Public Comment Period - April 1 to April 30, 1999

Proposed Plan for Operable Unit I and Radiologically Contaminated Soils

Brookhaven National Laboratory

Figure 1. *The Former Hazardous Waste Management Facility at Brookhaven National Laboratory (BNL). In the upper left of the photo is one of three landfills on BNL property that have been capped as part of the site-wide environmental cleanup.*

I. Introduction

This Proposed Plan describes remedies for certain contaminated areas at Brookhaven National Laboratory (BNL). These areas include Operable Unit I, which contains the Former Hazardous Waste Management Facility (Figure 1), radiologically contaminated soils, and an ash pit. (An Operable Unit is an administrative designation for a particular geographic area of the BNL site.) This Proposed Plan also includes Operable Unit VI, which contains areas that pose an ecological risk to the Tiger Salamander, a State endangered species. Since Operable Units II/VII and IV also have radiologically contaminated soils, their ***Areas of Concern*** (AOCs) have also been consolidated in this plan. Figure 2 shows the areas of concern that are discussed in this plan, as well as BNL's six Operable Units.

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Upcoming Meetings

See **page 2** for more information on the public meetings that will be held to discuss this document.

Public Meetings/ Poster Sessions*

Public Meeting

Berkner Hall, BNL
April 22, 1999
7:00 - 9:00 p.m.

Information Session

Berkner Hall, BNL
April 13, 1999
11:30 a.m. - 1:30 p.m.

Information Session

Berkner Hall, BNL
April 14, 1999
7:00 p.m. - 9:00 p.m.

** Briefings for other communities and groups can be arranged by calling BNL Community Relations at (516) 344-7459.*

Area of Concern (AOC) - a geographic area of BNL where there has been a release or the potential for a release of a hazardous substance, pollutant or contaminant including radionuclides

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - a federal law that establishes a program to identify, evaluate, and remediate sites where hazardous substances may have been released, leaked, poured, spilled, or dumped into the environment; also known as Superfund.

Administrative Record - documents including correspondence, public comments, and technical reports upon which the agencies base their remedial action selection.

This plan discusses the proposed remedies for cleanup of:

- radiologically contaminated soils
- minor areas of concern such as recharge basins, ecologically sensitive areas, and an ash pit
- final ***removal actions*** such as capping of landfills, excavation of disposal pits and a groundwater treatment system, and planned removal actions such as remediation of a medical isotope facility.

The U.S. Department of Energy (DOE), working with the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC), provides this Proposed Plan as its cleanup recommendation for these areas of concern. The DOE, with the concurrence of EPA and NYSDEC, will select the actual remedy only after the public comment period has ended. The proposed remedy may be modified or a different remedial action may be selected based upon public comments. The public is encouraged to review and comment on all alternatives identified here.

This Proposed Plan provides a description of site concerns and discussion of completed investigations, a summary of risk assessments performed, evaluations of remedial alternatives and recommendations for preferred alternatives.

This document is required by the Superfund Law (***Comprehensive Environmental Response, Compensation and Liability Act of 1980 or CERCLA***). It summarizes information from several reports which are listed at the end of this document. These and other related reports will be used to determine the final remedy. All reports used in this determination are included in the site's ***Administrative Record***. The Administrative Record is available for public review at locations listed on page 14 and at the end of this document (page 28).

II. Proposed Remedy

As shown in Figure 3, several areas at BNL contain soils that are contaminated with ***radionuclides*** above remediation goals. Six cleanup alternatives, which are discussed in Section VII, have been evaluated for these soils. In addition, alternatives have been developed and evaluated for an ash pit and several other minor areas of concern posing a risk to the Tiger Salamander. These alternatives are detailed in Section X.

Based on these detailed evaluations, proposed cleanup actions (called the remedy) have been recommended for these areas and are summarized below. The public is invited to comment on the proposed remedy as well as the other alternatives developed.

Radiologically Contaminated Soils

The proposed remedy for radiologically contaminated soils is **Large Scale Excavation and Off-site Disposal**. This alternative involves the excavation of approximately 39,000 cubic yards of contaminated soil and debris and transportation off site to a permitted facility for disposal. Out-of-service tanks and

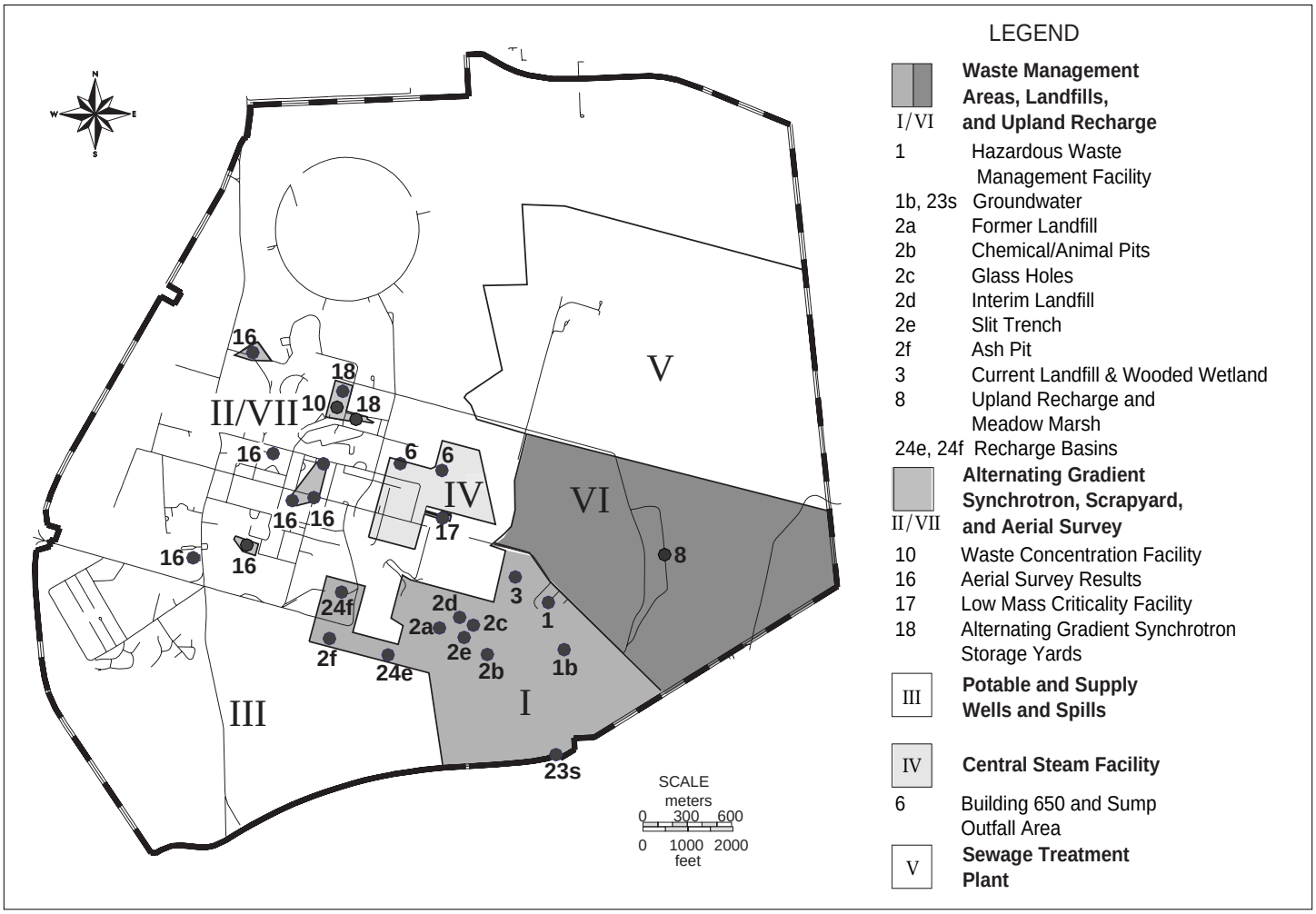

Figure 2. *BNL's six Operable Units are shown above. Also shown by circles are the areas of concern discussed in this Proposed Plan.*

underground pipelines associated with the Waste Concentration Facility (AOC 10B and 10C) will also be removed and disposed of off site. In addition, contaminated wetlands excavated at the Former Hazardous Waste Management Facility (AOC 1) would be rebuilt and replaced.

This alternative was selected because it provides protection from both direct exposure and groundwater infiltration risks and greatly reduces the future risks to the public if ***institutional controls*** are lost. It does this by removing all radiologically contaminated soils above the primary remediation goals from the site.

The excavation and transportation of large quantities of soil off site for disposal, while protective of local public health and safety, will involve some increased short term worker and transportation risks. The short-term impacts and risks of this alternative are outweighed by the long-term benefits of off-site disposal.

Some aspects of this proposed remedy may be modified. Improving technologies will continue to be evaluated during the design and implementation of the preferred remedy to reduce the volume and costs of radiologically contaminated soils requiring off-site disposal. For example, future improvements in soil sorting and/or washing technologies may result in decreased volumes of con-

removal actions - those actions taken early and/or quickly to prevent, minimize or mitigate damage to public health or the environment which may otherwise result from a release or threatened release of hazardous substances, pollutants or contaminants

radionuclide - an element such as cesium-137, strontium-90, radiium-226 or uranium-238, which breaks down to form another element and produces ionizing radiation due to its unstable nuclear structure.

institutional controls - controls and procedures established by BNL to prevent exposure of workers or the public to hazards. These may include fencing, postings or signing an entrance log to restrict entry into an area.

For More Information

For more information on this project in particular or Brookhaven National Laboratory's environmental restoration program in general, contact:

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taminated soils that require off-site disposal and thus reduce the total cost of the project. This will only be done with the concurrence of EPA and the State and will be documented if there is no fundamental change in the remedy.

Any radiologically contaminated soils associated with the Brookhaven Graphite Research Reactor (AOC 9) are not included in this Proposed Plan. These soils will be characterized and addressed during the decontamination and decommissioning of this facility. Also, contaminated soils in Operable Units III and V are addressed in their respective Proposed Plans.

Several active facilities identified during the Aerial Radiological Surveys and listed as sub-areas in AOC 16 do not require remediation. These facilities (such as sub-AOC 16D - Accelerator Storage) were identified during the Aerial Radiological Surveys because radiological work is currently performed in these facilities and they contain radioactive materials. There was no evidence of releases to the environment from these facilities and no specific sampling was performed as part of the Operable Unit II/VII remedial investigation. These facilities are monitored under BNL's routine environmental monitoring program and corrective actions will be taken if needed.

