NA	NA	NA	ND	ND
WZ	0.056	0.88	<260	NS	ND	ND
W1	-0.057	18.8	1,450	14.0	6.5	4.97
W2	0.83	65.1	1,410	7.2	5.9-6.1	0.24
2L	0.076	1.31	107	0.02	5.2-5.9	0.33
2M	0.029	1.90	11,200	<0.26	5.2-5.7	0.23
2N	-0.057	1.76	15,600	<0.04	5.4-5.6	0.25
MW1	0.25	3.72	207	0.82	5.4-5.9	0.31
MW2	0.28	61.2	13,300	34.7	5.5-6.0	0.35
MW3	0.41	69.8	22,800	2.66	5.1-6.6	0.30
MW4	0.21	2.65	743	0.19	5.6-6.8	0.70
MW5	0.170	7.78	4,500	2.65	5.1-5.6	0.59
MW6	0	0.71	<400	0.24	5.5-6.1	0.55
MW7A	0.36	45.6	5,090	18.8	5.3-5.6	0.57
MW7B	0.13	2.28	2,640	0.17	4.8-6.0	0.77
MW8	1.05	5.03	212	0.30	5.4-6.6	1.14
MW9A	0.85	2.80	115	0.82	6.3-6.6	1.54
MW9B	1.84	5.78	<300	0.14	5.7-6.1	1.07
MW10	1.06	4.47	1,220	ND	5.7-7.5	0.103
MW11	1.32	6.24	97	NS	6.0-6.3	0.164
MW12	0.90	5.94	8,300	NS	6.3-7.8	1.19
MW13	2.40	7.79	580	0.23	6.6-6.4	2.60

Source: Adapted from Day et al., 1986.
NA = Not analyzed
NS = Not sampled
ND = No data presented

location for selective recharge. The purpose of the latter was to add "cleaned-up" water to dilute the plume. Groundwater monitoring data in Table 3-18 indicates that these contaminants were above drinking water standards in 1986.

The use of this system has also contributed to soil contamination from other contaminants in the groundwater (see Findings 3.2.4.3.1, 4.1.2.3.1(a, b, c, and d), and 4.5.2.3.1(d)). Survey-related sampling has been proposed.

- The Former Landfill Area - This 12-acre area, which contains several disposal sites, is located in the southeast section of BNL and includes the following actual and potential sources of groundwater contamination:

  - Former Landfill
  - Chemical and Animal Pits
  - Glass Pits
  - Slit Trench
  - Small Dump used in 1966

  These areas are known to contain hazardous and radioactive substances as the result of previous disposal practices. Groundwater monitoring data indicates contamination is present in the form of iron, manganese, pH, gross alpha and beta, tritium, and Sr-90. The wells downgradient, D6, 1I, 1J, WP, and WQ, generally show the highest levels of contamination. Well D6, closest to the Former Landfill, has the highest reported average concentrations for 1986 of Sr-90, 11.35 pCi/l (EPA drinking water standard is 8 pCi/l and the DOE Derived Concentration Guide (DCG) is 1,000 pCi/l); gross beta, 12.90 pCi/l (EPA required radionuclide specific analyses at >50 pCi/l.); and chlorides, sulfates, sodium, and conductivity--three to ten times the levels in the upgradient wells D2, D3, and D4 (Miltenberger et al, 1987). Table 3-19 presents selected averages of 1986 analytical data from wells in the Former Landfill Area. VOCs have also been detected in the low ppb range, but cannot be conclusively related to any specific source area. Since this area is currently inactive, there are no controls in operation beyond monitoring. Information on past practices and estimates of the quantities and types of contaminants are provided in Section 4.5.1.1, and Finding 4.5.2.3.1(a, b, c, g, and i).

- The Current Landfill Site - Operated since 1967, the Current Landfill may have received hazardous and radioactive substances (see Finding 4.5.2.3.1(f)). Currently, this landfill is permitted to receive only nonputrescible wastes, but has likely received other wastes.

TABLE 3-18

AVERAGE VOC CONCENTRATIONS: HWMA AREA WELLS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Well ID	No. of Samples	Chloroform mg/l	1,1,1-Trichloroethane mg/l	Trichloroethylene mg/l	Tetrachloroethylene mg/l
MW2	2	ND	0.014	ND	0.084
WC	3	0.002	0.106	ND	ND
WD	3	0.005	0.078	ND	0.016
W2	2	0.018	0.125	0.054	0.093
MW3	4	ND	ND	ND	0.002
WL	1	ND	0.017	ND	NA
W1	1	ND	ND	ND	0.013
MW5	1	0.007	0.048	0.009	0.022
2M	2	0.012	0.216	ND	0.067
MW7A	3	0.019	0.112	ND	0.129
MW7B	1	ND	0.019	ND	0.013
MW13	1	0.021	0.073	0.008	0.037
MW8	1	0.576	0.378	0.007	0.009
MW12	2	ND	0.056	ND	ND
MW11	1	0.019	0.007	ND	ND
MW10	1	ND	0.203	ND	ND
NYS Drinking Water Standards		0.100	0.050(a)	0.010	0.050(a)

Sources: Adapted from Miltenberger et al, 1987.
(a): NYSDOH advisory guidelines.
ND: Not detected.
NA: No analysis performed.

TABLE 3-19

FORMER LANDFILL AREA WELLS
AVERAGE RADIOACTIVITY AND WATER-QUALITY DATA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Well ID	Gross Alpha pCi/l	Gross Beta pCi/l	H-3 pCi/l	Sr-90 pCi/l	pH	Fe mg/l	Mn mg/l	Na mg/l	Cond. µmhos/cm	Chlorides mg/l	Sulfates mg/l
D1	0.028	0.79	25.5	0.033	5.8-5.9	2.52	0.5	4.82	87	2.2	10.6
D2	0.245	0.94	10.5	0.020	5.5-5.7	1.19	0.17	3.91	44	2.3	6.3
D3	0.132	0.69	70.5	0.040	5.5-6.0	2.03	0.23	3.33	48	1.6	3.2
D4	0.188	0.51	45.9	0.160	5.3-5.9	3.19	0.35	4.42	60	1.8	14.3
D5	0.151	0.23	28.6	<0.200	5.3-6.0	2.21	0.29	6.91	59	2.5	13.1
D6	0.376	12.90	32.4	11.350	6.4-6.7	0.96	0.16	11.83	402.5	8.0	58.8
D7	0.339	1.18	459.7	3.604							
1I	0.244	0.44	376.6	<0.300							
1J	0.151	-0.22	136.9	<0.200							
WO	0.282	0.37	87.7	0.001							
WP	0.151	0.35	228.3	0.059							
WQ	0.151	1.22	902.7	0.024							

Source: Adopted from Miltenberger et al., 1987

Until 1978, BNL systematically disposed of low-level radioactive waste, using disposal guidelines formulated in 1954. Similar to the Former Landfill area, the Current Landfill downgradient wells show elevated levels of gross alpha and beta, tritium, Sr-90, iron, manganese, zinc, sodium, conductivity, chlorides, and sulfates; and low pH. Of these tritium shows the highest average in wells 2C and W9 of 20,000 and 26,700 pCi/l respectively (Day, 1986a), in excess of the current 20,000 pCi/l drinking water standard. (An Advance Notice of Proposed Rule Making was published September 30, 1986, which would raise the drinking water standard to 90,000 pCi/l.) Although not in excess of drinking water standards, Sr-90 and gross alpha and beta are at approximately 50 percent of the standard or compliance levels of 8, 15, and 50 pCi/l respectively. The low pH values, down to 4.9, are likely to influence iron, manganese, and zinc concentrations. Table 3-20 presents selected averages of 1985 analytical data from wells near the current landfill.

No controls other than monitoring are in operation. Institutional controls regarding waste management are discussed in Section 4.1.1.4.

- The Meadow Marsh Study Area - The Upland Recharge Experiment, which utilized land application for disposal of sewage effluent in the Meadow Marsh area, has resulted in tritium and nitrates reaching the groundwater. Monitoring wells sampled in the area of the disposal plots were last reported in the 1976 Environmental Monitoring Report, although disposal continued until December 1978. Analytical results from sampling these wells, if such information exists, have not been reported after the 1976 report. At that time nitrate was at approximately 50 percent of the drinking water standard in wells 1-5 and 1Y and 75 percent in well 1T. Reported levels of gross beta and tritium were up to approximately 25 percent of current drinking-water standards in wells 1Q, 1T, 1Y, 12, and 14 (Hull and Ash, 1976). Because the site does not have a comprehensive well location map, it is not possible to determine the location of these wells relative to the groundwater gradient. Other contaminants that were known to be in the effluent (e.g., metals and Sr-90) have not been characterized (see Finding 4.5.2.3.1(n)).

- The Sewage Treatment Plant (STP) and Sand Filter Beds - Sludge from the anaerobic digester is placed on drying beds near the sewage treatment facility. The sludge contains Co-60, Cs-137, Am-241, Sr-90, Eu-154, Cd-109, and K-40. Additionally, sand that was used for filter beds was piled up into berms, a practice which allows natural precipitation to filter through them and into the groundwater. Both of these sources have the potential to contaminate the groundwater (see Finding 4.5.2.3.1(h)). As part of the treatment process, the sand filter beds pass water downward to a drainage tile collection system that

TABLE 3-20

CURRENT LANDFILL WELLS
AVERAGE RADIOACTIVITY AND WATER QUALITY DATA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Well ID	Gross Alpha pCi/l	Gross Beta pCi/l	H-3 pCi/l	Sr-90 pCi/l	pH	Fe mg/l	Mn mg/l	Na mg/l	Zn mg/l	Cond µmhos/cm	Chlorides mg/l	Sulfates mg/l
WG	-0.57	1.1	na	<0.13	4.9	0.98	na	na	0.14	78	6.0	8.4
WR	0.63	15.0	14,300	1.57	6.0-6.4	76.7	5.72	47.8	0.81	883	41.6	10.9
WS	1.28	24.4	6,530	2.51	6.2-6.4	87.3	2.8	36.6	7.5	595	22.8	17.9
WT	0.73	1.41	<280	0.10	5.0-5.6	15.5	0.30	11.8	5.79	186	27.3	13.5
1K	2.78	19.0	1,580	3.77	6.3-6.4	74.1	3.81	22.9	0.73	588	18.8	5.0
2C	2.37	20.4	20,000	0.90	6.0-6.6	73.0	na	na	0.19	531	4.1	7.5
W9	1.97	14.3	26,700	2.67	5.7-6.6	91.2	na	na	5.40	560	15.7	6.9
2H	0.34	4.11	411	na	5.7	0.025	na	na	0.029	74	9.8	11.4
2K	0.057	5.17	703	4.63	6.0	1.05	na	na	0.116	80	10.9	9.1
2I	0.42	6.0	1,040	na	6.4	3.22	na	na	4.1	103	11.0	0.6
2J	0.20	4.86	562	na	5.6	0.82	na	na	0.017	75	7.2	8.3
2B	-0.03	0.30	<280	<0.20	5.5-5.7	<0.05	na	3.93	<0.01	63	5.6	11.3
W6	0.084	1.8	<280	0.23	6.5-6.9	0.76	0.24	11.3	0.56	270	19.5	10.6

na = Not analyzed
Source: Adopted from Day et al., 1986

is then discharged to the Peconic River. As with unlined leachate collection systems, percolating fluids will also pass by the collection system and will continue downward to the groundwater. An estimated 380,000 liters per day of filtered effluent are recharged to the groundwater in this manner. (Section 3.3.2 discusses the STP in greater detail.) Monitoring wells in the vicinity of the STP and sand filter beds indicate elevated levels of iron, manganese, lead, zinc, Sr-90, gross beta; and low pH. Volatile organic compounds have been detected in the low ppb range. Of the known contaminants, Sr-90 exceeded drinking water standards in well XL in 1985. Tritium was reported at 10,300 pCi/l, approximately 50 percent of the current drinking water standard. The metals exceeded drinking water standards in several wells. Levels of iron were up to 30 times the standard of 0.3 ppm. There are no controls over the discharge to the Peconic River or recharge through the sand filter beds beyond effluent monitoring. See Section 3.3.3 for information relating to the monitoring program performed for the STP.

- Building 650 Sump - Groundwater in the area of B-650 is contaminated with radionuclides. Effluent from B-650 was inadvertently piped to a surface drainage course for approximately 10 years (see Finding 4.5.2.3.1 (j)). The effluent ultimately percolated to groundwater. Three of eight monitoring wells, installed in the area after the error was discovered, have consistently shown gross beta and Sr-90 concentrations above drinking water standards. Concentrations of other radionuclides (Na-22, Co-60, Cs-137, and tritium) and gross alpha were consistently below drinking water standards or detectable limits. No recent data (last reported data for Sr-90 and gross beta was in 1983 and 1984, respectively) are available; hence, the current nature and extent of contamination is unknown. Section 4.5.1.1 and Finding 4.5.2.3.1 (j) provide additional details.

- Septic Tanks, Cesspools, and Sanitary Sewer Lines - The past and present use of septic tanks and cesspools to dispose of liquid wastes from various buildings constitutes a potential source of groundwater contamination (see Finding 4.5.2.3.2). Leaking sewer lines, some constructed as early as 1917, also constitute a potential source of groundwater contamination. The sewer lines are an inadvertent source of groundwater recharge that contributes an estimated 1.2 million liters per day (317,000 GPD) of untreated effluent to the groundwater (see Section 3.3.2). Additionally, 1.3 million liters per day are discharged to cesspools. The composition of effluents discharged to the cesspools and septic tanks and lost through the sewer line leaks is likely to be highly variable, given the sources: residences, laboratories, and building shops. Because of this variability, characterization of source contamination in specific areas is difficult.

Controls of these sources consist of decommissioning of the septic tanks and cesspools. Further discussion is presented in Sections 3.3.2, and 4.5 1. Sewer line leakage is currently uncontrolled. Further discussion on this subject is presented in Section 3.3.2.

- Miscellaneous Abandoned Drums and Spill Sites - Several areas on-site contain abandoned drums of unknown substances and/or areas of stained soils. These areas constitute a potential source of groundwater contamination.

  Section 4.5.1.2 and Finding 4.5.2.2.1 provide additional details on these potential sources.

- Satellite Disposal Area - An area referred to as the "Satellite Disposal Area" was discovered by BNL when chemical containers were unearthed there in 1985. Little is currently known about this area. This area represents a potential source of groundwater contamination (see Finding 4.5.2.3.1(k)).

3.4.3 Environmental Monitoring Program

The need for monitoring wells, their construction, sampling, and evaluation of data are the responsibility of the Safety and Environmental Protection (S&EP) Division. Table 3-21 presents a summary of the wells with reported analyses in the 1986 Environmental Monitoring Report (Miltenberger et al., 1987).

In the early years of operation of BNL, most liquid waste was discharged to streams, sand recharge basins, and swampy areas around the various facilities. As a result of infiltration, contamination of the groundwater beneath the various facilities occurred. As time passed, these practices were discontinued in some areas, and better waste management practices were instituted. Studies have been conducted to determine the direction and rate of groundwater flow. Groundwater monitoring has also been undertaken to evaluate the downward rate of migration of contaminants into the aquifer. Since radiological and nonradiological contaminants are in the shallow aquifer and the groundwater rate of movement is slow, monitoring of contaminants in the groundwater can be expected to continue for many years after technology replaces the former, and some existing, discharge methods.

3.4.3.1 Well Locations and Construction

Until 1984, when it was decided that RCRA-type wells were to be constructed at BNL, data were collected from any well available; regardless of the condition of the well or the procedures used to

TABLE 3-21

MONITORING WELLS WITH REPORTED ANALYSES IN 1986
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Sand Filters & Peconic River	Hazardous Waste Management Area	Solid Waste Landfill	Miscellaneous On-site Areas
XA	WC	WG	SE
XB	WD	WR	SI
XC	WE	WS	S6431
XD	WI	WT	S6434
XE	WJ	W6	S6455
XF	WK	W9	
XI	WL	1K	
XJ	W1	2B	
XK	W2	2C	
XL	2L	2D	
XN	2M	2H	
XO	2N	2J	
XS	MW1	2K	
XT	MW2		
XX	MW3		
XY	MW4		
X1	MW5		
X2	MW6		
X3	MW7A		
X4	MW7B		
X5	MW8		
	MW10		
	MW11		
	MW12		
	MW13		
	PW1		
	PW2		
	PW3		
	PW4		
	PW5		

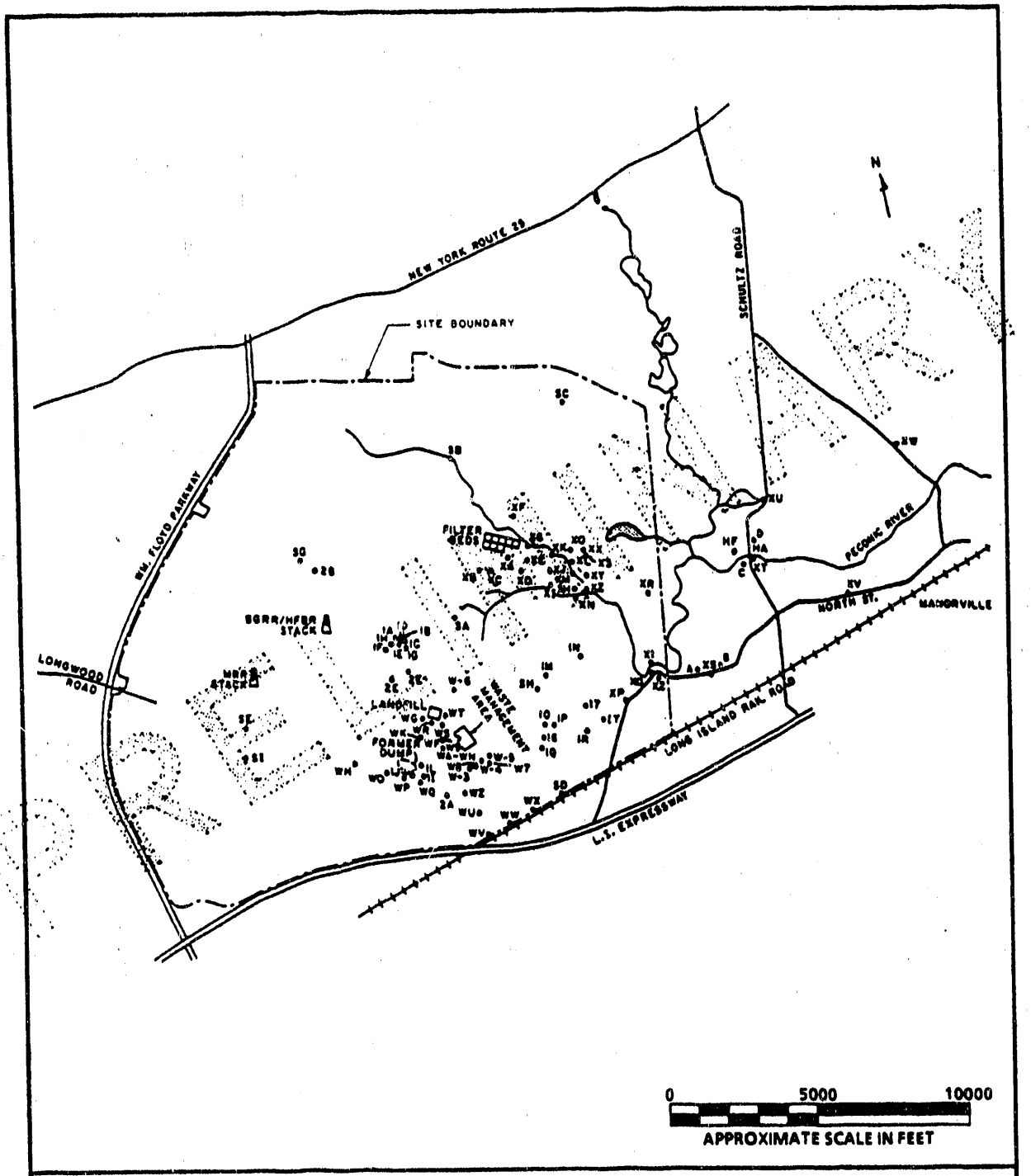
Sources: Adapted from Miltenberger et al., 1987.

collect the samples. Since that date, standardized wells are being constructed, standard sampling procedures are being followed, and specific laboratories are being used for sample analysis. The end result is that data collected after 1984 is of better quality than data collected before 1984. However, many of the older wells are still in use.

More than 130 monitoring wells are installed adjacent to or downgradient from identified source areas or areas where there is a potential for the percolation and migration of radionuclides as well as other contaminants in the groundwater. The rationale that BNL has used to establish the location of monitoring wells is based on the need to understand the groundwater movement and the contamination in the groundwater around a specific facility. Based upon existing data, a determination is made where wells are needed to obtain the best information about the migration of a contaminant from a specific facility. As a result, several of the facilities have a sufficient number of wells surrounding them, but only a limited number of wells exist for environmental monitoring away from specific facilities. The principal facilities monitored are the former landfill area, the current landfill, the HWMA area, the sand filters, and Peconic River, the Meadow Marsh area, and the general on-site controls. Figures 3-9, 3-10, and 3-11 show the approximate locations of many of these wells.

Although the number of wells (more than 130) at BNL appears to be relatively large for the six facilities monitored, the need for characterizing the VOC plume in the HWMA requires wells drilled to different depths. Since the VOCs are heavier than water and tend to migrate downward through the saturated zone, the wells are screened at different levels to allow vertical contaminant concentration characterization. However, these wells are installed only in the upper portion of the Pleistocene aquifer, and there are no wells drilled into the deeper portions of the saturated zone to monitor for possible deeper migration of contaminants. Several wells drilled by the U.S. Geological Survey (USGS) penetrate into the deep aquifer. However, the knowledge of the migration of contaminants into and through the deep aquifer is uncharacterized.

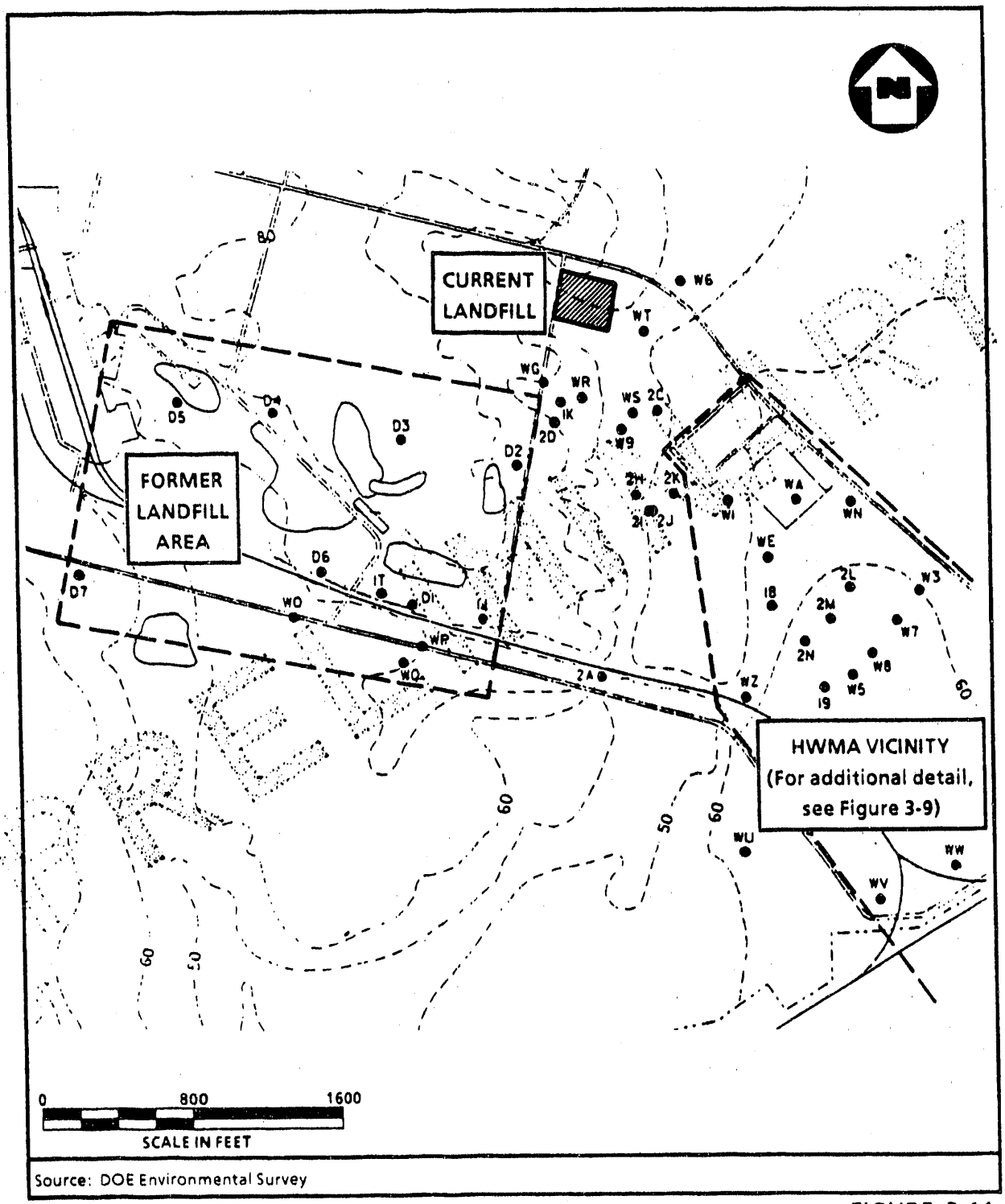
Many wells are no longer used (e.g., several sanitary water supply and cooling water wells, the wells in the Meadow Marsh Project area, the "Old" carbon steel wells, and wells used to monitor old spill sites). Currently, more than 50 wells need to be properly abandoned or upgraded. This fact is supported by the Survey team, which observed several abandoned wells that were not capped and were in a deteriorated condition. At present there is no well abandonment program, and the maintenance program is purely reactive.



Source: Day et al., 1986.

FIGURE 3-10

LOCATION OF SELECTED GROUNDWATER SURVEILLANCE WELLS
BNL - UPTON, NY



Source: DOE Environmental Survey

FIGURE 3-11

APPROXIMATE WELL LOCATIONS AT LANDFILLS AND HWMA
BNL - UPTON, NY

Wells are numbered according to the facility for which they are designed to monitor and the sequence in which they were drilled. A listing of the wells by facility or general area monitored in 1986 was previously presented in Table 3-21.

According to the BNL S&EP Division, the current specifications for well design and installation have been formulated by consultants and approved by BNL. The current design for monitoring wells requires that wells be constructed of 2-inch or 4-inch-diameter, No. 20 slotted, PVC screen and an appropriate length of blank PVC pipe. The casing is to be set inside a hollow-stem auger, drilled 10 feet into the water table. The augers are to be pulled 15 feet and the formation allowed to collapse around the screened section of the casing. A bentonite/cement slurry is to be pumped down a tremmie pipe to fill the annulus to near the surface. A 6-inch-diameter protective steel casing is then cemented in place to the land surface with a 1-foot to 2.5-foot stick-up. See Figure 3-12 for typical well details.

3.4.3.2 Groundwater Sampling and Analysis

The groundwater monitoring at BNL is carried out by the Safety and Environmental Protection Division. This S&EP staff is responsible for the frequency of monitoring and the parameters selected for analysis. Groundwater is monitored at the six facility areas and the general site, as listed in Table 3-21. Typically, wells are monitored for the parameters shown on Table 3-22. The frequency of monitoring varies, although each well is monitored at least annually. Generally, the frequency of monitoring varies based upon past data (e.g., if a well sampled on a quarterly basis shows an upward trend of tritium, the well will be placed on a monthly schedule). However, only the Current Landfill is presently monitored on a quarterly basis (Miltenberger et al., 1987).

Sample analysis is performed by both on-site and off-site contract laboratories. In general, most samples are analyzed at BNL by personnel who are certified by the state of New York. In addition, contract laboratories provide assistance when the on-site laboratory is overloaded or when consultants investigate specific facilities as part of remedial studies. Off-site laboratories used recently include the following:

Holzmacher, McClendon, and Murrell, P.C.
575 Broad Hollow Road
Melville, NY 11747

Pednealt Associates, Inc.
1615 Ninth Avenue
Bohemia, NY 11716

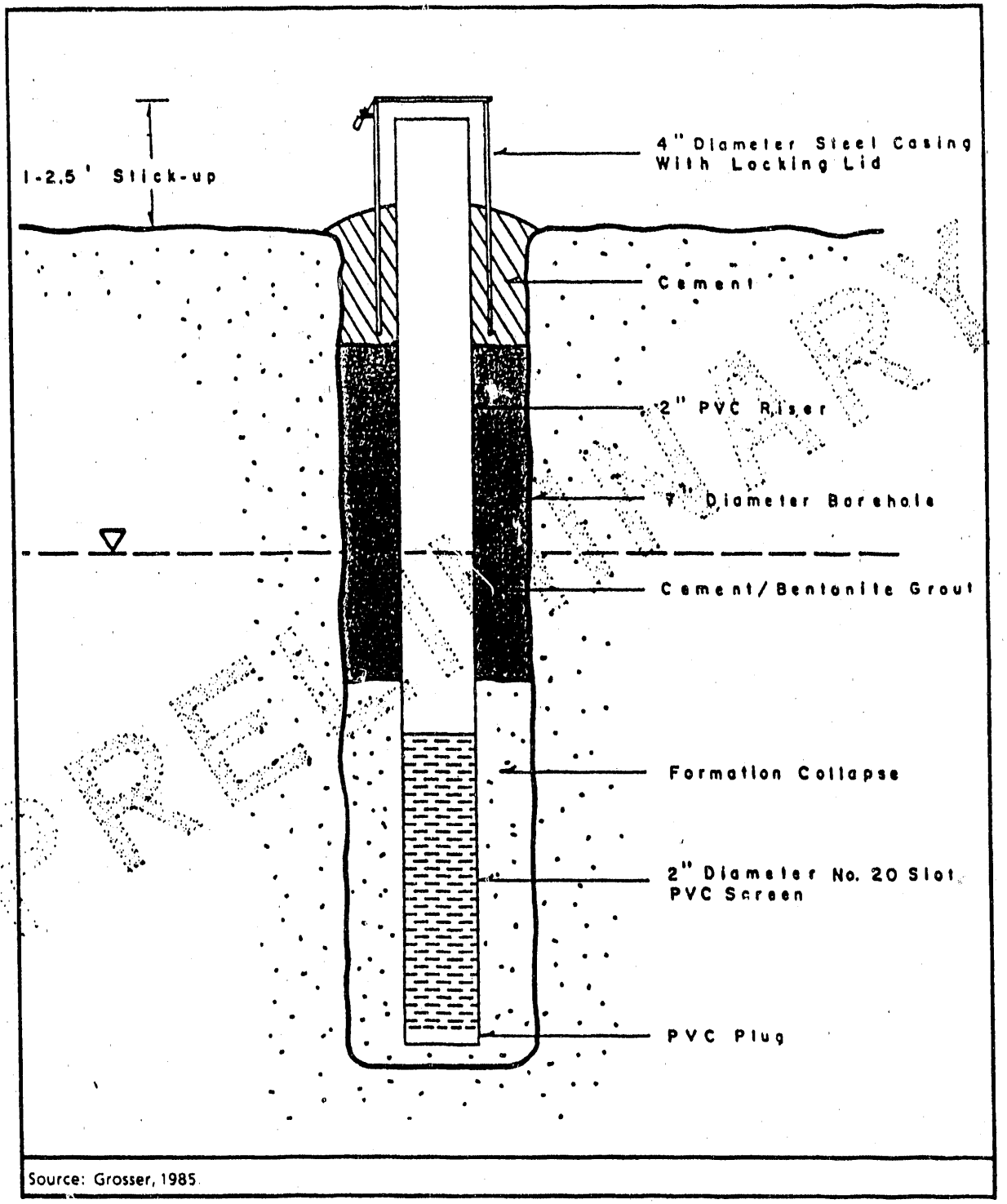


FIGURE 3-12

TYPICAL WELL CONSTRUCTION
BNL - UPTON, NY

TABLE 3-22

REPORTED CONTAMINANTS ANALYZED IN 1985
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Potable Supply Wells & Cooling Water Wells
Radionuclides: Gross alpha & beta, H-3, Be-7, Na-22, Cr-51, Co-60, Sr-90 & Cs-137
Water Quality: pH, Specific Conductance, Ammonia-N, Nitrate-N, Nitrite-N, Total Solids, Chlorides, Fluorides & Sulfates
Metals: Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Na, Pb, Se & Zn
Organic compounds: Acrolein, Acrylonitrile, Benzene, Bromodichloromethane, Bromoform, Carbon Tetrachloride, Chlorobenzene, Chlorodibromomethane, Chloroethane, 2-Chloroethyl Vinyl Ether, Chloroform, Chloromethane, Dichlorodifluoromethane, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethylene, trans-1,2-Dichloroethylene, 1,2-Dichloropropane, 1,3-Dichloropropane, Ethylbenzene, Methylene Chloride, 1,1,2,2-Tetrachloroethane, Tetrachloroethylene, Toluene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethylene, Trichlorofluoromethane, & Vinyl Chloride

Sand Filters & Peconic River Landfill Areas and On-Site Controls & Waste Management Area*
Radionuclides: Gross alpha & beta, H-3, Be-7, Na-22, Co-60, Sr-90 & Cs-137
Water Quality: pH, Conductivity, Chlorides, Sulfates, Nitrate-N
Metals: Ag, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Na, Pb, Zn
Organic compounds: Chloroform, 1,1,1-Trichloroethane, Trichloroethylene & Tetrachloroethylene

Source: Adapted from: Day et al., 1986.
* Nitrate-N not reported.

Nytest Environmental, Inc.
75 Urban Avenue
Westbury, NY 11590

Environmental Testing and Certification
284 Raritan Center Parkway
Edison, NJ 08837

Of these four laboratories, the first three provided only organic analyses. The fourth provided the full suite of analyses normally performed by the site laboratory.

During field visits to the well sites, the sampling procedures and protocols were observed by the Survey team. The following are some of the items noted during the visits:

- Bicycle flags were used to mark the locations of the wells, with the number of the well written on the flag. These flags were frequently stolen, and the writing that was on the remaining flags weathered to the point that numbers were illegible. Wells that were drilled more recently (e.g., wells at the Former Landfill) have the identification number on the well casing. It was indicated to a Survey member that the number is placed on the well as soon as the well is completed. Older wells do not have any markings on them for identification.

- Most wells did not have a cap that would protect the well from intrusion. The 2-inch wells had a small, screw-on cap with no locking device, and the larger wells had a locking cap that was easily broken (e.g., a well near one of the air strippers had a cap that appeared to have been broken with a rock and an obstruction caused by dropping the pieces down the well casing). This resulted in the loss of the well as a monitoring point.

- The procedures for collecting a sample involved purging the well with a nondedicated, submersible pump to remove three well volumes. The purge volume was estimated, since no flow meters were used. Purge water from the wells is discharged directly to the ground surface. After purging, the pump was disconnected and the sample was collected by means of a bailer. The sampling procedures were consistent with EPA-established protocols for chain-of-custody, field measurements, and sample handling.

3.4.3.2 Data Handling, Distribution, and Interpretation

Most of the analytical data generated in the sampling program is maintained in S&EP's computer data base at BNL. The BNL goal is to have all analytical data from the chemical and radioactive monitoring programs and other specialized programs in the laboratory's central data base.

Once data is entered into the data base, the analytical data can be evaluated in an interactive fashion. At present, the data is organized so that it can be retrieved by (1) computer printouts of analytical data, (2) computer printouts of specific wells, and (3) data for the annual reports. Groundwater monitoring data are reported annually in accordance with DOE Order 5484.1.

3.4.4 Findings and Observations

3.4.4.1 Category I

None.

3.4.4.2 Category II

1. Groundwater Monitoring Program Deficiencies. Deficiencies in the groundwater monitoring program make it difficult to characterize the nature and extent of groundwater contamination both on-site and off-site. In addition, these deficiencies directly affect the reliability of results generated by the BNL groundwater monitoring program. The deficiencies include the following:

   a. Uncertainty regarding well construction (i.e., the well as-built construction was not recorded during installation to confirm that they were built as designed).

   b. Wells at strategic locations may not be screened at the appropriate depth; hence, contaminants could go undetected. This is especially critical for the wells involved in evaluating the progress of the air stripping project and wells that are located in areas to detect the presence of contaminants that could either sink or float in the saturated zone.

   c. The use of a non-dedicated pump for purging monitoring wells can result in cross contamination of the wells and of samples.

d. Placement of monitoring equipment directly on the ground may result in the introduction of contaminants into the well and/or the sample.

e. Lack of a site map with the correct location of all groundwater monitoring wells. There are several maps showing the location of various wells around specific areas at BNL; however, there is no map that shows the location of all wells at the facility.

f. Lack of physical identification markings on each well. The well casings observed during the site visit did not have any type of identification marking on them.

g. Lack of physical field markers indicating the location of each well. While visiting the various well sites, it was noted that some wells had a "bike" flag placed in the ground near the well site and the well name was written on the flag. Many of the flags were missing from the well sites, and the markings on the flags that still existed were extremely difficult, if not impossible, to read. The ink that was used to mark the flags was not weatherproof, and it simply faded with time.

h. Lack of tamper-proof well caps. Most wells did not have a cap that would protect the well from intrusion. The 2-inch wells had small screw-on caps with no locking devices, and the larger wells had locking caps that were easily broken (e.g., a well near one of the air strippers had a cap that appeared to have been broken with a rock and an obstruction caused by dropping the pieces down the well). This resulted in the loss of the well as a monitoring point.

i. Purge water from groundwater monitoring wells is discharged on the ground in proximity to the well casing. This practice could result in the release of hazardous constituents to the soil if the well from which the purge water is taken is contaminated. In addition, purge water discharged in proximity to the well casing may result in the reintroduction of contaminants to the well.

3.4.4.3 Category III

1. Known Groundwater Contamination. Groundwater in several areas, discussed below, is known to be contaminated with radiological and nonradiological constituents as a result of past and/or ongoing site activities. The full nature and extent of contamination at areas known to be contaminated is currently unknown. There are additional areas of potential

groundwater contamination for which no groundwater monitoring has been performed. These areas include the following:

a. Hazardous Waste Management Area (HWMA) - Groundwater beneath and in the vicinity of the HWMA is contaminated with VOCs and radionuclides. Levels of certain contaminants exceed drinking water standards. There are four primary contaminants: chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. According to the results, 8 of the 30 wells sampled exceeded the NYSDH drinking water guideline levels (50 ppb for individual constituents; no greater than 100 ppb for the sum of concentrations for multiple contaminants). The sum of the concentrations for the organics detected was 2,100 ppb. The wells containing the higher VOC levels also showed the higher levels of tritium. The available analytical data show that the likely source of the plume appears to be the HWMA. The Current Landfill may also be a source. The plume appears to be relatively narrow, and is migrating in a southerly direction with the 50 parts per billion isopleth extending approximately 2,500 feet. Because of the lateral extent of the plume, a series of five wells was installed in 1985 to recover the contaminated groundwater for treatment by spray aeration. Section 3.4.2 provides a discussion of this treatment system (see related Findings 4.1.2.3.1(a, b, c, d) and 4.5.2.3.1(d)).

b. The Current Landfill Site - Leachate from the landfill may be contaminating groundwater. However, contamination from the Current Landfill may not be distinguishable from contamination attributable to the HWMA. Consequently, the Current Landfill is a potential source of groundwater contamination within a larger source area that includes the HWMA. The wells downgradient from the Current Landfill show elevated levels of gross alpha and beta, tritium, Sr-90, iron, manganese, zinc, sodium, conductivity, chlorides, and sulfates; and low pH. Tritium was found in wells 2C and W9. The highest average concentrations were 20,000 and 26,700 pCi/l, respectively (Day et al., 1986). The drinking water standard for tritium is 20,000 pCi/l. (An Advance Notice of Proposed Rule Making was published September 30, 1986, which would raise the drinking water standard to 90,000 pCi/l.) Levels of Sr-90, gross alpha, and gross beta were at approximately 50 percent of the drinking water standard or at compliance levels of 8, 15, and 50 pCi/l respectively. The low pH values, down to 4.9, likely influence iron, manganese, and zinc concentrations (see related Findings 3.2.4.3.1(a), 4.1.2.2.2, and 4.5.2.3.1(f)).

c. Sewage Treatment Plant (STP) - Contamination has migrated from the surface into the groundwater at the STP. Monitoring wells in the vicinity of the STP and sand filter beds

indicate elevated levels of iron, manganese, lead, zinc, Sr-90, gross beta; and low pH. Volatile organic compounds have been detected in the low ppb range. Of the known contaminants, Sr-90 exceeded drinking water standards in well XL in 1985. Tritium was reported at 10,300 pCi/l, or approximately 50 percent of the current drinking water standard. The metals exceeded drinking water standards in several wells. Levels of iron were up to 30 times the standard of 0.3 ppm. Section 3.3.2 addresses the releases to the river from the sand filter beds (see related Findings 3.2.4.3.1 and 4.5.2.3.1(h)).

d. The Former Landfill Area - This area and the associated disposal areas, grouped on approximately 12 acres, are located in the southeast section of BNL and include the following actual and potential sources of groundwater contamination:

- Former Landfill
- Chemical and Animal Pits
- Glass Pits
- Slit Trench
- Small Dump used in 1966

Estimates of the quantities and types of contaminants are given in Section 4.5.1.1, and Finding 4.5.2.3.1(a, b, c, g, and i). A number of sampling wells have been installed in the direction of groundwater flow to evaluate migration of chemical and radiological contamination. Data has showed concentrations of gross beta activity to be somewhat above ambient values, but far below applicable radiation protection guide levels. Correspondingly, there is some tritium seen in sampling wells around the Former Landfill. Chemical analyses were high for iron (Liverman, 1977). The wells downgradient--D6, 1I, 1J, WP, and WQ--generally show the highest values of contamination. Well D6, closest to the Former Landfill, has the highest reported average concentrations for 1986 of Sr-90, 11.35 pCi/l; gross beta, 12.90 pCi/l; and chlorides, sulfates, manganese, sodium, and conductivity--three to ten times the levels in the upgradient wells D2, D3, and D4 (Miltenberger et al., 1987). VOCs have also been detected in the low ppb range but cannot be conclusively related to any specific source area.

e. Meadow Marsh and Substation Well Area - Tritium has reached the groundwater in this area, and as of 1987, has migrated beyond the boundary of BNL. It can be measured in a LILCO Substation well located southwest of the site. The tritium contamination is the result of a sewage effluent land-spreading operation that occurred in the 1970s and is discussed further in Findings 3.2.4.3.1(d) and 4.5.2.3.1(n).

f. B-650 Sump Discharge Area - Groundwater in the area of the B-650 sump discharge area is contaminated with Sr-90 and gross beta. The highest concentration of Sr-90, when last reported by BNL in 1983, was 80.1 pCi/l. The highest level of gross beta, when last reported by BNL in 1984, was 55.3 pCi/l. The drinking water standards for Sr-90 and gross beta are 8 pCi/l and 50 pCi/l, respectively. The source of the contamination, discussed in detail in Finding 4.5.2.3.1(j), was effluent from the B-650 decontamination building which was inadvertently pumped to a storm sewer instead of a hold-up tank. Eight monitoring wells were drilled near the discharge area after the error was discovered. Three of the wells consistently showed levels of Sr-90 and gross beta in excess of drinking water standards. Table 3-23 shows the gross beta and Sr-90 concentrations for the wells 1A, 1E, and 1H during the period from 1975 to 1984. In 1984, however (the last year for which B-650 sump monitoring well data was available), concentrations for Sr-90 were not reported. Concentrations of gross alpha, tritium, Na-22, Co-60, and Cs-137, during the period of 1975 to 1984 were below drinking water standards or detectable limits. No data for any of the B-650 sump monitoring wells were reported in either the 1985 or 1986 Environmental Monitoring Reports.

Although no clear trend emerges from the available data (because values are typically based on one sample), it appears that the contaminant concentrations are declining with time. Because of the lack of recent data, uncertainties regarding monitoring well construction, and the paucity of samples, it is not possible to conclusively determine whether the apparent decline in concentrations is due to natural decay of the contaminants or to movement of the contaminants away from the existing monitoring wells.

g. Miscellaneous - There are presently two drinking water wells that are shut down because of VOC contamination. Additionally, there is one well which has a low level of volatile organics and one which is on standby, for fear of bringing higher levels of volatile organics into the well area. The source(s) of contamination is (are) not known.

