

Contents

Executive Summary	iii
Acknowledgments	xv
List of Figures	xxiii
List of Tables.....	xxv

CHAPTER 1: INTRODUCTION

1.1 Laboratory Mission.....	1-1
1.2 History	1-2
1.3 Research and Discoveries.....	1-4
1.4 Facilities and Operations	1-4
1.5 Location, Local Population, and Local Economy	1-8
1.6 Geology and Hydrology	1-9
1.7 Climate.....	1-10
1.8 Natural Resources.....	1-12
1.9 Cultural Resources.....	1-12
References and Bibliography	1-13

CHAPTER 2: ENVIRONMENTAL MANAGEMENT SYSTEM

2.1 Integrated Safety Management, ISO 14001, and OHSAS 18001	2-2
2.2 Environmental, Safety, Security, and Health Policy.....	2-2
2.3 Planning.....	2-3
2.3.1 Environmental Aspects.....	2-3
2.3.2 Legal and Other Requirements.....	2-3
2.3.3 Objectives and Targets	2-3
2.3.4 Environmental Management Programs.....	2-5
2.3.4.1 Compliance.....	2-6
2.3.4.2 Groundwater Protection.....	2-6
2.3.4.3 Waste Management.....	2-6
2.3.4.4 Pollution Prevention and Waste Minimization.....	2-8
2.3.4.5 Water Conservation	2-13
2.3.4.6 Energy Management and Conservation.....	2-13
2.3.4.7 Natural and Cultural Resource Management Programs	2-17
2.3.4.8 Environmental Restoration	2-17
2.3.4.9 EPA Performance Track Program.....	2-18
2.4 Implementing the Environmental Management System.....	2-18
2.4.1 Structure and Responsibility	2-18
2.4.2 Communication and Community Involvement.....	2-20

2.4.2.1	Communication Forums	2-20
2.4.2.2	Community Involvement in Cleanup Projects.....	2-21
2.4.3	Monitoring and Measurement	2-22
2.4.3.1	Compliance Monitoring.....	2-24
2.4.3.2	Restoration Monitoring.....	2-25
2.4.3.3	Surveillance Monitoring	2-25
2.4.4	EMS Assessments	2-25
2.5	Environmental Stewardship at BNL.....	2-26
	References and Bibliography	2-27

CHAPTER 3: COMPLIANCE STATUS

3.1	Compliance with Requirements.....	3-2
3.2	Environmental Permits	3-2
3.2.1	Existing Permits	3-2
3.2.2	New or Modified Permits	3-5
3.2.2.1	Air Emissions Permits	3-5
3.2.2.2	SPDES Permits	3-7
3.2.2.3	NESHAPs Authorization	3-8
3.3	NEPA Assessments	3-8
3.4	Preservation Legislation	3-8
3.5	Clean Air Act	3-9
3.5.1	Conventional Air Pollutants	3-9
3.5.1.1	Boiler Emissions.....	3-9
3.5.1.2	Ozone-Depleting Substances	3-9
3.5.2	Hazardous Air Pollutants.....	3-10
3.5.2.1	Maximum Available Control Technology.....	3-10
3.5.2.2	Asbestos	3-10
3.5.2.3	Radioactive Airborne Emissions.....	3-11
3.6	Clean Water Act.....	3-11
3.6.1	Sewage Treatment Plant.....	3-11
3.6.1.1	Chronic Toxicity Testing	3-12
3.6.2	Recharge Basins and Stormwater	3-16
3.7	Safe Drinking Water Act.....	3-18
3.7.1	Potable Water	3-18
3.7.2	Cross-Connection Control.....	3-20
3.7.3	Underground Injection Control	3-23
3.8	Preventing and Reporting Spills	3-24
3.8.1	Preventing Oil Pollution and Spills.....	3-24
3.8.2	Emergency Reporting Requirements	3-25
3.8.3	Spills and Releases.....	3-25

