U. S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
CERCLIS Number NY7890008975

RECORD OF DECISION

for
Area of Concern 16T
g-2 TRITIUM SOURCE AREA AND GROUNDWATER PLUME
Area of Concern 16K
BROOKHAVEN LINAC ISOTOPE PRODUCER
and
Area of Concern 12
FORMER UNDERGROUND STORAGE TANKS

April 6, 2007

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I. DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

g-2 TRITIUM SOURCE AREA AND GROUNDWATER PLUME (AOC 16T)
BROOKHAVEN LINAC ISOTOPE PRODUCER (AOC 16K)
FORMER UNDERGROUND STORAGE TANKS (AOC 12)
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK
CERCLIS Number NY7890008975

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) documents the selected remedial actions for the g-2 Tritium Source Area and Groundwater Plume (AOC 16T), Brookhaven Linac Isotope Producer (BLIP) (AOC 16K), and Former Underground Storage Tanks (USTs) (AOC 12) at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL) facility in Upton, New York.

The remedial actions are selected in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended (hereinafter referred to as CERCLA), and are consistent, to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan). This decision is based on the documents included in the Administrative Record for the BNL Site.

The State of New York concurs with the selected remedial actions.

ASSESSMENT OF THE SITE

Releases of hazardous substances from the g-2 and BLIP source areas may present a threat to public health, welfare, or the environment if they are not addressed by implementing the response actions selected in this Record of Decision. There are no potential human health or environmental impacts associated with the former USTs.

DESCRIPTION OF THE SELECTED REMEDIES

This ROD documents the selected remedial actions (also called remedies) for the g-2 Tritium Source Area and Groundwater Plume (AOC 16T), soil and groundwater at the Brookhaven Linac Isotope Producer (BLIP) (AOC 16K), and Former Underground Storage Tanks (USTs) (AOC 12). These remedies were presented in the Proposed Remedial Action Plan (PRAP). Based on an evaluation of the potential remedial alternatives, and discussions with the regulatory agencies and community, the following remedies were selected:

g-2 Tritium Source Area and Groundwater Plume (AOC 16T): The selected remedy for the g-2 Tritium Source Area and Groundwater Plume, is Alternative 2, as modified in response to public comment, and requires continued routine inspection and maintenance of the concrete cap and other storm water controls. In addition, this alternative requires continued groundwater monitoring immediately downgradient of the source area to verify the continued effectiveness of the storm water controls, and to verify that the tritium plume attenuates to less than the Maximum Contaminant Level (MCL) of 20,000 pCi/L as predicted by the BNL groundwater model (BNL, 2006a). Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality (i.e., until the radioactivity decays to an acceptable level or until the soils are remediated). Monitoring of the plume will continue until the plume attenuates to less than 20,000 pCi/L. This monitoring program will be accomplished using a combination of permanent (fixed) wells and temporary wells. All monitoring plans will be reviewed with the regulatory agencies before implementation in accordance with the Interagency Agreement.

Two contingency trigger levels have been developed in the event of unexpected future releases from the source area or if the tritium plume does not attenuate as predicted by the BNL groundwater model. If the trigger levels are reached, BNL's Groundwater Protection Contingency Plan (BNL 2003 and subsequent updates) will be implemented, and the need for additional corrective actions will be evaluated. This contingency plan provides for a consistent, systematic approach to respond to the detection of unexpected levels of contamination, including verification of results, conducting additional sampling and/or characterization, and informing stakeholders about the monitoring results and any follow-up actions. The two trigger levels for the g-2 tritium plume are:

1. <u>Detection of >1,000,000 pCi/L within the Tritium Plume</u>: If tritium levels greater than 1,000,000 pCi/L are observed within the plume, actions would include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. If detected in the wells immediately downgradient of the source area, actions would include the immediate inspection of the existing storm water controls and implementation of improvements, as necessary. The actions would also include an evaluation of whether active remediation (e.g., low-flow extraction with off-site disposal or high-flow pumping with on-site recharge) is appropriate to limit plume growth.

2. <u>Detection of >20,000 pCi/L South of Brookhaven Avenue</u>: If tritium levels south of Brookhaven Avenue are found to exceed the 20,000 pCi/L MCL, actions will include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. An assessment will be made to determine whether active remediation is appropriate to control plume growth. Brookhaven Avenue is located approximately one mile north of the BNL site boundary.

The regulatory agencies will make a decision on the need to implement active groundwater remediation measures after receiving DOE's assessment and recommendation in accordance with the Interagency Agreement. DOE is committed to preventing the migration of tritium beyond the BNL property boundary at concentrations greater than the 20,000 pCi/L MCL. Groundwater data will be evaluated and reported annually in the *Groundwater Status Report* (which is Volume II of the annual *BNL Site Environmental Report*) and during CERCLA Five-Year Reviews, both of which are made available to the public.

In addition to publishing the results of the monitoring program in these reports, summary reports will be provided to the BNL Community Advisory Council (CAC) and other interested community organizations and individuals.

Institutional and engineered controls are in place to prevent possible exposure to the contaminated soils and groundwater. These controls include physical barriers and work control procedures to restrict access to activated soils near the VQ12 source area, operational restrictions on existing potable/process water supply wells within the vicinity of the plume's path, and restrictions on the future placement of pumping wells and/or recharge basins that might impact groundwater flow directions in this area. If the former g-2 beam line were to be used in the future, institutional controls would also require procedures to limit the amount of beam loss, and further activation of the soil shielding. Final disposition of the activated soil will be addressed during facility decommissioning.

Visual inspections of the g-2 source area cap will be conducted on a frequency of at least two times per year. An annual certification will be prepared by a professional engineer or other such expert acceptable to the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC), until the EPA and NYSDEC notifies DOE in writing that this certification is no longer needed. This submittal would contain certification that the institutional controls and engineering controls are still in place, and that nothing has occurred that would impair the ability of the controls to protect public health or the environment, or constitute a violation or failure to comply with the BNL *Land Use Controls Management Plan* (BNL, 2005 and subsequent updates). The regulatory agencies will have access to the site to conduct inspections, as necessary.

An environmental easement/restrictive covenant will be filed in the property records of Suffolk County at the time the Federal Government disposes of the property if residual contamination levels are present that do not allow for unrestricted use. This includes the completion and submission of periodic certifications to ensure that the institutional and engineering controls are in place.

BLIP (AOC 16K): The selected remedy for BLIP requires continued inspections, certifications, and maintenance of the cap; groundwater monitoring; institutional controls; and the previously completed activities (i.e., installation of the cap, improved roof drains, and containment with colloidal silica grout) are selected as the final action. Groundwater monitoring will verify that the cap and other storm water controls are effective. Groundwater data will be evaluated and reported annually in the *Groundwater Status Report* and during CERCLA Five-Year Reviews.

Institutional and engineered controls are in place to prevent possible exposure to the contaminated soils and groundwater. These controls include physical barriers and work control procedures to restrict access to activated soils at BLIP and restrictions on installing new potable/process water supply wells within the vicinity of the plume's path, and controlling the future placement of pumping wells and/or recharge basins that might impact groundwater flow directions in this area. Final disposition of the activated soil will be addressed during facility decommissioning.

Visual inspections of the BLIP source area cap will be conducted on a frequency of at least two times per year. An annual certification will be prepared by a professional engineer or other such expert acceptable to the EPA and NYSDEC, until the EPA and NYSDEC notifies DOE in writing that this certification is no longer needed. This submittal would contain certification that the institutional controls and engineering controls are still in place, and that nothing has occurred that would impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the BNL *Land Use Controls Management Plan* (BNL, 2005 and subsequent updates). The regulatory agencies will have access to the site to conduct inspections, as necessary.

An environmental easement/restrictive covenant would be filed in the property records of Suffolk County at the time the Federal Government disposes of the property if residual contamination levels are present that do not allow for unrestricted use. This includes the completion and submission of periodic certifications to ensure that the institutional and engineering controls are in place.

Former UST areas (AOC 12): Confirmatory sampling conducted after the tanks were removed did not identify residual levels of contamination that could impact human health or the environment. Therefore, the closure work already completed on these eight tanks under the requirements of Suffolk County Sanitary Code Article 12 is the final action.

The DOE does not envision any sale or transfer of property within the accelerator research area of the BNL site. If it were to occur, the sale or transfer of BNL property would meet the requirements of Section 120 (h) of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination.

STATUTORY DETERMINATION

The selected remedies are protective of human health and the environment, comply with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial actions, are cost-effective, and use permanent solutions to the maximum extent possible. Active treatment of contaminated soil and groundwater was not found to be practicable; therefore, this remedy does not satisfy the statutory preference for treatment as a principal element. However, engineered and institutional controls have been put in place to reduce the potential for future human exposure to the activated soil, releases of tritium to the groundwater, and possible human exposure to contaminated groundwater.

Because these remedies will result in some hazardous substances remaining above levels allowed for unlimited use and unrestricted exposure, five-year reviews will be conducted pursuant to CERCLA §121(c) to ensure that the remedy continues to provide protection of human health and the environment.

AUTHORIZING SIGNATURES

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TABLE OF CONTENTS

I. DECLARATION OF THE RECORD OF DECISION

II. DECISION SUMMARY

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
BER	Brookhaven Executive Roundtable
BNL	Brookhaven National Laboratory
BLIP	Brookhaven Linac Isotope Producer
BSA	Brookhaven Science Associates
CAC	Community Advisory Council
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOE	United States Department of Energy
EE/CA	Engineering Evaluation / Cost Analysis
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FFS	Focused Feasibility Study
H-3	tritium
IAG	Interagency Agreement
LUCMP	Land Use Controls Management Plan
MCL	maximum contaminant level
mrem/yr	millirem per year
NYCRR	New York State Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
pCi/L	picoCuries per liter
ROD	Record of Decision
SDWA	Safe Drinking Water Act
Sr-90	Strontium-90
TBC	To-Be-Considered
U.S.C.	United States Code
UST	Underground Storage Tank

II. DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Brookhaven National Laboratory (BNL) is a federal facility owned by U.S. Department of Energy (DOE). The DOE conducts research in physical, biomedical and environmental sciences and energy technologies.

BNL is located about 60 miles east of New York City, in Upton, Suffolk County, New York, near the geographic center of Long Island (Figure 1). Distances to neighboring communities from BNL are as follows: Ridge, immediately to the west and north of the site; North Shirley/East Yaphank, less than one mile to the south; and Manorville, immediately to the east of the site.

The BNL property, consisting of 5,321 acres, is an irregular polygon, and each side is approximately 2.5 miles long. Figure 2 is a current land-use map of the BNL Site.[1] The developed portion of the BNL site includes the principal research and support facilities, which are located near the center of the site on relatively high ground (approximately 100 feet above mean sea level). The developed portion is approximately 900 acres, 500 acres of which were originally developed for Camp Upton during World Wars I and II. The central 400 acres are occupied mostly by various large research facilities. The outlying facilities occupy approximately 550 acres and include an apartment area, Biology Field, Former Hazardous Waste Management Area, Sewage Treatment Plant, firebreaks, and the Former Landfill Area. The terrain is gently rolling, with elevations varying between 40 to 120 feet above mean sea level. The land lies on the western rim of the shallow Peconic River watershed, with a tributary of the Peconic River beginning in the marshy areas in the northern section of the site.

The aquifer system beneath BNL is composed of three water-bearing units: the Upper Glacial aquifer, the Magothy aquifer, and the Lloyd aquifer. These units are hydraulically connected and make up a single zone of saturation with varying physical properties extending from a depth of five to 1,500 feet below the land surface. These three water-bearing units are a U.S. Environmental Protection Agency (EPA) designated “sole source aquifer” system, and serve as the primary source of drinking water for Nassau and Suffolk Counties.

This Record of Decision addresses the g-2 Tritium Source Area and Groundwater Plume (AOC 16T), Brookhaven Linac Isotope Producer (BLIP) Soils (AOC 16K), and Former Underground Storage Tank (UST) areas (AOC 12), which are centrally located within the BNL Site. The locations of the g-2, BLIP and UST areas are presented in Figures 3 and 4.

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1 The BNL Land Use Map is subject to change in accordance with the process delineated in the BNL Land Use Management Plan (BNL, 2005).

Figure 1. Regional Map

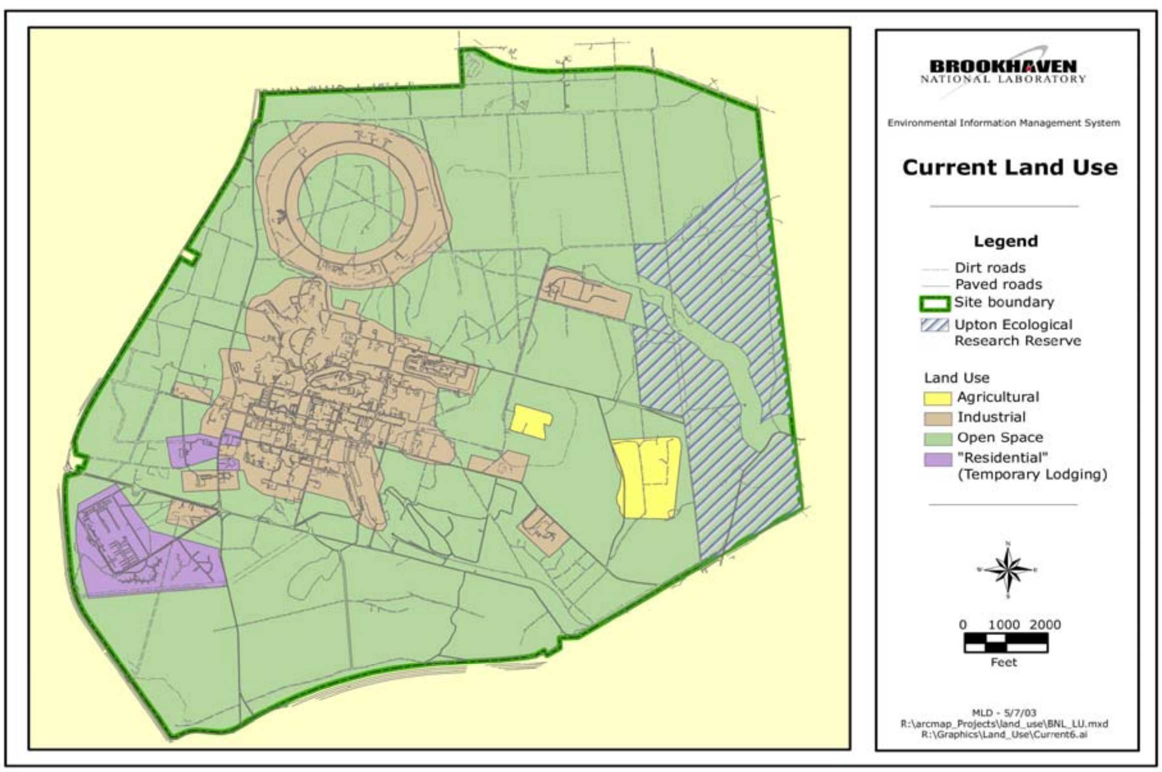

Figure 2. BNL Current Land Use Map

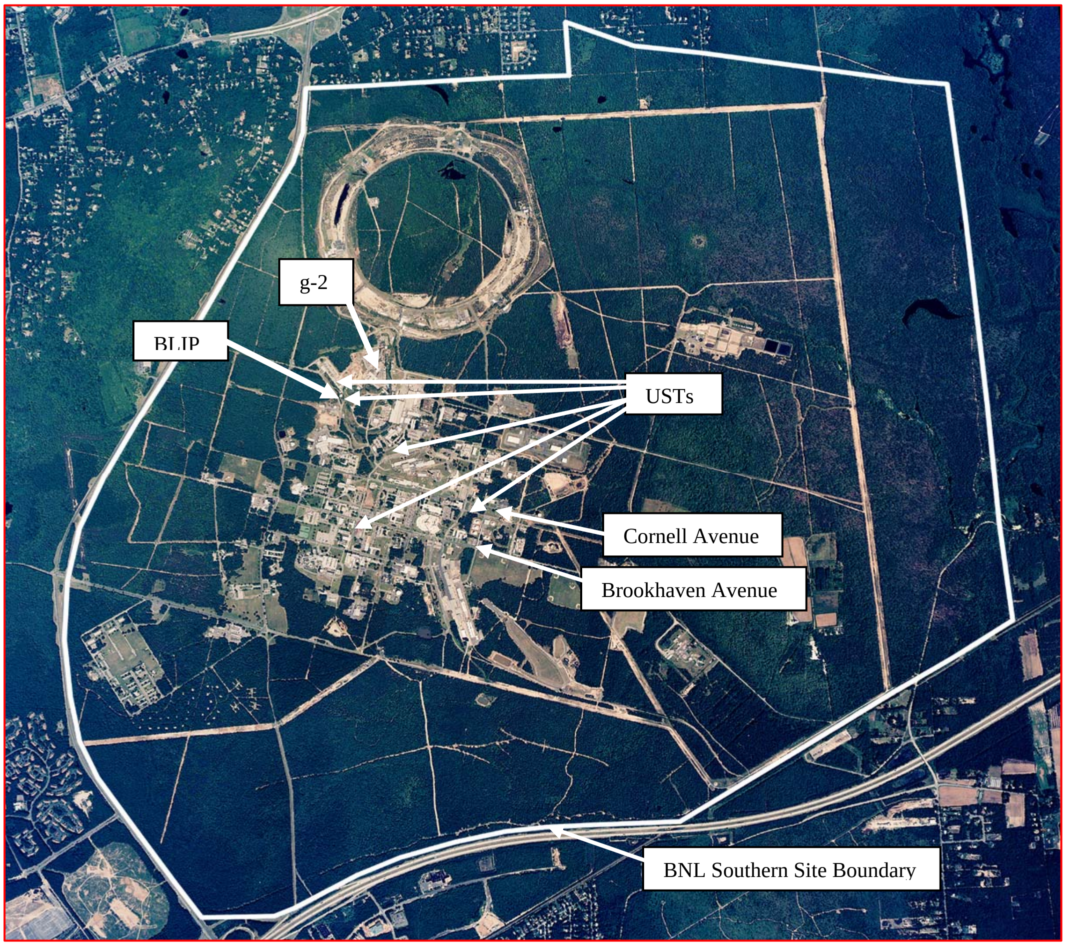

Figure 3. Locations of the BLIP and g-2 Facilities, and Former Underground Storage Tanks

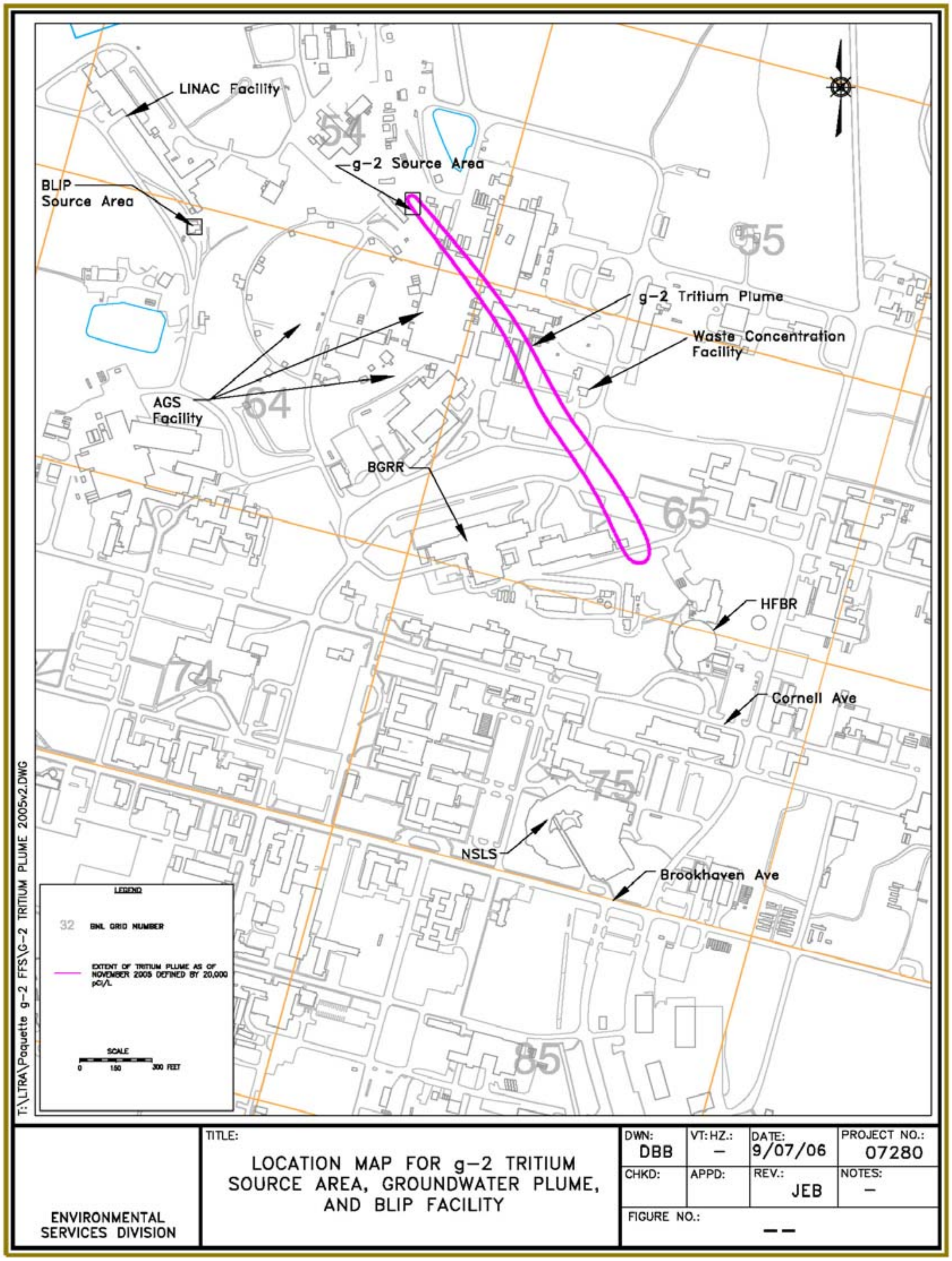

Figure 4. Location Map for g-2 Tritium Source Area, Groundwater Plume and BLIP Facility

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The U.S. Army occupied the BNL site, formerly Camp Upton, during World Wars I and II. Between the wars, the Civilian Conservation Corps operated the BNL site. It was transferred to the Atomic Energy Commission in 1947, to the Energy Research and Development Administration in 1975, and to DOE in 1977. Brookhaven Science Associates (BSA) operates BNL under a contract with DOE.

