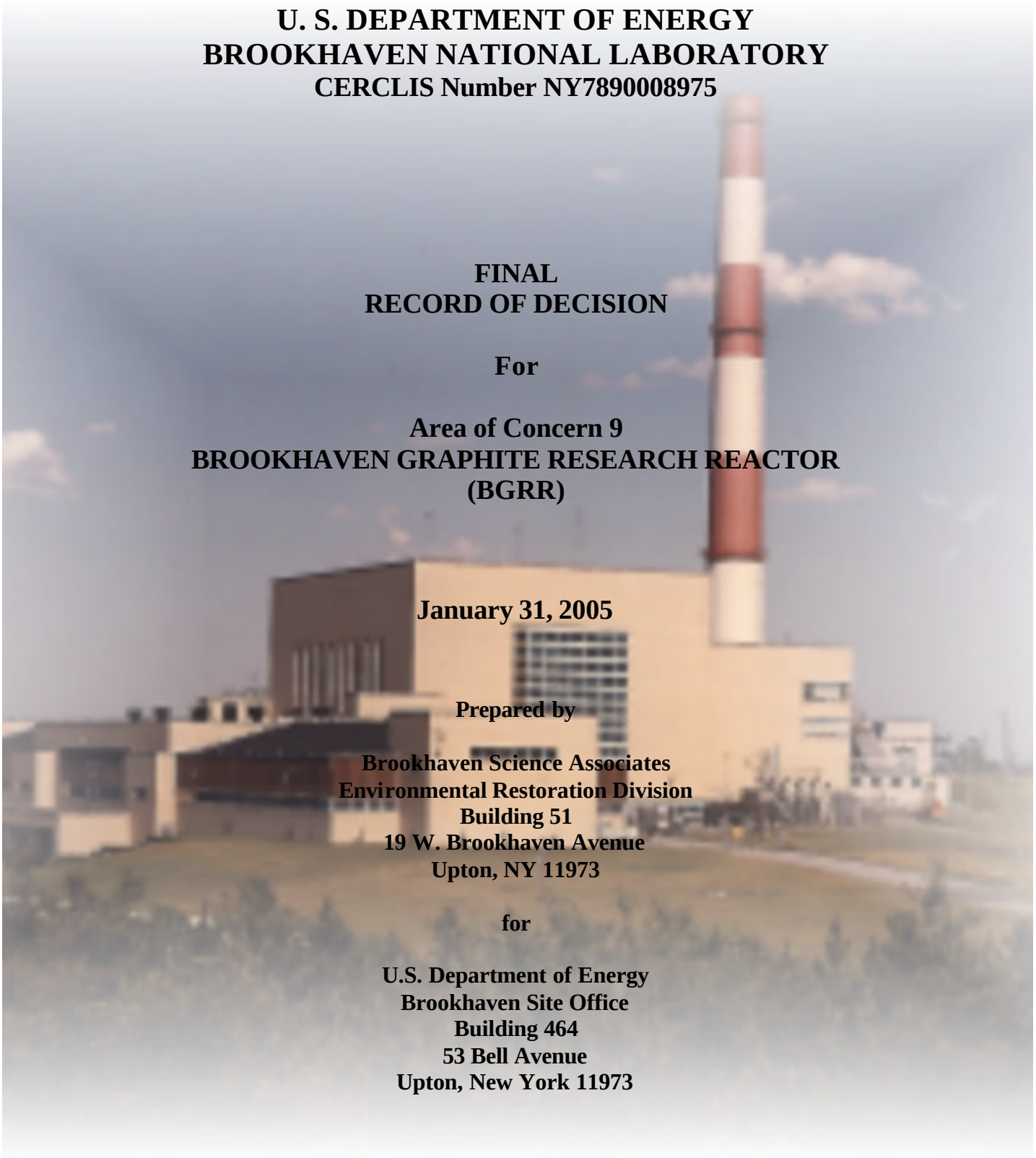

U. S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
CERCLIS Number NY7890008975

FINAL
RECORD OF DECISION

For

Area of Concern 9
BROOKHAVEN GRAPHITE RESEARCH REACTOR
(BGRR)

January 31, 2005

Prepared by

Brookhaven Science Associates
Environmental Restoration Division
Building 51
19 W. Brookhaven Avenue
Upton, NY 11973

for

U.S. Department of Energy
Brookhaven Site Office
Building 464
53 Bell Avenue
Upton, New York 11973

I. DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

BROOKHAVEN GRAPHITE RESEARCH REACTOR
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK
CERCLIS Number NY890008975

STATEMENT OF BASIS AND PURPOSE

This Record of Decision documents the selected remedial action for the Brookhaven Graphite Research Reactor (BGRR) at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL) facility in Upton, New York.

The remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended (hereinafter jointly referred to as CERCLA), and is 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 action.

ASSESSMENT OF THE SITE

Releases of hazardous substances from the BGRR complex present a threat to public health, welfare, or the environment if they are not addressed by implementing the response action selected in this Record of Decision.

DESCRIPTION OF THE SELECTED REMEDY

The BGRR is Area of Concern 9 (AOC 9) and includes the following sub-AOCs: 9A Canal, 9B Underground Ductwork, 9C Spill Sites, and 9D Pile Fan Sump. Several alternatives were evaluated for cleanup of the BGRR. Based on these evaluations, DOE is proposing a cleanup action (called the remedy) summarized below. The public was invited to comment on the proposed remedy as well as on the other alternatives considered.

Based on an evaluation of the alternatives, discussions with the regulatory agencies, and community interaction, the alternative for cleanup of the BGRR that represents a balance of the National Contingency Plan's remedy selection criteria is the removal of the graphite pile, biological shield, canal structure and reasonably accessible contaminated soils. This alternative is known as Alternative C in the Proposed Remedial Action Plan. This remedy includes all interim measures either completed or ongoing in addition to the remedy described in Alternative C.

Several response actions previously completed or currently underway were interim measures to reduce or eliminate potential threats to human health or the environment.

Completed activities include the removal and disposition of the:

- Contaminated water that infiltrated and accumulated within the below-ground ducts;
- Experimental equipment and systems from the reactor building;
- Reactor exhaust fans, motors, valves and instruments;
- Pile fan sump, pipes and associated contaminated soil;
- Above-ground ducts, pipes and associated contaminated soil;
- Canal house and water treatment house, along with associated equipment, pipes, asphalt, concrete and accessible contaminated soils; and
- Reactor exhaust cooling coils and filters.

Activities currently underway include the removal of the:

- Reactor below-ground duct primary liner; and
- Portion of the fuel canal outside the structural foundation footprint of the reactor building and accessible subsurface contaminated soil in the vicinity of the fuel canal, below-ground duct expansion joint #4 and secondary cooling air bustle.

Remaining activities included in the selected remedy are as follows:

- Isolation of the below-ground duct and demolition of the instrument house;
- Installation of water infiltration control and monitoring system for remaining structures and subsurface contaminated soils;
- Removal of the graphite pile and biological shield;
- Completion of final status surveys to document that cleanup objectives are met and to document final conditions;
- Development and implementation of land use and institutional controls that includes routine inspection and surveillance of the BGRR complex, maintenance and upkeep of Building 701 and surrounding water infiltration system and reporting requirements to ensure that planned uses are protective of public health; and
- Submittal of an annual certification to the NYSDEC that institutional and engineering controls are in place, are unchanged from the previous certification and nothing has occurred that would impair the ability of the control to protect public health and the environment.

Because of the complexity of the Building 701 foundation and the potential for disrupting the structural integrity of the building, inaccessible contaminated soils located below the Building 701 foundation will not be removed. In the event future activities cause the contaminated deep soils to become readily accessible, the removal of these soils will be evaluated. This evaluation will be based on the actual distribution, depth and concentration of the residual radioactive material encountered and the risk to human health and the environment.

Historical leaks and spills at the BGRR complex have resulted in contaminated groundwater. Groundwater treatment and monitoring for strontium-90 (Sr-90) and other contaminants are being performed as part of an approved Record of Decision for BNL Operable Unit III (OU III) (BSA, 2000a) and the proposed Explanation of Significant Differences (ESD) (BSA, 2004c). Additional monitoring wells will be installed south of the BGRR as part of this remedial action. Once installed, the wells will be monitored and maintained under the OU III groundwater-monitoring program. Although the installation of these wells is not formally part of the BGRR remedial action, sampling and analyses of the data obtained through the OU III groundwater monitoring is part of this remedy and will be used to help evaluate the effectiveness of the BGRR remediation in controlling the migration of residual contaminants to groundwater. The DOE does not envision any sale or transfer of property within the BGRR complex.

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 remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy uses permanent solutions to the maximum extent practicable for the BGRR complex. Treatment of contaminated soil was not found to be practicable; therefore, this remedy does not satisfy the statutory preference for treatment as a principal element. However, techniques that minimize waste volumes or further stabilize wastes to meet disposal facility waste acceptance criteria will be factored into the detailed design work plan.

Because this remedy 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.

AUTHORIZING SIGNATURES

_____ _____

Rodrigo V. Rimando, Jr. Date
Brookhaven Project Director
Office of Environmental Management
U.S. Department of Energy

_____ _____

William McCabe Date
Acting Director, Emergency & Remedial Response Division
U.S. Environmental Protection Agency – Region 2

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LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
BER	Brookhaven Executive Roundtable
BGRR	Brookhaven Graphite Research Reactor
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
C-14	carbon-14
Ca-41	calcium-41
CAC	Community Advisory Council
CERCLA	Comprehensive Environmental Response Compensation & Liability Act
Ci	Curie
CFR	Code of Federal Regulations
Co-60	cobalt-60
COPC	Contaminants of Potential Concern
Cs-137	cesium-137
DOE	United States Department of Energy
EE/CA	Engineering Evaluation / Cost Analysis
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
Eu-152	europium-152
Eu-154	europium-154
Eu-155	europium-155
Fe-55	iron-55
ft^3	cubic feet
H-3	tritium
IAG	Interagency Agreement
LLRW	low-level radioactive waste
LUCMP	Land Use Controls Management Plan
MCL	maximum contaminant level
MDA	minimum detectable activity
mrem/yr	millirem per year
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Ni-63	nickel-63
NYCRR	New York State Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PCB	polychlorinated biphenyls
pCi/g	picoCuries per gram
Pu-239	plutonium-239
RAO	Remedial Action Objective
RCM	Radiological Control Manual
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision

SHPO	State Historic Preservation Officer
Sr-90	strontium-90
U-238	uranium-238
U.S.C.	United States Code

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.

Brookhaven National Laboratory is located about 60 miles east of New York City, in Upton, Suffolk County, New York, near the geographic center of Long Island (Figure 1-1). Distances to neighboring communities from BNL are as follows: Patchogue ten miles west-southwest, Bellport eight miles southwest, Center Moriches seven miles southeast, Riverhead 13 miles east, Wading River seven miles north-northeast, and Port Jefferson eleven miles northwest.

The BNL property, consisting of 5,321 acres, is an irregular polygon, and each side is approximately 2.5 miles long. Figure 1-2 is a current land-use map of the BNL Site. The developed portion of the BNL Site includes the principal facilities, which are located near the center of the BNL Site on relatively high ground. The developed portion is approximately 900 acres, 500 acres of which were originally developed for Army use. The remaining 400 acres are mostly occupied by various large research machine 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 rising in marshy areas in the northern section of the tract.

The sole-source aquifer beneath BNL comprises three water-bearing units: the Moraine and outwash deposits, the Magothy Formation, and the Lloyd Sand Member of the Raritan Formation. These units are hydraulically connected and make up a single zone of saturation with varying physical properties extending from a depth of five to 1,500 feet below the land surface. These three water-bearing units are designated as a "sole source aquifer" by the U.S. Environmental Protection Agency (EPA) and serve as the primary source of drinking water for Nassau and Suffolk Counties.

The Brookhaven Graphite Research Reactor (BGRR) is centrally located within the BNL Site. Figure 1-3 (Location of the BGRR on BNL Site) shows its extent. This Record of Decision addresses the remediation of the BGRR complex shown in Figure 1-4 (BGRR Complex). Certain structures, components and some soils associated with the complex are radiologically contaminated as a result of normal reactor operation, water intrusion, and leaks throughout the history of the facility.

Figure 1-1. Regional Site Location Map.

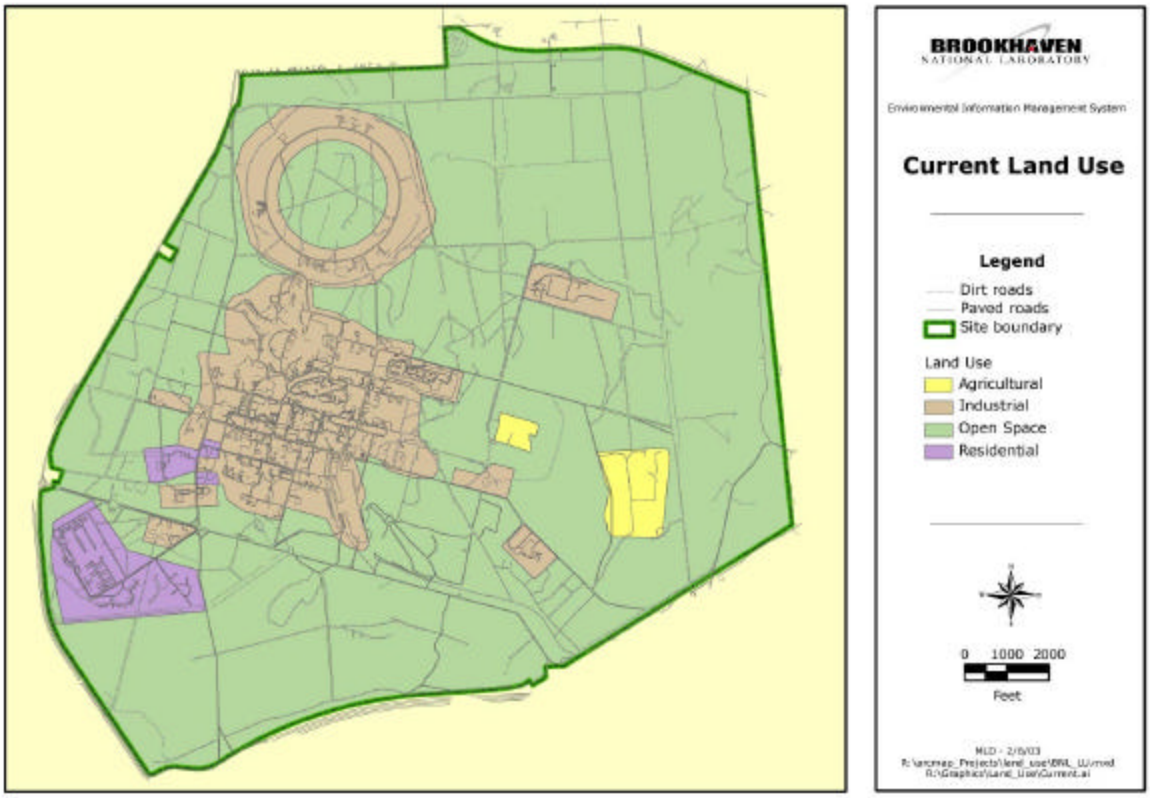

Figure 1-2. Current Land Use Map.