3.8.4 Major Petroleum Facility License	3-27
3.8.5 Chemical Bulk Storage	3-27
3.8.6 County Storage Requirements.....	3-28
3.9 RCRA Requirements	3-28
3.10 Polychlorinated Biphenyls.....	3-28
3.11 Pesticides	3-29
3.12 Wetlands and River Permits.....	3-29
3.13 Protection of Wildlife	3-29
3.13.1 Endangered Species Act.....	3-29
3.13.2 Migratory Bird Treaty Act.....	3-31
3.13.3 Bald and Golden Eagle Protection Act.....	3-31
3.14 External Audits and Oversight	3-31
3.14.1 Regulatory Agency Oversight	3-31
3.14.2 DOE Assessments/Inspections	3-31
3.14.2.1 Environmental Multi-Topic Assessment.....	3-32
3.14.2.2 Nevada Test Site Inspection.....	3-32
3.15 Enforcement Actions and agreements	3-33
References and Bibliography	3-33

CHAPTER 4: AIR QUALITY

4.1 Radiological Emissions	4-1
4.1.1 Brookhaven Medical Research Reactor	4-1
4.1.2 High Flux Beam Reactor.....	4-3
4.1.3 Brookhaven Linac Isotope Producer	4-4
4.1.4 Evaporator Facility.....	4-4
4.1.5 Target Processing Laboratory.....	4-4
4.1.6 Additional Minor Sources	4-5
4.1.7 Nonpoint Radiological Emission Sources.....	4-5
4.2 Facility Monitoring.....	4-5
4.3 Ambient Air Monitoring	4-6
4.3.1 Gross Alpha and Beta Airborne Activity.....	4-7
4.3.2 Airborne Tritium	4-7
4.4 Nonradiological Airborne Emissions.....	4-8
References and Bibliography.....	4-10

CHAPTER 5: WATER QUALITY

5.1 Surface Water Monitoring Program.....	5-1
5.2 Sanitary System Effluents.....	5-2
5.2.1 Sanitary System Effluent – Radiological Analyses.....	5-3
5.2.2 Sanitary System Effluent – Nonradiological Analyses	5-8

5.3 Process-Specific Wastewater	5-8
5.4 Recharge Basins.....	5-11
5.4.1 Recharge Basins – Radiological Analyses	5-12
5.4.2 Recharge Basins – Nonradiological Analyses.....	5-12
5.4.3 Stormwater Assessment	5-14
5.5 Peconic River Surveillance.....	5-14
5.5.1 Peconic River – Radiological Analyses	5-17
5.5.2 Peconic River – Nonradiological Analyses.....	5-19
References and Bibliography.....	5-23

CHAPTER 6: NATURAL AND CULTURAL RESOURCES

6.1 Natural Resource Management Program.....	6-1
6.1.1 Identification and Mapping	6-1
6.1.2 Habitat Protection and Enhancement.....	6-2
6.1.2.1 Salamander Protection Efforts.....	6-2
6.1.2.2 Other Species.....	6-3
6.1.2.3 Migratory Birds	6-4
6.1.3 Population Management.....	6-5
6.1.3.1 Wild Turkey	6-5
6.1.3.2 White-Tailed Deer.....	6-5
6.1.4 Compliance Assurance and Potential Impact Assessment.....	6-6
6.2 Upton Ecological and Research Reserve.....	6-6
6.3 Monitoring Flora and Fauna	6-7
6.3.1 Deer Sampling.....	6-7
6.3.1.1 Cesium-137 in White-Tailed Deer.....	6-7
6.3.1.2 Strontium-90 in Deer Bone.....	6-14
6.3.2 Other Animals Sampled	6-14
6.3.4 Fish Sampling	6-14
6.3.4.1 Radiological Analysis of Fish.....	6-15
6.3.4.2 Fish Population Assessment	6-15
6.3.4.3 Nonradiological Analysis of Fish	6-15
6.3.5 Aquatic Sampling.....	6-21
6.3.5.1 Radiological Analysis.....	6-21
6.3.5.2 Metals in Aquatic Samples	6-21
6.3.5.3 Pesticides and PCBs in Aquatic Samples	6-22
6.3.6 Peconic River Post-Cleanup Monitoring	6-22
6.3.6.1 Sediment Sampling.....	6-22
6.3.6.2 Water Column Sampling.....	6-22
6.3.6.3 Fish Sampling.....	6-24
6.3.6.4 Remedial Actions.....	6-24