2. Off-site groundwater is contaminated. Volatile organics and radionuclides have been detected at elevated levels in residential wells off-site. VOCs have been found in wells off-site near the boundary of BNL. The wells of two residences to the east of the site were sampled by SCDHS in February 1985 and were found to contain organic compounds. The highest measured concentration was that of trans-dichloroethylene at 12 parts per billion (ppb). Other compounds detected were 1,1 dichloroethane, 3 ppb; cis-dichloroethylene, 3 ppb; and

TABLE 3-23

SELECTED HISTORICAL DATA: B-650 SUMP DISCHARGE AREA WELLS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Year	Well 1A		Well 1E		Well 1H	
	Sr-90 pCi/l	Gross Beta pCi/l	Sr-90 pCi/l	Gross Beta pCi/l	Sr-90 pCi/l	Gross Beta pCi/l
1975	63.6 ± 6.4	160 ± 6.0	121 ± 10.2	260 ± 7.0	54.6 ± 5.5	209 ± 6.0
1976	21.6 ± 0.6	25.6 ± 1.3	60.1 ± 0.8	65.8 ± 1.9	51.2 ± 0.8	175.0 ± 3.0
1977	16.9 ± 0.5	27.6 ± 1.5	18.1 ± 0.5	60.4 ± 1.9	29.5 ± 0.8	66.5 ± 2.0
1978	83.62 ± 1.29	190.0 ± 4.2	67.45 ± 1.16	62.3 ± 1.8	70.80 ± 1.2	149.4 ± 3.8
1979	53.08 ± 0.80	106.00 ± 3.31	57.11 ± 0.81	117.40 ± 3.46	ND	61.87 ± 2.58
1980	56.58	124.0	ND	ND	ND	ND
1981	9.20	23.90	8.69	19.42	81.5	160.20
1982	5.25	18.59	6.20	28.34	51.35	200.69
1983	53.9	71.0	46.5	41.0	80.1	79.0
1984	ND	55.30	ND	40.0	ND	50.0
1985	ND	ND	ND	ND	ND	ND

Source: Adapted from BNL Environmental Monitoring Reports for years 1975 through 1985.
ND = not reported
NYS Drinking Water Standards: Sr-90 = 8 pCi/l
gross beta = 50 pCi/l

1,1,2 trichloroethylene, 5 ppb (SCDHS, 1985a & SCDHS, 1985b). Tritium has been detected in these two wells in the range of approximately 1,000 to 2,000 pCi/l (Anonymous, 1985), with one well increasing to approximately 7,000 pCi/l in November, 1986 (Anonymous, 1986). Additionally, wells at the LILCO substation and the Manorville school, both in Manorville, have been found on one occasion to contain tritium in concentrations of approximately 1,340 and 1,060 pCi/l, respectively (Anonymous, 1986). BNL acknowledges that the tritium that is found off-site is the result of BNL operations; however, there is still some question as to the source of the VOCs that have been found in the off-site wells. SCDH samples off-site wells for VOCs and radionuclides, and BNL performs some of the analyses. BNL does not have SCDHS's sampling procedures on file, nor does BNL have control over the sampling. The validity of the data generated from SCDHS's samples is unknown because the sampling methods, protocols, and quality assurance measures used by SCDHS are unknown.

3.4.4.4 Category IV

1. Nitrate levels in groundwater may be underestimated. Groundwater samples that are collected during the Friday sampling run are held in the laboratory until start of work on Monday; hence the 48-hour hold time is exceeded. The nitrate results obtained from these samples may be underestimated because of the time delay of completing the analysis. The levels of nitrate in the groundwater at BNL are generally below drinking water standards and, at the present time, do not pose a human health or environmental problem.

2. Inactive wells are not properly abandoned. Old wells (which are not going to be integrated into the BNL groundwater monitoring program) provide a direct conduit for contaminants to move to groundwater (e.g., the stem of an old well in the HWMA is broken off below the ground surface, and the stems of old wells in the Meadow Marsh Experiment area were sheared off when the field was leveled).

3. Purge water is discharged close to well casing. Purge water is discharged in proximity to the well casing, a factor which may allow soil or surface contamination to reinfiltrate into the groundwater system. The purge water may also enter the well filter and alter the concentration of the formation water by dilution or by flushing additional contaminants from the soil into the well.

4.0 NON-MEDIA-SPECIFIC FINDINGS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to one medium, as was the case with the discussions in Section 3.0. These discussions include an environmental monitoring program section, where appropriate, and where information was available. The findings for hazardous, radioactive, mixed, and solid waste management are summarized in a section addressing waste management.

4.1 Waste Management

4.1.1 General Description of Pollution Sources and Controls

4.1.1.1 Hazardous Waste Management

The broad range of research activities carried out at BNL, in combination with the use of BNL facilities by numerous experimenters (including numerous outside experimenters on-site for short terms), results in the generation of a large variety of hazardous, toxic, and/or radioactive wastes, usually in small quantities. The varieties of wastes handled are illustrated in BNL's 1986 Biannual Hazardous Waste Report (Bebon, 1987), which listed 1,323 individual hazardous wastes. Most of the wastes were small quantities of laboratory chemicals. This listing did not include radioactive, mixed, or nonradioactive/nonhazardous solid wastes. Thus, BNL can be characterized as a site where a large number of sources generate small volumes of a wide variety of wastes. These wastes generally contain toxic, radioactive, and/or hazardous constituents. Table 4-1 describes the major sources and types of hazardous wastes generated at BNL.

The hazardous wastes generated in BNL's laboratories, generally consist of discarded laboratory chemicals such as inorganic salts, organic reagents, acids, oils, and solvents. Liquid wastes such as acids, solvents, and contaminated oils are usually collected in small containers such as 5-gallon carboys. Support operations such as machine shops, equipment cleaning facilities, and maintenance shops, usually generate wastes such as solvents and solvent-contaminated oils, both of which are often accumulated in drums or in tanks. The following is a discussion regarding the movement of hazardous wastes from the various generators to the Hazardous Waste Management Area.

DOE Order 5480.2 titled Hazardous and Radioactive Waste Management, issued December 13, 1982, and DOE Order 5820.2, titled Radioactive Waste Management, issued December 6, 1984, are the

TABLE 4-1

HAZARDOUS WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Building	Description/Division	Waste Material	Quantities or Shipments*
1005	Accelerator Development	Used Oil	2,400 gallons
1006	Accelerator Development	Oil/Waste	1,350 gallons
117	Accelerator Development	Filter	15.0 cubic feet
129, 129A	Accelerator Development	Mercury	1.0 pound
129, 129A	Accelerator Development	Chlorinated Solvents	120 gallons
134C	Plant Eng.	Waste Oils	3,320 gallons
158	Safety	Lab Chemicals	Small Quantities
194	Oceanographic Lab/DAS	Paints	10 gallons
197	DNE	Alcohols	440 gallons
197	DNE	Acids	600 gallons
197	DNE	Oakite 166 & Oakite 360L	3,520 gallons
197	DNE	Cont. Sod. Bicarb.	500 pounds
197	DNE	Chlorinated Solvents	120 gallons
208	Welding Shops	Oakite 164, 3600 & Oakite Dioxidizer	800 gallons
209	Offices	Capacitors	500 cubic feet
209	Offices	Transformer (PCB)	200 pounds
209	Offices	PCB Oil	2,000 gallons
246	Offices	Alcohols	32 gallons
282	Offices	Organic Solvents	24 gallons
318	Env. Prog/DAS	Lab Chemicals	Small Quantities
318	Env. Prog/DAS	Nitric Acid/Acetonitrile	35 gallons
318	Env. Prog/DAS	Non-chlorinated Solvents	24 gallons
318	Env. Prog/DAS	Hexane/Oil	8 gallons
318	Env. Prog/DAS	Formaldehyde/Seawater	60 gallons
318	Env. Prog/DAS	Formalin/Seawater	84 gallons
355	Contracts & Procurement	Unidentified	8 gallons

TABLE 4-1
HAZARDOUS WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

Building	Description/Division	Waste Material	Quantities or Shipments*
422	Carpenter Shop/PE	Paint Thinners	320 gallons
426	Environmental Chem/DAS	Lab Chemicals, Acids	10 shipments
452	Utilities	Glycol	480 gallons
452	Utilities	Waste Oil	800 gallons
460	Director's Office	Hexane and Charcoal	110 cubic feet
462	Shops	Waste Oil	80 gallons
462	Shops	Oil/Water	200 gallons
463	Biology	Asbestos	130 pounds
463	Biology	Beryllium/Oil	16 pounds
463	Biology	Chlorinated Solvents Organic Lab Chemicals Inorganic Lab Chemicals Ion Exchange Resins Chromerge Cleaning Solvents Waste Oils Waste Acids, Bases Non-chlorinated Solvents	174 shipments
480	Metallurgy/DAS	Inorganic Lab Chemicals Organic Lab Chemicals	20 shipments
480	Metallurgy/DAS	Waste Oils	320 gallons
480	Metallurgy/DAS	Acids	200 gallons
490	Medical	Hexane/Charcoal	655 pounds 510 cubic feet
490	Medical	Waste Oils	897 gallons
490	Medical	Organic Lab Chemicals Inorganic Lab Chemicals Chlorinated Solvents	877 shipments
490	Medical	Acids, Bases	2 gallons

TABLE 4-1
HAZARDOUS WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE THREE

Building	Description/Division	Waste Material	Quantities or Shipments*
494	Medical	Acids, Cement Solvents Thinners, Cleaning Fluids Floor Sealers, Methanol Pharmaceuticals Cements and Salt Solutions	215 shipments
496	Medical	Varsol-Solvent	800 gallons
51	NSLS	Paraffin Oil	128 gallons
51	NSLS	Uranine	48 gallons
510	Physics	Oils-Soluble	800 gallons
510	Physics	Chlorinated Solvents Alcohols Organic Lab Chemicals Inorganic Lab Chemicals Resins Acids, Bases	291 shipments
510B	Physics	Lab Chemicals	15 shipments
526	Process Technology/DAS	2,4,6-Trichlorotoluene	160 gallons
526	Process Technology/DAS	Lead Oxide	1,600 pounds
526	Process Technology/DAS	Zinc Chloride	450 pounds
526	Process Technology/DAS	Organic Lab Chemicals Inorganic Lab Chemicals	18 shipments
528	Laboratory/DNE	Lab Chemicals	3 shipments
535	Instrumentation NSLS/ SEEP/NSLS	Waste Oil	235 gallons
535	Instrumentation NSLS/ SEEP/NSLS	Toners	34 pounds
558	Chemistry	Waste Oils	442 gallons
558	Chemistry	Solvent/Water Organic Lab Chemicals Inorganic Lab Chemicals Acids	86 shipments
703	BGGR Labs/Chemistry	Waste Oil	80 gallons
703	BGGR Labs/Chemistry	Organic Lab Chemicals Inorganic Lab Chemicals	30 shipments

TABLE 4-1
HAZARDOUS WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE FOUR

Building	Description/Division	Waste Material	Quantities or Shipments*
725	NSLS	Waste Oils	Not Available
725	NSLS	Organic Lab Chemicals	29 shipments
726	NSLS	Solvents	460 gallons
750	HFBR/Reactor	Waste Oils	808 gallons
750	HFBR/Reactor	Organic Lab Chemicals Inorganic Lab Chemicals	136 shipments
801	Medical	Organic Lab Chemicals Inorganic Lab Chemicals	50 shipments
815	Chemical Sciences/DAS	Waste Oils	480 gallons
815	Chemical Sciences/DAS	Organic Lab Chemicals Inorganic Lab Chemicals	49 shipments
820	DNE	Waste Oils	9,800 gallons
830	Nuclear Waste Management/DNE	Organics	Not available
830	Nuclear Waste Management/DNE	Resins	108 gallons
9-508	Nuclear Waste Management/DNE	Organic Lab Chemicals Inorganic Lab Chemicals	30 shipments
901	Nuclear Waste Management/DNE	Solvent/Water Organic Lab Chemicals Inorganic Lab Chemicals	18 shipments
911	Physics	Acetone/Alcohol	800 gallons
911	Physics	Waste Oils	1,920 gallons
911	Physics	Organic Lab Chemicals Inorganic Lab Chemicals	14 shipments
912	AGS	Waste Oils	1,200 gallons
914	Beam Component Assembly/AGS	Resins Paints Cement	7 shipments
919	AGS	Waste Oils	2,160 gallons
919	AGS	Vythene/Oil	1,760 gallons

TABLE 4-1
HAZARDOUS WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE FIVE

Building	Description/Division	Waste Material	Quantities or Shipments*
919	AGS	Resins Hardeners Epoxy	28 shipments
922	AGS	Vac. Oil and Trichloroethylene	360 gallons
923	AGS	Waste Oil	2,360 gallons
923	AGS	Trichloroethylene	280 gallons
923	AGS	Oil/Vythene	810 gallons

Source: Emma, 1986.

* Column indicates quantities for 1986, where drumload quantities were shipped to HWM or number items shipped for less than drumload quantities; typically, laboratory chemicals in small quantities (e.g., pounds, grams, or gallons).

principal DOE orders regulating waste management at DOE sites. The Resource Conservation and Recovery Act (RCRA) of 1976, the 1984 RCRA amendments, and associated regulations issued by EPA, establish the technical and management standards used by the Survey as the basis for evaluating hazardous waste and mixed waste handling and facilities. The ALARA principles, as outlined in DOE orders, were the basis for evaluating waste facilities and practices associated with wastes containing radionuclides and hazardous constituents.

New York State regulations for hazardous waste are virtually mirror images of EPA's. The most significant difference is the application by New York of hazardous waste regulations to certain PCB wastes. Solid waste including sanitary and inert wastes were evaluated in accordance with New York State regulations and good management practices.

4.1.1.1.1 Waste Accumulation Areas

The existence of numerous points where hazardous wastes are generated has resulted in the need for many Waste Accumulation Areas (WAAs). Small quantities of hazardous, radioactive, and mixed wastes are accumulated at WAAs prior to pickup and transport to the Hazardous Waste Management Area (HWMA) for further processing and/or off-site shipment to treatment or disposal facilities. BNL has more than 30 WAAs which are used for hazardous, radioactive, and mixed wastes. (Mixed and radioactive wastes will be discussed in Sections 4.1.1.2 and 4.1.1.3.) One WAA may serve a building, part of a building, or a group of buildings. Most WAAs at BNL are located outdoors. Waste liquids such as solvents, acids, and bases are contained in small plastic and glass containers and solid laboratory chemicals in bottles and boxes. Larger containers such as drums and tanks are used to store oils, solvent/oil mixtures, and oil/coolant mixtures. WAAs at BNL are not listed or managed on a site-wide basis. Building Health and Safety Coordinators are generally responsible for maintaining WAAs and ensuring that wastes are properly packaged and labeled. However, in certain areas, wastes were being accumulated in areas unknown to the H&S Coordinator responsible for the building.

The Survey team made several observations regarding conditions and practices relating to WAAs. Waste containers placed in WAAs were generally not labeled as hazardous wastes or with accumulation start dates. Virtually none of the WAAs had secondary containment. This included the waste oil tanks. Surface grade at some WAAs would allow spills to gain access to storm and sanitary drains, or soil. In several cases, there was visible evidence that spills had occurred at WAAs. Stains indicative of oil releases were observed at the B-510 WAA, the B-928 WAA, the B-535 WAA, and around the 300-gallon waste crankcase oil tank at B-423. Spillage occurred on such a routine basis at

B-423 that spill-absorbent material was always kept around the tank and replaced as a matter of routine.

Table 4-8 in Finding 4.1.2.4.1 gives a more detailed listing of WAAs and conditions as observed during the Survey.

Even though no permit is required, certain regulatory requirements are applicable to WAAs. These requirements include separating incompatible wastes; labeling, as hazardous waste containers, all containers holding hazardous waste; recording the accumulation start dates on each container; and not exceeding the 90-day storage limit. Although requirements for impermeable surfaces and secondary containment (which are applicable to permitted hazardous waste storage facilities) do not apply to WAAs, it is considered an accepted industry practice to comply with these requirements. This is especially appropriate at BNL, since it sits on relatively porous soils over a sole-source aquifer.

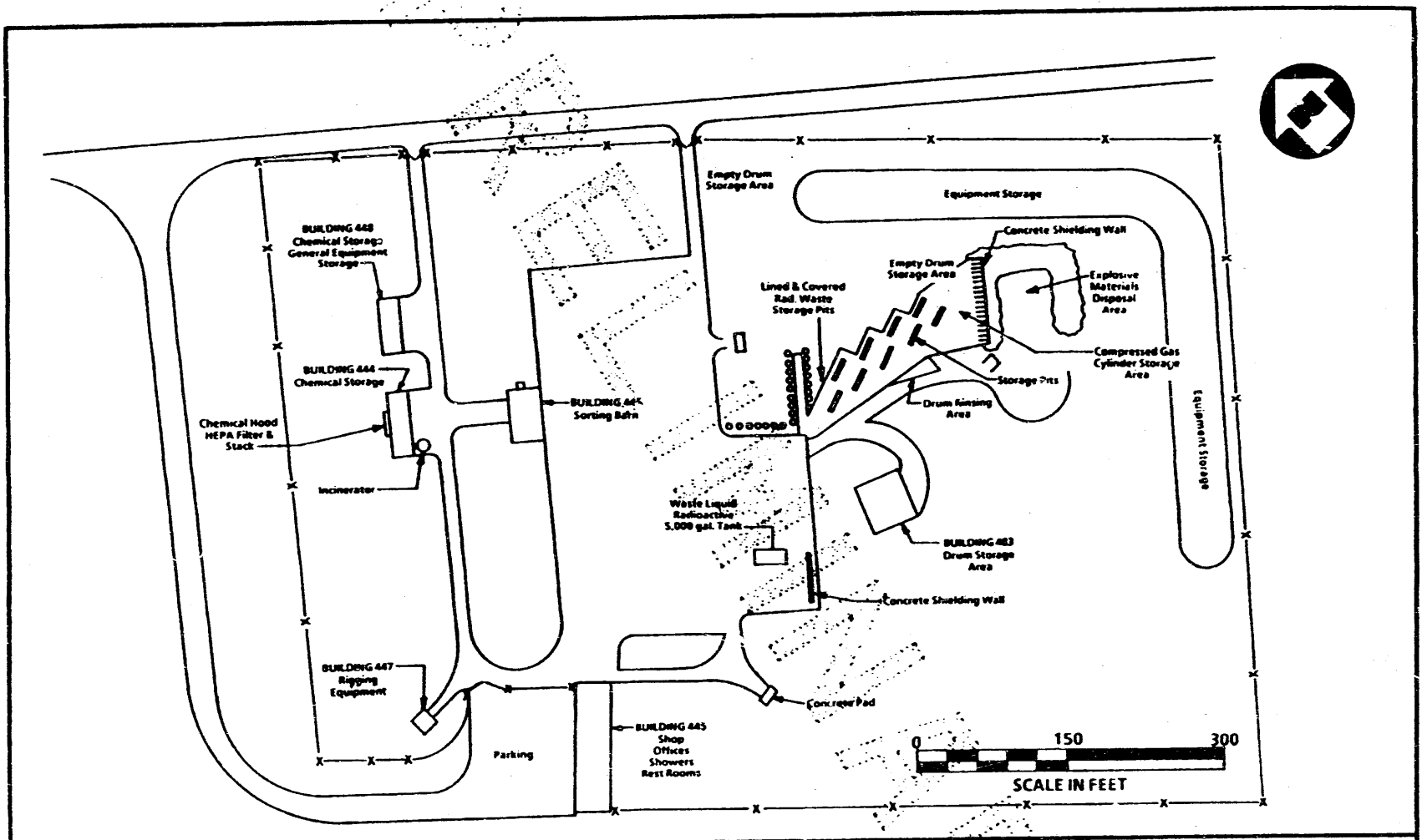
4.1.1.1.2 Hazardous Waste Pickup Procedures

Requests for pickups of hazardous wastes are made by the generator to Hazardous Waste Management (HWM) on a "Hazardous Materials Waste Control Form (Nonradioactive)." This form requires that the generator provide information on the physical and chemical properties of the waste. The forms are numbered sequentially and their number is placed on a tag attached to the waste container. The truck driver from HWM then picks up the designated container at the WAA.

Certain wastes generated on a regular basis at a specific point are assigned a "routine number." These wastes, when placed in a WAA and designated by the routine number on the tag, are picked up by the truck driver. The truck driver, rather than the waste generator, fills out the required information on the cont form.

4.1.1.1.3 Hazardous Waste Management Area (HWMA)

The HWMA is the central receiving, processing, and storage area for all BNL hazardous, radioactive, mixed, and PCB wastes (Figure 4-1). The HWMA is fenced; about one-fourth of the area is paved with blacktop and the remainder is natural field grass and weeds. Four permanent buildings are used for waste processing, treatment, and storage; six railway cars are used for storage of equipment such as new drums, vermiculite, cement, and packing materials; and an incinerator is situated in the HWMA. Areas and activities in the HWMA related to hazardous waste management are discussed below, whereas HWMA radioactive waste management areas and activities are discussed in Section 4.1.1.2.



Source: Day et al., 1986

FIGURE 4-1

HAZARDOUS WASTE MANAGEMENT FACILITY SCHEMATIC
BNL - UPTON, NY

Results of routine groundwater monitoring have shown that groundwater in the area of the HWMA has been contaminated with organics, including 1,1,1-trichlorethane, trichloroethylene, chloroform, and tetrachloroethylene. The plume of organic contamination from the HWMA is currently being treated by air stripping to remove volatile organics. See Section 3.2 for further details.

Radioactive contamination of the soil and subsurface has also occurred and is discussed in Sections 3.2 and 4.1.1.2. Runoff from the HWMA drains outside the fenced area and ponds during wet periods. The runoff is not analyzed. See Section 3.3 for further details.

The northern portion of B-444 is used for receiving, sorting, and storing nonradioactive hazardous wastes. Wastes are segregated into broad classifications (e.g., carcinogens, solids, caustics, ignitable, etc.) by HWM personnel. Large quantities (barrels) of waste material are transferred to B-483, if liquid. Small quantities (liters) are stored in spill trays until packaged for off-site disposal. PCB oils and/or equipment is transferred to B-448. Packaging of small waste containers into larger containers (laboratory packs) for disposal at off-site facilities is performed by vendor personnel. Waste materials, when delivered, are placed on a workbench or tables for segregation. Delays in segregating the waste result in a cluttered work area, as was observed during the Survey.

The flammable liquid storage cabinets in B-444 contain flammable waste; however, the building lacks fire protection. In addition, mechanical ventilation is inadequate. The situation is further aggravated in winter when doors, windows, and fresh air intakes are closed to prevent possible freezing and rupturing of liquid containers.

The south end of B-444 is used as the work and storage area for the adjacent incinerator. The incinerator is used for the burning of certain low-level radioactive wastes. The incinerator is a vertical, three-stage, air-controlled unit, equipped with an automatic hopper feed system. The first stage is ignition, with two oil-fired burners. The second stage is the afterburner, with one burner, and the third stage encompasses heat retention and particle separation.

Until early 1986 the wastes incinerated in B-444 included scintillation vials. This practice of burning scintillation vials was stopped, since these vials contained hazardous solvents and BNL did not want to undertake the process for permitting the incinerator as a hazardous waste incinerator. Currently, the incinerator is used only for burning small quantities of animal carcasses and laboratory debris such as gloves, pipettes, needles, and syringes. HWM personnel estimated current usage to be only 2 hours/month.

Building 446 is used for radioactive waste (see Section 4.1.1.2 for further details).

Building 448 is a sheet metal building on a concrete pad that is used as a general works and storage area. PCB-contaminated oils and equipment are stored in this location prior to shipment off-site. Secondary containment trays for PCB liquids are provided.

Building 483 is beam and post construction with a corrugated, sheet-metal roof, open on one end and with three corrugated fiberglass sides and a concrete floor. This is the storage area for drums and containers holding hazardous waste. Several discrete diked areas are used to separate incompatible wastes. Dikes are made of concrete and integral with the concrete floor, so that releases may be contained. Most drums are stored on 1-inch bars to keep them from coming into contact with any liquids that may be on the floor. This building does not have any utilities. Application has been made for a RCRA Part B storage permit.

The paved asphalt area in the central portion of the HWMA is used to store drums containing hazardous and/or radioactive waste. During the time of the Survey, no drums containing hazardous waste were being stored on the paved area. However, according to a BNL assessment (Safety Assessment Committee, 1986), several hundred drums of oil were being stored there as recently as December 1986. Prior to construction of the B-483 storage facility for containerized liquid hazardous waste, all such wastes would have been stored in this area. A portion of the paved area was heavily stained. Runoff from the area had a visible oil sheen. No analytical information was available on either the runoff or the receiving soils.

Thirty-five drums of oil-contaminated sand, generated by cleanup of ignitable hazardous waste fuels and fuel oil spills at the Central Steam Facility (CSF), were being stored on a paved area near Building 448.

In addition, radioactive oils, shipping containers holding compacted radioactive trash, and solidified slurry resulting from the evaporative concentration of radioactive wastewaters are stored on the paved areas (see Sections 4.1.1.2 and 4.1.1.3 for more details).

Low-level-activated AGS equipment is stored on a grass field, and highly contaminated equipment was stored in covered trenches and holes (see Section 4.1.1.2).

The detonation area is used to burn or detonate explosive and highly reactive wastes. The burning area is surrounded on three sides by an 8-foot-high earthen berm. Leaking gas cylinders are vented to the atmosphere in this area, a practice that BNL planned to phase out.

HWM personnel neutralized small quantities of acids, bases, and alkali metals at the neutralization area of the HWM facility. The salts resulting from the neutralization are still stored at the HWMA. Supernatant was disposed of by pouring it on the pavement. This practice was stopped in 1986. Neither the wastes nor the neutralized supernatant were tested for hazardous constituents, such as metals. See Section 4.5 for additional details on the HWMA.

4.1.1.1.4 Underground Storage Tanks

Subtitle I of the Resource Recovery and Conservation Act (RCRA) requires EPA to promulgate regulations for underground storage tanks (USTs) on notification, leak detection, records, release reporting, corrective actions for releases, tank closure, and new tank performance standards. USTs are tanks with 10 percent of the tank volume, including piping, underground. The regulations apply to all USTs holding chemical substances as listed in Section 101(14) of CERCLA, petroleum, and substances derived from petroleum (fuel oil, gasoline, etc.) and are separate from hazardous waste tank regulations (in Sections 264 and 265 of RCRA regulations) for tanks containing listed or characteristic hazardous wastes.

EPA promulgated regulations in Section 280.3 of the RCRA regulations requiring notification to agencies as designated by states of all USTs either in service as of May 8, 1986, or taken out of service after January 1, 1974. Proposed technical standards for USTs regarding leak detection, records, releases, corrective actions, and new tank performance standards were proposed on April 17, 1987, but are not yet in effect.

Suffolk County, in which BNL is located, has also established in Article 12 "Toxic and Hazardous Materials Storage and Handling Controls" regulations that apply both to aboveground and underground storage tanks. The county regulates tanks as part of a county-wide program to protect the sole-source aquifer from contamination.

Table 4-2 describes information regarding USTs in the notification submitted by BNL, May 1986, to the NYSDEC. Information is given on construction material, age, capacity, substance stored, corrosion protection, and usage status. Most of the USTs listed are more than 25 years old, with the true age being unknown in several cases. Corrosion protection is either not provided or unknown in

TABLE 4-2

UNDERGROUND STORAGE TANKS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Bldg /Tank Identification No	Jurisdiction	Age (Years)	Capacity (Gallons)	Substance Currently or Previously Stored	Construction Materials	Piping Materials	External Protection	Internal Protection	Last Used
490-1	MRR	29	550	Aqueous radionuclides	Steel	Heavy gauge cast iron	Unknown	Unknown	1979
490-2	MRR	29	550	Aqueous radionuclides	Steel	Heavy gauge-cast iron	Unknown	Unknown	1979
490-3	Medical	30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	1980-1981
190-4	Medical	30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	1980-1981
490 5	Medical	30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	1980-1981
490-6	Medical	30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	1980 1981
491-1	Medical	29 30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	Disconnected, out of service
491 2	Medical	29 30	1,000	Aqueous radionuclides	Steel*	Unknown	Unknown	Unknown	Disconnected, out of service
650-1	S&EP	29	2,000	Aqueous radionuclides	Steel	Bare steel	None	None	In use
650-2	S&EP	29	2,000	Aqueous radionuclides	Steel	Bare steel	None	None	In use
811-1	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use
811 2	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use
811 3	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use
811 4	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use

TABLE 4-2
UNDERGROUND STORAGE TANKS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

Bldg /Tank Identification No	Jurisdiction	Age (Years)	Capacity (Gallons)	Substance Currently or Previously Stored	Construction Materials	Piping Materials	External Protection	Internal Protection	Last Used
811-5	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use
811-6	S&EP	36	8,000	Aqueous radionuclides	Steel	Bare steel	Coated, concrete vault	None	In use
445 1	S&EP	25	5,000	Aqueous radionuclides	Steel	Bare steel	Painted	Lining	In use
830 1	DNE	24	1,000	Aqueous radionuclides	Stainless steel	Stainless steel	None	Glass-lined	Currently out of use
830-2	DNE	24	1,000	Aqueous radionuclides	Stainless steel	Stainless steel	None	Glass-lined	Currently out of use
931-1	BLIP	14	550	Aqueous radionuclides	Carbon steel	Reinforced rubber	None	None	Not in use, abandoned
197 1	HEF	Unknown	Unknown	Benzonitrile, 1,500 mg/l	Unknown	Unknown	Unknown	Unknown	Unknown
902-1	HEF	Unknown	550	Diesel	Unknown	Unknown	Unknown	Unknown	Unknown
911-1	HEF	Unknown	Unknown	Gasoline	Unknown	Unknown	Unknown	Unknown	Unknown
912A-1	HEF	Unknown	3,000	Diesel	Steel	Steel	Fiberglass	None	In use
927 1	HEF	Unknown	500	Aqueous radionuclides	Fiberglass	PVC	None	None	In use
930-A	HEF	Unknown	275	Aqueous radionuclides	Unknown	Unknown	Unknown	Unknown	In use
527 1	DAS	26	257-550	Aqueous radionuclides	Steel	Plastic or steel	None	None	1965
463 1	Biology	Unknown	Unknown	Unknown	Brick/concrete	Unknown	Unknown	Unknown	Not in use, abandoned
463 2	Biology	Unknown	Unknown	Unknown	Brick/concrete	Unknown	Unknown	Unknown	Not in use, abandoned

Sources: Day, 1986a; Kinne, 1986a.

* Assumed, but not documented.

most cases. All but four tanks store radionuclide-contaminated wastewaters.

Table 4-3 lists underground oil tanks at BNL. These tanks, although underground, were considered by BNL to be exempt from the RCRA notification requirements.

4.1.1.1.5 Central Steam Facility

The BNL Central Steam Facility (CSF) supplies steam for heating and cooling to all major BNL facilities. Since 1976 the CSF has utilized Alternative Liquid Fuel (ALF) in the four high-efficiency boiler units as a fuel source. ALF is the blended product of No. 6 oil or various other heavy (viscous) oils and a combination of government surplus fuels (such as JP-4, JP-5, Navy Special, etc.), and Light Feed Stocks (LFS), which are spent or wasted solvents classified as hazardous due to their ignitability. Light Feed Stocks include petroleum distillates, alcohols, solvents, and mineral spirits with heating values ranging from 80,000 to 140,000 BTU/gallon. The fuel usage in 1985 was 5.8 million gallons, of which approximately 80 percent were Light Feed Stocks.

Typical constituents of ALF include the following: methanol, ethanol, propanol, isopropanol, hexanol, benzene, toluene, xylene, naptha, Navy Special, "Bunker C," petroleum tank line interface, No. 6 residual oil tank and barge bottoms, processed petroleum product spill recoveries, substandard JP-4 and JP-5, and substandard distillate oils (No. 2 and 4). Many of these fuels are hazardous wastes, with most classified as hazardous because of their ignitability.

EPA hazardous waste regulations allow the utilization of hazardous wastes or fuels in "industrial furnaces" and high efficiency boilers of the type used at the CSF. The burning of the fuels in such units is currently exempt from RCRA regulation, although storage is regulated. Burners storing hazardous waste fuels on-site must submit Part A notifications to EPA and submit a notification to EPA of their hazardous waste as fuel activities. BNL has fulfilled these requirements. BNL also complies with the requirements that all shipments of hazardous waste fuels to BNL are to be accepted only when accompanied by a manifest.

EPA published on May 6, 1987, proposed regulations that would subject facilities utilizing waste-derived fuels, such as the CSF, to the general facility standards for hazardous waste treatment, storage, and disposal facilities. Permit requirements would be similar to those for hazardous waste incinerators. A Destruction Removal Efficiency (DRE) of 99.99 percent would be required for the principal organic constituents in the hazardous waste feed. Tests conducted on the boilers discussed later indicate that this standard may be attainable (see Section 3.1.2 for further details on the CSF).

TABLE 4-3

UNDERGROUND OIL TANKS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Bldg No.	Type Fuel	Capacity (gallons)	Latest Date Tested	Date New Tank Installed	Date Re-Test Required
30	No. 2 Oil	1,000	-	5/83	5/88
30	No. 4 Oil	1,000	-	5/83	5/88
50	Diesel	275	9/82	-	9/87
51	No. 2 Oil	1,000	6/82	-	6/87
87	No. 2 Oil	2,000	6/82	-	6/87
88	No. 2 Oil	1,000	6/82	-	6/87
90	No. 2 Oil	1,000	6/82	-	6/87
91	No. 2 Oil	2,000	6/82	-	6/87
93	Gasoline	275	7/83	-	7/88
99	Diesel	275	6/82	-	6/87
168	Gasoline	275	7/83	-	7/88
184	No. 2 Oil	3,000	6/82	-	6/87
244	No. 2 Oil	2,000	6/82	-	6/87
321	No. 2 Oil	2,000	6/82	-	6/87
326	Diesel	275	6/82	-	6/87
339	No. 2 Oil	2,000	6/82	-	6/87
405	No. 2 Oil	1,000	-	5/83	5/88
406	Lube Oil	4,000	8/83	-	8/88
422	No. 2 Oil	3,500	6/82	-	6/87
423	Gasoline	15,000	9/82	-	9/87
423	No. 4 Oil	3,500	6/82	-	6/87
424	No. 2 Oil	2,000	6/82	-	6/87
444	No. 2 Oil	1,000	-	5/83	5/88
445	No. 2 Oil	1,000	6/82	-	6/87

TABLE 4-3
UNDERGROUND OIL TANKS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
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Bldg No.	Type Fuel	Capacity (gallons)	Latest Date Tested	Date New Tank Installed	Date Re-Test Required
452	Diesel	275	6/82	-	6/87
452	No. 4 Oil	3,500	8/83	-	(1)
457	No. 4 Oil	3,000	8/82	-	8/87
479	No. 4 Oil	3,500	7/82	-	(1)
479	No. 4 Oil	10,000	7/82	-	(1)
490	Diesel	2,500	6/82	-	6/87
493	No. 4 Oil	2,000	7/82	-	7/87
494	No. 2 Oil	1,000	-	5/83	5/88
526	No. 2 Oil	1,000	-	5/83	5/88
535	Diesel	6,000	6/82	-	6/87
575	No. 2 Oil	1,000	6/82	-	6/87
629	Diesel	6,000	6/82	-	6/87
630	No. 2 Oil	1,000	-	5/83	5/88
630	Gasoline	8,000	9/83	-	9/88
630	Gasoline	8,000	8/83	-	8/88
630	Gasoline	6,000	11/83	-	11/88
630	Lube Oil	550	8/83	-	8/88
633	Lube Oil	1,000	-	1/84	1/89
912A	Diesel	3,000	-	1/85	1/90

Source: Kinne, 1986b.

(1) These buried fuel oil tanks to be either removed or abandoned in place and filled with sand after buildings are connected to central underground steam system.

BNL submitted a RCRA Part B application to EPA for the CSF. This submittal was returned by EPA when New York attained RCRA primacy. BNL resubmitted the RCRA Part B application to New York as a Part 373 application, which essentially consisted of the RCRA Part B application. New York's Department of Environmental Conservation said that the submittal was unnecessary since, under New York regulation, the utilization of hazardous wastes as fuels in high-efficiency boilers was currently exempt from regulations. Since New York will be regulating the storage of hazardous waste fuels in the future, BNL has requested that NYSDEC process the application as a hazardous waste storage permit application.

The CSF utilizes 21 tanks to receive and store the various components of the ALFs. These steel tanks do not have protective linings, since the fuel oil and hydrocarbon products stored are generally in the neutral range not requiring protective linings, according to BNL. No significant internal corrosion has been noted during inspections of tanks emptied for cleaning and/or modification.

Tanks storing Liquid Fuel Supplies are enclosed in impervious containment dikes. Tanks 5, 6, the mini-tank farm area, and tanks 7, 8, and 12 through 17 have a bentonite clay liner installed inside the diked area. Tanks 30 through 35 (tank trailers) are housed on concrete pads with concrete blocks on three sides and a sand bag end-closure to allow tanker movement. Unloading stations have concrete containment pads. Tanks 611A and 611B, with a 210,000-gallon and 215,880-gallon capacity, respectively, do not have any impervious liners but are not currently being used. BNL is planning on installing impervious liners for these tanks. Table 4-4 describes tanks used in the ALF program at BNL.

Runoff collected in the mini-tank farm containment area is periodically pumped to the sanitary system. Prior to discharge to the sanitary system, the runoff is checked for a visible oil sheen. If an oil sheen is visible, further analysis will be performed; although BNL has no formal procedures detailing further analytical requirements.

The Survey team observed that spills occur around unloading areas. These spills are cleaned with sand. Oil-contaminated sand is then shipped to the HWMA for disposal.

Underground fuel transport piping is of welded "conduit system" design and construction. Above-ground piping is mounted on piers of welded construction, heat-traced, insulated, and is remote from vehicular traffic. Containment for releases is not in place; however, leaks from pipes have not occurred.

TABLE 4-4

CENTRAL STEAM FACILITY TANK CAPACITY
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Tank Number	Building Designation	Capacity Gallons	Capacity BBLS	Present Usage
1	611A	210,000	5,000	ALF blending tank
2	611B	215,880	5,140	ALF blending tank
3	611C	300,000	7,143	Day tank - ALF storage
4	611D	420,000	9,524	Day tank - ALF storage
5	611E	300,006	7,143	GSA storage - govt. surplus fuel
6	611F	300,006	7,143	GSA storage - govt. surplus fuel
7	NA	19,992	476	LFS storage/ALF blending
8	NA	59,976	1,428	GSA receiving/holding tank
12	NA	59,976	1,428	GSA receiving/holding storage
13	NA	9,996	238	Waste solvent receiving/holding-light feed stock (LFS)
14	NA	9,996	238	Waste solvent receiving/holding-light feed stock (LFS)
15	NA	9,996	238	Waste solvent receiving/holding-light feed stock (LFS)
16	NA	9,996	238	Waste solvent receiving/holding-light feed stock (LFS)
17	NA	9,996	238	Waste solvent receiving/holding-light feed stock (LFS)
29	NA	4,998	119	GSA/LFS receiving/holding tank(1)
30	NA	4,998	119	GSA/LFS receiving/holding tank(1)
31	NA	3,880	92.4	Holding tank noncombustible sediments
32	NA	4,998	119	GSA/LFS receiving/holding tank(1)
33	NA	4,998	119	GSA/LFS receiving/holding tank(1)
34	NA	4,998	119	GSA/LFS receiving/holding tank(1)
35	NA	18,001	428.6	Waste solvent receiving trail order day tank

Source: Kinne, 1986c.

(1) Tanks 29, 30, 32, 33, and 34 used only when no other tank is readily available.
NA Not available

Test programs have been carried out to determine the Destruction Removal Efficiency (DRE) of CSF boilers for destroying hazardous constituents in the hazardous waste derived fuels. The test program was carried out as part of a research program conducted by EPA's Environmental Research Laboratory to evaluate the thermal destruction of hazardous wastes in industrial furnaces and industrial boilers. In addition to determining the DRE for hazardous components in the fuel, the testing program sought to identify any hazardous products of incomplete combustion (PICs) formed in the boiler tested.

DREs were determined for the principal organic hazardous constituents (POHCs) identified in the fuels fired and for three chlorinated spiking compounds. Better than 99.99-percent destruction efficiency was obtained for all compounds, except for xylenes present in the No. 6 Oil, the 70-percent No. 6 Oil/30-percent waste solvent mixture, and the spiked waste solvent mixture. Xylenes, a listed hazardous waste, are not cited because of hazardous constituents (like other listed wastes) but are considered hazardous due to ignitability. The only PICs identified during the test program were substituted phenols, which were formed during the tests. Phenol present as a major component (23 weight percent) of the spiked waste solvent mixture exhibited a DRE in excess of 99.99 percent. Trace metal emissions were found to be higher during the hazardous waste tests than during background tests.

Bottom ash has, on occasion, exceeded the EP toxicity limits for cadmium. However, the mixed CSF ash from all boilers passes the EP test.

Specifications for the wastes used in the ALF call for the absence of PCB contamination. All incoming shipments are checked for PCBs. Currently, military fuels are not blended until shown to be below the 50 ppm level. The practice of holding military fuels for PCB analysis, before blending, resulted from the PCB contamination incident described below.

Currently, the CSF is storing 286,000 gallons of PCB-contaminated military fuel. This contaminated fuel resulted from blending a shipment of PCB-contaminated jet fuel with fuel oil and other waste fuels in an ALF blending tank. The PCB-contaminated fuel was being burned when the contamination was discovered. Burning was stopped immediately when the analytical results showing PCB contamination became available. Currently, the contaminated fuel is being stored, while BNL awaits final regulatory agency approval to combust the fuel in accordance with technical requirements previously negotiated. See Section 3.1.2 for further details.

The ALF program is being suspended due to lower fuel oil prices, which have significantly reduced the economic incentives that have driven this program. The program may be revived if negotiations,

regarding transportation charges, are successfully concluded between BNL and ALF component suppliers.

4.1.1.1.6 RCRA Part B Application

BNL has submitted a RCRA Part B permit application for the HWMA to NYSDEC. Currently, BNL is negotiating permit conditions with the agency.

The RCRA Part B application listed nine Solid Waste Management Units (SWMUs).

1. Current Landfill - Nonhazardous waste
2. Former Landfill - Received hazardous waste
3. Chemical Pits - Received hazardous waste
4. Sewage Treatment Plant - Sludge drying beds, no hazardous waste
5. Incinerator - Mixed scintillation vials burned until April 1986
6. Wastewater Treatment Unit - Sanitary sewage treatment plant, nonhazardous waste
7. Storage Tanks - Central steam facility, handles ignitable hazardous waste
8. Waste Recycling/Energy Recovery - Central steam facility, ignitable hazardous waste
9. Hazardous Waste Management Facility

The former landfills and chemical pits are likely to be addressed under RCRA Section 3004(u) provisions regarding continuing releases from SWMUs (see Section 4.5 for more details).

4.1.1.2 Radioactive Waste

Radioactive waste is defined in 49 CFR 171.3 as any material whose concentration is greater than 2 μCi/g. DOE Order 5480.2 defines radioactive waste as "solid or fluid materials of no value containing radioactivity; discarded items such as clothing, containers, equipment, rubble, residues or soils contaminated with radioactivity, or soils, rubble equipment or other items containing induced radioactivity such that the levels exceed safe levels for unconditional release." Since specific numerical levels are not included, in effect, this defines any waste that contains radioactivity in excess of background levels as a radioactive waste at DOE facilities.