In 1980, the BNL site was placed on the New York State Department of Environmental Conservation's (NYSDEC) list of Inactive Hazardous Waste Sites. On November 21, 1989, the BNL site was included on EPA's National Priorities List because of soil and groundwater contamination that resulted from the Laboratory's past operations. Subsequently, to coordinate the cleanup the EPA, NYSDEC, and DOE entered into a Federal Facility Agreement (CERCLA-FFA, 1992) (herein referred to as the Interagency Agreement [IAG]) that became effective in May 1992.

The Alternating Gradient Synchrotron (AGS) facility is located in the middle-western section of the BNL site, and is used to conduct accelerated particle beam experiments. The g-2 experiment was conducted on an independent beam line originating from the AGS. The experiment operated from April 1997 through April 2001. Radionuclides were produced in some of the soil shielding used along the accelerator beam line by the interaction of secondary particles (primarily neutrons) that were created when the beam would strike fixed targets and beam stops. The primary radionuclides of concern in the soil are tritium, with a half-life of 12.3 years, and sodium-22, with a half-life of 2.6 years. The infiltration of rainwater through activated soil may transport tritium and sodium-22 to the groundwater. At the beginning of the g-2 experiment, beam losses were expected to produce activated soil below the target building and the nearby beam stop. The building structure and the underlying concrete pad protect the activated soil below the target building, and an impermeable cap was constructed over the g-2 beam stop to protect the soil shielding from rainfall infiltration. In November 1999, BNL detected tritium in the groundwater near the g-2 experiment at concentrations above the 20,000 pico curies per liter (pCi/L) drinking water standard, also known as the maximum contaminant level, or MCL (see Subpart 5-1 of the New York State Sanitary Code under NYCRR Title 10 for information on establishing MCLs). Sodium-22 was also detected in the groundwater, but the levels were less than the 400 pCi/L MCL. Following the discovery, an investigation into the source of the contamination revealed that the tritium and sodium-22 originated from activated soil shielding located adjacent to the g-2 target building. The investigation determined that approximately five percent of the beam was inadvertently striking the experiment's VQ12 magnet, which is located inside the g-2 target building. The previously installed concrete base pad and beam stop cap did not protect this new soil activation area. A new cap was installed over this area in December 1999. In early 2000, the activated soil shielding and groundwater plume were designated Area of Concern (AOC) 16T.

The Brookhaven Linac Isotope Producer (BLIP) is an active accelerator facility also located in the central portion of the site (Figure 3). The BLIP facility has been in operation since 1972, and is a national resource for producing the radioisotopes that are crucial in nuclear medicine for both research and clinical use. BLIP also supports BNL's research on diagnostic and therapeutic radiopharmaceuticals. Beam line operations have resulted in the activation of soils that surround the BLIP target vessel. These activated soils are approximately 30 feet below the BLIP building, in a small zone surrounding the target vessel. In 1998, low levels of tritium were detected in the groundwater near the BLIP facility experiment at concentrations of approximately three times the 20,000 pCi/L MCL. Sodium-22 was also detected in the groundwater, but the levels were less than the 400 pCi/L MCL. Prior to the discovery of the tritium contamination, the BLIP facility had been designated as AOC 16K in the IAG based upon the results of an earlier aerial radiation survey.

A total of 16 underground storage tanks (USTs) were included as AOC 12 in the IAG. These low-level radioactive waste storage tanks were designated as AOCs due to the potential for environmental releases. The USTs were removed from the ground between 1988 and 1996. Eight of them were previously closed out in other RODs. These were: two tanks at Building 445 (Operable Unit [OU] I ROD), four tanks at Building 650 (OU IV ROD), and two tanks at Building 830 (OU III ROD). The removal of the remaining eight USTs, one at Building 462, two at Building 463, one at Building 527, one at Building 703, one at Building 927, and two at Building 931, will be closed out under this ROD.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

3.1 BNL Community Relations

In accordance with CERCLA, sections 113 (k)(2)(B)(i-v) and 117, the community relations program focuses on informing and involving the public. A variety of activities were used to provide information and to seek public participation, including holding community meetings, information sessions, and distributing fact sheets. The Administrative Record, which documents the basis for removal and remedial actions was established and is maintained at the libraries listed below.

Mastic-Moriches-Shirley Community Library
301 William Floyd Parkway
Shirley, NY 11967
631-399-1511

Brookhaven National Laboratory
Research Library
Bldg. 477A
Upton, NY 11973
631-344-3483

U.S. EPA - Region II
Administrative Record Room
290 Broadway, 18th Floor
New York, New York 10007
212-637-4308

3.2 Community Involvement in the ROD

Community involvement and participation was solicited for all significant documents and decisions associated with this Record of Decision. The community involvement process has been an integral part of making cleanup decisions. Project staff made numerous presentations to the BNL Community Advisory Council (CAC), the Brookhaven Executive Round Table (BER), and several local civic associations. Additionally, documents and information about g-2, BLIP and the former USTs have been posted to the BNL web page at http://www.bnl.gov/erd.

Following the 1998 discovery of the tritium in groundwater at the BLIP facility, an Engineering Evaluation/Cost Analysis (EE/CA) was prepared for the activated soil shielding (CDM Federal, 1999). The public comment period for the BLIP EE/CA was held from September 29 through October 20, 1999. It was announced in the newspapers *Newsday* and *Suffolk Life* with advertisements and legal notices.

The *Proposed Remedial Action Plan for the g-2 Tritium Source Area and Groundwater Plume, Brookhaven Linac Isotope Producer Soils and Former Underground Storage Tanks* (BNL 2006c), was released for public review and comment on October 12, 2006. The Notice of Availability was published in *Newsday* and *Suffolk Life,* as were advertisements for two information sessions and the public meeting. Information sessions were held on October 18, 2006, and the public meeting was held on October 25, 2006. The public comment period closed on November 13, 2006.

The Responsiveness Summary section of this document (Section III) summarizes the written and oral comments received during the public comment period and DOE's responses to these comments.

4.0 SCOPE AND ROLE OF g-2/BLIP/UST RECORD OF DECISION

This Record of Decision selects the remedial actions for the g-2 Tritium Source Area and Groundwater Plume, Brookhaven Linac Isotope Producer Soils, and the former USTs. The remedial actions necessary to complete the selected remedies are described below and also in Section 10.0 - Selected Remedy.

4.1 Interim measures that have been completed.

4.1.1 g-2 Source Area and Tritium Groundwater Plume

Since detecting tritium in groundwater in November 1999, DOE has implemented a number of corrective actions to prevent rainwater from entering the activated soils at g-2, and has been tracking the movement of tritium in the groundwater.

- 1999 – Installed concrete cap over soil activation area (Figure 5)
- 1999 – Installed 18 temporary wells and collected soil samples to verify the source of the contamination and extent of the tritium contamination in the groundwater

- 1999 – Tuned particle beam and improved beam line loss monitoring to minimize soil activation
- 2000 to Present – Using 23 permanent wells and 58 temporary wells, conducted routine groundwater monitoring to verify cap effectiveness, monitor the movement and attenuation of the tritium in the groundwater. Performed routine cap inspections and maintenance

4.1.2 BLIP

DOE implemented a number of corrective actions since 1998 to prevent rainwater from entering the soils surrounding the BLIP building and to monitor the groundwater. These actions included:

- 1998 - Reconnected and rerouted the building's downspouts
- 1998 - Sealed existing pavement south of the building
- 1998 - Placed a concrete cap on the western, northern, and eastern sides of the building
- 1998-1999 - Installed seven additional groundwater monitoring wells to allow BNL to verify that the stormwater controls are effective
- 1999 - Conducted an EE/CA to evaluate additional actions to address the activated soil
- 2000 – Issued an Action Memorandum (BNL, 2000b) to select the injection of a colloidal silica grout into the activated soil as a corrective action
- 2000 – Injected the grout into the activated soils as part of a DOE innovative technology demonstration project (BNL 2001)
- 2004 – Capped the Linac-to-BLIP beam line (Figure 6)
- 1998 to Present – Conducted routine groundwater monitoring to verify effectiveness of the stormwater controls. Continue to perform cap inspections and maintenance

4.1.3 USTs

The eight former underground tanks were removed from the ground between 1988 and 1996. Removal was performed under the requirements of Suffolk County Sanitary Code Article 12, which regulates the storage and handling of toxic and hazardous materials. The tank removals were coordinated with the Suffolk County Department of Health Services. Tank closeouts were documented through the BNL Facility Review Disposition Project (FRDP). The FRDP was started in 1998 to resolve all of the issues identified during the preceding Facility Review Project. Details on the UST removal actions are presented in *Technical Memorandum and Supporting Documentation for the Proposed Plan, AOC 12 and AOC 16K* (BNL 2006b).

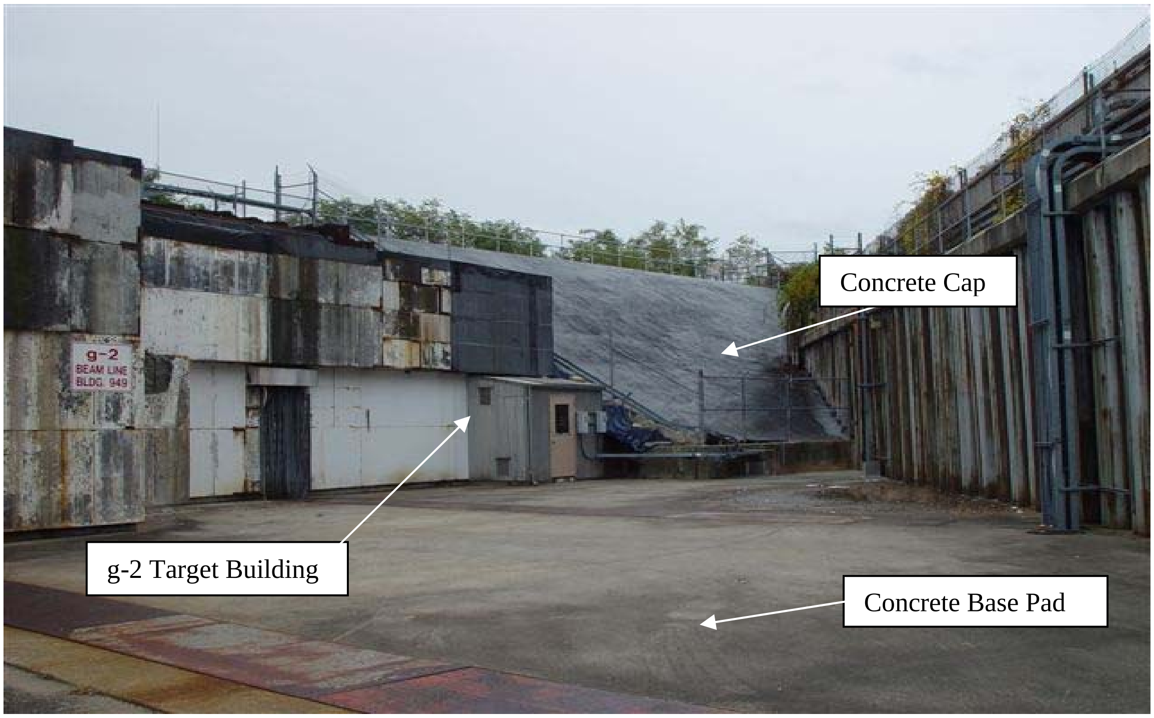

Figure 5. Concrete Cap at the g-2 Source Area (View from the Northwest)

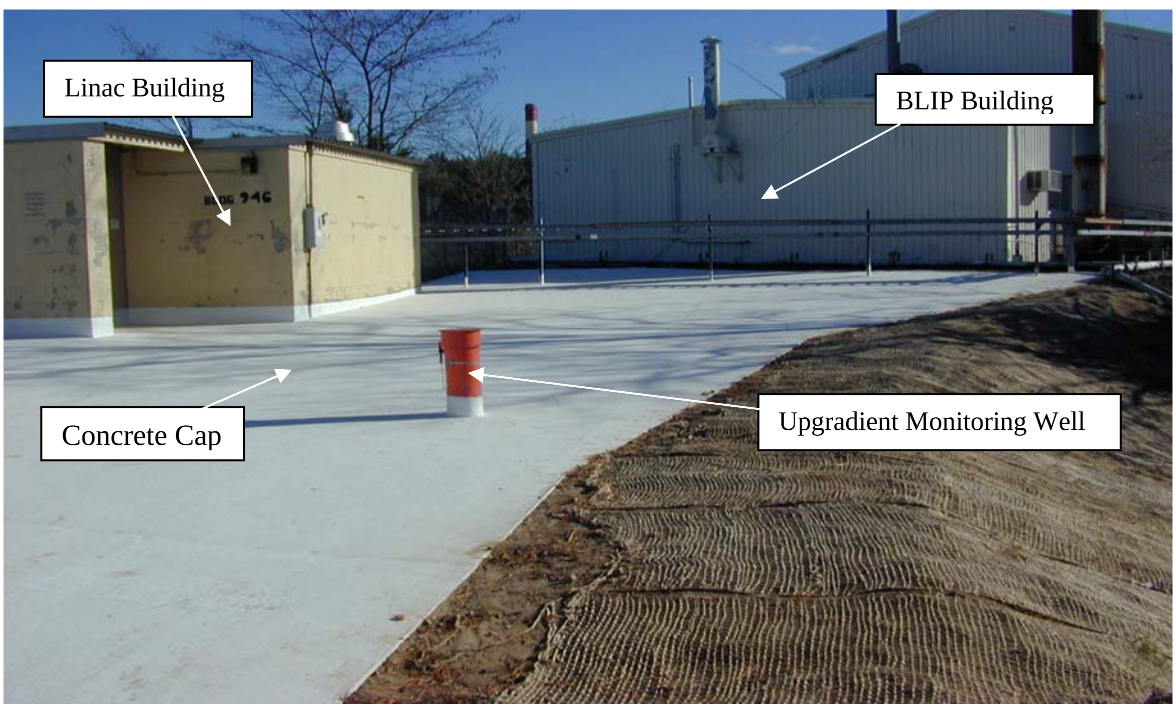

Figure 6. Concrete Cap on the North Side of the BLIP Facility, Including the Linac to BLIP Cap Installed in 2004

5.0 SUMMARY OF SITE CHARACTERISTICS

The DOE conducted extensive characterization of the g-2 Tritium Source Area and Groundwater Plume, BLIP Soils, and former UST areas to determine the nature and extent of radiological contamination. The characterization included direct sampling of soils and groundwater, and computer modeling to evaluate the fate and transport of tritium in the groundwater. Results of the characterization are available in the Administrative Record published in three separate characterization reports.

- *Brookhaven Linac Isotope Producer Engineering Evaluation/Cost Analysis* (CDM Federal, 1999)
- *Brookhaven National Laboratory g-2 Source Area and Tritium Plume – AOC 16T, Focused Feasibility Study* (BNL, 2006a)
- *Technical Memorandum and Supporting Documentation for the Proposed Plan, AOC 12 and AOC 16K* (BNL 2006b)

5.1 Nature and Extent of Contamination

5.1.1 g-2 Tritium Source Area and Groundwater Plume

The Alternating Gradient Synchrotron (AGS) facility is used to conduct accelerated particle beam experiments. The g-2 experiment was on an independent beam line originating from the AGS. The g-2 experiment operated from April 1997 through April 2001. The AGS facility is located in the middle-western section of the BNL site, approximately 1.5 miles north of the BNL southern property boundary (Figure 3).

Radionuclides were produced in some of the soil shielding used along the accelerator beam line by the interaction of secondary particles (primarily neutrons) that were created when the proton beam would strike fixed targets and beam stops. The primary radionuclides of concern in the soil are tritium, with a half-life of 12.3 years, and sodium-22, with a half-life of 2.6 years. The infiltration of rainwater through activated soil may transport tritium and sodium-22 to the groundwater. During the design of the g-2 experiment, beam losses were expected to produce activated soil below the target building and the nearby beam stop. The building structure and the underlying concrete pad protect the activated soil below the target building, and an impermeable cap was constructed over the g-2 beam stop to protect the soil shielding from rainfall infiltration. Groundwater monitoring wells were installed to verify the effectiveness of these controls.

In November 1999, BNL detected tritium in the groundwater near the g-2 experiment at concentrations above the 20,000 pCi/L MCL. Following the discovery, an investigation into the source of the contamination revealed that the tritium originated from activated soil shielding located adjacent to the g-2 target building. The investigation determined that approximately five percent of the beam was inadvertently striking the experiment's VQ12 magnet, which is located inside the g-2 target building. The previously installed concrete base pad and beam stop cap did not protect this new soil activation area. Figure 6 is a simplified cross-section view of the beam line and associated activated soil shielding. The highest tritium level detected in groundwater during the 1999 investigation was approximately 1.8 million pCi/L. Sodium-22 was also detected in the groundwater, but at concentrations below the 400 pCi/L MCL. To prevent additional rainwater infiltration into the activated soil, a concrete cap was constructed over the VQ12 area in December 1999 (Figure 5). Other corrective actions included refocusing the beam and improved beam loss monitoring to reduce additional soil activation, stormwater management improvements, and additional groundwater monitoring. The g-2 experiment concluded its operations in April 2001, and the facility is being maintained for possible future use.