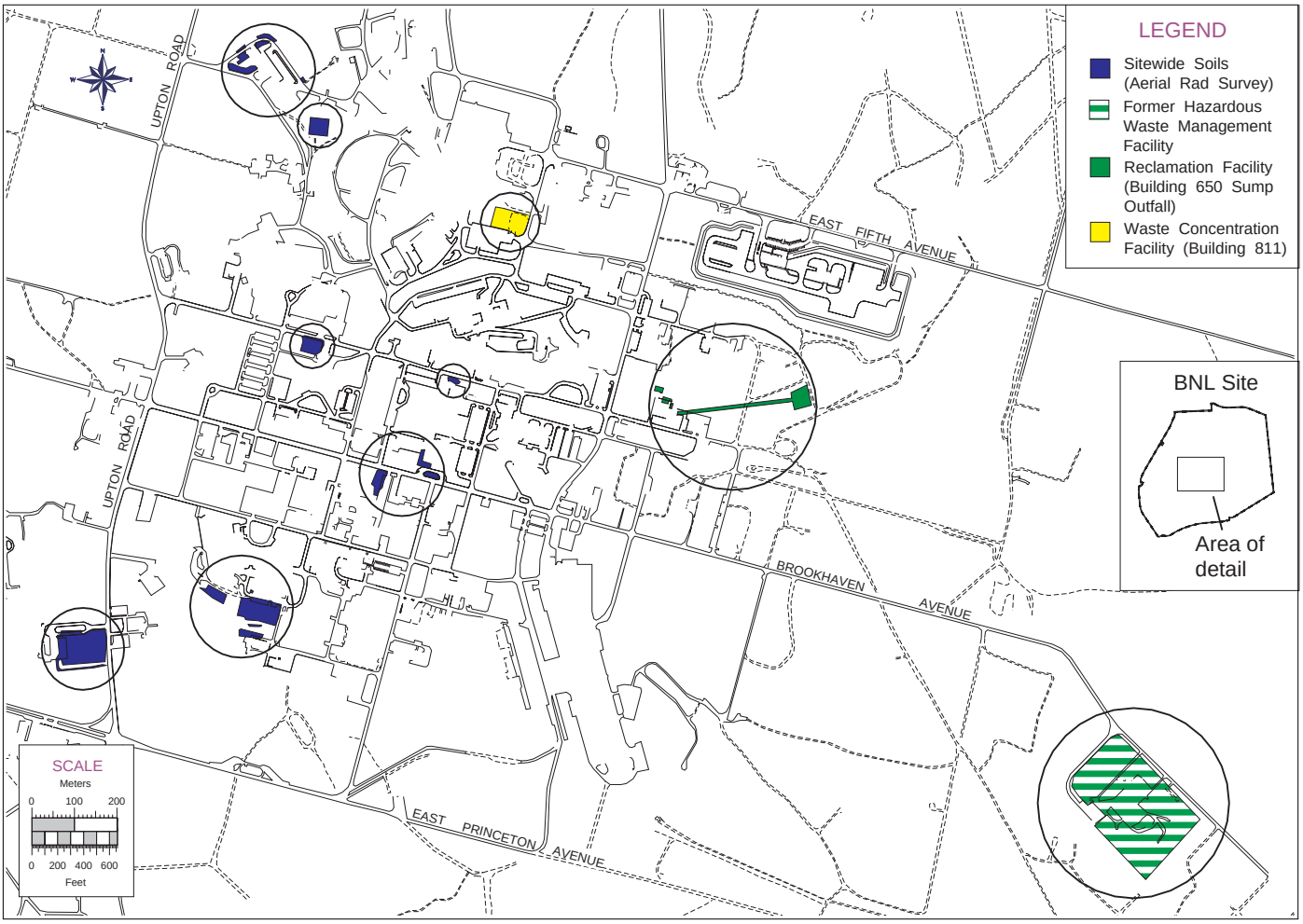

Figure 3. *Operable Unit I Radiologically Contaminated Soils*

Minor Areas of Concern

The preferred final remedy for the Ash Pit (AOC 2F) is placement of a soil cap with institutional controls and monitoring.

The preferred final remedy for the two man-made basins which serve as breeding ponds for Tiger Salamanders in the Upland Recharge/Meadow Marsh Area (AOC 8) is excavation, off-site disposal at a permitted landfill and reconstruction of wetlands.

The preferred final remedy for the Recharge Basins (AOCs 24E and 24F) is operational maintenance and monitoring. BNL is currently preparing a Tiger Salamander Habitat Management Plan with NYSDEC which will detail the routine maintenance of these basins to reduce impacts to the Tiger Salamanders. Monitoring will be performed in accordance with NYSDEC permit requirements.

The preferred final remedy for the Wooded Wetland is monitoring of surface water to ensure that the Current Landfill cap remains effective at preventing landfill leachate from contaminating this wetland and that additional actions are not needed.

In addition, any transfer or leasing of BNL properties will also meet the requirements of120H of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination from any of these Areas of Concern.

Final Actions for the Removal Actions

Cleanup has been completed or is underway at several AOCs within Operable Unit I through accelerated removal actions. The removal actions were taken to prevent further contamination and are consistent with the final site cleanup. Public comment was taken on each of the removal actions before implementation.

This Proposed Plan proposes that these removal actions will be the final actions for those AOCs:

- The Current Landfill (AOC 3), Former Landfill (AOC 2A), Interim Landfill (AOC 2D) and Slit Trench (AOC 2E) have been capped in accordance with New York State requirements.

- Buried wastes at the Glass Holes (AOC 2C) and Chemical/Animal Pits (AOC 2B) were excavated in 1997 and off-site disposal is underway.

- Soils containing cesium-137 below the soil remediation goal from the National Weather Service Stockpile (AOC 16S) were placed beneath the Former Landfill Cap. One 55-gallon drum of soil with cesium-137 levels above the soil remediation goals was segregated and consolidated with other low-level waste for off-site disposal.

How You Can Participate

Whether you are new to BNL and are reviewing this type of document for the first time, or you are familiar with the Superfund process, you are invited to:

• **Read** this proposed plan and review additional documents in the Administrative Record file at Information Repository locations listed on pages 14 and 28; and access fact sheets and other information about the Lab and the cleanup process on the internet at http://www.oer.dir.bnl.gov.

• **Call** BNL Community Relations (516-344-7459) to ask questions, request information, or make arrangements for a briefing.

• **Attend** a public meeting or information session (listed on page2).

• **Comment** on this plan at the meeting or submit written comments (see comment form on back cover).

• **Contact** NYSDEC, EPA Region II and DOE project managers (see pages 18, 19, and 20).

Table 1	Summary of Proposed Remediation Actions	
Area of Concern	**Proposed Remedial Actions**	**Reference**
1 - Former Hazardous Waste Management Facility	Large-scale excavation with off-site disposal.	Operable Unit I Feasibility Study
1b & 23c - Groundwater	Pump and treat.	Operable Unit I Groundwater Action Memorandum
2a, d & e - Former Landfill Areas, Slit Trench and Interim Landfill	Cap in accordance with State requirements.	Former Landfill Action Memorandum
2b & c - Chemical/Animal Pits and Glass Holes	Excavation of buried wastes and off-site disposal.	Final Action Memorandum Phase III-Landfill Closure Removal Action
2f - Ash Pit	Soil cap.	Operable Unit I Feasibility Study
3 - Current Landfill	Cap in accordance with State requirements.	Current Landfill Action Memorandum
6 - Building 650 and Sump Outfall Area	Excavate contaminated soils and sewer line and dispose off site.	Operable Unit I Feasibility Study
8 - Upland Recharge/ Meadow Marsh Area	Excavation and off-site disposal of sediments; reconstruction of two eastern basins.	Operable Unit I Feasibility Study
10 - Waste Concentration Facility	Excavate and consolidate low level soils (AOC 10A, 10B and 10C) with AOC 1. Excavate and remove underground storage tanks (AOC 10C) and pipes (AOC 10B).	Operable Unit I Feasibility Study
16 - Aerial Rad Survey Results (Sub-AOCs 16E, 16F, 16G, 16S.6a and 16S.6d)	Excavate low-level radioactive soils and consolidate with AOC 1 for off-site disposal.	Operable Unit I Feasibility Study
16 - Aerial Rad Survey Results (Sub-AOCs 16S.1 - S.4, 16S.6b, 16S.6c, 16S.6e and 16S.6f)	Institutional controls.	Operable Unit II/VII Remedial Investigation Report
16 - Aerial Rad Survey Results (Sub-AOCs 16A - D, 16I, 16J and 16M - Q)	Active facilities that will be monitored.	Operable Unit II/VII Remedial Investigation Report
16S - National Weather Service Stockpile	Place soils with cesium-137 below the soil remediation goal beneath cap for the former landfill. Soils with cesium-137 above the soil remediation goal will be disposed of off site.	Former Landfill Action Memorandum
17 - Low Mass Criticality Facility	Institutional control and monitoring.	Operable Unit I Feasibility Study, Operable Unit II/VII Remedial Investigation
18 - Alternating Gradient Synchrotron Storage Yard	Institutional control and monitoring.	Operable Unit I Feasibility Study, Operable Unit II/VII Remedial Investigation
24e & 24f - Recharge Basins HS and HW	Operational Maintenance with Institutional controls. Preparation of Tiger Salamander Habitat Management Plan.	Operable Unit I Feasibility Study

- A groundwater extraction and treatment system has been in operation since 1995 to treat volatile organic compounds in groundwater downgradient of the Current Landfill (AOC 3) and the Former Hazardous Waste Management Facility (AOC 1).

Sections IX and XII summarize the preferred remedies for the Areas of Concern in this Proposed Plan and provides a reference for that determination. The preferred remedies are also given in Table 1.

An ***Engineering Evaluation/Cost Analysis*** report is currently being prepared for the Brookhaven LINAC Isotope Producer (AOC 16K) and will be made available for public review. Once the report is finalized, an ***Action Memorandum*** will be prepared detailing the selected alternative and submitted to the Administrative Record.

Engineering Evaluation/Cost Analysis (EE/CA) - a document that evaluates feasible and cost-effective alternatives for proposed removal actions

Action Memorandum - a formal document that describes actions to be taken to remediate an area as part of a removal action

III. Community Role in Selection Process

Public input is encouraged by DOE to ensure that the preferred remedy effectively meets community needs and protects human health and the environment.

Written comments on the Feasibility Study Report and the Proposed Plan will be accepted for 30 days from April 1 to April 30, 1999. At a public meeting to be held on **April 22 (see page 2)**, during the comment period, conclusions of the Feasibility Study and the Preferred Remedy will be presented and discussed. Verbal comments will be accepted at this meeting.

After considering public comments, DOE, EPA and NYSDEC will make a final decision on the cleanup remedy for Operable Unit I and Site-Wide Soils. This decision will be formalized in a document called the ***Record of Decision*** (ROD). Attached to the ROD will be a responsiveness summary that summarizes public comments and DOE response. Following final remedy selection, these documents will be available for public review at the BNL environmental repositories, listed at the end of this document. Finally, the public will be kept informed during the remedy implementation phase.

Record of Decision (ROD) - documents the regulators' decision on a selected remedial action, and includes the responsiveness summary and a bibliography of documents that were used to reach the remedial decision. When the ROD is finalized, remedial design and construction begin.

IV. Site Description and Completed Investigations

BNL is a U.S. Department of Energy owned laboratory that conducts research in physical, biomedical and environmental sciences and energy technologies. BNL is currently managed by Brookhaven Science Associates.

BNL is located 60 miles east of New York City, close to the geographic center of Suffolk County on Long Island (Figure 4). It is bordered on the west by William Floyd Parkway, on the east by residential areas and parkland, on the north by residential areas, and on the south by the Long Island Expressway.

National Priorities List - a formal listing of the CERCLA sites that have been identified for possible remediation. Sites are ranked by the EPA based on their potential for affecting human health and the environment.

Operable Unit (OU) - an administrative designation grouping geographical portions of a site, specific site problems, or initial phases of an action. Operable Units may also consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site. BNL has six Operable Units.

In 1980, the BNL site was placed on NYSDEC's list of Inactive Hazardous Waste Disposal Sites. In 1989, EPA placed BNL on the ***National Priorities List***. The Lab's inclusion on the EPA and NYSDEC lists was primarily due to the effects of past operations, which pose a threat to Long Island's sole source aquifer, the island's primary source of drinking water.

BNL has 29 Areas of Concern (AOCs) that are required to be investigated under an Interagency Agreement among DOE, EPA and NYSDEC. To ensure effective management, these areas were grouped into six distinct ***Operable Units***. The Operable Units are shown in Figure 2 and described in Table A-1 in Appendix A. Figure 2 also shows all areas of concern in Operable Unit I.

Operable Unit I is a relatively undeveloped 950-acre area in the southeastern part of the site. It includes historical waste handling areas such as the Former Hazardous Waste Management Facility (AOC 1), shown in Figure 1, the Former Landfill Areas (AOC 2), shown in Figure 5, the Current Landfill (AOC 3), also shown in Figure 1, and two recharge basins (AOCs 24E and 24F).