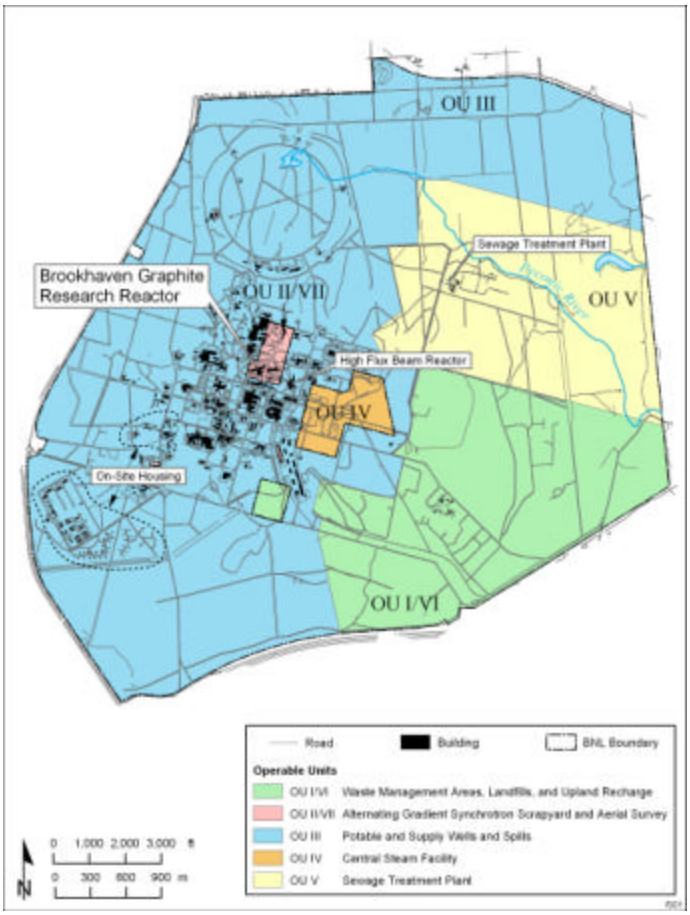

Figure 1-3. Location of the BGRR on BNL Site.

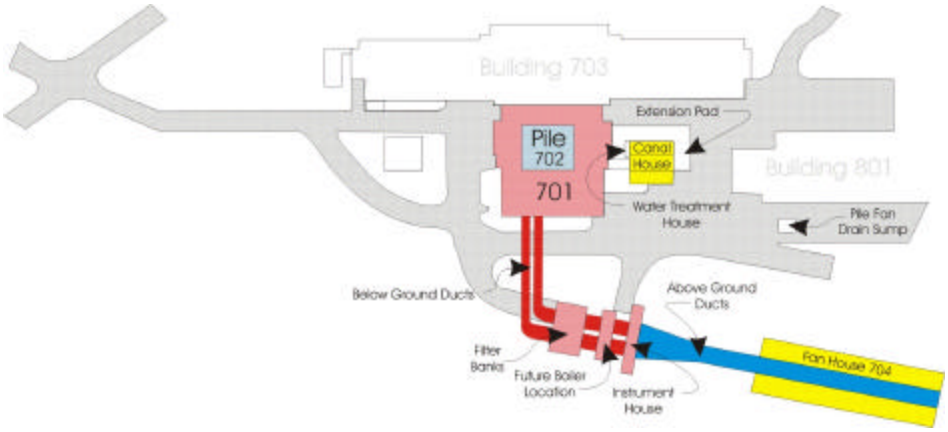

Figure 1-4. BGRR Complex. The colored regions show the areas discussed in this document.

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, the EPA, NYSDEC, and DOE entered into a Federal Facilities Agreement (CERCLA-FFA, 1992) (herein referred to as the Interagency Agreement; [IAG]) that became effective in May 1992 to coordinate the cleanup.

The BGRR, which was the first reactor in the U.S. built solely to perform experiments, operated from 1950 to 1968. Deactivation of the facility was initiated in September 1969. In March 1972, the last fuel element was removed from the reactor and shipment of the fuel to the DOE Savannah River Site was completed shortly thereafter. Portions of the BGRR facility were used as the BNL Science Museum from 1977 through 1997.

BGRR is subject to the provisions of Section X – Areas of Concern of the IAG and is identified as Area of Concern (AOC) 9. The remediation of the BGRR complex is divided into four sub-AOCs (Figure 2-1). These include AOC 9A, the Canal; AOC 9B, Underground Ductwork; AOC 9C, Spill Sites; and, AOC 9D, the Pile Fan Sump. Additional areas of remedial action outside the scope of the AOC sub-divisions include removal of the above-ground ductwork, graphite pile and biological shield. Interim measures have been authorized through issuance of Action Memorandums or *National Environmental Policy Act* (NEPA) Categorical Exclusions. The remaining cleanup activities for the BGRR are addressed within this Record of Decision (ROD).

A Feasibility Study for the BGRR complex (BSA, 2004a) was prepared to evaluate the alternatives for remediation of the contaminated structures and subsurface soils.

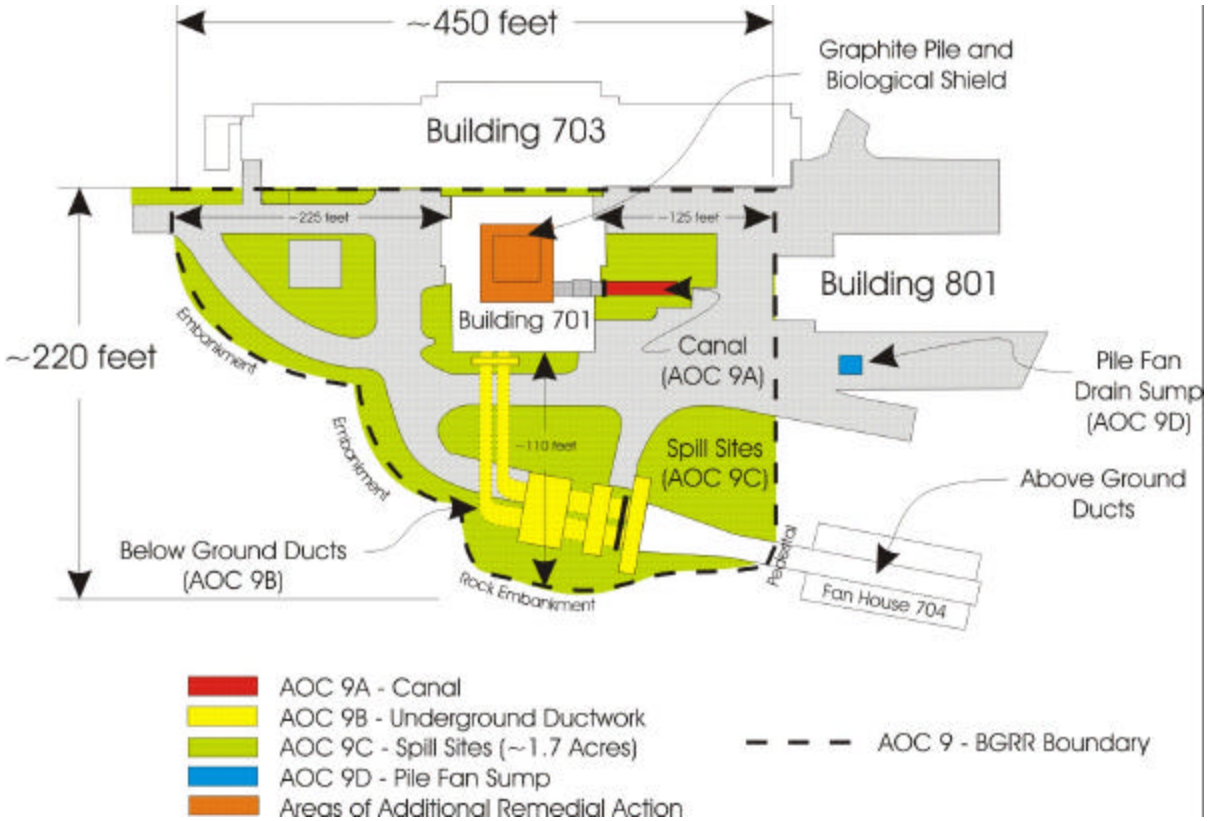

Figure 2-1. Sub-AOCs of BGRR AOC 9.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

3.1 BNL Community Relations

The BNL Community Relations Plan was written in September 1991 and is supplemented by activity specific plans. In the case of the BGRR, a BGRR Community Relations Plan (BSA 2000c) was issued in November 2000 and is also regularly updated. In accordance with these two plans and *Comprehensive Environmental Response, Compensation, and Liability Act* (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 are used to provide information and to seek public participation, including compilation of a stakeholders mailing list, holding community meetings, availability sessions, roundtables, working groups, site tours, workshops, and preparing 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.

Mastics-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 Involveme nt in the BGRR ROD

Community involvement and participation have been solicited for all significant documents and decisions associated with this Record of Decision. The feasibility study and the proposed plan were made available for public review.

The community involvement process for the BGRR is and has been an integral part of making cleanup decisions. Project staff made numerous presentations to the Community Advisory Council (CAC), the Brookhaven Executive Round Table (BER), and various local civic associations. Additionally, documents and information about the BGRR are regularly posted to the web at http://www.bnl.gov/bgrr.

Shortly after the 1997 decision to begin decommissioning the BGRR, possible decommissioning alternatives were developed and considered. Three roundtable meetings to elicit public values and concerns were held in July and August of 1999. The preliminary conclusions from those roundtables were sent to the roundtable participants, and the report was finalized in October 1999. Meeting attendees, a total of 56 people (excluding project staff), included 11 CAC members or alternates and two BER members.

Information obtained from the roundtable meetings was used to develop initial cleanup alternatives. The

draft *Brookhaven Graphite Research Reactor Decommissioning Project Removal Action Alternatives Study* (DOE 2000) was released for public review in January 2000. Two outreach events, a workshop and an open house were held in February 2000 to discuss the draft study with the public. The report was finalized in April 2000.

Concurrent with the development of the Removal Action Alternatives Study, the *BGRR Pile Fan Sump Removal Action Memorandum* (DOE 1999b) was issued in September 1999 for a time-critical removal action. Two months later, in November 1999, the *BGRR Above Grade Duct Removal Action Memorandum* (DOE 1999c) was issued for a time-critical removal action.

Because final disposition of the BGRR had yet to be decided and recognizing that such decision would be made over an extended period of time, DOE looked for means to increase interaction with the public. While regular updates would be provided to CAC and BER, it was felt that there needed to be more opportunities for the general public to follow the project and provide input. Two methods were chosen: expanding the BGRR web site, and forming a working group. The BGRR web site was expanded so that interested people could find current information. Weekly status reports were also posted.

Additionally, the DOE invited interested parties to participate in the BGRR Working Group. Members included some local residents, representatives of several Suffolk County agencies, and representatives of BNL's Citizens Advisory Council. The Working Group had its initial meeting in June, 2000, and met until April, 2003. The Working Group closely followed the removal actions and provided input on when information should be presented to the CAC.

The Working Group met and provided input to the *Canal and Water Treatment House Removal Action Memorandum* (DOE 2001a), which was issued in January 2001. In addition to Working Group meetings and briefings to the CAC and BER, two information sessions were held for the *Lower Canal and Water Treatment House Engineering Evaluation/Cost Analysis (EE/CA)* (BSA 2001b). The documents were placed in the Administrative Record and made available on the BNL web site. Fact sheets were also mailed to more than 2,300 stakeholders.

The public comment period for the EE/CA was scheduled from August 22 through September 30, 2001. It was announced in the newspapers *Newsday* and *Suffolk Life* with advertisements and legal notices. Originally the information sessions were scheduled for August 28 and September 12, 2001; the second meeting was moved to September 18, 2001. DOE received a request for an extension of the public comment period, and extended it for 30 additional days until October 19, 2001.

In addition to the removal actions for the canal and above-ground ducts, two more action memorandums were released to the public: the *Coolers and Filters Removal Action Memorandum* (DOE 2001b) in December 2001 and the *Below-ground Duct Primary Liner Removal Action Memorandum* (DOE 2003b) in September 2003. As with previous documents, Notices of Availability were published, and presentations were given to CAC and the BER.

Lastly, the *Brookhaven Graphite Research Reactor Proposed Remedial Action Plan (BGRR-061)* (BSA 2004b), was released for public review and comment on August 2, 2004. 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 August 17 and 19, and the public meeting was held on August 24, 2004. The public comment period closed on September 3, 2004.

The Responsiveness Summary section of this document 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 BGRR RECORD OF DECISION

This Record of Decision selects the remedial action for the BGRR complex, designated AOC 9, which is subdivided into four sub AOCs (see Figure 2-1). Several interim measures within sub-AOCs have been completed through Action Memorandums or NEPA Categorical Exclusions. Additionally, there are removal actions authorized through Action Memorandums that are currently underway.