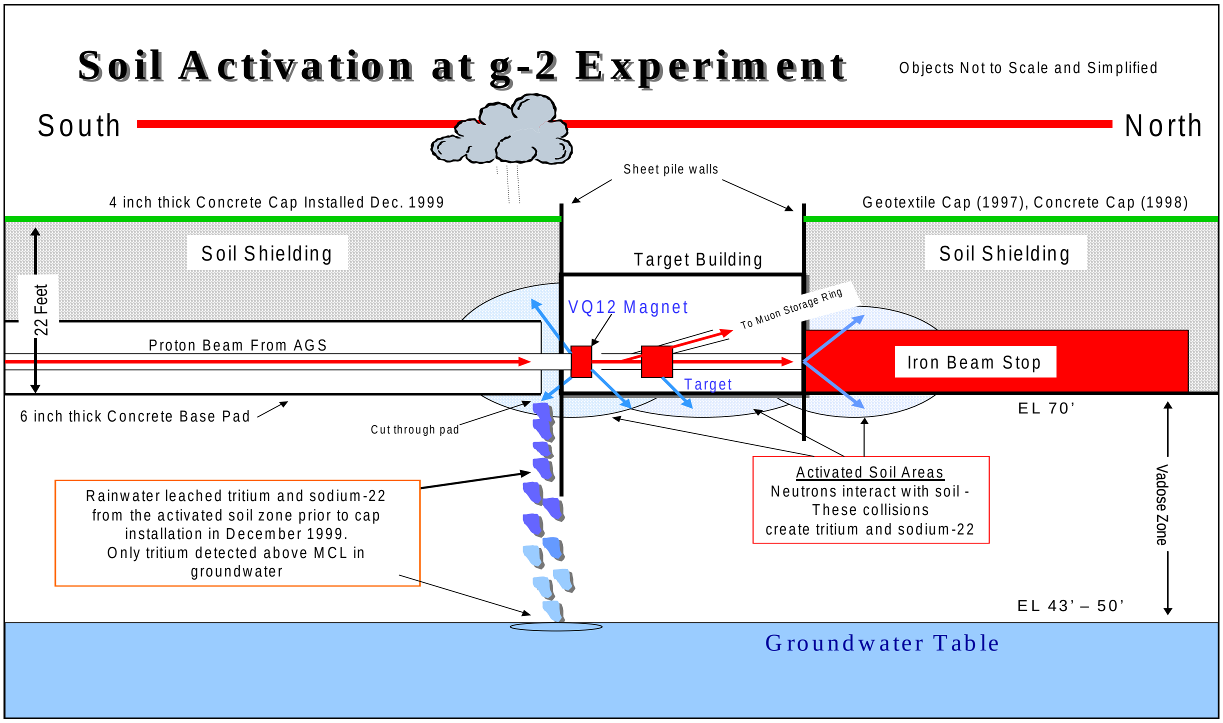

Figure 7. Simplified Cross-Section View through the g-2 Source Area

Following the installation of the cap over the source area, some of the tritium that was previously leached from the activated soil zone may have been trapped in the unsaturated zone (also known as the vadose zone) soil directly above the water table, as shown in Figure 7. Monitoring data suggest that "slugs" of high concentrations of tritium have been mobilized into the groundwater during periods of high groundwater table elevations, which can occur following heavy seasonal rainfall. This flushing mechanism has released three high-concentration slugs. The highest concentration was observed in July 2002, when one groundwater sample had a tritium concentration of 3.4 million pCi/L. With each water table rise, coupled with natural radioactive decay, it is expected that the amount of residual tritium in the unsaturated zone soils will decrease. Since June 2004, tritium concentrations in wells directly downgradient of the source area have been less than 100,000 pCi/L during nine of the last ten quarterly monitoring periods. Samples collected in October 2006 indicated that tritium concentrations in the source area monitoring wells have dropped to less than 45,000 pCi/L. Groundwater monitoring results are presented in the *Annual Groundwater Status Report (which is Volume II of the Annual Site Environmental Report).* Figure 8 presents the location of the plume in late 2005.

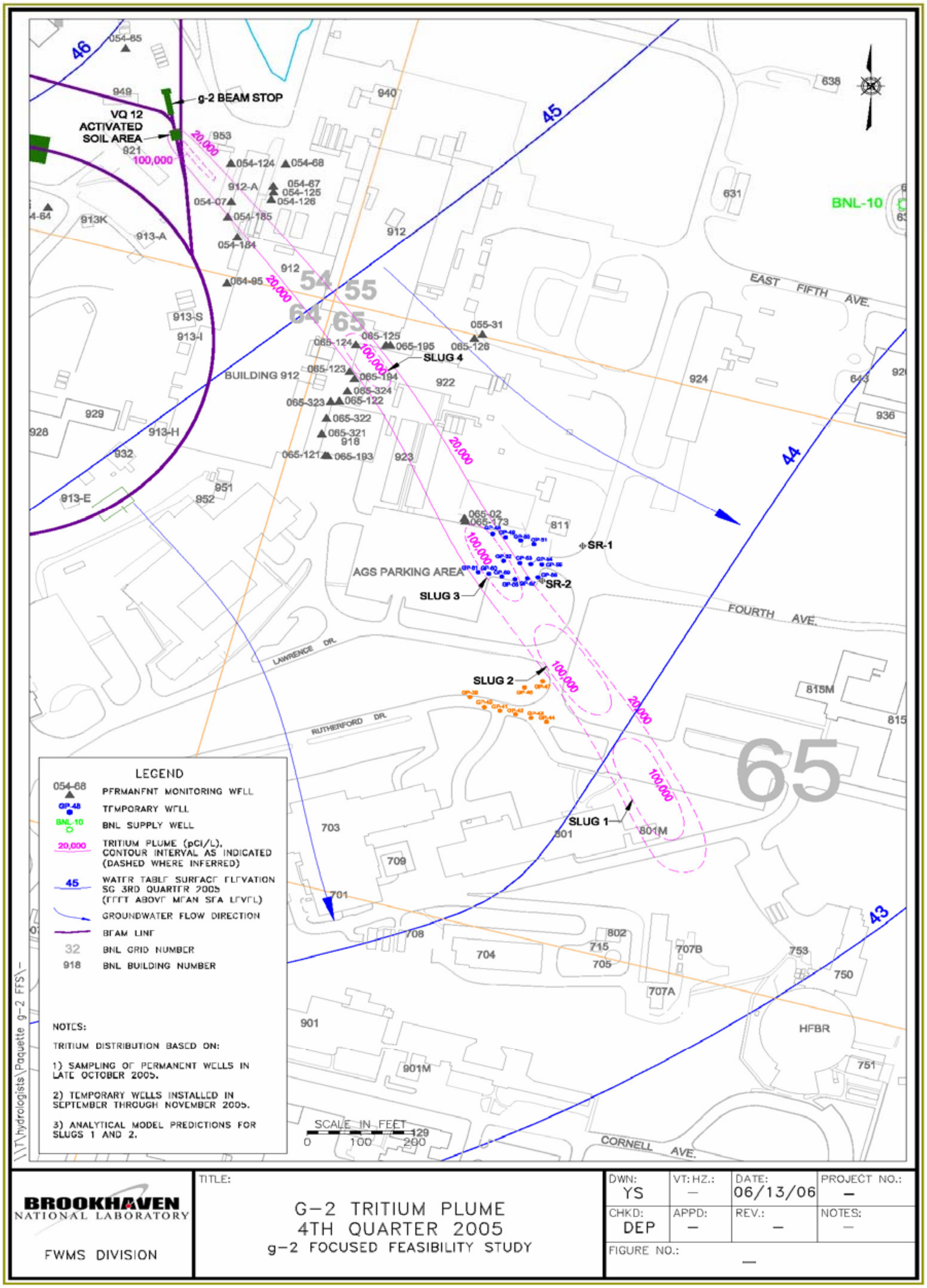

Figure 8. Position of the g-2 Tritium Plume during the Fourth Quarter of 2005

As with the other contaminant plumes at BNL, a computer model was used as a tool to predict the movement of the g-2 tritium plume and reductions in tritium concentrations due to natural radioactive decay and dispersion in the aquifer. Based on the model results, tritium concentrations in the g-2 plume are expected to decrease to less than the 20,000 pCi/L MCL near Cornell Avenue between 2010 and 2015 by natural decay and dispersion in the aquifer, assuming that there are no additional significant tritium releases from the source area. At that time, the plume would still be over one mile north of the BNL southern property boundary line. Cornell Avenue is located approximately 800 feet north (upgradient) of Brookhaven Avenue (Figure 4). The g-2 plume will not impact any public or private drinking water supply wells. Further details of the groundwater characterization activities and model results are presented in the *g-2 Source Area and Tritium Plume – AOC 16T Focused Feasibility Study* (BNL 2006a).

5.1.2 Brookhaven Linac Isotope Producer

BLIP is an active accelerator facility also located in the middle-central portion of the site (Figures 3 and 4). The facility has been in operation since 1972, and is a national resource for producing the radioisotopes that are crucial in nuclear medicine for both research and clinical use. BLIP also supports BNL research on diagnostic and therapeutic radiopharmaceuticals. Beam line operations have resulted in the activation of soils that surround the BLIP target vessel. These activated soils are approximately 30 feet below the BLIP building, in a small zone surrounding the target vessel. Figure 9 is a simplified cross-section view of the beam line, target vessel and associated activated soil shielding.

In February 1998, a sample from a groundwater monitoring well 300 feet south of BLIP contained tritium at a concentration of 14,000 pCi/L. To confirm the source and extent of the contamination, BSA installed a series of temporary wells and reviewed the operations of nearby facilities, including BLIP. The maximum tritium concentration detected was 53,000 pCi/L in a well approximately 40 feet downgradient (south) of the BLIP target. Sodium-22 was also detected in the groundwater, but at concentrations below the 400 pCi/L MCL. An inspection of the BLIP building revealed that significant rainwater infiltration could occur along the building's foundation. When this water infiltrated the activated soil surrounding the target vessel, tritium and sodium-22 were leached from the soils and transported to the groundwater.

Once the source of the contamination was confirmed, a number of corrective actions were implemented in 1998 to prevent rainwater from entering the soils surrounding the BLIP building. These included repairing and reconfiguring the building's roof gutters and downspouts, resealing the paved areas south of the building, and installing a concrete cap in the remaining areas around the building (see Figure 5). The BLIP facility was designated AOC 16K as the result of an earlier aerial radiation survey.

Groundwater monitoring results for 1999 and 2000 revealed a significant reduction in tritium, indicating that these actions were very effective in controlling surface water infiltration into soils surrounding BLIP. In addition, an Engineering Evaluation/Cost Evaluation (EE/CA) was prepared that evaluated additional actions to address the activated soil (CDM Federal, 1999). Alternatives were developed involving: no action; upgrades to the existing cover; containment using cement grout; and containment using an innovative colloidal silica grout developed by DOE's Technology Development program. The EE/CA recommended installation of the colloidal silica grout, which would be injected into the activated soil to further immobilize tritium and sodium-22. The EE/CA was issued for public review and comment in late1999. An Action Memorandum (BNL, 2000), selecting the injection of the colloidal silica grout was issued in March 2000 and the grout was installed during May and June of 2000. Monitoring conducted after the grout injection process identified a short-term release of tritium to the groundwater. Tritium concentrations in the groundwater downgradient of this facility increased to a maximum of 61,000 pCi/L in 2001. Sodium-22 levels remained below the 400 pCi/L MCL. An investigation into the cause of the release determined that tritium in the soil pore water near the target vessel was displaced by the grout.

Since 2001, the tritium concentrations in the groundwater have been generally declining, but have periodically increased to approximately twice the MCL. These periodic increases appear to be related to changes in the water table elevation as described previously for the g-2 source area. As the water table rises, residual tritium is flushed from the unsaturated zone close to the water table. The amount of tritium remaining in the unsaturated zone close to the water table is expected to decline over time due to the flushing mechanism from the rise and fall of the water table and by natural radioactive decay. The slugs of tritium from BLIP are small and narrow (approximately 20 feet long and within the upper five feet of the aquifer). It is projected that the tritium concentrations in groundwater decrease via decay and dispersion to less than the MCL within 300 feet downgradient (south) of BLIP. During the most recent sample period in October 2006, the maximum tritium concentration detected in wells directly downgradient of BLIP was 5,800 pCi/L. Groundwater monitoring results are presented in the *Annual Groundwater Status Report*.

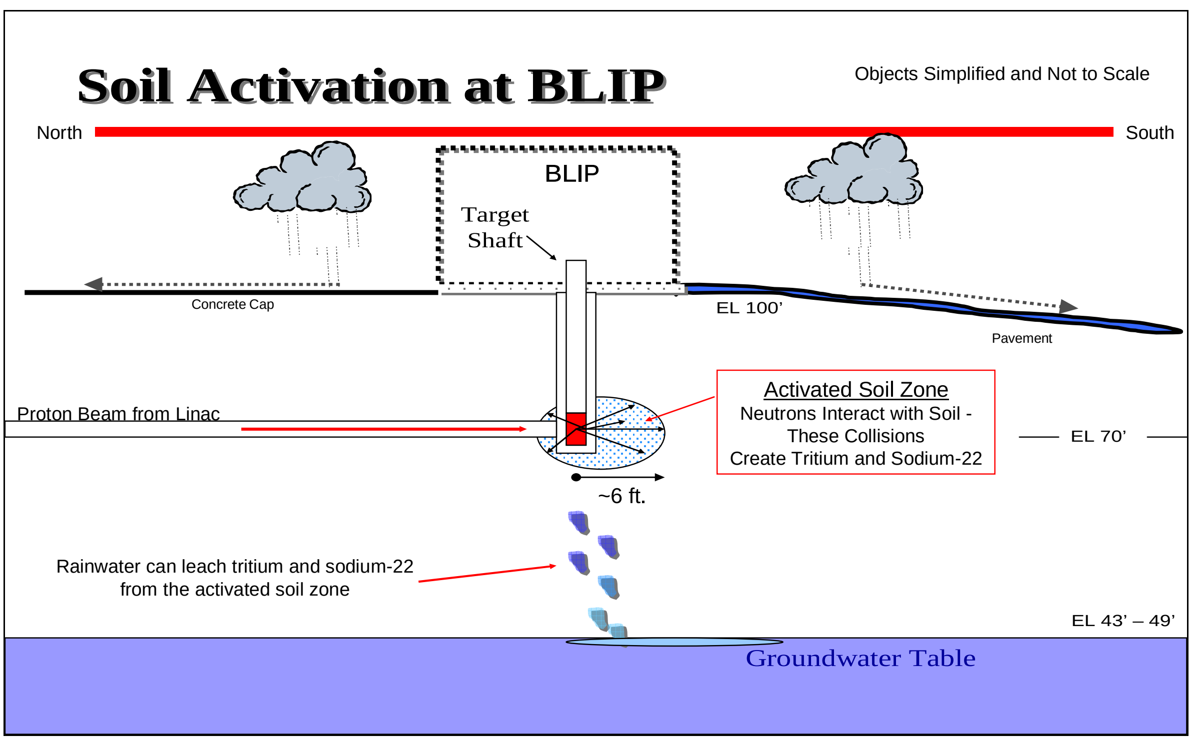

Figure 9. Simplified Cross-Section View through the BLIP Source Area

5.1.3 Underground Storage Tanks

A total of 16 USTs were included as AOC 12 in the IAG. These low-level radioactive liquid waste storage tanks were designated as an AOC due to the potential environmental impact that may occur if they were to leak. All 16 USTs were removed from the ground between 1988 and 1996. This removal process was performed under the requirements of Suffolk County Sanitary Code Article 12, which regulates the storage and handling of toxic and hazardous materials. Eight of the USTs were previously closed out in other RODs. These were: two tanks at Building 445 (Operable Unit [OU] I ROD), four tanks at Building 650 (OU IV ROD), and two tanks at Building 830 (OU III ROD).

The remaining eight USTs, one at Building 462, two at Building 463, one at Building 527, one at Building 703, one at Building 927, and two at Building 931, will be closed out under this ROD. Confirmatory sampling was performed for the eight tanks, and they were all subsequently closed out under Article 12 and no further action is required. The Suffolk County Department of Health Services (SCDHS) was present for the removal of six of the eight tanks, and they were aware of the closure of the other two. Suffolk County field inspection forms and other closure documents are presented in the *Technical Memorandum and Supporting Documentation for the Proposed Plan, AOC 12 and AOC 16K* (BNL 2006b). Tank 931B-02 was determined to be suitable for reuse, and it is currently in use at Building 931 (the BLIP facility).

6.0 SUMMARY OF SITE RISKS

6.1 g-2 Activated Soil and Tritium Plume

For the g-2 Area of Concern, a quantitative baseline risk assessment was not performed since it was determined by DOE that response actions were already required to address the activated soil shielding and tritium in the groundwater. A qualitative discussion of potential risks follows.

An evaluation of pathways indicates that potential risks to human health for the g-2 soils and groundwater are primarily through direct exposure to activated soil or the consumption of contaminated groundwater by BNL site workers.

In proximity to the tunnel wall, near the highest level of activated soil shielding at the VQ12 magnet area, there is currently a radiation field from the sodium-22 in the soil that would result in a dose of approximately 0.0002 mrem per hour. However, the radiation field from the nearby beam-line components (e.g., the magnets, targets, stops, etc.) and concrete shielding is much greater. For example, the dose rates at the g-2 target at the present time range from tens to hundreds of mrem per hour. Therefore, any significant work in that area today would involve significant radiation exposure to workers. This dose rate comes predominantly from the activated concrete and iron in the beam line, and is decaying with a half-life of about 5 years. The g-2 experiment ended in April 2001, and the beam line has not operated since that time.

The risk to BNL workers from the activated soil is minimal because the activated soil areas have been capped and access to these areas is controlled, effectively eliminating the potential for direct exposure to the soils. Access to all BNL radiological facilities is controlled such that access controls and physical barriers meet or exceed the requirements of 10 CFR 835 Occupational Radiation Protection, and all radiation workers have the proper radiological training and surveillance. Acceptable dose rates are based on the As Low As Reasonably Achievable policy and the dose limits prescribed in 10 CFR 835. The activated soil shielding is located immediately outside the beam-line tunnel, and workers cannot come into direct contact with the activated soil either from inside or outside of the tunnel. All work associated with routine maintenance or dismantlement of the beam line would be planned and monitored in accordance with DOE requirements. Institutional controls are defined in BNL's *Land Use Controls Management Plan* (BNL, 2005), and BNL's Land Use and Institutional Controls website contains a fact sheet outlining the specific institutional controls for this Area of Concern (e.g., work planning, reporting and change in use). Digging and excavation restrictions are in place to prevent damage to the cap and possible exposure to the activated soil shielding (Figure 10).

There is a potential human exposure scenario based upon the consumption of groundwater from an on-site drinking water supply well that captured a high concentration segment of the g-2 tritium plume. This scenario assumes that mixing with non-contaminated water did not dilute the tritium concentrations, and the water was delivered to the drinking water tap at concentrations above the 20,000 pCi/L MCL. This scenario does not include exposure to sodium-22 because its reduced migration rates and shorter half-life restricts it to the area immediately downgradient of the source area, and it is usually detected at concentrations below the 400 pCi/L. MCL. The established 20,000 pCi/L MCL for tritium and 400 pCi/L MCL for sodium-22 are based upon a 4 mrem per year dose rate, as required by the Safe Drinking Water Act (SDWA) for beta/photon emitters. This dose is based upon a 70 kg (154 pound) person consuming two liters of contaminated water per day for a period of one year.

However, this drinking water exposure scenario is only speculative because the present pumping configuration does not cause the tritium plume to encounter the capture zone of any of the on-site water supply wells. Therefore, site workers cannot consume contaminated groundwater from the tritium plume. In early 2000, BNL water supply well 10, which is the closest supply well to the g-2 area, was taken off line to prevent the tritium plume from migrating toward this well and to stabilize groundwater flow directions in the AGS area. Institutional controls are in place that would prevent the drilling of any new supply wells in the defined pathway of the tritium plume, and there are also no risks to current members of the public since the tritium plume has not migrated beyond the BNL property boundary. Future risks to the public are also expected to be non-existent because groundwater modeling of the g-2 tritium plume indicates that the plume would attenuate to less than the 20,000 pCi/L MCL near Cornell Avenue, by 2010–2015. Cornell Avenue is located approximately 800 feet north (upgradient) of Brookhaven Avenue, and more than one mile north of the BNL southern boundary (Figures 3 and 4). Combined with the fact that most of the local residents south of BNL are connected to public water and Suffolk County Sanitary Code requirements that would restrict the installation of private and municipal supply wells downgradient of BNL, there is no potential for human exposure beyond the BNL property boundary. Furthermore, there are no surface water features recharged by groundwater within the projected plume migration pathway.

In summary, the activated soil at g-2 and the associated tritium groundwater plume do not pose significant risk to on-site workers and members of the public, and the plume is expected to attenuate to the 20,000 pCi/L MCL entirely on the BNL site within 10 years.