Radiologically Contaminated Soils

Remedial investigations were performed in order to identify the nature and extent of soil and groundwater contamination within each Operable Unit. This Proposed Plan mainly addresses radiologically contaminated soil. The largest volume of contaminated soil is located within the **Former Hazardous Waste Management Facility (AOC 1)** (see Figure 6). Based on the results of the investigations, the DOE, EPA and NYSDEC agreed that a more efficient and consistent remediation could be performed if radiologically contaminated soils from other Operable Units were evaluated under one Feasibility Study. Therefore, the feasibility study and this Proposed Plan also address radiologically contaminated soils from several other AOCs within other Operable Units.

The Areas of Concern with radiologically contaminated soils are described in detail in Table A-2 in Appendix A and are shown in Figure 3. Approximately 39,000 cubic yards of contaminated soils and debris (such as concrete and

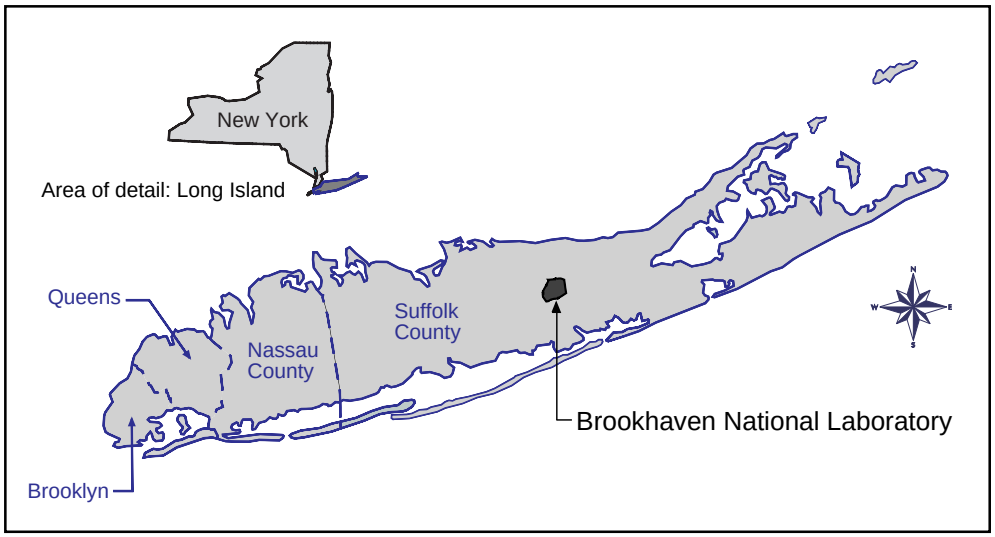

Figure 4. *Brookhaven National Laboratory's location with respect to New York State and Long Island.*

asphalt) exist above the primary soil remediation goals contained in Table 2. About 34,000 cubic yards of these soils and materials are located at the Former Hazardous Waste Management Facility (AOC 1). There is also some mercury contamination in soils at this facility. About 5,000 cubic yards of contaminated soils are located in other areas of concern.

Radiologically Contaminated Surface Soils (AOCs 16, 17, 18) have been found adjacent to or near several buildings as described in Table A-2 in Appendix A. Most of the elevated radiation levels are related to use and handling of activated materials (AOCs 17 and 18) or use of slightly contaminated landscaping soils (AOC 16) contaminated with low levels of radionuclides from soils removed from the Former Hazardous Waste Management Facility.

At the **Reclamation Facility (Building 650)**, radiologically contaminated clothing and heavy equipment were decontaminated. Wastewater from operations discharged to a low-lying wooded area (the **Building 650 Sump and Outfall Area, AOC 6**) about 800 feet northwest of Building 650. This area has been fenced off to prevent unnecessary access and is monitored as an interim action pending the proposal of the final remedy in this document. This interim action was documented in the Operable Unit IV Record of Decision.

The **Waste Concentration Facility (AOC 10)**, Building 811, has been used since 1949 to store and reduce the volumes of liquid radioactive wastes. The Waste Concentration Facility includes several sub-areas that are described in Table A-2 in Appendix A.

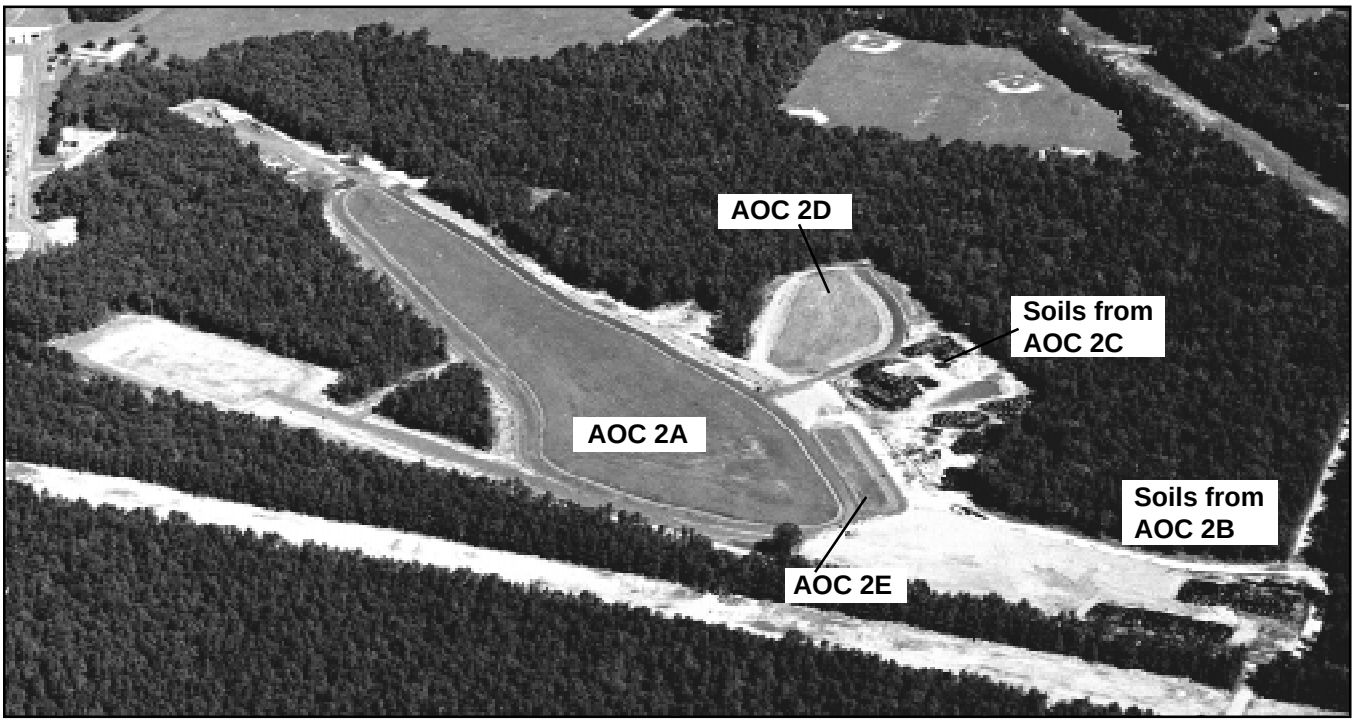

Figure 5. *Former Landfill (AOC 2A), Interim Landfill (AOC 2D) and Slit Trench (AOC 2E). These three areas have all been capped under a removal action. To the right of the landfills are soils that were excavated from the Glass Holes (AOC 2C) and Chemical/Animal Pits (AOC 2B). These soils are being stored prior to disposal.*

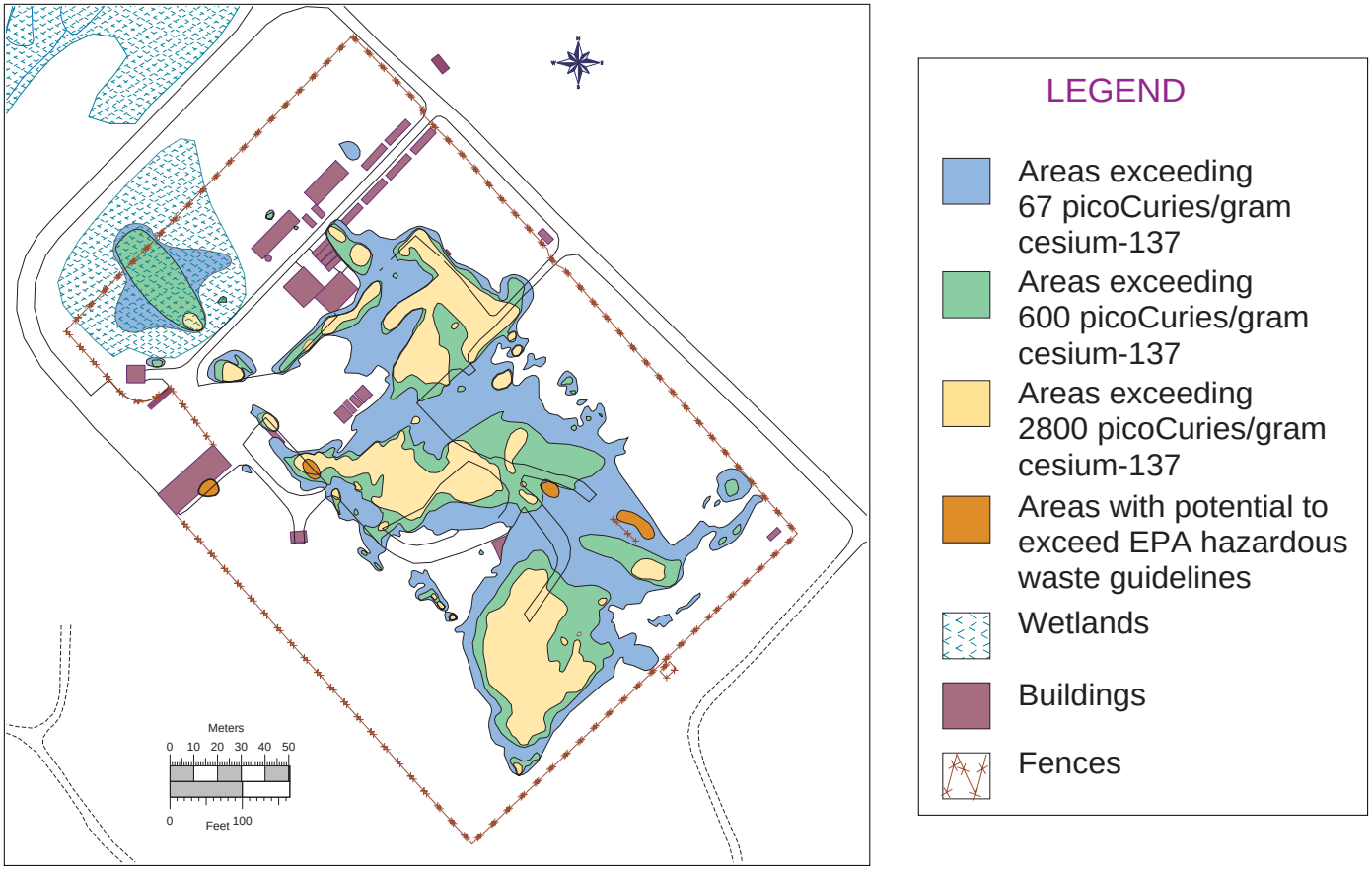

Figure 6. *Principal areas of contamination within the Former Hazardous Waste Management Facility*

Minor Areas of Concern

The **Upland Recharge/Meadow Marsh Area (AOC 8)** consists of six man made basins and associated agricultural fields. This area was the site of joint Brookhaven Town/BNL experiments evaluating the capacity of small natural and man-made terrestrial and aquatic ecosystems for sewage treatment and recharge of ground and surface waters. Treated and untreated sewage were applied to various study areas.