4.1.1.2.1 Sources

BNL generates radioactive wastes from experiments and maintenance activities at several large facilities, the machining of radioactive materials, and activities utilizing radioactive isotopes and

chemicals in various laboratories. Table 4-5 describes sources and general composition of radioactive wastes at BNL. Major facilities at BNL that generate radioactive wastes include the following:

a. High Flux Beam Reactor (HFBR). The HFBR is a heavy-water moderated and air-cooled, 60-megawatt research reactor (Commercial Reactor 500-1,000 megawatts) designed to produce a concentrated neutron beam for use in experiments. This results in a need to change fuel rods much more frequently than in reactors designed for power production. Spent fuel rods, when changed, are stored in the reactor storage pool until shipped off-site. Five-hundred fuel rods were in storage at the time of the Survey. The canal contains 68,000 gallons of water. Five-hundred gallons of water are added weekly to make up for evaporative losses caused by heating of the water as the result of heat generated by radioactive decay of the rods. BNL personnel noted that the volume and radionuclide concentration of the air-conditioning condensate of the HFBR correlates with that expected from the volume of make-up water. Cut-off fuel rod ends are stored in aboveground concrete vaults at the HWMA until radioactive levels are low enough to meet shipping standards and Hanford's acceptance criteria. The 10,000 gallons of heavy water in the reactor are periodically changed to keep the tritium content at acceptable levels. The heavy water is shipped to Savannah River. The principal radioactive wastes are compactible trash and radioactive resins. The resins contaminated with tritium, and moderately contaminated with neutron-activated materials, are generated in the ion-exchange system used to purify the reactor storage pool water.

b. Medical Research Reactor (MRR). The MRR, which is a small reactor that can be virtually turned on and off as needed, is used for medical treatment and research experiments.

c. Brookhaven Linear Isotopes Producer (BLIP). The BLIP uses a proton beam to irradiate targets. Waste targets are shipped to the HWMA for long-term storage. Highly radioactive target cooling waters are produced and treated at the B-811 Radioactive Wastewater Treatment Facility.

d. Miscellaneous Facilities. Other facilities involving radioactivity and producing radioactive wastes include the Research Van de Graaff, used mostly as a tritium accelerator; the Tandem Van de Graaff, used to accelerate protons and other atomic nuclei; the

TABLE 4-5

RADIOACTIVE WASTES

BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
318	125I	3 8	5.000	GL	40 0			DAS Shops												Y	
462	60Co	0 1		CF	50 0	4 0		DAS Shops			Y		Y	Y							
462	3HL0	5 3	1 000	GL				DAS Shops												Y	
462	60Co	0 1		CF	200 0	10 0		DAS Shops		Y			Y								
462R	60Co	0 1		CF	200 0	9 0		DAS Shops		Y		Y	Y								
463	32P	900	3 500	GL	15 0		Water	Biology												Y	
463	3H	4		CF	2 0	0 75		Biology	Y	Y	Y	Y	Y								
463	32P	1		CF	5 0	0 75		Biology	Y		Y										
463	32P	1,000		CF	5 0	0.75		Biology	Y	Y	Y		Y								
463	35S	500		CF	5 0	0 75		Biology	Y	Y	Y		Y								
463	32P	1,000		CF	5 0	0 75		Biology	Y		Y		Y								
463	32P	2,000	2 000	GL	10 0			Biology	Y	Y	Y	Y									
463	C14	5		CF	5 0	0 75		Biology		Y	Y	Y	Y								
463	3H	5		CF	5 0	0 75		Biology		Y	Y	Y	Y								
463	32P	500	4 000	GL	40 0		Acetone/Water	Biology												Y	
463	32P	1,000		CF	2 0	0 75		Biology			Y										
463	35S	100		CF	5 0	0 75		Biology	Y												
463	32P	1,000		CF	5 0	0 75		Biology	Y	Y	Y	Y									
463	35S	200		CF	[illegible]	0 75		Biology	Y	Y	Y	Y									
463	32P	100	4 000	GL	40 0		Aqueous	Biology												Y	

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
463	C14	1		CF	10 0	0 75		Biology			Y					Y					
463	32P	200		CF	5 0	0 75		Biology	Y	Y	Y										
463	3P	400		CF	5.0	0 75		Biology		Y											
463	35S	5,000	4 000	GI	40 0		Acetone/Water	Biology												Y	
463	125I	2		CF	5 0	0 75		Biology	Y		Y	Y	Y								
463	None			CF	5 0	0 75		Biology	Y												
463	P82	1		CF	5 0	0 75		Biology	Y	Y	Y	Y	Y								
463	32P	100		CF	5 0	0 75		Biology	Y		Y	Y	Y								
463	32P	500		CF	5.0	0 75		Biology	Y		Y										
463	32P	2,000		CF	5 0	0 75		Biology	Y	Y	Y	Y	Y								
463	35S	2,000		CF	5.0	0.75		Biology	Y	Y	Y	Y	Y								
463	32P	10		CF	5 0	0 75		Biology	Y		Y										
463	35S	100		CF	5 0	0 75		Biology	Y	Y	Y		Y								
463	3H	5,000		LB	10 0		Hydrofluor	Biology												Y	
463	C14	1		CF	10 0	0 75		Biology	Y	Y	Y					Y					
463	32P	100		CF	5 0	0 75		Biology	Y	Y	Y	Y	Y								
463	35S	100		CF	5 0	0 75		Biology	Y		Y	Y									
463	3H	1		CF	10 0	0 75		Biology			Y					Y					
463	3H			LT	30 0		Water	Biology												Y	
463	3H	1		CF	10 0	0 75		Biology	Y		Y					Y					

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE THREE

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
463	32P	100		CF	5.0	0.75		Biology	Y		Y										
463	182P	100		CF	5.0	0.75		Biology	Y	Y	Y		Y								
463	3H	100		CF	10.0	0.75		Biology	Y		Y									Y	
463	3H	100		LT	30.0	20.0	Water	Biology													
463	35S	10		CF	5.0	0.75		Biology	Y		Y										
479	60Co	130	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	70	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	100	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	170	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	100	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	70	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	170	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	100	55.00	GL	400.0		Shavings	Machine Shops		Y											
479	60Co	100	55.00	GL	400.0		Shavings	Machine Shops		Y											
490	14C	800		ML	1.0		Toluene	Medical												Y	
490	3H	19,000		CF	45.50	0.75		Medical			Y	Y									
490	60Co	0.01		CF	10.0	4.0		Medical													
490	3H	69,000		CF	69.0	1.0		Medical													
490	3H	70,000		CF	82.0	2.0		Medical													
490	3H	100		CF	10.0	2.0		Medical		Y											

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE FOUR

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
490	3H	1,000		CF	5 0	0 75		Medical	Y		Y	Y	Y									
490	125I	25		CF	2.0	0 75		Medical	Y		Y											
490	125I	4		CF	3.0	0 75		Medical	Y		Y											
490	3H	2,000		GM		3 00		Medical														
490	51Cr	1		LB	1 0			Medical												Y		
490	3H	4,000	5 000	GL	40 0		Water	Medical												Y		
490	3H	25		CF	2 0	0 75		Medical	Y		Y											
490	3H	50		CF	4 0	0 75		Medical	Y		Y											
490	125I	2,000		CF	2 0	0 75		Medical	Y		Y											
490	145Sm	10		CF	5.0	0 75		Medical	Y		Y	Y	Y									
490	3H	20,000	1 000	GL	10 0		Water	Medical												Y		
490	3H	2,200		CF	66 0	1 50		Medical														
490	3H	39,000		CF	19.50	1 0		Medical														
490	3H	101,000		CF	89 0	2 0		Medical														
490	14C	120,000		CF	10 0	0 75		Medical	Y				Y									
490	131I	0 5		CF	2 0	0 75		Medical			Y											
490	125I	10		CF	7 0	0 75		Medical		Y	Y	Y										
490	14C	50,000		CF	5 0	0 75		Medical	Y		Y											
490	14C	500		ML	1 0		Formaldehyde	Medical												Y		
490	3H	1,000		CF	3 0	0 50		Medical	Y	Y	Y											

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE FIVE

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
490	125I	10		CF	6 0	0 75		Medical													
490	3H	1		CF	5 0	0 75		Medical	Y		Y	Y									
490	68Ge	500	1 000	LT	2 0		Water	Medical												Y	
490	3H	75,000		CF	36 0	2 0		Medical													
490	125I	5,000		CF	4.0	0 75		Medical	Y	Y											
490	3H	1,000		CF	1 0	0 50		Medical													
490	60Co	0 001		CF	1 0	0 25		Medical													
490	35S	10		CF	16 0	0 75		Medical	Y	Y	Y	Y	Y								
490	3H	44,000		CF	77 0	4 0		Medical													
490	134Cs	0.001		CF	1.0	0 25		Medical	Y												
490	137Cs	0.001		CF	1 0	0 25		Medical	Y												
490	3H	13,400		CF	20 0	2 25		Medical	Y	Y	Y										
490	125I	100		CF	10.0	0 75		Medical	Y	Y	Y	Y	Y								
490	14C	880		ML	1 0	1 0	Toluene													Y	
490	3H	116,000		CF	120 5	2 0		Medical													
490	3H	100-	7 500	GL	5 0			Medical			Y										
490	3H	7,630	70.00	GL	500 0		Water	Medical												Y	
491	137Cs	10		LB	200.0			Med-Reactor			Y	Y									
510	Cu60	1		CF	5 0	1 0		Physics			Y										
510	58Co	3 6		CF	10 0	4 0		Physics	Y	Y	Y										

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE SIX

Building	Isotope	Micro Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
510	58Co	4		CF	15 0	3 000		Physics		Y	Y										
535	3H	1		CF	20 0	3 0		NSLS	Y	Y	Y										
535	60Co	4		LB	40 0			NSLS		Y											
535	60Co	25		CF	10 0	0 50		NSLS		Y											
535	3H	1,700	5 000	GL	40 0			NSLS												Y	
535	60Co	1		CF	20 0	3 0		NSLS	Y	Y	Y										
535	137Cs	1		CF	20 0	3 0		NSLS	Y	Y	Y										
535	90Sr	1		CF	20 0	3.0		NSLS	Y	Y	Y										
650	Co60	10,000		CF	140 0	18 0		NSLS													
650	152Eu	1,800		CF	4,000 0	6 0		Decon		Y											
650	3H	10,000		CF	140,0	18 0		Decon													
650	57Co	663		CF	4,000 0	6 0		Decon		Y											
650	109Cd	650		CF	4,000 0	6.0		Decon		Y											
650	137Cs	217		CF	4,000 0	6 0		Decon		Y											
703	Cs137	5		CF	100 0	20 0		BGGR labs/ chemistry			Y										
703	Cs137	30		CF	40 0	2 250		BGGR labs/ chemistry			Y				Y						
703	Cs137	5		CF	100 0	20.0		BGGR labs/ chemistry			Y										
703	Cs137	5		CF	100 0	20 0		BGGR labs/ chemistry			Y										

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE SEVEN

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
703	Cs137	30		CF	40 0	2.250		BGGR labs/ chemistry			Y				Y						
703	Cs137	5		CF	100 0	20 0		BGGR labs/ chemistry			Y										
703	Cs137	5		CF	100 0	20 0		BGGR labs/ chemistry			Y										
703	Cs137	5		CF	100 0	20.0		BGGR labs/ chemistry			Y										
703	Cs137	5		CF	200 0	20 0		BGGR labs/ chemistry			Y										
750	3H	301,000	50 00	GL	420.0			BGGR labs/ chemistry			Y										
750	51Cr	37		CF	5.0	3 0		BGGR labs/ chemistry			Y		Y								
750	3H	20,000		CF	15 0	5 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	Bi	08	50 00	GL	420 0			BGGR labs/ chemistry													
750	3H	10,000		CF	5 0	3 0		BGGR labs/ chemistry			Y										
750	182Ta	8		CF	3 0	40		BGGR labs/ chemistry			Y	Y									
750	51Cr	178		CF	5 0	3 0		BGGR labs/ chemistry			Y		Y								

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE EIGHT

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
750	60Co	11		CF	5 0	3 0		BGGR labs/ chemistry			Y		Y								
750	59Fe	3 5	50 00	GL	420 0			BGGR labs/ chemistry													
750	60Co	18.7	50 00	GL	420 0			BGGR labs/ chemistry													
750	51Cr	187	50 00	GL	420 0			BGGR labs/ chemistry													
750	65Zn	31,000		CF	80 0	6 0		BGGR labs/ chemistry		Y											
750	60Co	17,000		CF	80 0	6 0		BGGR labs/ chemistry		Y											
750	51Cr	74		CF	15.0	5 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	3H	10,000		CF	40.0	6 0		BGGR labs/ chemistry	Y	Y	Y		Y				Y		Y		
750	54Mn	2 1	50 00	GL	420.0			BGGR labs/ chemistry													
750	60Co	5		CF	20 0	8 0		BGGR labs/ chemistry		Y											
750	60Co	352		CF	7,500 0	28 0		BGGR labs/ chemistry		Y											
750	65Zn	9 3	50 00	GL	420 0			BGGR labs/ chemistry													
750	60Co	22		CF	35 00	6 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE NINE

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
750	3H	10,000		CF	30.0	3.0		BGGR labs/ chemistry		Y	Y	Y					Y				
750	51Cr	739		CF	30.0	3.0		BGGR labs/ chemistry		Y	Y	Y					Y				
750	65Zn	41		CF	30.0	3.0		BGGR labs/ chemistry		Y	Y	Y					Y				
750	60Co	222		CF	30.0	3.0		BGGR labs/ chemistry		Y	Y	Y					Y				
750	3H	10		CF	20.0	7.0		BGGR labs/ chemistry			Y	Y									
750	Cu64	1		CF	20.0	7.0		BGGR labs/ chemistry			Y	Y									
750	65Zn	21		CF	5.0	3.0		BGGR labs/ chemistry			Y		Y								
750	3H	10,000		CF	10.0	1.0		BGGR labs/ chemistry		Y											
750	64Cu	2		CF	10.0	6.0	Acetone/Alcohol	BGGR labs/ chemistry		Y	Y	Y				Y					Y
750	3H	1		CF	10.0	6.0	Acetone/Alcohol	BGGR labs/ chemistry		Y	Y	Y				Y					Y
750	3H	20,000		CF	30.0	6.0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	51Cr	178		CF	30.0	6.0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	65Zn	12		CF	30.0	6.0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TEN

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept.	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
750	60Co	7		CF	30 0	6 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	65Zn	41		CF	35.0	6 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	3H	10,000		CF	5 0	3 0		BGGR labs/ chemistry			Y		Y									
750	64Cu	1		CF	5 0	3 0		BGGR labs/ chemistry		Y	Y	Y				Y						
750	65Zn	12		CF	5.0	3.0		BGGR labs/ chemistry			Y		Y									
750	60Co	7		CF	5 0	3 0		BGGR labs/ chemistry			Y		Y									
750	51Cr	1,400		CF	40.0	6 0		BGGR labs/ chemistry	Y	Y	Y		Y				Y		Y		
750	65Zn	99		CF	40.0	6 0		BGGR labs/ chemistry	Y	Y	Y		Y				Y		Y		
750	60Co	53		CF	40 0	6 0		BGGR labs/ chemistry	Y	Y	Y		Y				Y		Y		
750	182Ta	1		CF	2 0	3 0		BGGR labs/ chemistry			Y										
750	3H	10,000		CF	15 0	3 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	51Cr	2,100		CF	15 0	3 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	3H	10,000		CF	80 0	6 0		BGGR labs/ chemistry		Y											

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE ELEVEN

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
750	65Zn	41		CF	15 0	5 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	60Co	22		CF	15 0	5 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	3H	20,000		CF	35 0	6 0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	51Cr	74		CF	35 0	6 0		BGGR labs/ chemist		Y	Y	Y	Y				Y				
750	60Co	13		CF	35 0	8 0		BGGR labs/ chemistry		Y	Y		Y				Y				
750	3H	20,000		CF	45 0	6.0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	51Cr	178		CF	45 0	6 0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	65Zn	12		CF	45 0	6.0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	60Co	7		CF	45.0	6 0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	182Ta	3		CF	5 0	4 0		BGGR labs/ chemistry			Y	Y									
750	51Cr	178		CF	15 0	6.0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	65Zn	12		CF	15 0	6 0		BGGR labs/ chemistry			Y	Y	Y				Y				

TABLE 4-5
RADIOACTIVE WASTES
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWELVE

Building	Isotope	Micro-Curies	Volume	Unit	Weight (pounds)	Cubic Feet	Material Name	Dept	Glass	Metal	Plastic	Rubber	Cloth	Wood	Concrete	Tissue	Wire	Pipe	Hose	Liquid	Solvent
750	60Co	7		CF	15 0	6.0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	3H	30,000		CF	35.0	8 0		BGGR labs/ chemistry		Y	Y		Y				Y				
750	51Cr	133		CF	35 0	8 0		BGGR labs/ chemistry		Y	Y		Y				Y				
750	65Zn	148		CF	15 0	3.0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	60Co	80		CF	15.0	3.0		BGGR labs/ chemistry		Y	Y	Y	Y				Y				
750	3H	20,000		CF	15 0	6.0		BGGR labs/ chemistry			Y	Y	Y				Y				
750	3H	0006		CF	7,500 0	28 0		BGGR labs/ chemistry		Y											
750	65Zn	25		CF	35 0	8 0		BGGR labs/ chemistry		Y	Y		Y				Y				
750	3H	6,000		LB	300 0		Quik-Off	BGGR labs/ chemistry												Y	
801	Sn113	10	0 500	GL	4 0		Chromic Acid	Medical												Y	
801	Sn113	10	0 500	PT	1.0		Ammonium Hydroxide	Medical													
801	137Cs	0 0001		LB	400 0			Medical		Y											
801	203Pb	1		CF	5 0	0 75		Medical	Y		Y										
801	Co57	10		CF	25 0	4 50					Y										

Source: Emma, 1987 GL = Gallon CF = Cubic Feet LT = Liters

Dynamatron, a 3-MeV electron accelerator and a 60-inch Cyclotron used to accelerate protons and helium nuclei, and ongoing laboratory activities using small amounts of radioactive materials.

e. Brookhaven Graphite Research Reactor (BGRR). The BGRR was retired from service in 1968. The reactor was a graphite moderated and reflected, uranium-fueled, air-cooled reactor. It consisted of a graphite cube (25 feet) penetrated in a north-south direction by an array of horizontal, parallel, cylindrical channels containing uranium fuel elements. Cooling air was drawn through the fuel channels.

In 1968, when the reactor was shut down, radioactive material within the shield was reduced to a minimum. All fuel elements from the graphite core were removed. Experimental apparatus that could not safely be left for an extended period were removed. Penetrations through the biological shield were closed and sealed, with one opening remaining with air vented through an absolute filter. Fuel elements in the canal were removed and shipped off-site for reprocessing. Table 4-6 describes radioactively contaminated material associated with the BGRR, which is still in place and must ultimately be removed.

4.1.1.2.2 Collection and Storage of Radioactive Wastes

Small quantities of liquid wastes, generated in laboratories, are collected in small containers such as 5-gallon carboys and, depending on the nature of the wastes, are either shipped to the HWMA facility for solidification or to B-801 prior to treatment in the B-811 WCF. Usually these small quantity wastes are handled in the waste accumulation areas discussed in Section 4.1.1.1.

Larger volumes of aqueous radioactive waste are collected in retention tanks. Processes or laboratories generating radioactive wastewaters are plumbed directly to retention tanks with the contents periodically trucked to B-811. Radioactive wastewaters are piped from the HFBR and the 801 Hot Laboratory Complex directly to the B-801 radioactive wastewater storage tanks for initial pH adjustment. Table 4-2 contains information on retention tanks used for radioactive wastewaters. Further details regarding the collection of radioactive wastewaters in tanks can be found in Section 3.3.1.

Compactible radioactive solid wastes, such as rags, paper containers, and general laboratory debris are segregated from nonradioactive trash at the source. Noncompactible radioactive wastes (such as acids, solvents, laboratory chemicals, oils, contaminated equipment, etc.) are placed, along with

TABLE 4-6

BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)
RADIOACTIVELY CONTAMINATED MATERIAL
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

BGRR

1.	Reactor - 25-foot cube of graphite within biological shield. 65,000 pieces of graphite. Highly contaminated.
2.	Control rods - highly contaminated.
3.	Interior pneumatic tube facility on north face - highly contaminated.
4.	Building 701 Canal Facility (a) Deep Pit - highly contaminated; (b) Shallow Pit - highly contaminated; (c) Chute from South Plenum to Canal - highly contaminated.
5.	Plenum floor at both north and south faces - highly contaminated.
6.	Animal and instrument tunnels under reactor - moderately contaminated.
7.	Fuel storage vault - very lightly contaminated (alpha).
8.	Plumbing in building for liquid waste - moderately contaminated.
9.	3,000 feet^2 in basement used for storage of radioactive beam transport components, pipe, pumps, etc. This equipment is moderately to highly activated.

BGRR COOLING AIR DUCT WORK - Fission Product Contaminated

1.	Exit cooling air ducts below grade out of reactor - highly contaminated.
2.	Filter housing pit ahead of fans - highly contaminated.
3.	Instrument house ahead of fan house - moderately contaminated.

FAN HOUSE WITH FIVE FANS AND ASSORTED DUCTS

1.	Fan housing and plenums - highly contaminated.
2.	Fan motors - very lightly contaminated.
3.	Ducts above and below blowers - highly contaminated.
4.	Silencers in ducts - highly contaminated.

TABLE 4-6
BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)
RADIOACTIVELY CONTAMINATED MATERIAL
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

CANAL HOUSE - BUILDING 709 - Moderately Contaminated

1.	Water treatment house - moderately contaminated.
2.	East yard area around canal house: (a) Parts of the yard might have light contamination under pads; (b) Digging may be required after concrete of canal has been removed because of possible low-level ground contamination; walls of canal highly contaminated; (c) Storage pits in yard - moderately contaminated; (d) East yard storm drain system - possibly very lightly contaminated; (e) Pneumatic tubes to Hot Laboratory under east yard - highly to moderately contaminated.

BGRR LABORATORIES - Building 703

1.	Possibly very lightly contaminated in hoods and hood filters.
2.	Plumbing for liquid waste lightly contaminated.
3.	Basement, east end, east enclosure very lightly contaminated.

Source: BNL, 1986c.

compactible wastes, in WAAs. (See Section 4.1.1.1 for further details on WAAs.) Waste generators must submit a Radioactive Waste Pickup Form to HWM for transportation to the HWMA for processing treatment and storage.

The Survey team observed that BNL procedures for the labeling of radioactive wastes were not always followed and that one BNL procedure, "routine pickups," is questionable. These procedures are discussed in detail in Section 4.1.1.1 and Finding 4.1.2.4.1.

4.1.1.2.3 Hazardous Waste Management Area

The Hazardous Waste Management Area (HWMA) is the central receiving, processing, treatment, and storage area for radioactive and hazardous wastes. Areas and activities in the HWMA related to radioactive waste management are discussed below, whereas hazardous waste management areas and activities are described in Section 4.1.1.1. Problems relating to past releases are discussed in Sections 4.5.1 and 4.5.2.

Building 446, a sheet metal, garage-type building on a concrete pad, is used for receiving, sorting, and storing compactible radioactive waste. Some noncompactible waste with low radiation levels is also stored in B-446. Neutralization and solidification of small quantities of liquid radioactive wastes, such as acids, bases, chromic acid cleaning solutions and solvents, takes place either in B-446 or right outside the door.

Drums and radioactive-waste shipping containers are stored outside on the asphalt-paved area. Shipping containers holding radioactive wastes that are to be shipped off-site for disposal are stored in this area. At the time of the survey, 26 drums of radioactively-contaminated oil were being stored on a paved area outside of B-446. Secondary containment was not provided. Fifty-three drums of solidified sludge from the B-811 WCF were also being stored. This sludge resulted from the evaporative distillation of radioactive wastewater.

The field storage area is used for interim and long-term storage of activated materials, such as iron magnets, copper windings, and stainless-steel components from various experimental facilities. At the time of the Survey, much of the material being stored was from the Alternating Gradient Synchrotron (AGS). This material had not yet been characterized for radionuclide contamination by AGS personnel. It had been shipped to the HWMA prior to the time when use of the "Radioactive Waste Pickup Form," which requires identification of radionuclide contaminants, was initiated. Other items stored include the cut-off ends of fuel rods from the Brookhaven High Flux Beam Reactor, which are stored aboveground in concrete vaults.

Certain items of equipment, such as the fuel rod ends, destined for disposal, are initially too "hot" for immediate shipment. These items either cannot be packaged in shipping containers so that DOT shipping requirements are met, or would cause the total radionuclide content of individual shipping containers to exceed Hanford criteria. They are placed in covered, concrete-lined trenches (22-feet long, 2-feet wide and 5-feet deep), or vertical (9-foot depth), or slanted (12-foot long) holes to allow them to cool. These trenches and holes formerly held equipment from the retired Brookhaven Graphite Research Reactor (BGRR). Much of this equipment has been removed and disposed at Hanford and other off-site facilities. Materials currently stored include irradiated targets and some material that could not be identified by BNL personnel. HWM personnel said that many of the trenches and holes were currently not in use.

Groundwater has leaked into trenches when the water table was at a high level (e.g., during sustained periods of heavy precipitation).

4.1.1.2.4 Incinerator

The HWMA incinerator formerly was used for burning scintillation vials, which are widely used at BNL for counting low-energy beta emitters, such as tritium (as HTO), or in labeled organic compounds. Approximately 70 cubic feet of scintillation vials were incinerated yearly. Incineration of scintillation vials was stopped in 1986 because the vials contain listed solvents such as toluene and xylene; hence a hazardous waste incineration permit would be required. Currently, BNL is storing these vials until a new disposal or treatment option becomes available . The incinerator is now used only for the incineration of biological wastes and small quantities of tritium-contaminated animal carcasses. The major radionuclide released as the result of incineration is tritium, with 945 mCi released in 1986. Section 4.1.1.1 has additional details on the incinerator.

4.1.1.2.5 Radioactive Waste Disposal

Solid radioactive waste is currently shipped off-site for disposal. Compaction of compactible wastes and packaging in Department of Transportation (DOT) approved shipping containers takes place in the HWMA. From 1953 to 1966, material such as laboratory debris; unreclaimable, partially decontaminated equipment; contaminated clothing; and personnel protection devices were disposed of in the former landfill. From 1967 to 1978, these types of materials were disposed of in the current landfill. All such radioactive wastes have been shipped off-site since 1978.

Currently, BNL ships all radioactive wastes to Richland, Washington, for disposal, although BNL has used several off-site disposal areas since 1953. Table 4-7 lists the shipments, number of containers, and off-site disposal areas for BNL radioactive wastes shipped since 1953.

The State of Washington, where the Hanford disposal site is located, has recently issued new "Dangerous Waste" regulations, which limit the shipment of radioactive hazardous (mixed) wastes formerly sent to Hanford. Mixed wastes include the acids, bases, chromic acid cleanup solutions, and solvents solidified at B-446. The solidified B-811 evaporator concentrate sludge may be EP toxic, and may therefore be a mixed waste. Currently, all of these wastes are being stored at the HWMA until questions regarding the hazardous nature of the solidified B-811 WCF wastes are resolved.

4.1.1.2.6 Radioactive Waste Contamination - HWMA

The HWMA has several areas where radioactive contamination of the soil and groundwater have occurred. This contamination was attributed by BNL personnel to practices employed prior to 1980. In the outdoor paved area, there are several spots that are highly contaminated from past spills of fission products. Additional "hot spots" marked with stakes exist in the ground surrounding the paved area and buildings. The underground trenches and pits are also radioactively contaminated.

Data from the groundwater monitoring program at the HWMA indicates that tritium, fission, and activation products have entered the groundwater and are migrating from their sources (see Sections 3.3 and 4.5 for further details).

4.1.1.2.7 Alternating Gradient Synchrotron (AGS) Steel Storage Yard

The AGS department maintains two storage yards for storage of steel. One yard is used for storing radioactively contaminated steel, the other for storing "clean" or nonradioactively contaminated steel. However, contaminated steel has inadvertently been mixed with the clean steel yard. In both yards steel is stored for extended periods of time, often several years.

Long-term storage of steel in the open (and exposed to the weather) has resulted in the rusting of the steel plates. Many of the plates, especially in the contaminated steel storage yard, are extensively rusted, and rust is flaking off onto the ground. This rusted material may be contaminating the ground with radioactive constituents. The Survey team observed rust-colored pools of water in the contaminated steel storage yard during periods of rainfall. The soil in the yards has not been analyzed for radioactive contamination.

TABLE 4-7

OFF-SITE RADIOACTIVE WASTE SHIPMENTS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Calendar Year	No. of Containers	Type of Containers	Curie Contents	Destination
1954	476	55-gallon drums	233	Sea disposal
1955	685	55-gallon drums	597	Sea disposal
1956	640	55-gallon drums	600	Sea disposal
1957	704	55-gallon drums	500	Sea disposal
1958	692	55-gallon drums	1,100	Sea disposal
1959	1,354	55-gallon drums	2,000	Sea disposal
Unknown	20	Concrete vaults	500	Oak Ridge
1960	92	Large packages*	2,000	Oak Ridge
1961	60	Large packages*	1,300	Oak Ridge
1962	55	Large packages*	1,200	Oak Ridge
1963	45	Large packages*	980	West Valley, NY
1964	38	Large packages*	75	West Valley, NY
1965	32	Vaults, boxes, and tanks**	152	West Valley, NY
1966	50	Vaults, boxes, and tanks**	346	West Valley, NY
1967	32	Vaults, boxes, and tanks**	4,846	West Valley, NY
1968	43	Vaults, boxes, and tanks**	3,132	West Valley, NY
1969	None Shipped	--	--	--
1970	34	Vaults, boxes, and tanks**	3,379	West Valley, NY
1971	34	Vaults and boxes	2,400	West Valley, NY
1972	16	Vaults and boxes	653	West Valley, NY
1973	40	Vaults, boxes, and tanks**	9,824	West Valley, NY and Morehead, KY
1974	47	Vaults, boxes, and drums	35,504	Morehead, KY
1975	48	Vaults, boxes, and drums	81.4	Morehead, KY
1976	None Shipped	--	--	--
1977	136	Vaults and drums	505.6	Sheffield, IL
1978	None Shipped	--	--	--

TABLE 4-7
OFF-SITE RADIOACTIVE WASTE SHIPMENTS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

Calendar Year	No. of Containers	Type of Containers	Curie Contents	Destination
1979	150	Vaults and drums	763.8	Barnwell, SC
1980	None Shipped	--	--	--
1981	None Shipped	--	--	--
1982	None Shipped	--	--	--
1983	155	Vaults, bins, and drums	1,227.1	Richland, WA
1984	177	Vaults, bins, and drums	17.0	Richland, WA
1985	39	Vaults and bins	20.2	Richland, WA
1986	32	Vaults and bins	127.9	Richland, WA

Source: BNL, 1986c.

* Concrete vaults with 6-inch, 12-inch, and 17-inch shielding walls and a few sheet steel boxes for containing less active bulk gamma wastes that have been baled.

** Same concrete vaults and steel boxes plus 1,000-gallon oil tanks used for shipping solidified slurry.

4.1.1.2.8 Radioactive Wastewater Treatment

Radioactive wastewaters collected in holding tanks and small containers such as carboys are transported to the B-801 Hot Laboratory Complex for initial pH adjustment in two 2,000-gallon tanks. Radioactive wastewaters from the High Flux Beam Reactor and the B-801 Hot Laboratory Complex are piped directly to the Hot Laboratory tanks. After initial pH adjustment, the radioactive wastewaters drain to the D-2 100,000-gallon holding tank at the B-811 Radioactive Waste Concentration Facility.

Wastewaters are pumped from the D-2 holding tank into one of two 5,000-gallon blending tanks, where final pH adjustments are made. The neutralized wastewaters are fed into the evaporator, where a liquid volume reduction of 100-to-1 is obtained. The heating is provided by steam passing through heat exchangers. Evaporator distillate, which contains some tritium, was discharged to the sanitary sewer system until December 1984. When the system was last run in late 1985, 70,000 gallons of distillate were discharged to a plastic-lined, sewage treatment, emergency holding pond. BNL personnel said that the distillate remained in the pond until 90 percent of the activity was gone. During December of 1985, the pond (along with accumulated precipitation) was discharged into the Peconic River. BNL is currently evaluating disposal of the distillates via vaporization in the HFBR stack. (See Section 3.3.1 for a discussion of this proposal and Section 3.3.2 for additional discussion on the WCF.)

The slurry residue, which remains after evaporative distillation, is solidified. Solidification consists of mixing the slurry with a mixture of vermiculite and cement inside a shipping container. The slurry was formerly transported to the HWMA, where it was solidified prior to shipment for disposal at Hanford. It is now solidified at the B-811 WCF prior to transport to the HWMA.

BNL has not evaluated either the slurry or the solidified slurry to determine if it is a hazardous waste. Currently 100,000 gallons of radioactive wastewater at the WCF are awaiting processing. This is the equivalent of at least 4,000 gallons (80 drums) of solidified product.

The B-811 WCF has three 100,000-gallon storage tanks in a partially contained asphalt area. Tanks D-1 and D-3 are not in use because of leaks. The two tanks contain approximately 3,000 cubic feet of sludge, which is contaminated with mixed fission products and transuranics, including plutonium. Tank D-2, still in use, contains 700 cubic feet of similar sludge and 60,000 gallons of wastewater. The sludge in the tanks resulted primarily from wastewaters received from the BGRR. Before replacement of the natural uranium fuel rods at the BGRR, with improved enriched uranium

fuel elements, the natural uranium fuel elements that were used corroded when they were placed in the storage canal. The canal water became grossly contaminated with uranium oxide, some plutonium, and considerable fission products. Diatomaceous earth filter media and ion-exchange resins were used to remove contaminants in the canal water released from the natural uranium fuel rods. The diatomaceous earth filter media and back flush from the ion exchange columns were pumped to the B-811 tanks for storage. Most of this material settled into a clay-like solid on the bottom of the tanks. It is possible that any waste disposal option would require that the waste package be retrievable due to the presence of plutonium. BNL has submitted a request for funding to package the wastes in a form suitable for retrievable storage at a DOE repository. The sludge has not been tested for hazardous characteristics, although it is known from sludge analyses that heavy metals (such as lead and chromium), which may leach, are present.

BNL had Chem-Nuclear perform a scoping study on options for handling the tank sludge. According to BNL personnel Chem-Nuclear's study showed that there are "hot spots" within the sludge, as evidenced by surface counts ranging from 100 to 1,800 mR/hour. These "hot spots" may be items such as fuel chips, thermocouple tips, gold-plated cobalt pellets, etc. Volume is not known, but BNL personnel believe it is minimal. Chem-Nuclear, after concluding laboratory tests, recommended a solidification procedure, whereby 120 cubic feet of wet sludge would be solidified with 50 cubic feet of solidifying agent in 6-foot by 6-foot steel boxes. One foot of water would be added on top of the sludge in the tanks to act as a moderator, and sludge would be "dredged" out to avoid "hot spot" material. Wastewaters would be treated within the regular radioactive wastewater treatment system. BNL plans to ship the resulting 36 to 38 steel boxes to Hanford for disposal. However, disposal at Hanford may be precluded if testing shows that the solidified sludge is a mixed waste. Treatment and disposal of the "hot spot" material has not been evaluated. BNL has requested bids for the treatment of the sludge, based on the Chem-Nuclear scoping study. Cleaning and decommissioning would take place by the end of fiscal year 1990.

The containment capacity of the diked area would not be sufficient to hold a catastrophic release from Tank D-2, if it were filled to its 100,000-gallon capacity. B-811 also has six 36-year-old, 8,000-gallon, underground storage tanks constructed of steel in concrete vaults, storing radioactive wastewaters. Currently, 5 tanks are full, with one taken out of service due to a leak. Information was not available regarding the presence of sludges in these tanks (see Finding 4.5.2.3.1 (e)).

4.1.1.3 Mixed Wastes

Mixed wastes are defined in DOE Order 5480.2 as radioactive wastes that also contain hazardous waste constituents. Chapter II of this order, entitled "Guidance For Managing Radioactive Mixed

Waste," states that DOE facilities should comply with the technical requirements of 40 CFR 260-265 (Hazardous Waste Regulations). Compliance with procedural requirements (i.e., permitting) was not required.

Until May of 1987, DOE had taken the position that most mixed wastes were exempt from RCRA regulations under provisions in Section 1006(a) of the RCRA statute, which exempts from RCRA regulations those activities or substances subject to the Atomic Energy Act of 1954. Relying on this exemption, many DOE facilities (including BNL), have not submitted RCRA Part B applications for mixed waste facilities. Mixed wastes were usually treated as radioactive wastes and were disposed of in radioactive waste incineration and/or disposal facilities. Thus, until recently, BNL shipped solidified mixed wastes (such as solidified solvents and solidified EP toxic wastes) to Hanford for disposal (see Section 4.1.1.2 for more details).

EPA has published requirements for states to apply for RCRA mixed waste program primacy by July of 1988 or face loss of RCRA primacy. New York State does not yet have a RCRA mixed waste program. In May of 1987, EPA and DOE agreed that mixed wastes would be subject to RCRA regulations for the hazardous component of the waste and DOE regulations for the radioactive portion. It was agreed, by the agencies, that the Atomic Energy Act Exclusion applied only to the radioactive portion of the waste. Therefore, DOE facilities will now have to comply with the procedural requirements of RCRA, including making RCRA Permit Part A notifications, submitting RCRA Part B applications, and manifesting mixed wastes (including those that are shipped to DOE disposal facilities).

BNL does not have any procedures for identification of mixed wastes. Forms used by generators, to characterize radioactive wastes, do not contain any provisions for providing information regarding the presence of hazardous wastes or constituents. Until recently, small quantities of mixed wastes (e.g., radioactively contaminated chlorinated solvents and toxic chromic acid cleaning solutions) were solidified and shipped to Hanford for disposal. Currently, these solidified wastes are being stored at the HWMA.

Potential mixed wastes at BNL include the 3,000 cubic feet of sludge, in Tanks D-1, D-2, and D-3 at the B-811 WCF. The sludge, which contains transuranic nuclides, also contains toxic metals. RCRA Extraction Procedure (EP) data are not available to determine whether the tank sludge is a mixed waste. The concentrated sludge (resulting from the evaporative concentration of radioactive wastewaters) is another potential mixed waste, since the wastewater from which it was derived contains metallic constituents. See Section 4.1.1.2 for additional details.

BNL has historically solidified the slurry and shipped it as radioactive waste to DOE facilities for disposal. The Extraction Procedure (EP) currently used to characterize solid wastes (to determine whether they are hazardous) allows testing of stabilized wastes in a monolithic form, if it passes the structural integrity procedure. However, the Toxicity Characteristic Leaching Procedure (TCLP), which may replace the EP, requires grinding solidified wastes to maximize leaching potential. Therefore, even if the solidified sludge could pass the EP, it may not pass the TCLP.

Scintillation vials, many of which contain ignitable solvents, are a mixed waste. These vials were previously incinerated at the HWMA incinerator. As discussed in Section 4.1.1.2, BNL has stopped incinerating the vials because of reluctance on the part of BNL to permit the HWMA incinerator as a hazardous waste incinerator. Scintillation vials are being stored at the HWMA. NRC permits disposal of scintillation cocktails below a specified activity limit, without regard to activity (for tritium and C-14). However, BNL treats all vials containing scintillation cocktails as radioactive waste.

Washington, the location of the Hanford disposal site which receives BNL radioactive wastes, has enacted so called "Dangerous Waste" regulations. Such regulations limit the shipment of mixed wastes from BNL. Eliminating mixed wastes at Hanford, and the discontinued usage of the HWMA incinerator may result in the long-term storage of mixed wastes at BNL. Storage areas will be required to meet RCRA-interim status standards, and RCRA Part B permit applications will have to be made.

4.1.1.4 Solid Waste

BNL has disposed of solid wastes in on-site landfills since the beginning of operations in 1947. The former landfill was used by the Army during World War II and by BNL from 1947 until 1966. Limited records exist regarding the types of wastes disposed of in the facility. Much of the waste was construction and demolition debris. The types of laboratory wastes disposed of included laboratory debris, unreclaimable decontaminated equipment, contaminated clothing, radioactive animal carcasses, and personnel protective clothing. Sludge from the sewerage plant was disposed of once per year. It is likely, based on general practices in existence at that time, that both hazardous and mixed wastes were disposed of in the landfill.

The present or current BNL landfill was put into operation in January 1967. Since the beginning of the operation, putrescible and nonputrescible trash and building materials were deposited in the landfill. Since February of 1981, putrescible trash has been taken off-site to the Brookhaven Town Landfill. Lightly contaminated radioactive wastes were disposed of in the landfill. Such wastes included paper towels, contaminated clothing, personnel protective devices, mouse litter

contaminated with tritium, and carcasses of animals used in experiments. Disposal of radioactive wastes was officially stopped in 1978, although at least one load of radioactively contaminated sewage sludge was disposed of after 1978. Currently, the landfill is receiving 6 to 8 tons daily of non-putrescible waste and building materials.

Administrative controls requiring waste segregation at the sources of generation are used to keep radioactive wastes from being disposed of at the landfill. BNL procedures call for a radiation monitor to be used for checking each truckload of material for the presence of radioactivity, prior to disposal at the landfill. Various departments/divisions and outside contractors use the landfill on a routine basis (e.g., carpenters, refrigeration workers, plumbers, electricians, etc.) as well as technicians from the AGS and other departments. An audit of landfill operations (Day, 1986b) concluded that these users did not use the radiation monitor and that, as a result, approximately half of the 20 loads of waste delivered daily were not monitored for radiation. Access to the landfill is restricted by a fence and a locked gate, except during working hours. The Survey observed that attendants are not on duty when the gate is opened for truck access. New York regulations require that one attendant be on duty during operating hours.

Asbestos wastes, generated on a routine basis at BNL, require special handling and disposal procedures designed to prevent the air dispersion of asbestos particles. Requirements for asbestos disposal include the designation of a specific cell for asbestos disposal, fencing, 5-foot separation from groundwater, daily cover, record keeping, and notification to NYSDEC prior to asbestos disposal.

The landfill currently is operating in accordance with a permit issued by NYSDEC. Special conditions prohibit disposal of perishable or radioactive materials and require quarterly monitoring and reporting of analyses of groundwater for metals and excess radioactivity as well as an outline of the requirements for asbestos disposal.

Fourteen monitoring wells are in the area, although results for some may be questionable, since BNL audits have shown several to be screened at a depth not suitable for obtaining representative samples. See Section 3.4 for additional details. Chloroform and radioactivity have been detected in the groundwater. Leachate seeps were observed flowing from the landfill and collecting at the bottom of the landfill.

Section 27-0704 of Article 27 of the New York Environmental Conservation Law, imposes conditions for operations of landfills in Nassau and Suffolk Counties beyond 1990. These provisions include requirements that the landfill be underlain by two or more natural and/or synthetic liners, each with

provisions for leachate collection, and that the landfill have a leachate treatment and disposal system. Retrofitting double liners into the existing landfill would be impractical. Therefore, BNL will close the landfill in 1990, when the liner requirements must be met. Section 4.5 discusses, in greater detail, historical disposal practices at the existing and old landfill.

4.1.2 Findings and Observations

4.1.2.1 Category I

None.

4.1.2.2 Category II

1. Mixed-Waste Determination Procedures. There is a potential for mismanaging mixed wastes because BNL has not routinely analyzed its radioactive wastes for hazardous constituents. BNL, at the time of the Survey, had no procedures in place to identify or handle mixed wastes. Potential mixed waste sources include, but may not be limited to, the following:

   a. B-811 Waste Concentration Facility (WCF) - The WCF processes radioactive wastewaters from laboratories in the Departments of Applied Sciences, Biology, Chemistry, and Physics, and from the Decontamination Facility, Linac Isotope Production Facility, and Hot Laboratory Complex. Most of these facilities produce wastewaters that may contain heavy metals and/or solvents. The wastewater is reduced in volume (100:1) by evaporative distillation at the WCF. This volume reduction results in a concentration of metals in the resultant slurry to a level that may make the radioactive slurry a hazardous and, therefore, a mixed waste.

      Until recently, this slurry after solidification (with a cement/vermiculite mixture) at the HWMA was shipped to Hanford for disposal. The slurry is now being solidified at the WCF and stored in 53 drums at the HWMA, until questions regarding its mixed waste status are resolved. There are currently 100,000 gallons of radioactive wastewater at the WCF awaiting processing. This is equivalent to at least 4,000 gallons (80 drums) of solidified waste.

   b. B-811 WCF Storage Tanks - There are three 100,000-gallon radioactive waste storage tanks at the WCF. Two tanks, D-1 and D-3, are not actively used because of leaks. These two tanks contain about 2,500 feet^3 of sludge contaminated with mixed fission products

(primarily Cesium-137) and transuranics (including plutonium). Tank D-2, which is still in use, contains 700 feet^3 of sludge and 60,000 gallons of wastewater, the latter of which is awaiting evaporative distillation (see discussion above). Analyses of the sludges in Tanks D-1 and D-2 by BNL (Phillips, 1987) indicate the presence of chromium (5,500 and 1,900 ppm, respectively) and lead (8,900 and 5,900 ppm, respectively). The presence of these metals may result in the sludges failing the EP toxicity tests, thus making the sludges a hazardous, and hence, mixed waste. The solidified sludges also would have to pass the EP toxicity tests or otherwise be considered a mixed waste and, if so, they could not be shipped to Hanford for disposal. Finding 4.5.2.3.1(e) has additional details on these tanks.

c. Various laboratories - Radioactive wastes from various laboratories and experiments may also contain hazardous constituents. According to BNL, there are more than 50 buildings at this facility that generate hazardous wastes and 13 buildings that generate radioactive wastes. Several of these buildings may house 50 to 100 individual laboratories generating hazardous, radioactive, and mixed wastes. Each generator is responsible for filling out either a "Radioactive or Non-Radioactive Hazardous Materials Waste Control Form" for each package of waste to be picked up. The form requires that the generator provide information on the waste's physical and chemical properties. However, the form used by generators to characterize radioactive wastes does not contain any provisions for contributing information regarding the presence of hazardous wastes or constituents. Consequently, some radioactive wastes may contain hazardous constituents and, in fact, be mixed wastes.