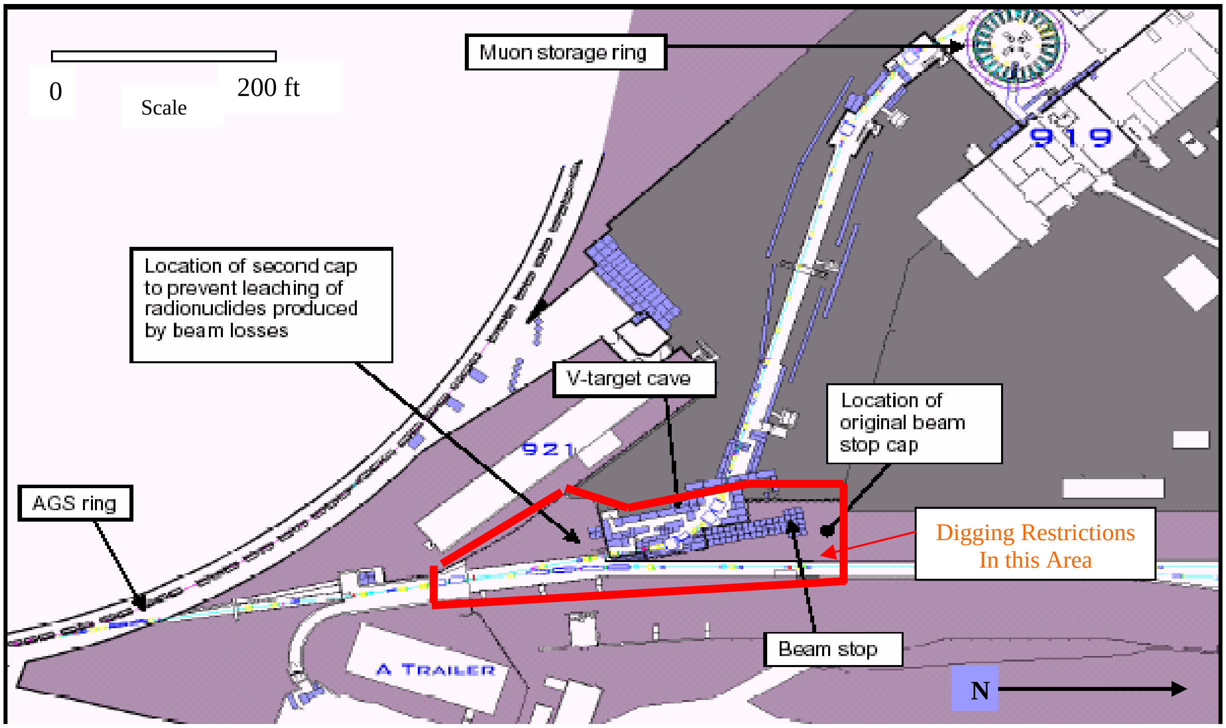

Figure 10. g-2 Source Area – Area of Digging/Excavating Restrictions in Place to Prevent Damage to the Cap and Possible Exposure to the Activated Soil Shielding

6.2 BLIP Activated Soil

For the BLIP Area of Concern, a quantitative baseline risk assessment was not performed since it was determined by DOE that response actions were already required to address the activated soil shielding. A qualitative discussion of potential risks follows.

An evaluation of pathways indicates that potential risks to human health for the BLIP soils and groundwater are primarily through direct exposure to activated soil or the consumption of contaminated groundwater by BNL site workers.

In proximity to the tunnel wall near the highest level of activated soil shielding, there is currently a radiation field from the sodium-22 of approximately 0.012 mrem per hour. However, the radiation field from the nearby beam-line components (e.g., the magnets, targets, stops, etc.) and concrete shielding is greater. For example, the dose rates along the Linac to BLIP beam line at the present time range from tens to hundreds of mrem per hour, and any significant work in that area today would involve significant radiation exposure to workers.

However, the risk to BNL workers from the activated soil at the BLIP facility is minimal because the activated soil is located approximately 30 feet below ground and has been capped, and access to the Linac to BLIP beam line tunnel is controlled, effectively eliminating the potential for direct exposure to the soils. Access to all BNL radiological facilities is controlled such that access controls and physical barriers meet or exceed the requirements of 10 CFR 835 Occupational Radiation Protection, and all radiation workers have the proper radiological training and surveillance. Acceptable dose rates are based on the As Low As Reasonably Achievable policy and the dose limits prescribed in 10 CFR 835. The activated soil shielding is located immediately outside the beam-line tunnel, and workers cannot come into direct contact with the activated soil either from inside or outside of the tunnel. All work associated with routine maintenance or dismantlement of the beam line would be planned and monitored in accordance with DOE requirements. Institutional controls are defined in BNL's *Land Use Controls Management Plan* (BNL, 2005), and BNL's Land Use and Institutional Controls website contains a fact sheet outlining the specific institutional controls for this Area of Concern (e.g., work planning, reporting and change in use). Digging and excavation restrictions are in place to prevent damage to the cap and possible exposure to the activated soil shielding (Figure 11).

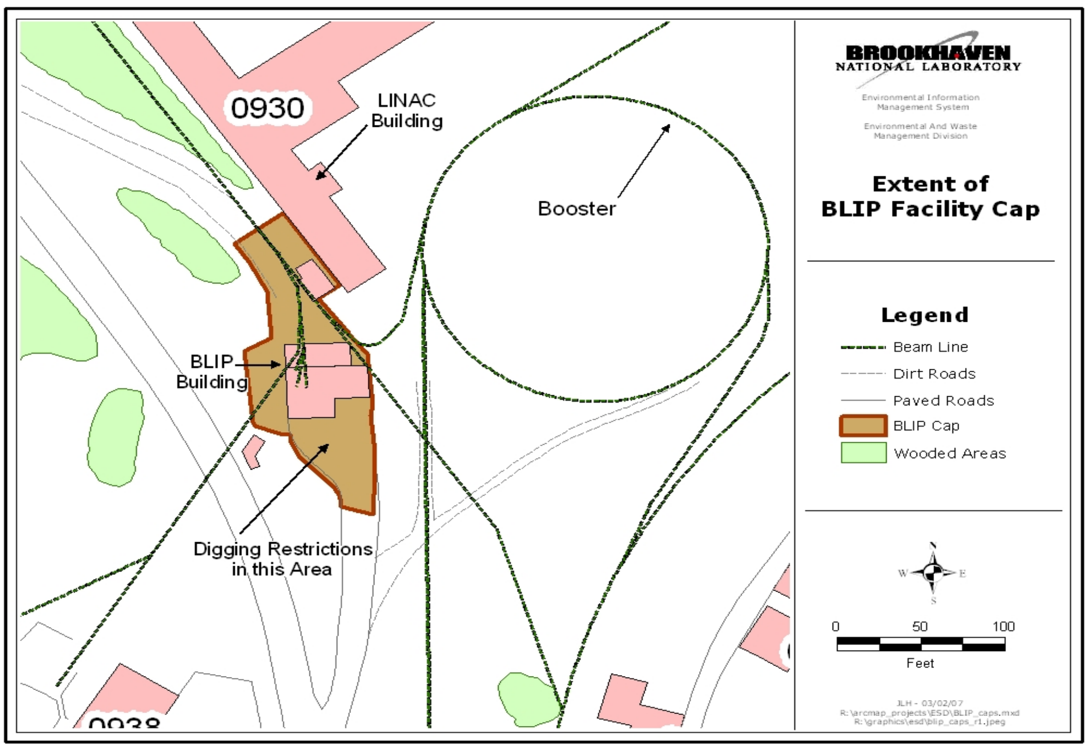

Figure 11. BLIP Source Area – Area of Digging/Excavating Restrictions in Place to Prevent Damage to the Cap and Possible Exposure to the Activated Soil Shielding

There is also a scenario for human exposure based upon the consumption of groundwater from an on-site drinking water supply well that captured a high concentration segment of the BLIP tritium plume. This assumes that mixing with non-contaminated water did not dilute the tritium concentrations, and the water was delivered to the drinking water tap at concentrations above the 20,000 pCi/L MCL. Exposure to sodium-22 is not considered in this scenario because of its reduced migration rates and shorter half-life restricts its impact to the area immediately near the source area, and it has not been detected at concentrations above the 400 pCi/L MCL. The established 20,000 pCi/L MCL for tritium and 400 pCi/L MCL for sodium-22 are based upon a 4 mrem per year dose rate, as required by the SDWA for beta/photon emitters. This dose is based upon a 70 kg person consuming two liters of contaminated water per day for a period of one year.

However, this exposure scenario can be discounted because tritium concentrations drop to less than the 20,000 pCi/L MCL within 300 feet of the BLIP facility, and the facility is not within the capture zones of any of the on-site water supply wells. Therefore, no current site workers consume contaminated groundwater from the BLIP area. Institutional controls are in place that would prevent the drilling of any new supply wells in the vicinity of BLIP. Because tritium levels drop to less than 20,000 pCi/L within a short distance of the BLIP facility, there is no potential for human exposure beyond the BNL property boundary.

6.3 Former UST Areas

For the former UST areas, a risk assessment is not needed because confirmatory sampling of the soils following the removal of the tanks did not identify any environmental or human health concerns.

7. 0 REMEDIAL ACTION OBJECTIVES

For the former UST areas, no additional remedial activities are required based upon the removal work that has already been completed. For BLIP, continued inspections and maintenance of the cap, groundwater monitoring, and institutional controls in addition to the previously completed work (i.e., installation of the cap, improved roof drains, and colloidal silica grout) are sufficient to support the selection of no further action. In addition, institutional controls are in place to prevent possible exposure to the contaminated soil and groundwater at BLIP. The contaminated soil is located approximately 30 feet below ground, and access to the adjoining LINAC tunnel is controlled. Institutional controls are also in place to prevent the installation of any new drinking water wells in contaminated areas of the aquifer. Groundwater data will be evaluated and reported in the *Annual Groundwater Status Report* and during the CERCLA Five-Year Reviews.

BNL has prepared remedial action objectives for the g-2 tritium source area and groundwater plume. The remedial action objectives are based on the available contaminant data, the results of contaminant transport modeling, and the risk evaluation. The specific objectives of the remedial action for the g-2 tritium source area and groundwater plume include the following components:

- Minimize the potential exposure of BNL employees to the activated soil and protect the activated soil from rainwater infiltration
- Minimize the current and potential future exposure of BNL employees to the tritium plume
- Minimize the potential for the migration of the tritium plume beyond the BNL property boundary at concentrations greater than the 20,000 pCi/L MCL
- Reduce the level of tritium in the Upper Glacial aquifer to below the 20,000 pCi/L MCL.

7.1 Land Use

BNL is a DOE research facility with associated support facilities and is expected to remain so for the foreseeable future. Access to the BNL site is currently restricted and controlled. To assist in the evaluation of risks associated with current and future uses of the sites, BNL developed a *Future Land Use Plan* in 1995, which articulates the projected land use at the end of the cleanup. The Plan is comprehensive and long-term, and provided the initial framework and assumptions for incorporating future land use considerations into cleanup decisions. The Plan provides guidance for future development and considers use restrictions determined to be necessary to support response actions in the protectiveness of human health and the environment. DOE and BNL continuously evaluate and update future land use plans through the DOE's Ten Year Site Planning process, which addresses the need for new facilities to meet emerging research needs while making maximum use of existing facilities and assets.

BNL has five general land use categories in its plans: 1) Industrial/commercial; 2) residential; 3) agricultural; 4) recreational; and 5) open space/wilderness. Only industrial and commercial uses are currently applicable for the g-2 and BLIP areas.

Because the remedies for the g-2 and BLIP areas will result in some hazardous substances remaining above levels allowed for unlimited use and unrestricted exposure, five-year reviews will be conducted pursuant to CERCLA §121(c) to ensure that the remedy continues to provide adequate protection of human health and the environment. Additionally, as long as these hazardous substances remain above levels allowed for unlimited use and unrestricted exposure, future reuse of the g-2 and BLIP facilities will be limited to commercial or industrial uses. Commercial application involving the potential for continuous direct exposure in these areas to the general public, such as child day care or health care facilities, will be prohibited.

Land use control objectives for the g-2 and BLIP areas are:

- Prevent the installation of new water supply wells that could intercept contaminated groundwater from these source areas
- Maintain integrity of the monitoring systems and control the future placement of pumping wells and/or recharge basins that could significantly impact groundwater flow directions in these areas
- Maintain physical barriers to prevent stormwater infiltration into activated soils (e.g., concrete caps and other stormwater infiltration controls)
- Prohibit use of the g-2 and BLIP areas for residential housing, elementary schools, child care facilities or other uses that are inconsistent with industrial/commercial use
- Ensure worker safety by preventing exposure to the activated soils.

8.0 DESCRIPTION OF EVALUATED ALTERNATIVES

8.1 Alternatives for g-2 Tritium Source Area and Groundwater Plume

The *g-2 Source Area and Tritium Plume - AOC 16T Focused Feasibility Study* (BNL 2006a) evaluated reasonable remedial alternatives and recommended actions, where appropriate, to meet the remedial action objectives previously stated. The five remedial alternatives for the g-2 tritium source area and groundwater plume evaluated in this process were:

8.1.1 Alternative 1: Continued Maintenance of Source Controls

This alternative represents no further actions beyond inspections and routine maintenance of the concrete cap installed over the activated soil source area and other storm water controls. It allows for natural decay of the radioactivity in the soil shielding and natural radioactive decay and dispersion of the tritium plume. Final disposition of the activated soil will be addressed during facility decommissioning. This alternative does not include continued groundwater surveillance of the source area to verify that the storm water controls continue to be effective or to verify the predicted reductions of tritium concentrations in groundwater.

- Cost over 30 years is estimated to be $202,177.

8.1.2 Alternative 2: Continued Maintenance of Source Controls and Groundwater Monitoring with Contingency Actions

Similar to Alternative 1, this option requires continued routine inspection and maintenance of the concrete cap and other storm water controls. In addition, this alternative requires continued groundwater monitoring immediately downgradient of the source area to verify the continued effectiveness of the storm water controls, and to monitor the downgradient segments of the plume to verify that the tritium levels will decrease as predicted. Two trigger levels have been developed to require the evaluation of unexpected future releases from the source area or if the tritium plume does not attenuate as predicted. If reached, BNL's Groundwater Protection Contingency Plan (BNL, 2003) will be implemented, and the need for additional corrective actions will be evaluated. This contingency plan provides for a consistent, systematic approach to respond to the detection of unexpected levels of contamination, including verification of results, conducting additional sampling and/or characterization, and informing stakeholders about the monitoring results and any follow-up actions. The two trigger levels for the g-2 tritium plume are:

1. <u>Detection of >1,000,000 pCi/L within the Tritium Plume</u>: If tritium levels greater than 1,000,000 pCi/L are observed within the plume, actions would include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. If detected in the wells immediately downgradient of the source area, actions would include the immediate inspection of the existing storm water controls, and implementation of improvements, as necessary. The actions would also include an evaluation of whether active remediation (e.g., low-flow extraction with off-site disposal or high-flow pumping with on-site recharge) is appropriate to limit plume growth.

2. Detection of >20,000 pCi/L South of Brookhaven Avenue: If tritium levels south of Brookhaven Avenue are found to exceed the 20,000 pCi/L MCL, actions would include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. An assessment would be made to determine whether active remediation is appropriate to control plume growth. Brookhaven Avenue is located approximately one mile north of the BNL site boundary.

The regulatory agencies will make a decision on the need to implement active groundwater remediation measures after receiving DOE's assessment and recommendation in accordance with the Interagency Agreement. DOE is committed to preventing the migration of tritium beyond the BNL property boundary at concentrations greater than the 20,000 pCi/L MCL.

Institutional controls are in place to prevent possible exposure to the contaminated soils and groundwater. The activated soils are located below ground, and workers cannot come into direct contact with the soil either from inside or outside of the beam line tunnel. Final disposition of the activated soil will be addressed when the facility is no longer in use and is decommissioned. The tritium plume will not impact any of BNL's existing drinking water supply wells, and controls are also in place to prevent the installation of any new drinking water wells in contaminated areas of the aquifer. Groundwater monitoring data will be evaluated and reported in the *Annual Groundwater Status Report* and as part of the CERCLA Five Year Reviews. The CERCLA Five-Year Review process provides for community notification at the beginning of the review process.

- Cost over 30 years is estimated to be $963,751. Approximately $420,000 of this amount would be spent in the first three years to conduct the monitoring activities needed to verify that the plume attenuates as predicted. The remaining costs are associated with long-term cap maintenance and groundwater surveillance of the source area.

8.1.3 Alternative 3: High-Flow Pumping with On-Site Recharge/Recirculation, and Continued Source Area Controls and Groundwater Monitoring

Alternative 3 would use hydraulic control using one or more groundwater extraction wells with pumping rates of 25-50 gallons per minute (gpm) to prevent downgradient migration of the tritium plume. The extracted groundwater would be transmitted via subsurface conduit to an existing on-site recharge basin. The recovery wells would be designed such that effluent tritium concentrations would not exceed the 20,000 pCi/L MCL. Due to the current close proximity of the g-2 tritium plume and the Waste Concentration Sr-90 plume, the extracted water might contain levels of Sr-90 that could require treatment prior to recharge.

Institutional controls are in place to prevent possible exposure to the contaminated soils and groundwater. The soils are located below ground, and workers cannot come into direct contact with the soil either from inside or outside of the beam line tunnel. Final disposition of the activated soil will be addressed when the facility is no longer in use and is decommissioned. The tritium plume will not impact any of BNL's existing drinking water supply wells, and controls are also in place to prevent the installation of any new drinking water wells in contaminated areas of the aquifer. Similar to Alternative 2, this alternative also requires continued routine inspections and maintenance of the cap, and continued groundwater monitoring. Groundwater monitoring data will be evaluated and reported in the *Annual Groundwater Status Report* and as part of the CERCLA Five Year Reviews. The CERCLA Five-Year Review process provides for community notification at the beginning of the review process.

- Cost over 30 years is estimated to be $2,133,689. Approximately $1,500,000 of this amount would be spent in the first five years to conduct the remediation activities. The remaining costs are associated with long-term cap maintenance and groundwater surveillance of the source area.

8.1.4 Alternative 4: Low-Flow Pumping with Off-Site Disposal, and Continued Source Area Controls and Groundwater Monitoring

Alternative 4 would use low-flow pumping to extract three segments of the plume where tritium concentrations are currently greater than 100,000 pCi/L ("Slugs" 1, 2 and 3 presented in Figure 7). Extraction would continue until the tritium levels are reduced to approximately the 20,000 pCi/L MCL. If implemented, this action would reduce the amount of tritium in the aquifer, and slightly reduce the amount of time needed for tritium levels in groundwater to decrease to less than the 20,000 pCi/L MCL. The groundwater would be pumped from the aquifer at a rate of approximately 5 gpm, placed into containers, and then disposed of off-site at an approved facility. Due to the current close proximity of the g-2 tritium plume and the Waste Concentration Sr-90 plume, the extracted water might contain levels of Sr-90 that could require on-site treatment prior to off-site disposal. Similar to Alternative 2, this alternative also requires continued cap maintenance and groundwater monitoring.

Institutional controls are in place to prevent possible exposure to the contaminated soils and groundwater. The soils are located below ground, and workers cannot come into direct contact with the soil either from inside or outside of the beam line tunnel. Final disposition of the activated soil will be addressed when the facility is no longer in use and is decommissioned. The tritium plume will not impact any of BNL's existing drinking water supply wells, and controls are also in place to prevent the installation of any new drinking water wells in contaminated areas of the aquifer. Groundwater monitoring data will be evaluated and reported in the *Annual Groundwater Status Report* and as part of the CERCLA Five Year Reviews. The CERCLA Five-Year Review process provides for community notification at the beginning of the review process.

- Cost over 30 years is estimated to be $6,247,899. Approximately $5,700,000 of this amount would be spent in the first two to three years to conduct the remediation activities. The remaining costs are associated with long-term cap maintenance and groundwater surveillance of the source area.

8.1.5 Alternative 5: Source Removal, Plus Continued Source Area Controls and Groundwater Monitoring

This option would physically remove the activated soils and underlying leachate-contaminated soils at the VQ12 source area. Because of their close proximity, activated soils below the nearby g-2 target building and beam stop and below a nearby section of the RHIC tunnel would also need to be removed. Leachate-contaminated soils in the unsaturated zone would require excavation to a depth of approximately 20 feet below land surface. A section of the nearby RHIC beam line would have to be reconstructed after the excavation. Activated soils would be characterized and containerized for off-site disposal at an approved facility. There would be some dose to workers involved with dismantling the beam lines, tunnel structures, and excavation of the soils. Similar to Alternative 2, this alternative requires continued groundwater monitoring to verify that the tritium levels in groundwater decrease as predicted. Groundwater monitoring data will be evaluated and reported in the *Annual Groundwater Status Report* and as part of the CERCLA Five Year Reviews. The CERCLA Five Year Review process provides for community notification at the beginning of the review process.

- Cost over 30 years is estimated to be $11,896,681. Approximately $11,400,000 of this amount would be spent in the first three years to conduct soil remediation and beam line reconstruction and monitoring of the tritium plume. The remaining costs are associated with post-remediation groundwater surveillance of the source area. There would also be a projected $80,000,000 in lost experiment and worker productivity for the RHIC experiment over a two-year period.