The area currently consists of overgrown fields, agricultural research fields and abandoned man-made basins. Two of the easternmost basins are lined with plastic and in wet years retain water for most of the year. Low levels of metals were found in this area. These basins also are used by Tiger Salamanders for breeding.

The **Ash Pit (AOC 2F)** was used for the disposal of ash and slag from a solid waste incinerator that operated from 1943 to 1963. The southern portion is currently overgrown with trees and shrubs, although in some areas ash and slag are on the surface. The northern portion has a road and grass covered fire break.

The principal contamination sources in the Ash Pit are bottom ash from the incinerator and coal ash. Low concentrations of radionuclides above site background levels were detected in this area. These levels are typical of ash. Other contaminants of concern include metals such as zinc, lead and copper.

Recharge Basin HS (AOC 24E) and **Recharge Basin HW (24F)** receive cooling tower blowdown and stormwater runoff. The basins are discharge outfalls permitted by NYSDEC and undergo periodic monitoring. Low levels of metals such as aluminum, copper, and lead, and organic chemicals such as Arochlor-1260 were present at concentrations below those of human health concern. Tiger Salamanders, a state endangered species, have been found to breed in these basins.

The **Wooded Wetland** is located adjacent to the Current Landfill (AOC 3). Runoff contaminated with leachate from the Current Landfill drained into the area prior to capping of the landfill in 1995. Elevated concentrations of aluminum and copper were found at concentrations below a human health concern. While Tiger Salamanders have not been confirmed in this wetland, the habitat is suitable breeding grounds.

Operable Unit I Groundwater

The Operable Unit I Groundwater Engineering Evaluation/Cost Analysis Report discusses the ***VOC*** and strontium-90 groundwater data in Operable Unit I. Cleanup alternatives for VOCs and Strontium-90 contaminated groundwater were also evaluated and include combinations of no action; institutional controls with monitoring; public water hookups and active remediation such as pump-and-treat systems.

Volatile organic compounds (VOCs) - organic chemicals commonly used as solvents, degreasers, paints, thinners and fuels

The selected alternative documented in the *Final Operable Unit I Groundwater Removal Action* and *Operable Unit I & III Public Water Hookups Action Memorandum* involved public water hookups and the installation of a pump-and-treat system at the site boundary to treat VOCs in the groundwater from the Current Landfill and the Former Hazardous Waste Management Facility. This system was constructed and became operational in December 1996. Monitoring, natural attenuation and radiological decay was selected for the strontium-90 groundwater contamination at the Former Hazardous Waste Management Facility since the highest strontium-90 concentration of 150 ***picoCuries per liter*** (pCi/l) in the groundwater at the time was calculated to naturally attenuate and decay to less than the Drinking Water Standard of 8 pCi/l before reaching the site boundary.

picoCuries per liter (pCi/l) - a unit of measure of radioactivity per liter of groundwater. A picoCurie is one-trillionth of a Curie.

Curie - a unit of measure for radioactive materials based on the number of disintegrations per second (3,700 x 10^{10} per second)

Strontium-90 contaminated groundwater at the Former Hazardous Waste Management Facility will be monitored as part of all of the remedial alternatives discussed in this Proposed Plan. All remaining VOCs in the groundwater associated with Operable Unit I will be addressed in Operable Unit III as part of a comprehensive approach to remediating contaminated groundwater.

Accelerated Removal Actions

Operable Unit I contains several areas addressed by accelerated Removal Actions that are currently underway or completed. The **Current Landfill (AOC 3)**, **Former Landfill (AOC 2A)**, **Interim Landfill (AOC 2D)** and **Slit Trench (AOC 2E)** have been capped in accordance with New York State requirements. Buried wastes at the **Chemical/Animal Pits (AOC 2B)**, and the **Glass Holes (AOC**

2C) were excavated in 1997 and off-site disposal is underway. These actions are proposed to be the final actions for these AOCs.

The **National Weather Service Stockpile (AOC 16S)** consisted of material excavated during the 1992 construction of the Weather Service's balloon launch site. The soil stockpile was temporarily stored at the entrance to the Current Landfill. Stored at the site were approximately 127 cubic yards of soil containing low levels of cesium-137, which were below soil remediation goals, and one 55- gallon drum with soils containing higher concentrations of cesium-137, which was consolidated for off-site disposal with other low-level waste.

The **Brookhaven Linac Isotope Producer (BLIP) (AOC 16K)** has operated from 1972 to the present. The BLIP produces radioisotopes for medical research and clinical use. Soil in the vicinity of the target area has become contaminated with several radionuclides as a result of BLIP operations. Most of the radionuclides are short-lived. Tritium and sodium-22 are two of the longer-lived radionuclides produced and were found in the groundwater south of the BLIP in 1998.

Additional evaluations of groundwater and soil contamination are underway. An Engineering Evaluation/Cost Analysis is currently being prepared to assess corrective actions for this issue and will be made available for the public to review and comment on.

V. Risk Assessments

Based upon the results of the Remedial Investigations, ***risk assessments*** were conducted to estimate the ***risks*** associated with current and future site conditions. These risk assessments evaluate both human health and ecological risks.

risk assessment - an assessment required by CERCLA to evaluate potential risks to human health and the environment. This assessment estimates risks/hazards associated with existing and/or potential human and environmental exposures to contaminants at an area, assuming no remedial action is taken.

risk - an estimate of the probability that exposure to contamination at a site will cause cancer development or noncarcinogenic health effects.

Human Health Risks

A four-step process is utilized for assessing site-related human health risks within a reasonable maximum exposure scenario:

- *Hazard Identification* identifies the contaminants of concern based upon factors such as toxicity, frequency of occurrence and concentration.

- *Exposure Assessment* estimates the magnitude of actual and/or potential human exposures, the frequency and duration of these exposures and exposure pathways (e.g., external exposure from gamma radiation of contaminated soil, ingestion of contaminated well water, etc.) by which humans could be exposed.

- *Toxicity Assessment* determines the types of adverse health effects associated with exposures and the relationship between the amount of exposure (dose) and severity of adverse effects (response).

- *Risk Characterization* summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site-related risks.

Two human health risks were addressed in the Risk Assessments: risk of cancer and non-carcinogenic toxicity. Current federal guidelines for acceptable exposures are an individual lifetime excess carcinogenic risk in the range of a one in 10,000 ($1x10^{-4}$) to one in 1,000,000 ($1x10^{-6}$) excess cancer risk and a maximum health ***Hazard Index*** equal to 1.0, which reflects non-carcinogenic health effects for a human receptor. A Hazard Index greater than 1.0 indicates a potential for non-carcinogenic health effects. These effects may include nerve disorders, liver toxicity, blood disorders, and other diseases.

Hazard Index - an index used as a measure of the potential for site contaminants to present unacceptable noncarcinogenic toxic effects. When the hazard index is greater than 1, there may be concern for potential noncarcinogenic effects.

Chemical Risks

With respect to chemical risks, no media in the areas of concern, with the exception of groundwater, present an unacceptable carcinogenic risk from present or future exposure. The highest risks were attributed to potential future residential scenarios (i.e. living in a house on the site). The risks were in the range of one in 100,000. For groundwater, future on-site potential residential carcinogenic risks from ingestion were above the target range only for the Former Hazardous Waste Management Facility/Current Landfill plume.

Non-carcinogenic chemical hazards above a Hazard Index of 1.0 were found at the Former Hazardous Waste Management Facility for mercury and lead and at the Ash Pit for lead. In addition, all future on-site potential residential Hazard Indexes for groundwater plumes exceeded 1.0. These were attributed to the presence of manganese and thallium.

Radiological Risks

With regard to radiological risk, soil and groundwater could present an unacceptable future risk. The radiological risk assessments were performed using one of two methods. The first method used estimates of radiological doses derived from an approved computer model known as RESRAD (Residual Radioactive Material Guideline Computer Code). The second method compared site contamination levels to EPA standards or the acceptable risk range. An exposure of 15 ***millirems per year*** (mrem/yr) above background is consistent with the EPA acceptable risk range.

millirem (mrem) - a unit of radiation exposure to people. The average yearly radiation exposure for a United States resident is 300 mrem. (A millirem is 1/1000 of a rem.)

The soil at the Former Hazardous Waste Management Facility has high levels of radiological contamination that would exceed acceptable risks for any unrestricted future use without remediation. However, public access and exposure to contaminants in the area are currently not realistic risk scenarios. Stringent institutional controls restricting public access are in place.

The radiologically contaminated soils at several AOCs scattered around the site contain relatively low levels of cesium-137. These soils do not currently present a hazard to the health of BNL employees or the public. Since cesium-137 binds to soil particles, it does not present a threat to area groundwater. The soils could present a future risk, particularly to children, if the area was developed for residential use.

Potential human health risks to humans who consume deer have also been evaluated. Deer graze on BNL lawns including those contaminated with ce-

sium-137. Low levels of cesium-137 have been detected in deer sampled on and off site. These levels are not harmful to the deer.

The potential radiation dose to humans who consume deer was evaluated by the New York State Department of Health in a March 1999 report. A conservative estimate for a person consuming 64 pounds of deer meat results in a dose of five millirems per year. This estimate uses the average cesium-137 concentration in deer meat calculated from data collected between 1992 and 1999. A worst-case estimate, using the highest observed cesium-137 concentration, is nine millirems per year.

The NYSDEC will be providing information and fact sheets to hunters and permit holders but are not recommending hunting restrictions around BNL. Hunting on the BNL site is prohibited.

Groundwater at the Chemical/Animal Pits (AOC 2B), and the Glass Holes (AOC 2C) exceeds drinking water standards for strontium-90. No one is currently drinking this water, but in the future the groundwater could present a public health hazard. This groundwater contamination is being monitored and will be addressed in Operable Unit III as part of a comprehensive approach to cleanup contaminated groundwater.

Ecological Risks

A Focused Ecological Risk Assessment was conducted as part of the Feasibility Study on areas that are breeding grounds for the Tiger Salamander, a New York State endangered species. The presence of metals such as aluminum, copper and zinc are a concern in these areas. The areas with the highest risks are the wetland at the Former Hazardous Waste Management Facility and two of the man-made basins in the Upland Recharge/Meadow Marsh Area (AOC 8). Sampling conducted prior to and post capping of the Current Landfill in 1995 indicate that the cap is successful in reducing contamination of the nearby Wooded Wetland by landfill leachate.

VI. Basis for Cleanup

This section describes development of soil remediation goals for radionuclides and other considerations that were used to develop the various cleanup alternatives.

The results of the remedial investigation and risk assessment reports for Operable Units I and related AOCs indicated that the potential for radiological exposure from contaminated soil required remediation of soils in several areas. This risk is primarily due to direct exposure to gamma radiation from cesium-137 in the soil. There is also the potential of contaminating the sole source aquifer beneath the site by strontium-90 since this radionuclide can migrate through soil.

The soil remediation goals were developed using RESRAD, a computer program used for the analysis of radiological exposure pathways. An allowable

Administrative Record Locations

The Feasibility Study Report, Proposed Plan, and all Administrative Record documents can be found at the following locations:

U.S. EPA — Region II
Administrative Records Rm.
290 Broadway
New York, NY 10001
Phone: (212) 637-4296
Contact: Jennie Delcimento

Longwood Public Library
800 Middle Country Road
Middle Island, NY 11953
Phone: (516) 924-6400
Contact: Reference Librarian

BNL Research Library
Technical Information Div.
Building 477A
Upton, NY 11973
(516) 282-3483
Contact: Reference Librarian

Mastics-Moriches-Shirley
Community Library
301 William Floyd Parkway
Shirley, NY 11967
Phone: (516) 399-1511
Contact: Reference Librarian

radiation exposure of 15 mrem/yr above background based upon EPA and DOE guidance was used. The 15 mrem/yr includes the total exposure from all radionuclides contaminating the soil. Exposure to this level of radiation is consistent with EPA's acceptable risk range of one in 10,000 to one in 1,000,000.