These removal actions and interim measures were considered in determining the proposed remedy and are not inconsistent with this selected remedy. These removal actions and interim measures are being adopted as final actions in this Record of Decision. Completion of these removal actions and interim measures are documented through submittal of their respective completion/closure reports. A listing of the BGRR sub-AOCs and their related action memorandums is provided in Table 4-1.

Table 4-1. BGRR Sub-AOCs and Corresponding Action Memorandums.

Area of Concern	Action Memorandum
AOC 9A - Canal	*Canal and Water Treatment House Removal Action*[1] *Canal and Deep Pockets of Soil Contamination Removal Action*[1]
AOC 9B - Underground Ducts	*Reactor Coolers and Filters Removal Action*[2] *Reactor Below-Ground Duct Primary Liner Removal Action*[2]
AOC 9C – Spill Sites and Soils	*Canal and Deep Pockets of Soil Contamination Removal Action*[1]
AOC 9D – Pile Fan Sump	*Pile Fan Sump Removal Action* (Rev 1)[2]

Note 1 - Non-Time Critical Removal Action
Note 2 – Time Critical Removal Action

In summary, this Record of Decision addresses the remedial action necessary to complete the remedy for the BGRR complex (AOC 9) that is more fully described below and also in Section 10.0 - Selected Remedy.

4.1 Interim measures that have been completed.

Removal of the primary air cooling fans, motors, valves and instruments

This activity was performed under the Atomic Energy Act through a NEPA Environmental Evaluation Notification Form, *NEPA Categorical Exclusion, CH NEPA Tracking No. BNL-367*. The purpose of the activity was to remove and dispose of contaminated equipment in the fan rooms and decontaminate or fix surface contamination.

Completion of this activity was documented through submittal of an activity closure report - *Primary Air Cooling Fans and Materials Removal*, dated April 28, 2000 (BSA 2000b).

Removal of the pile fan sump, pipes and contaminated soil

This time-critical removal action was authorized by approval of the CERCLA action memorandum, *BGRR Pile Fan Sump Removal Action* (Rev 1). The removal action was performed to remove the pile fan drain sump, associated piping, and contaminated soils to reduce the radiological "footprint" of the BGRR complex.

Completion of this removal action satisfied the cleanup criteria for AOC 9D – Pile Fan Sump and was documented through submittal of the *Pile Fan Sump, Piping, and Soils Removal Completion Report*, dated January 24, 2001 (BSA 2001a).

Removal of the above-ground ducts, pipes and contaminated soil

This time-critical removal action was authorized by approval of the *BGRR Above-Grade Ducting Removal Action Memorandum.* The activities within this action memorandum included removal of the above-ground ducts, removal of components from the Instrument House, and transportation and disposal of the resulting wastes. This removal action was undertaken to prevent low-level radioisotopes being released to surface soil and subsequently migrating into surrounding soils and groundwater.

Completion of this removal action was documented through submittal of the *Removal of the Above-Ground Ducts and Preparation of the Instrument House (708) for Removal Completion Report*, dated April 26, 2002 (BSA 2002c).

Removal of the canal house and water treatment house, along with associated equipment, pipes, asphalt, concrete and accessible contaminated soils

This non-time-critical removal action was authorized by approval of the *Canal and Water Treatment House Removal Action Memorandum.* This removal action was undertaken to reduce the amount of contamination in the concrete structures of the canal and remove contaminated surface soils to reduce the radiological "footprint" of the BGRR complex.

Completion of this removal action partially satisfied the cleanup criteria for AOC 9A – Canal and was documented through submittal of the *Canal and Water Treatment Houses, Equipment, and Associated Soils Completion Report*, dated April 15, 2002 (BSA 2002b).

4.2 Interim Measures currently underway authorized through Action Memorandums

Removal of the reactor exhaust cooling coils and filters

This time-critical removal action was authorized by approval of the *BGRR Reactor Coolers and Filters Removal Action Memorandum.* This removal action was undertaken to remove the BGRR exhaust air coolers and filters from the below-ground ducts and dispose of them in a licensed facility. This removal action was undertaken to prevent the future migration of radiological contamination into surrounding soils and groundwater.

Completion of this removal action partially satisfies the cleanup criteria for AOC 9B – Underground Ducts and will be documented through submittal of a completion report specific to the remediation objectives of the Action Memorandum.

Removal of the below-ground duct primary liner

This time-critical removal action was authorized by approval of the *BGRR Reactor Below-Ground Duct Primary Liner Removal Action Memorandum*, (DOE 2003). This removal action included removal of the below-ground duct exhaust filter support structures, the entire inner binding plates and aluminum thermal shield and the portions of the outer binding plate exposed to the contaminated water collected within the ducts. The action was undertaken to prevent the future migration of radiological contamination into surrounding soils and groundwater.

Completion of this removal action in conjunction with the removal action related to the *BGRR Reactor Coolers and Filters Removal Action Memorandum*, will satisfy the cleanup criteria for AOC 9B –

Underground Ducts and will be documented through submittal of completion reports addressing the remediation objectives of the two Action Memorandums.

Removal of the fuel canal structure and subsurface contaminated soils located outside of the footprint of the reactor building

This non-time-critical removal action will be authorized following final approval of the proposed *Canal and Deep Pockets of Soil Contamination Removal Action Memorandum.* This removal action is being performed to remove the BGRR fuel canal structure and accessible surrounding subsurface soils. Additionally, accessible contaminated subsurface soils located in the reactor building trench area and near the below-ground duct secondary cooling air bustle, cooler drain sumps and the below-ground duct expansion joint #4 will be removed. This removal action was undertaken to prevent the future migration of radiological contamination into surrounding soils and groundwater.

Completion of this removal action, in conjunction with the removal action relating to the *Canal and Water Treatment House Removal Action Memorandum*, will complete the cleanup criteria for AOC 9A Canal, and AOC 9C – Spills Sites and Soils and will be documented through submittal of the completion reports specific to the remediation objectives of the two Action Memorandums.

4.3 Remaining Actions within the Scope of this Record of Decision

The scope of this ROD also includes the remedial activities necessary to complete the selected remedy. These activities include the removal of the graphite pile and the biological shield, sealing of the below-ground ducts, installation of an engineered infiltration management system, and establishment of land use and institutional controls that will ensure continued protection of human health and the environment.

Completion of this remedial action will be documented through submittal of the closeout report associated with this ROD.

5.0 SITE CHARACTERISTICS

The DOE conducted extensive characterization of the BGRR complex to determine the nature and extent of radiological and non-radiological contamination. The characterization included direct sampling for hazardous and radiological contaminants and isotopic analyses of activated components, contaminated surfaces and debris. Results of the characterization are available in the Administrative Record published in four separate characterization reports.

- *Lower Canal and Water Treatment House, Equipment and Associated Soils EE/CA* (BSA, 2001b)
- *Characterization Reports for the Below-Ground Ducts And Associated Soils* (BSA, 2002a)
- *Characterization Report for Building 701/702 Below-ground Structures, Pile and Remaining Soils* (BSA 2003a)
- *Characterization Report for Building 701 Above-ground Surfaces, Systems and Structures* (BSA 2002d)

5.1 Nature and Extent of Contamination

Certain chemicals and materials were used during the construction and operation of the BGRR. For example, polychlorinated biphenyls (PCBs), organic solvents for degreasing equipment, mineral acids for extracting radionuclides, asbestos and lead in materials of construction, and elemental mercury in certain instruments were used at one time or another during the operating life of the facility. Many of these chemicals and materials have since been removed from the BGRR complex as part of several interim measures that have already been completed. Non-radiological characterization findings are limited to the following.

- Asbestos intrinsic to insulation, floor tiles, mastic and plaster
- PCBs and lead intrinsic to original wall and floor coatings
- Isolated areas of PCB surface contamination in the vicinity of the freight elevator, personnel elevator and control rod drive mechanisms
- Elevated levels of sodium, calcium and zinc within the reactor building pipe trench

Radiological contamination within the BGRR complex consists of activation and fission products within the reactor graphite pile and surrounding biological shield, contaminated concrete within the fuel handling system deep pit and fuel canal and contaminated steel and concrete within the below-ground ducts. Additionally there are isolated pockets of radiologically contaminated soils associated with the below-ground duct secondary cooling air bustle, cooler drain sump and expansion joints, fuel canal outer walls and construction joint, the reactor building pipe trench and floor drains.

5.2 Contaminated Structures

Several contaminated structures exist at various locations within the BGRR complex (see Figures 5-1 and 5-2).

Graphite pile – The graphite pile contains approximately 3,239 Curies (Ci) of radioactivity consisting of hydrogen-3 (H-3, also referred to as tritium) (2,460 Ci), carbon-14 (C-14) (767 Ci), nickel-63 (Ni-63) (7 Ci), cesium-137 (Cs-137) (3 Ci), several isotopes of europium (Eu-152, Eu-154 and Eu-155) (1 Ci), and cobalt-60 (Co-60) (less than 1 Ci). Other pile contaminants include much smaller quantities (i.e. less than 0.1 Ci) of uranium, plutonium and americium. The estimated volume of radioactive graphite is 580 cubic yards.

Biological shield – The biological shield contains approximately 4,805 Ci of radioactivity. The structural materials of the biological shield are volumetrically activated at varying levels based on their relative position to the neutron flux generated within the reactor. Characterization results indicate that almost all of the radiological inventory is confined to the inner one-third of the biological shield. The isotopic inventory within the biological shield consists of Ni-63 (1,945 Ci), H-3 (1,648 Ci), Co-60 (871 Ci), iron-55 (Fe-55) (189 Ci), calcium-41 (Ca-41) (108 Ci), C-14 (31 Ci), and Ni-59 (13 Ci). The estimated volume of radioactive concrete and steel is 100 cubic yards.

Deep pit and fuel canal under the footprint of Building 701 – Contamination is contained in the top few inches of the concrete floors in the deep pit and fuel canal. The affected concrete was soaked and penetrated by contaminated water containing high levels of fission products from the handling of fuel. Radioactivity associated with the deep pit and fuel canal consists primarily of fission products. The contaminated concrete contains approximately 0.167 Ci consisting of strontium-90 (Sr-90) (0.028 Ci) and Cs-137 (0.139 Ci). There are also smaller quantities (about 0.0015 Ci) of surface contamination consisting of uranium, plutonium and americium. The estimated volume of contaminated concrete is 65 cubic yards.

Fuel canal outside the footprint of Building 701 – The fuel canal outside the footprint of Building 701 consists of the contaminated concrete on the inner surface of the fuel canal, and walkway drain lines embedded in concrete that were not removed during prior decontamination efforts. This contaminated material contains approximately 0.022 Ci of radioactivity consisting of Sr-90 (0.003 Ci) and Cs-137 (0.019 Ci). There are also smaller quantities (about 0.0002 Ci) of surface contamination consisting of uranium, plutonium, and americium. The estimated volume of radioactive material is 178 cubic yards.

Below-ground duct concrete and steel outside Building 701 – This contaminated structure includes the concrete and steel remaining within the portion of the duct located outside of the foundation of Building 701. This contaminated structure will remain following completion of the primary liner removal. The contaminated concrete and steel contains approximately 0.825 Ci consisting primarily of Cs-137 (0.784 Ci), Sr-90 (0.038 Ci) and Co-60 (0.001 Ci). There are also smaller quantities (about 0.0002 Ci) of surface contamination consisting of uranium, plutonium, and americium. The estimated volume of radioactive material is 2,284 cubic yards of concrete and 100 cubic yards of steel plate.

Below-ground duct concrete and steel under Building 701 – This section of the below-ground duct extends below Building 701 and will also remain after primary liner removal. The contaminated concrete and steel contains approximately 0.422 Ci of radioactive materials consisting of Cs-137 (0.399 Ci), Sr-90 (0.022 Ci) and Co-60 (0.001 Ci). There are also smaller quantities (about 0.001 Ci) of surface contamination consisting of uranium, plutonium and americium. The estimated volume of radioactive material is 377 cubic yards of concrete and 100 cubic yards of steel plate.

5.3 Contaminated Soils

Pockets of contaminated soil exist at several locations within the BGRR complex (see Figure 5-3).

Bustle area – The bustle area contamination consists of soils adjacent to the secondary air bustle on the northeast side of the below-ground duct where it exits from Building 701. This subsurface soil pocket begins approximately mid-height of the below-ground duct (26 feet below grade) and extends to the soil below the duct to a depth of 40 feet below grade (27 feet above groundwater). The soil is contaminated with Cs-137 at a peak level of 89,000 picocuries per gram (pCi/g) and Sr-90 at a peak level of 11,200 pCi/g. The estimated volume of contaminated soil is 35 cubic yards.

Canal outer walls – The soil in some areas immediately adjacent to the canal structure is contaminated. This subsurface soil pocket begins approximately mid-height of the outer walls of the canal on the north, east and south walls and extends outward one foot from the surface and below the canal to a depth of 18 feet below grade (47 feet above groundwater). The soil is contaminated with Cs-137 at a peak level of 900 pCi/g and Sr-90 at a peak level of 56 pCi/g. The estimated volume of contaminated soil is 18 cubic yards.

Lower canal construction joint – This contamination pocket includes the soil beneath the canal floor in the vicinity of the canal construction joint east of Building 701. This subsurface soil pocket begins immediately below the canal structure (12.5 feet below grade) and extends below the canal to a depth of 29.5 feet below grade (37.5 feet above groundwater). The soil is contaminated primarily with Cs-137 at a peak level of 1,500 pCi/g and Sr-90 at a peak level of 572 pCi/g. Trace concentrations of uranium-238 (U-238) (6.2 pCi/g) and plutonium-239 (Pu-239) (5.2 pCi/g) were detected at their respective minimum detectable activity (MDA) limit for the corresponding sample. The estimated volume of contaminated soil is 11 cubic yards.