8.2 Alternatives for BLIP Activated Soil

Other than the corrective actions taken to date to protect the activated soil, no new remedial alternatives are proposed or evaluated. Once the source of the contamination was confirmed, a number of corrective actions were implemented in 1998 to prevent rainwater from entering the soils surrounding the BLIP building. These included repairing and reconfiguring the building's downspouts, resealing the paved areas south of the building, and installing a concrete cap in the remaining areas around the building. In May-June 2000, a colloidal silica grout was injected into the activated soil in the unsaturated zone above the water table to further immobilize tritium and sodium-22. Institutional controls are in place to prevent possible exposure to the contaminated soils and groundwater. The activated soils are located below ground, and workers cannot come into direct contact with the soil either from inside or outside of the beam line tunnel. Final disposition of the activated soil will be addressed when the facility is no longer in use and is decommissioned. The tritium contaminated groundwater at BLIP will not impact any of BNL's existing drinking water supply wells, and controls are also in place to prevent the installation of any new drinking water wells in contaminated areas of the aquifer. Groundwater monitoring data will be evaluated and reported in the *Annual Groundwater Status Report* and as part of the CERCLA Five Year Reviews. The CERCLA Five Year Review process provides for community notification at the beginning of the review process.

Long-term actions will include maintenance of the storm water controls (cap and building downspouts) and groundwater verification monitoring.

- The estimated cost for maintaining the cap and the groundwater monitoring program over 30 years is approximately $450,000.

8.3 Alternatives for Former USTs

Because of the remedial actions already conducted, no additional remedial alternatives are proposed or evaluated. The remaining eight USTs, one at Building 462, two at Building 463, one at Building 527, one at Building 703, one at Building 927, and two at Building 931, were registered with SCDHS and used to hold low-level radioactive liquid waste. These tanks were removed between 1988 and 1996. This removal process was performed under the requirements of Suffolk County Sanitary Code Article 12, which regulates the storage and handling of toxic and hazardous materials.

Confirmatory sampling was performed for the eight tanks, and they were all subsequently closed out under Article 12 as not being a further environmental concern. SCDHS was present for the removal of six of the eight tanks, and they were aware of the closure of the other two. As noted below, county field inspection forms and registration forms are available to document the closeout. Tank 931B-02 was removed and determined to be suitable for reuse. It is currently in use at Building 931 (the BLIP facility).

Further details of the groundwater and other activities for BLIP, and investigation results for the USTs, are discussed in the *Technical Memorandum and Supporting Documentation for the Proposed Plan and Record of Decision* (BNL 2006b).

- There are no future maintenance or remediation costs associated with the Former UST areas.

9.0 SUMMARY OF COMPARATIVE ANALYSIS OF g-2 ALTERNATIVES

CERCLA guidance requires that each remedial alternative identified in the Feasibility Study be compared according to nine criteria: 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, and volume; 5) short-term effectiveness; 6) implementability; 7) cost; 8) state acceptance; and 9) community acceptance.

In accordance with CERCLA guidance (EPA, 1999), these criteria are subdivided into three categories:

1. Criteria 1 and 2 are “Threshold Criteria” that relate directly to statutory findings and must be satisfied by any alternative in order to be eligible for selection;
2. Criteria 3 through 7 are “Primary Balancing Criteria” that are used to identify major trade-offs between remedial alternatives. These trade-offs are ultimately balanced to identify the preferred remedial alternative and to select the final remedy; and
3. Criteria 8 and 9 are “Modifying Criteria” that measure the acceptability of the preferred remedies to state agencies and to the community.

DOE identified its preferred remedy for g-2 by evaluating all of the alternatives against the nine evaluation criteria. To the maximum extent practical, CERCLA requires that remedial action alternatives must: 1) be protective of human health and the environment; 2) attain ARARs; 3) be cost effective; 4) utilize permanent solutions and alternative treatment technologies to the extent practicable; and 5) reduce toxicity, mobility, or volume. A summary of the comparative analysis is provided in Table 1.

9.1 Overall Protection of Human Health and the Environment

Under current conditions, engineered and institutional controls prevent public and worker access to the activated soil shielding at VQ12. Access to all BNL radiological facilities is controlled such that access controls and physical barriers meet or exceed the requirements of 10 CFR 835 Occupational Radiation Protection, and all radiation workers have the proper radiological training and surveillance. Furthermore, the BNL digging permit process would prevent any unintended intrusive activities that might result in exposure to the activated soil. The g-2 tritium plume has not impacted any of the on-site drinking water supply wells, it is located more than 20 feet below land surface, and the plume will not discharge into any surface water bodies. The groundwater flow and transport model utilized for the FFS (BNL 2006a) predicts that the g-2 tritium plume would decrease naturally to concentrations below the 20,000 pCi/L MCL near Cornell Avenue by 2010–2015. Cornell Avenue is located approximately 800 feet north (upgradient) of Brookhaven Avenue, and more than one mile north of the BNL southern boundary (Figure 3). For Alternative 2, contingency trigger levels have been developed that would require the evaluation of unexpected future releases from the source area or if the tritium plume does not attenuate as predicted.

While Alternative 1 (Continued Maintenance of Source Controls) calls for the continued management and protection of the activated soil shielding at the VQ12 source area, it lacks verification monitoring of the plume. Alternative 2 (Source Control and Groundwater Monitoring) calls for continued management and protection of the activated soil shielding, and a groundwater monitoring program to verify the effectiveness of the source controls and to verify that the tritium plume attenuates as predicted. Alternative 3 (High-flow Pumping) would require sufficient dilution at the wellhead to ensure that the tritium concentrations were below 20,000 pCi/L before being discharged to an on-site recharge basin. Implementation of Alternative 4 (Low-flow Pumping) and Alternative 5 (Source Removal) would result in some radiation dose, with the highest doses to workers involved in the dismantlement of the beam-line components and associated structures required for implementing Alternative 5. Doses to workers involved in the activated soil removal, packaging and transportation activities are expected to be moderate.

9.2 Compliance with Applicable or Relevant and Appropriate Requirements

Implementation of Alternatives 1 through 4 would meet ARARs by maintaining source controls designed to prevent additional tritium from entering the aquifer, and tritium concentrations in groundwater would decrease to below the 20,000 pCi/L MCL using natural attenuation (Alternatives 1 and 2) or active remediation (Alternatives 3 and 4). Alternative 5 would result in the physical removal of the activated soil, thus eliminating the potential for future releases. The institutional controls implemented at BNL as part of the OU III ROD provides the same level of plume migration pathway control by managing water pumpage and recharge activities, including restrictions for the placement of any new water supply wells in the pathway of the plume. Alternative 3 (High-flow Pumping) would require sufficient dilution at the wellhead to ensure that the tritium concentrations were below 20,000 pCi/L before being discharged to an on-site recharge basin. If Sr-90 were present in the pumped water at concentrations greater than the 8 pCi/L MCL, the water would have to be treated prior to recharge. Implementation of Alternative 4 (Low-flow Pumping) and Alternative 5 (Source Removal) would require compliance with all applicable transportation and disposal regulations. EPA and NYSDEC guidance would be utilized to establish soil cleanup levels for Alternative 5.

9.3 Long-Term Effectiveness

Both Alternatives 1 and 2 would provide long-term effectiveness because of natural radioactive decay and dispersion of the plume over time. Alternative 2 provides for monitoring of this attenuation process to assure that target concentrations will be met, and sets triggers for additional evaluations if unexpected conditions arise. Based on groundwater modeling results, tritium concentrations are predicted to decline to below the 20,000 pCi/L MCL by 2010–2015, due to natural radioactive decay and dispersion alone. It is estimated that the potential radioactivity in the leachate after a cap failure will decline by a factor of two for every 12.3 years (the half-life of tritium) the cap remains intact. Based on soil activation calculations, the potential to exceed the MCL below the source area will exist for approximately 80 more years, assuming no additional radioactivity is added by future beam line activities. Land use controls, as described in the *BNL Land Use Controls Management Plan* (LUCMP) (BNL, 2005), will control access to contaminated soil and groundwater. BSA has established institutional controls to prevent the unplanned alteration of contaminant plume flow pathways, and to prevent the future installation of any water supply wells in the projected plume pathway, and the BNL digging permit process would prevent any unintended construction or maintenance activities that might result in exposure to the activated soils. Facility Use Agreements establish acceptable operating conditions for the potable supply wells and recharge basins at BNL. In addition, a Water and Sanitary Planning Committee has been created to monitor water pumpage and recharge activities at BNL, and to make changes to these operations, as necessary.

Alternatives 3 and 4 provide contaminant concentration reductions over that contributed by natural processes alone, assuming that the defined contingency levels of contamination are observed. Alternative 3 provides the greatest degree of plume control, and uses dilution/dispersion to further reduce tritium concentrations, whereas Alternative 4 physically removes radioactivity from the aquifer. Alternative 5 physically removes the radioactively contaminated soils, and reduces the chances of future impact to groundwater quality should the engineered or institutional controls that protect these soils from rainwater infiltration fail.

9.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and 2 reduce the toxicity and volume of contamination over the long term by natural radioactive decay and dispersion processes. Only Alternative 3 provides for hydraulic control of the leading edge of the plume, and would actively reduce the volume of water with concentrations greater than 20,000 pCi/L by dilution and recirculation. With the source controlled by capping, and most of the residual tritium flushed from the unsaturated zone, allowing for natural migration of the plume provides time for radioactive decay and dispersion to reduce concentrations and total radioactivity. Under Alternatives 1, 2, and 3, the total tritium content in the aquifer will only be reduced by natural radioactive decay. Alternative 4 would actively remove tritium from the aquifer, and Alternative 5 would physically remove the source soils.

9.5 Short-Term Effectiveness

These alternatives would not pose short-term risks to the public or the environment. The soil contamination at VQ12 is isolated from direct human contact and there are no groundwater to surface water discharge points or extraction wells in the immediate vicinity of the source or plume. Institutional controls are already in place to maintain consistent groundwater flow directions, and to prevent potential exposure to the contaminated groundwater. Monitoring results indicate that the concrete cap installed over the activated soil area is effectively preventing the infiltration of stormwater. Additional tritium production in the soil was eliminated with the completion of the g-2 experiment in April 2001. Implementation of Alternative 5 (Source Removal) would require the dismantlement of sections of the g-2 beam line, and a section of the adjacent beam line that leads from the AGS to the RHIC. As a result, there would be significant negative long-term impacts to BNL's ongoing accelerator physics program—a core research activity. It is estimated that it would take up to two years to remove the activated soil and rebuild the experiment beam lines.

9.6 Implementability

Each alternative is technically feasible, and services, technology, and materials are readily available. Alternative 1 is the easiest to implement because it does not involve well installation and monitoring activities. Alternative 5 is the hardest to implement because it involves significant engineering (e.g., beam line and structure dismantlement and soil excavation) and health and safety monitoring. Implementation of Alternative 5 would also result in a significant negative disruption to BNL's ongoing accelerator science program, primarily the RHIC project. Alternatives 2, 3, 4, and 5 require additional groundwater sampling and the installation of temporary and permanent monitoring wells to provide more precise characterization of the plume at key stages of slug migration. Drilling and sampling contracts and procedures that allow for the timely delivery of these services are currently in place. None of the alternatives require special drilling techniques or conditions; however, accessibility to suitable drilling locations may be limited by existing and planned structures and underground utilities. During the planned well installation events, it may be necessary to close sections of roadways and parking lots. This will represent an inconvenience to some BNL workers, but should not create a significant problem. A long-term monitoring program for the g-2 plume is complicated by the narrowness of the plume, small sizes of the high concentration plume slugs, small-scale changes in groundwater flow directions, and plume dispersion effects.

Alternative 3 would be impractical to implement at the present time because of the close proximity of the g-2 tritium plume to the Waste Concentration Facility (WCF) Sr-90 plume. High-flow pumping of the tritium plume would result in the entrainment of Sr-90, and the extracted groundwater would probably have to be treated to remove the Sr-90 prior to recharging it on site. Changes in groundwater flow patterns caused by g-2 extraction well pumping could also have a negative impact to the operation of the current Sr-90 extraction wells. Furthermore, computer model predictions indicate that the g-2 tritium plume would naturally attenuate to less than the 20,000 pCi/L MCL by 2010-2015 entirely in the center of the BNL site without any additional treatment. However, high-flow pumping can be maintained as a contingency action if the plume does not attenuate as predicted. Discharging the pumped water to a recharge basin would require a State Discharge Elimination System (SPDES) permit equivalency application, and compliance with this program.

Alternative 4 (Low-flow Pumping) would be impractical to implement at the present time due to the need to pump and transport large volumes of water (estimated to be as much as 360,000 gallons), and the potential to pull in Sr-90 from the nearby Waste Concentration Facility plume as the water is extracted from the aquifer. Computer model predictions indicate that that the g-2 tritium plume would naturally attenuate to less than the MCL by 2010-2015 entirely in the center of the BNL site without further treatment. If implemented, low-flow pumping procedures are well established from similar programs that were implemented for the HFBR tritium plume, and are not expected to represent significant difficulties. All of the materials, equipment and personnel required for the implementation of either Alternative 3 or 4 are readily available. During any well installation or groundwater extraction event, it may be necessary to close sections of roadways and parking lots. This will represent an inconvenience to some BNL workers, but should not create a significant problem.

Alternative 5 requires special procedures to excavate and dispose of the activated soils. However, these procedures are well established from similar contaminated soil removal programs implemented at BNL, and are not expected to represent special difficulties. All of the materials, equipment, and personnel required for the implementation of Alternative 5 are readily available.

9.7 Cost

A comparison of the costs associated with the five alternatives is provided in Table 1. Alternative 1 represents the lowest total cost of $202,177 and Alternative 5 is highest, with a cost of $11,896,681. For Alternative 5, there could also be a projected $80,000,000 in lost experiment and worker productivity for the RHIC experiment over a two-year period. For cost estimating purposes, all five alternatives assume 30-year implementation periods, although it is acknowledged that cap maintenance activities may extend beyond 30 years. Detailed cost analyses for each evaluated alternative are presented in the *g-2 Source Area and Tritium Plume – AOC 16T Focused Feasibility Study* (BNL, 2006a).

9.8 State Acceptance

During the development of the Feasibility Study and the Proposed Plan, DOE worked closely with the New York State Department of Environmental Conservation (NYSDEC) representing the State of New York. The State of New York concurs with the selected remedy described in this Record of Decision.

9.9 Community Acceptance

During 2006, a number of presentations were given to local community groups, the Brookhaven Executive Roundtable, and the BNL Community Advisory Council to provide background information on the extent of soil and groundwater contamination, and actions taken to date to prevent additional impacts to the environment. During the public comment period on the Proposed Plan (October 12, 2006 through November 13, 2006), public information sessions were

	Threshold Criteria		**Balancing Criteria**					**Modifying Criteria**	
Alternative	**Overall Protection of Public Health and the Environment**	**Compliance with ARARs**	**Long-term Effectiveness and Permanence**	**Reduction of Toxicity, Mobility, or Volume Through Treatment**	**Short-term Effectiveness**	**Implementability**	**Cost**	**State Acceptance**	**Community Acceptance**
Alternative 1: Continued Maintenance of Source Controls	Maintains source control, access control, and protection of potable water supply. Tritium levels in groundwater should meet MCLs by natural attenuation. However, without groundwater monitoring, overall protection cannot be confirmed.	Meets ARARs, but does not provide for confirmatory groundwater monitoring.	Effective due to natural attenuation of the plume, and cap protects the activated soil. However, without groundwater monitoring, the effectiveness cannot be verified.	Does not actively reduce toxicity, mobility or volume in groundwater. Mobility in soil is reduced by source control (i.e., cap).	No short-term risks to public or environment. Contaminated soil is isolated from direct human contact, and plume will not impact drinking water supply.	No feasibility issues, readily implemented. Services and materials readily available.	$202,117	This alternative was not selected.	This alternative was not selected.
Alternative 2: Source Control and Groundwater Monitoring	Maintains source control, access control, and protection of potable water supply, and tritium levels in groundwater meet MCLs by natural attenuation. Groundwater monitoring will verify effectiveness. Trigger concentrations are in place for additional evaluations if conditions change.	Meets ARARs, and provides for confirmatory groundwater monitoring.	Effective due to natural attenuation of the plume, and cap protects the activated soil. Groundwater monitoring will verify effectiveness. Trigger concentrations are in place for additional evaluations if conditions change.	Does not actively reduce toxicity, mobility or volume in groundwater. Mobility in soil is reduced by source control (i.e., cap).	No short-term risks to public or environment. Contaminated soil is isolated from direct human contact, and plume will not impact drinking water supply.	Structures and underground utilities may hamper well installations. No administrative feasibility issues. Services and materials readily available.	$963,751	The State has accepted this alternative.	The Community has accepted this alternative.
Alternative 3: High-flow Pump and Recharge/Recir-culation; Source Control and Groundwater Monitoring	Maintains source control, access control, and protection of potable water supply, and tritium levels in groundwater meet MCLs by active recirculation and natural attenuation.	Meets ARARs, and provides for confirmatory groundwater monitoring.	Effective due to containment, dilution and attenuation processes, cap over activated soil. Groundwater monitoring used to verify effectiveness.	Significantly reduces toxicity, and mobility in groundwater. Mobility in soil is reduced by source controls (i.e., cap).	There is a potential for the entrainment of Sr-90 with high-flow pumping. Contaminated soil is isolated from direct human contact, and plume will not impact drinking water supply.	Difficult to implement due to position of the g-2 plume and the WCF Sr-90 plume.	$2,133,689	This alternative was not selected.	This alternative was not selected.
Alternative 4: Low-flow Extraction and Off-site Disposal; Source Control and Groundwater Monitoring	Maintains source control, access control, and protection of potable water supply, and tritium levels in groundwater meet MCLs by mass removal and natural attenuation.	Meets ARARs, and provides for confirmatory groundwater monitoring.	Effective due to mass removal and attenuation processes, cap over activated soil. Groundwater monitoring used to verify effectiveness.	Moderately reduces mobility and toxicity by mass removal of high tritium levels in groundwater. Mobility in soil is reduced by source controls (i.e., cap).	There is a potential for the entrainment of Sr-90 while pumping the tritium plume. Possible low-level dose to workers involved in groundwater extraction activities. Contaminated soil is isolated, and plume will not impact supply wells.	Difficult to implement due to large volume of water to be extracted, the close proximity of the WCF Sr-90 plume, accessibility issues due to buildings and utilities.	$6,247,899	This alternative was not selected.	This alternative was not selected.
Alternative 5: Source Removal; Groundwater Monitoring	Actively removes contaminated soil, protection of potable water supply, and tritium levels in groundwater meet MCLs by natural attenuation.	Meets ARARs, and provides for confirmatory groundwater monitoring.	Effective due to natural attenuation of the plume, activated soil is removed. Groundwater monitoring used to verify effectiveness.	Reduces mobility of tritium in soils by removal and offsite disposal. Does not actively reduce toxicity, mobility or volume in groundwater.	Short-term issues include potential radiation dose to workers involved in beam line dismantlement and excavation. Excavation activities would result in significant impact to the operations of RHIC.	Because some of the activated soil is below a section of the RHIC tunnel, excavation activities could disrupt RHIC operations for up to two years.	$11,896,681	This alternative was not selected.	This alternative was not selected.

Table 1. Comparative Analysis of Alternatives

held on October 18, 2006 and a public meeting was held on October 25, 2006. No comments were received during information sessions or during the public meeting. Comments were received from the BNL Community Advisory Council and several of its participating civic associations and environmental advocacy groups. While many of the organizations supported the preferred alternatives described in the PRAP (BNL 2006c) with recommendations for changes and clarifications, one of the organizations did not agree with the Proposed Plan for the g-2 plume and activated soil. This organization expressed a preference that all of the proposed actions should include active remediation of the soil and groundwater. Questions and comments received during the public comment period and responses are presented in the Responsiveness Summary, Section III. Copies of the actual public comments received are provided in Appendix C.

10.0 SELECTED REMEDIES

In addition to the remedies described below, DOE does not envision any sale or transfer of property within the accelerator research area of the BNL site. If it were to occur, the sale or transfer of BNL property would meet the requirements of Section 120 (h) of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination. An environmental easement/restrictive covenant shall be filed in the property records of Suffolk County at the time the Federal Government disposes of the property if residual contamination levels are present that do not allow for unrestricted use. This includes the completion and submission of periodic certifications to ensure that the institutional and engineering controls are in place. Each transfer of fee title from the U.S. will include a CERCLA 120(h)(3) covenant which will have, at a minimum, a description of the residual contamination on the property and any existing environmental use restrictions, as described in Sections 5.0, 6.0 and 10.0.