6.3.7 Vegetation Sampling	6-24
6.3.7.1 Farm and Garden Vegetables	6-24
6.3.7.2 Grassy Plants	6-24
6.4 Other Monitoring	6-24
6.4.1 Soil Sampling	6-24
6.4.2 Basin Sediments	6-24
6.4.3 Chronic Toxicity Tests	6-25
6.4.4 Radiological and Mercury Monitoring of Precipitation	6-25
6.5 Wildlife Programs	6-26
6.6 Cultural Resource Activities	6-27
References and Bibliography	6-28

CHAPTER 7: GROUNDWATER PROTECTION

7.1 The BNL Groundwater Protection Management Program	7-1
7.1.1 Prevention	7-1
7.1.2 Monitoring	7-2
7.1.3 Restoration	7-2
7.1.4 Communication	7-2
7.2 Groundwater Protection Performance	7-2
7.3 Groundwater Monitoring	7-3
7.4 Facility Monitoring Program	7-3
7.5 CERCLA Monitoring Program	7-7
7.6 Groundwater Treatment Systems	7-8
References and Bibliography	7-11

CHAPTER 8: RADIOLOGICAL DOSE ASSESSMENT

8.1 Direct Radiation Monitoring	8-2
8.1.1 Ambient Radiation Monitoring	8-2
8.1.2 Facility Area Monitoring	8-4
8.2 Dose Modeling	8-7
8.2.1 Dose Modeling Program	8-8
8.2.2 Dose Calculation Methods and Pathways	8-10
8.2.2.1 Maximally Exposed Individual	8-10
8.2.2.2 Effective Dose Equivalent	8-10
8.2.2.3 Dose Calculation: Fish Ingestion	8-10
8.2.2.4 Dose Calculation: Deer Meat Ingestion	8-10
8.3 Sources: Diffuse, Fugitive, “Other”	8-10
8.3.1 Brookhaven Graphite Research Reactor (BGRR)	8-10
8.3.2 Waste Transfer Lines, Buildings 801 to 811	8-11

8.3.3 Waste Management Facility (Building 865)	8-12
8.3.4 Brookhaven Avenue Soil Removal	8-12
8.3.4 Cyclotron.....	8-13
8.4 Dose from Point Sources	8-13
8.4.1 Brookhaven Linac Isotope Producer.....	8-13
8.4.2 High Flux Beam Reactor.....	8-14
8.4.3 Brookhaven Medical Research Reactor	8-14
8.4.4 Unplanned Releases	8-14
8.5 Dose from Ingestion	8-14
8.6 Dose to Aquatic and Terrestrial Biota.....	8-14
8.7 Cumulative Dose	8-15
References and Bibliography.....	8-15

CHAPTER 9: QUALITY ASSURANCE

9.1 Quality Program Elements.....	9-1
9.2 Sample Collection and Handling.....	9-2
9.2.1 Field Sample Handling.....	9-3
9.2.1.1 Custody and Documentation	9-3
9.2.1.2 Preservation and Shipment	9-3
9.2.2 Field Quality Control Samples.....	9-3
9.2.3 Tracking and Data Management	9-4
9.3 Sample Analysis	9-5
9.3.1 Qualifications	9-5
9.4 Verification and Validation of Analytical Results.....	9-5
9.4.1 Checking Results.....	9-6
9.5 Contract Analytical Laboratory QA/QC.....	9-6
9.6 Performance or Proficiency Evaluations	9-6
9.6.1 Summary of Test Results.....	9-6
9.6.1.1 Radiological Assessments	9-7
9.6.1.2 Nonradiological Assessments	9-7
9.7 Audits.....	9-7
9.8 Conclusion.....	9-8
References and Bibliography	9-9
Appendix A: Glossary	A-1
Acronyms and Abbreviations.....	A-1
Technical Terms.....	A-4
Appendix B: Understanding Radiation.....	B-1
Appendix C: Units of Measure and Half-Life Periods	C-1
Appendix D: Federal, State, and Local Laws and Regulations Pertinent to BNL.....	D-1