A 50 year period of continued federal institutional control of BNL was assumed in developing the remediation goals. It is believed that the federal government will maintain use of the facilities at BNL for the foreseeable future. Federal control of the facility beyond this 50-year period is also a reasonable assumption.

After 50 years, exposures from any remaining radioactivity in the soil would be less than 15 mrem/yr. Institutional controls such as deed restrictions and access controls would be used to ensure that unanticipated changes in land use do not occur that could result in unacceptable exposures to remaining contamination. Maintenance of existing fencing and signs and installation of any new fencing would be performed as necessary. Groundwater monitoring at the Former Hazardous Waste Management Facility and Building 650 Sump Outfall; periodic radiation surveys and preparation of monitoring reports would also be performed under all alternatives to ensure that conditions remain as expected and that additional actions are not necessary.

Leasing and disposition of DOE property is regulated under Section 120H of CERCLA as well as the Atomic Energy Act. Information on contaminant releases, where hazardous materials were stored and what remedial actions were taken are required to be included in the contract or lease and in the deed if portions of BNL were either sold or leased to the public.

In developing the soil remediation goals, future land use was also considered. The Former Hazardous Waste Management area is proposed for industrial use. The primary remediation goals for the developed portion of BNL are based on a more restrictive residential scenario.

A soil remediation goal of 15 ***picoCuries per gram*** (pCi/g) for strontium-90 was developed which considered its potential to leach into groundwater and the subsequent use of the groundwater as a source of drinking water. This level is also protective of all future land uses.

picoCuries per gram (pCi/g) - a measure of radioactivity per unit weight of a substance. One picoCurie is one trillionth (10^{-12}) of a Curie.

Table 2 summarizes the soil remediation goals for cesium-137, strontium-90 and radium-226. For cesium-137, a goal of 67 pCi/g for industrial land use is proposed for the Former Hazardous Waste Management Facility. For soils within the other AOCs in which cesium-137 was the dominant radionuclide, a goal of 23 pCi/g was selected based on a proposed future residential use and 50 years of institutional control. These goals will meet the allowable radiation exposure of 15 mrem/yr above background levels in 50 years. Since cesium-137 has a half-life of approximately 30 years, any remaining cesium-137 at the Former Hazardous Waste Management Facility would also decay to residential levels in 100 years.

For Building 650 and the Sump Outfall (AOC 6), long-lived isotopes such as radium-226 and plutonium-239/240 are also present. The goal of 5 pCi/g for

radium in Table 2 represents a cleanup criteria commonly used by EPA. Primary remediation goals for plutonium and other radionuclides are also developed using RESRAD. Post remediation sampling and dose assessments would also be performed in areas where soil is excavated to ensure that the 15 mrem/yr criteria is met for all radionuclides that are present.

A secondary action level of 600 pCi/g of cesium-137 was developed in the Feasibility Study for use with some of the alternatives (3, 5 and 6) to ensure that the highest levels of radioactivity that pose the greatest risk would be treated or disposed of off site. Soil above this secondary level would be either treated or disposed of off site. Soils below this secondary level would remain on site and would be contained to meet the 15 mrem/yr requirement. These alternatives were included to provide options which reduce the volume of soils for off-site disposal for detailed evaluation. The period of institutional control for the contained soils is 100 years in these alternatives.

Table 2 — **Soil Remediation Goals and Secondary Action Level for Radionuclides at BNL**

Radionuclide	Soil Remediation Goal Residential Land Use (pCi/g)	Soil Remediation Goal Industrial Land Use (pCi/g)	Secondary Action Level (pCi/g)
Cesium-137	23 [a]	67 [b]	600 [c]
Strontium-90	15 [d]	15 [d]	Not Applicable
Radium-226	5 [e]	5 [e]	Not Applicable

a. Acceptable soil concentration for 15 mrem/year above background exposure and Residential Land Use with 50 years of Federal Government Institutional control of the site. This Goal applies to areas other than the Former Hazardous Waste Management Facility.

b. Acceptable soil concentration for 15 mrem/year above background exposure and Residential Land Use with 50 years of Federal Government Institutional control of the site. This Goal applies to the Former Hazardous Waste Management Facility.

c. Secondary Action Level applies to higher levels of contaminated soils proposed for special treatment or disposal.

d. The Strontium-90 goal is based on an evaluation of ground water impacts. It is also protective of residential and industrial use.

e. DOE Order 5400.5 Radiation Protection of the Public and the Environment. Also, commonly used by the Environmental Protection Agency.

f. In addition to the above levels, a post remediation sampling and a dose assessment will be performed to ensure that the dose from the remaining concentrations of all radionuclides present is less than 15 mrem/year above background considering 50 years of Federal Government Institutional Control for the selected land use.

The volume of contaminated soils from the other radiologically contaminated AOCs is much less than that present at the Former Hazardous Waste Management Facility. Therefore, these other soils would be consolidated at the Former Hazardous Waste Management Facility in several of the alternatives. Disposal would include the combined soils.

VII. Alternatives for Radiologically Contaminated Soils

Six remedial action alternatives were selected for detailed evaluation and analysis in the Operable Unit I Feasibility Study Report for radiologically contaminated soils. These alternatives include one or more of the following: no action; institutional controls; monitoring; containment; excavation with off-site disposal; soil washing; and vitrification. The alternatives for radiologically contaminated soils are referred to throughout by a number designation. Each of the following alternatives is comprised of one or more of the above technologies and are described below.

Alternative 1: No Action With Monitoring

This alternative provides a baseline for comparison with the other alternatives selected. Under this alternative, no further action would be implemented. Long-term monitoring would be performed for 100 years, including collection of groundwater and surface water samples. Monitoring reports would be completed every five years and a final walkover radiation survey would be conducted at the end of 100 years.

Alternative 2: Containment Using an Engineered Cell for AOC 1; Excavation of other AOCs

In this alternative, an engineered cell would be constructed at the Former Hazardous Waste Management Facility. The radiologically contaminated soils would be excavated and disposed in the cell. The cell would be designed to isolate the contaminated soil from contact with surface water runoff and precipitation as well as to prevent human exposure to these soils. The cell would consist of a composite double bottom liner with a leachate collection system and a composite, multiple layer cover.

Approximately 34,655 cubic yards of soils from the Former Hazardous Waste Management Facility with concentrations of radionuclides above the soil remediation goals listed in Table 2 (e.g. 67 pCi/g for cesium-137) would be excavated, stockpiled and disposed of in the cell. This would prevent exposure from airborne contamination and surface exposure to gamma radiation, and protect groundwater.

Approximately 3,450 cubic yards of soils from the other radiologically contaminated AOCs would be excavated and disposed in the cell, except for soils contaminated with long half-life radionuclides from Building 650 and the Sump Outfall (AOC 6). Approximately 1,040 cubic yards of these soils would be excavated and disposed of off-site.

Long-term monitoring and maintenance on the cell would be performed and institutional controls would be put in place to limit access to the site and prevent the construction of structures on the cap and the installation of drinking water wells in contaminated groundwater for 100 years. Monitoring and posting of any remaining contamination at the other AOCs would also be performed.

In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

Alternative 3: Moderate Excavation, Off-Site Disposal and RCRA Cap

RCRA - the Resource Conservation and Recovery Act. A federal law which defines hazardous wastes and disposal requirements.

With moderate excavation and off-site disposal, the most contaminated material is removed from the site. In this alternative, approximately 14,585 cubic yards of soils and debris above the secondary action level of 600 pCi/g of cesium-137 would be excavated from the Former Hazardous Waste Management Facility and disposed of off site at a permitted facility.

The remaining 19,490 cubic yards of soils within the Former Hazardous Waste Management Facility that contain radionuclides above the soil remediation goal would be excavated, consolidated and capped to meet the requirements of the Resource Conservation and Recovery Act (RCRA). This cap would be the same design as discussed in Alternative 2, but there would be no bottom liner.

In addition, approximately 3,450 cubic yards of soils outside of the Former Hazardous Waste Management Facility would be excavated down to the soil remediation goals for those areas and either consolidated under the geomembrane cap or, in the case of the 1,040 cubic yards of soils contaminated with long half-life radionuclides at Building 650 and the Sump Outfall, disposed of off site at a permitted facility.

Long-term monitoring and maintenance on the cap would be performed, and institutional controls would be put in place to limit access to the site and prevent the construction of structures on the cap and the installation of drinking water wells in contaminated groundwater for 100 years. Monitoring and posting of any remaining contamination at the other AOCs would also be performed.

In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

Alternative 4: Large-Scale Excavation and Off-Site Disposal

In this alternative, approximately 39,000 cubic yards of soils above the soil remediation goals would be excavated and disposed of off-site at a permitted facility.

Following excavation and disposal, the sites would be available for either industrial commercial use (Operable Unit I) or residential use (Operable Units II/VII, and IV) after the 50 year period of institutional control ends.

United States Department Of Energy

The **U.S. Department of Energy (DOE**) is one of the three agencies identified in the Interagency Agreement, which establishes the scope and schedule of remedial investigations at BNL. Correspondence with DOE staff concerning this project can be found in the Administrative Record under Operable Units I, II and VI.
For additional information concerning DOE's role in preparing this proposed plan, contact:

Gail Penny
U.S. Department of Energy - Brookhaven Group
P.O. Box 5000
Upton, NY 11973-5000
(516) 344-3429

Monitoring and posting of any remaining contamination at any of the AOCs would also be performed for the 50 years of institutional control period in accordance with a monitoring plan. In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

Alternative 5: Moderate Excavation, Soil Washing, Off-Site Disposal, and RCRA Cap

This alternative is identical to Alternative 3, except that a portion of the most contaminated soil would be treated by soil washing prior to off-site disposal. As in Alternative 3, contaminated soils above the secondary action level of 600 pCi/g of cesium-137 would be excavated at the Former Hazardous Waste Management Facility.

Approximately 6,030 cubic yards of soils between the secondary action level and 2,800 pCi/g of cesium-137 (the processing limit of the soil washing technology) would be treated to reduce the volumes of soil that require off-site disposal. It is estimated that about 70 percent of this soil could be successfully cleaned to the soil remediation goal of 67 pCi/g of cesium-137 using this technology.

Approximately 7,880 cubic yards of soil above 2,800 pCi/g, and soils that were not successfully treated and the concentrated treatment residuals, would then be disposed of off site.

The approximately 24,490 cubic yards of soil below the secondary action level of 600 pCi/g of cesium-137 but above the soil remediation goal of 67 pCi/g of cesium-137, and clean soil from the treatment process, will be consolidated at the Former Hazardous Waste Management Facility and capped with a RCRA cap as described in Alternative 3.

Approximately 3,450 cubic yards of soils outside of the Former Hazardous Waste Management Facility containing radionuclides with short half-lives will be excavated to meet the soil remediation goal for those areas and consolidated under the cap. The approximately 1,040 cubic yards of soils contaminated with long half-life radionuclides from Building 650 and the Sump Outfall, would be disposed of off site.

This alternative would reduce the volume of contaminated material requiring off-site disposal from the 14,585 cubic yards estimated in Alternative 3 to 11,404 cubic yards.

Long-term monitoring and maintenance on the cap would be performed and institutional controls would be put in place to limit access to the site and prevent either the construction of structures on the cap or the installation of drinking water wells in contaminated groundwater for 100 years. Monitoring and posting of any remaining contamination at the other AOCs would also be performed.