Land use controls will be maintained at the g-2 and BLIP areas until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. The BNL Land Use Control Management Plan (LUCMP) summarizes the land use and institutional controls that will be deployed at BNL to prevent exposure to environmental contamination and ensure long-term effectiveness of the environmental cleanup remedies. The LUCMP will be revised within 90 days of ROD signature, and submitted for EPA and NYSDEC review and approval. The document will be revised to include the g-2 and BLIP AOCs and all appropriate Institutional and Land Use Controls, and will be revised to address implementation and maintenance actions including periodic inspections of the g-2 and BLIP areas.

DOE is responsible for implementing, maintaining, reporting on and enforcing the land use controls. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the DOE shall retain ultimate responsibility for the remedy integrity.

10.1 g-2 Tritium Source Area and Groundwater Plume (AOC 16T)

After evaluating the alternatives against the CERCLA criteria, Alternative 2 - Continued Source Area Controls and Groundwater Monitoring, with changes made in response to public comments as described in Section 9.9, is the selected remedy to achieve the remedial action objectives.

Alternative 2 requires continued routine inspection and maintenance of the concrete cap and other storm water controls. In addition, this alternative requires continued groundwater monitoring immediately downgradient of the source area to verify the continued effectiveness of the storm water controls, and to monitor the downgradient segments of the plume to verify that the tritium plume attenuates to less than the 20,000 pCi/L MCL as predicted by the BNL groundwater model (BNL, 2006a). Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality (i.e., until the radioactivity decays to an acceptable level or until the soils are remediated). Monitoring of the plume will continue until the plume attenuates to less than the MCL. This monitoring program will be accomplished using a combination of permanent (fixed) wells and temporary wells. All monitoring plans will be reviewed with the regulatory agencies before implementation.

Two contingency trigger levels have been developed to require the evaluation of unexpected future releases from the source area or if the tritium plume does not attenuate as predicted by the BNL groundwater model. If reached, BNL's Groundwater Protection Contingency Plan (BNL, 2003 and subsequent updates) will be implemented, and the need for additional corrective actions will be evaluated. This contingency plan provides for a consistent, systematic approach to respond to the detection of unexpected levels of contamination, including verification of results, conducting additional sampling and/or characterization, and informing stakeholders about the monitoring results and any follow-up actions. The two trigger levels for the g-2 tritium plume are:

- Detection of >1,000,000 pCi/L within the Tritium Plume: If tritium levels greater than 1,000,000 pCi/L are observed within the plume, actions would include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. If detected in the wells immediately downgradient of the source area, actions would include the immediate inspection of the existing storm water controls and implementation of improvements, as necessary. The actions would also include an evaluation of whether active remediation (e.g., low-flow extraction with off-site disposal or high-flow pumping with on-site recharge) is appropriate to limit plume growth.

- Detection of >20,000 pCi/L South of Brookhaven Avenue: If tritium levels south of Brookhaven Avenue are found to exceed the 20,000 pCi/L MCL, actions will include an evaluation of the groundwater data and the need for additional characterization and/or monitoring. An assessment will be made to determine whether active remediation is appropriate to control plume growth. Brookhaven Avenue is located approximately one mile north of the BNL site boundary.

The regulatory agencies will make a decision on the need to implement active groundwater remediation measures after receiving DOE's assessment and recommendation in accordance with the Interagency Agreement. DOE is committed to preventing the migration of tritium beyond the BNL property boundary at concentrations greater than the 20,000 pCi/L MCL.

Groundwater monitoring data will be evaluated and reported annually in the *Groundwater Status Report* and as part of the CERCLA Five-Year Review. In addition to publishing the results of the monitoring program in the annual reports, DOE and BSA routinely provide summary reports to the CAC and other interested community organizations and individuals.

Institutional and engineered controls are in place to prevent possible exposure to the contaminated soils and groundwater. These controls include physical barriers and work control procedures to restrict access to activated soils near the g-2 source area, operational restrictions on existing potable/process water supply wells within the vicinity of the plume's path, and controlling the future placement of pumping wells and/or recharge basins that could significantly impact groundwater flow directions in the area. If the former g-2 beam line were to be used in the future, institutional controls would also require procedures to limit the amount of beam loss, and further activation of the soil shielding. Final disposition of the activated soil will be addressed during facility decommissioning. As long as these hazardous substances remain above levels allowed for unlimited use and unrestricted exposure, future reuse of the g-2 facility will be limited to commercial or industrial uses. Commercial application involving the potential for continuous direct exposure in these areas to the general public, such as child day care or health care facilities, will be prohibited.

Visual inspections of the g-2 source area cap will be conducted on a frequency of at least two times per year. An annual certification will be prepared by a professional engineer or other such expert acceptable to the NYSDEC and EPA, until NYSDEC and EPA notify DOE in writing that this certification is no longer needed. This submittal would contain certification that the institutional controls and engineering controls are still in place, and that nothing has occurred that would impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the BNL *Land Use Controls Management Plan* (BNL, 2005 and subsequent updates). The regulatory agencies will have access to the site to conduct inspections, as necessary.

10.2 Brookhaven Linac Isotope Producer (AOC 16K)

Continued inspections, certifications, and maintenance of the cap; groundwater monitoring; institutional controls; and the previously completed work (i.e., installation of the cap, improved roof drains, and containment with colloidal silica grout) are selected as the final action. Groundwater monitoring will verify that the cap and other storm water controls are effective. Groundwater data will be evaluated and reported annually in the *Groundwater Status Report* and during the CERCLA Five-Year Reviews.

Institutional and engineered controls are in place to prevent possible exposure to the contaminated soils and groundwater. These controls include physical barriers and work control procedures to restrict access to activated soils, and restrictions on installing new potable/process water supply wells within the vicinity of the plume's path, and controlling the future placement of pumping wells and/or recharge basins that could significantly impact groundwater flow directions in the area. Final disposition of the activated soil will be addressed during facility decommissioning. As long as these hazardous substance remain above levels allowed for unlimited use and unrestricted exposure, future reuse of the BLIP facility will be limited to commercial or industrial uses. Commercial application involving the potential for continuous direct exposure in these areas to the general public, such as child day care or health care facilities, will be prohibited.

Visual inspections of the BLIP area cap will be conducted on a frequency of at least two times per year. An annual certification will be prepared by a professional engineer or other such expert acceptable to the NYSDEC and EPA, until the NYSDEC and EPA notify DOE in writing that this certification is no longer needed. This submittal would contain certification that the institutional controls and engineering controls are still in place, and that nothing has occurred that would impair the ability of the control to protect public health or the environment, or constitute a violation or failure to comply with the BNL *Land Use Controls Management Plan* (BNL, 2005 and subsequent updates). The regulatory agencies will have access to the site to conduct inspections, as necessary.

10.3 Former Underground Storage Tanks (AOC 12)

Based upon the closure work that was already completed on these eight tanks under the requirements of Suffolk County Sanitary Code Article 12, no additional actions are required under this Record of Decision.

11.0 STATUTORY DETERMINATIONS

Remedy selection is based on CERCLA as amended and on the National Contingency Plan. All remedies must meet the threshold criteria: protection of human health and the environment, and compliance with ARARs. CERCLA also requires that the remedy use permanent solutions and alternative treatment technologies to the maximum extent practicable, and that the implemented action must be cost-effective. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedies meet these statutory requirements.

11.1 Protection of Human Health and the Environment

Under current conditions, engineered and institutional controls prevent public and worker access to the activated soil shielding at g-2 and BLIP. Access to all BNL radiological facilities is controlled such that access controls and physical barriers meet or exceed the requirements of 10 CFR § 835 Occupational Radiation Protection, and all radiation workers have the proper radiological training and surveillance. Furthermore, any proposed work activities that could compromise the integrity of the g-2 or BLIP caps, or result in possible exposure to the activated soils, would be fully evaluated as required by the BNL Subject Area on *Work Planning and Control for Experiments and Operations* (BNL, 2006d). All proposed excavation or drilling activities are evaluated as part of BNL's digging permit process, which includes a review of all land use and institutional controls that may apply to the work area (BNL, 2006e)

The g-2 groundwater plume has not impacted any of the on-site drinking water supply wells; is located more than 20 feet below land surface; and the plume will not discharge into any surface water bodies. The groundwater flow and transport model predicts that the g-2 groundwater plume would naturally decrease to concentrations below the 20,000 pCi/L MCL near Cornell Avenue by 2010–2015. Cornell Avenue is located approximately 800 feet north (upgradient of Brookhaven Avenue, and more than one mile north of the BNL southern boundary (Figure 3). For Alternative 2, contingency trigger levels have been developed that would require the evaluation of unexpected future releases from the source area or if the groundwater plume does not attenuate as predicted. If high-flow pumping were implemented as a contingency, pumping would require sufficient dilution at the wellhead to ensure that the tritium concentrations were below 20,000 pCi/L before being discharged to an on-site recharge basin. If low-flow pumping is implemented, it would result in some radiation dose to workers involved in the extraction and transportation of the contaminated water.

Tritium released from the BLIP facility has resulted in only localized impact to groundwater quality. Tritium levels drop to less than the 20,000 pCi/L MCL within 300 feet of the facility. The contaminated groundwater does not impact any of the on-site drinking water supply wells, is located more than 20 feet below land surface, and it will not discharge into any surface water bodies.

Based upon confirmatory soil samples collected after the USTs were removed, there are no human health or environmental concerns associated with the former UST areas.

11.2 Compliance with ARARs

The National Contingency Plan 40 CFR § 300.430 (f)(1)(ii)(B) requires that the selected remedy attains the Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) or a waiver of an ARAR be obtained. Presented below is a summary of significant chemical-specific, location-specific, and action-specific ARARs applicable to the g-2 activated soils and groundwater plume, and the activated soils at BLIP. There are no human health or environmental concerns associated with the former UST areas. A complete list of ARARs and To Be Considered (TBC) requirements is presented in Appendix A, including those ARARs/TBCs that would apply if active remediation is conducted as a contingency action.

11.2.1 Chemical-specific ARARs

- National Primary Drinking Water Standards (40 CFR § 141): Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are used as groundwater standards for sole source aquifers. The selected remedies will comply with these regulations through source control and monitored natural attenuation.

- NYSDOH State Sanitary Code, Drinking Water Supplies (10 NYCRR, Subpart 5-1): Requirements designed to protect present and future sources of drinking water. Establishes MCLs for potable water supplies. The selected remedies will comply with these regulations through source control and monitored natural attenuation.

11.2.2 Location-specific ARARs

- Safe Drinking Water Act (SDWA) (42 USC, Chapter 6A): Sets national health-based standards for drinking water to protect against natural and man-made contaminants. The aquifer system underlying BNL is a designated Sole Source Aquifer. The selected remedies will comply with SDWA regulations through source control and monitored natural attenuation of the tritium plume.

- NYSDEC Water Classification and Quality Standards (6 NYCRR Parts 609, 700-703): Determines the classification system and quality standards for surface water and groundwater. The underlying aquifer is designated as a Sole Source Aquifer, which is defined as Class GA groundwater under this regulation. Groundwater cleanup goals are based on State specific standards. The selected remedies will comply with these regulations through source control and monitored natural attenuation of the groundwater plume.

11.2.3 Action-specific ARARs

- National Primary Drinking Water Standards (40 CFR § 141): Establishes MCLs and MCLGs that are used as groundwater standards for sole source aquifers. The selected remedy will comply with these regulations through source control and monitored natural attenuation of the groundwater plume.

- NYSDEC Water Classification and Quality Standards (6 NYCRR Parts 609, 700-703): Determines the classification system and quality standards for surface water and groundwater. The underlying aquifer is designated as a Sole Source Aquifer, which is defined as Class GA groundwater under this regulation. Groundwater cleanup goals are based on State specific standards. The selected remedy will comply with these regulations through source control and monitored natural attenuation of the groundwater plume.

- NYSDOH State Sanitary Code, Drinking Water Supplies (10 NYCRR, Subpart 5-1). Requirements designed to protect present and future sources of drinking water. Establishes MCLs for potable water supplies. The selected remedy will comply with these regulations through source control and monitored natural attenuation.

- Occupational Radiation Protection (10 CFR § 835): These rules establish radiation protection standards for all DOE activities. They apply to all radiation workers and sets standards for training and surveillance. Work controls are in place to protect workers from direct exposure to the activated soil (BNL, 2006d).

11.3 Cost-Effectiveness

Based on the expected performance standards, the selected remedies for g-2 and BLIP are cost-effective. They effectively provide short- and long-term protection of human health and the environment. There are no costs associated with the former UST areas because no additional actions are required.

11.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The National Contingency Plan prefers a permanent solution whenever possible. The selected remedies for g-2 and BLIP require continued monitoring, institutional controls and reporting. Immediate removal of the activated soil or contaminated groundwater was found not to be practical or cost effective. BLIP soils were treated with a colloidal silica grout to reduce mobility of the contaminants. The activated soil shielding will decay in place, and will be properly protected and maintained on-site until the facilities are decommissioned. Once the facilities are decommissioned, a decision will be made for the proper disposition of the soil. Tritium levels in groundwater are expected to decline to less than the 20,000 pCi/L MCL by natural attenuation (by natural radioactive decay and dispersion) in the aquifer entirely on the BNL site.

The USTs were removed and disposed of off-site. No additional actions are required and this portion of the remedy is permanent.

11.5 Preference for Treatment as a Principal Element

The selected remedy for the g-2 source area and groundwater plume is Alternative 2: Continued Source Controls and Groundwater Monitoring, with Contingency Actions.

The selected remedy for g-2 does not meet the EPA's statutory preference for treatment as a principal component. There will be no active treatment to reduce the toxicity, mobility, or volume of the radioactive contaminants in the soil and groundwater. Reduction in contaminant levels in the soil was found to not be cost effective or practical and will be accomplished by natural radioactive decay. Contaminant levels in groundwater will decrease by radioactive decay and dispersion. For tritium in groundwater, the principal contaminant of concern, there are no technologies available to filter out or change its properties through the use of treatment systems. Remedial options are limited to extraction with off-site disposal, extraction with dilution at the wellhead and on-site recirculation, and natural attenuation (via dispersion and radioactive decay) in the aquifer. The remedy does include triggers if concentrations in groundwater are higher than predicted. These triggers require additional evaluations for active treatment. The only viable remedial options available for tritium in source soil are removal with off-site disposal or on-site decay in place. A remedial technology demonstration involving the injection of a silica grout into the activated soil shielding was conducted at the BLIP facility, which involves similar conditions as the g-2. However, the installation of the grout displaced some of the tritiated pore water and caused an additional short-term release. Because of the release, this treatment technology was not considered for the g-2 source area.

For the BLIP Soils, the selected remedy is continued source controls and groundwater monitoring. Source controls at the g-2 and BLIP areas consist of grouting, impermeable caps and other drainage features designed to prevent rainwater infiltration and leaching of tritium from the activated soil shielding. BLIP soils were treated with a colloidal silica grout to reduce mobility of the contaminants. However, the grout displaced some of the tritium contaminated pore water during installation causing an additional short-term release to the groundwater. Because of the potential for a similar release, this treatment technology was not used at the g-2 source area.

For the former UST areas, no additional actions are required beyond the removal of the USTs.

11.6 Documentation of Significant Changes

The PRAP was released for public comment in October 2006. For the g-2 Tritium Source Area and Groundwater Plume, it identified Alternative 2 – Continued Source Controls and Groundwater Monitoring, with Contingency Actions as the Preferred Alternative. For the BLIP, the PRAP identified Continued Source Controls and Groundwater Monitoring. For the Former UST areas, no additional actions are required. DOE reviewed all comments submitted during the public comment period. It was determined that no significant changes to the remedies, as originally identified in the PRAP, were necessary or appropriate at this time. However, the following minor changes have been incorporated into this ROD for the g-2 tritium source area and groundwater plume remedy: 1) the 1,000,000 pCi/L trigger level originally proposed for just the area immediately downgradient of the g-2 source area will be applied to the entire plume, 2) the proposed second trigger level of 2,000,000 pCi/L in the AGS Parking lot area will be deleted, 3) clarification that DOE would recommend to the regulatory agencies that active remediation of the g-2 groundwater plume be conducted if there is a potential for the plume to migrate beyond the site boundary at concentrations greater than the 20,000 pCi/L MCL, 4) clarification that the frequency of the cap inspections at g-2 and BLIP will be twice per year, 5) a description of the groundwater monitoring goals for tracking the g-2 plume, and 6) how DOE will provide information to the public on the g-2 monitoring strategy and if a contingency action is triggered.

11.7 Review/Certification

In addition to the CERCLA Five-Year reviews necessary to evaluate the effectiveness of the institutional control to restrict inappropriate land use, annual certification to the NYSDEC and EPA will be required. This review will certify to the State and EPA that the institutional controls and engineering controls put in place are unchanged from the previous certification, and nothing has occurred that would impair the ability of the control to protect public health or the environment or constitute a violation or failure to comply with the site management plan. The annual certification will be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC and EPA. Implementation of institutional controls will also be reviewed annually and any needed changes provided to the regulatory agencies as part of BNL's Land Use Controls Management Plan (BNL, 2005 and subsequent updates).

III RESPONSIVENESS SUMMARY

The community involvement process is an integral part of making cleanup decisions. Project staff made multiple presentations to the Community Advisory Council (CAC), Brookhaven Executive Roundtable (BER), and several local civic associations. A timeline of significant regulatory and community involvement activities is presented in Appendix B.

A public comment period for the *Proposed Remedial Action Plan for the g-2 Tritium Source Area and Groundwater Plume, Brookhaven Linac Isotope Producer, and Former Underground Storage Tanks* was from October 12 through November 13, 2006. Two information sessions were held on October 18, 2006. Additionally, a public meeting was held on October 25, 2006.

All written and verbal comments submitted during the public comment period were compiled and reviewed. Copies of the comments received are presented in Appendix C. The transcript for the public meeting has been placed in the Administrative Record. During the public comment period, DOE received written comments from the CAC and four of its member organizations: the Wading River Civic Association, Science and Technology organization, LI Pine Barrens Society (LIPBS), and the Citizens Campaign for the Environment (CCE). No comments were received during either of the October 18, 2006 information sessions, or during the October 25, 2006 public meeting.

1. Comments from the BNL Community Advisory Council

During the November 9, 2006 CAC meeting, the CAC was able to reach a consensus to support the Proposed Plan for g-2, BLIP, and the former USTs. The CAC also proposed the following amendments to the Proposed Plan for g-2 source area and groundwater plume (i.e., proposed Alternative 2):

CAC Comment 1: "At an identified trigger level of 1,000,000 pCi/L of tritium formal regulatory and public review of the remedy would be required as a 'Fundamental Difference' under CERCLA."

Response: In response to the CAC recommendation, and a similar recommendation from the CCE (see below), the 1,000,000 pCi/L trigger level originally proposed for just the area immediately downgradient of the g-2 source area has been applied to the entire plume. The proposed second trigger level of 2,000,000 pCi/L in the AGS Parking lot area has been deleted.

If triggered, DOE will conduct a thorough evaluation of the situation. The regulatory agencies will make a decision on the need to implement active groundwater remediation measures after receiving DOE's assessment and recommendation in accordance with the Interagency Agreement. The CERCLA process has provisions for reevaluating a remedy after a ROD is signed. Remedy changes can fall into one of three categories: minor, significant, and fundamental. If a contingency is triggered, a determination will be made as to which category is most appropriate for the response. If it is determined that a significant or fundamental change is required, then DOE will provide time for public review of any planned changes, including a 30-day public comment period. A Responsiveness Summary will be prepared which documents public comments on the proposed changes and DOE responses to those comments. Under normal conditions, annual monitoring data reviews and the CERCLA Five-year Reviews are used to evaluate the effectiveness of the remedies, and to determine whether modifications to these actions are required. In addition to publishing the results of the monitoring program in the annual reports, DOE and BSA routinely provide summary reports/presentations to the BNL CAC and other interested community organizations and individuals.

CAC Comment 2: "If tritium in groundwater at or above 20,000 pCi/L approaches the site boundary active remediation would be required."

Response: The second trigger requires additional actions if tritium levels exceed 20,000 pCi/L south of Brookhaven Avenue. Brookhaven Avenue is located approximately one mile north of the BNL southern boundary. If triggered, DOE will conduct a thorough evaluation of the situation. In accordance with the IAG, the regulatory agencies will make a decision on the need to implement active groundwater remediation measures after receiving DOE's assessment and recommendation. DOE is committed to prevent the migration of tritium beyond the BNL property boundary at levels greater than the 20,000 pCi/L MCL.