If the waste streams described above prove to be mixed wastes, then all treatment, storage, and disposal activities undertaken by BNL, with regard to these wastes, will require compliance with applicable RCRA hazardous waste regulations.

2. Leachate From the Current Landfill. Leachate, which was observed emanating from the sides of the current landfill, may be a potential source of soil and groundwater contamination. Because of the age of the landfill and the types of wastes disposed of, the leachate may contain radioactive and/or hazardous constituents. The leachate was observed to be pooling outside the landfill fence during the Survey (see Finding 3.2.4.3.1(e)).

The current landfill began operation in 1967 and has been primarily used for putrescible and nonputrescible solid waste. Low-level radioactive wastes (e.g., contaminated gloves, clothes, animal carcasses, and sewerage treatment plant sludge) were disposed of until the practice was prohibited in 1978. According to BNL, about 2,500 feet^3 of low-level radioactive sewage

sludge was mistakenly disposed of in the landfill in the early 1980s. BNL ceased disposing of putrescible trash in the landfill in 1981.

Although the current landfill began operating at the time that on-site chemical waste disposal (in the chemical pits and former dump) ceased, no records are available to document that such wastes were disposed of in the current landfill. However, it is possible that with the on-site disposal options limited and the prevailing climate of environmental regulations, some hazardous waste was disposed of in the landfill (see Finding 4.5.2.3.1(f)).

Chloroform and radioactivity have been detected in monitoring wells near the landfill. If this contamination can be attributed to the landfill through additional investigations, then the leachate (even if it does not contain radioactive or hazardous constituents at this time), may serve as a conduit for the release of such contaminants in the future (see Finding 3.4.4.3.1(b)). Survey-related sampling is planned.

4.1.2.3 Category III

1. Spills and Releases in the Hazardous Waste Management Area (HWMA). Spills and releases in the HWMA have resulted in contamination of soil and paved surfaces (and potential contamination of surface water and groundwater), with hazardous and radioactive constituents. These spills and releases, which have occurred in the past and may continue to occur, are the result of the following practices:

   a. Past and present outdoor storage of drums of both liquid and solid hazardous and radioactive wastes. This includes the current outdoor storage of radioactive solidified slurry from the B-811 WCF, radioactive oils, and contaminated sorbent material (sand) used to clean up spills of hazardous waste fuel components and oil at the CSF. At present, BNL cannot ship radioactive waste oil to Hanford for disposal because Hanford will not accept liquid radioactive wastes. The drums of solidified slurry from the B-811 WCF cannot be shipped to Hanford until the waste is tested and shown not be a mixed waste. During the Survey, there were a total of 26 drums of radioactive oil, 53 drums of solidified B-811 WCF slurry, and 35 drums of oil-contaminated sand stored on the paved area in the central portion of the HWMA. According to a report of the Safety Assessment Committee for the HWMA, this same area housed "several hundred drums of oil.. at the time of the audit" (December 1986). Prior to construction of the B-483 covered hazardous waste storage facility in 1983, drums of hazardous waste were also stored in this area. The Safety Assessment Committee Report (Safety Assessment Committee, 1986) noted that waste

solvents were stored outside and that there was "evidence of spillage and leakage" due to "weathering" of drums and the delivery of leaking drums to the HWMA. During the Survey, it was observed that the paved area, next to where empty drums are now stored, was heavily stained and that stormwater had a visible oil sheen. Because runoff in the HWMA is neither controlled nor analyzed, it is possible that the soils surrounding the paved area and nearby surface water are contaminated with hazardous and radioactive constituents (see Findings 3.2.4.3.1, 3.3.5.2.1, and 4.5.2.3.1(d)). In fact, radiation scans of the HWMA show that there are numerous areas where radioactive contamination has occurred. The paved area contains several marked areas that are contaminated with fission products from past spills. Additional "hot spots" in the soil surrounding the paved area and HWMA buildings are marked with stakes. Groundwater beneath the HWMA is contaminated with chlorinated organic compounds, tritium, and strontium (see Finding 3.4.4.3.1). The number of drums stored outdoors and the length of storage is expected to increase if certain of BNL's radioactive wastes are determined to be mixed wastes (see Finding 4.1.2.2.1).

b. Spills in the acid/base neutralization area from the past practice of dumping the neutralization supernatant on the ground. The past practice of routinely dumping several gallons of neutralization supernatant on the ground may have contaminated the ground with heavy metals. This practice ceased in 1986. The nonradioactive acids and bases that were neutralized were not analyzed for hazardous metallic constituents. In lieu of analyses, BNL has relied on the generator to indicate on the waste pickup form whether metals are present. Since the Survey team identified several instances in which waste pickup forms were improperly filled out or incomplete, the reliability of such forms is questionable (see Finding 4.1.2.4 1). The salts resulting from neutralization were disposed of until 1980. The salts are now stored at the HWMA. Survey-related sampling of the spill area is planned.

Liquid radioactive wastes (e.g., oils, solvents, chromic acid, acids, and bases) are currently neutralized in small quantities (typically gallons) and then solidified. This ongoing practice takes place outside of B-446, which is used for receiving, sorting, and storage of compactible radioactive waste. Although the neutralization process takes place in containers, accidental releases would not be contained, since there is no secondary containment and no means of controlling runoff. The slurry resulting from neutralization is solidified and will be stored at the HWMA (since it can no longer be shipped to Hanford) until an off-site disposal option for mixed wastes is found.

c. Long-term storage of activated Alternating Gradient Synchrotron (AGS) equipment on the ground. Activated AGS equipment, stored for periods ranging from months to 20 years, may have resulted or could result in the release of radioactive contaminants to the soil. The equipment has not been characterized as to the extent and nature of the radionuclide contamination. According to BNL, the current procedures for identifying radionuclide contamination in materials shipped to the HWMA were not in place during the time when most of the AGS equipment was sent to the HWMA. Survey-related sampling is planned.

d. Detonation/burning of explosive and highly reactive wastes, and venting of gas cylinders. The detonation and burn area, located in the southeastern part of the HWMA, is surrounded on three sides by an 8-foot-high earthen berm. The area was used from the early 1960s until 1986. The area now contains a variety of gas cylinders which, based on their deteriorating condition, have been stored for some time. No information is available on the quantities and exact kinds of chemicals and gases that were detonated, burned, or vented.

e. Long-term storage of highly radioactive solid wastes in trenches and holes. Long-term storage, for periods of up to 20 years, of highly radioactive material in holes and trenches increases the potential for release of radioactive constituents to the groundwater. Nine underground trenches (22 feet long, 2 feet wide, and 5 feet deep) and 16 vertical (9 feet deep) and slanted (12 feet long) holes are used to store highly radioactive materials, which are considered too "hot" for immediate handling or shipping (i.e., radioactivity levels such that the materials cannot be packaged in containers and meet DOT radiation level limits and/or would contain total radionuclides in excess of limits established by Hanford). The storage is considered "interim," even though some of the material has been "stored" for as long as 20 years, and there are no existing plans for final disposition. The trenches are concrete-lined and covered to prevent run-on from entering the trenches. The holes are either concrete-lined or consist of large tile pipes. Five holes and six trenches presently contain radioactive materials. All materials stored are solids. Groundwater infiltrated at least one of the trenches, when the water table was elevated.

2. Disposal of Nonradioactive Neutralization Salts. Nonradioactive neutralization salts from the acid/base neutralization process in the HWMA may be a hazardous waste due to the presence of toxic metal constituents. According to BNL, neutralization salts were routinely disposed of in or near trenches in the HWMA until 1980 (see Finding 4.1.2.3.1(b)). Currently, neutralization salts are stored at the HWMA. Survey-related sampling is planned.

3. Long-term Storage of Activated Steel in AGS Steel Storage Yards. Rust from activated steel in the AGS steel storage yards is flaking off and potentially contaminating the soil with radionuclides (see Finding 3.2.4.3.1(b)).

The AGS Department maintains two unfenced steel storage yards. Although the yards are designated as activated (contaminated) steel and nonactivated (clean) steel, contaminated steel has accidentally been placed in the clean steel yard by BNL personnel. The steel stored in the contaminated yard has surface exposure levels ranging from 10 to 1,000 mR/hour.

Steel has been stored in these yards for up to 20 years. During this time much of the exposed surface of the steel has rusted and, in many cases, rust has flaked off onto the ground. Rain tends to pool in the yard and provides a potential pathway for migration of contaminants into the subsurface. No data was available on radiation level in the soil. Survey-related sampling is planned.

4. Secondary Containment for Waste Tanks. Releases of hazardous and/or radioactive wastes from tanks lacking or having insufficient secondary containment could contaminate soil and/or groundwater. The Survey identified the following tanks as lacking or having insufficient secondary containment:

   a. B-811 WCF Radioactive Waste Storage Tanks (D-1, D-2, and D-3). Three 100,000-gallon tanks are in the diked area at the B-811 WCF. The principal tank of concern is the D-2 tank, which contains 60,000 gallons of radioactive wastewaters. Tanks D-1 and D-3 have been emptied due to leaks and are not likely to be used again. These two tanks currently contain about 2,500 feet^3 of nonpumpable radioactive sludge (see Finding 4.1.2.2.1). The diked area in which the three tanks are located does not have sufficient capacity to contain a catastrophic release of wastewater from Tank D-2. Even if there was only a partial release from D-2, no tank capacity is readily available to receive any spilled wastewater that would be contained by the dikes. Five of six 8,000-gallon underground storage tanks at B-811 are filled to capacity. The sixth tank is unavailable, due to leaks.

   b. Waste oil/coolant tanks. Accumulation tanks, including the B-423 300-gallon waste motor oil tank, B-479 500-gallon waste oil/coolant tank, B-462 275-gallon waste oil/coolant tank, and the B-930 500-gallon waste oil tank lack secondary containment. There was evidence of spillage at B-423.

c. Oil tanks 611 A and B at the CSF. Tanks A and B, which have 210,000 and 215,880 gallons respectively, are currently empty. The tanks lack impermeable secondary containment. However, BNL does not plan to use the tanks until such containment is installed. Although these tanks are oil tanks, BNL (as part of its Alternate Fuels Program), uses fuels that are hazardous due to ignitability. If such fuels were stored in these tanks, any release would result in contamination of the soil. The possibility of this occurring is negligible at the present time because BNL is suspending its ALF program, in response to changing economic conditions.

4.1.2.4 Category IV

1. Waste Accumulation Areas (WAAs). Releases of hazardous and/or radioactive constituents to soil and/or groundwater may occur from spills of wastes stored in WAAs due to

- Lack of secondary containment
- Lack of impermeable bases
- Prolonged storage of wastes
- Mislabeling and subsequent potential for mishandling of wastes
- Past spills of radioactive and/or hazardous wastes

Table 4-8 outlines deficiencies in WAAs that were observed by the Survey team.

BNL has numerous sources (principally laboratories but including scattered machine shops and service shops), which generate small quantities of a large variety of hazardous, radioactive, and mixed wastes. The inventory prepared by BNL for the Survey, listing buildings and hazardous wastes generated, showed more than 50 buildings that were sources of chemical wastes (Table 4-1). The 1987 HWM Isotopes Report, prepared by BNL for the Survey, listed 13 buildings generating radioactive wastes (see Table 4-2 for further details). Within several buildings there may be as many as 50 to 100 individual laboratories where hazardous, radioactive, or mixed wastes are generated. The multitude of generating sources results in the need for numerous Waste Accumulation Areas (WAAs), where wastes can be temporarily accumulated prior to pickup and transportation to the Hazardous Waste Management Facility for further processing.

TABLE 4-8

DOE SURVEY OBSERVATIONS
WASTE ACCUMULATION AREA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

WAA	Waste Type	Container	Containment	Spill Release Pattern	Labeling	Comments
462	Oils	Drums	None	---	---	---
462	Oils/Coolants	275-Gallon Tank	None	Cement Soil	---	
479	Oils/Coolants	500 Gallons	None	---		
650	Dry Rad Wastes	20 Drums	None	Sewer	Deficient	Drums around sewer
463	Chemicals	5-Gallon Carboys	None	---	Deficient	
490	Chemicals	• Bottles • Carboys • Ice cream containers		Sanitary Dram	Deficient	Inside, but next to safety shower
801	Chemicals Acids Solvents	Drums	None			DAS Area
490	Oils	2 Drums and smaller containers	None	Drain	Deficient	Outside access area to basement leaking drum
422	Thinners Paints	Carboys	None	Soil	Deficient	
423	Crankcase Oil	300-Gallon Tank	None	Concrete		Spill, routine absorbent to SWM
318	Chemicals					2 unofficial WAAs inside and outside.

TABLE 4-8
DOE SURVEY OBSERVATIONS
WASTE ACCUMULATION AREA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

WAA	Waste Type	Container	Containment	Spill Release Pattern	Labeling	Comments
924	Vythane Epoxy Resins	Drums	None	Drain (to cesspool?)	Deficient	
930	Oil	Tank (500 Gallon)	None	To gravel bed	None	One 500-gallon oil tank. One 500-gallon waste oil tank
919B	Oil/Vythene	8 Drums	None	Nearby drain	Deficient	3 of 8 drums had Rad
919	Oil	2 Drums	None			Permeable surface stains Product stored also
811	Rad wastewater	60,000 Gallons in tank	Insufficient	Soil	NA	
510	Oil	Drum	None			Stains visible
555			None			Outside
555	Solvents Acids		Good	Sewer drain	Deficient	Rooms sloped to contain spills Drain in middle of floor
750	Compactible, and noncompactible Rad wastes Waste oil Solvents	None				Poor housekeeping No liquid Rad

TABLE 4-8
DOE SURVEY OBSERVATIONS
WASTE ACCUMULATION AREA
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE THREE

WAA	Waste Type	Container	Containment	Spill Release Pattern	Labeling	Comments
922	Oil	3 Drums	None		Deficient	
928	Oil/Solvents	Drums	None	Sewer	None	Stains
526	Solvents	Drums	None	Concrete and Soil	Good	8 Drums-unused solvent
535	Unknown	Drums Carboys	None	Drain	None	Loading pits sloppy, stains
535	Unknown	Plastic Gallons	None	Concrete	None	Machine shop non-designated WAA
197	Phosphoric acid, phosphates	5-Gallon Plastic Carboys	None		Deficient	Generator unknown 1 carboy dated September 22, 1986 Non-designated WAA

Source: Survey team observations

WAAs may serve one building, part of a building, or several buildings. In most cases, WAAs are designated, and usually known to the responsible health and safety personnel for each building; although there were several instances where so called unofficial WAAs were found by the Survey. BNL did not have any list of designated WAAs.

New York and EPA regulations allow the accumulation of hazardous wastes in temporary accumulation areas for periods up to 90 days without a RCRA permit. The basic requirements are that incompatible wastes be separated and that all containers, holding hazardous wastes, be labeled as hazardous waste containers. Accumulation start dates must be noted, and wastes cannot be accumulated for more than 90 days. Adherence to requirements for RCRA permitted storage areas, such as impermeable surfaces and spill containment capacity, is technically not required but is considered good practice. This is especially true at BNL, due to the highly toxic and/or radioactive properties of many of the wastes stored in the WAAs and the susceptibility to contamination of the sole-source aquifer underlying BNL (see Section 4.1.1 for details).

Several deficiencies were observed at WAAs at BNL. The most significant was the almost total lack of secondary containment for retention of any releases of liquid wastes. Secondary containment can consist of diked areas or storage of liquid waste containers on plastic or fiberglass pallets with self-contained spill retention capacity. Secondary containment was lacking not only in WAAs, where drums and carboys of liquid hazardous and/or radioactive liquid wastes were accumulated, but also for tanks where waste oils and coolants were stored; such as the 275-gallon tank containing waste oils/coolants at B-462 and the 300-gallon waste motor oil tank at B-423 (see Finding 4.1.2.3.3). The need for secondary containment was demonstrated by evidence of past spills and by drainage patterns that would enable spills to contaminate soil or gain access to storm sewers.

Examples of past spillage include the 300-gallon waste motor oil tank at B-423, where stained concrete was observed and where spill-absorbent material was routinely used to clean up spills. Other examples include B-510, where visible stains were observed from oil releases, and B-928, where oils and solvents are accumulated as described in Table 4-8.

Releases of liquid wastes from WAAs could, in many cases, directly contaminate soil or groundwater; either through direct access to soil or by releases into storm sewers or sanitary sewers. Examples include B-490, where releases of oil could reach a sewer; B-422, where paint

thinner and paints would be released to soil; and B-928, where oils and solvents could reach a sewer. See Table 4-8, for further details.

Labeling of containers in WAAs was deficient. Accumulation start dates were not noted on the containers. In some instances, information on tags was incomplete. The lack of proper labeling was illustrated during a waste pickup run. During the waste pickup at B-490, the following observations were made regarding labeling and packaging:

- Container which truck driver had authorization to pick up was not in WAA.
- One package consisted of plastic bottles in a plastic bag, but should have been in a radioactive waste container known as an "ice cream" container.
- Lid of a container popped open due to improper taping.

The practice of "routine" pickups is also questionable. Certain laboratory wastes are routinely generated. Numbers have been assigned to these wastes, which consist of a variety of hazardous, toxic, and radioactive wastes. Containers of these wastes are then identified only by the number of the waste on the tag. The driver then refers to the number and fills out either a "Hazardous Material Waste" form or a "Request for Disposal, Decontamination and Storage Radioactive Wastes" form, which ordinarily are filled out by the waste generator. This practice could lead to misidentification of wastes by errors in the number on the tags. It also removes the responsibility to completely identify a waste from the generator (who is most knowledgeable of the waste) and puts the onus on the truck driver, who is not likely to have much knowledge of the waste or the process from which it was produced.

2. Hazardous/Mixed/Radioactive Waste Training. The lack of a site-wide training program for hazardous/mixed/radioactive waste-handling procedures could result in mishandling and misidentification of such wastes. The following observations by the Survey team illustrated the problems resulting from the lack of training of the waste generators:

- Incorrect/insufficient labeling of containers
- Lack of accumulation start dates on hazardous waste containers
- Placing of radioactive waste containers with excessively high surface counts in WAAs
- Improper packaging
- Discarded chemicals and unknowns in shutdown laboratories

BNL, as previously described (see Finding 4.1.2.4.1), has many generators of small quantities of toxic/hazardous/radioactive waste and numerous waste accumulation areas. As a result of one of BNL's primary missions to provide and maintain large, scientific facilities for the use of outside researchers, there are many short-term users who may be on-site for periods ranging from several days to months and generate toxic/hazardous/radioactive wastes. These experimenters would not be familiar with BNL procedures, without at least a minimal training program.

Potential problems relating to outside users of BNL facilities are illustrated in the NSLS, where there are 440 experiments and 800 registered experimenters who produce a large diversity of small-quantity wastes.

Problems with discarded chemicals and unknowns from experiments that have been completed were observed at BNL. The problem arises when an experiment terminates, without adequate provisions for laboratory cleanup, prior to use of the laboratory facilities by the next researchers.

Improper labeling and packaging of wastes by researchers was discussed in detail in the findings on WAAs (see Finding 4.1.2.4.1).

BNL's Safety and Environmental Protection Department has initiated a series of talks with BNL laboratory personnel regarding hazardous waste minimization. However, formal training programs for generators of hazardous/mixed/radioactive waste are not in place.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources and Controls

At BNL, the toxic and chemical materials survey covered PCBs, asbestos, pesticides, chemical storage and handling, and fuel tanks.

PCB Sources/Controls

The total amount of PCBs reported in BNL's 1986 inventory is 1,623,000 kilograms. The PCBs are contained in various pieces of equipment and in one alternate liquid fuel tank. Table 4.9 lists the equipment. The majority of this equipment is still in service. BNL has an active program to identify, label, and replace existing PCB equipment. This program consists of the following:

- A yearly PCB inventory form is sent out to all BNL departments by Environmental Protection (EP).
- Safety inspections are carried out in each department with emphasis on PCB items.
- Safety representatives who identify PCB items contact EP. EP makes arrangement for labels and analysis and maintains the records of analysis.

The program is ineffective, based on the observations of the Survey team. BNL's inventory of PCB equipment, especially in warehouses and storage areas, was found to be incomplete and incorrect. A number of pieces of PCB equipment in other areas were not labeled.

The electrical group of Plant Engineering is responsible for performing routine inspections of PCB equipment and any cleanup associated with spills or leaks. This program is also ineffective. The Survey team did observe PCB equipment that was leaking and/or was improperly stored. Details of these observations are provided in Section 4.2.2.2.

The designated PCB storage area at BNL is Building 448. Although the area does not contain a continuous 6-inch dike as required by regulations (EPA, 1981), the PCB equipment is stored in individual portable trays with 6-inch sides. The area is inspected weekly and appeared to be well maintained. No fire suppression system was in place.

TABLE 4-9

PCB EQUIPMENT
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Type of Equipment	Quantity
PCB Transformer	1
Contaminated Transformer	46
PCB Regulator	1
Large Capacitors	553
Small Capacitors	1,900
Contaminated Fuel Tank	1
Oil Switch	3

Source: BNL, 1986d.

BNL did not have a program or procedures to prevent researchers from inadvertently or intentionally bringing PCB-containing equipment on-site. According to shipping/receiving personnel, the normal procedure is for incoming equipment to be checked radiologically prior to delivery to the on-site location. No other check is conducted unless the equipment is sent to Building 87 for temporary storage. At Building 87, incoming equipment is checked for PCBs. During a tour of the receiving area, the Survey team observed three capacitors and one transformer that were awaiting distribution to a researcher's laboratory. Because the researcher was not ready to receive the equipment, it was sent to Building 87, where it was checked for PCBs. The transformer was found to be PCB-contaminated (53 ppm). If the equipment had gone directly to the researcher, it would not have been labeled and BNL would have been unaware of the PCB-contaminated transformer.

Asbestos Sources/Control

BNL has an active program to identify all sources of asbestos at the facility. This program has been ongoing for about 4 years, during which more than 600 samples were taken, and has identified 79 buildings as containing asbestos. BNL's objective is to remove all sources of friable asbestos.

During the on-site Survey, ongoing removal projects were in place at the Personnel (B-185) and Biology (B-463) buildings. The ceiling of the cafeteria is also identified as containing asbestos. BNL conducts yearly air monitoring studies at the cafeteria to ensure that no friable asbestos is present. There has been no evidence of friable materials. BNL is currently awaiting funding to replace the ceiling.

Asbestos removal projects are either conducted by BNL personnel for small projects or contracted to an outside contractor for large ones. BNL safety personnel review procedures to ensure that the removal projects are carried out according to Occupational Safety and Health Administration (OSHA) regulations.

BNL has initiated an X-ray monitoring program of personnel in plant engineering and other related areas who may be exposed to asbestos. More than 300 people have been studied so far. Only about 5 percent have shown any indication of exposure from handling asbestos, and the majority of these were traced back to prior jobs working in shipyards, where handling asbestos was common.

During a tour of the cooling tower at Building 750, asbestos in the form of transite was observed as part of the siding material. Because it had been observed that transite begins to deteriorate after a period of time and the asbestos particles begin to accumulate in the cooling waters, other industries

and facilities have initiated programs to remove the transite. BNL has been alerted to this problem and is inspecting other towers to assess the integrity of the siding material.

BNL's active asbestos disposal site at the current landfill is about 1,200 feet^3 in volume, and has been in use for about 8 years. It was reported that a total of 600 feet^3 of asbestos was disposed of in 1986. Material from asbestos removal projects is transported to the disposal site by trucks or high-lifts. During a visit by the Survey team, most of the material appeared to be single-bagged or was contained in broken bags. Shingles from the removal project at Building 185 were unbagged or partially bagged in the asbestos pit. Many other industries have been double-bagging asbestos wastes. BNL uses sanitary landfill dirt to cover its asbestos wastes. An 18-inch cover is applied, as required in BNL's operating permit.

Pesticide Sources/Controls

BNL uses about 2,000 pounds of pesticides per year for pest control and experimental purposes. The responsibility for the use and application of pesticides at BNL is divided between Plant Engineering and the Biology Department. Plant Engineering uses pesticides to control the growth of weeds and insects around buildings. These pesticides are stored and mixed in Building 412. The pesticides used include TREFLA, REP TRIM, BAYGON, SEVIN, and about 10 others.

The Biology Department uses pesticides mostly for experimental purposes and the control of insects in the hothouse area. Some of the more frequently used pesticides include LANNATE, VAPONA, ATRAZINE, and ROUNDUP. The equipment used for the hothouse applications are stored in the basement of Building 463. This storage/mixing area has been identified by BNL, during a recent pesticide inspection, as a potential problem because of the proximity to the employee's eating area. BNL is currently in the process of preparing a new mixing area. The Biology Department also stores pesticides and fertilizers, that are used at the experimental farming patch, in Building 496C.

Applicators from the Plant Engineering and Biology Departments are licensed and attend regular training sessions. The pesticide storage areas for both departments are routinely inspected by state officials.

Other Sources/Controls

At the Central Steam Facility (CSF, Building 610), 21 tanks with a combined total capacity of 1,982,693 gallons are used to receive the various flammable liquids used as fuels for the CSF.

Table 4-10 contains a list of these tanks and their locations, capacity, and use. There are four classes of fuel used at the CSF:

1. No. 6 Fuel Oil is a virgin product and is procured from a commercial distributor.

2. Government Surplus Administration Fuels include such products as JP-4, Navy Special, etc., which have been declared excess by governmental agencies. These products are classified as waste fuels because they are flammable and the original purchaser has determined that they have served their useful life.

3. Light Feed Stocks (LFS) are a broad class of products, basically spent or waste solvents available from the commercial sector.

4. Alternate Liquid Fuel (ALF) is the blended product of No. 6 oil or other heavy (viscous) oil, and a combination of the waste fuels to produce a product of the approximate viscosity of a No. 4 fuel oil, suitable for combustion in a utility-type boiler.

All tanks at the CSF have impervious dikes for secondary containment except Tank No. 32, which is only used when others are not available. Tank Nos. 5 and 6, the mini-tank farm area, and Tank Nos. 30-35 (tank trailers) are housed on concrete pads with concrete blocks on three sides and a sandbag end-closure to allow tanker movement. Unloading stations have concrete containment pads. Tank Nos. 611A and 611B, with 210,000-gallon and 215,800-gallon capacities, respectively, do not have any impervious liners but are not currently being used. BNL plans to install impervious liners for these tanks. The following methods are utilized by CSF personnel to ensure that no overflows occur: (1) reverse-reading liquid-level indicators, (2) automatic tank gauges, (3) remote electronic reading devices and alarms, (4) Acoust-A-Larms, and (5) manual dip-sticks.

Twenty-six other aboveground tanks, throughout BNL, are used for storage of fuels and chemicals. Table 4-11 lists these tanks, their locat ns, capacity, and use. Only 5 of the 26 aboveground tanks are diked. These include the three diesel fuel tanks at Building 326 and the two chemical storage tanks at Building 603. The other tanks have no secondary containment.

TABLE 4-10

CENTRAL STEAM FACILITY TANK CAPACITY
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Tank Number	Building Designation	Capacity Gallons	Capacity (BBLS)	Present Usage
1	611A	210,000	5,000	ALF blending tank
2	611B	215,880	5,140	ALF blending tank
3	611C	300,000	7,143	Day tank - ALF storage
4	611D	420,000	9,524	Day tank - ALF storage
5	611E	300,006	7,143	GSA storage - government surplus fuel
6	611F	300,006	7,143	GSA storage - government surplus fuel
7	NA	19,992	476	LFS storage/ALF blending
8	NA	59,976	1,428	GSA receiving/holding tank
12	NA	59,976	1,428	GSA receiving/holding storage
13	NA	9,996	238	Waste solvent receiving/holding - light feed stock (LFS)
14	NA	9,996	238	Waste solvent receiving/holding - light feed stock (LFS)
15	NA	9,996	238	Waste solvent receiving/holding - light feed stock (LFS)
16	NA	9,996	238	Waste solvent receiving/holding - light feed stock (LFS)
17	NA	9,996	238	Waste solvent receiving/holding - light feed stock (LFS)
29	NA	4,998	119	GSA/LFS receiving/holding tank (1)
30	NA	4,998	119	GSA/LFS receiving/holding tank (1)
31	NA	3,880	92.4	Holding tank noncombustible sediments
32	NA	4,998	119	GSA/LFS receiving/holding tank (1)
33	NA	4,998	119	GSA/LFS receiving/holding tank (1)
34	NA	4,998	119	GSA/LFS receiving/holding tank (1)
35	NA	18,001	428.6	Waste solvent receiving trail order day tank

Source: County of Suffolk, 1984.

(1) Tanks 29, 30, 32, 33, and 34 are used only when no other tank is readily available.

TABLE 4-11

INVENTORY OF ABOVEGROUND TANKS OTHER THAN CSF
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Tank Location	Capacity (Gallons)	Product
Building 86	1,000	No. 1, 2, or 4 fuel oil
Building 89	1,000	No. 1, 2, or 4 fuel oil
Building 96	275	No. 1, 2, or 4 fuel oil
Building 96	275	No. 1, 2, or 4 fuel oil
Building 158	275	Kerosene
Building 208	275	No. 1, 2, or 4 fuel oil
Building 326	10,000	Diesel
Building 326	5,000	Diesel
Building 326	5,000	Diesel
Building 423	260	Miscellaneous
Building 446	275	No. 1, 2, or 4 fuel oil
Building 452	275	No. 1, 2, or 4 fuel oil
Building 452	350	No. 1, 2, or 4 fuel oil
Building 457	4,000	No. 1, 2, or 4 fuel oil
Building 529	550	No. 1, 2, or 4 fuel oil
Building 603	2,499	Miscellaneous
Building 603	2,499	Miscellaneous
Building 610	275	Diesel
Building 610	63	Gasoline
Building 614	500	Diesel
Building 618	500	Diesel
Building 619	500	Diesel
Building 802	275	Diesel
Building 911	500	Diesel
Building 914	500	Diesel
Building 960	500	Diesel

Source: Baron, 1985

BNL uses a wide variety of chemicals in various quantities. Based on 1986 purchase records, BNL uses more than 200 chemicals with a total of 5,000 units (pounds, gallons, pints, etc.). Laboratory chemical supplies are received and stored at Building 86. These items are tracked by a computer and distributed to the users throughout BNL. In addition, a quality assurance check of chemicals that are stored at BNL is conducted in Building 211. Items are checked for frequency of use, age, and quantity on hand. Building 158 is used for the storage of bulk quantities of chemicals, while Building 210 is used for gas cylinder storage. All buildings appeared to be well-maintained and orderly. Personnel were observed using safe handling procedures and practices.

4.2.2 Findings and Observations

4.2.2.1 Category I

None.

4.2.2.2 Category II

1. Researcher's Equipment and Chemicals Not Checked Thoroughly. Lack of adequate formal equipment and chemical check-in procedures may result in the inappropriate handling, storage, and disposal of hazardous chemicals and equipment containing hazardous chemicals such as PCBs.

   Existing BNL procedures require that research equipment and chemicals, ordered in accordance with BNL procurement procedures, go through B-89 (Receiving) and undergo a check for radiation. A check for chemical content or contamination is not routinely performed. A check for PCBs is made only if the equipment/chemicals go to B-87 (Storage) prior to use by the experimenter.

   Researchers using BNL facilities are permitted to directly order or bring their own equipment/chemicals on-site. The Survey identified one instance in which a researcher ordered three used capacitors and one transformer for an experiment. Because the experimenter's laboratory was not ready to receive the equipment, it went to B-87 (Storage), where it was analyzed for PCBs. Although the levels of PCBs were low (less than 50 ppm in the capacitors and 53 ppm in the transformer), this incident is an example of how equipment containing hazardous chemicals (or how hazardous chemicals themselves) can be brought on-site outside of proper channels.

In most cases, equipment and chemicals that are brought on-site outside of normal BNL procurement channels bypass the radiation check at B-89 and the PCB check at B-87. In addition, there is no record of the equipment/chemicals being brought on-site. BNL individuals who are knowledgeable of correct handling, storage, disposal, and reporting requirements are not notified. If PCBs are involved, then there may be compliance problems with TSCA regulations, which require the following: an accounting and annual reporting of PCBs and PCB equipment; labeling of PCB equipment and the rooms or buildings in which located; and notifying the fire department of the location of the PCB equipment. The latter two requirements are especially critical in the event of a leak or a fire (see also Findings 4.2.2.4.1, 4.2.2.4.2, and 4.2.2.4.3).

2. Leaking PCB Equipment. There is a potential for human exposure to PCBs and the further spread of contamination due to leaking PCB transformers, capacitors, and/or switches. Table 4-12 contains a list of leaking PCB equipment that was identified by the Survey team and the corrective actions taken by BNL.

4.2.2.3 Category III

None.

4.2.2.4 Category IV

1. PCB Equipment Incorrectly Labeled and Stored. Incorrect labeling and storage of PCB and PCB-contaminated equipment could result in the mishandling of this equipment and/or fines during a TSCA inspection. Table 4-13 contains a list of equipment that was incorrectly labeled and stored at BNL during the Survey.

2. Incomplete Annual PCB Reports. The current method of documentation of PCBs and PCB-contaminated equipment at BNL does not satisfy the TSCA requirements and could result in fines during a TSCA inspection because of noncompliance. Following is a list of the shortcomings in the procedures used at BNL:

- Total amounts of PCBs (in Kg) are not shown.
- Total number of PCB capacitors is not shown.
- Total amount (Kg) of other PCBs (not transformers) is not shown.

TABLE 4-12

LEAKING PCB EQUIPMENT
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Type of Equipment/Identification	Problem	Status
AGS (Ring)	Transformer #20281 A1SN	Sweating drain valve and temperature port	Cleaned as of 4/8/87.
490	2 Oil switches	Drips on floor	Cleaned as of 4/8/87.
Building 901, Room 115	Transformer 292	Leaks on floor	Cleaned as of 4/13/87. Drip pan in place.
912/913 (yard outside)	Transformer 744	Leaking onto ground, needs analysis	Tested positive for PCB - was disposed of on 8/25/87.
935 (outside main entrance)	3 capacitors - #s SNY76138, Y54748, SNY54745	Leaking onto ground	Moved and cleaned as of 4/17/87.

Source: Survey Team Observations

TABLE 4-13

INCORRECTLY LABELED AND STORED PCB EQUIPMENT
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Type and Identification	Problem	Status
AGS (Ring)	Transformer #20281-AG 6N Transformer #20281-AJ 5N	Label painted over incorrect (yellow) label	Yellow labeled 4/8/87. Green labeled 4/8/87.
Building 510	Oil switches	No labels on doors	Corrected 4/8/87.
Building 490	2 Oil switches	No labels on doors	Corrected 4/8/87.
Building 901 Room 115	Transformer 292	No labels on doors	Corrected 4/13/87.
Building 912/913 I (outside yard)	Transformer 744	No labels on equipment and improperly stored	Action pending as of 4/27/87.
100/Warehouse	4 capacitors	Incorrect storage	No action as of 4/27/87.
209/Bulk Storage	6 capacitors 55-gallon drum 55-gallon (approx.) Electric box	If PCB, incorrect storage and no labeling	Sampled and analyzed 4/87. Not PCB but removed 7/87.
CSF	ALF Tank (200,000 gallon)	Incorrectly labeled (yellow)	Green labeled 4/8/87.
935 (outside main entrance)	3 capacitors Nos. SN76138, Y54748, SNY54745	No labeling and incorrect storage	Corrected 4/17/87.

Source: Survey Team Observations

- Total amount (Kg) of PCBs in transformers is not shown.
- Number of PCB transformers on-site is in error.
- Total amounts (Kg) of PCBs shipped off-site throughout the year are not shown.
- All PCB equipment at BNL is not being reported to SEP for inclusion in the annual report. For example, a capacitor in Building 480 was analyzed in the organic laboratory in Building 703 as PCB but was not reported.

3. Fire Department Not Informed of PCB Equipment. Failure to notify the fire department of PCB transformers could result in mishandling during an emergency and fines as a result of noncompliance with TSCA fire regulations. Prior to the end of the on-site Survey, SEP personnel had notified the fire department of the locations of known PCB equipment and provided proper labels on doors leading to this equipment.

4. Suffolk County Sanitation Code Violations. The Survey identified several problems at the Central Steam Facility. The following problems are also technical violations of Article 12 of the Suffolk County Sanitation Code:

   - Tanks 611A and B (currently empty) are not cathodically protected or epoxy-lined.
   - Tanks 13, 15, 16, and 17 are not equipped with visual or audible overfill alarms.
   - Truck transfer area lacks an impermeable base. The Survey noted that the material being transferred is highly viscous No. 6 diesel fuel and that spills were promptly cleaned up.

5. Pesticide Mixing Area. Pesticides are being mixed in the eating room in Building 463 hothouses. This is prohibited under regulations promulgated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (EPA, 1987a) in 40 CFR 165.10. A separate eating room was allocated nearby.

6. Mislabeled Mercury-Containing Crates. Approximately 300 pounds of mercury in the basement of B-555 was being stored in crates marked "Fuses and Ammunition" and could have been incorrectly shipped or disposed. The mercury was left over from an experiment and was to be shipped off-site. BNL correctly labeled the crates prior to the end of the on-site Survey.

4.3 Radiation

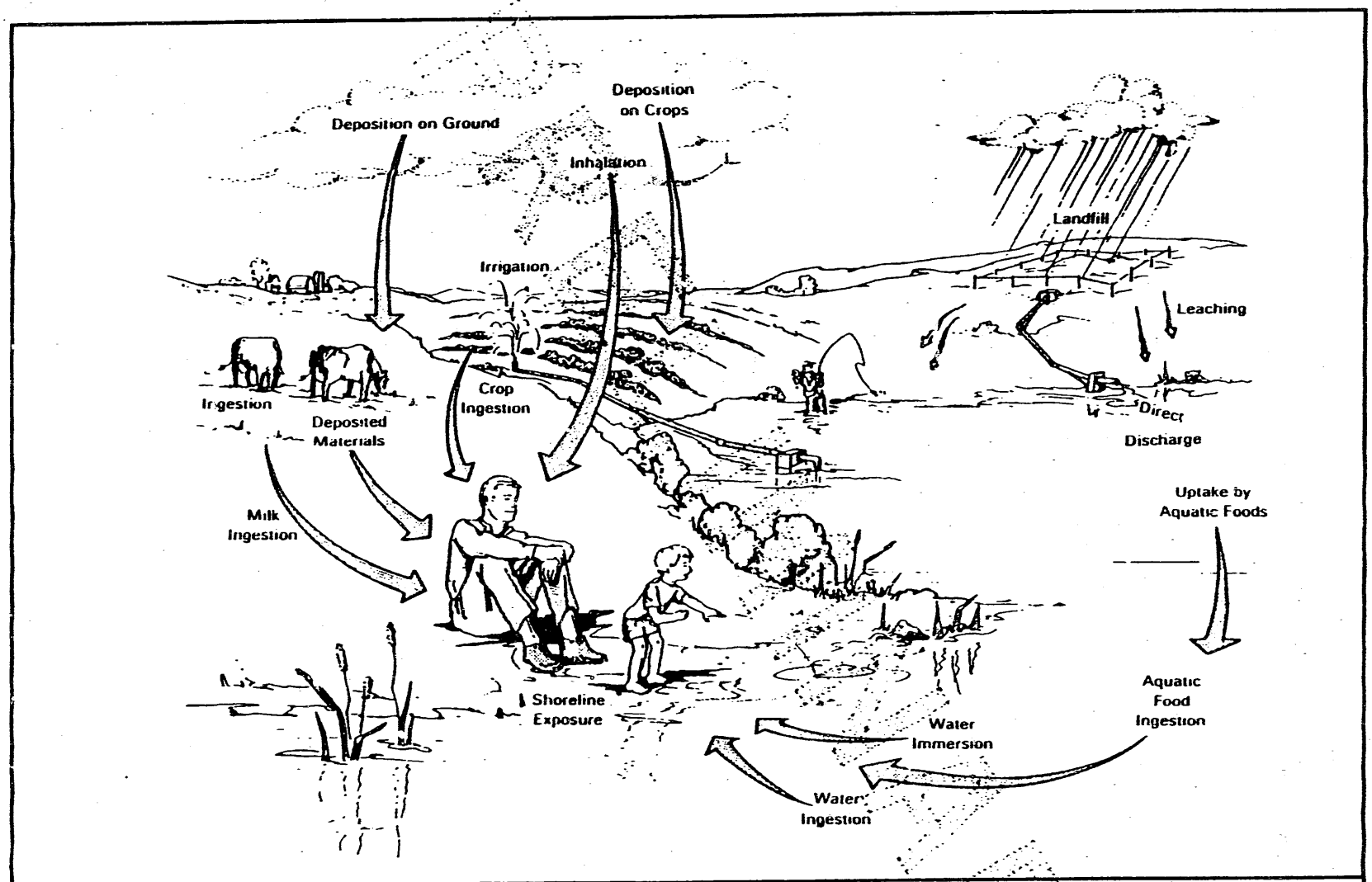
4.3.1 Background Environmental Information

The BNL radiation site setting can be described as a subset of each of the previous media settings (i.e., air, soils, surface waters, and hydrogeology). Each of these primary pathways is responsible for radionuclide transport and potential contamination of ambient air, soils, drinking water, groundwater, vegetation, and food. Figure 4-2 depicts graphically some of these transport/exposure scenarios (MEPAS, 1987).

Background radiation in the vicinity of BNL is a consequence of both natural and man-made sources. These sources include cosmic radiation, natural radioactive materials in the soils and building materials, fallout from past atmospheric weapons detonations, releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide, and the intake of radioactive materials in air, drinking water, and food. The most significant exposure is to the lungs from background levels of radon. The annual average effective dose equivalent for natural background in the United States is approximately 190 millirem/year (mrem/year) (United Nations, 1982). This dose is detailed in Table 4-14. About one-half of the dose equivalent is attributable to the inhalation of radon-222 and its decay products. Previously accepted estimates of background doses did not include the radon contribution and were estimated at about 100 mrem/year.

The data in Table 4-14 were derived in accordance with the approach recommended by the International Commission for Radiological Protection (ICRP) in ICRP Reports 26 and 30. This approach allows direct comparison of the effective dose for different organs, by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors" to the doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ. The sum of the dose equivalent for the individual organs provides an estimate of the total effect of the radiation on the whole body.

The EPA reports gamma radiation dose rates on a quarterly basis for select locations throughout the United States in Environmental Radiation Data (EPA, 1987b). During the reporting period of July-September 1986, measured dose rates equivalent to an annual dose of approximately 86.7 mrem ± 6.5 mrem were reported for the New York, New York, monitoring location, which is the closest one to BNL. As reported in the BNL 1985 Environmental Monitoring Report (Day et al., 1986), the annual average dose-equivalent rate measured by BNL thermoluminescent dosimeters (TLDs) was 63.7 mrem



SOURCE: MEPAS, 1987

FIGURE 4-2

TRANSPORT/EXPOSURE SCENARIOS
BNL - UPTON, NY

TABLE 4-14

AVERAGE ANNUAL EFFECTIVE
DOSE-EQUIVALENT TO HUMANS
FROM NATURAL BACKGROUND RADIATION
BROOKHAVEN NATIONAL LABORATORY,
UPTON, NEW YORK

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
TOTAL (1)	**189**

Source: United Nations, 1982

(1) Total represents the major product of the appropriate weighting factor times the annual dose-equivalent for pulmonary, trachial/ bronchial, and mean doses.