Expansion joint #4 – This pocket includes soil adjacent to and underneath the north and south duct cooler drain sumps and the duct expansion joint #4. This subsurface soil pocket begins within soil immediately below the expansion joint and cooler drain sump and extends from a depth of 18 to 30 feet below grade (38 feet above groundwater). The soil is contaminated primarily with Cs-137 at a peak level of 2,845 pCi/g and Sr-90 at a peak level of 37 pCi/g. The estimated volume of contaminated soil is 110 cubic yards.

Drains and drywells outside the footprint of Building 701 – The contamination in the drains and drywells outside the footprint of Building 701 consists of contaminated soil and crushed stone associated with the three building drain drywells located outside of the foundation footprint of Building 701. These include drywells from the east and west inlet air filter house drains, the west steam trap drains, the control-rod drive mechanism floor drains, the fuel vault floor drains and the east steam trap drains. Each drywell is an independent receptacle constructed of one cubic yard of crushed stone. The drywells are contaminated primarily with Cs-137 and Sr-90 with an average concentration of 93 pCi/g and 56 pCi/g respectively. The estimated volume of the contaminated soil and crushed stone is three cubic yards.

Drains and drywells under the footprint of Building 701 – The contamination in the drains and drywells under the footprint of Building 701 consists of contaminated soil and crushed stone associated with the two building drain drywells. These include drywells from the east and west inlet air plenum drains. Each drywell is an independent receptacle, constructed of one cubic yard of crushed stone. The drywells are contaminated primarily with Cs-137 and Sr-90 with an average concentration of 450 pCi/g and 1,730 pCi/g respectively. The estimated volume of contaminated soil and crushed stone is two cubic yards.

Reactor building trench area– The contamination in the reactor building trench area consists of contaminated soils located within the reactor building pipe trench. The trench is constructed with concrete walls extending vertically approximately four feet below the reactor building main floor level with exposed soil at its base. The contamination is isolated to an area of approximately 60 square feet extending to a depth of approximately one foot within the soil. The soil is contaminated primarily with Cs-137 at a peak level of 17,726 pCi/g and Sr-90 at a peak level of 1,020 pCi/g. Trace concentrations of U-238 (0.3 pCi/g), Pu-239 (0.88 pCi/g), and Eu-152 (0.8 pCi/g) were detected at their respective MDA limits for the sample. Elevated levels of metals (cadmium and zinc) were also identified in the contaminated soil. The estimated volume of contaminated soil is two cubic yards.

Below-ground duct under the footprint of Building 701 – This pocket consists of contaminated soils located beneath the north duct in the vicinity of the below-ground expansion joint immediately south of the reactor. This subsurface soil pocket begins within soils immediately below the duct foundation pad and extends to a depth of two feet (32 feet above groundwater). The soil is contaminated primarily with Cs-137 at a peak level of 79,000 pCi/g and Sr-90 at a peak level of 2,200 pCi/g. Trace concentrations of U-238 (0.2 pCi/g), Pu-239 (0.2 pCi/g), and Eu-152 (0.2 pCi/g) were detected at their respective MDA limit for the corresponding sample. The estimated volume of contaminated soil is 70 cubic yards.

Deep pit and fuel canal under the footprint of Building 701 – This pocket consists of contaminated soils below the deep pit and portions of the canal that are below the foundation footprint of Building 701. This subsurface soil pocket begins within soils below the pile foundation pad and extends to a depth of two feet below the pad (32 feet above groundwater). The soil is contaminated primarily with Cs-137 at a peak level of 405 pCi/g and Sr-90 at a peak level of 103 pCi/g. Trace concentrations of U-238 (0.2 pCi/g) and Pu-239 (0.05 pCi/g) were detected at their respective MDA limit for the corresponding sample. The estimated volume of contaminated soil is 20 cubic yards.

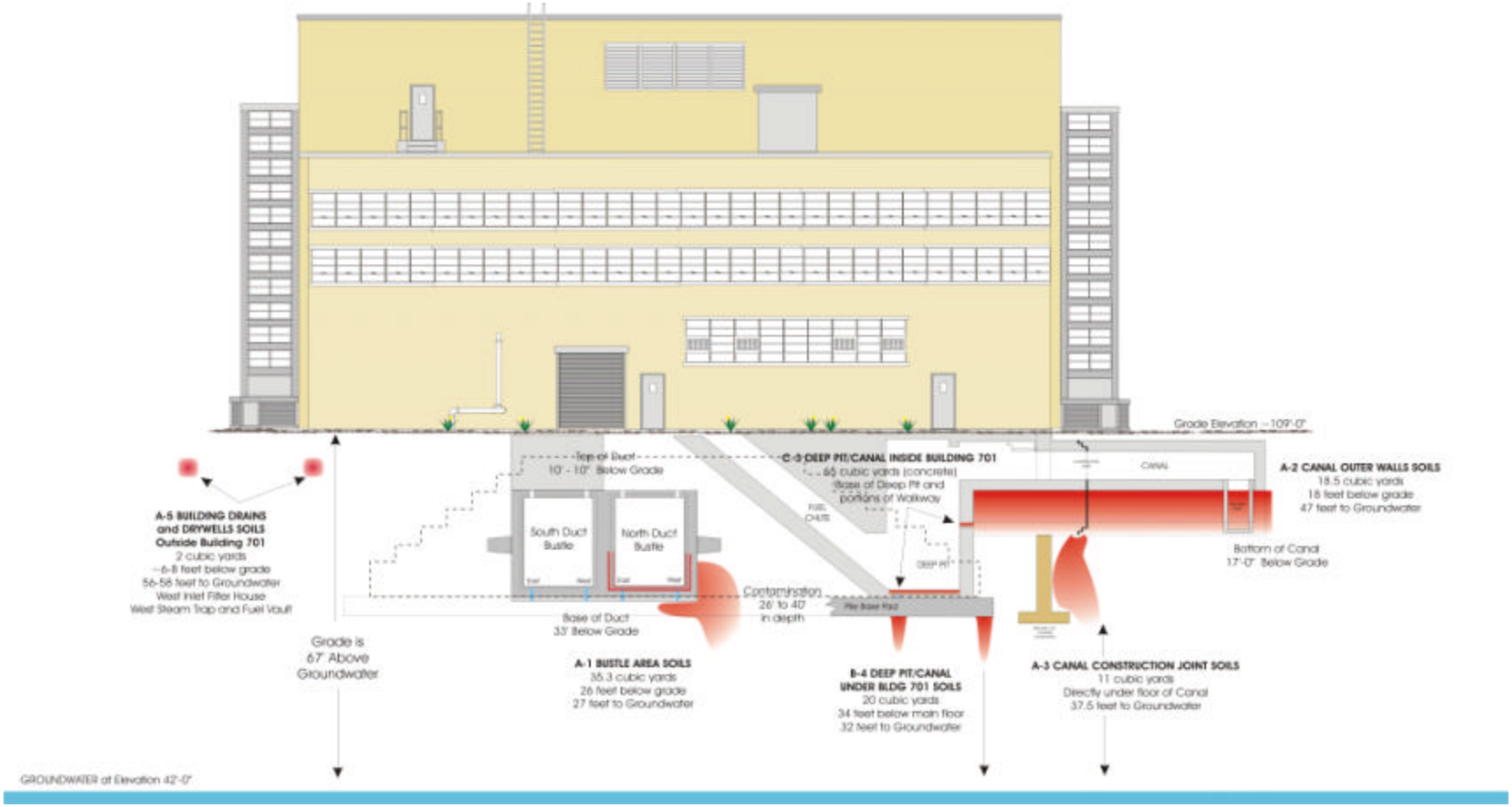

Figure 5-1. BGRR South Elevation, Looking North.

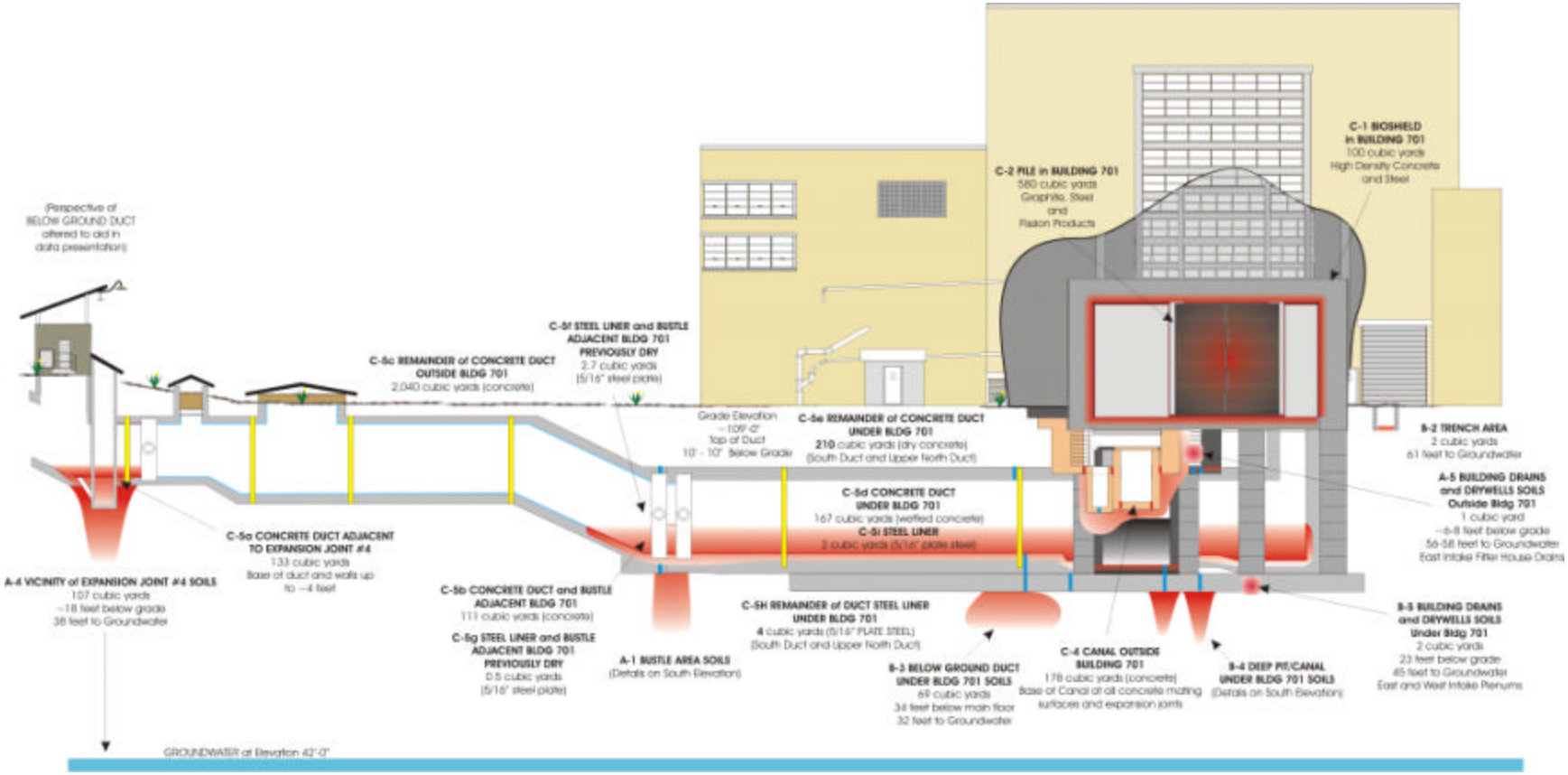

Figure 5-2. BGRR East Elevation, Looking West.

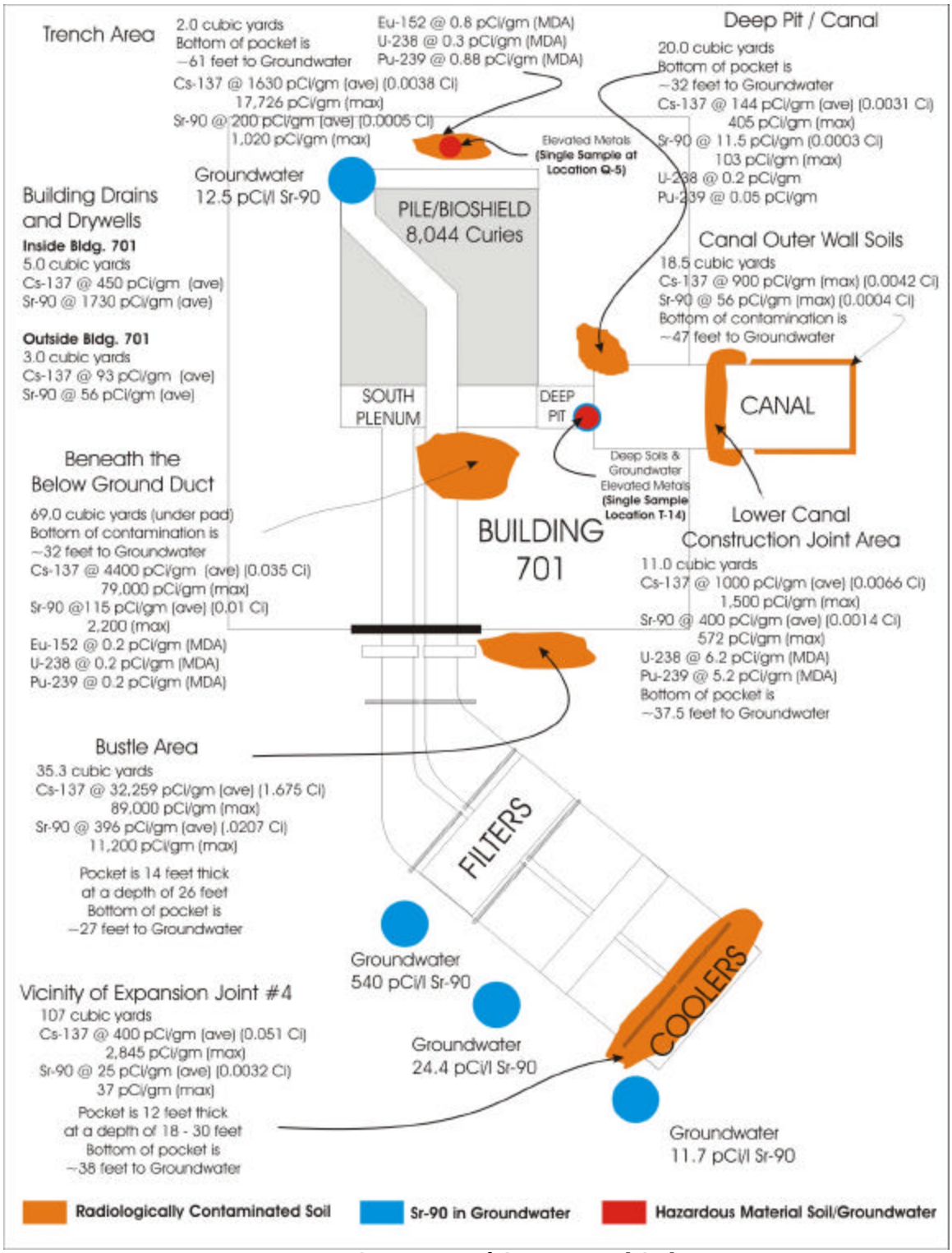

Figure 5-3. Location of Contaminated Soil.