List of Figures

Figure 1-1.	Major Scientific Facilities at BNL.....	1-6
Figure 1-2.	Major Support and Service Facilities at BNL.....	1-8
Figure 1-3.	BNL Groundwater Flow Map.....	1-10
Figure 1-4.	BNL Wind Rose (2009).....	1-11
Figure 1-5.	BNL 2009 Monthly Mean Temperature versus 60-Year Monthly Average.....	1-11
Figure 1-6.	BNL 2009 Annual Mean Temperature Trend (60 Years).....	1-11
Figure 1-7.	BNL 2009 Monthly Precipitation versus 60-Year Monthly Average.....	1-11
Figure 1-8.	BNL 2009 Annual Precipitation Trend (60 Years).....	1-11
Figure 2-1a.	Hazardous Waste Generation from Routine Operations, 1998 – 2009.....	2-7
Figure 2-1b.	Mixed Waste Generation from Routine Operations, 1998 – 2009.....	2-7
Figure 2-1c.	Radioactive Waste Generation from Routine Operations, 1998 – 2009.....	2-7
Figure 2-1d.	Hazardous Waste Generation from ER and Nonroutine Operations, 1998 – 2009.....	2-8
Figure 2-1e.	Mixed Waste Generation from ER and Nonroutine Operations, 1998 – 2009.....	2-8
Figure 2-1f.	Radioactive Waste Generation from ER and Nonroutine Operations, 1998 – 2009.....	2-8
Figure 2-2.	BNL Water Consumption Trend, 1998–2009.....	2-14
Figure 2-3.	BNL Building Energy Performance.....	2-16
Figure 3-1.	Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-13
Figure 3-2.	Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-14
Figure 3-3.	Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-14
Figure 3-4.	Maximum Concentrations of Mercury Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-14
Figure 3-5.	Maximum Concentrations of Nickel Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-15
Figure 3-6.	Maximum Concentrations of Silver Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-15
Figure 3-7.	Maximum Concentrations of Zinc Discharged from the BNL Sewage Treatment Plant, 2005–2009.....	3-15
Figure 4-1.	Air Emission Release Points Subject to Monitoring.....	4-2
Figure 4-2.	High Flux Beam Reactor Tritium Emissions, (1999–2009).....	4-3
Figure 4-3.	BNL On-Site Ambient Air Monitoring Stations.....	4-6
Figure 4-4.	Airborne Gross Beta Concentration Trend Recorded at Station P7.....	4-8
Figure 5-1.	Schematic of BNL’s Sewage Treatment Plant (STP).....	5-2
Figure 5-2.	Tritium Concentrations in Effluent from the BNL Sewage Treatment Plant (2009).....	5-5
Figure 5-3.	Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1994–2009).....	5-6
Figure 5-4.	Tritium Released to the Peconic River, 15-Year Trend (1995–2009).....	5-6
Figure 5-5.	Cesium-137 in the BNL Sewage Treatment Plant Influent and Effluent (1995–2009).....	5-6
Figure 5-6.	BNL Recharge Basin/Outfall Locations.....	5-10
Figure 5-7.	Schematic of Potable Water Use and Flow at BNL.....	5-11
Figure 5-8.	Sampling Stations for Surface Water, Fish, and Shellfish.....	5-18

Figure 6-1.	Deer Sample Locations, 2005—2009.	6-9
Figure 6-2.	Comparison of Cs-137 Average Concentrations in Deer, 2009.....	6-13
Figure 6-3.	Ten-Year Trend of Cs-137 Concentrations in Deer Meat at BNL and Within 1 Mile of BNL.....	6-13
Figure 6-4.	Peconic River Post Cleanup Mercury Distribution in Fish Species (Minimum, Maximum, and Average Values).....	6-21
Figure 7-1.	Groundwater Flow and Water Table Elevation (June 2009) with Supply and Remediation Wells Shown.	7-4
Figure 7-2.	Extent of VOC Plumes.....	7-5
Figure 7-3.	Extent of Radionuclide Plumes.	7-6
Figure 7-4.	Locations of BNL Groundwater Remediation Systems.	7-9
Figure 8-1.	On-Site TLD Locations.	8-2
Figure 8-2.	Off-Site TLD Locations.....	8-3
Figure 8-1.	On-Site Neutron TLD Locations.	8-8
Figure 9-1.	Flow of Environmental Monitoring QA/QC Program Elements.....	9-2
Figure 9-2.	Summary of Scores in the Radiological Proficiency Evaluation Programs.	9-8
Figure 9-3.	Summary of Scores in the Nonradiological Proficiency Evaluation Programs.	9-8