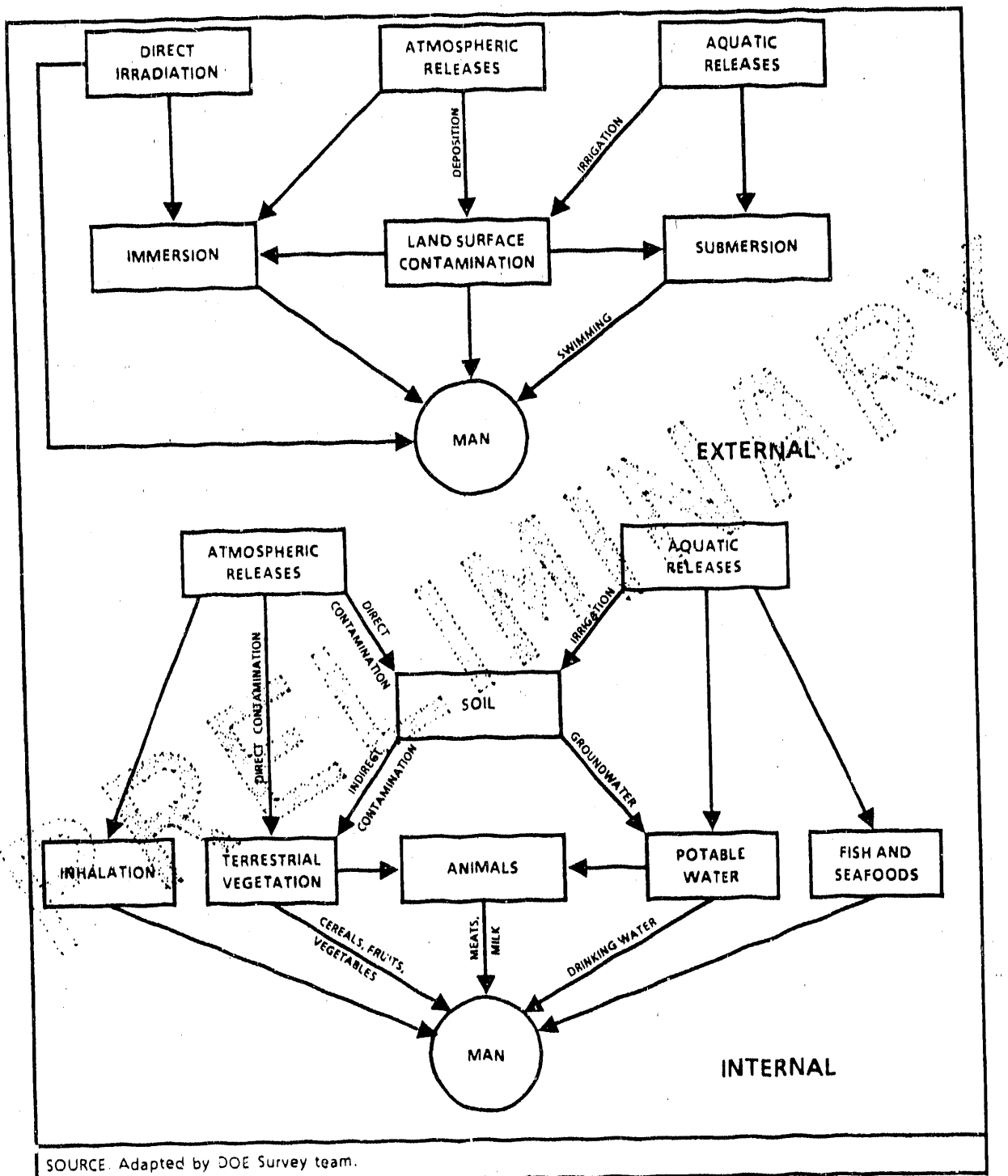
per 16-compass-point sector area. Site boundary and off-site dose-equivalent rates were 70.2 mrem/area and 59.7 mrem/area, respectively. These measures compare favorably with the above-mentioned background measurements reported for New York, New York.

As required by DOE Order 5484.1, Chapter III, 4d2d1-3, BNL conducts an annual "assessment and reporting of potential dose to the public." In 1985 DOE adopted an interim radiation protection standard for environmental activities to be implemented in calendar year 1985 (Vaughan, 1985). It is DOE policy to follow the guidance of the National Council on Radiation Protection and Measurements (NCRP) to the extent practicable with respect to radiation protection standards. A comprehensive revision of previous NCRP recommendations on a basic radiation protection system is still under development. However, current NCRP guidance is available regarding protection of the public in its September 18, 1984, advice to the Environmental Protection Agency which was published under the title "Control of Air Emissions of Radionuclides." In this document, the NCRP endorses the recommendation of the International Commission on Radiological Protection (ICRP) to limit the continuous exposure to any member of the public from other than medical sources and natural background to a whole body dose-equivalent of 100 mrem per year. The previously recommended limit of 500 mrem per year is retained for noncontinuous exposures. This recommendation is now adopted as an interim standard for DOE environmental activities for the sum of all exposure pathways.

Radiation exposures are received from external sources and from radionuclides taken into the body by inhalation of air and ingestion of water and foodstuffs. Radionuclides taken into the body will continuously irradiate the body until they are removed through either radioactive decay or metabolic processes. Consequently, internal dose estimates are calculated as "50-year dose commitments." These are obtained by integrating the total dose received by an individual's body over an assumed remaining lifetime of 50 years. Principal pathways for exposure of humans from radionuclides released from BNL are shown in Figure 4-3. The doses to the various major organs are considered for various exposure pathways. The radiation doses received by a specific organ are weighted and summed to determine the total dose.

4.3.2 General Description of Pollution Sources and Controls

Results of aerial radiation surveys used to characterize total gamma exposure rates conducted in 1983 are shown in Figure 4-4. These surveys indicate that the greatest site boundary gamma exposure rates are approximately 8-10 μrem/hour (~70 to 88 mrem/year), which compares favorably with EPA data collected in New York as mentioned before. Proposed source(s) and/or radionuclides for each identified area were provided by BNL Safety and Environmental Protection Division (S&EP)



SOURCE: Adapted by DOE Survey team.

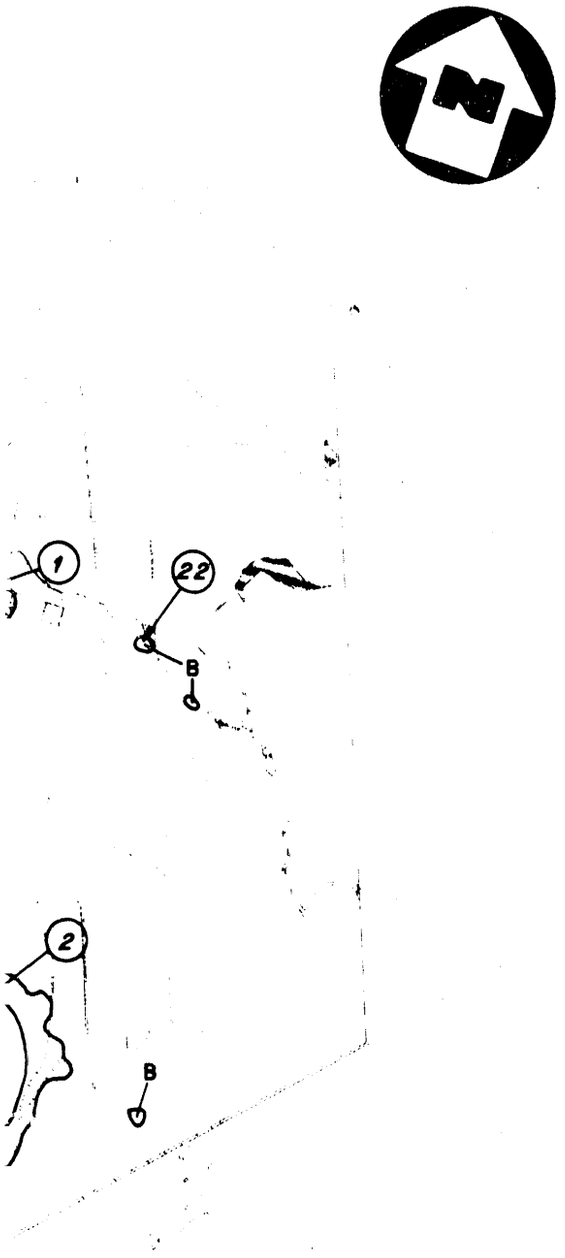
FIGURE 4-3

PATHWAYS FOR EXPOSURE OF MAN FROM
ATMOSPHERIC AND AQUATIC RELEASES OF RADIOACTIVE EFFLUENTS
BNL - UPTON, NY

2

Source: EG&G, 1985.

MAI



CONVERSION TABLE	
Letter Label	Exposure Rate(1) (μR/hr.)
	Negative
A	<0.6
B	0.6 - 2.0
C	2.0 - 5.0
D	5.0 - 15.0
E	15-25
F	25 - 50
G	50 - 250
H	250 - 750
I	750 - 1,500
J	1,500 - 1,750

0 2500 5000

SCALE IN FEET

(1) Contours are gamma exposure rates in the vertical plane and as such do not necessarily represent occupational exposure rates.
(2) The list of radionuclides present in each area was provided by BNL's S&EP Division.
(3) Locations 14-23 were not readily identifiable on the 1980 Survey.

SUMMARY OF MAN-MADE RADIOACTIVITY AREAS

Area Number	Description of the Area	Proposed Source and/or Radionuclides(2)
1	Sewage Treatment Plant	^{137}Cs, ^{60}Co, ^{65}Zn, ^{59}Fe
2	Waste Management Area	^{137}Cs, ^{134}Cs, ^{65}Zn, ^{60}Co, ^{54}Mn
3	Warehouse	Depleted Uranium, ^{60}Co
4	Warehouse Area	Space Effects Research Laboratory Magnets ^{60}Co, ^{54}Mn, ^{22}Na
5	Building 650	Outfall of Waste Water ^{137}Cs, ^{65}Zn, ^{60}Co
6	Decontamination and Hot Laundry	^{51}Cr, ^{7}Be, ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{60}Co, ^{22}Na, ^{59}Fe
7	Waste Concentration Facility	^{60}Co, ^{54}Mn, ^{137}Cs
8	Alternating Gradient Synchrotron Storage Area	^{54}Mn, ^{59}Fe, ^{22}Na
9	Accelerator Storage	^{58}Co, ^{60}Co, ^{54}Mn
10	Field behind Medical Building	^{137}Cs
11	Old Landfill	^{137}Cs
12	Field behind Chemistry Building	^{137}Cs
13	Field east of Brookhaven Center	^{137}Cs
14(3)	Forest Area southwest of Linac, Building 930	Suspected Artifact Radioactivity in CLIF, Building 931A; or BLIP, Building 931B
15	South end of Linac, Building 930; CLIF, Building 931A; or BLIP, Building 931B	Targets stored in Building 931B and Liquid Waste Storage Tank
	Building 914, AD Beam Components Assembly Building	Extraction Magnet Repair Facility
16	Building 919, Helium Systems Compressor Room	North Conjunction Area used for Beam Pipe Modification ^{22}Na, ^{60}Co, ^{54}Mn
17	Trailers north of Building 919A, Cryogenic Target Assembly Building	Service Area adjacent to Gate 3 of Fast Beam Tunnel ^{22}Na, ^{60}Co, ^{54}Mn
18	Building 912, On-Line Data Facility, Experimental Area Operations	Hot Magnet Storage Area west of Building 912 ^{22}Na, ^{60}Co, ^{54}Mn
19	Trailers north and east of Building 912	Storage Area for Surplus Steel Sheilding ^{22}Na, ^{60}Co, ^{54}Mn
20	Building 830, Nuclear Waste Management Facility	Radioactive Waste Research Program and High Intensity Radiation Laboratory Mixed Fission Products, ^{60}Co
21	East end of Building 930	^{137}Cs in Soil, Activation Activity from Linac Cooling Water ^{137}Cs
22	Peconic River Station M	Flow Gate Measurement plus Sedimentation due to Bend in Stream ^{134}Cs, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{65}Zn
23	Forested Area north of Atmospheric Sciences, Building 51	

FIGURE 4-4

-MADE ISORADIATION CONTOURS
BNL - UPTON, NY

personnel. Controls employed to limit exposure to penetrating radiation included shielding, fencing, restricted access, and most importantly from the standpoint of public exposure, distance.

Table 4-15 lists radionuclide atmospheric effluent release locations and quantities released during 1985. These represent the major air radionuclide pollution sources used to calculate off-site doses, which are discussed in greater detail in the environmental monitoring section of this chapter.

The majority of aquatic radionuclide releases are from the sewage treatment plant to the Peconic River. From a dose assessment perspective, aquatic pathway doses are much lower at BNL than airborne doses; however, groundwater recharge and sole-source aquifer issues have resulted in a great deal of concern regarding releases of radionuclides to surface waters. Methodologies for calculating drinking water and fish ingestion pathways are discussed in the environmental monitoring section. More discussion on aquatic sources is provided in Section 3.3.

4.3.3 Environmental Monitoring Program

BNL monitors penetrating radiation using calcium fluoride-dysprosium (CaF_2:Dy) thermoluminescent dosimeters (TLD) at locations both on-site (Figure 4-5) and off-site (Figure 4-6). Each of the 16 compass point sectors, with Sector No. 1 centering on true north, have been used to locate TLDs. Specific data for 1985 by compass point sector are shown in Table 4-16. As mentioned earlier, both on-site and off-site results are well within the range of background measurements expected for this area and represent ~34 percent of the previously-mentioned 190 mrem/year, average background dose from all sources.

Environmental monitoring for the purpose of calculating dose is accomplished in several ways. As shown in Table 4-17, the collective effective dose equivalent attributable to BNL 1985 emissions is made up of the inhalation pathways from both gaseous and particulate materials as well as the ingestion pathways from both fish and water consumption. More than 99 percent of this dose is the result of Argon-41 (an air activation product) emission from the Medical Research Reactor.

Total BNL operations emissions calculate to a collective effective dose equivalent (see Appendix F for a discussion of terms) of about 4.8 person-rem which represents about 0.0016 percent of the 300,000 person-rem 1985 collective effective dose equivalent attributable to natural background.

Table 4-18 presents data for the maximally exposed hypothetical resident in comparison with EPA NESHAPS requirements and DOE guidelines. The highest, annual-average, site-boundary concentration of tritium (HTO) vapor (21.1 pCi/m^3) was used to calculate the committed effective

TABLE 4-15

ATMOSPHERIC EFFLUENT RELEASE LOCATIONS AND RADIONUCLIDE ACTIVITY BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Building No.	Facility and Release Point	Principal Radionuclide	Type of Monitoring	Amount Released During 1985 (Ci)
490	Medical Research Center roof stack	tritium (HTO)	Desiccant for tritium (HTO) vapor	4.2×10^{1}
491	Medical Research Reactor Stack [a]	argon-41	Moving tape for radioparticulates and charcoal for radioiodines	1.1×10^{3}
555	Chemistry Roof Stack	tritium (HTO)	Desiccant for tritium (HTO) vapor	2.6×10^{1}
750	High Flux Beam Reactor Stack	tritium (HTO)	Desiccant for tritium (HTO) vapor	9.3×10^{1}
801	Hot Laboratory	Gross Beta particulates iodine-126 iodine-131 xenon-127	Beta scintillator for radioactive gases and particulate filter for gross beta; charcoal cartridge for radioiodines.	1.5×10^{5} 2.8×10^{-5} 2.3×10^{-5} 1.3×10^{-5}
901	Van de Graaff Accelerator	tritium (HTO)	Kanne chamber for tritium (HT) and desiccant for tritium (HTO) vapor	2.0×10^{2} (gas) 2.4×10^{0} (vapor)
931	Linac Isotope Facility [b]	oxygen-15 tritium (HTO)	G-M detector for radioactive gases and desiccant for tritium (HTO) vapor	1.9×10^{3} 9.0×10^{-5}
445	Incinerator [c]	tritium (HTO) carbon-14 phosphorus-32 sulfur-35 chromium-51 cobalt-57 tin-117m iodine-125	None	13.18×10^{3} 4.93×10^{-3} 6.87×10^{-3} 3.72×10^{3} 3.67×10^{-3} 0.36×10^{3} 0.24×10^{3} 0.61×10^{-3}

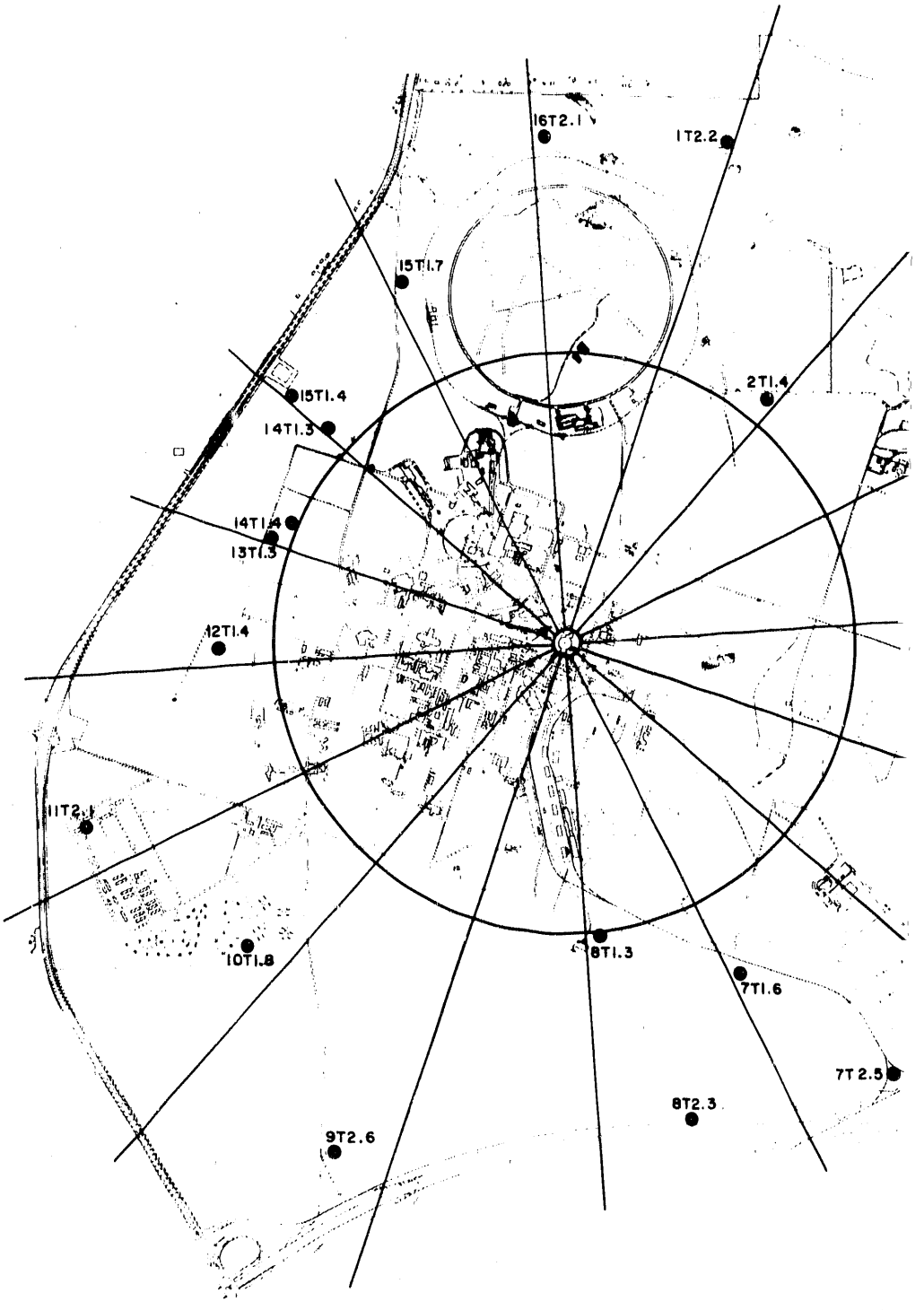
Source: Adapted from Day, et al., 1986.

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

(b) Calculated from reported operating and estimated production rate at 180 uamp full beam current. This quantity is generated in the beam tube and represents the absolute maximum. Facility shut down in June 1984 for major modifications.

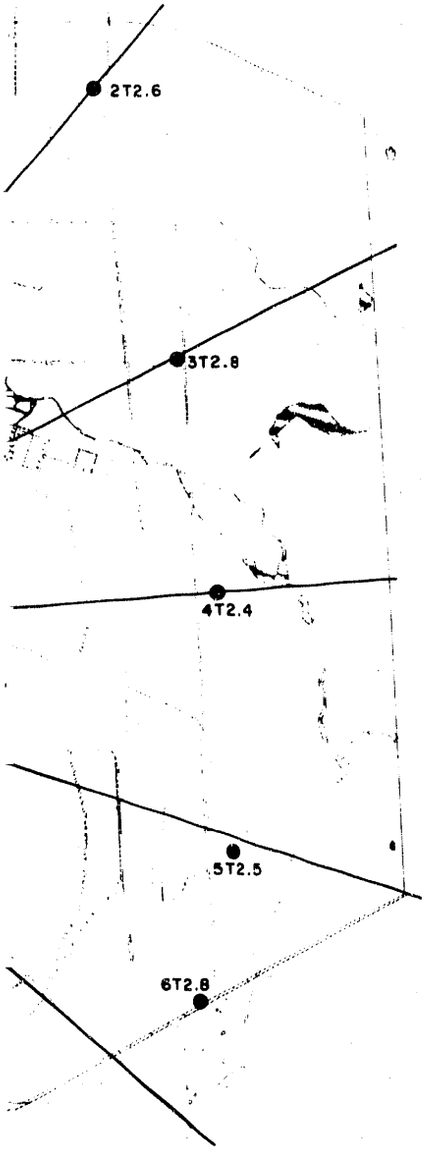
(c) Radionuclides released in annual quantities of less than 0.1×10^{-3} Ci have not been included.

2



Source: Day et al., 1986.

LOCATION OF OI



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SCALE IN FEET

FIGURE 4-5

-SITE THERMOLUMINESCENT DOSIMETERS (TLDs)
BNL - UPTON, NY

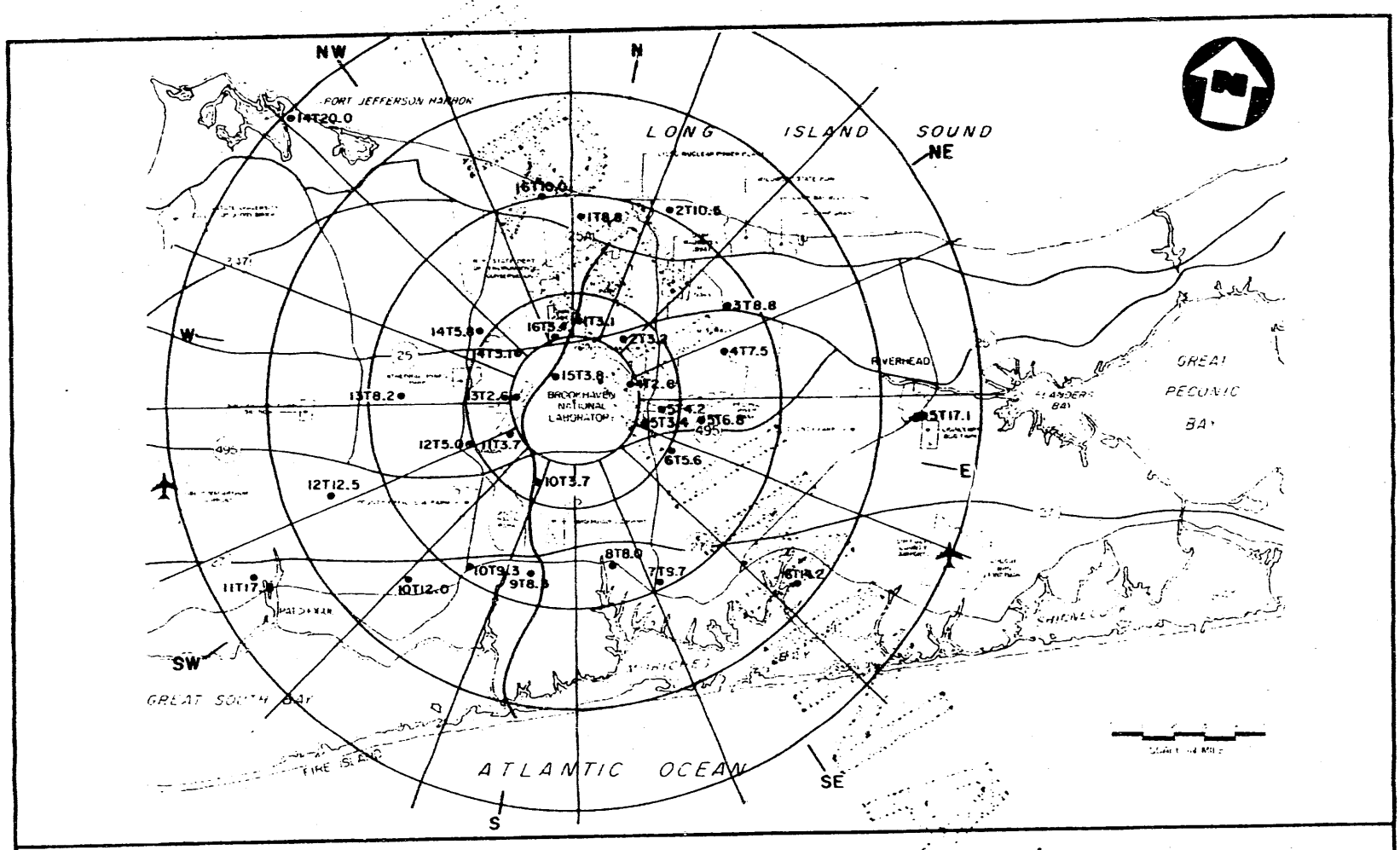


FIGURE 4-6

LOCATION OF OFF-SITE TLDs
BNL - UPTON, NY

TABLE 4-16

EXTERNAL DOSE-EQUIVALENT RATES FOR ALL TLD LOCATIONS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Sample Frequency (M = Monthly) (Q = Quarterly)	millirem				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1985 Annual Dose
1T2.2	M	14.5	14.2	15.7	16.2	60.5
1T3.0	Q	14.0	13.5	14.9	14.3	56.8
1T8.8	Q	14.7	12.4	14.1	13.5	54.8
2T1.4	M	15.4	16.1	16.8	17.6	65.8
2T2.6	M	16.6	17.2	18.2	17.6	59.6
2T2.6B (P-9)	M	16.7	16.0	17.9	17.5	68.0
2T3.2	Q	13.4	14.3	16.1	15.8	59.6
2T10.5	Q	17.3	16.0	17.0	17.9	68.3
3T2.8	M	14.9	15.5	17.4	17.9	65.7
3T8.8	Q	13.0	14.8	15.0	DM	58.2
4T2.4	M	14.8	15.9	15.8	15.8	62.3
4T2.6	Q	13.3	14.9	15.0	16.2	59.4
4T7.5	Q	13.0	13.9	15.1	15.0	56.9
5T2.5	M	17.9	18.3	21.0	19.8	76.9
5T4.2	Q	12.2	13.0	DM	13.9	52.0
5T6.5	Q	13.3	13.8	14.7	14.6	56.4
5T17.1	Q	16.3	13.3	14.9	14.5	59.0
6T2.8 (P-7)	M	15.0	16.6	18.1	18.0	67.8
6T5.6	Q	12.7	13.0	14.5	13.9	54.1
6T14.2	Q	14.3	12.1	12.9	13.4	52.6
7T1.6	M	21.6	21.3	24.2	22.0	88.6
7T2.5	Q	15.9	17.4	18.6	18.3	70.1
7T9.7	Q	16.6	15.3	15.7	15.8	63.4
8T1.3	M	18.0	18.3	20.7	19.5	76.5
8T2.3	Q	12.9	14.7	15.3	14.3	57.2

TABLE 4-16
EXTERNAL DOSE-EQUIVALENT RATES FOR ALL TLD LOCATIONS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE TWO

Location	Sample Frequency (M = Monthly) (Q = Quarterly)	millirem				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1985 Annual Dose
8T8.0	Q	15.1	13.4	15.7	14.7	59.0
9T2.6	M	16.8	17.7	16.7	17.4	68.9
9T8.3	Q	12.2	12.9	DM	15.7	54.1
10T1.8	M	17.3	17.1	20.4	19.3	74.0
10T3.7	Q	15.7	17.8	18.8	17.2	69.6
10T9.3	Q	10.6	13.9	16.7	13.5	54.7
10T12.0	Q	15.9	15.3	16.8	17.1	65.6
11T2.1 (P-4)	M	14.6	16.1	16.9	17.4	65.0
11T3.7	Q	13.3	14.7	16.0	12.3	56.3
11T17.8	Q	15.2	12.7	13.8	14.2	55.9
12T1.4	M	17.7	17.7	20.9	20.0	76.3
12T5.0	Q	11.9	14.0	15.0	15.1	56.1
12T7.2	Q	12.9	14.8	15.2	15.6	58.5
12T12.5	Q	17.0	15.7	14.9	18.1	65.6
13T1.3	M	17.5	17.2	20.2	21.0	76.1
13T1.4	Q	16.7	14.7	16.8	16.7	64.7
13T2.6	Q	13.3	15.2	16.7	DM	61.6
13T8.2	Q	12.2	13.4	13.4	13.9	52.9
14T1.3	M	17.0	17.3	20.9	19.9	75.2
14T1.4	Q	19.9	15.2	18.4	16.4	70.8
14T3.1	Q	14.9	16.7	18.1	16.2	65.8
14T5.6	Q	18.4	16.9	18.6	18.5	72.4
14T20.0	Q	13.8	15.3	17.6	15.6	62.3
15T1.7	M	16.9	16.7	20.3	19.0	73.0
15T3.0	Q	11.4	13.3	13.6	14.1	52.4

TABLE 4-16
EXTERNAL DOSE-EQUIVALENT RATES FOR ALL TLD LOCATIONS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK
PAGE THREE

Location	Sample Frequency (M = Monthly) (Q = Quarterly)	millirem				
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1985 Annual Dose
16T2.1 (P-2)	M	14.3	16.0	16.5	16.9	63.6
16T3.4	Q	13.6	15.5	16.8	15.9	61.8
16T10.0	Q	15.4	14.9	DM	17.2	63.0
Control A*	Q	4.42	5.72	4.55	4.33	19.01
Control B*	Q	4.21	4.10	5.28	4.24	17.82
Control C*	Q	4.92	4.35	4.67	4.55	18.49
Control M**	M	4.98	4.90	6.00	8.02	23.89

Source: Adapted from Day et al., 1986.

Annual average perimeter monthly samples (18 observations) = 70.2 mrem ± 7.41 mrem
Annual average perimeter quarterly samples (5 observations) = 64.4 mrem ± 6.13 mrem
Annual average offsite quarterly samples (31 observations) = 59.7 mrem ± 5.71 mrem

* Background control data for TLDs exposed for 3 month periods. Controls are lead-shielded.
** Background control data for TLDs exposed for 1 month periods. Controls are lead-shielded.

DM: Data Missing - Annual Dose calculated as a time-weighted average of the other three quarters.

TABLE 4-17

COLLECTIVE COMMITTED EFFECTIVE DOSE-EQUIVALENT[a]
FROM ALL PATHWAYS
BROOKHAVEN NATIONAL LABORATORY,
UPTON, NEW YORK

Pathway	1985 Collective Committed Effective Dose (Rem)
Airborne	
Gas	4.8
Particulates	0.03
Ingestion	
Fish	0.007
Water	0.003
Total Due to BNL Operations	4.8
Total Population Collective Dose-Equivalent Due to Natural Background	300,000

Source: Adapted from Day et al. 1986.

(a) See Appendix F for a discussion of terms.

TABLE 4-18

MAXIMUM DOSE-EQUIVALENT CALCULATIONS
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Radionuclide	1985 Maximum Dose Equivalent (mrem)	Percent of EPA Whole-Body Limit (25 mrem)	Percent of DOE Guideline (100 mrem)
argon-41/oxygen-15	0.34	1.36	0.34
tritium (HTO)	0.01	0.04	0.01
TOTAL	**0.35**	**1.40**	**0.35**

Source: Adapted from Day et al., 1986.

dose equivalent (0.011 mrem) for a hypothetical resident living at that location (see Finding 3.1.4.4.1 for more discussion on tritium in air results). Although exposure rates due to Argon-41 and Oxygen-15 are not measured at the site boundary, modeling parameters that result in the greatest concentration (most conservative), including short stack heights, were assumed for the calculations. As shown in Table 4-18, the total airborne dose to this hypothetical resident is approximately 1.4 percent of the applicable EPA limit.

Specific radionuclides, whole-body collective doses, and target organ collective doses for the air pathways from 10-meter and 100-meter stack effluents are shown in Tables 4-19 and 4-20. Methodology employed for inhalation pathways for dose-equivalent calculations is as follows:

Dispersion values (X/Q) are calculated for release elevations of 10 and 100 meters at each of the 16 directional sectors and for 5 distance increments (1.6-16 km, 16-32 km, 32-48 km, 48-64 km, and 64-80 km) from the center of the site. The resulting dispersion values represent a monthly integral of the rates (μCi/sec) for a given distance and sector. The radionuclide-specific release rates (μCi/sec) for a given month from the HFBR stack, the Chemistry Building roof vent, the Medical Building roof vent, Van de Graaff roof vent, BLIP stack, and the Hazardous Waste Management incinerator stack are then used to estimate the air concentrations at a given sector and distance. The air concentrations multiplied by the adult breathing rate (22.8 $m^3 d^{-1}$), the number of days per month, the dose conversion factor for a given radionuclide, and the dispersion and population values for that sector distance, resulted in the monthly population nuclide-specific dose-equivalent for each sector with distance. This procedure is conducted for each month, radionuclide, and release point. The dose-equivalents are then summed to obtain the total population dose-equivalent resulting from BNL operations.

The above briefly describes, in general terms, the "BNL Wind Rose Dispersion Model," which was developed specifically for the Brookhaven site. Although there is no reason to believe BNL-developed models for air dispersion are less accurate or less conservative than AIRDOS, BNL has not submitted its modeling strategy to EPA for approval as an alternate but equivalent dose assessment methodology. However, as stated in Section 3.1, BNL reached an agreement with EPA to use current strategies for the 1985 Environmental Monitoring Report (Welty, 1986) until simultaneous AIRDOS-BNL dose comparisons can be made. The use of models that have not been approved by EPA is a violation of NESHAPS requirements listed in 40 CFR 61.93 (see Finding 3.1.4.4.8) and may result in underestimation of public doses.

Ingestion pathways, considered relevant at BNL, included fish and water consumption. Methodology used for calculating the potable water ingestion pathways is as follows:

TABLE 4-19

COLLECTIVE DOSE-EQUIVALENT[a] FROM THE 10-METER STACK EFFLUENT RELEASE BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Nuclide	1985 Whole Body Collective Dose (mrem)	1985 Thyroid Collective Dose (mrem)
argon-41	4,770 [b]	----
tritium (HTO)	20.3	----
technetium-99	0.0014	
iodine-125	0.078	2.64
carbon-14	0.04	
Phosphorous-32	0.316	
sulfur-35	0.035	
tin-113m	0.0025	
iodine-131	0.0034	0.116
chromium-51	0.0059	
technetium-99m	0.00001	
iron-55	0.0000042	
cobalt-57	0.0113	
thallium-201	0.000005	
samarium-117m	0.0028	
ruthenium-103	0.0031	
TOTAL	**4,790**	**2.76**

Source: Day et al., 1986.

(a) See Appendix F for a discussion of terms.

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

m metastable

TABLE 4-20

COLLECTIVE COMMITTED EFFECTIVE DOSE-EQUIVALENT[a]
FROM THE 100-METER STACK EFFLUENT RELEASE
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Nuclide	1985 Total Collective Dose (mrem)	1985 Thyroid Collective Dose (mrem)
bromine-82	3.5E - 3	----
cobalt-60	8.2E - 4	----
iodine-123	2.9E - 4	8.6E - 3
iodine-124	5.1E - 3	1.7E - 1
iodine-126	2.0E - 2	6.4E - 1
iodine-131	2.6E - 2	8.9E - 1
iodine-133	1.7E - 3	5.5E - 2
xenon-125	5.4E - 4	----
xenon-127	1.6E - 4	----
mercury-203	1.44E - 5	----
scandium-44m	2.4E - 5	----
zirconium-95	1.33E - 4	----
cerium-139	2.4E - 5	----
tritium (HTO)	12.4E - 0	----
Others	7.5E - 4	----
TOTAL	**12.5**	**1.76**

Source: Day et al., 1986.

(a) See Appendix F for a discussion of terms
m metastable

For the maximally exposed individual, the highest annual average tritium (HTO) concentration, as measured from a single potable well, is used to calculate the total quantity of tritium (HTO) ingested via the drinking water pathway. For the collective dose equivalent calculation, the annual average tritium (HTO) concentration is obtained by averaging all results from potable wells that are in the demographic region adjacent to the laboratory. The annual intake of tritium (HTO) via the drinking water pathway is calculated from the following equation:

$$AI = 1 \times 10^{-6} \, C \bullet IR \bullet T$$

Where: AI = Activity Intake, µCi

C = Annual average water concentration (563 for the population and 1,873 for the maximum individual), pCi/l (1985 data)

IR = Ingestion rate (2.2) l d^{-1}

T = Time, 365 days

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

$$H = AI \bullet DCF \bullet P$$

Where: H = Committed effective dose equivalent, rem

AI = Activity intake, µCi

DCF = Dose conversion factor, rem/µCi [6.3 x 10^{-5} rem/µCi for tritium (HTO)]

P = Population at risk

To determine the maximum individual dose, the population parameter is set to unity. For the 1985 collective dose calculation, the following assumptions were made concerning the population at risk:

- The number of homes with the potential to have tritium (HTO) in their potable well water was approximately 25.

- The number of residents per household was four.

The following procedure was used to estimate the collective dose-equivalent from the fish consumption pathway:

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

b. In the past, the figure used for fish consumption was 1.6 kg/year and was based on a study done by the NYSDEC in 1978 for the Peconic River area. However, a recent study conducted in the same area suggests that the figure should be 7 kg/year. BNL has, therefore, used the amount 7 kg/year as the fish consumption rate in its 1985 calculations.

c. Committed Dose Equivalent Tables were used to get the 50-year committed dose equivalent factor--rem/μCi intake.

The factors for the ingestion pathways for the radionuclides identified were as follows:

Tritium (HTO):	6.3×10^{-5} rem/μCi intake
^{90}Sr:	1.2×10^{-3} rem/μCi intake
^{137}Cs	5.3×10^{-2} rem/μCi intake

d. Calculation: (7 kg/year) x (activity in flesh μCi/kg) x (factor rem/μCi intake) = rem/year

e. Because there was a cesium-137 background as determined by the control locations data, this background was subtracted from all data prior to use for domestic purposes (Day et al., 1986). Tables 3-14 and 4-22 list 1985 radionuclide concentrations in fish and committed dose-equivalent.

As a result of several inquiries, including the Blass Committee's inquiry regarding an incident in 1979, the question was raised about the total dose a helicopter pilot might receive if he passed through an effluent plume (argon-41 or oxygen-15) or was exposed to the cesium-137 gamma source that was

TABLE 4-21

COMMITTED DOSE-EQUIVALENT[a] FROM THE FISH CONSUMPTION PATHWAY
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Radionuclides	mrem			
	Control	1985 Maximum Individual Net Dose	1985 Average Individual Net Dose	1985 Collective Dose
tritium (HTO)	NA	0.0008	0.0005	0.3
strontium-90	NA	0.0280	0.0110	6.6
cesium-137	0.10	0.1008	0.88098	0.0059
TOTAL (mrem)	**0.10**	**0.13**	**0.0115**	**6.91**

Source: Day et al., 1986

NA No analysis
(a) See Appendix F for a discussion of terms

used at the BNL gamma forest until September of 1979. Helicopters that use radiation detectors to sense rotor pressure failure had apparently yielded false sensor readings in the past, while flying over the BNL site. An examination of the instrumentation in one typical helicopter indicated that the sensors would alarm, once the pilot was in a radiation field of approximately 2 mR/hour. Helicopters that were flown within 1,400 feet of the exposed gamma forest source or within 20 feet of air effluent stacks at the Medical Research Reactor or Brookhaven's Linear Isotope Production Facility could have been placed in radiation fields which would have been sufficient to trigger this false instrument reading. Worst-case dose estimates indicate that a total dose of 8.1 to 20 mrem was possible, but a more probable total dose estimate would be a factor of 10 to 100 below the worst-case estimate (Miltenberger et al., 1987).

4.3.4 Findings and Observations

4.3.4.1 Category I

None.

4.3.4.2 Category II

None.

4.3.4.3 Category III

None.

4.3.4.4 Category IV

None.

4.4 Quality Assurance/Quality Control

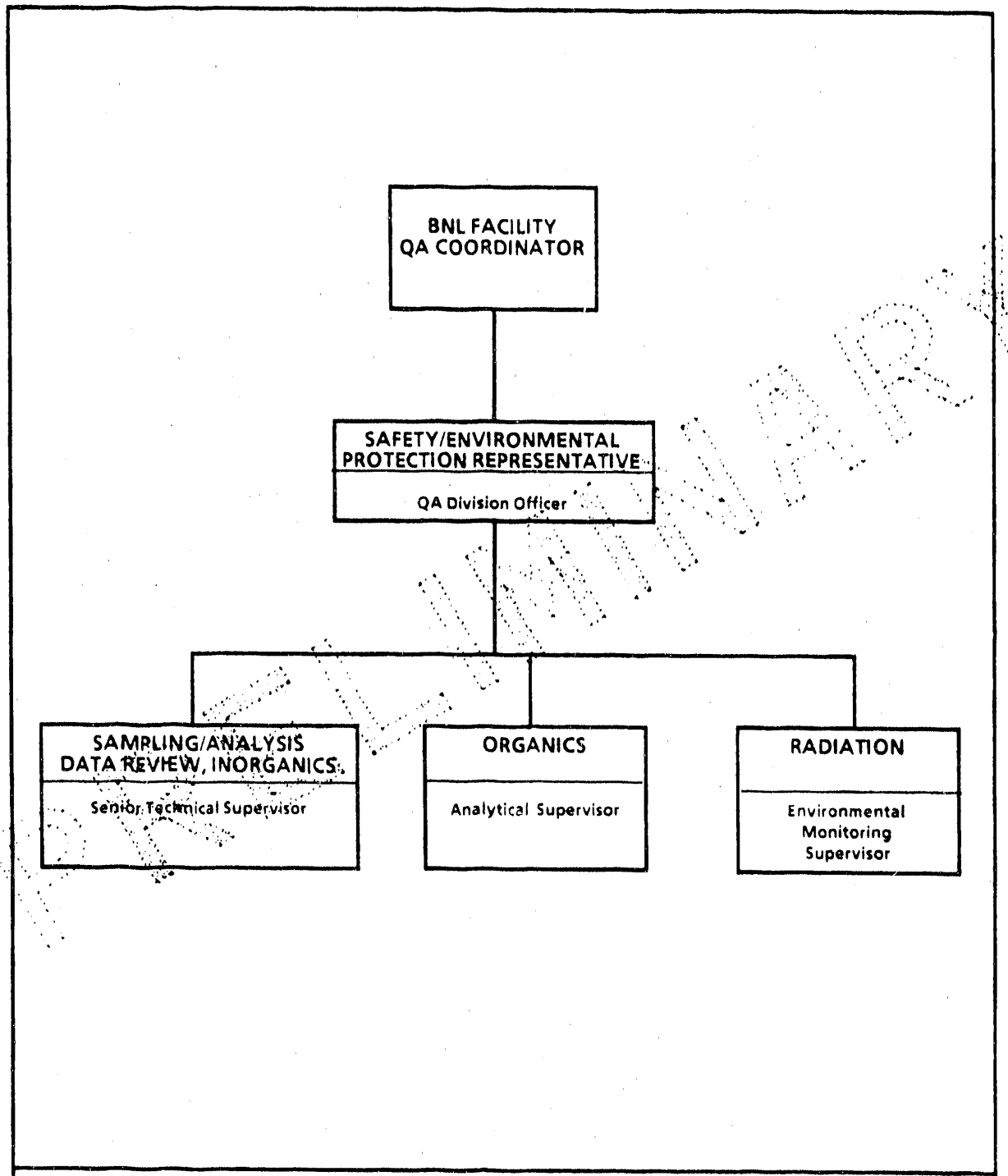
4.4.1 General Description of BNL Environmental Quality Assurance Program

The quality assurance (QA) hierarchy shown in Figure 4-7 has been in effect for about a year. Prior to this, BNL quality assurance responsibilities were under the direction of the site QA coordinator. In an effort to become more efficient in its QA function, BNL designed the system shown in Figure 4-7 so that individuals directly working in specific areas (laboratories, sampling, etc.) would have their respective QA responsibilities defined more clearly. BNL feels that this configuration is more efficient because of the Area Representatives' day-to-day contact with individuals in their areas.

In general, the BNL facility QA coordinator oversees quality assurance functions throughout the laboratory. He ensures good internal practices by conducting audits, inspections, and surveys. The Safety and Environmental Protection (SEP) representative acts as a liaison between the BNL facility coordinator and the individual responsible for QA in specific areas of the environmental monitoring program. The individuals responsible for the QA functions associated with sampling/analysis and the inorganics, organics, and radiation laboratories ensure that proper QA measures are taken in their areas to produce quality samples and results. These measures include chain-of-custody, personnel training, calibration of equipment, laboratory security, use of approved procedures, and internal audits. In addition, the individual laboratories demonstrate good internal controls by analyzing standards, blanks, duplicates, and some spike samples. The laboratories also participate in analyzing and/or preparing quality assurance samples for EPA, DOE, NRC, and the State of New York.

