

Contents

Message from the Laboratory Director	iii
Executive Summary	v
Acknowledgments	xvii
List of Figures	xxv
List of Tables.....	xxvii

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.....	1-5
1.6 Geology and Hydrology.....	1-8
1.7 Climate.....	1-10
1.8 Natural Resources	1-11
1.9 Cultural Resources	1-13
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	2-5
2.3 Planning	2-5
2.3.1 Environmental Aspects	2-5
2.3.2 Legal and Other Requirements	2-6
2.3.3 Objectives and Targets.....	2-6
2.3.4 Environmental Management Programs	2-6
2.3.4.1 Compliance.....	2-7
2.3.4.2 Groundwater Protection	2-7
2.3.4.3 Waste Management	2-7
2.3.4.4 Pollution Prevention and Minimization	2-8
2.3.4.5 Water Conservation	2-14
2.3.4.6 Energy Management and Conservation	2-15
2.3.4.7 Natural and Cultural Resource Management Programs	2-17
2.3.4.8 Environmental Restoration.....	2-18
2.3.4.9 EPA Performance Track Program.....	2-19
2.4 Implementing the Environmental Management System.....	2-21

2.4.1	Structure and Responsibility.....	2-21
2.4.2	Communication and Community Involvement	2-21
2.4.2.1	Communications Forums	2-21
2.4.2.2	Community Involvement in Cleanup Projects	2-22
2.4.3	Monitoring and Measurement.....	2-22
2.4.3.1	Compliance Monitoring	2-23
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.....	3-1
3.2	Environmental Permits.....	3-2
3.2.1	Existing Permits.....	3-2
3.2.2	New or Modified Permits.....	3-7
3.2.2.1	Wild Scenic Recreational Rivers Act	3-7
3.2.2.2	Air Emissions Permits	3-7
3.2.2.3	CERCLA Permits	3-7
3.3	NEPA Assessments	3-7
3.4	Preservation Legislation.....	3-7
3.5	Clean Air Act.....	3-8
3.5.1	Conventional Air Pollutants.....	3-8
3.5.1.1	Boiler Emissions	3-8
3.5.1.2	Ozone-Depleting Substances.....	3-9
3.5.2	Hazardous Air Pollutants	3-9
3.5.2.1	Maximum Available Control Technology	3-9
3.5.2.2	Asbestos.....	3-9
3.5.2.3	Radioactive Airborne Emissions	3-9
3.6	Clean Water Act	3-10
3.6.1	Sewage Treatment Plant	3-10
3.6.1.1	Chronic Toxicity Testing	3-14
3.6.2	Recharge Basins and Stormwater	3-14
3.7	Safe Drinking Water Act	3-14
3.7.1	Potable Water	3-16
3.7.2	Cross-Connection Control	3-16
3.7.3	Underground Injection Control.....	3-18
3.8	Preventing and Reporting Spills	3-22
3.8.1	Preventing Oil Pollution and Spills	3-22

3.8.2 Emergency Reporting Requirements	3-22
3.8.3 Spills and Releases	3-23
3.8.4 Major Petroleum Facility License	3-23
3.8.5 Chemical Bulk Storage	3-25
3.8.6 County Storage Requirements	3-25
3.9 RCRA Requirements.....	3-26
3.10 Polychlorinated Biphenyls.....	3-26
3.11 Pesticides.....	3-27
3.12 Wetlands and River Permits	3-27
3.13 Endangered Species Act.....	3-27
3.14 External Audits and Oversight	3-28
3.14.1 Regulatory Agency Oversight.....	3-28
3.14.2 DOE Assessments/Inspections.....	3-29
3.14.2.1 Environmental Multi-Topic Assessment.....	3-30
3.14.2.2 Nevada Test Site Inspection.....	3-31
3.15 Enforcement Actions and Agreements.....	3-31
References and Bibliography	3-31

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	4-5
4.3.1 Gross Alpha and Beta Airborne Activity	4-6
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.....	5-7
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	5-13
5.4.3	Stormwater Assessment.....	5-13
5.5	Peconic River Surveillance.....	5-18
5.5.1	Peconic River – Radiological Analyses.....	5-18
5.5.2	Peconic River – Nonradiological Analyses	5-20
	References and Bibliography.....	5-24