List of Tables

Table 2-1.	DOE Order 430.2B and Executive Order (EO) 13514 Goal Status.	2-4
Table 2-2.	BNL Pollution Prevention, Waste Reduction, and Recycling Programs.....	2-9
Table 2-3.	BNL Recycled Program Summary.	2-14
Table 2-4.	Summary of BNL 2009 Environmental Restoration Activities.....	2-19
Table 2-5.	Summary of BNL 2009 Sampling Program Sorted by Media.	2-23
Table 3-1.	Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL	3-2
Table 3-2.	BNL Environmental Permits.	3-6
Table 3-3.	Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001.	3-12
Table 3-4.	Analytical Results for Wastewater Discharges to Outfalls 002, 005 - 008, and 010.	3-16
Table 3-5.	Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).	3-19
Table 3-6.	Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables.	3-21
Table 3-7.	Summary of Chemical and Oil Spill Reports.	3-26
Table 3-8.	Existing Agreements and Enforcement Actions Issued to BNL, with Status.....	3-32
Table 4-1.	Airborne Radionuclide Releases from Monitored Facilities.....	4-3
Table 4-2.	Gross Activity in Facility Air Particulate Filters.	4-5
Table 4-3.	Gross Activity Detected in Ambient Air Monitoring Particulate Filters.	4-7
Table 4-4.	Ambient Airborne Tritium Measurements in 2009.	4-8
Table 4-5.	Central Steam Facility Fuel Use and Emissions (2000 – 2009).	4-10
Table 5-1.	Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).....	5-4
Table 5-2.	Gamma-Emitting Radionuclides and Strontium-90 in Water at the BNL Sewage Treatment Plant.....	5-7
Table 5-3.	BNL Sewage Treatment Plant (STP) Water Quality and Metals Analytical Results.....	5-9
Table 5-4.	Radiological Analysis of Samples from On-Site Recharge Basins at BNL.	5-12
Table 5-5.	Water Quality Data for BNL On-Site Recharge Basin Samples.	5-13
Table 5-6.	Metals Analysis of Water Samples from BNL On-Site Recharge Basins.....	5-15
Table 5-7.	Radiological Results for Surface Water Samples from the Peconic and Carmans Rivers.	5-19
Table 5-8.	Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.....	5-20
Table 5-8.	Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.....	5-20
Table 5-9.	Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers.....	5-21
Table 6-1.	New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL.....	6-2
Table 6-2.	Radiological Analyses of Deer Tissue (Flesh, Liver, Bone).	6-10
Table 6-3.	Radiological Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.	6-16
Table 6-4.	Surveillance Monitoring Metals Analysis of Fish from the Peconic River System and Carmans River, Lower Lake.	6-18
Table 6-5.	Mercury Analysis of Fish from the Peconic River System Post Cleanup Monitoring.	6-20
Table 6-6.	Radiological Analysis of Aquatic Vegetation and Sediment from the Peconic River System and Carmans River, Lower Lake.....	6-22
Table 6-7.	Metals Analysis of Aquatic Vegetation and Sediment from the Peconic River System and Carmans River, Lower Lake.....	6-23
Table 6-8.	Radiological Analysis of Farm and Garden Vegetables and Associated Soils.....	6-25
Table 6-9.	Precipitation Monitoring (Radiological and Mercury).....	6-26

Table 7-1. Summary of BNL Groundwater Monitoring Program, 2009.....	7-2
Table 7-2. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2009.....	7-10
Table 8-1. On-Site Direct Ambient Radiation Measurements.....	8-4
Table 8-2. Off-Site Direct Radiation Measurements.....	8-6
Table 8-3. Facility Area Monitoring.....	8-7
Table 8-4. Maximally Exposed Individual Effective Dose Equivalent From Facilities or Routine Processes.....	8-9
Table 8-5. BNL Site Dose Summary.....	8-15