BNL also utilizes an off-site laboratory to analyze some of the radiological samples, whenever its own laboratory is overloaded or whenever BNL needs cross-checks. The QA practices of this facility have been reviewed by BNL personnel during visits to the laboratory and found to be acceptable. In addition, the quality assurance manuals of laboratories used for nonradiological services have also been reviewed by BNL personnel during visits to the respective facilities. These have also been found to be acceptable.

The Suffolk County Department of Health Services collects samples of air, soils, and water for radiological and nonradiological parameters associated with BNL activities. However, BNL does not conduct any quality assurance checks of the sampling procedures used by the County. The County has its own QA program for sampling and analysis. BNL personnel have visited the county office, reviewed its QA procedures, and found them acceptable.



Source: Survey team observations.

FIGURE 4-7

QUALITY ASSURANCE HIERARCHY
BNL - UPTON, NY

During the BNL visit, the Survey team reviewed the following: written procedures for sampling; various analytical procedures; results for blanks; results for duplicate and spike recoveries; instrument calibration results; internal audit results; laboratory notebook entries; chain-of-custody; sample calculations; training records; and results from BNL's participation in various other governmental round-robins.

4.4.2 Findings and Observations

4.4.2.1 Category I

None.

4.4.2.2 Category II

None.

4.4.2.3 Category III

None.

4.4.2.4 Category IV

1. Environmental Monitoring Results May Be Suspect. The following quality assurance (QA) deficiencies observed in the nonradiation and radiation analytical laboratories for environmental samples may result in suspect environmental monitoring results:

   - Nonradiation Laboratory

     - A QA program was not fully in place at the time of the on-site Survey. BNL was in the process of updating this program and is currently working on completing the program.

     - The analytical results for blank water quality samples are not recorded on log sheets. BNL was observed recording these results on raw data sheets, which can be lost or misplaced and not be available for review in the event of questionable results.

- The laboratory currently records results on separate, loose pages that are eventually stored in a folder, instead of recording data in a hard-bound notebook. This practice could lead to lost data.

- Radiation Laboratory

  - No instrument operating procedures were in place during the time of the Survey.

  - The procedures that were in draft form during the Survey were not available to the Survey team. BNL has since updated and corrected this deficiency.

  - No spikes are added to samples for alpha, beta, or gamma spectroscopic analysis. Consequently, the reliability of the measurements cannot be fully documented. Although other quality assurance checks, such as standards and blanks, are in place, the absence of spike analysis reduces the reliability of the in-place QA measures.

2. QA Checks of Off-site Environmental Monitoring. BNL does not perform QA checks on sampling and analysis conducted by the Suffolk County Department of Health Services (SCDHS), which may result in the acceptance of suspect data. SCDHS conducts off-site groundwater, surface water, soil, and air monitoring for radiological and nonradiological contaminants related to BNL activities. Although BNL performs the analyses for radiological parameters, as requested by SCDHS, it exercises little or no control or oversight regarding when, where, why, and how the off-site samples are taken.

3. Calculation of Radiological Data. A review of the computer printouts of surface water and groundwater radionuclide analytical results by the Survey team revealed an anomaly that could result in understating activities expressed as averages. Understated values prevent calculation of the actual average values and may impair any assessment or evaluation based on such data.

   The computer operator enters negative activity values for samples having activity counts less than the blank. These negative values are entered with a minus sign (which is a logical convention). Consequently, when the columns of activity values are averaged, the computer treats the negative value as actual subtractions and thus reduces the sum of all of the results by the minus values.

Typically, this results in a small error because only 1 or 2 negative values will appear in a column of 12 to 20 numbers; however, the error can occasionally approach 50 percent, when a series of negative values appears in a single column. The overall significance of this error is not considered by the Survey team to be serious from an environmental or human health standpoint because all compliance-related radioactivity analyses for gross α, gross β, and tritium have yielded averages that are only a small fraction of permitted averages. Even so, BNL's method of calculating average radioactivity levels does underestimate "true" average radioactivity levels; hence, the methodology is susceptible to challenge.

4.5 Inactive Waste Sites and Releases

4.5.1 General Description of Pollution Sources/Controls

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) established (1) notification requirements, (2) liability standards, and (3) response authority for dealing with releases of hazardous substances to the environment. Also known as "Superfund," CERCLA's scope is expansive. The EPA and state agencies can undertake or order study or cleanup when there is a release, or the substantial threat of a release, of a hazardous substance to the environment.

Superfund was substantially expanded by the Superfund Amendments and Reauthorization Act (SARA) of 1986. In addition to significantly increasing the size of the fund to finance clean-ups, SARA creates a response authority for petroleum underground storage tank releases (technically an amendment to RCRA), and mandates community Right-To-Know and emergency preparedness programs (Title III). SARA also obligates Federal facilities to comply with the same regulations and policies as other entities. Hence, except for certain limited national security waivers, Federal facility cleanup plans for sites on the National Priorities List must undergo EPA review and concurrence.

This section introduces the sources of hazardous substance releases to the environment. Section 4.5.2 provides more detail on these sources, which are grouped into the following three categories:

- Disposal Areas
- Spills and Drum Sites
- Cesspools

The Disposal Area category represents a heterogeneous mixture of types of sites, including landfills, multiple pit clusters, spills, and contaminated facilities. At BNL, 16 sites fall within the Disposal Area category. In addition, at 25 sites, possibly hazardous substance spills or abandoned drums were observed by the Survey Team. Finally, 33 active or backfilled cesspools are actual or potential sources of groundwater contamination.

4.5.1.1 Disposal Areas

BNL contains approximately 16 areas or types of areas where disposal of hazardous substances is known or suspected. Because of the lack of a complete CERCLA investigation, the identification of

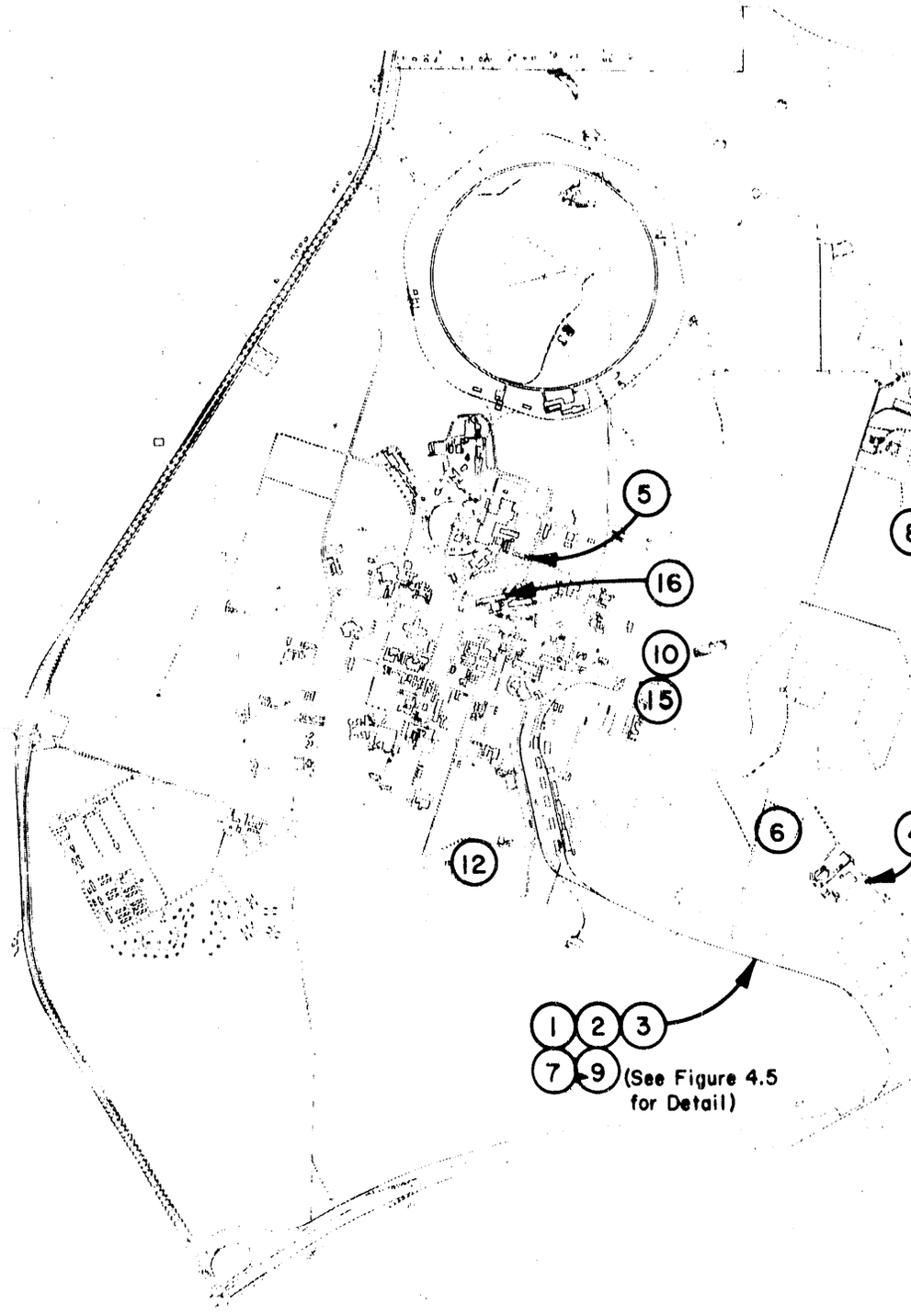
disposal areas may be incomplete. The following list provides a general inventory of these known areas, which are detailed in Section 4.5.2.3 and illustrated in Figure 4-8. The locations of the sites associated with the former landfill area (map sites 1, 2, 3, 7, and 9) are shown in Figure 4-9. The numbers following the names of the sites below and in the Section 4.5.2.3 headings refer to the map site numbers indicated on Figures 4-8 and 4-9.

a. Former Landfill (Map Site 1)
b. Chemical Holes (Map Site 2)
c. Glass Holes (Map Site 3)
d. Hazardous Waste Management Area (Map Site 4)
e. Waste Concentration Facility B811 Tanks (Map Site 5)
f. Current Landfill (Map Site 6)
g. Slit Trench (Map Site 7)
h. Sewage Treatment Plant (Map Site 8)
i. Small (1966) Dump (Map Site 9)
j. B650 Sump Drainage (Map Site 10)
k. Satellite Disposal Area (Map Site 11)
l. Old Army Incinerator (Map Site 12)
m. Rad Contaminated Soil (Various locations)
n. "Meadow Marsh" experiment (upland recharge area) (Map Site 14)
o. 1977 Oil/Solvent Spill (Map Site 15)
p. Brookhaven Graphite Research Reactor (Map Site 16)

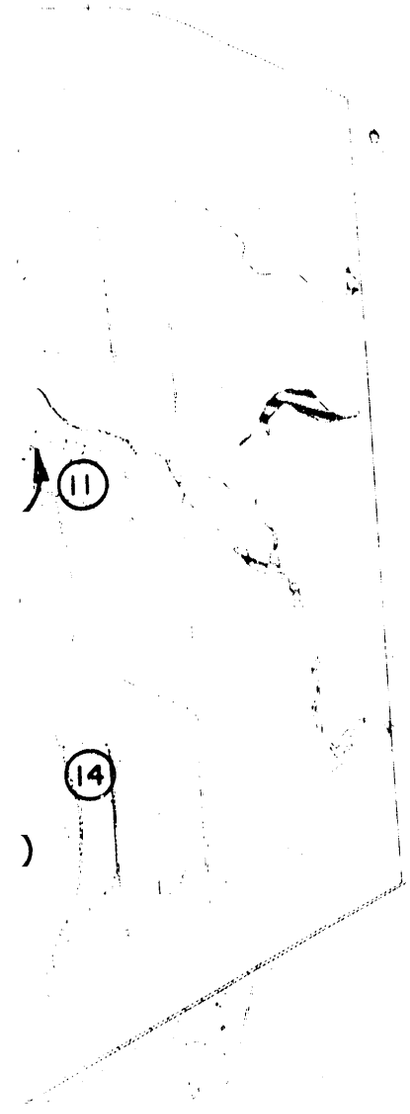
4.5.1.2 Spills and Drum Sites

The Survey Team observed numerous areas at BNL where soil appeared to have been stained with oil or other unidentified, possibly hazardous substance spills and where drums and other containers were abandoned. The following list, which is based on the Survey team's observations, provides only a partial inventory of spills and drum sites at BNL.

a. B975 bubble area: stained soil (SS), drums, tanker trailers
b. B423 spills
c. Meadow marsh shack: 50 empty drums; (SS)
d. B510 SS
e. B206 SS drums
f. B207 stained asphalt
g. B457 drum rack



Source: DOE Environmental Survey, 1987. BNL, 1986e.



KEY

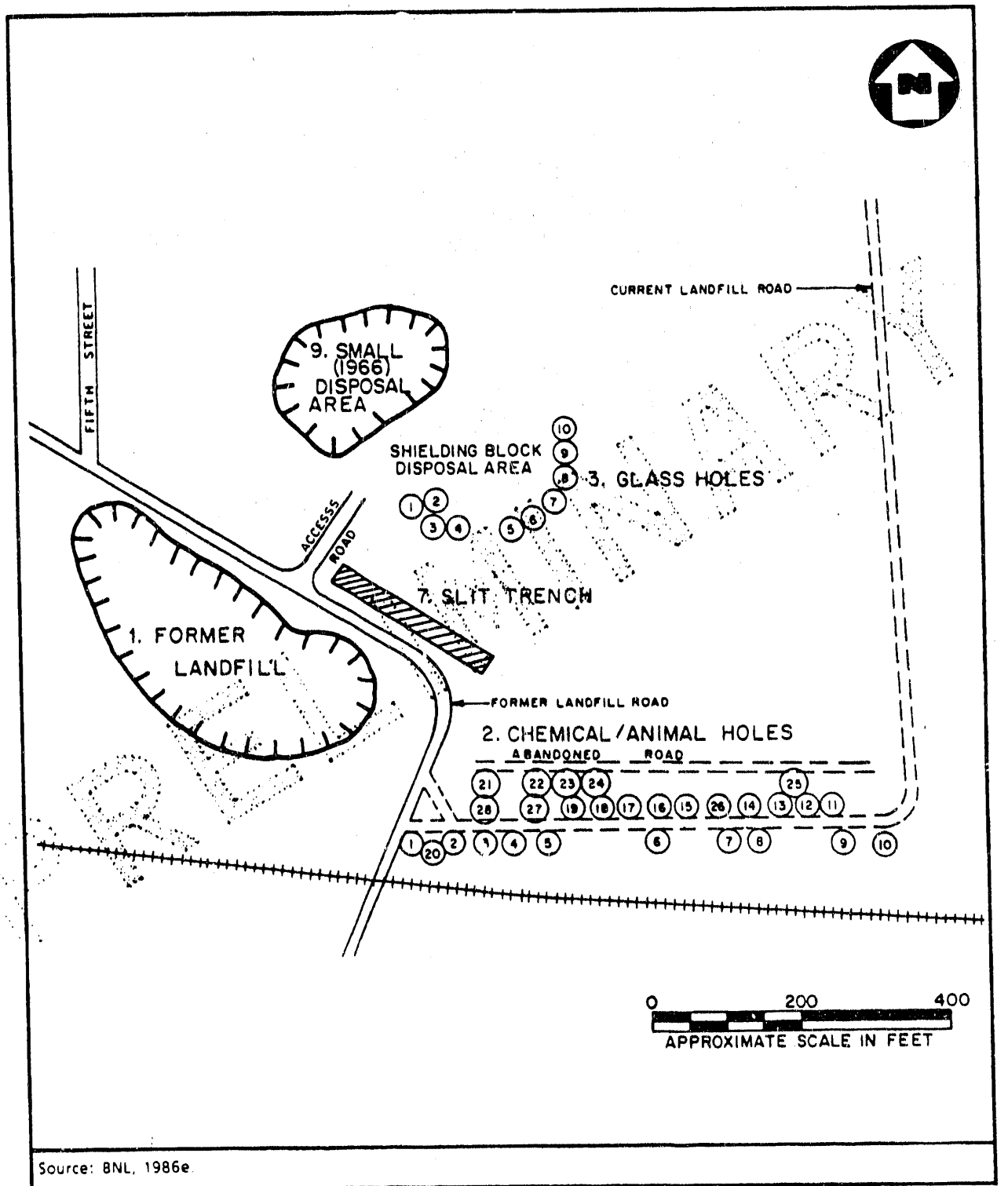
1. FORMER LANDFILL
2. CHEMICAL HOLES
3. GLASS HOLES
4. HAZARDOUS WASTE MANAGEMENT AREA
5. WASTE CONCENTRATION FACILITY B811 TANKS
6. CURRENT LANDFILL
7. SLIT TRENCH
8. SEWAGE TREATMENT PLANT
9. SMALL (1966) DUMP
10. B650 SUMP DRAINAGE
11. SATELLITE DISPOSAL AREA
12. OLD ARMY INCINERATOR
13. RAD CONTAMINATED SOIL
14. "MEADOW MARSH" EXPERIMENT
15. 1977 OIL/SOLVENT SPILL
16. BROOKHAVEN GRAPHITE RESEARCH REACTOR

0 2500 5000

SCALE IN FEET

FIGURE 4-

RCLA SITE LOCATIONS
BNL - UPTON, NY



Source: BNL, 1986e

FIGURE 4-9

DETAIL OF FORMER LANDFILL AREA
BNL - UPTON, NY

h. B158 drum, SS
i. B100 SS
j. 196 SS, drums, tanker trailers
k. B96 SS
l. B704 SS
m. B750 SS, drums
n. B452, SS
o. B535 SS
p. B924 drums, SS
q. B30 SS
r. B1005 drums, SS
s. B510 SS
t. B526 drums
u. 490 drums
v. B919/919A SS, drums
w. B726 SS
x. B935 SS
y. B452 drum

4.5.1.3 Cesspools

Cesspools have been used at BNL for disposal of liquid waste from many buildings where topography and building locations did not facilitate gravity-feed for sewage hookups. These cesspools are discussed further in Findings 3.3.5.3.1 and 4.5.2.3.2 because of their potential for serving as sources of groundwater contamination from past and ongoing activities. The cesspools in the nonresidential areas of BNL are listed in three categories in Table 4-22: (A) Active, phaseout planned; (B) Active, no phaseout planned, and (C) Inactive.

4.5.2 Findings and Observations

4.5.2.1 Category I

None.

TABLE 4-22

CESSPOOLS
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK

A. ACTIVE: PHASE OUT PLANNED[2]

Building No.	Status[1]
51	Priority I FY 87
244	Priority I FY 87
348	Priority I FY 87
422	Priority I FY 87
405	Priority I FY 87
122	Priority I FY 87
197	Pending
449	Pending
624	Pending
904	Pending
905	Pending
919A	Pending
914	Buried access sewer hookup with new project
919B	Pending
926	Pending
935	Pending
940	Pending
945	Pending

(1) Carlson & Sweatt, 1985. Emma and Day, 1987.

(2) 18 total, 5 sewer hookup in FY87 "Environmental Improvements;" one hookup with project.

TABLE 4-22
CESSPOOLS
BROOKHAVEN NATIONAL LABORATORY
PAGE TWO

B. ACTIVE, NO PHASE OUT PLANNED[3]

Building No.	Status[1]
963	Pumped out April 1987; leach field attached.
445	Dry well: 55-gallon drum with both ends removed, filled with coarse gravel and sunk into ground. A 2-inch PVC pipe leads out of building into well.
444	No specific information available.
479	No specific information available.
930A	No specific information available.

(3) BNL 1983; Carlson and Sweatt, 1985; BNL, 1982; BNL, 1976.

C. INACTIVE

Building No.	Status[4]
87	Backfilled
88	Backfilled
89	Backfilled
91	Backfilled
95	Backfilled[5]
96	Backfilled
209	Backfilled
429	Backfilled
452	Backfilled
964	Backfilled

(4) Day, 1984; Day, 1985.
(5) Slavinsky, 1987.

4.5.2.2 Category II

1. Spills and Drum Sites. Numerous spills and abandoned drums of possibly hazardous substances, as well as the lack of an adequate program to identify, characterize, clean up, and prevent these spills, has caused and will continue to cause widespread soil contamination. Many of these sites also represent potential sources of groundwater contamination.

   The abandoned drums and spill locations at BNL have not yet been characterized. The 25 sites listed in Section 4.5.1.2 do not necessarily represent a complete listing of all of the locations where spills have occurred or drums have been abandoned. Most of these sites had only a few drums and less than 100 square feet of contaminated soil. But, in one case (B-975 Bubble Chamber Area), dozens of drums, several tanker trailers, 12 "counters" (mattresss-shaped metal tanks full of scintillation fluid), and thousands of square feet of contaminated soil were found. There is no complete inventory of abandoned drums or spills at BNL, but a rough estimate would place the number of drums in the hundreds. Also, areas where spillage was visually evident are not documented. Areas where spills were known to have occurred but "cleaned up" were not quantitatively analyzed; hence there is no measure of the effectiveness of the "cleanup." Visual evidence and smell seemed to be the only methods used, but no documentation was available on any "cleanups."

   The following items were observed by the Survey team in the B-975 Bubble Chamber Area:

   - ~500 gallon tank - "nitric acid"
   - 12,000 gallon tank - scintillation fluid(?)
   - 5,700 gallon tank - scintillation fluid(?)
   - 6,000 gallon tank - scintillation fluid(?)
   - Drum - scintillation fluid(?)
   - 2 drums with pipes - scintillation fluid(?)
   - 6 drums of stained soil - "chloroethane"
   - Mobile laboratory with aniline - carbon tetrachloride
   - 12 liquid-filled "counters"

   According to BNL personnel, the labels indicating nitric acid, aniline, etc., are not reliable; hence the contents of the containers and the contaminated soil under the rusted drums are uncertain. Scintillation fluid is composed primarily of toluene. BNL personnel interviewed by the Survey team indicated that there were "dozens" of drums removed from the area in a

cleanup effort prior to the Survey. The former location of these drums pointed out by BNL personnel corresponds to areas of stained soil observed by the Survey team.

The spills and drum sites at BNL may be responsible for the groundwater contamination observed at monitoring well SE. This well is located immediately south, possibly downgradient of the two southwest seepage basins (SPDES permit No. 004 - Discharge to HP Recharge Basin), labeled as No. 8 on the 1985 Burns and Roe site map. No other potential contaminated sources seem to be present. In 1985 and 1986, well SE was found to be contaminated with 34 ppb and 24 ppb of trichloroethane, respectively, and 7 ppb of TCE in 1986. Non-point-source overland runoff from spills and abandoned drum sites in parking lots as well as stained soil may be contributing to this observed groundwater contamination. But, because of the widespread uncertainty with all groundwater monitoring data (which in this particular situation include lack of upgradient wells, lack of complete well construction information, and systematic organics sampling protocol problems) and because of the nature of the discharge to the HP recharge basins, the actual source of this contamination is not certain. The permit for discharges to basins HP require quarterly monitoring for metals, alpha and beta radioactivity, and tritium, but not for organics. There is no information available on the discharge of organics to basin HP. In 1986, only iron was found to be slightly elevated (1.5-2 ppm). Approximately 1,000,000 gallons per day of water flows into these basins. Of this amount, approximately 75 percent is cooling water from the nearby medical research reactor. The remaining 25 percent of the discharge comes from storm water runoff. Because of this relatively small contribution from non-point-source runoff and the absence of generally high metals and dissolved or suspended solids (TDS and TSS), the reason for the presence of nearby organics contamination in groundwater is unclear. If contaminated runoff from parking lots and ditches was contaminating the groundwater through the recharge basin, high metals (such as magnesium) and TDS/TSS would probably also be expected. However, without regular organics analysis of basin discharges and a more thorough groundwater monitoring system, the source of this contamination cannot be determined.

4.5.2.3 Category III

1. Disposal Areas. There are numerous disposal areas on-site that are actual or potential sources of soil, surface water, and/or groundwater contamination. In most cases, groundwater contamination is the most significant threat because of the highly permeable soils, the shallow aquifer, and the presence of a "sole source" aquifer, with nearby residences using private drinking water wells. Other sources of contamination may be present at BNL but have not yet been identified because of the lack of a complete CERCLA investigation, including a review of

historical documents, aerial photographs, and blueprints. Based on information from BNL and observations made by the Survey team, the following areas have been identified:

a. Former Landfill (Map Site 1). A formerly used, 8-acre landfill may be a source of groundwater contamination because of hazardous substances disposed of in the landfill from at least 1947 until 1966 (at least 19 years). Also, Cs-137 (half-life = 30 years) is present on the surface of the landfill in a patch measuring approximately 20 feet by 60 feet. The "former landfill" is a specific discrete area of BNL and should not be confused with the term "former landfill area," which is used in BNL documents to describe a broader area. This broader area includes the former landfill, but also includes the chemical/animal holes, slit trench, glass holes, and a small (1966) disposal area illustrated in Figure 4-9. Because of the close aggregation of these sources, it would be difficult to distinguish their plumes. Groundwater contamination from radionuclides is up to an order of magnitude higher in downgradient wells than in the wells upgradient of the area (see Sections 3.4.2 and 3.4.4.3). Volatile organics are observed in the low ppb range in downgradient wells, but because of questionable well design and sampling procedures (see Section 3.4.4.2), these results may not be representative of actual conditions.

The former landfill was first used by the Army prior to the construction of BNL. There are no specific records available from BNL on the use of the site by the Army. Archival information indicates generally that the site of BNL was originally used as an induction center called "Camp Upton" by the Army during World War I. The Army also used the site during World War II, and then as a hospital until 1947, when BNL took control of the site. BNL continued using the former landfill area until 1967, when the current landfill opened. No comprehensive search of Army records has yet (as of June 1987) been performed to determine what was disposed of in the former landfill.

Despite the few records available on the disposal inventory at the former landfill and other sites at BNL, some indication of disposal patterns may reasonably be surmised by considering some secondary information on BNL disposal. Figure 4-10 illustrates the chronology of the use of various disposal areas at BNL, compiled largely from records obtained by BNL for the preparation of its Phase I Installation Assessment Report. Prior to 1960, the former landfill appears to have been the only disposal area at BNL. In 1960, use of the chemical pits began. In the 7 years that an eventual total of 28 pits were in use, approximately 5,000 cubic yards of chemicals and radioactively contaminated animal carcasses were disposed of in these pits (see Finding 4.5.2.3.1(b)). This usage rate leads to an estimated average of approximately 750 cubic yards per year. If this same average is

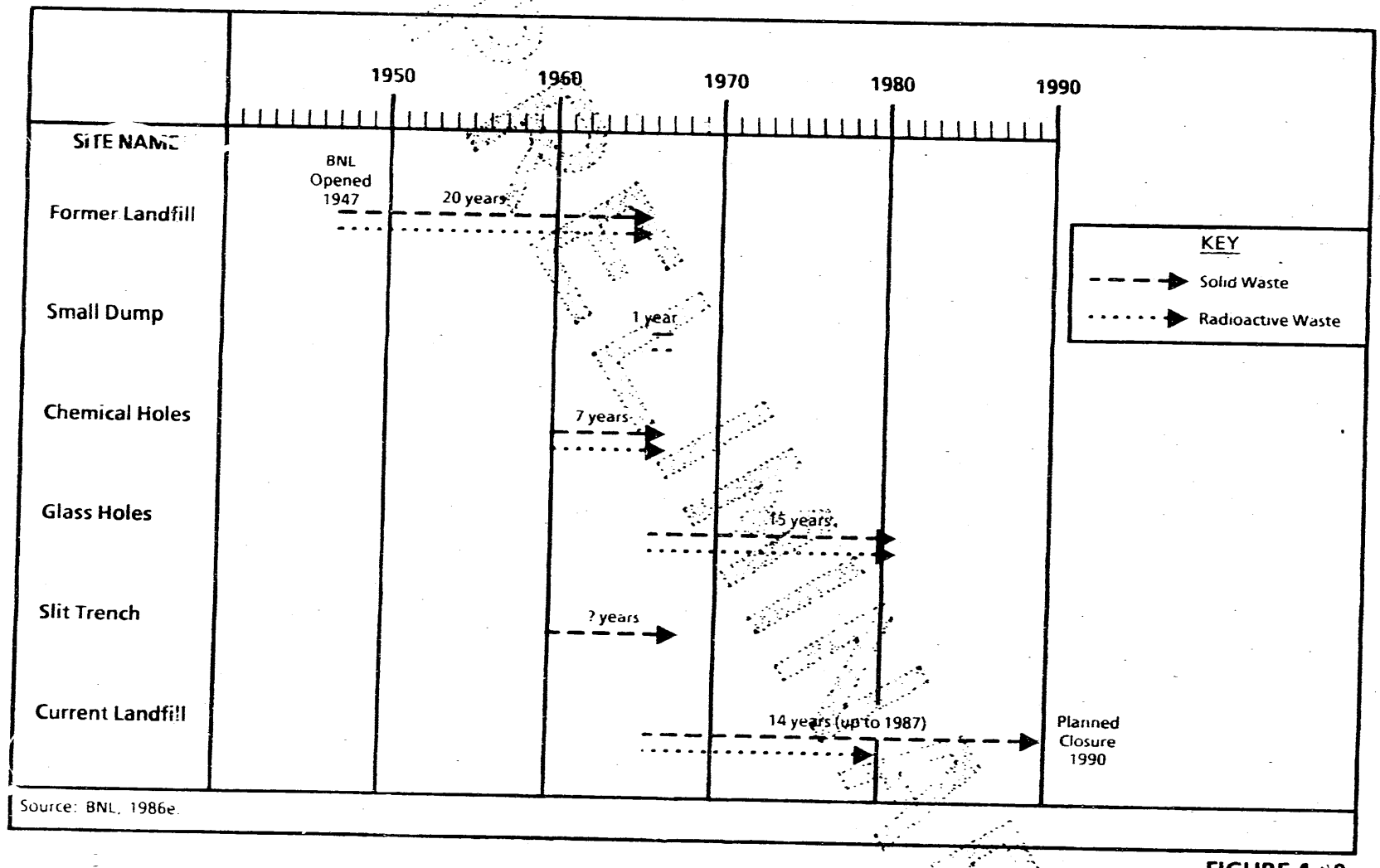


FIGURE 4-10

TIMELINE OF WASTE DISPOSAL AT VARIOUS LOCATIONS AT BNL
BNL - UPTON, NY

used for the previous 13 years when the same materials were being disposed of in the same location, then approximately 10,000 cubic yards of chemicals and radioactively contaminated animal carcasses may have been disposed of in the former landfill. This rough estimate may overstate the amount of hazardous substances disposed of in the former landfill because it includes an early period, when BNL may have been operating at a lower level of activity than in the early 1960s and, thus, produced less wastes.

A brief characterization study of the solid waste disposal at the former landfill, entitled, "Refuse Disposal," was prepared in May 1966 by Gibbs and Hill, Consultants for BNL (Gibbs and Hill, 1966). This report surveyed the refuse disposed of by BNL during a 6-week period in January to February 1966. An average of 10 tons of refuse per day and a maximum of 15 tons were disposed of during that period Of this waste, approximately 40 percent (4 tons) of "burnables," including rags, wood, paper, and cardboard, was disposed of in the former landfill. In addition, 1,500 pounds/week of animal carcasses were disposed of in the same site. These estimates may be lower than average for disposal at the landfill because of the typical summer surge in activity of approximately 20 percent. Hence, roughly 12 tons per day of refuse may have been disposed of during the summer. Using a weighted average calculation of 10 tons/day for 9 months of the typical year plus 12 tons/day for the remaining 3 months, the average solid waste disposal rate was roughly 10.5 tons/day. Current (1986-1987) summer activity is higher (25 to 50 percent seasonal population increase), but there is no documented reason to apply this weighting to the 1960s disposal rate.

The former landfill was covered with soil when it was closed in 1966. The appearance of the former landfill during the Survey was of a sparsely vegetated field. In one section of this field, several shielding blocks (concrete cubes approximately 4 feet on a side impregnated with steel shot) were being stored. A snow fence had been erected around the patch of Cs-137 contaminated soil, but half of this fence was lying broken and prone on the ground away from the perimeter of the patch. There is no information available on the specification of the landfill cover such as material type, permeability, compaction, or slope. The cover appeared to be composed of local sandy soil.

The Hazard Ranking System score for the BNL former landfill area was 35.46, when evaluated by NYSDEC. BNL personnel determined a score of 29.5 for the former landfill, but no quality assurance of the HRS score sheets was apparent, and several problems with scores (e.g., waste quantity score) were noted by the Survey team. A score of 28.5 or

higher is required to place a site on the National Priorities List (NPL). The BNL site was not on the NPL at the time of the survey.

b. Chemical Holes (Map Site 2). Approximately 28 holes used from about 1960 to 1967 for disposal of chemicals and animal carcasses are a source of groundwater contamination (see Section 3.4.2). A wide variety of acids, bases, and organic compounds were disposed of in these pits, according to BNL employees and documents. The only specific chemicals identified as being disposed of were nitric and sulfuric acid at a rate of 5-10 gallons per month (840 gallons over 7 years].

The Chemical Holes were approximately 10 to 12 feet in diameter and up to 30 feet deep, with about 5 to 8 feet of cover soil placed on top to close the holes. Assuming an average diameter of 10 feet and a chemical fill depth of about 20 feet, then about 1,628 cu. yd. of chemicals and contaminated animal carcasses were disposed of in these holes. If a 12-foot-diameter and 25-foot fill depth are assumed, then approximately 2,932 cubic yards of chemicals and animal carcasses may be contained in the 28 holes. The average of these two estimates is 2,280 cubic yards of chemicals and contaminated animal carcasses. This value may serve as a useful conservative estimate of the contents of the chemical pits because it uses the fill volume of the pits as a surrogate for chemical disposal volumes. Because of percolation of liquids into the soil, the disposal volume may be significantly larger than this estimate. However, lacking any documented evidence on the volume of liquids disposed of in these pits, no other clear basis for an estimate can be made.

The 1966 Gibbs and Hill report estimated that about 1,500 pounds per week of animal carcasses were disposed of at the former landfill. If this estimate is extrapolated over the 9 years that the chemical and animal pits were used, then an estimated total of 525,000 pounds of animal carcasses results. If a density of roughly 1,000 pounds/cubic yard is assumed (1,020 pounds/cubic yard = 5 pounds/gallon; somewhat less than the density of water), then a total volume of animal carcasses disposed of in the chemical/animal pits during their 7 years of use can be estimated at 514 cubic yards. The difference between this estimate (514 cubic yards) and the estimated total fill volume of the 28 holes (2,280 cubic yards) is 1,766 and may be attributable to (1) chemical disposal; (2) inaccuracy in the estimated total fill volume; or (3) an increase in the disposal rate of animal carcasses.

The holes are situated along both sides of an unpaved road, leading east from the old landfill, running parallel to Princeton Avenue. According to BNL employees interviewed by the Survey team, the holes were excavated with a crane and clamshell and were not

lined. All BNL employees interviewed by the Survey Team were confident of the methods and depth of excavation.

c. Glass Holes (Map Site 3). Approximately 10 holes, used from about 1967 to 1981 (14 years) for disposal of laboratory glassware, may be a source of groundwater contamination.

BNL personnel indicated that the glassware was not uniformly rinsed clean as directed by BNL procedures. According to BNL staff interviews, some residual contaminants were in the discarded glassware. The construction and dimensions of the glass holes were essentially the same as the chemical pits, according to interviews of BNL employees by the DOE Survey Team. No estimates are available on the inventory or the types of chemicals disposed of in these pits.

d. Hazardous Waste Management Area (Map Site 4). The Hazardous Waste Management Area (HWMA) is a source of groundwater and potential surface-water contamination.

The ongoing practices at the HWMA (also known as the "Igloo Area") are discussed in Section 4.1 (Waste Management). This section focuses on the following two primary types of historical hazardous substance releases:

- Spills
- Accidental 1960 "fission product injection"

In addition, the "detonation/burn area" and tritium deposition from the HFBR are addressed briefly within this HWMA section. The two cesspools (a dry well from Building 444, and a leach field from Building 445) in the HWMA are addressed as part of the section on cesspools in Finding 4.5.2.3.2 as well as in the surface water section (3.3).

Spills of hazardous substances onto the asphalt and ground at the 10.5-acre HWMA may be the most significant source, but the least understood of historical releases. The Survey team observed that significant portions of the soil and asphalt appeared to be soaked and heavily stained with oil. There is no estimate of the amount of hazardous substances spilled at the HWMA. Rainfall runoff from the asphalt-paved areas of HWMA during the Survey had a visible oily sheen. The HWMA consists of a total of 10.5 acres of ground, about 25 percent of which is paved with asphalt.

Several types of incidents may have caused the observed spillage. First, drums may have deteriorated while being stored outdoors. Also, according to BNL employees interviewed by the Survey team, BNL personnel routinely poured the supernatant from treated nonradioactive acids and bases on the ground, after collecting the precipitated salts from the neutralization.

An unsigned BNL memo dated April 11, 1980, lists the following eight areas at the HWMA where radioactive and/or hazardous wastes were spilled or disposed:

(1) Blowdown liquid and slurry spilled onto the ground from the cement mixer during the "early days of the cement mixer." No other information is available.

(2) Blowdown liquid leaked during the filling of the first vault. According to the memo, "When filling vault with blowdown liquid (and before mixing with cement) they thought pump was not working on filling vault. Soon after starting they walked around back and saw liquid gushing out." (emphasis in original)

(3) Blowdown liquid was accidentally pumped into a groundwater well (described in the paragraph below).

(4) Miscellaneous spills of blowdown liquid were covered with asphalt.

(5) Mixed fission product in "bridge tubes" was flushed to northwest. Cleanup was attempted.

(6) A 55-gallon drum of "black glop vacuumed from canal bottom . . . for sea burial," was spilled. The sludge contained mixed fission products.

(7) Mixed fission products from old canal racks (presumably HFBR or BGRR canal racks for holding fuel rods) were washed off by rain.

(8) Mixed fission products from old fan ducts from the BGRR were washed off by rain.

The blowdown liquid referred to in the memo was the concentrated radioactive wastewater (usually the supernatant above the sludge) from the B-811 Waste Concentration Facility. According to BNL employees, BNL previously solidified blowdown

liquid and sludge in a standard commercial cement mixer at the HWMA (see Section 4.1.1.2 for additional information).

In July 1960, a BNL employee accidentally pumped radioactively contaminated slurry into a water supply well at the HWMA (Davies, 1961). The unlocked well supplied water for decontamination and was located close to a similar pipe (1-1/2 inches in diameter) in the ground that led to the 5,000-gallon underground steel slurry storage tank in the HWMA. The inadvertent injection was attributed to the similarity and the proximity of the pipes. The slurry was supernatant from "solidified" waste, largely from blowdown from the B-811 Waste Concentration Facility. The pipe and well point were subsequently pulled inspected, and found to contain about 6 inches of cement and 2 inches of slurry mud. The gamma-dose rate from the well point was about 3.5 rad/hour at contact. The amount of radioactive material was estimated at approximately 5 Ci, predominantly Sr-90 and Cs-137. The incident was discovered about 1 month after it occurred during routine well monitoring. BNL attempted to remove some of the radioactivity by pumping from the test wells and discharging the water onto the ground, after treatment with a conventional water softener. No information was available on where this treated water was pumped, the volume of water pumped, the effectiveness of the treatment, or the volume and disposition of the treatment sludge. Groundwater contamination and monitoring are described further in Section 3.4.

A "detonation/burn area" is located in the southeastern part of the HWMA. This burn area is surrounded on three sides by an 8-foot earthen berm and has been used for burning and detonating highly explosive and reactive chemicals since the early 1960s. In addition, leaking gas cylinders have been vented to the atmosphere in this area. No exact information is available on the nature or extent of venting, burning, or detonation of chemicals. Some anecdotal information is available, however, on the type of material vented and the period when this area has been used. According to interviews with BNL employees by the DOE Survey Team, the burn area was used irregularly for individual or several cylinders. For example, on September 9, 1975, BNL personnel contacted Allied Chemical Corporation to attempt to return a 75-percent-full cylinder of anhydrous hydrofluoric acid for disposal. On December 3, 1975, BNL informed Allied that it had discovered a leak in the cylinder. The cylinder was subsequently vented at BNL in the burn area of the HWMA.

The burn area has apparently been used since the early 1960s. In an internal BNL memorandum, dated December 16, 1963, a BNL employee noted that an electric fuse, a

"blasting cap," and "30 minutes of labor" were the only current costs of disposal. Based on this cost comparison with a commercial disposal firm's proposed $15.00/drum of liquid waste solvents and concentrated acid waste, the memorandum concluded, ". . . . it does not seem to the writer that the cost of such commercial disposal could be justified."

In the 1975 "Igloo Area Survey" by BNL, airborne tritium releases from the High Flux Beam Reactor (HFBR) stack (B-705) were listed as a possible source of the soil and groundwater contamination detected by sampling at the HWMA. Because the HWMA is located downwind of the HFBR stack, some of its emissions may have been deposited on the ground and leached into the groundwater. Although there is no specific soil or groundwater sample data to confirm or refute this theory, some estimate can be made based on emissions data from the Annual Environmental Monitoring reports. The HFBR stack (B-705), which also receives a relatively small contribution from the Hot Lab, emitted an average of 183 ± 23.7 Ci/year tritium vapor (HTO) (and an insignificant amount of tritium gas--H-T) between 1975 and 1985 (the years for which environmental monitoring reports were available). The annual tritium discharges from the HFBR stack are summarized in Table 4-23. Assuming that this 11-year average can be reasonably extrapolated to the 23-year history of the HFBR, then approximately 4,209 Ci of tritium has been released from the B-705 stack. Finally, considering the 12.33-year half-life of tritium, about 2,479 Ci of this tritium would remain in 1987. If 1 percent (Survey team estimate) of this residual from the HFBR stack is assumed to have been deposited on-site because of the low exit velocity from the B-705 stack (see Air Section 2.1.2), and a portion (75 percent) of that residual deposition is assumed to have evaporated, then the groundwater contamination predicted for a 18.37-acre area is comparable to the observed concentrations in monitoring wells near the HWMA (assuming a plume depth of 45 feet, groundwater table depth of 10 feet, and soil porosity of 0.35).

In addition to this release route from the HFBR, smaller amounts of tritium vapor are also released from the Van de Graaff Reactor (B-901) and the Medical Research Reactor (B-490). The summed releases of tritium vapor (HTO) to the air over the quarter century of operations at BNL may, in part, account for the tritium contamination in the groundwater--especially in downwind areas, such as the HWMA. Tritium is not likely to be an ongoing soil contamination problem because it is completely soluble in water and runs off or percolates downward with each rainfall.

TABLE 4-23

TRITIUM EMISSIONS FROM HFBR(1) STACK AT BNL(2)
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Year	HTO Tritium Emission (Ci)
1975	170
1976	161
1977	119
1978	90
1979	119
1980	179
1981	240
1982	330
1983	270
1984	244
1985	93
TOTAL	**2,015**
MEAN	**183 (S.E. = 23.7)**

Source: Annual Environmental Reports.
(1) High Flux Beam Reactor.
(2) Brookhaven National Laboratory.
S.E. - Standard Error

Other radionuclides (e.g., argon-41) released to the atmosphere are less likely to be deposited on soil. Hence, they are a less significant concern for groundwater and soil contamination.

According to interviews with BNL employees, trichloroethane was used as a weed killer in the HWMA. There are no records of the quantity or dates of this use of trichloroethane. According to a secondary BNL source, the spraying occurred in 1978 or 1979 (Holzmacher et al, 1985). It is unlikely that this source contributed significantly to the groundwater contamination, but a precise determination cannot be made without additional data on the quantity, location, method, and duration of the application. Other sources, such as leaking and pouring of spent trichloroethane and trichloroethylene (TCE) solvents, are probably more significant. Again, the relative contribution of each source cannot be determined precisely without more information. However, according to interviews with BNL personnel, trichloroethane was used for weed control in hand-carried, 5-gallon spray cans; whereas disposal occurred in drum quantities that were poured onto the ground. Hence, it may have been easier to release a larger amount by pouring or spilling rather than spraying. In addition, less percolation into groundwater would have occurred from the sprayed TCE. This is because of the increased volatilization that occurs from spraying TCE and the higher surface area substrate (weeds) onto which it was sprayed.

e. Waste Concentration Facility (B-811) Storage Tanks (Map Site 5). The three 100,000-gallon, above-ground storage tanks are potential sources of groundwater, surface-water, and air contamination. In addition, six 8,000-gallon underground storage tanks containing radioactive wastewater (possibly mixed with hazardous wastes) are located at the Waste Concentration Facility (WCF) and may be leaking into the groundwater. Finally, process lines leading from the High Flux Beam Reactor (HFBR) and the Brookhaven Graphite Research Reactor to B-811 may contaminate groundwater. See Section 4.1.1.2 for a process description of the B-811 WCF.