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.....	6-3
6.1.2.2	Eastern Box Turtle.....	6-3
6.1.2.3	Other Species.....	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.....	6-8
6.3.1.1	Cs-137 in White-Tailed Deer.....	6-8
6.3.1.2	Strontium-90 in Deer Bone.....	6-13
6.3.2	Small Mammal Sampling.....	6-13
6.3.3	Other Animals Sampled.....	6-14
6.3.4	Fish Sampling.....	6-14
6.3.4.1	Radiological Analysis of Fish.....	6-14
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.....	6-24
6.3.5.3	Pesticides and PCBs in Aquatic Samples.....	6-24
6.3.6	Peconic River Post-Cleanup Monitoring.....	6-24
6.3.6.1	Sediment Sampling.....	6-25
6.3.6.2	Water Column Sampling.....	6-26
6.3.6.3	Fish Sampling.....	6-26
6.3.6.4	Wetland Sampling.....	6-26

6.3.7 Vegetation Sampling	6-26
6.3.7.1 Garden Vegetables	6-26
6.3.7.2 Grassy Plants	6-27
6.4 Other Monitoring	6-27
6.4.1 Soil Sampling.....	6-27
6.4.2 Basin Sediments.....	6-27
6.4.3 Chronic Toxicity Tests	6-29
6.4.4 Radiological and Mercury Monitoring of Precipitation	6-29
6.5 Wildlife Programs	6-30
6.6 Cultural Resource Activities	6-32
References and Bibliography	6-32

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 Supplemental Monitoring of Water Supply Wells	7-3
7.4.1 Radiological Results	7-7
7.4.2 Nonradiological Results.....	7-7
7.5 Environmental Surveillance Program	7-8
7.6 Long Term Response Actions Groundwater Monitoring Program	7-9
7.7 Groundwater Treatment Systems	7-10
References and Bibliography.....	7-12

CHAPTER 8: RADIOLOGICAL DOSE ASSESSMENT

8.1 Direct Radiation Monitoring.....	8-2
8.1.1 Ambient Monitoring	8-2
8.1.2 Facility Area Monitoring	8-4
8.2 Dose Modeling.....	8-7
8.2.1 Dose Modeling Program.....	8-7
8.2.2 Dose Calculation Methods and Pathways.....	8-9
8.2.2.1 Maximally Exposed Individual	8-9
8.2.2.2 Effective Dose Equivalent.....	8-9
8.2.2.3 Dose Calculation: Fish Ingestion	8-9
8.2.2.4 Dose Calculation: Deer Meat Ingestion	8-9
8.3 Sources: Diffuse, Fugitive, “Other”.....	8-9

8.3.1 Medical Department	8-10
8.3.2 Waste Loading Area.....	8-10
8.4 Dose from Point Sources	8-11
8.4.1 Brookhaven Linac Isotope Producer	8-11
8.4.2 High Flux Beam Reactor	8-11
8.4.3 Brookhaven Medical Research Reactor.....	8-11
8.4.4 Unplanned Releases.....	8-11
8.5 Dose from Ingestion.....	8-11
8.6 Dose to Aquatic and Terrestrial Biota	8-12
8.7 Cumulative Dose	8-12
References and Bibliography	8-13