6.0 SUMMARY OF SITE RISKS

The remaining contamination within the BGRR complex consists primarily of activation and fission products within the reactor graphite pile and surrounding biological shield, contaminated concrete within the fuel handling system deep pit and fuel canal, and contaminated steel and concrete within the below-ground ducts. Additionally there are isolated pockets of contaminated soils associated with the below-ground duct secondary cooling air bustle and expansion joints, fuel canal outer walls and construction joint, the reactor building pipe trench and reactor building drains. The majority of non-radiological hazardous materials associated with the BGRR have been removed through previous interim measures. Isolated pockets of non-radiological hazardous material contamination are present within the reactor building pipe trench, and within embedded drain lines. Hazardous materials intrinsic to construction materials such as floor tiles, paint and insulating materials remain within the reactor building.

The exposure pathways of BGRR contamination are illustrated in the Conceptual Site Model (Figure 6-1) and summarized below.

- *Direct exposure to worker, resident or trespasser.* This includes external gamma radiation emanating from radionuclides remaining in the interior of the reactor building and the graphite pile, residues in the fuel canal and underground ducts, and localized areas of soil.

- *Direct contact to worker, resident or trespasser.* This includes direct exposure to and potential ingestion of radioactive contamination in soil or dispersible radioactive materials on surfaces of structures.

- *Production of airborne radioactivity or leaching of contaminants from source to the surrounding environment or groundwater.* This includes potential inhalation of radioactive materials created as a result of disturbing contaminants or leaching from subsurface soil and structures.

An illustration depicting existing contaminant sources, actual and potential pathways, and control measures is provided in Figure 6-1 as a conceptual site model for the BGRR. Sources of contaminants are shown within heavy bordered boxes. Lines originating from each source and terminating at specific receptors depict actual or potential pathways from each source. A dashed line indicates a pathway that is blocked by an existing barrier or administrative control measure. Solid lines depict active pathways to the respective receptor.

As illustrated by the conceptual site model, with the exception of direct exposure to low-level external radiation from the pile and biological shield, the sources of contaminants at the BGRR are blocked (dashed lines) from impacting any of the identified receptors.

6.1 Basis for Remedial Action

Although the ongoing use of infiltration management and institutional controls provides barriers that are effective in protecting human health and the environment, the extremely long-lived hazards associated with BGRR radiological contaminants creates uncertainties as to the long-term reliability of such controls in ensuring future exposure pathways do not arise. Therefore, the DOE believes additional measures are appropriate as a way to manage these long-term uncertainties and further reduce the potential for unacceptable exposures occurring in the future.

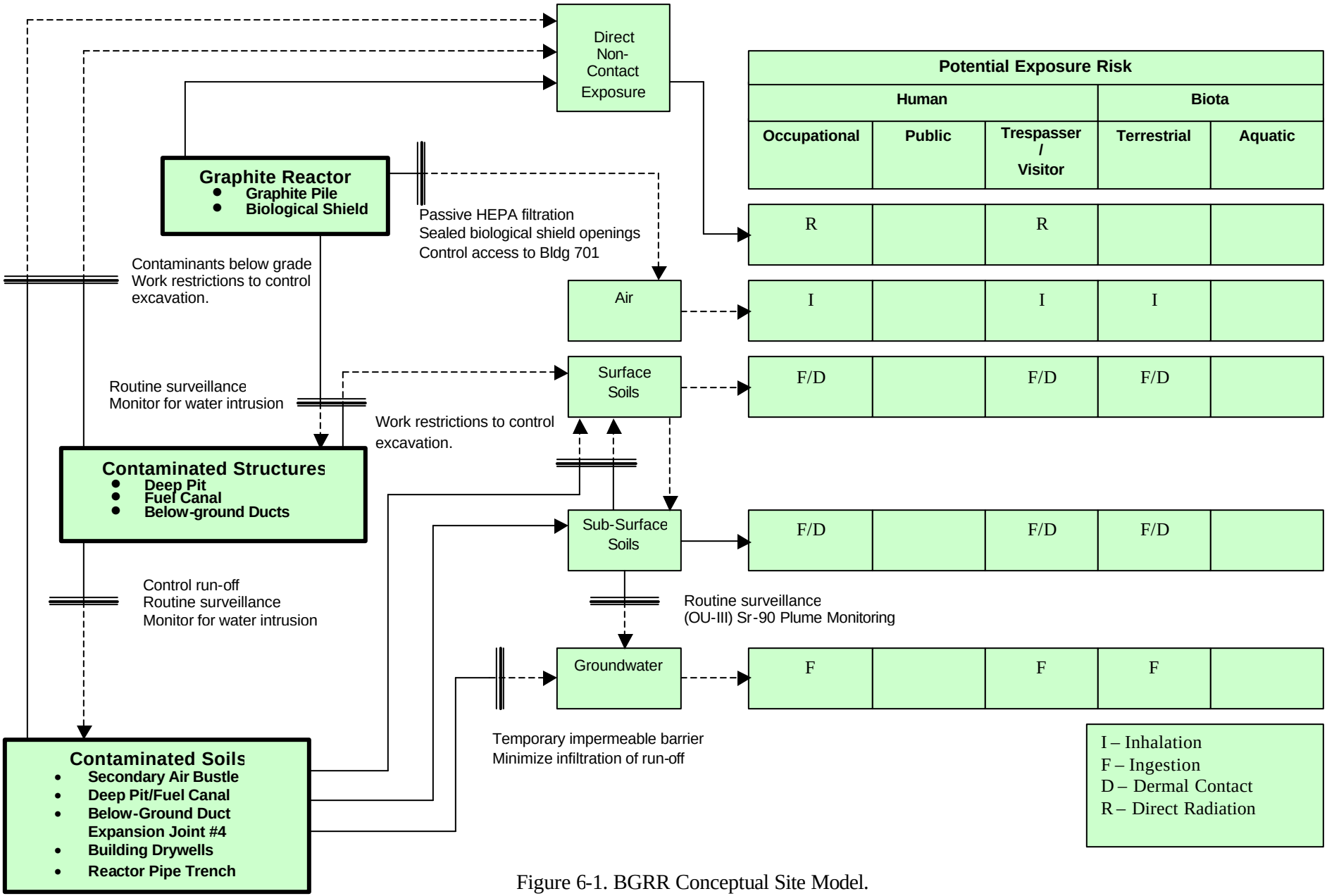

Figure 6-1. BGRR Conceptual Site Model.

7. 0 REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives (RAOs) used to evaluate the BGRR remedial action alternatives were developed considering land use, Contaminants of Potential Concern (COPCs), Applicable or Relevant and Appropriate Requirements (ARARs), and exposure pathways. The RAOs for the BGRR remedial action are stated below.

1. Through prudent remedial action, ensure the protection of human health and the environment from the potential hazards posed by the radiological inventory that resides in the BGRR complex. The remedial action should ensure protection of human health and the environment without undue uncertainties.

2. Use the As Low As Reasonably Achievable (ALARA) principle, while implementing the remedial action, to reduce further the potential hazard to human health and the environment posed by the considerable radiological inventory that resides in the BGRR complex.

3. Following completion of the remedial activities, implement long-term monitoring, maintenance and institutional controls to manage potential hazards to protect human health and the environment.

7.1 Land Use

Brookhaven National Laboratory 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.

A future land use study, *Brookhaven National Laboratory Future Land Use Plan* (AUI 1995) was undertaken and published by DOE in 1995. Potential land uses of the BNL Site that could occur after BNL closes as a national laboratory were identified as a mix of open space, industrial/commercial, recreational and residential uses. Additionally, specific post-remediation land use controls are contained within the *Brookhaven National Laboratory Land Use Controls Management Plan*, (DOE 2003a).

Because this remedy 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, future reuse of the BGRR complex will be limited to commercial or industrial uses such as research and development facilities, offices, manufacturing plants, rail yards, staging areas, power plants, utility systems, and waste management facilities. Commercial application involving the potential for continuous direct exposure to the general public such as child day care or health care facilities will be prohibited.

Federal regulations including 10 Code of Federal Regulations (CFR) Part 835, *Occupational Radiation Protection* and 10 CFR Part 830, *Nuclear Safety Management* require that DOE nuclear facilities establish and maintain procedures to ensure operational safety, worker health, environmental protection and regulatory compliance. These procedures require formal consideration of any work or modification and will ensure prompt identification and evaluation of the potential impact to the remedy at the BGRR complex.

7.2 Cleanup Goals

The cleanup goals for the activities within the scope of this ROD are established with the intent of using the ALARA principle to ensure the long-term protection of human health and the environment from the potential hazards posed by the radiological inventory that resides in the BGRR complex.

8.0 DESCRIPTION OF EVALUATED ALTERNATIVES

8.1 Alternative A – Stabilization and Source Management

Scope

In lieu of a "No Action" alternative, Alternative A, "Stabilization and Source Management," relies on several actions already taken and additional actions now in progress or planned to reduce the radiological footprint of the BGRR complex. This alternative relies heavily on infiltration management, surveillance and monitoring, and institutional controls to manage the residual radiological inventory, including the reactor pile and biological shield.

This alternative includes:

- Removal of contaminated water within the below-ground ducts;
- Removal of experimental equipment and systems from the reactor building;
- Removal of the reactor exhaust fans, motors, valves, and instruments;
- Removal of pile fan sump, pipes, and contaminated soil;
- Removal of above-ground ducts, pipes, and contaminated soil;
- Removal of the canal house, water treatment house, equipment, pipes, asphalt, concrete and accessible contaminated soils;
- Removal of the reactor exhaust cooling coils, filters, and below-ground duct primary liner;
- Design and installation of water infiltration control and monitoring system for structures and contaminated soils under Building 701 foundation, the remaining portion of the fuel canal, and below-ground ducts;
- Installation of up to six groundwater monitoring wells;
- Groundwater monitoring;
- Routine inspection and surveillance of BGRR complex; and
- Routine maintenance and upkeep.

Completion of the remedial activities will rely on established, field-proven practices and standard construction techniques. No new technologies are required, and there are no outstanding implementability issues and uncertainties.

End State

Upon completion, this alternative will remove a total of 47 Ci from the BGRR radiological inventory. Approximately 8,047 Ci will remain. The majority (8,044 Ci) of the remaining inventory is contained within the graphite pile and biological shield and will be isolated from the environment by the biological shield itself and the Building 701 superstructure and its massive concrete foundation. Approximately three curies would be contained within underground structures and deep, subsurface pockets of contaminated soils and will be monitored and controlled through the installation of an impermeable barrier. The long-term actions associated with this alternative include routine inspection and surveillance of the BGRR complex, scheduled upkeep and maintenance of Building 701, infiltration management, and groundwater monitoring.

Cost/Schedule

As of the end of fiscal year 2003, BGRR removal actions have cost approximately $39.3 million. The remaining ongoing and scheduled activities are estimated to take 18 months at a cost of $14.2 million, resulting in a total project cost of $53.5 million to complete this alternative.

Institutional Controls

The residual long-lived radioisotopes in the pile and biological shield would require institutional controls for an indefinite period of time.

These institutional controls would specify land use restrictions and reporting requirements. At a minimum, land use restrictions and reporting requirements will:

- Establish control measures for future excavation of residual subsurface contamination including characterization and limitations on use/reuse in accordance with NYSDEC regulations;
- Provide land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development;
- Specify requirements for annual certification to the NYSDEC, which would certify 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;
- Include the stipulation that the annual certification must be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC;
- Specify the requirement for annual certification of institutional controls to be passed on to any/all future landowners; and
- Establish a restriction that future use and development of the BGRR complex is limited to commercial or industrial uses only.

In light of the fact that a deed does not exist for this property owned by a Federal agency, DOE will be responsible for implementing these controls as long as DOE owns the property. Upon transfer of the property to a non-Federal agency by the U.S. Government, a deed will be established and an environmental easement will be added to the deed at that time.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the *Brookhaven National Laboratory Operable Unit -III Record of Decision* (BSA 2000a). Results of the OU-III monitoring will be used to help ensure the effectiveness of this remedy.

The costs associated with institutional controls will be approximately $275,000 annually for routine surveillance and groundwater monitoring. Additionally, it will require approximately $10,000 every ten years for infiltration barrier upkeep and $700,000 every 20 years to refurbish Building 701 exterior façade and roof system.

8.2 Alternative B – Pile and Biological Shield Removal

Scope

This alternative includes completion of the activities identified within Alternative A and removal of the graphite pile and biological shield. Completion of Alternative B will rely on established, field-proven technologies and techniques. No new technologies are required. Removal of the pile and biological shield will generate approximately 144,000 cubic feet (ft^3) of low-level radioactive waste (LLRW).

End State

Upon completion, this alternative will remove a total of 8,091 Ci from the BGRR complex including all of the long-lived radioisotopes. Approximately 3 Ci (predominantly Cs-137 and Sr-90) will remain in contaminated structures below the Building 701 footprint, canal, concrete and steel in the below-ground ducts and contaminated sub-surface soils. The remaining radioactivity will be monitored and controlled through the installation of an impermeable barrier and infiltration management system.