Three 100,000-gallon, "D" liquid waste storage tanks are located at the B-811 WCF. BNL documents (Phillips, 1987) indicate that tanks D-1 and D-3 are the most highly contaminated and contain approximately 10,127 gallons (1,354 cubic feet) and 10,000 gallons (1,337 cubic feet) of contaminated sludge, respectively. The tanks each contain the following amounts of "D" liquid waste and contaminated sludge:

Tank	Sludge Volume-- Cubic Feet (gallons)	"D" Liquid Waste (gallons)
D-1	1,354 (10,127)	Drained
D-2	700 (5,236)	60,000
D-3	1,337 (10,000)	Drained

In general, the sludges contain approximately 8 Ci of plutonium and 1,000 Ci of mixed fission product (Liverman, 1977). In addition to the radioactive contamination (primarily Cs-137), BNL (on 3/20/87) found that tanks D-1 and D-3 contained high levels of chromium (5,500 ppm and 1,900 ppm, respectively) and lead (8,900 and 5,900 ppm, respectively), based on dry-weight (59.4 percent and 66.2 percent moisture, respectively) direct analyses. These wastes may be considered "mixed," depending on the results of leachate analysis (see Section 4.1.1.3). The B-811 WCF was taken out of service in late 1985 and has been inactive since then, except for regular maintenance to clean up a leak from one of the 100,000-gallon storage tanks. The containment (a shallow asphalt curb) would be inadequate to contain a catastrophic failure of tank D-2. The tanks appear rusty and poorly maintained. Finding 4.1.2.3.4(a) describes the operation and adequacy of this area in more detail.

There are six 8,000-gallon underground storage tanks at the B-811 WCF, all of which are 36 years old. These tanks are enclosed in a concrete vault and are used to store radioactive wastewater. One of these tanks is known to have leaked and was taken out of service. (The date taken out of service, leak rate, and presence of groundwater contamination are unknown at this time.) Another of these tanks was discovered to be leaking because of water observed in the bottom of the vault. The integrity of the vault has not yet been tested.

There are several "D" liquid waste lines leading from the BGRR, B-801 Hot Laboratory, and the HFBR to the WCF. In addition, another line connects the HFBR to the Hot Laboratory. A June 4, 1986 internal memorandum (Meinhold, 1986b) indicated that

> "The questions of these waste lines (specifically leading from the BGRR) needs (sic) to be addressed as they could have lost their integrity with time and become a source of groundwater contamination."

There is no information available on the amount of waste conveyed through these lines or the potential volume, if any, of waste lost to groundwater. According to the 1986 BNL Site Waste Management Plan (p. 18): "the 'D' waste line from the HFBR to the Hot Laboratory is not in a trench." The type of trench referred to is designed to help protect the lines from settling stress and acidic precipitation as well as to help contain leakage.

The fuel-element storage canal in the HFBR contains approximately 68,000 gallons of water contaminated with 12.8 Ci of tritium (0.05 mCi/ml) (BNL, 1985b). BNL personnel add approximately 500 gallons of makeup water to this storage canal every week. According to BNL personnel, this makeup water replenishes evaporative loss. BNL studies of the radioactivity content of the air conditioning system at the HFBR have confirmed that the water loss is due to evaporation. The BGRR is described below in Finding 4.5.2.3.1 (p) and Table 4-6.

f. Current Landfill (Map Site 6). The "Current Landfill" may be a source of ongoing or future soil and groundwater contamination. Ongoing practices are described in Section 4.1.1.4 and Finding 4.1.2.2.2.

The Current Landfill has primarily been used for nonputrescible solid waste, for which it is presently permitted. However, it has also received a significant amount of low-level radioactive wastes and an undetermined amount of chemical wastes (Meinhold, 1986b). The ongoing management of the Current Landfill is discussed in Section 4.1. There is little information available on past management practices at the Current Landfill because it began operating during a period when the former landfill and chemical pits were shut down in January 1967 (see Figure 4-10). BNL personnel have indicated that they believe that some hazardous waste has been disposed of in the Current Landfill. No inventory of such waste disposal is available.

Several known or potential mechanisms and past practices have resulted in previous disposal of radioactive and nonradioactive hazardous substances in the Current Landfill. "Low-Level" radioactive wastes (e.g., contaminated gloves, animal carcasses, etc.) were disposed of in the Current Landfill for 11 years from 1967 until 1978. A self-imposed BNL limit on the amount of radioactive waste that could be landfilled on-site was established in 1954 and continued to be used until 1978, when on-site landfilling of radioactive waste was prohibited. The following four classes of radioactive waste, and the annual limits imposed for each, were used by BNL:

Class I	10 curies of short-lived isotopes (half-life of less than 100 days).
Class II	1 curie, if the half-life was in excess of 100 days.
Class III	100 millicuries, if the half-life was more than 5 years.
Ra and Pu	1 millicurie of radium and plutonium.

Assuming that the same average amount of each class of radioactive waste was disposed of in the Current Landfill as in the Former Landfill, then the amount of radioactive waste in the Current Landfill can be estimated. From 1955 until 1966 (BNL, 1986e) an annual average of 5.7 ± 1.6 mCi of Class I waste, 14.2 ± 6.1 mCi of Class II wastes, and 19.7 ± 10.6 mCi of Class III waste was disposed of in the Former Landfill. No information was available on radium disposal. Only one incident of accidental plutonium disposal (described below) was identified by the Survey team. Applying these annual averages to radioactive waste disposal in the Current Landfill, yields an estimated total of 62.7 mCi of Class I wastes, 156.2 mCi of Class II wastes, and 216.7 mCi of Class III wastes.

Radioactive waste was prohibited from the Current Landfill in 1978. Hence, most of the radioactivity from the Class I and II waste has probably decayed. Only the Class III waste is likely to remain active in the landfill. This amount of radioactivity, however, is not large enough to explain the radioactively contaminated groundwater downgradient of the Current Landfill (see Finding 3.4.4.3.1(b) for description of groundwater contamination). Additional radioactive groundwater contamination around the current landfill may have come from deposition of tritium and other radionuclides from the on-site reactors (HFBR, MRR) as well as the Van de Graaff Generator. In addition, annual sludge disposal from the sewage treatment plant contributed some radioactive contamination that was not accounted for in BNL's controls. According to BNL employees, approximately 2,500 cubic feet of low-level radioactive sewage sludge was disposed of in the current landfill in the early 1980s.

Sometime between March 4 and September 3, 1980, a 0.5 gram Pu-238 source was lost at BNL. This Pu source was triply-encapsulated and was similar to those used as heat sources in cardiac pacemakers. The Pu-238 source should not present a radioactivity hazard, as long as the source is encapsulated. The final disposition of the plutonium source was never determined and the source itself was never found. The DOE investigating committee determined that the most likely scenario was that the Pu source was disposed of in the Current Landfill with standard rubbish, after it was discarded during a fire safety cleanup (DOE, 1980).

Nonradioactive chemical waste and mixed waste may have been disposed of through two mechanisms. First, residual chemicals in bottles, jars, carboys, and other containers were probably routinely disposed of in the landfill, prior to the BNL's imposition of the requirements that empty chemical containers be triple-rinsed. During the April 1987 Survey, the Survey team observed dozens of empty bottles and jars in the working face of the landfill. These containers, however, appeared to be free of residual chemicals. The total amount of residual chemical disposal through this mechanism is probably not significant (i.e., not more than 1 liter per month [Survey team estimate]). If this amount is assumed to be the average amount of residual chemicals disposed of in the landfill over its 20-year life, then less than 240 liters (63 gallons) were disposed of in the landfill through this mechanism (1 liter/month x 12 months/year x 20 years).

Another potential mechanism for hazardous waste disposal in the Current Landfill is from chemical waste disposal. As shown in Figure 4-10, chemical wastes were disposed of on-site at BNL in the chemical pits until 1966, when the "small" dump was used and then followed by the use of the Current Landfill. Although no records are available to document systematic chemical waste disposal in the Current Landfill, it is possible that the practice of on-site chemical waste disposal continued in the Current Landfill until increased environmental awareness and regulatory requirements caused the practice to shift to off-site disposal. Internal BNL memoranda from the early 1960s, regarding a bid by the Aceto Chemical Company, indicated that off-site disposal was rejected as too expensive compared to current on-site practices.

g. Slit Trench (Map Site 7). The Slit Trench near the former landfill and chemical hole is an actual or potential source of groundwater contamination.

The trench is approximately 10-20 feet deep, 15 feet wide, and 230 feet long (total volume = 34,500-69,000 cubic feet or 1,278-2,555 cubic yards). It is located between the glass holes, chemical pits, and the former landfill, and was used in the early 1960s (see Figures 4-9 and 4-10). BNL personnel have indicated that they believe that the slit trench received only construction debris and no chemical wastes. No remedial investigation (e.g., borings, test trenches, or monitoring wells) has been performed (as of June 1987) to analyze the impact of the slit trench on soil and groundwater.

h. Sewage Treatment Plant (Map Site 8). The Sewage Treatment Plant (STP) filter beds (past and present) are potential sources of groundwater contamination. The filter beds at the

sewage treatment plant may be a source of hazardous substance releases through the following three mechanisms:

- Percolation of contaminants through the beds.
- Disposal of sludge in the landfill and drying beds.
- Disposal of sand onto adjacent banks of the filter beds.

The filter beds at the sewage treatment plants were constructed in 1942 by the Army to replace the original 36 to 48 filter beds constructed in 1917 and were located in the same area as what was then Camp Upton. Some hazardous substances are routinely discharged to the sewage treatment plant, although the concentrations are probably lower than they have been prior to regulatory controls on discharges. The hazardous constituents in the wastewater percolating through the filter beds, both now and in the past, contaminate groundwater.

Despite the paucity of precise quantitative historical information on the hazardous and radioactive wastes that went to the sewage treatment plant at BNL, some general information is available. Evaporation distillate from the B-811 Waste Concentration Facility (see Section 4.1.1.2 for process description), which contains some tritium, was discharged to the sanitary sewer system from 1950 until December 1984. Also, the current system of holdup tanks (to retain wastewaters until they are determined through analysis to be "safe" for discharge) has not always been operated in the same manner. Non-radioactive chemical wastes were not analyzed prior to the 1970s; a fact which possibly resulted in discharges of hazardous substances. Finally, a comparison of the dates of building construction (BNL, 1986b) and tank age (Table 4-2) revealed that Building 527 did not have holdup tanks to retain wastewaters until 1960--17 years after it was built in 1943 and 10 years after it was occupied by BNL. Building 527 is used for combustion research and used a 500-gallon holdup tank for retaining aqueous radionuclides from 1960 to 1965.

These are several potential mechanisms by which groundwater could become contaminated with hazardous and radioactive substances present in discharges to the STP. The first potential mechanism for contamination of groundwater, i.e., direct percolation through the filter beds, may be the most significant route at the STP for highly mobile and soluble contaminants such as tritium. Of the 3 million liters per day of wastewater piped to the clarifier at the sewage treatment plant (1984 figures, generally applicable), only 2.62 million liters are ultimately discharged to the Peconic River. Hence, approximately

380,000 liters per day is lost from the sewage treatment plant through evaporation and percolation. More loss can probably be attributed to percolation than to evaporation.

The second actual or potential mechanism for groundwater contamination from the sewage treatment plant is from the sludge that has been annually disposed of in the current and former landfills. The sludge may be contaminated with radioactive (e.g., tritium and strontium-90), organic (e.g., trichloroethane) and inorganic (e.g., heavy metals) wastes. In these unlined landfills, wastes may leach into the groundwater.

In addition, the filter bed sand underneath the sludge has been dredged out of the beds at least twice during the operation of the facility. The sand, which may have been contaminated in the same manner as the sludge, was placed in piles alongside the beds on the north and south sides. No information on the sludge or sand is available. Survey-related sampling is planned. From 1943 until approximately 1967, BNL used an "Imhoff tank" for settling solids from sewage. The Imhoff tank, which is still located at the STP and full of water and sludge, is an open, rectangular, concrete tank with two settling areas and an aeration chamber along the side. The in-ground Imhoff tank has not been tested for leaks and may be a source of groundwater contamination.

Wastewater previously flowed through the Imhoff filter before being pumped to the filter beds. Currently wastewater flows through the clarifier before going to the filter beds. Sludge (toilet waste, metals, etc.) has been collected in the Imhoff filter, the clarifier, and the filter beds. The sludge from the Imhoff filter and the clarifier have been pumped out into eight sludge drying beds located north of the clarifier, but west of the filter beds; except on one occasion (according to BNL personnel), when the Imhoff tank sludge was pumped out onto the ground west of the sludge drying beds. This Imhoff pump-out area was observed as an unvegetated area (not to be confused with the larger unvegetated area south of the filter beds) during the Survey.

At present, the sludge from the filter beds is pumped out and deposited in the landfills. (Both the former and the current landfills are under considerable scrutiny for a broader pattern of hazardous substance disposal.) This sludge disposal operation is performed approximately annually, although no records were available to confirm the frequency, volume, or location of disposal. The sand beneath the sludge in the STP has been dredged out only twice during the life of the facility, according to BNL personnel. Again, nc records were available to confirm this statement.

Sludge from the Imhoff tank and the clarifier was pumped out into eight sludge-drying beds and may be a source of groundwater contamination. The sludge-drying beds were lined with high-density polyethylene plastic in the early 1980s, but they were used for approximately 20 years before they were lined. Thus, direct percolation could have occurred during this period. Available data on the constituents of the effluent from the sewage treatment plant indicate the presence of radioactive (tritium and strontium-90), organic (trichloroethane), and inorganic (heavy metal) wastes.

The sludge drying beds at the STP were initially included in BNL's Part A application for a hazardous waste permit because cadmium was detected in concentrations higher than the extraction procedure (EP) Toxicity Criteria. Subsequent analysis in 1983, using the EP Toxicity test, indicated cadmium concentrations lower than the criteria.

An area in an open field north of the Imhoff tank, and west of the sludge-drying beds was used to discharge sludge pumped out from the Imhoff filter sometime during the mid-1970s. According to BNL personnel, the sludge from the Imhoff Filter Tank was pumped out onto the ground during the Meadow Marsh Experiment, which occurred between 1972 and 1978. The volume of sludge discharged during this one-time pump-out onto the ground was apparently significantly smaller than the amount pumped out into the sludge-drying beds over a period of years, but there are no records to quantify this volume.

Finally, an unvegetated area of about 2 acres at the STP south of the filter beds was observed by the Survey team. BNL personnel could not explain why this area was barren because no herbicides were used there. This area has been unvegetated for at least 16 years, according to BNL personnel. Survey-related sampling is planned.

i. Small (1966) Dump (Map Site 9). The landfill known by BNL as the "Small Dump," used in 1966, is a potential source of groundwater contamination.

The small (1966) dump is roughly 3/4 of an acre in size. There is no information about the depth of the landfill, the volume or type of material, or contaminants that were disposed of. Because this dump was believed to provide disposal capacity between the closing of the former landfill and the opening of the current landfill (see Figure 4-10), it is reasonable to assume that this dump received the same type of material and at the same rate as these landfills. Hence, approximately 4,000 tons of solid waste was likely disposed of in the small dump during the year it operated. Also, small quantities of hazardous

chemicals from unrinsed chemical containers were probably disposed of at this location. If the same rate of residual chemical disposal is assumed for the small dump as was used for the Current Landfill, then approximately 3 gallons of residual chemicals may have been disposed of at the dump. This approximation, however, may significantly underestimate the amount of residual chemical disposal in the small dump, because it was operated prior to significant regulatory controls on the disposal of chemicals and chemical wastes.

j. B-650 Sump Drainage (Map Site 10). The drainage area from the B-650 sump is a source of groundwater contamination and a potential direct-contact hazard.

Five curies of tritium were discharged to the groundwater via the Building 650 sump. This release was 50 times greater than the self-imposed release limits established in 1954 by BNL for its disposal (100 mCi for isotopes with a half-life greater than 5 years). Tritium may be particularly hazardous in groundwater because of its mobility.

Sometime before 1975 (the year for which the earliest Annual Environmental Monitoring Report is available), a BNL employee discovered that the drainage from the B-650 area was piped to a ditch, rather than to the sanitary system or holding tanks as had been previously assumed. Hence, for approximately 10 years, radioactively contaminated equipment was scrubbed down on a concrete pad behind B-650. The contaminated water ran down into a drain in the middle of the sloping pad and then into a small depression in the wooded area near the large "AGS" groundwater recharge sump. This discharge area is located west of the AGS sump (separated by a dirt road from the sump), south of Fifth Avenue, and east of B-650 (see Section 3.4.4.3). The eight wells (1A through 1H) installed at this discharge area were not marked at the time of the Survey. One unmarked bicycle flag was found on the ground near one well. The PVC casings were cracked on three wells. The area encompassed by the wells is roughly one-fifth acre (90 feet by 90 feet). In 1975 (the earliest year for which data are available), well 1E showed a gross beta concentration of 260 pCi/liter, HTO tritium of 6 nCi/liter (drinking water standard = 20 nCi/liter), and Sr-90 of 121 pCi/liter (Hull and Ash, 1976). In 1984, the last year for which monitoring data were recorded in the annual Environmental Monitoring Reports (EMR), no data for wells 1A-1H were listed. In the EMRs for 1985 and 1986, well 1E showed a gross beta concentration of 40 pCi/liter; HTO tritium was below detectable limits (220 pCi/liter) and 0.13 pCi/liter of Cs-137 (the highest cesium concentration) was recorded. No Sr-90 data were given. Of the eight B-650 sump wells, the highest gross alpha and beta concentrations were detected in well 1A, showing 0.66 and 55.30 pCi/liter, respectively. All wells showed HTO tritium at below detection (220 pCi/liter).

In addition to tritium, BNL estimated that no more than 2 mCi of alpha (no 239Pu), 55 mCi of Cs-137, and 1 mCi of Sr-90 were discharged from the B-650 area. BNL estimated the type and extent of contamination as part of a review of contaminated land at BNL (Miltenberger, undated). This paper indicated that the following contaminants were discharged from the B-650 sump: Cr-51, Be-7, Cs-137, Mn-54, Zn-65, Co-60, Na-22, and Fe-59. In addition, the amount of Cs-137-specific activity in the top 10 cm of soil at the B-650 sump was estimated at 1.4×10^{-4} mCi/g.

k. Satellite Disposal Area (Map Site 11). The Satellite Disposal Area is a potential source of groundwater contamination.

"Twelve to Fourteen" bromine trifluoride cylinders and two wooden ammunition boxes of laboratory chemicals were exhumed from this area in 1985 (Meinhold, 1986b). The Survey team observed an old sheet-metal sign of the ground near this area in an abandoned roadway, covered with vines that read "Danger, Chemical Disposal Area." No other specific information is available on this area. It is located a few hundred yards south of the present filter beds of the sewage treatment plant in an area previously used as the filter beds for the old sewage treatment plant, prior to its renovation in the 1940s.

l. Old Army Incinerator (Map Site 12). The Old Army Incinerator may be a potential source of soil contamination, and may present a direct-contact threat.

The old Army Incinerator (B-195) was used originally by the Army (beginning in 1943) for burning solid waste until the 1960s, when it was decommissioned by BNL (BNL Part B permit, p. 5, July 19, 1985). It is located on the north side of Princeton Avenue about one-fourth mile east to Upton Street. The building is now used for storage. Adjacent to the old incinerator is a black-colored building with "radioactive" stickers on the doors. This building is presently used as a Co-60 and Cs-137 calibration facility.

The Survey Team measured 40 μR of activity inside the chimney on the east side of the red brick incinerator building. This reading is several times above background but does not appear to present a significant health risk. BNL personnel, interviewed by the Survey Team, were unable to account for the elevated activity in the chimney. Ash removed from this incinerator and landfilled across Princeton Avenue in a 2-acre area, was sampled and found to contain no radioactivity above background (Burns and Roe, 1986). Failure to

investigate this contamination may result in an undetected release of hazardous or radioactive substances.

m. Radioactively Contaminated Soil. Several areas on-site where radioactively contaminated soil has been deposited may be potential sources of surface water or groundwater contamination, or direct contact hazards (see Finding 3.2.4.3.1(f)).

n. Meadow Marsh Experiment (Map Site 14). The Meadow Marsh Experiment Area is a source of groundwater and soil contamination. This experiment, also known as the Upland Recharge Area, was operated from 1972 to December 1978. The Upland Recharge Area/Meadow Marsh Experiment is located immediately south of Fifth Avenue along the eastern perimeter of the facility.

The Upland Recharge Area consisted of the following experimental sections:

- Plowed field/biology
- Pine Forest spray plots
- Pine and Oak Forest spray plots
- Old field spray plots
- Biology field nursery stock
- Agricultural spray fields
- Army spray research

Because untreated and partially treated sewage was applied directly to very highly permeable soil, the groundwater was contaminated by percolation of the effluent [see Finding 3.4.4.3.1(e)]. The depth to groundwater was estimated to be 10 to 15 feet in this area (Naidu, 1978). The effluent discharged to the Upland Recharge Area was approximately 2 percent of the flow from the clarifier of the sewage treatment plant. According to flow charts included in the Annual Environmental Monitoring Reports (see Naidu, 1978 and Naidu, 1979), part of the effluent discharged to the Meadow Marsh Experiment/Upland Recharge Area had bypassed the clarifier. Hence, raw sewage was applied to the Meadow Marsh Experiment. In addition to BNL effluent, residential sewage from cesspool pumpings was trucked to BNL for use in the Upland Recharge Area.

Relatively little information is available on the quality of the effluent discharged to the Meadow Marsh Experiment/Upland Recharge Area. Table 4-24 shows the monthly flow rate and the maximum and average contaminant concentrations for five metals and

TABLE 4-24

CHARACTERISTICS OF CLARIFIER EFFLUENT TO MEADOW MARSH EXPERIMENT BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Year[1]	Average Monthly Flow (million gallons)	Maximum/Average Concentration (ppm)					
		Cd	Cr	Cu	Fe	Zn	HTO[8] nCi/l
1975[3]	0.46	NA[2]	0.32/0.09	3.42/0.83	20.1/4.9	3.5/1.6	13.3/5.5
1976[4]	1.1	NA[2]	0.5/0.05	3.2/0.7	20/3.7	4/1.4	9.6/4.04
1977[5]	0.96	NA/100	NA/0.16	NA/1.94	NA/10.7	NA/3.5	19.8/5.5
1978[6]	0.72	NA/12.4	NA/NA	NA/1.7	NA/7.4	NA/1.5	4.3/1.95
Water Quality[7] Standard (ppm)		0.1	0.1	0.4	0.6	0.6	20

(1) Meadow Marsh experiment began in 1972, but Environmental Monitoring Reports prior to 1975 were not available.
(2) Data not available.
(3) Hull and Ash, 1976.
(4) Naidu, 1977.
(5) Naidu, 1978
(6) Naidu, 1979.
(7) New York State Water Standards.
(8) Tritiated Water.

tritium during the years 1975 through 1978. No information was available for effluent characteristics (e.g., organic contaminants) prior to 1975, for the first 3 years of the experiment.

For the years 1975 through 1978, the effluent contained metal concentrations significantly higher than the water quality standard, but the water quality standard for tritium was not exceeded. In 1975 the maximum concentration for chromium was 13 times the water quality standard. In 1977, the average cadmium concentration was 1,000 times the water quality standard and the average chromium (presumably total chrome, although the valence--III or VI--is not stated) concentration was 16 times the water quality standard. Also in 1977, the copper concentration of the effluent was almost 5 times the water quality standard.

The comparison of effluent concentrations with water quality standards is not strictly applicable, because these standards are intended to be used for surface waters. But without groundwater standards, the water quality standards provide a useful benchmark for comparison. In most cases, except for very low or very high pH situations, most of the metals would be filtered out and deposited on the soil surface [see Finding 3.2.4.3.1(d)]. However, some contaminants would percolate to groundwater after the adsorption capacity of the soil column was exceeded.

o. 1977 Oil/Solvent Spill at Central Steam Plant (Map Site 15). The 1977 oil and solvent spill near the Central Steam Plant may be a source of groundwater contamination.

On November 25, 1977, approximately 87,000 liters (23,000 gallons) of oil and solvent (a mixture of 60 percent No. 6 oil and 40 percent mineral spirits) was released from a ruptured pipe. The tank, from which the release occurred, was located southeast of the Central Steam Plant--west of North Sixth Street, in a partially wooded, low-lying area (see Figure 4-11). The pipe rupture occurred when a nearby 19,000 liter empty tank rose off its mounts, because of an accumulation of water beneath the tank, and sheared off the connecting lines between the tanks. The oil/solvent mixture spread over an area of approximately 0.5 hectares (1.2 acres). Using sand berms and portable pumps, BNL personnel recovered approximately 11,000 liters (2,900 gallons); hence, approximately 87 percent (76,000 liters or 20,100 gallons) of oil/solvent remained on the ground (Naidu, 1978). Some "oil-soaked" soil was removed, but the location or amount (volume or weight) of the soil was not documented. Also, no records were available on the

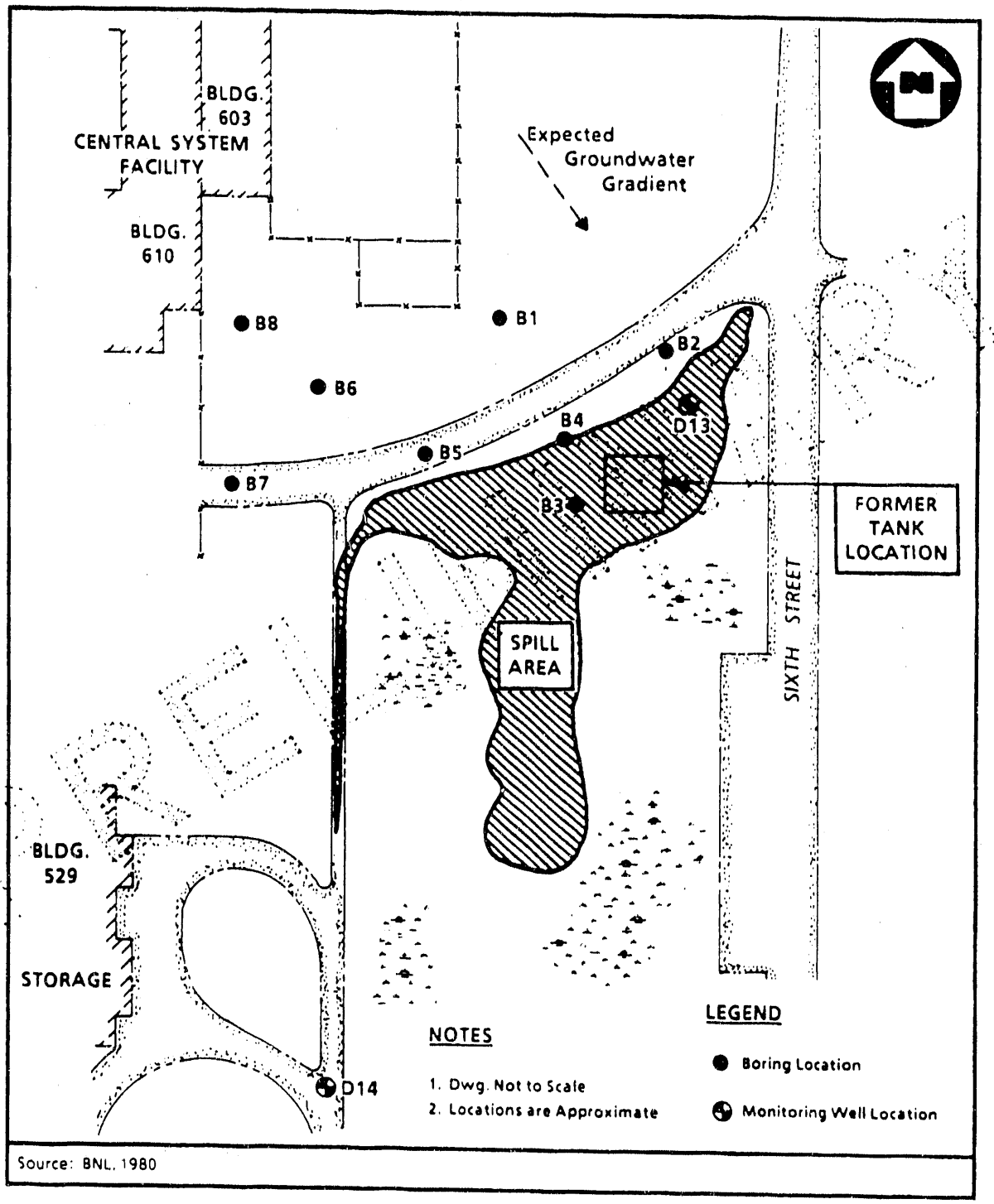


FIGURE 4-11

LOCATION OF 1977 OIL/SOLVENT SPILL
BNL - UPTON, NY

ultimate disposal location of the contaminated soil. In addition, clean "top soil" was added to this area, followed by fertilization and tilling. No information is available on the amount, type, or depth of top soil; date of application; type, amount, or date of fertilization; or tilling.

The total amount of oil and solvents in the ground is unclear. Another undated series of slides obtained from BNL files indicates that 25,000 gallons of oil/solvent spilled, instead of the 23,000 gallons reported in the 1977 Environmental Monitoring Report (Naidu, 1978). These undated slides also estimated that 80 percent of the oil/solvent was recovered, resulting in approximately 5,000 gallons left in the ground, contrary to the 20,100 gallon residual suggested by the 1977 Environmental Monitoring Report (Naidu, 1978).

While installing monitoring well D13, immediately north of the former tank location, oil soaked sand was encountered at the 40-50 foot depth. Because of the mixing process inherent with augering the exact depth of the oil soaked sand is unclear, but is deeper than 40 feet. Also, it is not clear from the available documentation whether or not the oil-soaked sand extends beyond 50 feet, because there do not appear to be deeper borings. Because the depth to groundwater at this location was estimated to be 35 feet, the oil/solvent spill did reach the groundwater and contamination is likely. No monitoring data is available on wells D13 and D14, which are located immediately north and south, respectively, of the spill site [according to a detailed map of the spill site provided by BNL (see Figure 4-11)]. Wells D13 and D14 were apparently installed prior to April 1985, when several soil borings were performed. Monitoring data for wells D13 and D14 do not appear in any Annual Environmental Monitoring Reports (EMR) from 1975 through 1986. In the 1986 EMR, wells D13, D14, and D15 appeared on a map of well locations (Miltenberger et al., 1987), but no monitoring data were given.

In April 1985, several soil borings were performed in the oil/solvent spill vicinity. The deepest observed "chemical odor" was 24 feet below the ground surface in boring B-3. The depth of groundwater was 30-35 feet in this area. Further characterization of this area is planned by BNL, but no additional information is available.

p. Brookhaven Graphite Research Reactor (Map Site 16). The Brookhaven Graphite Research Reactor (BGRR) may be a source of groundwater contamination because of potential leaks in the fuel rod storage canal and the D-waste lines leading to the B-801 Hot Laboratory.

The BGRR operated from August 1950 to June 1968. It was the first reactor built in the U.S. solely to provide neutrons for research. According to the 1977 EIS, "The BGRR was a graphite moderated and reflected, uranium-fueled, air-cooled reactor. It consisted of a graphite cube penetrated in the north-south direction by an array of horizontal parallel cylindrical channels, which contained the uranium fuel elements. Air was drawn through the fuel channels and after filtering and cooling was discharged through the reactor stack" (ERDA, 1977).

The various radioactive parts of the BGRR are listed in Table 4-6. The two primary potential sources of groundwater contamination from the BGRR are the fuel rod storage canal and the D-waste lines leading to the B-801 Hot Laboratory. The D-waste lines are discussed in subsection 4.5.2.3.1c. The fuel storage canal contained irradiated water as a moderator for the highly radioactive fuel rods. The fuel element storage canal at the BGRR is currently empty, but may have leaked into the groundwater during the period when it was full of tritiated water. According to the 1986 BNL Site Waste Management Plan, the BGRR canal is actually composed of a deep pit and a shallow pit as well as a "chute from south plenum to canal," and are all "highly contaminated" (see Table 4-6). The fuel rods were removed and sent off-site for reprocessing, and the canal was drained and cleaned by June 1972. Hence, the canal does not now present a threat to groundwater, but it may have leaked into the groundwater during the approximately 20 years, when it was full. The integrity of the BGRR canal has never been tested, nor is the groundwater in the vicinity of the BGRR being monitored.

2. Cesspools. Several active and inactive cesspools and septic tanks at BNL may be sources of groundwater contamination. BNL has identified cesspools (see Table 4-23) and their disposition. Because of the lack of sampling and the potential for contamination in these cesspools, inactive cesspools may serve as groundwater contamination sources, despite their disuse. Failure to sample these cesspools upon abandonment, remove contaminated sludge, and test for groundwater contamination may result in undetected groundwater contamination (see also Finding 3.3.5.3.1).

In addition to the cesspools, a "leaching pit" is located between Buildings 208 and 209, leading from sewage pumphouse 418 (or 481 depending on whether the main drawing or the exploded view on the blueline is considered credible). This pit was used as an overflow route, when the pumps in B-418/481 malfunctioned and were unable to pump sewage through manhole 165 to the gravity feed system through a forced main. BNL personnel interviewed by the Survey Team were unable to establish the exact location of this leaching pit under the asphalt between B-208 and B-209. If the pump in B-418/481 malfunctioned, the wastewater

would flow to this leaching pit, where it would percolate into the groundwater. A TCE degreaser and several acid baths and rinse tanks are located in B-208. Solvents, acidic rinse water, and metals may have been discharged to the sewer in B-208 and may have led to the leaching pit leading from B-418/481.

4.5.2.4 Category IV

1. CERCLA Section 103(c) Notification. The notification submitted in June 1981 by DOE to the U.S. Environmental Protection Agency pursuant to CERCLA Section 103(c), is incomplete and has not yet been corrected.

In general, a complete CERCLA 103(c) notification would include information on potential environmental and health problems associated with facilities that treated, stored, and disposed of hazardous substances. Sites excluded from the 103(c) notification are those that meet the limited exclusion and exemption criteria cited in 46 FR 22144, April 15, 1981, or those sites submitted pursuant to RCRA Section 3016. The Survey identified the following sites/areas at BNL that do not appear to meet the exemptions of 103(c) and were not reported to EPA pursuant to RCRA Section 3016:

- Waste Concentration Facility
- Cesspools (see Finding 4.5.2.3.2)
- Sewage Treatment Plant Filter and Sludge Beds
- Meadow Marsh Experiment Area (Upland Recharge Area)

Inclusion of these sites in the 103(c) notification does not constitute an implicit judgment that a problem exists, but rather that the potential for a problem exists. The notification is the first step in a process that sorts out which sites pose a threat and determines the relative degree of that threat.

Table 4-25 lists the various notification and internal reports compiling hazardous substance release locations at BNL. The compilations are ordered chronologically from the June 1981 CERCLA 103(c) notification to the DOE-wide notification from the Assistant Secretary to EPA in April 1987. Of these five compilations, three were prepared for submission to EPA (columns A, B, and E).

TABLE 4-25

WASTE AREA COMPILATION
BROOKHAVEN NATIONAL LABORATORY, UPTON, NEW YORK

Location	Waste Area Compilation				
	A1	B2	C3	D4	E5
Former Landfill	X	X	X	X	X
Chemical Holes	X	X	X	X	X
Glass Holes	X	X	X	X	X
Hazardous Waste Management Area	X		X	X	X
Waste Concentration Facility			X		
Current Landfill	X		X		
Slit Trench		X	X	X	X
Sewage Treatment Plant			X		
Small (1966) Dump		X	X	X	X
Building 650 Sump Drainage			X	X	X
Satellite Disposal Area			X	X	X
Old Army Incinerator/Ash Landfill			X	X	X
Radioactively Contaminated Soil			X	X	X
BGRR Canal			X		
Central Steam Facility			X		
Cesspools			X		
Upland Recharge Area			X		
Army Ammunition Dump	X				
"Chemical Pits" [?]		X			
"Refuge Trench"		X			

Sources:
A. CERCLA Section 103(c) Notification (June 9, 1981).
B. Letter from DOE to EPA, (May 1984).
C. Internal Memo from BNL to DOE (March 19, 1986) ("...areas of potential environmental concern...").
D. BNL Phase I Report for DOE Order 5480.14 (June 1986).
E. Letter from DOE to EPA (April 27, 1987).

References:
1. Bebon, 1981
2. Mares, 1984
3. Kinne, 1986d
4. Kinne, 1986e
5. Walker, 1987

2. Lack of Thorough Search of Historical Documents. The lack of a thorough search of historical documents may result in undetected sources of hazardous substance releases. Two primary sources of potential information on historical hazardous substance releases have not yet been investigated by BNL. Archival Army information may reveal disposal patterns during the Camp Upton periods of the BNL site history. Historical aerial photographs may show bare patches of unvegetated land, where hazardous substance contamination may have occurred. The Survey team performed a preliminary analysis of aerial photographs provided by the Suffolk County Department of Health Services and Cornell University. These photographs did not reveal any new major areas of contamination, although some small suspect areas were identified. A comprehensive analysis of aerial photographs was beyond the scope of this Survey. In addition, aerial photographs dating back to only 1960 were available. No photographs were available that dated back to earlier periods of BNL's operation during the 1950s.

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APPENDIX A

SURVEY PARTICIPANTS

APPENDIX A

SURVEY PARTICIPANTS

Larry Weiner	DOE Headquarters	DOE Team Leader
Susan Barisas	DOE Headquarters	DOE Assistant Team Leader
Barry Fritz	DOE, Chicago	CHO Survey Representative
Joseph Crist	NUS Corporation	Air Quality
Joseph Boros	NUS Corporation	Surface Water
Paul Eddy	Battelle Northwest	Hydrogeology/Soil
Doug Detman	NUS Corporation	Hydrogeology/Soil
Ralph Basinski	NUS Corporation	Waste Management
Arthur Olszewski	NUS Corporation	Toxic and Chemical Materials/Quality Assurance
Mark Francis*	NUS Corporation	NUS Coordinator/Radiation
James Werner	ICF	Inactive Waste Sites and Releases

* NUS Coordinator

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

APPENDIX B

SUMMARY OF SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The U.S. Department of Energy (DOE) Office of Environmental Audit, Assistant Secretary of Environment, Safety and Health, selected a Survey team for the Brookhaven National Laboratory in January 1987. Mr. Lawrence A. Weiner was designated the DOE Team Leader, with Ms. Susan Barisas serving as the Assistant Team Leader. Mr. Barry Fritz was the Chicago Operations Office Survey team representative during the on-site Survey. The remainder of the team was composed of contractor specialists from NUS Corporation and its subcontractor, ICF Corporation. These individuals and their areas of expertise are listed below.

Speciality	Name
Air	Joseph Crist
Surface Water	Joseph Boros
Waste Management	Ralph Basinski
Inactive Waste Sites	James Werner
Hydrogeology/Soil	Paul Eddy
Radiation	Mark Francis*
QA/Toxics	Arthur Olszewski

* Team Coordinator

Mr. L. Weiner sent an information request to BNL in January 1987, listing the types of documents of interest to the Survey team for Survey planning purposes. Messrs. Weiner, Crist, Werner, Francis, Basinski, Burd (NUS Health and Safety), B. Fritz (DOE, Chicago), S. Woodbury (DOE Headquarters) and Ms. S. Barisas conducted a pre-Survey site visit from March 9-11, 1987 to review documents prepared in response to the information request and to gain familiarity with key DOE and site personnel. They toured the facility and designated documents for shipment to NUS for reproduction and distribution to Survey team members. Survey team members began reviewing BNL general environmental documents and reports in March 1987.

Two meetings were held with regulatory agencies on March 10 and 11, 1987. The first meeting included representatives from the USEPA and the New York State Department of Environmental Conservation (NYSDEC). The second included representatives from Suffolk County and the town of Brookhaven. The purpose of these meetings was to review environmental issues of concern to the agencies and local governments and explain the scope of the Survey.

R. Basinski represented the Survey team in a meeting held March 25, 1987, between BNL Environmental and Engineering staff members and NYSDEC staff for a general discussion regarding permitting of BNL facilities. J. W. Ahner met with Suffolk County representatives on March 30, 1987, to provide the county with an additional opportunity to air concerns regarding the BNL site and to obtain information on the site including sampling and analysis results, inspection reports, and aerial photographs.

The Survey team intensively reviewed the documents provided by the site and prepared a Survey plan for the BNL site. The plan, transmitted to BNL on April 11, 1987, described the specific approach to the Survey for each of the technical disciplines and included a proposed schedule for the on-site activities. A Health and Safety Plan also was prepared for use by the Survey team during the on-site Survey.

B.2 On-Site Activities

The on-site portion of the Survey was conducted during the period of April 6 through April 17, 1987. The opening meeting was held April 6, 1987, and was attended by representatives from DOE Headquarters, the DOE Chicago Operations Office, the DOE Brookhaven Area Office, BNL, NUS Corporation, and ICF Corporation. Discussions during this meeting centered on the purpose of the Survey, logistics, and an introduction of the Survey team personnel, as well as the key BNL personnel involved in the Survey.

During the Survey, team members conducted extensive investigations of laboratory operations to identify existing and potential pollutants. Environmental facilities were evaluated, and site operations and monitoring procedures were observed. Extensive interviews were conducted with laboratory personnel regarding environmental controls, operations, monitoring and analyses, past operations, regulatory permits, and waste management practices. File documents, including permits and permit applications, background studies, engineering drawings, accident reports, and operating logbooks, were reviewed by the team members.

Survey team members met daily to report observations, compare findings, and discuss the progress of the Survey. Prior to the daily Survey team meeting, the Survey team met with BNL personnel to arrange for specific site personnel and facilities to be made available, as needed, on the following days.

The Survey team members identified further sampling and analysis requirements necessary to complete the Survey effort. The sampling and analysis requirements were discussed with Oak Ridge National Laboratory (ORNL) representatives during the second week of the Survey. ORNL was designated by DOE to provide the Sampling and Analysis for the BNL site.

A site close-out briefing was held on April 17, 1987, where the DOE Team Leader presented the preliminary findings and observations of the Survey team. These findings and observations were considered preliminary, pending additional research and, in some cases, field sampling.

B.3 Sampling and Analysis

Oak Ridge National Laboratory (ORNL) will perform the Sampling and Analysis portion of the Survey. ORNL evaluated the Sampling and Analysis requests made by the Survey team and determined sampling and analysis logistics, costs, and schedules. The Sampling and Analysis Plan prepared by ORNL includes a Quality Assurance Plan and a Health and Safety Plan. The Sampling and Analysis team began work at the site in April 1988.

B.4 Report Preparation

A Survey Preliminary Report will be prepared for DOE review. Comments from this review and the results of the sampling and analysis efforts will be incorporated and the report will be reissued as an Interim Report. The timing of the Interim Report is dependent upon the completion of the sampling and reporting of the analytical results to the Survey team.

TABLE B-1

DOE ENVIRONMENTAL SURVEY MEETING WITH NYSDEC AND USEPA MARCH 10, 1987

Name	Organization
Gerald P. B Rezour	NYSDEC Region 1
Susan Barisas	DOE/Washington, DC
Barrett Fritz	DOE-CH
Janakiram R. Naidu	BNL-SEP
Gus A. Vazquez	DOE-Area Office
Steven R. Woodbury	DOE/Washington, DC
Leonard C. Emma	BNL-SEP
Gerald C. Kinne	Assistant Director - BNL
M. Sue Davis	BNL-DO
Joan Shands	USDOE - Brookhaven Area Office
Joseph G. Crist	NUS - Pittsburgh
Mark Francis	NUS - Pittsburgh
Anne Baittinger	BNL
Charles Meinhold	BNL-SEP
Bob Bechrer	NYSDEC
Warren Black	USEPA (2 PM-EI)
Harold D. Berger	NYSDEC
Albert Mackli	NYSDEC
Larry Weiner	DOE/Washington, DC

TABLE B-2

DOE ENVIRONMENTAL SURVEY MEETING
WITH SUFFOLK COUNTY AND TOWN OF BROOKHAVEN
MARCH 11, 1988

Name	Organization
Larry Weiner	DOE - Headquarters
Susan Barisas	DOE - Headquarters
Barrett Fritz	DOE - Chicago Operations
Gus A. Vazquez	DOE - Area Office
Vincent Donnelly	Town of Brookhaven
Peter A. Scully	Town of Brookhaven
Mark R. Francis	NUS - Pittsburgh (Survey Team)
Joseph G. Crist	NUS - Pittsburgh (Survey Team)
Janakiram R. Naidu	BNL - SEP
Charles B. Meinhold	BNL - SEP
Anne Baittinger	BNL - Public Information
William Roberts	Suffolk Co. Dept. of Health Services
James H. Pim	Suffolk Co. Dept. of Health Services

APPENDIX C

SURVEY PLAN

ENVIRONMENTAL SURVEY PLAN

BROOKHAVEN NATIONAL LABORATORY

APRIL 6 - 17, 1987

UPTON, LONG ISLAND, NEW YORK

1.0 INTRODUCTION

The Brookhaven National Laboratory (BNL) Survey is part of the larger Department of Energy (DOE)-wide Environmental Survey effort announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no fault" baseline surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and allocate the resources necessary to correct these problems. Because the Survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance, or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The BNL Survey will be conducted in accordance with the protocols and procedures contained in the May 16, 1986, draft Environmental Survey Manual.