In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

United States Environmental Protection Agency

The **U.S. Environmental Protection Agency (**EPA) is one of the three agencies identified in the Interagency Agreement, which establishes the scope and schedule of remedial investigations at BNL. Correspondence with EPA Region II staff concerning this project can be found in the Administrative Record under Operable Units I, II, and VI. For additional information concerning the EPA's role in preparing this proposed plan, contact:

Mary Logan
U.S. EPA Region II
290 Broadway
New York, NY 10007-1866
(212) 637-4321

Alternative 6: Moderate Vitrification and RCRA Cap

Vitrification is a process that uses electric current to melt and solidify contaminated soil. In this alternative, 14,585 cubic yards of the most contaminated soil above the secondary action level of 600 pCi/g of cesium-137 from the Former Hazardous Waste Management Facility and the 1,040 cubic yards of soils contaminated with long half-life radionuclides from Building 650 and the Sump Outfall) would be treated by immobilizing the radionuclides in a vitrified mass. Treatment would occur at the Former Hazardous Waste Management Facility.

Upon completion of the treatment, the vitrified and untreated soils that exceed the soil remediation goals would be consolidated and covered with a RCRA cap, as described in Alternative 3. This alternative would require initial sampling of the vitrified product, institutional controls to prevent future site development, and long-term monitoring and maintenance of the cap for 100 years. Monitoring and posting of any remaining contamination at the other AOCs would also be performed.

In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

VIII. Analysis and Comparison of Alternatives for Radiologically Contaminated Soils

The Department of Energy has identified its preferred remedy by evaluating all of the alternatives against nine criteria established by EPA. The comparisons, including advantages and disadvantages, are summarized below.

1. *Overall Protection of Human Health and the Environment* addresses whether or not an alternative provides adequate protection, and describes how risks are eliminated, reduced or controlled through treatment, engineering controls or institutional controls.

Alternative 1 relies on natural dispersion and decay processes to reduce soil contamination levels. It does not meet the soil remediation goals and is not effective in reducing risks to human health if federal control of BNL is lost. All other alternatives protect human health and the environment. For alternatives 2, 3, 5 and 6, long-term maintenance of the cap or cell and institutional controls are required for 100 years in order for it to remain protective of human health and the environment.

2. *Compliance with Federal and State Environmental Regulations* considers if a remedy meets all applicable or relevant and appropriate requirements of federal and state environmental statutes, including provisions for invoking a waiver.

The cleanup goal of 15 mrem/yr selected meets EPA and DOE guidance for alternatives 2 through 6. The New York State Department of Environmental Conservation guidance for 10 mrem/yr has also been adopted as an As Low As

New York State Department of Environmental Conservation

The **New York State Department of Environmental Conservation (**NYSDEC) is one of the three agencies identified in the Interagency Agreement, which establishes the scope and schedule of remedial investigations at BNL. Correspondence with NYSDEC staff concerning this project can be found in the Administrative Record under Operable Units I, II, and VI.
For additional information concerning the state's role in preparing this proposed plan, contact:
Jim Lister
NYSDEC
50 Wolf Road
Albany, NY 12233
(518) 457-3976

Reasonably Achievable (ALARA) goal which will be reviewed during the design and construction phase.

Alternative 2 is expected to meet these requirements for the 100-year period of institutional control. There remains a potential for future exposure above federal and state requirements since all soil, though capped, remains in the Former Hazardous Waste Management Facility area and is otherwise untreated.

The excavation and off-site disposal alternatives (Alternatives 3 and 4) and soil washing alternative (Alternative 5) involve removal of a large fraction of the contaminated soil from the site and would lessen the chance of future exposures above federal and state requirements.

Cap or cell maintenance would be required for alternatives 2, 3, 5 and 6 in order to remain in compliance.

Alternatives in which soils are left on-site (Alternatives 1, 2, 3, 5 and 6) would also result in the de facto creation of a radioactive waste disposal facility and would be subject to applicable state and federal regulations. State regulations do not allow the siting of a radioactive waste disposal facility on Long Island or over a sole source groundwater recharge area.

3. *Long-Term Effectiveness and Permanence* relates to the amount of risk involved and addresses the ability of an alternative to protect human health and the environment over time, after the remediation goals have been met.

Alternative 1 is not effective in the long term because all contaminated soils are left in place.

Alternative 2 is effective in meeting future use federal and state requirements by preventing access to contaminated soils for the 100 year institutional control period. However, the highest levels of contamination remain on site and rely on the effectiveness and continued maintenance of an engineered barrier. Should that barrier fail or institutional control be lost, the long-term effectiveness of this alternative would be compromised.

Alternatives 3, 5 and 6 are more effective than alternative 2 in that the most contaminated soils are either removed from the site (Alternatives 3 and 5) or immobilized (Alternative 6). However, they also rely to some degree on the maintenance of an engineered barrier and continued institutional controls for 100 years to assure long-term effectiveness.

Alternative 4 is considered the most effective and permanent in the long term and if institutional controls fail since all contaminated soil above the soil remediation goals is removed and disposed of off site. In addition, the period of institutional control needed for the Former Hazardous Waste Management Facility is shorter than for the other alternatives (i.e. 50 versus 100 years).

4. *Reduction of Toxicity, Mobility or Volume* addresses the anticipated performance of treatment that permanently and significantly reduces toxicity, mobility or volume of waste.

Alternative 1 provides no active reduction in on-site toxicity, mobility or volume. There is a natural reduction in toxicity over time due to radioactive decay.

Alternative 2 provides no treatment of the contaminated soils and, hence, no reduction of toxicity and volume. Shielding of gamma radiation is provided by the cap, and the barrier provides a reduction in mobility.

Alternatives 3 and 5 provide a reduction of toxicity, mobility and volume through off-site disposal. In both alternatives, shielding of gamma radiation, as well as a reduction in radionuclide mobility, is provided by the cap. Soil washing provides an additional reduction in volume by treatment.

Alternative 4 provides a substantial reduction in toxicity, mobility and volume through off-site disposal, however no treatment is provided.

The vitrification in alternative 6 provides the greatest reduction in the toxicity, mobility and volume of the most contaminated soil through treatment into a glass monolith. Further, shielding of the gamma radiation as well as a reduction in radionuclide mobility is provided by the cap in this alternative.

5. *Short-Term Effectiveness and Environmental Impacts* addresses the impact to the community and site workers during construction/implementation of the remedy, and includes the time needed to finish work.

Risks to the community were evaluated for both radiological risk and transportation accidents associated with off-site disposal of contaminated soils. All alternatives are considered protective of the community in the short term. There are no significant pathways of exposure to contaminated soils and dust from excavation and cap construction activities can be easily controlled. Alternatives 2, 3, 4 and 5 involve disposal of various volumes of contaminated soils off-site and do have some risks associated with rail car and traffic accidents. These risks can be controlled by federal (i.e. Department of Transportation) shipping requirements and are considered negligible. Alternatives 1 and 6 do not involve any off-site disposal and associated transportation risks.

Risks to remediation workers include both radiation risks and nonradiation construction accident risks. Alternative 1 provides the least risks to workers since there is no active remediation. Alternatives 2 and 5 are expected to provide the highest radiation exposures to remediation workers. Alternatives 3, 4 and 6 result in less exposures than alternatives 2 and 5.

6. *Implementability* addresses both the technical and administrative feasibility of an alternative. This includes the availability of materials and services required for cleanup.

Alternative 1 could be readily implemented with limited technical and administrative requirements.

Alternative 2 is technically feasible. However, it involves extensive excavation and complex administrative requirements for regulatory permits and approvals of an engineered disposal cell.

Alternatives 3 and 5 involve partially intrusive remediation activities. Alternative 3 is technically feasible and uses readily implementable technologies with average administrative requirements since only limited off-site shipment of waste is involved. Alternative 5 is less technically feasible since the soil washing technology has not been demonstrated on cesium-137 contaminated soils.

Alternative 4 involves excavation of large volumes of soils. It is technically feasible and could be readily implemented. Alternative 4 is expected to have above-average administrative requirements due to extensive documentation procedures involved in the transport and off-site disposal of soil as low-level radioactive waste.

Alternative 6 is less intrusive except for the consolidation activities. The vitrification technology has only limited full-scale use and may not be implementable. This alternative would have above average administrative requirements due to this. Overall, this alternative is considered very complex.

7. *Cost* compares the differences in cost, including capital, operation and maintenance.

For estimated current costs of all alternatives, see Table 3.

Table 3	**Summary of Estimated Costs for Remedial Alternatives Radiologically Contaminated Soils**	
Alternative	**Description**	**Present Worth ($M)**
1	No Action With Monitoring	0.92
2	Containment Using a Geomembrane Cap	9.2
3	Moderate Excavation, Off-Site Disposal and Geomembrane Cap	15.5
4	Large-Scale Excavation and Off-Site Disposal	24.6
5	Moderate Excavation, Soil Washing, Off-Site Disposal and Geomembrane Cap	15.9
6	Moderate Vitrification and Geomembrane Cap	20.1

8. *State Acceptance* addresses whether the State agrees with, opposes, or has no comment on the preferred alternative.

The NYSDEC is currently reviewing the Feasibility Study and Proposed Plan and has expressed concerns to DOE about the surface soil sampling data in Operable Unit II/VII. NYSDEC has requested that additional surface soil samples be collected from the top three inches, as opposed to the one foot core samples collected, in areas in Operable Unit II/VII that are not currently proposed for remediation. They are concerned that contaminants could be concentrated in the top few inches of soil and would not be remediated based on the existing one foot data.

DOE has prepared a plan to collect additional surface soil samples and will collect these samples once the plan is concurred on by NYSDEC. Additional areas will be remediated if the new data shows concentrations that are above the radionuclide soil remediation goals or that pose an unacceptable risk under CERCLA.

9. *Community Acceptance* addresses the issues and concerns that the public may have regarding each of the alternatives.

This criterion will not be evaluated formally until comments on the Proposed Plan have been reviewed. A final decision will be made after public review is completed.

IX. Preferred Alternative for Radiologically Contaminated Soils

Based on an evaluation of the alternatives for the radiologically contaminated soils, the Department of Energy believes the alternative representing the best balance of the EPA's remedy selection criteria is:

Alternative 4: Large Scale Excavation and Off-site Disposal

All soils above the soil remediation goals will be excavated from their respective locations and transported off-site to a permitted facility for disposal. Out-of-service tanks and underground pipelines associated with AOC's 10B and 10C will also be removed and disposed of off site. In addition, contaminated wetlands destroyed during the previously described activities at the Former Hazardous Waste Management Facility would be rebuilt and replaced.

This alternative was selected because it provides protection from both direct exposure to gamma radiation and groundwater infiltration risks and greatly reduces the future risks to the public if institutional controls are lost. It does this by removing all radiologically contaminated soils above the soil remediation goals from the site. Any future transfer or leasing of BNL properties will also meet the requirements of 120H of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination.

The excavation and transportation of large quantities of soil off site for disposal, while protective of local public health and safety, will involve some increased short-term worker and transportation risks. The short-term impacts and risks of this alternative are outweighed by the long-term benefits of off-site disposal.

X. Alternatives for Minor Areas of Concern

This section presents alternatives for the **Ash Pit (AOC 2F)** and two manmade basins at the **Upland Recharge/Meadow Marsh Area (AOC 8)**, two **Recharge Basins (AOCs 24E and 24F)**, and the **Wooded Wetland**. These Areas of Concern require less complicated solutions that the radiologically contaminated soils and the evaluations have been streamlined.

Three alternatives were evaluated for the **Ash Pit (AOC 2F)**. These alternatives are:

No action with monitoring;
Soil Cover; and
Excavation with off-site disposal.

Under the first alternative, no further action would be implemented and the current status of the Ash Pit will remain. Long term monitoring will be performed during a 50-year period of institutional control. The cost of this first alternative is $29,000.

For the second alternative, the Ash Pit would be covered with a 12 inch layer of soil at a cost of $146,000. This soil cap would provide protection from potential exposure to workers, the public and wildlife.

The third alternative will involve excavation and offsite disposal of the ash. The area will be backfilled and the vegetation will be restored. This third alternative cost is $3.2 million.