Building 701 will remain intact with steel plate installed over the open floor created by removing the pile and biological shield. A fixative will be applied to the exposed surfaces of the reactor pile foundation, support structure, and deep pit to stabilize any residual surface radioactivity before covering the opening from the main floor level of Building 701. Long-term actions will include routine inspection and surveillance of the BGRR facility, scheduled upkeep and maintenance of Building 701, infiltration management and groundwater monitoring.

Cost/Schedule

As of the end of fiscal year 2003, BGRR removal actions have cost approximately $39.3 million. It is estimated that completing the remaining ongoing and scheduled activities including the removal of the graphite pile and biological shield will cost an additional $54 million, resulting in a total project cost of $93.3 million. Depending on the availability of funds, it is estimated that the activities within this alternative will take 30 months to complete.

Institutional Controls

Using conservative assumptions, it was calculated that it would require approximately 266 years for the decay of residual contamination to reach the OU I soil cleanup standards for industrial land use of 67 pCi/gm of Cs-137 and 15 pCi/gm of Sr-90. An additional 100 years would be necessary to decay the radioactivity to the acceptable levels for unrestricted land use. This calculation was performed to allow for a comparative analysis of the various BGRR remedial action alternatives, considered herein. It was not intended to establish definitive institutional control durations.

However, institutional controls, including land use restrictions, would help ensure that the remaining contaminated structures and soils can be managed to prevent inadvertent direct exposure and future migration to the soil regardless of these calculated durations. The risk to human health and the environment through the hypothetical excavation of these soils at some time in the future would be evaluated based on the actual distribution, depth and concentrations of the residual radioactive material encountered. Given the depth of these soils and the clean overburden, the concentrations of Cs-137 and Sr-90 would be significantly reduced when mixed with the clean overburden.

Institutional controls would specify land use restrictions and reporting requirements. At a minimum, land use restrictions and reporting requirements will:

- Establish control measures for future excavation of residual subsurface contamination including characterization and limitations on use/reuse in accordance with NYSDEC regulations;
- Provide land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development;
- Specify requirements for annual certification to the NYSDEC, which would certify 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;
- Include the stipulation that the annual certification must be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC;
- Specify the requirement for annual certification of institutional controls to be passed on to any/all future landowners; and
- Establish a restriction that future use and development of the BGRR complex is limited to commercial or industrial uses only.

In light of the fact that a deed does not exist for this property owned by a Federal agency, DOE will be responsible for implementing these controls as long as DOE owns the property. Upon transfer of the property to a non-Federal agency by the U.S. Government, a deed will be established and an environmental easement will be added to the deed at that time.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the *Brookhaven National Laboratory Operable Unit -III Record of Decision.* Results of the OU-III monitoring will be used to help ensure the effectiveness of this remedy.

The estimated costs associated with institutional controls will be $275,000 annually for routine surveillance and groundwater monitoring. Additionally, it will require approximately $10,000 every ten years for infiltration barrier upkeep and $700,000 every 20 years to refurbish the Building 701 exterior façade and roof system.

8.3 Alternative C – Removal of Pile, Biological Shield, Fuel Canal Structure and Reasonably Accessible Soils

Scope

Alternative C includes the Alternative B scope. As an ALARA measure, this alternative also removes accessible pockets of contaminated soil from the BGRR complex and portions of the fuel canal structure external to Building 701. This alternative includes removal of contaminated soil pockets adjacent to the below-ground duct expansion joint at the duct coolers (expansion joint #4), and soils located outside Building 701 foundation adjacent to and below the fuel canal and near the below-ground duct secondary cooling-air bustle. Because of the complexity of the Building 701 foundation and the potential for disrupting the structural integrity of the building, soils located within or below the Building 701 foundation will not be removed. Accessibility of soils will be defined through engineering evaluations determining the impact that removing soils will have on the integrity of the structure and will be included as part of the remedial work plan.

The structures and subsurface soil pockets listed below would be removed as part of this remedial action alternative.

- Soils adjacent to below-ground duct expansion joint #4

  Removal of this soil involves excavation and packaging of approximately 107 cubic yards of contaminated soils.

- Fuel canal concrete structure outside the Building 701 foundation footprint and contaminated soils

  Removal of the fuel canal involves excavation and removal of approximately 60 cubic yards of contaminated soils and 140 cubic yards of contaminated concrete.

- Soils adjacent to the below-ground duct secondary cooling-air bustle

  This activity involves the excavation and removal of approximately 40 cubic yards of contaminated soils.

Alternative C likewise relies on field proven and commercially available technologies and cleanup techniques. No new technologies are required.

End State

Upon completion, this alternative will remove a total of 8,093 Ci from the BGRR complex including all of the long-lived radioisotopes. Approximately 1 Ci (predominantly Cs-137 and Sr-90) will remain embedded in contaminated concrete and steel structures below the Building 701 footprint and within inaccessible soils. These remaining contaminants will be monitored and controlled through the installation of an impermeable barrier and infiltration management system.

As in Alternative B, Building 701 will remain intact with a covering over the open floor space and residual radioactivity within the reactor pile foundation, support structure, and deep pit stabilized in place and sealed from Building 701. Residual radioactivity will remain within inaccessible soils located in deep pockets below the Building 701 foundation and below-ground duct concrete structure. These contaminants are bound within concrete, embedded within steel or located within areas that are currently inaccessible and are not considered a groundwater contamination source term. Long-term actions will include routine inspection and surveillance of the BGRR facility, scheduled upkeep and maintenance of Building 701, infiltration management, groundwater monitoring and provisions requiring removal of contaminated soil in the event the soils become accessible during future excavation or component removal.

Cost/Schedule

As of the end of fiscal year 2003, BGRR removal actions have cost approximately $39.3 million. Completing the remaining ongoing and scheduled activities of Alternative A and removal of the graphite pile and biological shield of Alternative B is estimated to cost $54 million. Removal of the readily accessible sources identified within this alternative is estimated to cost an additional $3.5 million. Completion of this alternative is expected to take approximately 30 months at a total cost of $96.8 million.

Institutional Controls

Using conservative assumptions, it was calculated that it would require approximately 180 years for the decay of residual contamination to reach the OU I soil cleanup standards for industrial land use of 67 pCi/gm of Cs-137 and 15 pCi/gm of Sr-90 and an additional 100 years to decay to the acceptable levels for unrestricted residential land use. This calculation was performed to allow for a comparative analysis of the various BGRR remedial action alternatives, considered herein. It was not intended to establish definitive institutional control durations.

However, institutional controls, including land use restrictions, would help ensure that the remaining contaminated structures and soils can be managed to prevent inadvertent direct exposure and future migration to the soil regardless of these calculated durations. The risk to human health and the environment through the hypothetical excavation of the remaining soils at some time in the future would be evaluated based on the actual distribution, depth and concentrations of the residual radioactive material encountered. Given the depth of these soils and the clean overburden, the concentrations of Cs-137 and Sr-90 that an individual could be exposed to during excavation would be significantly reduced when mixed with the clean overburden.

Institutional controls would specify land use restrictions and reporting requirements. At a minimum, land use restrictions and reporting requirements will:

- Establish control measures for future excavation of residual subsurface contamination including characterization and limitations on use/reuse in accordance with NYSDEC regulations;
- Provide land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development;
- Specify requirements for annual certification to the NYSDEC, which would certify 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;
- Include the stipulation that the annual certification must be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC;
- Specify the requirement for annual certification of institutional controls to be passed on to any/all future landowners; and
- Establish a restriction that future use and development of the BGRR complex is limited to commercial or industrial uses only.

In light of the fact that a deed does not exist for this property owned by a Federal agency, DOE will be responsible for implementing these controls as long as DOE owns the property. Upon transfer of the property to a non-Federal agency by the U.S. Government, a deed will be established and an environmental easement will be added to the deed at that time.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the *Brookhaven National Laboratory Operable Unit -III Record of Decision.* Results of the OU-III monitoring will be used to help ensure the effectiveness of this remedy.

The estimated cost of long-term actions is $275,000 annually for routine surveillance and groundwater monitoring. Additionally, $10,000 every ten years for infiltration barrier upkeep and $700,000 every 20 years to refurbish the Building 701 exterior façade and roof system will be required.

8.4 Alternative D – Greenfield

Scope

Alternative D includes the complete removal of the BGRR complex systems, structures and components, and the removal of underlying soils necessary to reach the soil cleanup levels for industrial land use established in the OU I Record of Decision.

This alternative includes completion of all the activities identified in Alternative C and full removal of the Building 701 superstructure, underground foundations, deep soil pockets below the foundation footprint, and remaining underground structures including the remainder of the fuel canal, deep pit, and below-ground duct concrete and steel.

In addition to those removed in Alternative C, the structures and subsurface soil pockets listed below would be removed as part of this remedial action alternative:

- Removal of Building 701 superstructure

  This activity involves the demolition and removal of the above-ground structure of Building 701. Because Building 701 is a radiologically controlled building, demolition will create approximately 3,800 cubic yards of low-level radioactive wastes. The lower portion of the north wall of the reactor building (Building 701) will remain in place as an exterior wall of the adjoining BGRR research laboratories (Building 703).

- Removal of Building 701 foundation and remaining underground structures

  This activity involves removing the remainder of the fuel canal from the outer construction joint to the pile foundation buttresses, the reactor pile foundation buttresses and foundation pad, isolated contaminated soil pockets under the foundation pad, and remaining below-ground duct concrete and steel. Completion of this action will create approximately 8,300 cubic yards of low-level radioactive wastes consisting of steel, concrete and soil.

Completion of these remedial activities will rely on established, field-proven practices and standard construction techniques. No new technologies are required.

End State

Following removal of Building 701 superstructure and underground foundation, the BGRR complex will be excavated to approximate the current grade using clean fill, topsoil and indigenous plant life. Upon completion, this alternative will remove all radioactivity with the exception of residual contamination (less than 1 Ci) intermixed within deep soils. To ensure the effectiveness of these actions, the remaining radiological inventory will be monitored for the institutional control period established for industrial land use established in the OU I Record of Decision.

Cost/Schedule

As of the end of fiscal year 2003, BGRR removal actions have cost approximately $39.3 million. Completing the activities identified within this alternative is expected to take 56 months at an additional cost of $110 million for a total cost of approximately $150 million.

Institutional Controls

Using conservative assumptions, it was calculated that if the remaining contaminated soils within the BGRR complex were remediated to the OU I soil cleanup standards of 67 pCi/gm for cesium–137 and 15 pCi/gm for strontium-90 it would take approximately 100 years for the residual contaminants to decay to acceptable levels for unrestricted land use. This calculation was performed to allow for a comparative analysis of the various BGRR remediation alternatives considered herein. It was not intended to establish definitive institutional control durations.

However, following the excavation of the remaining contaminated soils the risk to human health and the environment would be evaluated based on the actual distribution, depth and concentrations of the residual radioactive material encountered. The duration and need for institutional controls would be determined based on the results of this evaluation.

If determined necessary, institutional controls will include routine inspection and surveillance of the BGRR grounds and if necessary, upkeep and maintenance of, an infiltration management and monitoring system. Additionally, controls for this alternative would specify land use restrictions and reporting requirements. At a minimum, these controls would:

- Establish measures for future excavation of residual subsurface contamination including characterization and limitations on use/reuse in accordance with NYSDEC regulations;
- Provide land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development;
- Specify requirements for annual certification to the NYSDEC, which would certify 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;
- This annual certification would be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC;
- Specify that land use restriction and reporting requirements to be passed on to any/all future landowners through an environmental easement on the deed to the property; and
- Establish a restriction that future use and development of the property is limited to commercial or industrial uses only.

In light of the fact that a deed does not exist for this property owned by a Federal agency, DOE will be responsible for implementing these controls as long as DOE owns the property. Upon transfer of the property to a non-Federal agency by the U.S. Government, a deed will be established and an environmental easement will be added to the deed at that time.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the *Brookhaven National Laboratory Operable Unit -III Record of Decision.* Results of the OU-III monitoring will be used to help ensure the effectiveness of this remedy.

With the structures removed from the BGRR complex the estimated cost for the administrative support necessary to provide annual certification and land use restrictions is less than $1,000 per year over the duration of the institutional control period for industrial land use.

9.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

9.1 Overall Protection of Human Health and the Environment

All four alternatives provide varying degrees of contamination removal and include measures such as infiltration management and/or institutional controls to manage any residual contamination. The removal actions which have been or are currently being performed in conjunction with the measures set forth in the four alternatives are fully capable of preventing direct human exposure and/or the spread of contamination to the environment for some long-term but finite period of time. However, because of the indefinite period of the required longevity of institutional controls, Alternative A is set apart from the other three alternatives.

Alternative A would leave the pile and biological shield in place at the BGRR complex. These structures contain long-lived radioisotopes that would remain as a potential threat for thousands of years should protective measures be compromised or conditions allow direct access or exposure. Infiltration management and institutional control would be required for what is essentially an indefinite period of time. Alternatively, a schedule would need to be established for the removal of these structures on some finite time line. Infiltration management and institutional controls can be effectively maintained for a finite duration. However, there are serious questions that arise over the sustainability of these same protective measures over an indefinite time frame. This is the largest single difference among the four BGRR cleanup alternatives. Alternatives B, C and D require institutional controls for a finite period of time. In the case of these alternatives, the long-lived radionuclides would be removed as a result of pile and biological shield removal.

9.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative A involves the storage of the long-lived radioactive contaminants in the pile and biological shield. The indefinite storage of these radioactive structures raises questions regarding the applicability of New York State's siting requirements for LLRW disposal facilities. This may preclude the indefinite storage or entombment of the pile and biological shield over Long Island's sole source aquifer. This issue would need to be resolved before proceeding with Alternative A.

With the exception of the uncertainty regarding New York State's siting requirements for LLRW waste disposal facilities, there are no apparent compliance issues or conflicts with ARARs.