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.....	9-5
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	9-7
9.6.1.1 Radiological Assessments	9-7
9.6.1.2 Nonradiological Assessments	9-7
9.7 Audits	9-7
9.8 Conclusion	9-9
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.	1-9
Figure 1-4. BNL Wind Rose (2007).	1-10
Figure 1-5. BNL 2007 Monthly Mean Temperature versus 59-Year Monthly Average.	1-11
Figure 1-6. BNL 2007 Annual Mean Temperature Trend (59 Years).	1-11
Figure 1-7. BNL 2007 Monthly Precipitation versus 59-Year Monthly Average.	1-12
Figure 1-8. BNL 2007 Annual Precipitation Trend (59 Years).	1-12
Figure 2-1a. Hazardous Waste Generation from Routine Operations, 1998 – 2007.	2-8
Figure 2-1b. Mixed Waste Generation from Routine Operations, 1998 – 2007.	2-8
Figure 2-1c. Radioactive Waste Generation from Routine Operations, 1998 – 2007.	2-8
Figure 2-1d. Hazardous Waste Generation from ER and Nonroutine Operations, 1998 – 2007.	2-9
Figure 2-1e. Mixed Waste Generation from ER and Nonroutine Operations, 1998 – 2007.	2-9
Figure 2-1f. Radioactive Waste Generation from ER and Nonroutine Operations, 1998 – 2007.	2-9
Figure 2-2. BNL Water Consumption Trend, 1998–2007.	2-16
Figure 2-3. BNL Building Energy Performance, 1998–2010.	2-17
Figure 3-1. Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-12
Figure 3-2. Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-12
Figure 3-3. Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-12
Figure 3-4. Maximum Concentrations of Mercury Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-13
Figure 3-5. Maximum Concentrations of Nickel Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-13
Figure 3-6. Maximum Concentrations of Silver Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-13
Figure 3-7. Maximum Concentrations of Zinc Discharged from the BNL Sewage Treatment Plant, 2003–2007.	3-14
Figure 4-1. Air Emission Release Points Subject to Monitoring.	4-2
Figure 4-2. High Flux Beam Reactor Tritium Emissions, Ten-Year Trend (1998–2007).	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 (2007).	5-4
Figure 5-3. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1993–2007).	5-6
Figure 5-4. Tritium Released to the Peconic River, 15-Year Trend (1993–2007).	5-6
Figure 5-5. Cesium-137 in the BNL Sewage Treatment Plant Influent and Effluent (1993–2007).	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.....	5-19
Figure 6-1. Deer Sample Locations, 2003—2007.	6-9
Figure 6-2. Comparison of Cs-137 Average Concentrations in Deer, 2007.	6-12
Figure 6-3. Trend of Cs-137 Concentrations in Deer Meat at BNL and Within 1 Mile of BNL, 1998—2007.....	6-12
Figure 7-1. Groundwater Flow and Water Table Elevation (December 2007) 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.	7-11
Figure 8-1. On-Site TLD Locations.	8-2
Figure 8-2. Off-Site TLD Locations.....	8-3
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	Elements of the Environmental Management System (EMS) and their Relationship to OHSAS 18001 and Integrated Safety Management (ISM) – Review of EMS Implementation at BNL.	2-2
Table 2-2.	BNL Pollution Prevention, Waste Reduction, and Recycling Programs.	2-10
Table 2-3.	BNL Recycled Program Summary.....	2-15
Table 2-4.	Summary of BNL 2007 Environmental Restoration Activities.	2-19
Table 2-5.	Summary of BNL 2007 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.....	3-5
Table 3-3.	Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001.....	3-11
Table 3-4.	Analytical Results for Wastewater Discharges to Outfalls 002, 005 – 008, and 010.	3-15
Table 3-5.	Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).....	3-17
Table 3-6.	Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables.....	3-19
Table 3-7.	Summary of Chemical and Oil Spill Reports.	3-24
Table 3-8.	Existing Agreements and Enforcement Actions Issued to BNL, with Status.	3-30
Table 4-1.	Airborne Radionuclide Releases from Monitored Facilities.	4-3
Table 4-2.	Gross Activity in Facility Air Particulate Filters.....	4-7
Table 4-3.	Gross Activity Detected in Ambient Air Monitoring Particulate Filters.....	4-7
Table 4-4.	Ambient Airborne Tritium Measurements in 2007.	4-8
Table 4-5.	Central Steam Facility Fuel Use and Emissions (1996 – 2007).....	4-9
Table 5-1.	Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).	5-5
Table 5-2.	Gamma-Emitting Radionuclides and Sr-90 in Water at the BNL Sewage Treatment Plant...	5-8
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.	5-14
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.....	5-20
Table 5-8.	Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.	5-21
Table 5-9.	Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers.	5-22
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 Analyses of Fish from the Peconic River System.....	6-15
Table 6-4.	Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake. ..	6-16
Table 6-5.	Pesticide and PCB Analyses of Fish from the Peconic River System and Carmans River, Lower Lake.	6-22

Table 6-6. Radiological Analyses of Aquatic Vegetation and Sediment from the Peconic River and Carmans River System, Lower Lake.	6-24
Table 6-7. Metals Analyses of Aquatic Vegetation and Sediment from the Peconic River System and Carmans River, Lower Lake.	6-25
Table 6-8. Radiological Analyses of Garden Vegetables, Grassy Vegetation, and Associated Soils.	6-27
Table 6-9. Metals Analyses of Basin Sediment.....	6-28
Table 6-10. Semi-Volatile Organic Compounds Analyses of Basin Sediments.	6-29
Table 7-1. Summary of BNL Groundwater Monitoring Program, 2007.	7-2
Table 7-2. Potable Well Radiological Analytical Results.	7-7
Table 7-3. Potable Water Supply Wells Water Quality Data.....	7-8
Table 7-4. Total Metals Concentration Data for Potable Water Supply Well Samples.	7-9
Table 7-5. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2007.	7-12
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. MEI Effective Dose Equivalent From Facilities or Routine Processes.	8-8
Table 8-5. BNL Site Dose Summary.	8-13