2.0 SURVEY IMPLEMENTATION

The Environmental Survey of the Brookhaven National Laboratory (BNL) will be managed by the Team Leader, Larry Weiner and the Assistant Team Leader, Susan Barisas. Barry Fritz and Gus Vazquez will serve as the Chicago Operations Office (CHO) and the Brookhaven Area Office (BHO) representatives, respectively, on the Environmental Survey Team. Technical support is provided by NUS Corporation personnel as follows:

Mark Francis	NUS Coordinator/Radiation
Joseph Crist	Air
Joseph Boros	Surface Water/Underground Tanks
Arthur Olszewski	QA/TSCA (Toxic Materials)
Ralph Basinski	RCRA (Solid, Hazardous and Radioactive Wastes)
James Werner (ICF)	CERCLA (Inactive Sites)
Paul Eddy (PNL)	Hydrogeology/Soil

2.1 Pre-Survey Activities

Pre-Survey activities began in early January, 1987, when Survey team members began reviewing BNL environmental documents that were available at the DOE office of Environmental Audit & Compliance (OAC). This review was followed by a January 16, 1987 memorandum from Lawrence A. Weiner (OAC) to Roger Mayes (CHO), announcing the pre-survey site visit and requesting additional Survey-related information.

The pre-survey site visit, March 9 -11, 1987, was conducted by Mr. Weiner, Ms. Barisas, Mr. Crist, Mr. Basinski, Mr. Francis, Mr. Werner and Mr. Burd (NUS Health and Safety Advisor). The purpose of the visit was to become familiar with the site, identify potential areas of concern for purposes of the Survey,

collect the documents requested in the January 16 memorandum, and coordinate plans for the upcoming Survey with CHO and BNL personnel. During this pre-survey visit, the team met with representatives of CHO and BNL, and officials of the various federal, state, and local environmental agencies. Team representatives toured the facility and collected the documents assembled by site personnel in response to the information request memorandum. These documents were transferred to NUS Pittsburgh offices in March for use by team members during the planning stage of the Survey. Additional information was requested during the pre-survey site visit and has been received. This Survey plan is based upon the information received by the survey team as of March 26, 1987.

2.2 On-Site Activities and Survey Reports

The Environmental Survey will be conducted from April 6, 1987 through April 17, 1987. A tentative agenda is as shown in Table 1. It is expected that modifications to the agenda will be made as appropriate to minimize disruption of site activities, and to enhance Survey efficiency and effectiveness. All modifications to the agenda will be coordinated with the site officials designated as Survey contacts.

The on-site activities of the Survey team will consist of discussions with, among others, environmental, safety, operations, waste management, purchasing, and warehousing personnel; a review of files and documents (including classified documents, if any) unavailable prior to the on-site portion of the survey; and process-specific and area-specific tours of the facility.

A closeout briefing will be conducted on Friday, April 17, to describe the preliminary findings of the Survey team. A preliminary report of the BNL Survey will be prepared within 8 to 10 weeks from the conclusion of the

Survey. The preliminary report will be sent to CHO and BNL for review and comment.

Within 6 months of the completion of the sampling and analyses (S&A) portion of the Survey (discussed below) an interim report will be prepared by the Survey team. The interim report will incorporate comments to the preliminary report and the data from the S&A results. The interim report will be made available to the public, upon request.

Upon completion of the Environmental Survey effort a final report will be prepared and will contain a DOE-wide list of environmental problems. The report will be used as an information base for the ranking of DOE's environmental problems.

2.3 Sampling and Analysis

Based on available site environmental information and the results of the on-site Survey activities, the BNL survey team will identify Survey-related sampling needs. Implementation of the S&A phase of the BNL Survey will begin approximately 12 weeks after the completion of the on-site Survey activities. This effort is expected to have a 2-4 week duration and will be conducted by Oak Ridge National Laboratory (ORNL). Mr. John Murphy will be the ORNL Team Leader for the S&A phase of the BNL Survey. The ORNL sampling team will draft a sampling plan based upon the sampling needs identified by the Survey team. The Assistant Team Leader (Ms. Barisas) will coordinate the review of this sampling plan with CHO, BHO, BNL, and EPA's Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas. EMSL has quality assurance and data validation responsibility for the S&A phase of the Environmental Survey.

Analysis of Survey-related samples will be performed by ORNL following the protocols specified in the May 16, 1986, draft Environmental Survey Manual and the BNL Sampling Plan. Results of the sampling and analysis will be transmitted to the Survey team leader for incorporation into the interim report.

3.0 QUALITY ASSURANCE

3.1 Issue Identification

The quality assurance area of the Survey will primarily be an evaluation of current sampling and analysis procedures performed at BNL or at any off-site laboratories conducting environmental analyses on samples from BNL. However, the intent will be to review the quality assurance procedures for collecting process effluent and environmental samples, for transporting and identifying samples, for performing the laboratory analytical work to identify and to quantify pollutants and for evaluating and reporting the data. The goal of the quality assurance review will be to verify that appropriate procedures are being followed. Aspects of the quality assurance program relating to environmental management of BNL which will be examined, if available, include: analyst training; equipment/instrument calibration and maintenance; sample collection, handling and chain-of-custody procedures; blank, replicate and spiked sample results; data reduction and reporting; and data documentation, including logbook, calculation reviews and archival data storage, and corrective actions.

Sampling and analysis procedures will be reviewed to ensure that they conform to accepted requirements and are being properly implemented by BNL. In particular, issues addressed in the Blass Report will be examined. An overall survey of the BNL environmental monitoring quality assurance program will be performed.

Primary contacts at BNL are expected to be personnel from the sampling/analytical facilities in the Safety and Environmental Protection (SEP) Division.

3.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Quality Assurance plans for BNL and any supporting analytical laboratories.
- BNL Environmental sampling and analysis procedures manuals.
- QA audits of environmental sampling and analysis at BNL (1981-present).
- Periodic or annual QA summary reports for BNL.
- Summaries of results of QA sample analyses on external performance evaluation samples, such as those from DOE's Environmental Measurements Laboratory and from the EPA.
- Training records for sample collection personnel and BNL laboratory staff.
- Laboratory notebooks, standard data reporting forms and sampling logbooks.
- Instrument maintenance, repair and calibration records for laboratory and field equipment.
- Results of internal precision and accuracy studies of environmental analyses.
- Results of interlaboratory analyses of standard samples, if any (e.g., studies between BNL and ANL).

4.0 SURFACE WATER/DRINKING WATER

4.1 Issue Identification

The focus of the surface water/drinking water portion of the Survey will be on the possible release of polluted or contaminated wastewaters to surface waters, or to the sole source groundwater aquifer underlying BNL. Potential pathways for off-site migration of pollutants include:

- o Spills or leaks into permeable soil areas.
- o Releases to the sanitary sewers or to storm drains without retention, chemical or radiological analysis, or treatment.
- o Use of cesspools for disposal of liquid wastes.

A review of available information indicates that considerable attention has been paid to control of radiological releases. However, less documentation exists on the fate of trace levels of toxic metals and organics in wastewaters. The Survey will assess the potential for inorganic and organic contamination of wastewaters, as well as review present conditions of wastewater control, collection and treatment. Liquid waste treatment, collection and handling equipment will be examined and records of operation will be reviewed.

The Survey will include identification of potential discharges to surface waters which may not be addressed in operating permits or other documents from BNL. The site will be investigated for evidence of possible breaks or obstructions in the sewer system which could result in releases of wastewater to the environment. The Survey will also address the possibility of cross-contamination of the potable water piping system by either the sanitary or storm drainage systems. Measures taken at BNL to prevent back-flow of process wastewater or sanitary sewer flows into the drinking water piping systems will

be reviewed, along with BNL's self-monitoring reports (required under primary drinking water regulations). Copies of standard operating procedures (SOPs), operating logbooks, and maintenance records will be reviewed with respect to wastewater monitoring and treatment systems. BNL field practices will be observed to determine how closely SOPs are being followed. Interviews with managers and operators of monitoring equipment and treatment systems will be conducted in order to understand modifications or significant deviations, if any, from written SOPs.

A walk-through of selected buildings will be made to observe normal routines, including maintenance activities which generate wastewaters. Various discharge and monitoring points will be reviewed, and actual sampling and analytical procedures will be observed. Emphasis will be placed on the major contributors to wastewater generation, for example, Building 490, the Medical Research Center; Building 801, the Hot Laboratory Complex; Building 650, the Reclamation facility; Building 750, the High Flux Beam Reactor; Building 610, the Central Steam plant; and Building 624, the Water Treatment Plant.

The sanitary wastewater collection, holding and treatment system will be evaluated under normal operating conditions, as will the final effluent monitoring and sampling station. Site surface drainage characteristics, such as culverts, will also be examined, along with any man-made efforts to control surface run-on and run-off. The impact of changes resulting from construction of new facilities will also be evaluated. BNL's program for leak-testing and assessing the integrity of underground storage tanks will be evaluated.

4.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents

not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Recent analytical data on wastewater releases to the Peconic River.
- Notices of violations relating to wastewater releases.
- Operators logbooks and treatment plant reports.
- Standard operating procedures for wastewater collection, holding, and treatment.
- Sampling protocols and logbooks.
- Wastewater lab tracking reports.
- Treatment plant and monitoring equipment maintenance records.
- Detailed drawings of the domestic water supply, storage and distribution system.
- Records of drinking water quality.
- SPCC plan, or its equivalent.
- Internal memos or correspondence relating to surface water/drinking water problems, e.g., back-flow prevention measures.
- Reports describing progress on the Uplands Recharge Project activities.
- Test records relating to underground storage tanks.
- Interval memos and correspondence relating to exfiltration losses form sanitary sewers and on-site losses to groundwater between the sewage treatment plant and the site boundary.
- Other records as determined on-site.

5.0 AIR

5.1 Issue Identification

The air-related Survey activities will involve assessments of the air emissions at the site, the administrative and emission controls applied to the sources, and the ambient air monitoring systems. The emphasis of the Survey will be on operational and procedural practices associated with the emission sources and the emission control equipment, fugitive emission sources, both within and outside buildings, and mitigation procedures applied to fugitive emission sources. Close liaison will be maintained with the radiation team member because of the importance of air-rad issues.

The general approach to the Survey will include a review of existing air permits, pending applications, and standard operating procedures. Processes and control equipment will be inspected for compliance with DOE ALARA requirements for radionuclide emissions. The survey will also review the nonradiological air contaminants from the different buildings at the site, evaluate any existing controls applied to the air emissions, and assess the need for additional monitoring or emission controls to characterize or reduce the environmental consequences of the emissions.

The ambient air monitoring system will be evaluated to assess the adequacy of the existing monitoring program to characterize environmental impacts of the air emissions from the facility. The activities involved in this part of the survey will include the inspection of the ambient air quality samplers, a review of documentation applicable to the ambient air data acquisition, and an evaluation of the processing procedures used to assure the accuracy of the data. All air data (effluent and ambient) will be scrutinized to determine its usefulness to other team members in preparing their assessments. For example, data concerning airborne tritium may be useful to the surface water

specialist in comparing the various sources of tritium additions to the Peconic River.

Areas of particular interest will include emissions of the criteria pollutants (e.g., sulfur oxides, nitrogen oxides, hydrocarbons, carbon monoxide and lead) as well as regulated hazardous air pollutants (e.g., radioactive-bearing particulates, and asbestos). Although not currently listed as hazardous air pollutants, freons will be included in this review. Special attention will be paid to the burning of alternate liquid fuels in the central steam plant.

In addition, the use of organic solvents will be assessed as a potential or actual source of emissions to determine if they are adequately characterized, monitored, and controlled. The organic emissions assessment will focus on those substances that the EPA intends to list as hazardous or toxic air pollutants, and others used in large quantities (e.g., 1,1,1-trichloroethane).

Fugitive emissions from the resuspension of contaminated soils will be evaluated as a potential means of the airborne release of radionuclides and hazardous materials from the facility. Consideration will be given to historical and current operations to determine the potential for soil contamination and windborne releases. The drying beds for sewage sludge will be surveyed to determine the potential for airborne releases.

Several areas of specific interest have been identified during a review of available documentation:

- Completeness of permitting for degreasers and parts cleaners and use of environmentally acceptable solvents. BNL has two vapor degreasers and numerous parts cleaners differing in size and choice of solvent.

- o Control and monitoring of radionuclides, freon, and solvent emissions.
- o Emission potential of fugitive dust sources such as roads, the drying beds for contaminated sewage sludge, and landfill activities.
- o Potential for asbestos emissions during building decontamination or demolition.
- o Effluent sampling and monitoring operations.

Throughout the survey, emphasis will be placed on assessing the available data to characterize the overall environmental impact of site operations.

5.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- o PSD ledger
- o Air effluent sampling and QA procedures
- o Ambient air sampling and QA procedures
- o Stack test results
- o Laboratory records on TSP analyses (ambient)
- o Any other documents pertinent to air emissions from individual BNL buildings

6.0 RADIATION

6.1 Issue Identification

Radiological issues to be addressed during the environmental Survey will center around the air, soil, surface water, and groundwater media. Each of the above mentioned media will be evaluated for radiation concerns by collecting background information and data (including ambient data), identifying existing and decommissioned radiation pollution sources and associated controls, and finally by reviewing environmental monitoring programs designed to gather data on identified pollution sources.

The Survey will also evaluate rad-waste management practices, direct radiation exposure issues, dose assessment methodologies, and radiochemistry quality assurance programs for environmental monitoring data. Review of rad-waste programs including management practices for low-level, transuranic, rad-hazardous (mixed), and adherence to BNL procedures will be a major focus of the radiation portion of the survey. A more detailed discussion of this subject is provided in section 8.0 of the work plan. The radiological evaluations will be closely coordinated with the other specialists on the Survey team.

Because radiation issues cut across all media evaluated during the survey, the attached daily agenda has been organized in an attempt to overlap the other specialists' activities when they are evaluating radiation issues. Some inefficiencies are to be expected as a result of this dual coverage approach, however, every effort has been made to minimize duplication. To improve the effectiveness of radiation evaluations, Mr. Francis will rely heavily on the expertise and assistance of Mr. Robert Miltenberger for accomplishing Survey objectives and pointing out where work plan inefficiencies exist. Discussions with operating and supervisory personnel will also be utilized to provide

needed information critical for complete evaluation. Reports, records, and other data associated with continuous, intermittent and any accidental or unscheduled releases should be readily accessible for review.

6.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Radiation-related ambient air quality information.
- Background radiation data for soil, surface water, and groundwater.
- Inventories of air, soil, surface water, and groundwater radionuclide release points and quantities.
- Vegetation radionuclide monitoring data.
- Unscheduled or accidental release reports.
- Radioanalytical quality assurance programs and procedures.
- Dose assessment methodologies, including assumptions, calculations, reporting, etc.
- Building plot plans with process and equipment locations.
- Description of radiation monitoring equipment practices and procedures (e.g., calibration, maintenance, etc.).
- Reports or recommendations for upgrading radiation monitoring systems.
- Reports prioritizing new radiation monitoring installations.
- Off-site and on-site radionuclide sampling point criteria.
- Rad-waste management practices, policies, procedures, and communication mechanisms.
- NESHAPS/DOE Subpart H 61.90-61.98 reports.
- Information regarding employee radiation exposure data.

- Historical rad-waste disposal activity logs and locations.
- State, county, and local radiation regulations.

7.0 TOXIC/HAZARDOUS SUBSTANCES

7.1 Issue Identification

The toxic substances Survey will address raw materials and process-related chemicals used at BNL as well as the usage, handling, storage and disposal of polychorinated biphenyls (PCBs), asbestos, pesticides (including herbicides and biocides) and other hazardous substances. The condition and environmental monitoring of underground storage tanks used for storage of substances other than wastes will also be examined. Through interviews with key BNL personnel and tours of plant facilities, the tracking control, and management of toxic/hazardous substances will be reviewed. This information and records of usage will be evaluated to determine the potential for environmental contamination.

The Survey will address inventory control of PCB-containing and PCB-contaminated electrical equipment, hydraulic equipment and heat transfer equipment. The condition of plant equipment containing PCBs and the potential for environmental contamination will also be examined. However, since only limited PCB information was received for the pre-survey visit, it was not possible to determine the exact amount of PCB containing equipment. Obsolete, stored or used PCB equipment will be checked for condition, proper containment, and protection. Plant storage records for PCBs will be reviewed. Disposal practices for non-radioactive PCB materials will also be addressed.

BNL projects involving the demolition/disposal of asbestos and asbestos-containing materials will be reviewed to identify pathways of contamination. Asbestos removal and disposal practices will be evaluated, and asbestos disposal areas will be visited.

Pesticide purchase, usage, and application records will be reviewed. The applicator training program will be reviewed. Pesticide storage areas and disposal practices will be examined to assess risk for environmental contamination.

Management, inventory, and control of chlorofluorocarbons ("freons") will be examined.

Toxic and hazardous materials purchase and usage records will be reviewed. Areas where these materials are stored and used will be visited and handling procedures will be evaluated.

Discussions will be held with those individuals knowledgeable of toxic/hazardous substances practices. This will be accomplished during facility tours, and discussions with individuals involved in the handling of toxic materials. The objective is to develop an understanding of current and past practices. Discussions will be held with personnel from at least the following groups:

- Safety and Environmental Protection Division
  - Environmental Monitoring and Assessment
  - Environmental Regulatory Matters
  - Analytical Chemistry

7.2 Records Required

Files will be reviewed as part of the Survey including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Toxic/hazardous substances inventory and chemical purchase records.
- Toxic substances labeling and tracking system overview.
- Procedures for purchasing, handling, storing, using and disposing of toxic substances.
- PCB transformer/capacitor inspection records (1981-present).
- Storage and inspection records for PCB contaminated equipment (1981-present) including radioactively contaminated and non-radioactive items.
- Disposal records for non-radioactively contaminated PCB items (1981-present).
- Procedures for storage, handling, and disposal of PCB fluids.
- Correspondence with BNL Fire Department regarding PCB electrical equipment, especially any records of fires involving PCB equipment.
- Locations of all BNL Plant buildings and areas containing asbestos.
- Procedures for asbestos removal, handling, and disposal as well as environmental monitoring information.
- Records of asbestos use in plant equipment and support facilities.
- Identification of active and inactive asbestos disposal areas at BNL.
- Pesticide/herbicide training, handling, storage, and disposal records and standard operating procedures.
- Pesticide annual reports (1981-1985).
- Special procedures involving handling, storage, use and disposal of chlorofluoroalkanes (e.g., freons).
- Inventory and environmental monitoring reports and procedures for underground storage tanks (1981-present).
- Other records as determined on site.

8.0 SOLID/HAZARDOUS/RADIOACTIVE WASTE

8.1 Issue Identification

The solid/hazardous/radioactive waste Survey will be carried out by reviewing and evaluating all activities generating solid wastes, and the treatment, storage, recycling and disposal practices involved in the handling of solid wastes including handling of wastes by commercial off-site facilities.

Management of all solid waste streams including mixed wastes, hazardous wastes, radioactive wastes and non-hazardous wastes will be reviewed. The review will generally consist of several activities. 1) Physical facilities where wastes are generated, accumulated, stored, treated, recycled or disposed will be inspected; 2) Personnel involved in these activities will be interviewed; 3) Files will be reviewed. Based on these activities the potential for releases that may contaminate the environment will be evaluated.

Wastes generated by BNL differ significantly from wastes produced by DOE production facilities. Production facilities generate a consistent waste stream because of the long term consistency in industrial processes. BNL conducts numerous experiments which are diverse and change frequently over time. A large variety of wastes in terms of quantity and composition is produced. The variety of wastes produced at BNL is illustrated in the 1986 Biannual Hazardous Waste Report which listed 1323 individual hazardous wastes which were handled at Brookhaven. Most of the wastes were small quantities of lab chemicals. This listing did not include radioactive, mixed or non-radioactive/non-hazardous solid wastes. BNL can be characterized as a site where a large number of sources generate a wide variety of wastes, usually in small volumes and generally containing toxic, radioactive and/or hazardous constituents.

Consequently, increased emphasis will be placed on reviewing general waste management procedures, and reviewing compliance with BNL, DOE, state and federal regulations.

Initial emphasis will be placed on BNL facilities which generate significant quantities of hazardous and radioactive waste, and waste treatment, storage and disposal facilities.

Radioactive waste generating and handling processes which will be evaluated include:

- o High Flux Beam Reactor (HFBR)
- o Department of Applied Science 3.5-Mev Van De Graaffs
- o Medical Research Reactor (MRR)
- o Hot Laboratory Complex
- o Waste Treatment, Storage and Disposal Areas (444, 445, 446, 448, 483)
- o Radioactive Waste Storage Area Trenches

The Central Steam Facility which uses flammable hazardous wastes as a fuel oil substitute will be evaluated. Flammable hazardous wastes used as fuels are exempt from regulation as a hazardous waste in New York, although storage will be regulated in the future. The hazardous waste management area where hazardous wastes are treated and/or stored for off-site shipment will be evaluated.

Divisions which will be emphasized in evaluating hazardous waste management practices include:

- Environmental Research and Development
- High Energy Physics
- Basic Energy Science

Waste handling practices that will be reviewed include the following:

- Waste minimization and recycling.
- Waste characterization, segregation and manifesting.
- Treatment and decontamination.
- Waste accumulation, packaging, and storage procedures.
- Waste management practices, including training, inventory control, record keeping, inspection protocols, and contingency planning.

Operations and practices will be compared with existing descriptions and written procedures. Information gathered on waste generation points and waste streams will be used to find any sources of waste not previously identified or properly characterized, which may have potential to affect the environment.

Discussions will be held with those individuals knowledgeable of waste management practices in order to develop an understanding of past and existing waste management practices. Discussion will be held with personnel from at least the following groups:

- Safety and Environmental Protection Department
- Plant Engineering
- Materials Management
- Supply and Distribution Operations

The review of solid/hazardous/radioactive waste practices will be co-ordinated with the CERCLA and hydrogeologic Surveys to identify past and present releases that may pose a threat to the environment; the radiological survey to define problems with wastes containing radioactive constituents; and the surface water/drinking water Survey since some aqueous process wastes are handled as solid wastes at BNL and wastewater treatment produces solid waste.

8.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Part B Application.
- Underground tank storage notification & associated records.
- Inspection records (state, local and federal).
- Groundwater monitoring, sampling, and analytical documentation.
- Release notification or occurrence records.
- Part 373 Permit Application.
- Biannual Hazardous Waste Generation Report.
- Waste inventory documentation.
- Enforcement action documents.
- Internal facility inspection documentation.
- Correspondence with regulatory agencies on solid waste.
- Records dealing with the reuse/recycling of wastes.
- Training records.

9.0 INACTIVE WASTE SITES/RELEASES (CERCLA)

9.1 Issue Identification

The Survey will attempt to identify environmental problems and potential risks associated with the historical handling, storage and disposal of hazardous substances at BNL. This aspect of the Survey will be coordinated with the RCRA and hydrogeology team members. The Survey will focus on current and future risks related to the following:

- o Past land disposal practices (on and off-site);
- o Past spills/releases from tanks, pipes, pits, trenches;
- o Potential for future spills/releases; and
- o On-going remedial action program

Facilities that have handled or are currently handling hazardous, mixed, and low-level radioactive substances at the Brookhaven Laboratory Site will be evaluated.

The following areas identified in the BNL Installation Assessment Report will be evaluated:

1. Former landfill
2. Chemical and glass holes
3. Slit trench
4. Incinerator ash disposal area
5. Satellite disposal area
6. Hazardous waste management area
7. Small dump
8. Building 650 sump

9. Eight areas where radioactively-contaminated soil was used for landscaping
10. Sewage treatment plant

The status of activities undertaken pursuant to DOE Order 5480.14 will be assessed. Any available material on the Phase I report will be reviewed. In addition, records of past off-site disposal from BNL will be reviewed.

Sites that have undergone or are undergoing remediation will be addressed. Records and analytical data in support of the site cleanup will be reviewed. Also, inactive tanks or containers that may have held hazardous substances will be identified and their status assessed. Former storage areas and staging locations will be included in this effort.

The Survey team will want to review additional material pertaining to the Phase I Installation Assessment report (i.e., map locations of all burial, spills, and release sites, aerial and surface photographs, personnel interview files and reconnaissance field data pertaining to HRS/mHRS evaluations). The team will also want to review the environmental records pertaining to the past management, disposal (on-site and off-site), clean-up, and regulatory compliance.

Contacts for this portion of the Survey will include personnel from the Safety and Environmental Protection Division.

9.2 Records Required

Files will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individual files, documents

not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Past waste mangement plans.
- SOPs regarding management of hazardous substances, disposal area and storage areas.
- Hazardous substances inventories.
- Listing of areas used for hazardous substances storage, receiving and shipping, and disposal.
- Historical files on past operations and processes, substances used, and methods of handling and disposal.
- Files on past off-site waste handling and disposal.
- Records of facility expansion and building rubble disposal.
- Descriptions and Notifications of inactive waste sites and potential areas of contamination.
- Description of all waste management facilities, including buried tanks and structures (existing and removed).
- Historical aerial and surface photographs of the facility.
- "Interview files" for the draft Phase I Installation Assessment report.
- Files pertaining to any radiometric surveys of the site grounds.
- Documents pertaining to past, current, and proposed remedial actions at BNL.
- Environmental records pertaining to past facility responses to hazardous substance spills and releases.
- Draft Phase II and III materials, including working copies, internal memoranda, correspondence, and calculation sheets.

10.0 HYDROGEOLOGY AND SOILS

10.1 Issue Identification

One of the major environmental issues at BNL is the release of contaminants to the sole source aquifer. Both radiological parameters and toxic organics have been found in the subsurface, mostly as a result of past practices.

The Survey effort will involve the evaluation of recent studies of site hydrogeology, determination of the status of on-going studies, and the review of plans for further investigations and remedial actions. Each potential or known source of groundwater contamination will be visited, and drilling and sampling activities will be observed. Many of these visits to sources will be conducted jointly with the RCRA, CERCLA, and/or surface water Survey team members. Personnel at these various facilities will be interviewed to determine past and present waste-handling practices. Well construction will be reviewed both on "as built" diagrams, and in the field. Potential groundwater recharge and discharge areas will be investigated.

BNL is located above a "sole source aquifer". Groundwater travels at a relatively fast rate in the sandy soils characteristic of Long Island. Non-contact cooling waters are discharged by recharging them into the aquifer. The sanitary treatment plant discharges into the headwaters of the Peconic River will percolate completely into the ground during the dry season prior to leaving the BNL site. Because BNL and its neighbors are all dependent on groundwater for water supply, contamination of groundwater can have potentially significant environmental and human health consequences.

Known or suspected areas of soil contamination will also be visited.

Observations of soil staining, surface drainage pathways, and nearby monitoring wells will be made. Soil sampling activities will also be observed.

Several areas of specific interest have been identified through review of the data received thus far. These include:

- Solvent contaminated groundwater plume adjacent to hazardous waste management facility.
- Tritium contamination of off-site monitoring wells from sewage treatment plant discharge.
- Groundwater recharge areas.
- Solvent contamination of water supply wells.
- Potential groundwater contamination from radioactive wastewater.

Discussions will be held with personnel from Safety and Environmental Protection, facility management, and facility operations.

10.2 Records Required

Files will be reviewed as part of the Survey including documents not yet reviewed or received (e.g., classified documents, individual files, documents not yet identified). Specific documents and files to be reviewed as part of the Survey include, but will not be limited to, the following:

- Sampling procedures and analytical protocol
- Well construction (as built) diagrams and current well locations
- Chemical analytical data for soils, groundwater, and/or springs
- Additional geologic and/or hydrogeologic investigations, as available
- Groundwater and soil monitoring program plan

- Identified areas of radioactive contamination shown by aerial radiation Surveys.
- Potential groundwater contamination from any leakage from radioactive waste transfer lines.
- Groundwater radionuclide contamination from 650 sump releases, and "chemical holes" at old landfill.

APPENDIX D

COMMENTS FROM USEPA, NYSDEC, BROOKHAVEN TOWN, AND SUFFOLK COUNTY DURING PRE-SURVEY SITE VISIT

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COMMENTS FROM USEPA, NYSDEC, BROOKHAVEN TOWN, AND SUFFOLK COUNTY DURING PRE-SURVEY SITE VISIT

D.1 Comments from March 10, 1987 Meeting with State and Federal Agencies

D.1.1 Site-Specific Issues

- Due to inactive waste disposal sites, BNL has been placed on the state Superfund list.
- Explained Suffolk County's concerns regarding discharge of radioactivity from sewage treatment plant, discharge of toxic or radioactive contaminants into septic systems, presence of alleged dumping pits for radioactive materials, and unaccounted-for radioactive air emissions.

D.1.2 Survey-Related Issues

- Expressed interest in how the Survey would solicit comments from individuals living on or near the Peconic River downstream of the site.
- Explained that there is a public perception problem regarding both off-site and on-site contamination, especially the latter.

D.2 Comments from March 11,1987 Meeting with Suffolk County and Brookhaven Town

D.2.1 Site-Specific Issues

(The majority of the site-specific issues were identified in a report entitled, "Preliminary Report, Findings and Recommendations by the Task Force Appointed by Presiding Officer Gregory J. Blass to Investigate Brookhaven National Laboratory, November 13, 1986.")

- Contamination in the 650 Sump Area
- Elevated levels of Strontium-90 in Well WL as a result of accidental injection of radioactive wastes into two monitoring wells.
- Contamination of the waste management site with tritium.
- Contamination of two off-site residential wells with tritium and organic solvents.
- Organic contamination plume emanating from the Hazardous Waste Management Area.
- Jurisdiction of Suffolk County over BNL activities.
- Discharge of toxic or radioactive substances into septic systems.
- Private citizen concerns over radioactive emissions and toxic dumping.
- Discharge of a wide variety of hazardous, toxic, and radioactive substances, over the years, from a large number of sources into groundwaters or surface waters.
- Disposal of large quantities of materials, including toxic and hazardous wastes in landfills.
- Off-site groundwater contamination as a result of organic chemical discharges from the sewage treatment plant leaching beds.
- Disposal of wastes into drains of unsewered buildings.
- Use of dilution to minimize the contamination impact of discharges from the sewage treatment plant.

- BNL view that contamination is not a problem of significance to the community as long as it is confined to BNL property.

- Reluctance of BNL to allow County surveillance or inspections.

- Lack of a BNL survey to identify past activities that may have resulted in the release of toxic materials into the environment.

- Lack of a building-by-building survey of air emissions.

- Lack of a state-certified laboratory for conducting monitoring analyses.

- Concern that 50 percent of the Cesium-137 radioactivity found in Peconic Lake was directly related to BNL activities.

- Historic emphasis on radioactive monitoring rather than chemical contamination, even though BNL has always used large volumes of chemicals.

- Groundwater monitoring wells not properly located or deep enough to adequately detect or define known or suspected contamination.

- Inadequate investigation of known or suspected sources of contamination.

- Sewage collection system, due to old age, may be a significant source of groundwater pollution.

- Lack of implementation of Suffolk County's Article 7 regarding storage of hazardous chemicals.

- Minimal inspections and monitoring by the state.

- Failure of annual environmental monitoring reports to cover all environmental problems.

- Lack of written documentation from BNL officials.

- Lack of a historical search to determine waste disposal practices at Camp Upton prior to DOE occupancy.

- Contamination of sediments and aquatic life in the Peconic River from the sewage treatment plant.

- Acceptability of the landfill closure plan.

- Lack of information on fuel leaks and spills.

- Delay in detecting off-site groundwater contamination due to insulation of BNL by a large block of property.

- Need for a building-by-building inspection to ensure that connections to cesspools no longer exist.

- Need to investigate whether roof drains have been tapped into and are a source of contamination.

- Disposal of sludge from the sewage treatment plant.

- Need to know location of old fuel tanks.

- Need adequate program for all underground tanks.

D.2.2 Survey-Related Issues

- Expressed concern that the Survey would wait 2½ years to rank findings and that, in time, pollution could spread and th ost of corrective action could increase.

- Asked if the county could get reimbursed for money spent to provide drinking water to local residents if DOE later determined that this was an appropriate action.

- Offered assistance for well drilling and sampling operations.

- Expressed strong interest in having the opportunity to review the Survey plan and the Preliminary Report.

- Explained that there is heavy pressure on the county from the public to know what is going on at BNL.

- Provided information on aerial survey study that is under way.

- Asked if the Survey could do a rigorous review of aerial photographs that are being assembled by the county.

- Asked if Survey would include off-site areas.

- Offered access to county files.

- Asked if the the Survey would look at the present use of buildings as well as trace the history of each building and associated discharges.

- Hoped that the Survey would not be just a listing of what is already known and that each of the known problems would be explored to conclusion.

APPENDIX E

CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS

APPENDIX E

CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS

α	Alpha
ADD	Accelerator Development Department
AEA	Atomic Energy Act
Ag	Silver
AGS	Alternating Gradient Synchrotron
AIRDOS	Estimation of radiation doses caused by airborne radionuclides in areas surrounding nuclear facilities
ALF	Alternate Liquid Fuel
ALARA	As Low as Reasonably Achievable
amu	Atomic mass units
Ar^{-41}	Argon (Nuclide, atomic weight = 41)
As	Arsenic
Avg.	Average
β	Beta
Be	Beryllium
BGRR	Brookhaven Graphite Research Reactor
BLIP	Brookhaven Linear Isotope Production Facility
BNL	Brookhaven National Laboratory
CaF_2: Dy	Calcium fluoride - dysprosium
Cd	Cadmium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
Ci	Curie(s)
CLIF	Chemistry Linac Irradiation Facility
cm	Centimeter(s)
Cr	Chromium
Cs	Cesium
CSF	Central Steam Facility
Cu	Copper
cu ft	Cubic Feet
cu yd	Cubic Yard(s)

APPENDIX E
CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS
PAGE TWO

d	Disintegration(s)
d/m/g	Disintegrations per minute per gram
d/m/100 ml	Disintegrations per minute per 100 milliliters
DAS	Department of Applied Sciences
DOE	Department of Energy
DOT	Department of Transportation
DRE	Destruction Removal Efficiency
DWS	Drinking Water Standards
EMR	Environmental Monitoring Report
EP	Extraction procedure
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
Fe	Iron
FEIS	Final Environmental Impact Statement
ft	Foot (feet)
ft^2	Square foot (feet)
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal year
γ	Gamma
Gal	Gallon(s)
GeV	Giga-electron-volt(s)
Gpd	Gallons per day
Gpm	Gallons per minute
Gross α	Total alpha activity
Gross β	Total beta activity
Ha	Hectare(s)
HEPA	High Efficiency Particulate Air Filter
HF	Hydrofluoric acid; hydrogen fluoride gas
HFBR	High Flux Beam Reactor
Hg	Mercury

APPENDIX E
CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS
PAGE THREE

HNO_3	Nitric acid
hr	Hour(s)
HT	Tritium gas
HTO	Tritiated water
HWMA	Hazardous Waste Management Area
ICRP	International Commission for Radiological Protection
in	Inch(es)
Kg	Kilogram(s)
Kg/year	Kilogram(s)/year
Km	Kilometer(s)
l	Liter(s)
lb	Pound(s)
LFS	Light Feed Stock
LINAC	Linear Accelerator
LLW	Low level waste
m	Meter(s)
m^2	Square meter(s)
µCi	Microcurie(s)
µCi/sec	Microcuries/second
m^3d^{-1}	Cubic meters per day
MeV	Million electron volt(s)
mg/l	Milligrams per liter
µmhos/cm	Micromhos per centimeter
mi	Miles
min	Minute(s)
ml	Milliliter(s)
MLD	Million liters per day
Mn	Manganese
MRC	Medical Research Center
mrem	Millirem
MRR	Medical Research Reactor
MW	Megawatt

APPENDIX E
CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS
PAGE FOUR

Na	Sodium
NE	Northeast
NCRP	National Council on Radiation Protection
NEPA	National Environmental Protection Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NNE	North-Northeast
NNW	North-Northwest
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NSLS	National Synchrotron Light Source
NY	New York
NW	Northwest
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDWS	New York State Drinking Water Standards
O^{-15}	Oxygen (Nuclide with atomic weight of 15)
Pb	Lead
PBB	Polybrominated biphenyl
PCB	Polychlorinated biphenyl
pCi	Picocurie(s)
pCi/kg	Picocuries per kilogram
pCi/m^3	Picocuries per cubic meter
pH	Negative logarithm of the hydrogen ion concentration
PIC	Product of incomplete combustion
POHC	Principal Organic Hazardous Constituent
ppm	Parts per million
psig	Pounds per square inch (gauge)
PVC	Polyvinyl chloride
QA	Quality assurance
Ra	Radium
RCG	Radiation Concentration Guideline

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CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS
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RCRA	Resource Conservation and Recovery Act
Rem	Roentgen Equivalent Man
RWDF	Radioactive Wastewater Distillation Facility
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHS	Suffolk County Department of Health Services
S.E.	Standard Error
SE	Southeast
SEP	Safety and Environmental Protection Division
SFMP	Surplus Facilities Management Program
SPDES	State Pollutant Discharge Elimination System
SSE	South-Southeast
SSW	South-Southwest
SPS	Special Program Services
Sr	Strontium
^{90}Sr	Strontium-90
STP	Sewage treatment plant
SW	Southwest
SWMU	Solid Waste Management Unit
TCDD	Tetrachlorodibenzo-p-dioxin
TCE	Trichloroethylene
TCLP	Toxicity Characteristics Leaching Procedure
TLD	Thermoluminescent dosimeters
TSCA	Toxic Substances Control Act
TSS	Total suspended solids
U	Uranium
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground storage tank
UV	Ultraviolet
VOC	Volatile Organic Compounds
VUV	Vacuum Ultraviolet

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CHEMICAL SYMBOLS, ACRONYMS, AND ABBREVIATIONS
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WAA	Waste Accumulation Areas
WCF	Waste Concentration Facility
WNW	West-Northwest
Zn	Zinc
%	Percent
^{3}H	Tritium
^{137}Cs	Cesium-137
^{60}Co	Cobalt-60
^{22}Na	Sodium -22
^{7}Be	Beryllium-7
°C	Degree Celsius (or degree centigrade)
°F	Degree Fahrenheit
<	Less than
~	Approximately

APPENDIX F

RADIATION EXPOSURE AND DOSE TERMS

APPENDIX F
RADIATION EXPOSURE AND DOSE TERMS

When discussing radiation exposure and dose there are several terms which must be defined to provide a basic understanding of dose assessment methodologies. For the purposes of this report, the following definitions and discussion are the basis for describing exposure and dose.

Three terms that describe units for measuring radiation are roentgen, rad, and rem. Roentgen is a unit of exposure, while rad and rem are units of dose. Therefore, before these units can be defined, it is necessary to know the difference between exposure and dose. Exposure is a measure of the radiation to which an object is exposed whereas dose is a measure of the radiation that actually interacts with the object.

The Roentgen (R) is a unit of exposure to ionizing radiation. It is that amount of x-ray or gamma radiation required to produce ions carrying one electrostatic unit of electrical charge in 1 cubic centimeter of dry air under standard conditions. It can be related to the rad and the rem. This unit is found on the indicators of many radiation detection instruments. Radiation readings in mR/hr (milliroentgens per hour) or μR/hr (microroentgens per hour) are frequently reported for penetrating radiation (x-ray or gamma).

Rad (acronym for radiation absorbed dose) - The basic unit of absorbed dose of ionizing radiation. A dose of one rad means the absorption of 100 ergs of radiation energy per gram of absorbing material. Although the rad is a measure of ionization produced, it does not give any information about the biological effects of the radiation that is absorbed.

Rem (acronym for roentgen equivalent man) - The unit dose of any ionizing radiation which produces the same biological effect as a unit of absorbed dose of ordinary x-rays. Rem is equal to the dose in rads multiplied by an appropriate quality factor, which takes into account the type and energy level of radiation causing the dose. Quality factors associated with each specific type of radiation are listed below:

Radiation Type	Quality Factor
Gamma and X-ray	1
Beta	1
Thermal Neutron	3
Fast Neutron	10
Alpha	20

Generally speaking, the higher the quality factor, the more harmful that radiation type is.

For example, if a person is exposed to 0.02 R of gamma radiation, 0.05 rad of beta radiation, 0.03 rad of thermal neutron radiation, and 0.01 rad of fast neutron radiation, the total dose in rems (for gamma radiation, roentgen (R) is equivalent to rad) is as follows:

	Rad Dose		QF		Rem Dose
Gamma	0.02	x	1	=	0.02
Beta	0.05	x	1	=	0.05
Thermal Neutrons	0.03	x	3	=	0.09
Fast Neutrons	0.01	x	10	=	0.10
TOTAL DOSE					**0.25 rem**

As mentioned in the definitions for rem, dose equivalent (usually expressed in rem) is the product of the absorbed dose (in rads) in the tissue of interest, and a quality factor (as described above).

Committed Dose Equivalent - The integrated total of the dose-equivalent rate, usually over a long time period, in a particular tissue following the ingestion or inhalation of radioactive material into the body. Ingestion or inhalation of radioactive material produces an internal dose (one which becomes part of the body) versus exposure to gamma and/or x-rays from sources producing an external dose (one which does not become part of the body and ceases when the individual moves away from the source). In keeping with ICRP recommendation, for DOE, this "committed" period is set at 50 years. The dose equivalent rate will decrease each year as a result of radioactive and biological decay.

In an effort to have a way of measuring, on an equal basis, the biological effects of radionuclides that affect only particular organs/tissues (so-called target organ irradiators) versus being distributed equally throughout the entire body (so-called whole-body irradiators), the concept of "Effective" dose-equivalent was proposed. Target Organ irradiators are materials which primarily concentrate biologically in one particular organ, such as strontium-90 in bones. Whole-body irradiators are materials that have no affinity for a particular organ and distribute somewhat evenly throughout the entire body such as tritium.

Effective Dose Equivalent (EDE) is a quantity defined by the sum

$$EDE = \Sigma W_T H_T \text{ (for all tissues affected)}$$

Where W_T is the weighting factor specified by the ICRP to represent the fraction of the total risk for the entire body resulting from irradiation of tissue T, and H_T is the average dose-equivalent in tissue T. H_T may be from external or internal sources. Values of W_T are listed below:

Tissues	Weighting Factors
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lungs	0.12
Thyroid	0.03
Bone surfaces	0.03
Each of up to 5 organs with the next highest dose equivalent	0.06

An example of Effective Dose Equivalent calculation for hypothetical ingestion of 1 microcurie of strontium-90 is as follows:

Tissue	Weighting Factor	Strontium-90 Tissue Dose Equivalent		Product
Red bone marrow	0.12	0.7 rem	=	0.084 rem
Bone surfaces	0.03	1.6 rem	=	0.048 rem
Whole-Body Effective Dose-Equivalent				0.132 rem

This hypothetical example shows that the tissue dose equivalent from ingesting 1 μCi of strontium-90 to the red bone marrow and bone surfaces is equivalent to a whole-body exposure of 0.132 rem.

Committed Effective Dose-Equivalent - The sum of committed dose-equivalent to individual tissues resulting from an intake, each multiplied by the appropriate weighting factor, W_T. As mentioned earlier, DOE has set the committed dose period at 50 years and takes into account radioactive and biological decays.

Collective Effective Dose-Equivalent - The collective effective dose-equivalent is equal to the integrated sum of individual effective dose-equivalent times the number of individuals exposed. For DOE purposes, the collective effective dose-equivalent includes those people living within 80 km (50m) distance from site boundaries and for 50 years following each year's release. Other terms that have been used to describe this are "population effective dose-equivalent" and collective "committed" effective dose-equivalent which, in the latter case, is intended to highlight the fact that it is not a single year's calculation.

For example, if the effective dose-equivalent attributable to natural background radiation in a particular area is 189 mrem and the population in that area is 210,000 people, the collective effective dose-equivalent is 189 mrem x 210,000 people = 39,690,000 person-mrem (or more commonly 39,690 person-rem).

END

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