9.3 Long-Term Effectiveness

Alternative A would leave the pile and biological shield in place at the BGRR reactor facility. Because these structures contain significant quantities of long-lived radioisotopes, DOE would be required to implement infiltration management and institutional controls for an indefinite duration. The longevity of this potential threat creates uncertainties over the fidelity of institutional controls over the prolonged period of time. Pile and biological shield removal set Alternative A apart from the other three BGRR cleanup alternatives.

In contrast, Alternatives B, C and D all include the removal of the pile and biological shield. For all three, these removal actions result in the removal of essentially all of the long-lived contaminants from the BGRR complex. Residual contamination would require infiltration management and/or institutional controls in the case of all three alternatives. However, the duration of these measures would be for a finite period of time that would not impose the same issues and uncertainties germane to Alternative A. These three alternatives are equivalent from a long-term effectiveness perspective.

9.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives considered in this Record of Decision include treatment to reduce the toxicity, mobility or volume of contaminants.

9.5 Short-Term Effectiveness

Alternative A has a relatively small scope of work in a radiologically harsh environment. In view of the diminished risk of contamination dispersion to the environment and transportation incidents, this alternative poses the least uncertainties in the area and thus is rated as high.

The removal of the pile and biological shield set Alternatives B, C, and D apart from Alternative A. Over 8,000 Ci of contaminated material would be removed from the BGRR complex. For all three alternatives, this involves a significant amount of work in a radiologically harsh environment. While not extraordinary from a waste form and activity standpoint, the wastes resulting from pile and biological shield removal would have to be carefully managed. Existing work controls and procedures will mitigate the risks of potential threats to humans and the environment. The ALARA principal would be used to manage direct human (worker) exposure throughout all phases of pile and biological shield removal. Nonetheless, these response actions pose potential threats and uncertainties to short-term effectiveness. While the scope of work varies significantly among Alternatives B, C and D, the relative complexity and challenges are minor in comparison to pile and biological shield removal.

9.6 Implementability

All four BGRR cleanup alternatives will rely on field proven techniques and practices. Most of these techniques and practices have been previously demonstrated at BNL, elsewhere in the DOE complex, or in the commercial nuclear power industry. These proven techniques and practices encompass all elements of cleanup, through and including waste handling, packaging, transportation, and disposal. All four alternatives are equivalent from an implementability standpoint and are rated as high.

9.7 Cost

The capital cost for each of the four alternatives is summarized as follows:

Table 9-1. Comparison of Alternatives Capital Costs, in Dollars.

	A	B	C	D
Previous Costs	39.3 Million	39.3 Million	39.3 Million	39.3 Million
Additional Costs	14.2 Million	54.0 Million	57.5 Million	110.0 Million
Total Costs	**53.5 Million**	**93.3 Million**	**96.8 Million**	**149.3 Million**

Alternative A is the least costly of the four BGRR cleanup alternatives. There is a large incremental increase of $40.2 Million for Alternative B because of pile and biological shield removal. The removal of the portion of the fuel canal outside the foundation footprint of building 701 and the accessible pockets of deep, subsurface contaminated soils (Alternative C) results in a small incremental increase of $3.5 million. Alternative D results in another large incremental cost of $52.5 because of the enormous scope of work and waste transportation and disposal involved with the demolition of the Building 701 superstructure and foundation.

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 the public comment period on the Proposed Plan, public information sessions were held on August 17 and 19, 2004 and a public meeting was held on August 24, 2004. The results of the public meeting and the public comments on the feasibility study and proposed plan indicate overall general acceptance and support of the preferred alternatives. Community response to the remedial alternatives is presented in the Responsiveness Summary in Section III, which addresses questions and comments received during the public comment period.

10. SELECTED REMEDY

After evaluating the likely alternatives against the CERCLA criteria, Alternative C – Pile and Biological Shield Removal and Reasonably Accessible Soils and Canal Structure is the selected remedy for the BGRR complex.

In addition to the removal actions and interim measures completed or underway through the various Action Memorandums, the remedy for the BGRR complex includes the removal of the graphite pile, biological shield, sealing of the below-ground ducts, installation of an engineered cap as part of an infiltration management system and establishment of land use and institutional controls. Further description of the measures included as part of this remedy is provided below.

The following removal actions have been performed. These response actions are consistent with the selected remedy for the BGRR complex.

Removal of the primary air cooling fans, motors, valves and instruments

This completed activity removed and disposed of contaminated equipment from the reactor exhaust fan rooms.

Removal of the pile fan sump, pipes and contaminated soil

This completed removal action removed the pile fan drain sump, associated piping, and contaminated soils in the vicinity of the pile fan sump.

Removal of the above-ground ducts, pipes and contaminated soil

This completed action removed and disposed of

- The above-ground portion of the reactor exhaust ducts,
- Components from the Instrument House containing hazardous materials, and
- Contaminated soils in the vicinity of the Instrument House.

Removal of the canal house, water treatment house, equipment, pipes, asphalt, concrete and accessible contaminated soils

This completed action removed and disposed of

- Above-ground canal and water treatment house structures and systems,
- Contaminated canal and water treatment house concrete structures and piping, and
- Asphalt surfacing and underlying contaminated surface soils.

The following removal actions are currently being performed. These response actions are consistent with the selected remedy for the BGRR complex.

Removal of the reactor exhaust cooling coils and filters

This ongoing removal action includes the removal and disposal of the reactor exhaust air coolers and filters from the below-ground ducts.

Removal of the below-ground duct primary liner

This ongoing removal action includes the removal and disposal of

- Below-ground duct exhaust filter support structures,
- Inner binding plates and aluminum thermal shield throughout the entire below-ground duct, and
- Outer binding plates that were exposed to the contaminated water collected within the ducts.

Removal of the fuel canal structure and subsurface contaminated soils located outside of the footprint of the reactor building

This ongoing removal action includes the removal and disposal of:

- Portions of the fuel canal structure outside the foundation footprint of Building 701; and
- Accessible subsurface contaminated soils in the vicinity of the
  - Canal,
  - Reactor building trench,
  - Below-ground duct secondary cooling air bustle, and
  - Cooler drain sumps and below-ground duct expansion joint #4.

Based on the foregoing response activities that have been or are being performed, the following additional remedial activities are being selected under this ROD.

Removal of the Graphite pile

Removal of the graphite pile includes removal of the concrete and steel plugs at the top of the biological shield, the shroud surrounding the pile, and the graphite blocks of the reactor pile. Graphite blocks will be removed to the steel plate at the base of the reactor. Loose debris will be removed and a fixative will be applied to the internal surfaces of the biological shield.

Removal of the Biological shield

Removal of the biological shield will include removal of the neutron shields and the steel-encased concrete walls. Loose debris will be removed and a fixative will be applied to the exposed surfaces.

Sealing of the below-ground ducts

Sealing of the below-ground ducts includes the installation of a permanent wall at the east end of the duct, and weather-tight covers over the plugs for the future boiler and filter access locations. Additionally, a grout will be used to permanently seal penetrations at the secondary air bustles, four expansion joints, and instrument ports located below the Instrument House (Building 708). Visible cracks will be sealed to prevent water intrusion.

Design and Installation of an Engineered Infiltration Management System

An engineered cap, as part of an infiltration management system, will be installed to prevent water intrusion into sub-surface components and soils remaining on the BGRR complex

following completion of the removal actions. The engineered cap will be installed over the grounds east and south of Building 701. Constructing the cap will involve grading the existing property to create a slope away from the below-ground duct and Building 701, laying a polymer liner over the soil, and covering it with low-permeability barrier soil and blacktop. The cap will capture and re-direct surface water away from Building 701 and affected underground structures and sub-surface soils.

Additional groundwater monitoring wells will be installed south of the BGRR complex to provide assurance of the protectiveness of the cap. Following installation, groundwater monitoring will be performed as required by the *Brookhaven National Laboratory Operable Unit -III Record of Decision*.

Establishment and Implementation of Land Use and Institutional Controls

Long-term activities will be conducted to ensure effectiveness of this remedy. The BNL Land Use Controls Management Plan (LUCMP) (DOE 2003a) contains site-wide control measures and land use restrictions to prevent exposure to environmental contamination and to protect the integrity of remedies specified within this and other approved RODs. To accomplish this objective, specific measures will be incorporated into the remedial design for the BGRR and will include the following:

- Routine environmental health and safety monitoring;
- Periodic structural inspections of Building 701;
- Water intrusion monitoring;
- Preventive maintenance of Building 701 and the infiltration management system; and
- Groundwater monitoring required as part of the OU III ROD and proposed Explanation of Significant Differences (ESD).

Institutional controls will be established to ensure land use restrictions and reporting requirements are maintained beyond the completion of the remediation of the BGRR complex. In addition to the administrative controls placed on the future land use at BNL, the following specific institutional controls will be included as part of the remedial design for the BGRR complex.

- Control measures for future excavation of residual subsurface contamination at the BGRR will include physical identification of the affected areas and work restrictions to prevent inadvertent personnel exposure to the remaining hazards.

No digging, drilling or ground-disturbing activities will occur within the area designated in Figure 10-1 - BGRR Complex - Land Use and Institutional Controls Area unless the activity has undergone DOE's review process, which includes but is not limited to following BNL's LUCMP, the Occupation Radiation Protection regulations and the Nuclear Safety Management regulations. Any digging, drilling or ground-disturbing activity that occurs deeper than 15 feet (other than those in response to emergencies necessitating prompt action) will require EPA's concurrence.

No groundwater shall be extracted within the area designated in Figure 10-1 unless it has undergone DOE's review process, which includes but is not limited to following BNL's LUCMP, the Occupation Radiation Protection regulations and the Nuclear Safety Management regulations. Any such activity outside the groundwater monitoring program will require EPA's concurrence.

- Upon implementation of the remedy, a reassessment will be made to determine the area in which the digging, drilling, ground-disturbing and

groundwater extraction restrictions will be applied during the post-remedy phase.

- Following any future excavation, modifications to the existing limitations on land use/reuse will be in accordance with NYSDEC regulations.

- Establish specific land use restrictions within the BNL LUCMP limiting future use and development of the BGRR complex to commercial or industrial uses only. Additionally, ensure that any future plans for excavation of the inaccessible contaminated soils include the assessment of risk to human health and the environment based on the actual distribution, depth and concentrations of the residual radioactive material encountered.

- Provide annual certification to the NYSDEC that the institutional controls and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the control to protect public health or the environment. The annual certification will be prepared and submitted by a professional engineer or environmental professional accepted by NYSDEC.

- Ensure that the land use restriction and reporting requirements be passed on to any/all future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a Federal entity, DOE will be responsible for implementing, enforcing, maintaining and reporting on these controls. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the DOE or its successor agency shall retain ultimate responsibility for remedy integrity. Upon transfer of the property to a non-Federal entity by the U.S. Government, a deed will be established and an environmental easement will be added to the deed at that time.

Figure 10-1 shows the area of the BGRR complex where land use and institutional controls will be implemented. Any activity that is inconsistent with the land use restrictions or actions that may interfere with the effectiveness of the institutional controls established for the BGRR complex will be addressed by DOE with IAG parties as outlined within the BNL LUCMP.

Following completion of the BGRR remediation, residual radioactivity will remain within inaccessible pockets of contaminated soil and contaminated below grade structures. These contaminants are bound within the concrete and steel structures and are located within the BGRR complex. These contaminants are currently inaccessible and are not considered a groundwater contamination source term. The relative location of the remaining structures and soil pockets are also depicted in Figure 10-1.

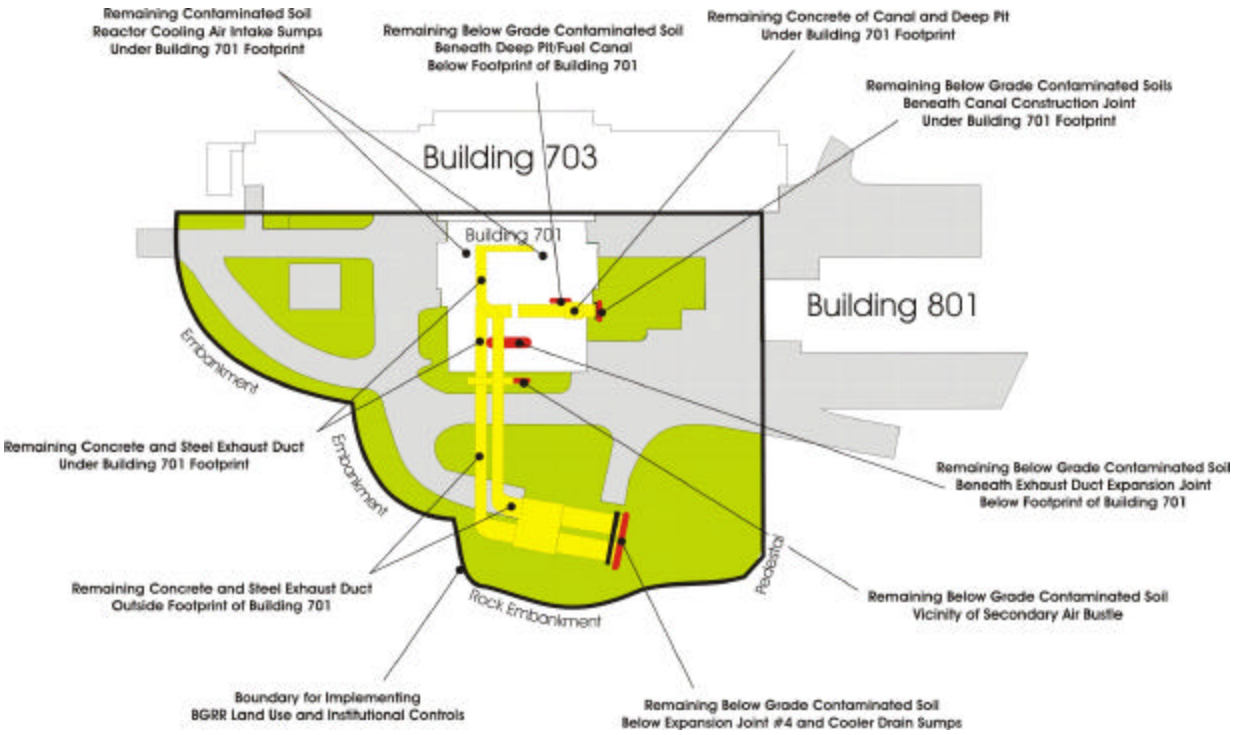

Figure 10-1. BGRR Complex - Land Use and Institutional Controls Area.