CAC Comment 3: "The Record of Decision (ROD) should include a sampling strategy for the plume that incorporates public input as part of that strategy."

Response: As part of the remedy for g-2, DOE is committed to monitor the groundwater downgradient of the source area to verify that the source controls continue to be effective, and to demonstrate that the tritium plume attenuates to less than the 20,000 pCi/L MCL, as predicted. Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality (i.e., until the radioactivity decays to an acceptable level or until the soils have been remediated). Monitoring of the plume will continue until the high concentration segments of the plume attenuate to less than 20,000 pCi/L. This monitoring will be accomplished using a combination of permanent (fixed) wells and temporary wells. An overview of this monitoring strategy will be provided to the BNL CAC at an upcoming meeting. All monitoring plans, which include specific information on well installation locations and sample depths, will be reviewed with the regulatory agencies prior to their implementation in accordance with the Interagency Agreement. DOE acknowledges that routine communication of monitoring program results is an important component of the cleanup process, and is valuable to maintaining community trust and understanding. In addition to publishing the results of the monitoring program in the annual Site Environmental Report/Groundwater Status Report, DOE and BSA routinely provide summary presentations to the CAC and other interested community organizations and individuals. At a minimum, DOE and BSA will provide the CAC with an annual summary of the monitoring data during the planned annual updates on the Groundwater Status Report.

2. Comments from the Wading River Civic Association

Wading River Civic Association Comment: The Association concurs with the Proposed Plan; and they emphasized that "ground[water] monitoring remain in place to verify effectiveness, and trigger concentrations are in place for continuous evaluations, and to be prepared to respond to changes as needed."

<u>Response</u>: As part of the remedy for g-2, DOE is committed to monitor the groundwater downgradient of the source area to verify that the source controls continue to be effective, and to demonstrate that the groundwater plume attenuates to less than the 20,000 pCi/L MCL, as predicted. DOE is prepared to respond to monitoring data that indicate that the current source controls are not effective or that the plume is not attenuating as predicted.

3. Comments from Science and Technology Organization

Science and Technology concurs with the Proposed Plan for g-2, BLIP, and the former USTs, and offered the following additional comments related to the g-2 source area and groundwater plume:

<u>Science and Technology Comment 1</u>: "Although currently inactive, since the g-2 Experiment Facility is reserved for future use, I am somewhat concerned about the structural integrity of the four inch thick concrete cap and significantly concerned about the cut that was made through the six inch thick concrete base pad along the southern side of the sheet pile wall. It was this cut in the base pad that was probably not properly patched permitting that rainwater to leach tritium and sodium-22 from the activated soil zone down into the unsaturated aquifer."

<u>Response</u>: The g-2 cap was constructed using wire mesh reinforced gunite cement. This method was used because of the steep angle of the soil shielding (i.e., the soil berm over the beam line). As an added measure of protection, the gunite cap was coated with an asphalt sealer. Since its installation in 1999, the cap has been routinely inspected and special attention is paid to the seal between the cap and the sheet pile wall. No major cracks have been found. Minor repairs have been conducted over the past six years, and the entire cap was resealed in the fall of 2006. As noted in this ROD, the cap will be inspected two times per year. Inspection reports will be provided to the regulatory agencies on an annual basis.

It is correct that the cut through the concrete base pad was not sealed on the south side once the sheet pile wall was installed. This cut allowed rain water that had leached tritium from the activated soils immediately above the base pad to migrate past the base pad and into the groundwater. However, once the gunite cap was installed over the source area in December 1999, this leaching process was stopped.

<u>Science and Technology Comment 2</u>: "Results derived from the models are not definitive. Therefore the projected dilutions of tritium concentrations down to the 20,000 pCi/L MCL might easily take twice as long to occur."

<u>Response</u>: It is correct to say that model results are not definitive. It is for this reason that the plume will be carefully monitored to verify that the plume attenuates (via dispersion and radioactive decay) in the aquifer as predicted by the model. However, it is important to note that for the HFBR tritium plume there has been very good correlation between the model-predicted and measured tritium concentrations over time as the plume has migrated downgradient.

<u>Science and Technology Comment 3</u>: "In order to arrive at the desired 20,000 pCi/L MCL the assumption made that no more leaks should occur from the VQ12 area may not quite hold good for a sustained period."

<u>Response</u>: Continued source control is required to reach the cleanup goal. Cap inspections and monitoring data indicate that the cap is effectively preventing rainwater infiltration into the activated soil shielding. However, as described in the Focused Feasibility Study and the Proposed Plan, some of the residual tritium that was leached into the unsaturated soil zone above the water table before the cap was installed has been released (flushed) into the groundwater during periods of high water table elevations, which can occur following heavy seasonal rainfall. The amount of this residual tritium in the unsaturated soil zone is expected to decrease by natural radioactive decay (half-life of tritium is 12.3 years) and by the water table flushing mechanism. Groundwater monitoring results suggest that this decrease is occurring. Over the past two years, tritium levels in the groundwater immediately downgradient of the source area have been continually less than 100,000 pCi/L, with concentrations showing a steady decline to less than 45,000 pCi/L by October 2006. We are hopeful that this trend continues, but realize that some small amount of tritium will continue to be released to the aquifer for some period of time.

<u>Science and Technology Comment 4</u>: "The projection for the tritium concentration in the g-2 plume to decrease to less than 20,000 pCi/L MCL between 2010 and 2015 immediately suggests that the large magnitude of variation in time element i.e. it could take 4 years (2006-2010) to 9 years (2006-2015) a 22% spread."

<u>Response</u>: As described in the Focused Feasibility Study, the model predicted that the plume would attenuate to close to the 20,000 pCi/L MCL by year 2010 near Cornell Avenue. The 2010-2015 timeframe was proposed to take into account the uncertainties in each of the key model parameters, which include: dispersivity, initial tritium concentrations (which includes sample analytical uncertainties), and groundwater flow rates. Cornell Avenue is located approximately 800 feet north (upgradient) of Brookhaven Avenue, and more than one mile north of the BNL southern site boundary. As noted previously, DOE is committed to properly monitor the plume to verify the model predictions.

<u>Science and Technology Comment 5</u>: "The three trigger mechanisms provided in alternative 2 requiring evaluation of unexpected future releases and if needed, invoking BNL's Groundwater contingency plan for implementation of corrective actions must be flagged and doubly committed."

<u>Response</u>: As part of the remedy for g-2, DOE is committed to monitor the groundwater downgradient of the source area to verify that the source controls continue to be effective, and to demonstrate that the groundwater plume attenuates to less than the 20,000 pCi/L MCL as predicted. Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality (i.e., until the radioactivity decays to an acceptable level or until the soils are excavated and removed from the site). Monitoring of the plume will continue until the high concentration segments of the plume attenuate to less than 20,000 pCi/L. This monitoring will be accomplished using a combination of permanent (fixed) wells and temporary wells.

4. Comments from the Long Island Pine Barrens Society

LIPBS Comment: In summary, the LIPBS does not concur with the selection of monitored natural attenuation as the remedy for the g-2 tritium plume. The Long Island Pine Barrens Society "…feels that active remediation should be part of every plan and not just a contingency option for when passive remediation does not work…Cleanup of hot spots should be included, as well as removal of the contaminated sources."

Response: Hot spot remediation of the plume as well as removal of the contaminated source area soils were evaluated as part of the Focused Feasibility Study (Alternative 4 and Alternative 5, respectively), but theses actions were not deemed to be feasible after careful consideration of the nine CERCLA decision-making criteria. The proposed remedies for g-2 and BLIP are appropriate because they are protective of human health and the environment, they comply with Federal and State requirements, and they are cost-effective. Monitored natural attenuation is a widely accepted and approved remedial alternative when its use meets applicable statutory and regulatory requirements. In the case of the g-2 plume, natural attenuation will reduce the mass, volume and concentration of tritium in the groundwater without removing the contaminated water. The activated soil shielding and contaminated groundwater at BLIP and g-2 are isolated from public access, and engineered controls are in place to prevent additional releases of tritium to the aquifer. At the BLIP facility, a colloidal silica grout was injected into the activated soil shielding to reduce mobility of the contaminants. Although this effort was successful, the grout displaced some of the tritium contaminated pore water during installation causing an additional short-term release to the groundwater. Because of the potential for a similar release, this treatment technology was not used at the g-2 source area.

The tritium contamination in groundwater will not impact public drinking water supply wells. Groundwater monitoring will be used to verify the continued effectiveness of the source controls and verify that the tritium levels in the groundwater attenuate as predicted. This monitoring program will detect changes in groundwater conditions, and allow ample time to make modifications to the remedies, if necessary. Furthermore, annual monitoring data reviews and the CERCLA Five-Year Reviews are used to evaluate the effectiveness of the remedies, and to determine whether modifications to these actions are required.

5. Comments from the Citizens Campaign for the Environment

The CCE supports Alternative 2 if it includes the BNL CAC's recommendations, and they have offered the following comments and recommendations:

CCE Comment 1: "Active remediation is needed for this type of cleanup due to its high level of contamination. A simple 'wait and see' approach for the groundwater plume combined with no planned remediation of the activated soils, is a remedy fraught with potential future problems…The trigger levels described in Alternative 2 and the follow up actions are too obscure, don't provide for any substantive actions or change of course, and don't allow for public notice of a continuing problem."

Response: DOE believes that the proposed remedies are appropriate because they are protective of human health and the environment, they comply with Federal and State requirements, and they are cost-effective. Monitored natural attenuation is a widely accepted and approved remedial alternative when its use meets applicable statutory and regulatory requirements. At the BLIP facility, a colloidal silica grout was injected into the activated soil shielding to reduce mobility of the contaminants. The grout displaced some of the tritium contaminated pore water during installation causing an additional short-term release to the groundwater. Because of the potential for a similar release, this treatment technology was not used at the g-2 source area.

Annual monitoring data reviews and the CERCLA Five-year Reviews are used to evaluate the effectiveness of the remedies, and to determine whether modifications to these actions are required. The CERCLA process has provisions for reevaluating a remedy after a ROD is signed. Remedy changes can fall into one of three categories: minor, significant, and fundamental. If a contingency is triggered, a determination will be made as to which category is most appropriate for the response. If it is determined that a significant or fundamental change is required, then DOE will provide time for public review of any planned changes, including a 30-day public comment period. A Responsiveness Summary will be prepared which documents public comments on the proposed changes and DOE responses to those comments.

In addition to publishing the results of the monitoring program in the annual reports, DOE and BSA routinely provide summary reports/presentations to the CAC and other interested community organizations and individuals. DOE acknowledges that routine communication of monitoring program results is an important component of the cleanup process, and is valuable to maintaining community trust and understanding. If future monitoring results were to trigger one of the contingency actions, there would be timely notification to the regulatory agencies and the community.

CCE Comment 2: In addition to the CAC recommendations, CCE requests clarification that "the cap inspection program will be conducted twice per year, as stated at the CAC meeting...."

Response: The requirement for twice a year inspections of the caps has been clarified in this ROD (see Section 10, above).

CCE Comment 3: "Eliminate the trigger of 2,000,000 pCi/L since actions and remedies should occur at the lower level of 1,000,000 pCi/L…"

Response: In response to the CCE recommendation, and a similar recommendation from the CAC (see above), the 1,000,000 pCi/L trigger level originally proposed for just the area immediately downgradient of the g-2 source area has been applied to the entire plume. The proposed second trigger level of 2,000,000 pCi/L in the AGS Parking lot area has been deleted.

CCE Comment 4: "Before an alternative is agreed on, the detailed sampling plan needs to be finalized and released to the public and CAC."

Response: Typically, Proposed Plans only provide an overview of the monitoring strategy or monitoring goals. In the case of g-2, groundwater monitoring will continue to be conducted immediately downgradient of the source area to verify the continued effectiveness of the storm water controls, and to monitor the downgradient segments of the plume to verify that the groundwater plume attenuates to less than the 20,000 pCi/L MCL as predicted. Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality (i.e., until the radioactivity decays to an acceptable level or until the soils are remediated). Monitoring of the plume will continue until the high concentration segments of the plume attenuate to less than the 20,000 pCi/L MCL. This monitoring program will be accomplished using a combination of permanent (fixed) wells and temporary wells. While BNL's existing monitoring well network is sufficient to monitor the source area, additional wells are required to monitor the downgradient segments of the plume as it migrates. Detailed monitoring plans will be prepared prior to each phase of the monitoring project (e.g., sampling that would be conducted in the spring 2007, fall 2007, spring 2008, etc.), and will include information on specific well installation locations, sampling techniques, sample depths, and analytical requirements. These plans will be reviewed with the regulatory agencies prior to their implementation. To provide a better understanding of the monitoring strategy, an overview of the monitoring strategy will be provided to the CAC at an upcoming meeting.

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APPENDIX A
Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered (TBCs)

Table A-1. Chemical-specific ARARs and TBCs

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
Federal Regulatory Requirement	Drinking Water/ Groundwater	Safe Drinking Water Act (42 USC, Chapter 6A)	ARAR	Applicable to the use of public water systems. Sets national health-based standards for drinking water to protect against natural and man-made contaminants. Establishes criteria for sole source aquifer designations.	BNL overlies a designated sole source aquifer. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
Federal Regulatory Requirement	Drinking Water/ Groundwater	National Primary Drinking Water Standards (40 CFR § 141)	ARAR	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are used as groundwater standards for sole source aquifers.	The selected remedy will comply with these regulations through source control and monitored natural attenuation.
Federal Regulatory Requirement	Radiation	Radiation Protection of the Public and the Environment DOE Order 5400.5	TBC	This order establishes the standards and requirements with respect to protection of members of the public and the environment against undue risk from radiation.	The selected remedy will comply with these regulations through source control and monitored natural attenuation.
State Regulatory Requirement	Surface Water/ Groundwater	NYSDEC Classification and Quality Standards (6 NYCRR Parts 609, 700-703).	ARAR	Determines the classification system and quality standards for surface water and groundwater.	Groundwater cleanup goals are based on State specific standards. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
State Regulatory Requirement	Drinking Water/ Groundwater	NYSDOH State Sanitary Code, Drinking Water Supplies (10 NYCRR, Subpart 5-1).	ARAR	Requirements designed to protect present and future sources of drinking water. Establishes	The selected remedy will comply with these regulations through source control and

				maximum contaminant level (MCLs) standards for potable water supplies.	monitored natural attenuation.
Federal Regulatory Requirement	Waste Management	Radioactive Waste Management (DOE Order 435.1).	TBC	Establishes requirements for radioactive waste management at DOE facilities.	If groundwater extraction is required, water handling and disposal operations will comply with these requirements.

Table A-2. Location-specific ARARs and TBCs

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
Federal Regulatory Requirement	Drinking Water/ Groundwater	Safe Drinking Water Act (42 USC, Chapter 6A).	ARAR	Applicable to the use of public water systems. Sets national health-based standards for drinking water to protect against natural and man-made contaminants. Establishes criteria for sole source aquifer designations.	The underlying aquifer is a designated Sole Source Aquifer. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
Federal Regulatory Requirement	Drinking Water/ Groundwater	National Primary Drinking Water Standards (40 CFR § 141).	ARAR	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are used as groundwater standards for sole source aquifers.	The underlying aquifer is designated as a Sole Source Aquifer. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
State Regulatory Requirement	Surface Water/ Groundwater	NYSDEC Water Classification and Quality Standards (6 NYCRR Parts 609, 700-703).	ARAR	Determines the classification system and quality standards for surface water and groundwater.	The underlying aquifer is designated as a Sole Source Aquifer – Class GA under this regulation. Groundwater cleanup goals are based on State specific standards. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
State Regulatory	Drinking Water/	NYSDOH State Sanitary Code, Drinking Water	ARAR	Requirements designed to protect	The underlying aquifer is designated

Requirement	Groundwater	Supplies (10 NYCRR, Subpart 5-1).		present and future sources of drinking water. Establishes maximum contaminant level (MCLs) standards for potable water supplies.	as a Sole Source Aquifer. Groundwater cleanup goals are based on State specific standards. The selected remedy will comply with these regulations through source control and monitored natural attenuation.

Table A-3. Action-specific ARARs and TBCs

Authority	Medium	Requirement	Status	Synopsis of Requirement	Action to be Taken to Attain Requirement
Federal Regulatory Requirement	Air	National Emission Standards for Emissions of Radionuclides Other Than Radon from DOE Facilities (40 CFR Part 61, Subpart H).	ARAR	Establishes limits on radionuclide emissions (other than radon) to ensure that the public does not receive an effective dose equivalent of more than 10 mrem per year.	If active remediation is implemented as a contingency action, any potential air emissions resulting from water disposal or on-site recharge will comply with these requirements.
Federal Regulatory Requirement	Groundwater	National Primary Drinking Water Standards (40 CFR § 141).	ARAR	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are used as groundwater standards for sole source aquifers.	The selected remedy will comply with these regulations through source control and monitored natural attenuation.
Federal Regulatory Requirement	Groundwater	Drinking Water Regulations and Health Advisories, EPA Office of Drinking Water.	ARAR	Federal health advisories established for certain chemicals to protect drinking water.	These guidelines are used to establishing cleanup goals. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
Federal Regulatory Requirement	Groundwater	Safe Drinking Water Act, Underground Injection (40 CFR § 144-146).	ARAR	The SDWA protects sources of drinking water by controlling underground injection activities.	If active remediation is implemented as a contingency action, any on-site discharges of the extracted water will conform to these requirements.
Federal Regulatory	Groundwater	Water Pollution Control Act (33 USC 1251),	ARAR	The objective of this act is to restore and	If active remediation is implemented, these

Requirement		Federal Clean Water Act Ambient Water Quality Criteria.		maintain the chemical, physical and biological integrity of the nation's waters.	requirements would apply to alternatives involving discharges to surface water and groundwater, which may occur during construction.
Federal Regulatory Requirement	Radiation	Occupational Radiation Protection (10 CFR § 835).	ARAR	This regulation applies to all radiation workers and sets standards for training and surveillance.	Work and institutional controls are in place to protect workers from being exposed to the activated soil. If active remediation is implemented, all work activities would be conducted in accordance with this requirements.
Federal Regulatory Requirement	Radiation	Radiation Protection of the Public and the Environment (DOE Order 5400.5).	TBC	This order establishes the standards and requirements with respect to protection of members of the public and the environment against undue risk from radiation.	If active remediation is implemented, all work activities would be conducted in accordance with this requirements.
Federal Regulatory Requirement	Radiation	Radioactive Waste Management, DOE Order 435.1	TBC	Establishes requirements for radioactive waste management at DOE facilities.	If groundwater extraction is required, water handling and disposal operations will comply with these requirements.
State Regulatory Requirement	Surface Water/ Groundwater	NYS Pollution Discharge Elimination System (SPDES) (6 NYCRR Part 750).	ARAR	Establishes the requirements and provisions of discharge permits to effluent limits.	If active remediation is implemented as a contingency action (high-flow pumping), any on-site discharges of the extracted water will conform to these requirements.
State Regulatory Requirement	Surface Water/ Groundwater	NYSDEC Water Classification and Quality Standards (6 NYCRR Parts 700-703).	ARAR	Establishes standards for chemical concentrations and physical properties of surface water and groundwater.	Groundwater cleanup goals are based on State specific standards. The selected remedy will comply with these regulations through source control and monitored natural attenuation.
State	Drinking	NYSDOH State	ARAR	MCLs must not be	Applicable if active

Regulatory Requirement	Water/ Groundwater	Sanitary Code Public Water Systems (10 NYCRR, Subpart 5-1).		exceeded in the treatment process, in the water to be discharged, or in the character of the watershed or aquifer.	remediation is conducted which involves the operation of groundwater remediation systems.
State Regulatory Requirement	Waste Transportation	NYSDEC Subchapter C Radiation, Transporters of Low Level Radioactive Waste (6 NYCRR Part 381).	ARAR	Establishes requirements for low-level radioactive waste transported permit and manifest system.	If active remediation is implemented as a contingency action (low-flow pumping), any off-site transportation of the extracted water will conform to these requirements.
State Regulatory Requirement	Waste Disposal	NYSDEC Subchapter C Radiation, Transporters of Low Level Radioactive Waste Disposal Facilities (6 NYCRR Part 382).	ARAR	Specified concentration limits for disposal of low-level radioactive wastes.	If active remediation is implemented as a contingency action (low-flow pumping), any off-site disposal of the extracted water will conform to these requirements.
State Regulatory Requirement	Surface Water and Groundwater	NYSDEC Division of Technical and Operational Guidance Series (2.1.2), Underground Injection Recirculation for Groundwater Remediation.	TBC	Provides guidance on the applicability of SPDES permits and groundwater effluent standards to the use of Underground Injection Recirculation as a remedial measure.	If active remediation is implemented as a contingency action (high-flow pumping), any on-site discharges of the extracted water will conform to these requirements.