For the two man-made basins at the **Upland Recharge/Meadow Marsh Area (AOC 8)**, three remediation alternatives were evaluated for protection of the Tiger Salamander. These alternatives are:

No action with monitoring;
Excavation with on-site disposal and reconstruction of the wetlands;
Excavation with off-site disposal and reconstruction of the wetlands.

Under the first alternative, no further action will be implemented and the current status of the ponds will remain. Long term monitoring will be performed during a 50-year period of institutional control. The cost of this alternative is $44,000.

Under the second alternative, the sediments and plastic liners will be removed and placed in an approved on-site clean fill site. The pond will then be restored as a wetland. This action will provide protection and future habitat for the Tiger Salamander at a cost of $227,000.

For the third alternative, the sediments and plastic liners will be removed and disposed of at an off-site landfill. The pond will then be restored as a wetland. This action will provide protection and future habitat for the Tiger Salamander and remove contaminated soils from the BNL site at a cost of $442,000.

The two **Recharge Basins (AOCs 24E and 24F)** are operated, maintained and monitored according to NYSDEC permits. Because of this, remedial alternatives were not evaluated. However, it was realized that operation of these basins must be performed in a manner to reduce negative impacts to Tiger Salamanders. BNL is currently preparing a Tiger Salamander Habitat Management Plan with the regional NYSDEC office. This plan will specify how activities at these basins will be performed to reduce impacts to the Tiger Salamanders.

Since sampling conducted before and after the capping of the Current Landfill in 1995 indicated that the cap is successful in reducing contamination of the **Wooded Wetland** by landfill leachate, remedial alternatives were not evaluated. However, monitoring of surface water will be conducted as part of the remedial action to ensure that the cap remains successful and that additional actions are not needed.

XI. Analysis and Comparison of Alternatives for Minor Areas of Concern

For the **Ash Pit (AOC 2F)**, the no action alternative was not considered protective of human health and the environment and did not comply with EPA's soil guidance for lead. In addition the toxicity, mobility and volume would not be reduced.

For the second alternative, a soil cap would provide protection for workers, the public and wildlife and meets EPA's guidance. It is relatively simple to implement and would reduce the mobility of contaminants of concern. This alternative is also cost effective.

The third alternative, excavation and off-site disposal, would provide protection for workers, the public and wildlife. It is relatively simple to implement and would reduce the mobility of contaminants of concern. This alternative is relatively costly for the limited benefits received.

For the two man-made basins at the **Upland Recharge/Meadow Marsh Area (AOC 8)**, the no action alternative was not considered protective of breeding Tiger Salamanders. In addition the toxicity, mobility and volume of the contaminants of concern would not be reduced.

For the second alternative, Tiger Salamanders would be protected. It is relatively easy to implement and would reduce the toxicity, mobility and volume of contaminants in the ponds.

The third alternative would also protect Tiger Salamanders. It is relatively easy to implement and would reduce the toxicity, mobility and volume of contami-

nants in the ponds but slightly contaminated sludges would be removed from the site. This alternative is the most costly though it is only slightly more expensive than the second alternative.

XII. Preferred Alternatives for the Minor Areas of Concern

The preferred final remedy for the **Ash Pit (AOC 2F)** is placement of a soil cap with institutional controls and monitoring. Any future transfer or leasing of this property would also be subject to Section 120H of CERCLA.

The preferred final remedy for the **Recharge Basins (AOCs 24E and 24F)** is operational maintenance and monitoring. BNL is currently preparing a Tiger Salamander Habitat Management Plan with NYSDEC which will detail the routine maintenance of these basins to reduce impacts to the Tiger Salamanders. Monitoring will be performed in accordance with NYSDEC permit requirements. The preferred remedy for the two man-made basins which serve as breeding ponds for Tiger Salamanders in the **Upland Recharge/Meadow Marsh Area (AOC 8)** is excavation, off-site disposal at a permitted landfill and reconstruction of wetlands.

The preferred remedy for the **Wooded Wetland** is monitoring of surface water to ensure that the Current Landfill cap remains effective at preventing landfill leachate from contaminating this wetland and that additional actions are not needed. This information will be published along with the annual monitoring report for the Current Landfill.

XIII. For More Information

The three agencies identified in the Federal Facilities Agreement, which establishes the scope and schedule of remedial work at BNL, are the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation.

For additional information on each agency's role in preparing this Proposed Plan, contact:

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Albany, NY 12233
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The Feasibility Study Report, the Proposed Plan and supporting documents are available at the libraries listed below.

Longwood Public Library
800 Middle Country Road
Middle Island, NY 11953
(516) 924-6400
Contact: Reference Librarian

U.S. EPA - Region II
Administrative Records Room
290 Broadway
New York, NY 10001-1866
(212) 637-4296
Contact: Jennie Delcimento

Mastics-Moriches-Shirley Library
301 William Floyd Parkway
Shirley, NY 11973
(516) 399-1511
Contact: Reference Librarian

Brookhaven National Laboratory
Research Library
Technical Information Division
Building 477A
Upton, NY 11973
(516) 344-3483
Contact: Reference Librarian

XIV. Appendix A

Table A-1	Description of Operable Units at BNL
Operable Unit	**Description**
I	*Operable Unit I* is a relatively undeveloped 950-acre area in the southeastern part of the site. It includes historical waste handling areas such as the Former and Current Landfills (AOCs 2 and 3), and the Former Hazardous Waste Management Facility (AOC 1). It also includes the Ash Pit (AOC 2F) and two recharge basins (AOCs 24E and 24F). Operable Unit I contains six areas covered by accelerated removal actions: the Current and Former Landfills, Chemical/Animal Pits and Glass Holes, the Interim Landfill, the Slit Trench and Groundwater.
II/VII	*Operable Unit II/VII* consists of several AOCs located in the developed central portion of the site. It includes contaminated soils and out-of-service underground storage tanks and pipelines proposed for removal at the Waste Concentration Facility (AOC 10), along with various isolated areas of contaminated surface soils (AOC 16, 17, 18). It also includes the BLIP facility (AOC 16K).
III	*Operable Unit III* contains the south central and developed portions of the site. This Operable Unit contains most of the site's contaminated groundwater.
IV	*Operable Unit IV* is located on the east-central edge of the developed portion of the site. It includes the 1977 Oil/Solvent Spill as well as the Reclamation Facility Building 650 and Sump Outfall Area (AOC 6), where radiologically contaminated soils have been found.
V	*Operable Unit V* is located in the northeast portion of the site and includes the Sewage Treatment Plant (AOC 4) and releases to the Peconic River.
VI	*Operable Unit VI* is located on the southeastern edge of the site. It is a largely wooded area which contains various agricultural research fields and manmade experimental basins known as the Upland Recharge/Meadow Marsh Area (AOC 8). No contaminated soils of concern have been found in this Operable Unit, however, contaminated sediments in two of the manmade basins pose an ecological risk to the Tiger Salamander. Ethylene dibromide, a pesticide, has been found in groundwater south of BNL's southern boundary, and is addressed in a separate Record of Decision.

Table A-2	Description of Areas of Concern with Radiologically Contaminated Soils
Operable Unit I Areas of Concern	
Former Hazardous Waste Management Facility (AOC 1)	This Facility was the central receiving, processing and storage facility for radioactive waste generated at BNL since 1947. Since 1979, it has also been the receiving area for hazardous waste. There have been numerous spills during the Facility's operation. An asphalt cap was placed over spills in the slurry fission product area to prevent the spread of contamination. The Facility was closed in 1997 and was replaced by a new NYSDEC-permitted facility located in the northeastern part of the central portion of the BNL site. This Facility is a fenced area covering 12 acres with controlled access. Approximately one-quarter of the area is paved, with the remainder consisting of a field of grass and weeds. It contains various buildings and operational areas, as well as containment pits, concrete vaults and trenches which were used to store radioactive materials and radiation sources. (See Figures 1 & 6.) All remaining low level radioactive wastes will be removed and the buildings will be demolished and, if contaminated, disposed of off-site. One 5,000 and one 1,000 gallon Underground Storage Tanks (USTs) were also located at the facility and were removed in 1994. These were used to store liquid radioactive wastes and acid from a mercury still. This area was evaluated in the *Operable Unit I/VI Remedial Investigation/ Risk Assessment Report* and contains the most of the radiologically contaminated soil at BNL. The predominant radionuclide found is Cesium-137, which emits beta and gamma radiation, at concentrations up to 180,000 pCi/g. This radionuclide is the primary source of direct exposure risk. Strontium-90, which emits beta radiation, is also present at concentrations up to 1,300 pCi/g. This radionuclide is a concern because it migrates to groundwater. Both radionuclides are relatively short-lived, with half-lives of 30 and 28 years, respectively. Most of the soil contamination is at or near the surface, although contamination in some locations extends to 12 feet below the soil surface. Figure 6 illustrates the principal areas of surface contamination, and relative concentrations within the facility. There is no significant chemical contamination of soil within the Facility though there are several locations where low concentrations of mercury were detected in surface soils. The maximum concentration of mercury found was 184 mg/kg. There is also a shallow, seasonally ponded wetland partially located within the Facility. The wetland is divided by a fence which borders the facility's northwest boundary. This wetland is a confirmed breeding area for the Tiger Salamander.

Table A-2, cont.	Description of Areas of Concern with Radiologically Contaminated Soils
Operable Unit II/VII Areas of Concern	
Waste Concentration Facility (AOC 10)	This is the main liquid radioactive waste storage and processing facility at BNL. Certain liquid wastes received at the facility between 1947 and 1987 were stored in three 100,000-gallon aboveground D Tanks (AOC 10A). Leakages involving two of the tanks occurred in 1982, 1985 and 1987. These tanks were dismantled in 1995, but concrete and asphalt pads remain. Soil is contaminated to a depth of 12 feet beneath the pad. The maximum concentrations found of cesium-137 and strontium-90 are 464 pCi/g and 454 pCi/g, respectively. The concrete/asphalt foundation and underlying contaminated soils were capped with a temporary soil and asphalt cover in 1998. The facility also contains six out-of-service 8,000-gallon underground storage tanks (AOC 10C) enclosed in a concrete vault. The tanks were used to store class A and B radioactive wastes. Residual sludges remaining in the tanks are to be removed and the tanks excavated. In-service equipment includes two 25,000-gallon aboveground storage tanks and underground pipe lines. The Underground Pipelines (AOC 10B) consists of four lines used to transport class A, B, and D liquid wastes from various buildings to the Waste Concentration Facility and associated storage tanks. In 1995, one D-line was removed and replaced with a new line. Soil sampling adjacent to this underground pipeline during a 1995 upgrade project did not show chemical or radionuclide contamination. The remaining three A, B, and D lines are out-of-service and scheduled to be removed.
Sitewide Soils (AOCs 16, 17, & 18)	Radiologically Contaminated Surface Soils have been found adjacent to or near the following buildings as shown in Figure 3: ● Building 30 - Brookhaven Center (subAOC 16G) ● Building 355 - Contracts/ Procurement (subAOC 16S) ● Building 490 - Medical (subAOC 16E) ● Building 510 - Physics (subAOC 16S) ● Building 515 - Applied Math (subAOC 16S) ● Building 555 - Chemistry (subAOC 16F) ● Building 930 - Linear Accelerator (subAOC 16S) ● Building 526 - Low Mass Criticality Facility (AOC 17) ● AGS Storage Yards (AOC 18) These areas were evaluated in the Operable Unit II/VII Remedial Investigation Report. The dominant radionuclide found in these locations is cesium-137 with concentrations up to 348 pCi/g. Most of the elevated radiation levels are related to use and handling of activated materials (AOCs 17 and 18) or use of slightly contaminated landscaping soils (AOC 16) . Soils contaminated with low levels of radionuclides from the Hazardous Waste Management Facility were used as landscaping material outside several buildings during their construction. The contamination is found in the upper two feet of the soils.