11. 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. Comprehensive Environmental Response Compensation & Liability Act 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 remedy meets these statutory requirements.

11.1 Protection of Human Health and the Environment

This remedy removes over 99 percent of the radioactive material inventory at the BGRR complex. The massive Building 701 foundation and superstructure would protect the contaminated soil and components that would remain under the building footprint. These structures form a significant barrier to future excavation and direct exposure, and serve as an effective barrier to prevent the migration of the remaining contaminants to groundwater. Coupled with infiltration management and institutional controls these removal actions will be effective in protecting human health and the environment.

11.2 Compliance with ARARs

The National Contingency Plan 40CFR300.430 (f)(1)(ii)(B) requires that the selected remedy attains the Federal and State ARARs or obtains a waiver of an ARAR.

Chemical Specific ARARs

1. 6 New York Code, Rules and Regulations (NYCRR) part 212, *General Process Emission Sources*: These State regulations will be followed to determine the need for air-emission control equipment. All remedial work will be performed in accordance with standards and procedures that will ensure compliance with these regulations.

2. 6 NYCRR Part 380, *Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials*: These regulations are the relevant and appropriate regulations for controlling radioactive emissions and liquid releases to the environment while completing the remedial action. Potential radioactive surface contamination release, airborne radioactivity generation and release or radioactive liquid release will be controlled to eliminate emissions that would affect human health or the environment.

3. Resource Conservation and Recovery Act (RCRA) (40CFR260-281): These Federal regulations define hazardous wastes.

4. New York State Hazardous Waste Management System Regulations (6 NYCRR 370 – 376): These regulations define hazardous wastes in New York State. All wastes classified as hazardous will be handled, stored, and disposed of off-site at a permitted facility in accordance with these regulations.

5. Safe Drinking Water Act (40CFR141.16): Establishes maximum contaminant levels (MCLs) that are used as groundwater standards for sole source aquifers. BNL site wide conformance with the ARAR is addressed in the OUOU III Record of Decision. U.S. Department of Transportation

Requirements for the Transportation of Hazardous Materials (49CFR Parts 100 to 170) will be applicable for any wastes that are transported off-site.

Location-Specific ARARs

1. National Historic Preservation Act (36CFR800): This Act requires Federal agencies to take into account the effects of their actions on historic properties.

Action-Specific ARARs

1. 10CFR835, *Occupational Radiation Protection*: These rules establish radiation protection standards for all DOE activities. Remedial action will be performed in accordance with the requirements of a DOE-approved radiation protection program and dosimetry program and appropriate procedures established to ensure compliance with this regulation.

2. 10CFR830, *Nuclear Safety Management*: These rules establish the minimum acceptable quality assurance and controls for all applicable DOE activities. Remedial action will be performed in accordance with the requirements of a DOE-approved quality assurance and control program and appropriate procedures established to ensure compliance with this regulation.

3. RCRA (40CFR260-268): As described above.

4. New York State Hazardous Waste Regulations (6 NYCRR Parts 370 – 376): As described above.

5. Clean Air Act (42 United States Code [U.S.C.] Section 7401, et seq.) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40CFR 61): This Act regulates and limits the emissions of hazardous air pollutants, including radionuclides. All activities that have the potential for creating airborne emissions will require confinement or containment with confirmatory air sampling to verify compliance with these requirements and applicable standards.

6. 49CFR Sections 173.4 through 173.471, Packaging and Transportation of Radioactive Material.

To Be Considered Guidance

1. DOE Order 451.1B, National Environmental Policy Act Compliance Program: This order requires that CERCLA actions address NEPA values.

2. NYSDEC Technical and Administrative Guidance Memorandum *Remediation Guideline for Soils Contaminated with Radioactive Materials* (#4003), September 1993: This memorandum contains State guidance for remediating radiologically contaminated soils. The State's value of 10 millirem per year (mrem/yr) above background serves as an additional goal for remediation that will be evaluated during remedial action planning and implementation.

3. NYSDEC's Division of Air Guidelines for Control of Toxic Ambient Air Contaminants, Air Guide 1: This guide will be used to assess the impacts of air emissions for activities having the potential for creating airborne radioactivity. Contents of this guide will be used to aid in evaluating the need for having air-emissions control equipment.

4. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*: This order establishes the standards and requirements with respect to protection of members of the public and the environment against undue risk from radiation. As with 10CFR835, remedial action will

be performed in accordance with appropriate procedures established to ensure continued protection of the public and the environment.

5. DOE Order 435, Radioactive Waste Management: This order provides guidance and requirements for management and disposal of radioactive waste generated at DOE facilities.

6. As Low As Reasonably Achievable (ALARA) is the practical approach to radiation protection used to manage and control exposures (both individual and collective) to the work force and to the general public, to levels as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. Technologies and techniques incorporated into this remedy will be such that radioactive waste is minimized and direct exposure to radiation sources is reduced to as low as reasonably achievable.

7. 40CFR300.440, *The Off-Site Rule* – (52FR49200): The purpose of the rule is to avoid having wastes generated from response actions authorized or funded under CERCLA contribute to present or future environmental problems by directing these wastes to management units determined to be environmentally sound. The rule establishes the criteria and procedures for determining whether facilities are acceptable for the receipt of wastes generated from response actions authorized or funded under CERCLA. The rule establishes compliance criteria and release criteria, and establishes a process for determining whether facilities are acceptable based on those criteria. The rule also establishes procedures for notification of unacceptability, reconsideration of unacceptability determinations, and re-evaluation of unacceptability determinations. In accordance with this rule, BGRR wastes will only be sent to off-site facilities that meet EPA's acceptability criteria.

8. *Memorandum of Agreement Between Brookhaven Area Office and New York State Historic Preservation Office Concerning the BGRR Decommissioning Project*: DOE determined that the BGRR is eligible for inclusion in the National Register of Historic Places in accordance with the National Historic Preservation Act of 1966. DOE also established a number of measures to mitigate the adverse impacts of decommissioning in consultation with the New York State Historic Preservation Officer (SHPO).

11.3 Cost-Effectiveness

Based on the expected performance standards, the selected remedy is cost-effective. It effectively provides short and long-term protection of human health and the environment at an acceptable cost.

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. Although the selected remedy requires continued monitoring, institutional controls and reporting, the selected remedial action involves the removal and disposal of contaminated components and soils that pose a potential risk to exposed populations, and, therefore, is a permanent remedy with respect to risk reduction. The waste generated from this remedial action will be disposed of in off-site facilities that meet EPA's acceptability criteria.

11.5 Preference for Treatment as a Principal Element

This alternative does not meet the EPA's statutory preference for treatment as a principal component. The principal contaminants of concern are radioactive isotopes and there are no technologies to change

the radioactive properties of these isotopes through the use of treatment systems. There will be no treatment to reduce the toxicity, mobility, or volume of the contaminants in soil.

11.6 Documentation of Significant Changes

The Proposed Plan for the remediation of the BGRR complex was released for public comment in August 2004. It identified Alternative C – Removal of Pile, Biological Shield, Fuel Canal Structure and Reasonably Accessible Soils as the Preferred Alternative. DOE reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate at this time.

11.7 Review/Certification

In addition to the five-year CERCLA reviews necessary to evaluate the effectiveness of the institutional control to restrict inappropriate land use, annual certification to the NYSDEC will be required. This review will certify to the State 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.

III RESPONSIVENESS SUMMARY

The community involvement process for the BGRR is, and has been, an integral part of making cleanup decisions. Project staff made multiple presentations to the CAC, BER, and various local civic associations.

A public comment period for the *BGRR Proposed Remedial Action Plan* was from August 2 through September 3, 2004. Two information sessions were held, on August 17 and 19, 2004. Additionally, a public meeting was held on August 24, 2004. All written and verbal comments submitted during the public comment period were compiled and reviewed. Copies of the comments received, along with a copy of the public meeting transcript, are appended to this ROD.

Public Comment Summary: Comments from the public include three emailed comments, one comment-response form, four letters, a recommendation from the Community Advisory Council, the public meeting transcript, and 180 copies of one form letter. Two commenters recommended Alternative A. The selected alternative was supported by the Community Advisory Council, Citizens Campaign for the Environment, the Huntington Breast Cancer Action Coalition, the International Brotherhood of Electrical Workers local 2230, and a member of the public. One unique letter and the180 copies of the form letter supported Alternative D.

Comments are grouped into six classes: cost, safety, transportation, groundwater, surveillance and monitoring, and building re-use.

Cost: Comments about cost ranged from supporting Alternative A because it would save money, to supporting Alternative D because it would save money.

Comment: A comment was received expressing concern that the cost estimates were too low.

Response: It should be noted that the cost estimates were generated by a team of experts independent from the Laboratory, and validated by an independent DOE group. The validation team concluded that the cost estimates were reasonable and accurate.

Comment: A comment was received suggesting a remedial action between Alternatives A and B, that is, the writer recommended removing the graphite pile but leaving the biological shield.

Response: While technically possible, removing only the pile would leave 4,805 Curies or approximately 54 percent of the total radioactivity. A major constituent of the radioactivity within the biological shield is long-lived radioactive nickel-63. The nickel-63 represents over 60 percent of the long-lived contamination on the site and thus justifies removal of the biological shield as part of the BGRR remedy.

Comment: A comment was received indicating Congressman Tim Bishop had assured $250 million for the cleanup of the BGRR and thus adequate funding was available to complete Alternative D - Greenfield.

Response: Unfortunately, this is inaccurate. Congressman Bishop announced that there was $240 million in the FY06 Federal budget for Brookhaven National Laboratory, of which approximately $43 million was earmarked for *all* cleanup at BNL, not just for the BGRR decommissioning. That $43 million is about what DOE had previously announced they expected to fund in fiscal year 2006.

Safety: Comments about safety ranged from supporting Alternative A because it would pose less risk to the workers and public while another suggested that advances in technology may eliminate the risk from radiation.

Comments: Two people who wrote to support Alternative A expressed concern about the safety of workers and the surrounding communities.

Response: It should be noted that reactor decommissioning is a mature industry, and detailed planning is part of the process. Before work begins, tasks are evaluated to ensure that they are being performed with as little exposure to risk as is possible. Job safety assessments are performed before work permits are issued. Workers and neighbors will be further protected because the work will be done with sufficient confinement to ensure that no effluents will leave the work site. Moreover, neighboring communities ought not be impacted due to the work, as no shipment of material will be capable of causing exposure to our neighbors or those drivers en route to the disposal facilities.

Comment: One Alternative A supporter expressed a preference for waiting for a breakthrough in technology to solve the problem of radiation.

Response: There may be legal issues that preclude waiting for a technological breakthrough. New York State has enacted laws that specifically prohibit the siting of low-level radioactive waste over Long Island's sole-source aquifer. Since the BGRR is no longer an operating facility, the State may choose to view the indefinite long-term storage of the pile and biological shield as tantamount to creating a low-level waste disposal facility.

Transportation: Concerns were expressed about transportation accidents.

Comment: Two commenters expressed concern regarding the potential for truck and rail accidents and the potential for packages to leak.

Response: While truck and rail accidents are always a concern, it should be noted that the waste generated during the BGRR decommissioning is limited to low-level waste. (The spent fuel was transported off site in 1972.) Standard shipping containers designed for low-level waste will be used, and the waste will be transported to licensed disposal sites designed for this type of material.

Groundwater: Issues concerning the BGRR contribution to contaminants in groundwater were raised.

Comment: Three commenters expressed concern regarding continued monitoring and surveillance to ensure groundwater is not affected by contaminants remaining in the soil.

Response: Groundwater remediation is addressed within the OU III ROD and proposed ESD. Pursuant to the ROD, pump and treat technology is currently used to reduce the concentrations of contaminants in the groundwater. Routine groundwater monitoring is performed to evaluate the effectiveness of the treatment and ensure groundwater contaminants are not released from the BNL Site boundary. The selected remedy for the BGRR includes the installation of additional groundwater-monitoring wells south of the BGRR complex. Once installed, monitoring of these wells will be incorporated into the OU III surveillance and monitoring program.

Surveillance and monitoring: Concerns were expressed regarding continued surveillance of the BGRR complex.

Comment: One commenter expressed concern regarding assurance that Building 701 will continue to be monitored and maintained.

Response: The planned remedy includes regular environmental health and safety monitoring, periodic structural inspections, and preventive maintenance of the structure and the infiltration management system.

Comment: One commenter expressed a desire to ensure additional soil sampling be performed on deep soils while excavating the accessible soil pockets.

Response: The selected remedy includes removal of accessible soils. During this removal, samples will be obtained in the vicinity of the excavation to provide additional data related to the remaining soils. Additionally, measures will be taken to ensure any future excavation of the soils at the BGRR complex include additional characterization and establishment of limitations on use/reuse based on the actual distribution, depth, and concentrations of the residual radioactive material encountered.

Building Re-Use: Concerns regarding Building 701 ranged from protecting it for its historical value to removing it to ensure it is not used for a nuclear facility in the future.

Comment: Two commenters noted that the building has historic significance, and felt that it should remain.

Response: Under DOE's preferred alternative, the building would remain for possible re-use.

Comment: One commenter wrote that, if the building were removed, the public would be assured that it could never be re-used for a nuclear venture.

Response: Removing the pile and biological shield would serve the same purpose. Moreover, it is extremely unlikely that DOE would ever consider building another small research reactor at BNL over a sole-source aquifer.

Comment: One commenter noted that removing the building would restore real estate to the Laboratory property.

Response: While true, the restored real estate would be far less than the 800 acres the writer assumes; in fact, the building occupies an area of only approximately one-half acre. Moreover, re-using the acreage would entail construction of a new building after demolishing the current serviceable building.

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