APPENDIX B

Timeline of Public and Inter-Governmental Interactions Regarding the g-2, BLIP and USTs Proposed Remedial Action Plan

September 20 - October 20, 1999	Public comment period conducted on BLIP Engineering Evaluation/Cost Analysis. No public comments were received.
February 14, 2000	g-2 tritium plume and source area are designated Area of Concern 16T by U.S. EPA.
April 25, 2000	Final BLIP Action Memorandum, selecting engineered controls and installation of liquid silica grout, issued.
December 13, 2001	Presentation on g-2 groundwater characterization activities to BNL Community Advisory Council (CAC).
March 9, 2006	Background presentation on the upcoming g-2, BLIP and g-2 PRAP made to the CAC.
June 14, 2006	Presentation on the g-2 Focused Feasibility Study Alternatives made to Brookhaven Executive Roundtable (BER).
September 14, 2006	Presentation on the g-2 Focused Feasibility Study Alternatives made to CAC.
October 11, 2006	Public notice announcing start of PRAP public comment published in *Suffolk Life*.
October 12, 2006	Start of PRAP public comment period. Press release issued. Public notice announcing start of PRAP public comment period was published in *Newsday*. Presentation on the g-2/BLIP/UST PRAP made to the CAC.
October 18, 2006	Lunchtime and evening information sessions on PRAP were held at BNL. No public comments were received.
October 25, 2006	Public meeting on PRAP was held at BNL. No public comments were received.
November 9, 2006	Community Advisory Council meeting. The CAC was able to reach a consensus to support the Proposed Plan for g-2, BLIP and the former USTs. The CAC also proposed

	amendments to the Proposed Plan for g-2 source area and tritium plume (i.e., proposed Alternative 2).
November 13, 2006	End of public comment period. Four CAC member organizations provided separate comments on the Proposed Plan.

APPENDIX C
Comments Provided to DOE during the October 12 – November 13, 2006 Public Comment Period

Directors Office

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BROOKHAVEN
NATIONAL LABORATORY

managed by Brookhaven Science Associates
for the U.S. Department of Energy

www.bnl.gov

November 13, 2006

Mr. Michael D. Holland, Manager
U.S. Dept. of Energy
Brookhaven Site Office
53 Bell Avenue
Upton, New York 11973

Dear Mr. Holland:

SUBJECT: COMMUNITY ADVISORY COUNCIL (CAC) RECOMMENDATION ON THE PROPOSED REMEDIAL ACTION PLAN FOR g-2 TRITIUM SOURCE AREA AND GROUNDWATER PLUME, BLIP SOILS, AND FORMER UNDERGROUND STORAGE TANKS

During their November 9, 2006 meeting, the Community Advisory Council (CAC) was able to reach a consensus recommendation regarding the Proposed Remedial Action Plan for the g-2 Tritium Source Area and Groundwater Plume, BLIP Soils, and Former Underground Storage Tanks.

The CAC concurs with Alternative 2, the preferred alternative, with the following recommended alternatives:

- At an identified trigger level of 1,000,000 pCi/L of tritium formal regulatory and public review of the remedy would be required as a "Fundamental Difference" under CERCLA.
- If tritium in groundwater at or above 20,000 pCi/L approaches the Site boundary active remediation would be required.
- The Record of Decision (ROD) should include a sampling strategy that incorporates public input as part of the strategy.

The CAC requests that their statement be included in the public record for the g-2 tritium cleanup.

Sincerely,

FOR

Samuel Aronson
Director

c: J. Carter, DOE/BHSO
G. Penny, DOE/BHSO
R. Rimando, DOE
M. Lynch, BNL
G. Goode, BNL
W. Dorsch, BNL
D. Paquette, BNL

IQBAL M. CHAUDHRY P.E.
U.S. Foreign Service Officer (Ret)
6 Lefferts Place, Coram, NY 11727
Tel: 631-476-0502

November 9, 2006

To: Mr. Michael Holland
Site Manager Brookhaven Site office
U.S. Department of Energy
BNL P.O. Box 5000
Upton NY 11973-5000

REVIEW OF PROPOSED REMEDIAL ACTION PLAN (PRAP)
For the;

- g-2 Tritium Source Area and Groundwater Plume,
- Brookhaven Linac Isotope Producer (BLIP) Soils, and
- Former Underground Storage Tanks (USTs)

at Brookhaven National Laboratory (BNL)

In response to request for comments on the PRAP I reviewed the document(s) and other related information made available in conferences and am glad to provide the following input.

PRAP has presented a fairly detailed and comprehensive discussion of five remedial alternatives to deal with the g-2 Tritium source area and groundwater plume. Illustrations and cost estimates corresponding to each of the five alternatives have been provided. The description of the issue includes background information, interfacing elements, model studies and analysis made and satisfaction of CIRCLA Criteria. Strengths and weaknesses of various alternatives were presented. The PRAP is prepared methodically and in an understandable fashion. I commend the efforts put into this task by the BSA and the DOE.

DISCUSSION:

I. G-2 SOURCE AREA and TRITIUM GROUNDWATER PLUME

PROBLEM
The Alternating Gradient Synchrotron (AGS) facility is used to conduct accelerated particle beam experiments. Radionuclides can be produced in some of the soil shielding used along accelerated beam lines and in soil below experimental buildings by the interaction of secondary particles (primary neutrons) that are created when the beam strikes fixed targets and beam stops. The primary radionuclides of concern in the soil are Tritium with a half life of 12.3 years and Sodium-22, with a half life of 2.6 years. The g-2 experiment began operations in April 1997. The building structure and the underlying 6 inch thick concrete pad protect the activated soil below the target building and an impermeable 4 inch thick concrete cap was constructed over the g-2 beam stop to protect

the soil shielding from rainwater infiltration. In November 1999 BNL detected tritium in the groundwater near the g-2 experiment at concentrations above the 20,000 pico curies per liter (pCi/L) drinking water standard also known as the maximum contaminant level or MCL (NY State Sanitary Code Title 10 Subpart 5-1). The investigation determined that the highest tritium level detected in the groundwater was approximately 1.8 million pCi/L. Sodium-22 as also detected but at concentrations well below the 400 pCi/L MCL. The g-2 experiment concluded its operations in April 2001 and the facility is being maintained for possible future use. Monitoring data suggest that "slugs" of high concentration of tritium have been mobilized into the ground water during periods of high ground water table elevations, which can occur following heavy seasonal rainfall. The highest concentration was observed in July 2002 when one ground water sample had a tritium concentration of 3.4 million pCi/L. Of course with each water table rise, coupled with natural radioactive decay, it is expected that the amount of residual tritium in the unsaturated zone soil will decrease. Since June 2004 tritium concentrations in wells directly downgradient of the source area have been less than 100,000 pCi/L. based on a BNL computer model tritium concentrations in the g-2 plume are projected to decrease to less than 20,000 pCi/L between 2010 and 2015 by natural decay and dispersion in the aquifer assuming that there are no additional significant releases from the VQ12 source area. At that time the plume would still be over one mile north of the BNL southern property boundary line and will not impact any public or private drinking water supply wells.

Alternative 1.

This alternative simply proposes Continued Maintenance of Source Controls and protection of potable water supply. It relies on natural decay of radioactivity in the soil shielding and natural radioactive decay and dispersion of the Tritium plume down to 20,000 pCi/L MCL in the upper glacial aquifer. Its estimated cost over 30 years is $202,177. This alternative is least costly but it does not provide for continued groundwater monitoring of the source area thus disallowing verification of the effectiveness of storm water controls and the prediction of reductions of tritium concentrations in groundwater. I would grade the acceptance of this alternative at 50%.

Alternative 2.

This alternative proposes Continued Maintenance of Source Controls as well as Groundwater Monitoring immediately downgradient of the source area. Its estimated cost over 30 years is $963,751. It allows verification of effectiveness of stormwater controls and provides for monitoring the downgradient segments of the plume to verify the predicted decrease in tritium levels. This alternative has also developed three triggers which require the evaluation of unexpected future releases from the source area or if the tritium plume does not attenuate as predicted. This alternative has the least weaknesses. I would grade the acceptance of this alternative at 80%.

Alternative 3.

This alternative proposes High-Flow Pumping with On-Site Recharge/Recirculation, and Continued Source Area Controls and Groundwater Monitioring. It requires installation of groundwater extraction wells pumping at 25-50 gpm to prevent downgradient migration of tritium plume. The extracted groundwater would be transmitted via a subsurface conduit to an onsite recharge basin. The recovery wells would be designed so that the effluent tritium concentration would not exceed the 20,000pCi/L MCL. Of course this remedy gets complicated due the proximity of the g-2 tritium plume and the Waste Concentration Sr-90 plume because the pumps although primarily pumping the g-2 tritium plume, might also pull in certain quantities of Sr-90 that could require treatment prior to recharge. Estimated cost of this alternative over 30 years is $2,133,689. I would grade the acceptance of this alternative at 60%.

Alternative 4.
This alternative proposes Low-Flow Pumping with Off-Site Disposal and Continued Source Area Controls and Groundwater Monitoring. The low flow pumping would be at the rate of 5 gpm to extract the existing three slugs of g-2 plume where tritium concentrations are currently greater than 100,000 pCi/L. Extraction would continue until the tritium levels are reduced to approximately the 20,000 pCi/L MCL. This remedy is complicated by the large volumes of highly radioactive water (360,000 gallons) requiring off-site disposal. Estimated cost of this alternative over 30 years is $6,247,899. I would grade the acceptance of this alternative at 30%.

Alternative 5.
This alternative proposes Source removal, Plus Continued Source Area Controls and Groundwater Monitoring. This scheme requires physical removal of the activated soils and underlying leachate-contaminated soil at the VQ12 source area. Activated soil would be characterized and containerized for off-site disposal at an approved facility. Because of their close proximity, activated soil below the nearby g-2 target building and beam stop and below a nearby section of the RHIC tunnel would also need to be removed. Leachate-contaminated soil in the unsaturated zone would require excavation to a depth of approximately 20 feet below land surface. A section of the nearby RHIC beam line would have to be reconstructed after the excavation. All this would virtually halt the RHIC operations for a two years period. This remedy is too complicated and clearly not feasible. Estimated cost of this alternative over 30 years is $11,896,681 plus a projected $80,000,000 in lost experiment and worker productivity for the RHIC experiment over a two year period. So it is prohibitively expensive as well. I would grade the acceptance of this alternative at zero percent.

CONCLUSIONS.

a. My Concerns

1. Although currently inactive, since the g-2 Experiment Facility is reserved for future use, I am somewhat concerned about the structural integrity of the four inch thick concrete cap and significantly concerned about the cut that was made through the six inch thick concrete base pad along the southern side of the steel sheet pile wall. It was this cut in the base pad that was probably not properly patched permitting the rainwater to leach tritium and sodium-22 from activated soil zone down into the unsaturated aquifer.

2. Results derived from the models are not definitive. Therefore the projected dilutions of tritium concentrations down to the 20,000 pCi/L MCL might easily take twice as long to occur.

3. In order to arrive at the desired 20,000pCi/L MCL the assumption made that no more leak should occur from the VQ12area may not quiet hold good for a sustained period.

4. The projection for the tritium concentration in the g-2 plume to decrease to less than 20,000 pCi/L MCL between 2010 and 2015 immediately suggests the large magnitude of variation in time element i.e. it could take from 4 years (2006-2010) to 9 years (2006-2015) a 225 % spread.

5. The three trigger mechanisms provided in alternative 2 requiring evaluation of unexpected future releases and if needed, invoking the BNL's Groundwater contingency plan for implementation of corrective actions must be flagged and doubly committed.

b. Preferred Alternative.

Regardless of the concerns expressed in (a) above, in view of the foregoing observations derived from the PRAP, additional information collected during discussions at conferences and the requirements of compliance with CIRCLA criteria the Alternatives # 4 and 5 are to be ruled out of consideration. Among the remaining Alternatives # 1, 2 and 3, the number 2 clearly stands out. Therefore consoled by the trigger mechanisms included therein I recommend acceptance of Alternative # 2.

II. BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP) (AOC16K)

BLIP has been in operation since 1972 and is an active accelerator facility. It is a national resource for producing radioisotopes that are crucial in nuclear medicine for both research and clinical use. BLIP also supports BNL research on diagonostic and therapeutic radiopharmaceuticals. Beam line operations have resulted in the activation of soils that surrounds the BLIP target vessel. In 1998 tritium concentration of 14,000 pCi/L was found in a sample from a groundwater monitoring well 300 feet south of BLIP. The maximum tritium concentration of 53,000 pCi/L was detected in a temporary well installed 40 feet downgradient (south) of the BLIP target. This was ascribed to rainfall infiltration from improperly connected downspouts. Corrective repair actions were then taken to deflect and seal the rainwater infiltration.

As discussed in the PRAP continued inspections, certifications and maintenance of the cap; groundwater monitoring; institutional controls; and the previously completed work (i.e. installation of the cap, improved roof drains, and containment with colloidal silica grout) are acceptable as the final action. **I agree with the recommendations made in the PRAP.**

III. EIGHT FORMER UNDERGROUND STORAGE TANKS (AOC12)

From a total of 16 radioactive USTs designated as area of concern (AOC) 12 in the IAG eight were previously removed and closed out in the RODs. The remaining eight USTs were registered with the SCHDS and used to hold low-level radioactive nuclear waste. Later these tanks were also removed between 1988 and 1996 under the requirements of Suffolk County sanitary Code Article 12 which regulates the storage and handling of toxic and hazardous materials.

As proposed in the PRAP the closure work that was already completed on these eight tanks under the requirements of Suffolk county Code Article 12 is acceptable as the final action. **I find this proposition acceptable.**

Prepared By

Iqbal M. Chaudhry PE 11/9/2006
BNL/CAC- Science and Technology

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Protecting the environment and working for a healthy community.

Comments for the Proposed Remedial Action Plan for the g-2 Tritium Source Area and Groundwater Plume, Brookhaven Linac Isotope Producer Soils, and Former Underground Storage Tanks
Monday, November 13, 2006

Dear Mr. Michael Holland, Site Manager,

CCE would like to thank the U.S. Department of Energy and Brookhaven National Lab for the opportunity to comment on the alternatives for the remedial action plan for the contamination on the G-2 tritium source area and groundwater plume. However, CCE is unable to fully support any of the five alternatives described, especially the recommended alternative two.

Active remediation is needed for this type of cleanup due to its high level of contamination. A simple "wait and see" approach for the groundwater plume combined with no planned remediation of the activated soil, is a remedy froth with potential future problems. CCE agrees that a strenuous monitoring and maintenance plan of the plume, slugs, and the source is needed, as described in Alternative 2; however, this approach isn't comprehensive or detailed enough. The trigger levels described in Alternative 2 and the follow up actions are too obscure, don't provide for any substantive actions or change of course and don't allow for public notice of a continuing problem.

A preventative, active remediation plan is a much-needed option that CCE feels isn't adequately represented within any of the five alternatives. CCE is very disappointed that an alternative was not offered which would better address the very highest levels of tritium in groundwater. The current Alternative Two doesn't offer an active response if high levels of tritium persist nor if contamination continues to spread throughout the aquifer and behave in a manor different than the modeling has predicted. Simply stating you will have a "groundwater contingency plan" as stated at the CAC meeting on November 9, 2006 is not enough. BNL should be willing and able to make a commitment to the regulators and the public as to the details of the plan for the plume should any of the scenarios identified above occur.

In addition, before an alternative is agreed on, the detailed sampling plan needs to be finalized and released to the public and CAC.

At a bare minimum, CCE can reluctantly support Alternative Two if it includes the BNL CAC's recommendations of:

1. At an identified trigger of 1,000,000 pCi/L of tritium, a formal regulatory and public review of the remedy as a "Fundamental Difference" under CERCLA will occur.
2. If tritium in groundwater at or above 20,000 pCi/L approaches the Site boundary active remediation will occur.
3. The Record of Decision (ROD) should include a sampling strategy that incorporates public input as part of the strategy.

In addition, Alternative Two should:

4. Clarify that inspection of storm water control will be performed twice per year, as stated at the CAC meeting. This inspection will allow for the effectiveness of the storm water controls to be evaluated.
5. Eliminate the trigger of 2,000,000 pCi/L since actions and remedies should occur at the lower level of 1,000,000 pCi/L as stated above.

Thank you for considering our position. I look forward to reviewing the final plan.

Adrienne Esposito
CCE Executive Director

Cc: Senator Hillary Clinton
Senator Charles Schumer
Congressman Tim Bishop
Congressman Steve Israel
Peter Scully, Regional Director, DEC
NY State Senator LaValle
Suffolk County Executive Steve Levy
Andrew Rapiejko, Suffolk County Department of Health

From: Elina Alayeva [mailto:alayeva@pinebarrens.org]
Sent: Monday, November 13, 2006 4:02 PM
To: tellDOE@BNL.gov
Subject: g-2 Remedial Action Plan Comments

The role of the Community Advisory Council to the Brookhaven National Lab is to scrutinize the alternatives presented to us, particularly, the preferred alternative. The CAC has been presented with five alternatives for remedial action. The first two are inactive options, utilizing only passive remediation. The manner in which the more proactive alternatives 3 - 5 have been presented leads one to assume that they would be highly impossible to implement. Furthermore, it seems that the weaknesses of alternatives 3 - 5 actually act to strengthen alternatives 1 and 2.
The manner in which the alternatives were presented is therefore, problematic. Not only should all alternatives include active remediation as their central action, but they should all be presented in a way that gives equal weight and consideration to each.

Alternative 2, the preferred alternative, includes monitoring and active control of the plume only as a contingency. This is a minimal approach to remediation and wholly insufficient. The preferred alternative also did not provide a guarantee that active remediation would occur should tests indicate that natural decay was not working. Sufficient numbers of CAC members felt that they trusted the natural decay process enough not to require active remediation. However, they did choose to set specific benchmarks to test how the decay is progressing and provide the opportunity to reopen the CERCLA process should the progress of the natural decay not meet anticipated rate. Specifically, the CAC has decided that:

- At an identified trigger of 1,000,000 pCi/L of tritium formal regulatory and public review of the remedy as a “Fundamental Difference” under CERCLA will occur.
- If tritium in groundwater at or above 20,000 pCi/L approaches the Site boundary active remediation will occur.
- The Record of Decision (ROD) should include a sampling strategy that incorporates public input as part of the strategy.

While the CAC has made a decision to amend alternative 2 to include these guarantees, the Long Island Pine Barrens Society feels that active remediation should be a part of every plan and not just a contingency option for when passive remediation does not work. The Society advocates taking a much more proactive approach from the very beginning of the remediation process. Clean up of hot spots should be included, as well as removal of the contamination sources.

Elina Alayeva
Alternate to the CAC
Project Coordinator
Long Island Pine Barrens Society
547 East Main Street
Riverhead, NY 11901

Comments: on the Proposed Remedial Action Plan for the G-2 Tritium Source Area and Groundwater Plume, Brookhaven Linac Isotope Producer soils, and Former Underground Storage Tanks at Brookhaven National Laboratory.

Mr. Michael Holland
Site Manager
Brookhaven Site Office
U.S. Department of Energy
Brookhaven National Laboratory
P.O. Box 5000
Upton, NY 11973-5000

Dear Mike Holland,

Thank you for taking public comments into account when making clean up decisions, at Brookhaven Lab. I am sending these comments on behalf of the Wading River Civic Assn., and myself.

We agree with your preferred Alternative 2, Source Area Control and Groundwater Monitoring plan, and believe it will achieve the remedial action objectives described in the CERCLA (Comprehensive Environmental Response Compensation, and Liability Act) criteria, and provide the best balance when comparing this alternative against the other five. Which is to control the source and access of the plume, to protect the potable water supply, and that tritium levels in groundwater meet the maximum contamination levels by natural attenuation. This is achieved by continued routine inspections, and maintenance of the concrete cap, and other stormwater controls.

We want to stress that ground monitoring remain in place to verify effectiveness, and trigger concentrations are in place for continuous evaluations, and to be prepared to respond to changes as needed.

Sincerely,

Helga S. Guthy

Helga S. Guthy
(CAC representative for the Wading River Civic Assn.)
11 Bayberry Rd, Wading River, NY 11792
631-929-8287