Table A-2, cont.	Description of Areas of Concern with Radiologically Contaminated Soils
Operable Unit II/VII Areas of Concern	
Sitewide Soils (AOCs 16, 17, & 18) (continued)	Tritium and sodium-22 have been found in soils at the Building 931B - Brookhaven Linac Isotope Producer (AOC 16K). These radionuclides are isolated in an area adjacent to the target area approximately 24 feet to 32 feet below land surface. Maximum detected concentrations of tritium and sodium-22 were 4,023 pCi/g and 42,550 pCi/g, respectively. An Engineering Evaluation/Cost Analysis report is currently being prepared and recommendations on a final remedial action decision will be made when the report is issued for public review and comment.
Operable Unit IV Areas of Concern	
Reclamation Facility (Building 650) Sump and Outfall Area (AOC 6)	The Building 650 sump outfall area is contaminated with several radionuclides which includes: cesium-137 (2,800 pCi/g), strontium-90 (140 pCi/g), and plutonium-239/240 (170 pCi/g). Radiologically contaminated clothing and heavy equipment were decontaminated at this facility. Wastewater from equipment decontamination, performed outside the building on a concrete pad, drained into two of four underground storage tanks or sumps. Wastewater from clothing decontamination inside the building drained into the sump's other two tanks. The contents of these tanks were regularly transferred by truck to BNL's Waste Concentration Facility. In the summer of 1994, the underground storage tanks were removed and it was determined that they had not leaked. During its operation, it was believed that the equipment decontamination pad located at Building 650 drained into the underground tanks, then discharged into BNL's sanitary sewage system. In 1969, however, five curies of tritium were released from the Building 650 Sump outdoor decontamination waste pad into what was believed to be BNL's sanitary sewer system, but was not detected at the Sewage Treatment Plant. The subsequent investigation revealed that the drainage pipe from the Building 650 Sump discharged into a natural depression in a wooded area about 800 feet northeast of Building 650. The area is now known as the Building 650 Sump Outfall Area. This area is fenced off to prevent unnecessary access and is monitored as an interim action pending the proposal of the final remedy in this document. This interim action was documented in the *Operable Unit IV Record of Decision*.

XV. List of References

1. *Operable Unit IV Remedial Investigation Report* (CDM Federal Programs Corp., November 1994) describes the nature and extent of contamination in Operable Unit IV.

2. *Current Landfill Removal Action Memorandum.* (BNL - Office of Environmental Restoration, December 1994) authorized remediation (capping and sealing) of BNL's "current" landfill.

3. *Landfills Engineering Evaluation/Cost Analysis* (CDM Federal Programs Corp., March 1995) analyzes several remediation alternatives for the "current" and "former" landfills.

4. *Operable Unit IV Feasibility Study* (CDM Federal Programs Corp., November 1995) describes how cleanup options were developed and evaluated for the Building 650 and sump outfall.

5. *Operable Unit I Groundwater Engineering Evaluation/Cost Analysis* (CDM Federal Programs Corp., December 1995) analyzes several alternatives for groundwater remediation on the BNL site and in the North Shirley area.

6. *Former Landfill Removal Action Memorandum.* (BNL - Office of Environmental Restoration, May 1996) authorized remediation (capping and sealing) of BNL's former landfill.

7. *Operable Unit IV Record of Decision.* (BNL - Office of Environmental Restoration, April 1996) describes the selected remedial action for the treatment of chemically and radiologically contaminated soil and groundwater contaminated with organic components within Operable Unit IV.

8. *Operable Unit I/VI Remedial Investigation/Risk Assessment Report* (CDM Federal Programs Corp., June 1996) describes the nature and extent of contamination within Operable Unit I/VI and reports on risks to public health and the environment in the absence of cleanup.

9. *Final Operable Unit II/VII Remedial Investigation Report* (IT Corp., February 1999) describes the nature and extent of contamination within Operable Unit II/VII.

10. *Final Feasibility Study* Report: *Operable Unit I and Radiologically Contaminated Soils* (CDM Federal Programs Corp., March 1999) describes how the cleanup options were developed and evaluated for soils at BNL.

11. *Final Operable Unit I Groundwater Removal Action and Operable Units I & III Public Water Hookups Action Memorandum* (BNL - Office of Environmental Restoration, December 1996) describes remedial actions for groundwater problems at the south boundary of BNL.

12. *Final Evaluation of Alternatives Report. Chemical/Animal Pits and Glass Holes*. (CDM Federal Programs Corp., April 1997) Describes and evaluates remedial actions for these disposal pits.

13. *Closeout Report for 445 Tanks Removal*. (IT Corporation, February 1995) Describes activities involved with contents removal and excavation of two underground storage tanks (UST) at Building 445 at BNL.

14. *Final Action Memorandum Phase III - Landfill Closure Removal Action* (BNL- Office of Environmental Restoration, June 1997).

15. *Deer Meat Contaminated with ^{137}Cs at Brookhaven National Laboratory* (New York State Department of Health, March 1999).

XVI. Glossary of Terms and Abbreviations

Alpha Radiation: A form of ionizing radiation which is emitted during decay of a radionuclide such as uranium-238 or plutonium-239. This radiation consists of particles having two protons and two neutrons. It has a very low ability to penetrate any substance. (See **ionizing radiation**.)

ALARA: As Low As Reasonably Achievable. DOE policy for achieving exposures to radiation lower than acceptable standards.

Aquifer: An underground layer of rock, sand or gravel capable of storing water within cracks and pore spaces, or between grains. When water contained within an aquifer is of sufficient quantity and quality, it can be tapped and used for drinking or other purposes. The water contained in the aquifer is called groundwater.

Area of Concern (AOC): A geographic area of BNL where there has been a release or the potential for a release of a hazardous substance, pollutant or contaminant including radionuclides.

Baseline Risk Assessment: Estimates human health and ecological risk which could result from the contamination at the site if no remedial action were taken.

Beta Radiation: A form of ionizing radiation which is emitted from the nucleus of an atom in the form of electrons during decay of a radionuclide such as strontium-90 or tritium. It has a low ability to penetrate materials. (See **ionizing radiation**.)

BNL: Brookhaven National Laboratory.

Cesium-137: A chemical element which is an unstable radionuclide with a half-life of about 30 years. It emits beta and gamma radiation through decay and is relatively immobile in soil.

Curie: A unit of measure for radioactive materials based on the number of disintegrations per second (3,700 x 10^{10}/sec).

DOE: U.S. Department of Energy, owner of BNL.

Downgradient: A downward hydrologic slope that causes groundwater to move toward lower elevations. Therefore, wells downgradient of a contaminated groundwater source are prone to receiving pollutants.

Engineering Evaluation/Cost Analysis (EE/CA): Document which evaluates feasible and cost-effective alternatives for proposed removal actions.

EPA: U.S. Environmental Protection Agency. An Interagency Agreement party which reviews and oversees remedial work at BNL.

Feasibility Study (FS): A process for developing, evaluating and selecting remedial actions, using data gathered during the remedial investigation to: define the objectives of the remedial program for the site and broadly develop remedial action alternatives; perform an initial screening of these alternatives; and perform a detailed analysis of a limited number of alternatives which remain after the initial screening stage.

Gamma Radiation: A form of highly penetrating ionizing radiation which is emitted during decay of a radionuclide such as cesium-137 or radium-226. It consists of short wavelength electromagnetic radiation from the nucleus of the atom. (See **ionizing radiation**.)

Half-life: The amount of time for one-half of the mass of a radionuclide to decay to another nuclide.

Hazardous Waste: Toxic, corrosive, reactive or ignitable materials that can negatively affect human health or damage the environment as defined by RCRA and state regulations.

Interagency Agreement: A written agreement between EPA and a federal agency that has the lead for site cleanup activities (e.g., DOE) that sets forth the roles and responsibilities of the agencies for performing and overseeing the activities. The NYSDEC is also party to the BNL Interagency Agreement.

Ionizing Radiation: A form of radiation including alpha, beta, gamma, cosmic and X radiation that is highly energetic and causes atoms to form ions. Ionizing radiation can cause damage to living cells and genetic material.

Landfill: A disposal facility where waste is placed in or on land.

Leach/Leaching: The process by which soluble chemical components or hazardous materials are dissolved and carried through soil by water or some other percolating liquid.

Millirem (mrem): a unit of radiation exposure to people. A mrem is 1/1,000 of a rem.

NYCRR: New York State code of regulations. For example, 6 NYCRR Part 360 provides regulatory requirements for waste facilities including landfill capping.

NYSDEC: New York State Department of Environmental Conservation. An Interagency Agreement party which reviews and oversees remedial work at BNL.

Operable Unit (OU): One or more areas of concern or contamination problems which need to be addressed. Operable Units may address geographical portions of a site, specific site problems or initial phases of an action, or may consist of any set of actions performed over time located in different parts of a site.

pCi/g: picoCuries/gram. A measure of radioactivity per unit weight of a substance. It represents one trillionth (10^{-12}) of a Curie.

Plume: A body of contaminated groundwater flowing from a specific source. The movement of the groundwater is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained and the density of contaminants.

Proposed Plan: Summarizes the decision that led to the recommended remedial action by discussing each alternative and the reasons for choosing or rejecting it.

Radium-226: A radioactive chemical element or radionuclide with a half life of about 1,600 years. It emits alpha and gamma radiation through decay and is relatively mobile in soil and groundwater.

Radionuclide: An element such as cesium-137, strontium-90, radium-226, and uranium-238, which breaks down to form another element and produces ionizing radiation due to its unstable nuclear structure. Some radionu-

clides are man-made and others, such as radon-222, thorium-232 and potassium-40, are naturally occurring in the environment.

RCRA: The Resource and Conservation Recovery Act. A Federal law which defines hazardous wastes and disposal requirements.

Record of Decision (ROD): Includes the selected remedial action, the Responsiveness Summary and a bibliography of documents that were used to reach the remedial decision. When the ROD is finalized, remedial design and construction can begin in order to remediate the site.

REM: Radiological Equivalent Man. A unit of radiation dose to people. The dose includes different biological effects of various types of radiation.

Remedial Investigation (RI): Thorough study, sampling and laboratory analyses of problem site. The RI identifies the types and extent of contamination, defines the pathways of migration and measures the degree of contamination in surface water, groundwater, soils, air, plants and animals.

Remediate: To restore, clean up or otherwise prevent or reduce exposure to hazardous substances.

Removal Actions or Removals: Those actions taken early and/or quickly to prevent, minimize or mitigate damage to public health or the environment which may otherwise result from a release or threatened release of hazardous substances, pollutants or contaminants.

Responsiveness summary: An accumulation of responses to comments/concerns/questions received from a public meeting and/or during a public comment period. Modifications to a proposed remedial action may be made as a result.

RESRAD: Residual Radioactive Material Guidelines. A computer program used to estimate site-specific soil concentrations of radionuclides for remediation goals based on an acceptable radiation dose.

Strontium-90: A radioactive chemical element with a half-life of about 27.7 years. It emits beta radiation through decay and is moderately mobile in soil and groundwater.

Sump: A pit or tank that catches liquid runoff for drainage or disposal.

Tritium: A form of hydrogen which is a radionuclide with a half-life of about 12.3 years. It emits beta radiation through decay. Tritiated water is very mobile in soil and groundwater.

Vitrification: A process of converting soil and wastes into a form of glass which permanently binds up hazardous materials, thus eliminating potential exposure to humans, plants and animals.

Volatile Organic Compounds (VOCs): These potentially toxic organic chemicals are used as solvents, degreasers, paints, thinners and fuels. Because of their volatile nature, they readily evaporate into the air. They include acetone, trichlorethylene, perchloroethylene, dichloroethylene, benzene, vinyl chloride, and many other compounds.

Wetland: An area that is regularly saturated by surface or groundwater, and under normal circumstances, capable of supporting vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes and bogs.

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What's Your Opinion?

The DOE wants and needs to hear from you to effectively decide what actions to take at Brookhaven National Laboratory.

Comments: