Final

CLOSEOUT REPORT

High Flux Beam Reactor Underground Utilities Removal Area of Concern 31

Brookhaven National Laboratory
Upton, New York

August 2011

Prepared by:

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EPA Comments on
DRAFT HFBR UNDERGROUND UTILITIES CLOSEOUT REPORT
July 2011

COMMENT RESOLUTION FORM

Reviewer and Organization: EPA – Jessica Mollin		
Number	**NYSDEC Comment**	**Response**
EPA-01	Page 8, Paragraph 1 and throughout text of report: Clarify whether (i) non-restricted residential scenario is used in dose assessment or (ii) restricted residential non-farmer scenario. If the latter is used, then add words "restricted" and/or "non-farmer" as applied to this scenario throughout the text of the report. Include brief explanations on land and/or water use.	The scenario termed "residential" was "resident non-farmer." The report was revised throughout to reflect this. For resident non-farmer dose assessment, land use included vegetable consumption from vegetable gardening, no meat consumption and no milk consumption. Water use included drinking water and no aquatic food consumption.
EPA-02	Page 21, Paragraph 3: Provide details on maximum depths and depth intervals for the core samples.	Core samples were collected in two foot intervals to a depth of 8 feet below existing grade. Paragraph 3 on Page 21 was revised to include this information.
EPA-03	Page 42, Bullet 2: Indicate if the unknown pipes were surveyed for residual or RAM and if yes, what the results were.	The unknown pipes were other utilities that were not a part of the removal of the contaminated piping. They were not opened for surveying but were externally surveyed as part of the final status survey. The survey results were below the project screening level.

EPA Comments on
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EPA-04	Appendix A, Page 4, Table 3: Clarify units for Gross Alpha and Gross Beta data rows. If they are pCi/g, include background portion of the values, explain how this unit is applied and why the values are high relative to the remaining data in the columns.	Results for Gross Alpha and Gross Beta are in pCi/g. Typically, due to the method of analysis, the gross alpha and gross beta analyses yield higher values than isotope specific analyses. Essentially all of the activity in the gross alpha and gross beta analyses are from background radionuclides such as K-40 and the decay products from the naturally occurring uranium and thorium chains.

NYSDEC Comments on
DRAFT HFBR UNDERGROUND UTILITIES CLOSEOUT REPORT
July 2011

COMMENT RESOLUTION FORM

Reviewer and Organization: NYSDEC – Chek Beng Ng, P.E.		
Number	**NYSDEC Comment**	**Response**
DEC-01	Executive Summary, Page 1: Bullet 1 states that the Sr-90 concentration is less than the laboratory detection limit. It should be made clear that the laboratory detection limit is less than the site cleanup goals for Sr-90.	The detection limit for Sr-90 is approximately 0.8 pCi/g. The Executive Summary was revised to clarify this.
DEC-02	Section 3.1.2, Page 15: In the second paragraph, it was stated that approximately 100 gallons of water was extracted inside Building 750. From page 42, it was later revealed that the water was contaminated. If analysis of the water was performed, the results should be made part of the report, either stated clearly in the main text or referenced to an appropriate section in the Appendix.	The approximately 100 gallons of water removed from the D/F waste line prior to excavation was co-mingled with other HFBR waste water, solidified at BNL's Waste Management Facility and later disposed at Nevada Test Site. Waste characterization data is retained by BNL's Waste Management Division and is available for review upon request, but is typically not included in Closeout Reports. Radionuclides detected in the comingled water were: • Cs-137 (48.3 pCi/L) • Co-60 (5,660 pCi/L) • Sr-90 (17.4 pCi/L) • H-3 (2,010,000 pCi/L)

DEC-03	Section 3.2.2, Page 22: "...As shown in Figure 3-2, an isolated area..." Figure 3.2 should be corrected to read Figure 3-4.	Revised as suggested.
DEC-04	Figures 3-4, 3-5A, 3-5B, 3-5C, 3-5D, 3-5E: The legend for the gamma count rate should be included in each of the figures.	Revised as suggested
DEC-05	Table 3-2, Page 30: This table states that "No samples indicated detectable values" for Sr-90. The table should indicate what the detection limit was for this analysis.	The detection limit for Sr-90 is approximately 0.8 pCi/g. The table was revised accordingly.
DEC-06	Table 3-2, Page 30: The note states that "Other radionuclides as listed in Table 3 of the FSP were analyzed for, and no detectable concentrations..." It should be made clear that the detection limit is less than the site cleanup goals listed in Table 2-1.	The note was revised to indicate that detection limits for radionuclides in Table 3 of the FSP are less than 20% of their respective cleanup goals.

NYSDEC Comments on
DRAFT HFBR UNDERGROUND UTILITIES CLOSEOUT REPORT
July 2011

COMMENT RESOLUTION FORM

DEC-07	Section 3.2.2, Page 30: The summary of the soil sample results for chemical contaminants should be referred to Table 3-3, not Table 3-10.	Revised as suggested.
DEC-08	Section 11.0, Page 44: A carry over comment from the Five Year Review document - departure(s) from five-year reviews should be communicated with regulatory agencies.	Section 11.0 was updated to include the following statement: Remedy implementation at the HFBR, including the removal of the HFBR Underground Utilities, was discussed in the *Five Year Review Report for Brookhaven National Laboratory Superfund Site* (BNL, March 2011).The HFBR complex will be included in the next sitewide five year review in 2016. Reporting of any departures from the 2011 five year review recommendation/follow-up action milestones will be addressed separately as part of the regulatory comment resolution on the five year review report.
DEC-09	A minor typographical error was noted at the last line of page 6, section 1.4: cobal-60 should be cobalt-60.	Revised as suggested.

Final

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Executive Summary

The High Flux Beam Reactor (HFBR) Underground Utilities, as described in Table 1-1, are associated with Area of Concern (AOC) 31 at Brookhaven National Laboratory (BNL). Removal of the HFBR Underground Utilities and the subsequent final status survey (FSS), referred to herein as the HFBR Underground Utilities Project, are part of the actions described as near-term decontamination and dismantlement (D&D) in the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (BNL, February, 2009) (HFBR ROD). The project was performed with funding from the American Recovery and Reinvestment Act (ARRA) and in accordance with *Closeout Procedures at National Priority List Sites*, Office of Solid Waste and Emergency Response (*OSWER) Directive 9320.2-09A-P* (EPA, 2000a).

Remedial activities associated with the HFBR Underground Utilities Project were divided into three work phases that commenced in February 2010 and were completed in December 2010. Upon completion of the removal of the HFBR Underground Utilities and any associated contaminated soil within each work phase, an FSS and independent verification (IV) of the associated trenches were completed to ensure that soil cleanup objectives were met in accordance with the HFBR ROD. The soil cleanup objectives for radiological contamination were based on a dose, to a resident (non-farmer) from remaining concentrations of all radionuclides present, of less than or equal to 15 millirem per year (mrem/year) above background after 50 years of institutional control by the Department of Energy (DOE), and industrial land use with no decay time (0 years).

The following summarizes the as-left conditions for the HFBR Underground Utilities and how they satisfy the requirements of the HFBR ROD:

- The average Cs-137 and Ra-226 concentrations remaining in the HFBR Underground Utilities soils are 0.04 picocuries per gram (pCi/g) and 0.35 pCi/g, respectively. Sr-90 concentrations were below laboratory detection limits (<0.8 pCi/g). The as-left average concentrations are well below the site cleanup goals (Cs-137=23 pCi/g, Sr-90=15 pCi/g and Ra-226=5 pCi/g). The maximum concentrations detected in soil samples were as follows: 1.0 pCi/g for Cs-137, less than laboratory detection limits for Sr-90 (<0.8 pCi/g), and 1.0 pCi/g for Ra-226.

- The average lead and mercury concentrations remaining in the HFBR Underground Utilities soils are 7.6 milligrams per kilogram (mg/kg) and 0.011 mg/kg, respectively. The as-left average concentrations detected in soils samples are below the site cleanup goals (lead=400 mg/kg and mercury=1.84 mg/kg). The maximum concentrations of lead and mercury detected in soil samples were 15 mg/kg and 0.016 mg/kg, respectively.

- For the HFBR Underground Utilities, the maximum projected dose to a resident non-farmer after 50 years of institutional controls is 0.2 millirem/yr. The maximum projected dose to a resident non-farmer with no decay time is 0.6

millirem/yr. The results of the dose assessment are below the objectives established in the HFBR ROD, including the dose objective of 15 millirem/yr and the New York State Department of Environmental Conservation (NYSDEC) cleanup guideline of 10 millirem/yr from Technical and Administrative Guidance Memorandum (TAGM) 4003, which was adopted as an ALARA goal.

- Site restoration for the HFBR Underground Utilities Project was completed in December 2010. Restoration included backfilling, re-grading, re-paving and reseeding lawn areas with Long Island native grasses.

The HFBR Underground Utilities meet all the completion requirements as specified in OSWER Directive 9320.2-09-A-P, *Closeout Procedures for National Priorities List Sites*.

The *HFBR Long Term Surveillance and Maintenance Manual* will be prepared to include the post remediation monitoring and maintenance activities for the HFBR Underground Utilities area. These activities will include institutional controls (land use controls, notifications and restrictions, work planning controls such as digging permits, and government *ownership*). The topsoil cover, placed during site restoration, will also be inspected for signs of erosion.

Brookhaven Science Associates (BSA) will perform operation and maintenance activities. In addition to maintaining institutional controls for the HFBR Underground Utilities area, BSA will ensure that that routine monitoring/inspections are performed. DOE will ensure enforcement of all institutional controls.

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FIGURES

TABLES

PHOTOGRAPHS

APPENDICES (See Enclosed Disc)

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ACRONYM LIST

ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
ARRA	American Recover and Reinvestment Act
BNL	Brookhaven National Laboratory
BGRR	Brookhaven Graphite Research Reactor
BSA	Brookhaven Science Associates
CDM	CDM Federal Programs
CPM	Counts Per Minute
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
Ci	Curies
DAC-Hr	Derived Air Concentration-Hour
D&D	Decontamination and Dismantlement
DOE	Department Of Energy
EPA	United States Environmental Protection Agency
EPD	Environmental Protection Division
ERP	Environmental Restoration Projects
ES	Energy Solutions of Utah
F&O	Facility and Operations
FRDP	Facility Review Disposition Project
FS	Feasibility Study
FSS	Final Status Survey
GPS	Global Positioning System
HASP	Health and Safety Plan
HFBR	High Flux Beam Reactor
IAG	Interagency Agreement
IH	Industrial Hygiene
IV	Independent Verification
JRA	Job Risk Assessment
JSA	Job Safety Assessment
LLRW	Low-Level Radioactive Waste
LUCMP	Land Use Controls Management Plan
mg/kg	Milligrams per Kilograms
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manuel
mrem/yr	Millirem Per Year
NaI	Sodium Iodide
NTS	Nevada Test Site
NYSDEC	New York State Department of Environmental Conservation
ORISE	Oak Ridge Institute for Science and Education
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
pCi/g	Picocuries per Gram
PCBs	Polychlorinated Biphenyls
PRAP	Proposed Remedial Action Plan

PVC	Polyvinyl Chloride
PWGC	P.W. Grosser Consulting, Inc.
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RCD	Radiological Controls Division
RCT	Radiological Controls Technician
RESRAD	Residual Radioactivity Computer Code
RI	Remedial Investigation
ROD	Record of Decision
RWP	Radiological Work Permit
SCDHS	Suffolk County Department of Health Services
SBMS	Subject Based Management System
SOP	Standard Operating Procedure
SU	Survey Unit
TAGM	Technical and Administrative Guidance Memorandum
TLD	Thermoluminscent Dosimeter
USC	United States Code
WAC	Waste Acceptance Criteria

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Closeout Report is to document the completed actions associated with the removal of the High Flux Beam Reactor (HFBR) Underground Utilities and the subsequent final status survey (FSS). This work is referred to herein as the "HFBR Underground Utilities Project." The HFBR is designated as Area of Concern (AOC) 31 at Brookhaven National Laboratory (BNL). The HFBR Underground Utilities Project is part of the actions described as near-term decontamination and dismantlement (D&D) in the *Record of Decision – Area of Concern 31, High Flux Beam Reactor* (BNL, February, 2009) (HFBR ROD). The project was performed with funding under the American Recovery and Reinvestment Act (ARRA) and in accordance with *Closeout Procedures at National Priority List Sites, OSWER Directive 9320.2-09A-P* (EPA, 2000a).

Remedial activities associated with the HFBR Underground Utilities Project were performed by BNL's Environmental Restoration Projects (ERP), ERP-seconded and task order subcontractors, Brookhaven Science Associates (BSA) Radiological Control Division (RCD), and Environmental Protection Division (EPD) personnel. Verification radiological surveys and sampling were performed by ORISE.

Work was performed in accordance with the HFBR ROD and the *Remedial Design/Remedial Action Work Plan for the Decontamination and Dismantlement (D&D) of the Stack and Removal of the HFBR Underground Utilities* (BNL, August 2010). The FSS was performed in accordance with the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010).

The scope of work for the HFBR Underground Utilities Project included the following:

- Permanent isolation, characterization and removal of the HFBR Underground Utilities. As further discussed in Section 1.2, the HFBR Underground Utilities do not include all of the underground ducts and piping specified in Table 8.2 of the HFBR ROD. Ducts and piping that are outside of the scope of the HFBR Underground Utilities Project were either removed during the Building 801-811 Waste Transfer Lines Project or will be removed as part of the HFBR Fan Houses Project; and the removal of those ducts and piping was, or will be, documented by the applicable closeout report;
- Characterization of overburden and underlying soils, and if necessary, removal of contaminated soils associated with the HFBR Underground Utilities;
- Packaging, transport, and disposal of radiologically and chemically contaminated project waste at an off-site permitted facility;
- Performing an FSS of the trenches associated with the HFBR Underground Utilities, including an IV performed by ORISE; and

- Preparing a dose assessment and a closeout report.

1.2 Site Description and Operational History

The BNL site covers almost 5,300 acres, much of which is wooded. It is an irregular polygon, and each side is approximately 2.5 miles long. 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 1,650 acres, 500 acres of which were originally developed for U.S. Army use. Large, specialized research facilities occupy 200 acres and another 400 acres are occupied by roads, parking lots and connecting areas. The remaining 550 acres are occupied by outlying facilities including 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 upper glacial 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 5 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.

A map illustrating the location of the BNL site is presented as Figure 1-1.

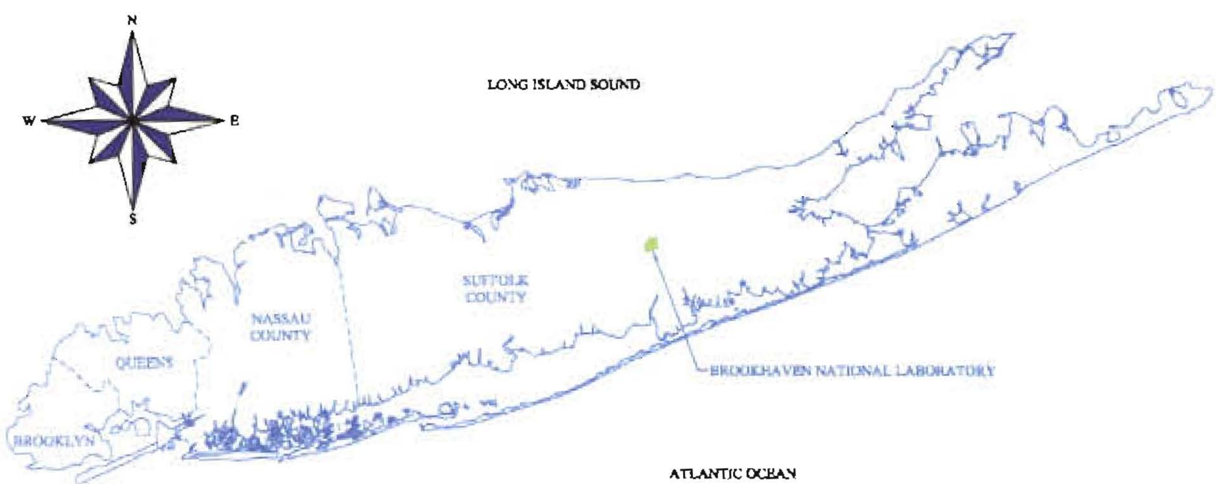


Figure 1-1 Location of Brookhaven National Laboratory

Figure 1-2 HFBR Complex Location at BNL

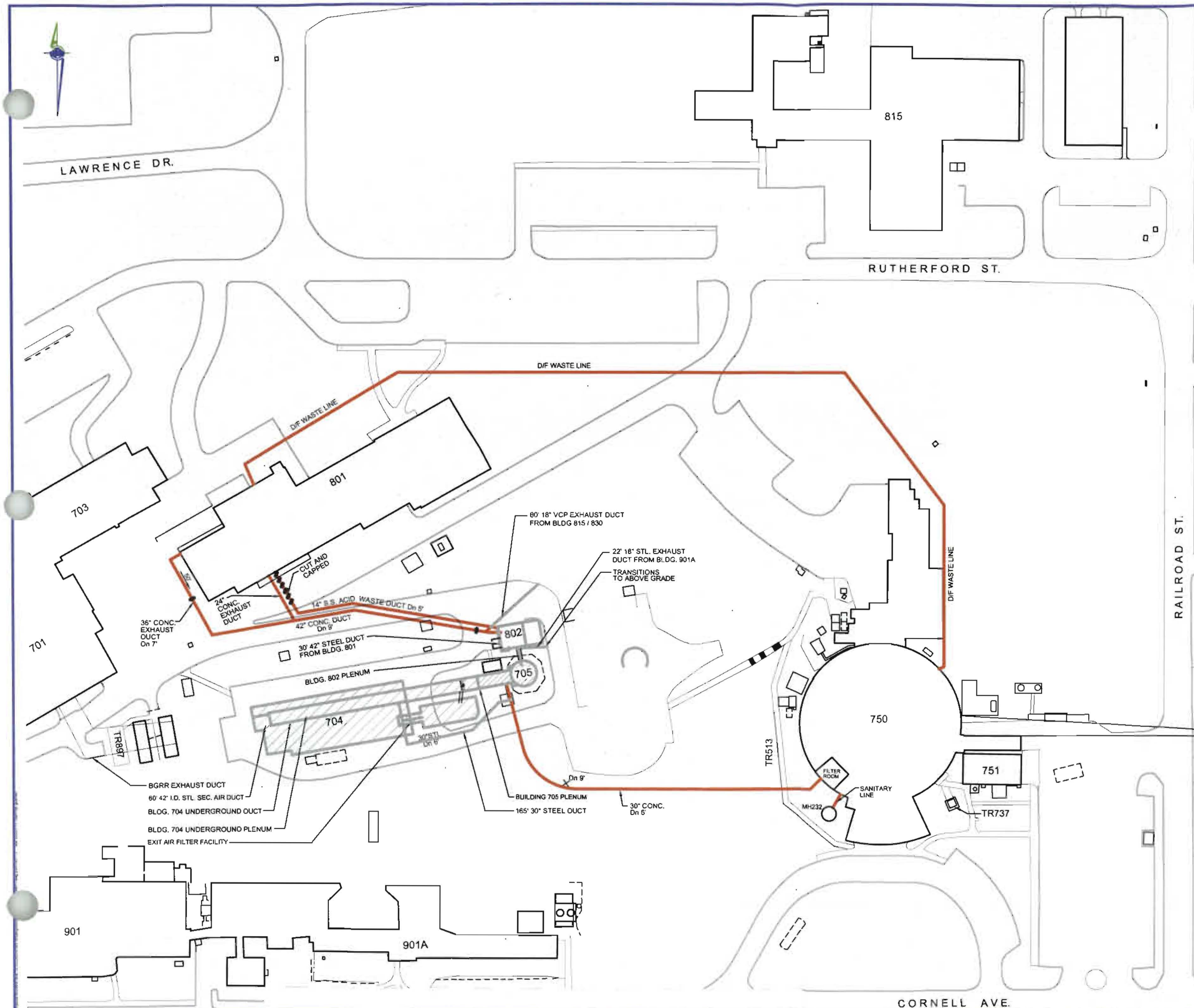
The HFBR complex is centrally located within the BNL site, as shown in Figure 1-2. The HFBR (Building 750) was designed and constructed for basic experimental research. During its operating lifetime from 1965 to 1996, it provided neutrons for materials science, chemistry, biology, and physics experiments. The HFBR utilized the ducts specified in Table 1-1 to transport exhaust to the Stack (Building 705). The D/F-waste line, which was a double-walled pipeline, carried D/F-category liquid radioactive waste from Building 750 to Building 801. The locations of the HFBR Underground Utilities and their relationship to the HFBR, Building 801 and Stack are shown in Figure 1-3.

Table 1-1

Description of the HFBR Underground Utilities

Work Phase	Duct/Line	Size/Material	Length (ft)	Description
1	Duct 750 to the Stack	30-in./concrete	425	Concrete duct runs from 750 to valve pit adjacent to the Stack where it transitions to steel.
1	Sanitary Line 750 to MH232	8-in./steel	26	Sanitary line runs from southwest side of Building 750 to MH232
2	D/F Waste Line 750 to 801	2-in./steel within 4-in./bituminous coated steel	1,083	Buried line runs from 750 around annex to 801
3	Acid Waste Duct 801 to the Stack	14-in./stainless steel	300	Includes the portion of the line that runs from a point approximately 60 feet south of Building 801 to just outside (west) of Building 802. The remainder of the line, inside/under Building 802 and from Building 802 to the Stack, will be removed as part of the HFBR Fan Houses Project.
3	Duct from connection with 36-in. duct from 801 to 802	42-in./concrete	230	Duct runs from transition point with the 36-in. duct to Building 802.
3	Duct 801 to 42-in. duct	24-in./concrete	60	Duct runs from south wall of Building 801 to the 42-in. diameter duct just downstream of point it transitions from 36-in. to 42-in.
3	Duct 801 to 42-in duct	36-in./concrete	205	Duct runs from west wall of Building 801 to a point approximately 60 ft south of Building 801, where it transitions from 36-in. to 42-in. diameter.

Note.
It should be noted that the HFBR Underground Utilities do not include all of the underground ducts and piping specified in Table 8.2 of the HFBR ROD. Ducts and piping that are outside of the scope of the HFBR Underground Utilities Project were either removed during the Building 801-811 Waste Transfer Lines Project or will be removed as part of the HFBR Fan Houses Project; and the removal of those ducts and piping was, or will be, documented by the applicable closeout report



ABBREVIATIONS

S.S.	STAINLESS STEEL
INV	INVERT ELEVATION
RCP	REINFORCED CONCRETE PIPE
ABAND.	ABANDONED
C.I.	CAST IRON PIPE
VCP	VITRIFIED CLAY PIPE
CONC	CONCRETE
A.G.	ACID GAS
STL	STEEL
Dn	DOWN
NIC	NOT IN CONTRACT

LEGEND

	OFF GAS LINE
	ABANDONED OFF GAS LINE
	HEAD WALL
	STORM TRENCH
CB	CATCH BASIN
MH	MANHOLE
DW	DRY WELL
CO	CLEAN OUT
SG	STORM GRATES
LP	LEACHING POOL
SP-	SEWAGE PUMPING STATION
HW	HORIZONTAL WELL

COLOR CODES

- IN SCOPE OF WORK
- NOT PART OF WORK

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DRAWINGS PREPARED FOR

REVISIONS	DATE	INITIAL	COMMENTS

DRAWING INFORMATION

PROJECT: BNL1001	APPROVED BY: BMM
DESIGNED BY: MWM	DATE: 11/15/10
DRAWN BY: LLG	SCALE: AS SHOWN

SHEET TITLE

HFBR UNDERGROUND UTILITIES

CONTAMINATED DUCTS AND LINES

FIGURE NO.

FIGURE 1-3

SHEET - OF -

1.3 Regulatory and Enforcement History

In 1980, the BNL site was placed on New York State's Department of Environmental Conservation (NYSDEC) list of Inactive Hazardous Waste Sites. On December 21, 1989, the BNL site was included on the U.S. Environmental Protection Agency (EPA) National Priorities List because of soil and groundwater contamination that resulted from BNL's past operations. Subsequently, EPA, NYSDEC, and DOE entered into a Federal Facilities Agreement (herein referred to as the Interagency Agreement; [IAG]) that became effective in May 1992 (Administrative Docket Number: II-CERCLA-FFA-00201) to coordinate the cleanup.

The IAG identified Areas of Concern (AOCs) that were grouped into Operable Units (OUs) to be evaluated for response actions. The IAG required a remedial investigation/feasibility study (RI/FS) for OU I, pursuant to 42 United States Code (USC) 9601 et seq., to meet Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements. OU I consists of areas of soil contamination at the BNL site where waste was historically managed or disposed. The OUs and AOCs identified by the IAG are discussed further in Sections 1.5 and 2.0.

Upon completion and review of the results of a Remedial Investigation (RI) and Feasibility Study (FS) for OU I, the *Record of Decision – Operable Unit I and Radiologically Contaminated Soils (Including Areas of Concern 6, 8, 10, 16, 17, and 18)* (OUI ROD), was signed in August 1999. The OU I ROD specified the excavation and off-site disposal of radiologically and chemically contaminated soils.

In April 2009, the HFBR ROD was finalized. The HFBR ROD specified the removal of the HFBR Underground Utilities as well as the removal of contaminated soil within the HFBR complex utilizing the dose-based cleanup goal and methodology specified in the OU I ROD.

1.4 Site Investigation

Comprehensive sampling and analyses were performed to characterize the HFBR complex between 2000 and 2005. These activities included both radiological and non-radiological characterization of surface and subsurface soils and various underground duct and piping systems. Radiological characterization of the acid waste line and the interconnecting ducts indicates that the ducts from Building 750, Building 801, and Building 802 are contaminated above the criteria specified in Table 2-2 of the BNL Radiological Controls Manual, with an isotopic content of cobalt-60, nickel-63, and cesium-137. The D/F-waste line characterization, based upon process knowledge, indicates that the double-walled underground pipeline that runs between Building 750 and Building 801 is contaminated above the criteria specified in the BNL Radiological Controls Manual, with an isotopic content of tritium, cobalt-60, nickel-63, and cesium-

2.0 OPERABLE UNIT BACKGROUND

2.1 Site Cleanup Criteria

The primary radiological contaminants of concern for the soil within HFBR complex were specified in the HFBR ROD and are the same as those for OU I radiologically contaminated soils: cesium-137, radium-226, and strontium-90. The cleanup goals for specific radionuclides were calculated using RESRAD, considering a resident non-farmer scenario. The dose limit used was 15 millirem per year (mrem/yr) above background (*OSWER Directive 9200.4-1., EPA, 1997*), resident non-farmer land use after 50 years of institutional control by the DOE, and industrial land use with no decay time (0 years). In addition, the NYSDEC cleanup guideline of 10 mrem/yr, from TAGM 4003, was adopted as an ALARA goal. The primary radiological isotope present at the site was cesium-137; its cleanup goal, as established in the OU I ROD and specified in the HFBR ROD, is 23 pCi/g.

The potential for radiologically contaminated soil to impact groundwater was also considered. A soil cleanup goal of 15 pCi/g was calculated for strontium-90, based on its potential to impact the groundwater. The goal also protects both resident non-farmer and industrial uses. A cleanup goal of 5 pCi/g was selected for radium-226, based on DOE Order 5400.5, *Radiation Protection of the Environment and the Public* (DOE, 1993).

Additional radionuclides that were not addressed in the OU I ROD were also evaluated. As discussed in Section 1.4, previous site investigations indicated that HFBR Underground Utilities were contaminated with cobalt-60 and tritium. These radionuclides, in addition to europium-152, europium-154, uranium-235, uranium-238, plutonium-238, plutonium-239/240 and americium-241, were considered as additional radiological contaminants of concern and are listed with their respective cleanup goals in Table 2-1.

The primary chemical contaminants of concern for soil within the HFBR complex are the same as those for OU I chemically contaminated soils: mercury and lead. The cleanup goal established for mercury is 1.84 mg/kg, based on the EPA's soil screening level guidance (*OSWER Directive 9355.4-23*) for protecting groundwater and resident non-farmer use. The choice of a cleanup goal of 400 mg/kg for lead also was based on the EPA's soil screening level guidance; this level is protective of resident non-farmer use. The cleanup goals for these chemical contaminants were established in the OU I ROD and specified in the HFBR ROD.

2.2 Design Criteria

Technical specifications and design criteria for the HFBR Underground Utilities Project were established in the HFBR ROD and the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010). The remedial design included:

- Specifications for the exposure and removal of the HFBR Underground Utilities;
- A plan and process for ensuring the total exposure from all radioisotopes does not exceed 15 mrem/yr above background following the 50-year period for institutional control for the site;
- Methods to reduce waste volumes that require offsite disposal; and
- An approach for sampling to confirm that cleanup goals have been achieved for the HFBR Underground Utilities Project.

2.3 Community Relations Activities

2.3.1 BNL Community Relations

The BNL Community Involvement Plan was published April 15, 1999. It is supplemented by project-specific plans. In the case of the HFBR, a Communications Plan for the Regulatory Decision-Making Process for Decommissioning the High Flux Beam Reactor was developed. In accordance with these two plans and CERCLA Sections 113 (k)(2)(B)(i-v) and 117, the Community Relations Program focuses on informing and involving the public in the decision-making process to ensure that the views of the internal and external stakeholder communities are considered. A variety of activities are used to provide information and to seek public participation, including distribution of materials to a stakeholders' mailing list; holding community meetings, information sessions, tours, and 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:

Brookhaven National Laboratory
Research Library
Bldg. 477A
Upton, NY 11973
631-344-3483 or 631-344-3489

Stony Brook University
Melville Library
Room E-2320, Special Collections and University Archives
Stony Brook, NY 11794
631-632-7119

3.0 CONSTRUCTION ACTIVITIES

The objective of the HFBR Underground Utilities Project was to safely remove the piping and ductwork specified in Table 1-1, as well as to characterize and remove any associated contaminated soil in accordance with the HFBR ROD and project specific plans. Following the removal of the HFBR Underground Utilities and any associated contaminated soil, an FSS and a dose assessment were performed by BNL ERP. The FSS was independently verified by ORISE. This work is further discussed in Section 3.2. The FSS was completed using the *Multi-Agency Radiological Survey and Site Investigation Manual* (*MARSSIM*) guidelines.

Activities associated with the removal of the HFBR Underground Utilities and the associated contaminated soil took place between February 2010 and December 2010. The HFBR Underground Utilities Project was divided into three work phases, as identified in Table 1-1 and described further in Sections 3.1 and 3.2. FSS and IV activities were performed upon completion of each of the three phases of remediation, as described further in Section 3.2. All pre-construction tasks for each work phase were completed prior to beginning remedial and characterization activities within the associated work area, including equipment mobilization, site inspections, securing the general work area, as well as marking out the HFBR Underground Utilities and verifying their locations.

Photograph 1 – Marking out utilities with ground-penetrating radar prior to excavation

An Excavation Plan, ALARA/Contamination Control Plan, Environmental, Safety & Health (ES&H) Plan, Job Risk Assessments (JRAs), Radiological Work Permits (RWPs), and project-specific work procedures were developed to address hazards and work steps associated with the HFBR Underground Utilities Project. The information presented in the project plans was reviewed by the site workers prior to initiating the project work

Photograph 2 – Removal of 30-inch duct during Phase I of the project

An 8-inch steel sanitary line was also addressed during Phase I. The 26-foot pipe runs from the southwest side of Building 750 to a manhole designated as MH232. Soil borings were performed with a Geoprobe along the span of the sanitary line in accordance with *Remedial Design/Remedial Action Work Plan for the Decontamination and Dismantlement (D&D) of the Stack and Removal of the HFBR Underground Utilities* (BNL, August 2010) and the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010). Soil samples were analyzed for the radionuclides of concern specified in Section 2.1 and results were consistent with background levels.

The sanitary line was surveyed and released in accordance with FS-SOP-1005, *Radiological Surveys Required for Release of Materials from Areas Controlled for Radiological Purposes* (BNL, November 2007), and subsequently grouted in place in accordance with the *Remedial Design/Remedial Action Work Plan for the Decontamination and Dismantlement (D&D) of the Stack and Removal of the HFBR Underground Utilities* (BNL, August 2010). Upon completion, the sanitary line was backfilled and site restoration was performed in accordance with *High Flux Beam Reactor Underground Utilities Removal Excavation Plan, Rev 4* (BNL, May 2010), as discussed further in Section 3.4.

Prior to backfilling the sanitary line, a field and data summary was prepared and submitted to DOE for approval. The summary provides soil boring data as well as radiological survey procedures and results for the sanitary line. The summary is provided as Appendix A.

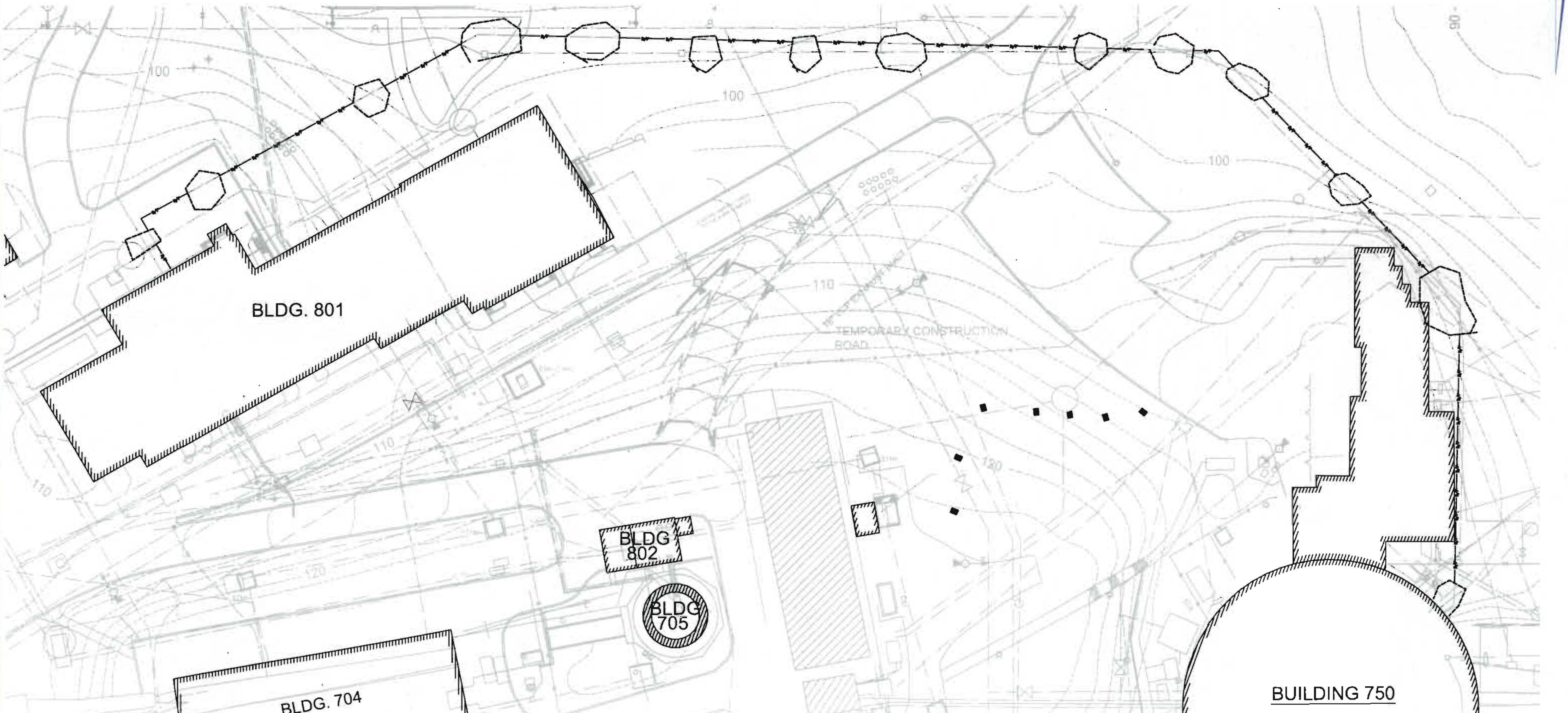
NOTES:

1. THE D/F WASTE LINE HAS BEEN CUT AT BOTH ENDS OF EACH TRENCH.
2. THE 4-INCH SECONDARY PIPING WAS PULLED FROM EACH SECTION OF PRIMARY PIPING BETWEEN TRENCHES.
3. THE REMAINING PIPE IN THE GROUND WAS GROUTED AND CAPPED.

LEGEND

TRENCH

D/F — D/F WASTE LINE



4-INCH SECONDARY D/F WASTE LINE LEFT IN GROUND

SCALE= 1" = 60'

Figure No: 3-1

Date: 03/31/11

3.1.3 Phase III

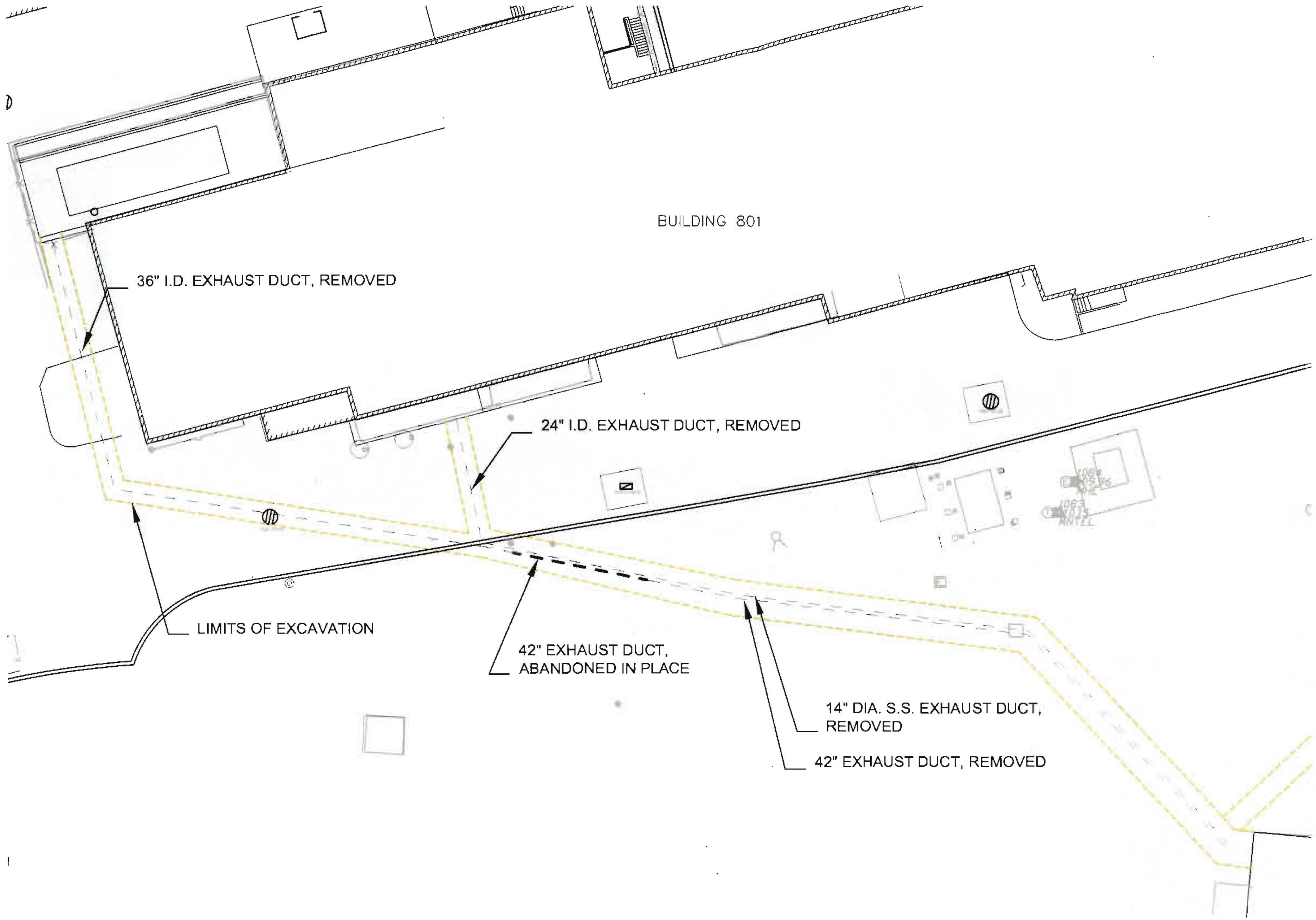
Phase III of the HFBR Underground Utilities Project, completed between June 2010 and December 2010, included the removal of the acid waste line and associated ducts as described below:

- 14-inch stainless steel acid waste duct from Building 801 to the Stack (300 feet in length);
- 42-inch concrete duct from connection with 36-inch duct from Building 801 to Building 802 (230 feet in length);
- 24-inch concrete duct from south wall of Building 801 to the 42-inch duct just downstream of the point where it transitions from 36-inch to 42-inch (60 feet in length); and
- 36-inch concrete duct from the west wall of Building 801 to the where it transitions from 36-inch to 42-inch (205 feet in length).

The excavation and removal of the acid waste line and ducts were divided into 5 separate trenches based on the location of joints and duct transitions. The locations of the trenches are discussed further in Section 3.2 and are illustrated on Figures 3-5a through 3-5e.

Photograph 4 – Trench boxes installed in Phase III, Trench 4

The location of an electrical duct bank, which crossed over the 42-inch concrete duct in the vicinity of trench 5, prevented the removal of approximately 36 feet of duct. A radiological survey was performed on the segment of 42-inch duct that was left in place. The radiological survey procedure and results are provided in Appendix A. Sonotubes,



PHASE 3, TRENCH 5 - 42 INCH DUCT LEFT IN GROUND

SCALE= 1" = 30'

Figure No: 3-2
Date: 03/30/11

3.2 Final Status Survey and Sampling

After completion of the removal of the HFBR underground utilities and associated contaminated soil, walkover surveys were performed and soil samples were collected and analyzed in accordance with the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010), as specified in Section 3.2.1.

As discussed in Section 2.1, the primary radionuclides of concern, based on exposure potential, were strontium-90, cesium-137, and radium-226. Although less likely to be present, certain other radionuclides were monitored, including tritium, cobalt-60, europium-152, europium-154, uranium-235, uranium-238, plutonium-238, plutonium-239/240, and americium-241. The chemical contaminants of concern were mercury, lead and PCBs.

3.2.1 Final Status Survey Design

The HFBR Underground Utilities were evaluated in phases as the utilities were removed, and grouped into Class 1 survey units 1, 2, and 3, as described below in Table 3-1.

Table 3-1 - Survey Unit Description

ID No.	Description	Survey Unit	Dimensions
A	Duct 801 to 42-in. duct (36" concrete)	1	205 ft
B	Duct 801 to 42-in. duct (24" concrete)	1	60 ft
C	Duct from connection with 36-in. duct from 801 to 802	1	230 ft
D	Acid Waste Line 801 to the Stack	1	300 ft
			Total SU-1 Length = ~795 ft
E	Duct 750 to the Stack	2	425 ft
F	Sanitary Line 750 to MH232	2	26 ft
			Total SU-2 Length = ~451 ft
G	D/F Waste Line 750 to 801	3	1,083 ft

A two-step approach to cleanup confirmation for radiological soil contamination was followed using the MARSSIM approach for the FSS of the HFBR Underground Utilities. The first step consisted of a global positioning system (GPS)-based gamma scintillation walkover survey using a 2-inch by 2-inch Sodium Iodide (NaI) detector in conjunction with a Ludlum Model 2221 scaler/ratemeters and a PRO XR Satellite Receiver Trimble model TSCe Data Logger (Trimble Unit). The second step involved the collection of soil samples, in accordance with BNL ERP standard operating procedures (SOP) for offsite analysis to verify that residual radiological contamination levels were sufficiently low to meet the cleanup goals established for the site.

Photograph 5 – Performing radiological walkover survey of trench during Phase I

Surface samples were analyzed for cesium-137, radium-226, and other gamma emitters. Composite surface samples were analyzed for Strontium-90, tritium, alpha emitters, and chemical contaminants.

Core samples were collected in 2-foot intervals to a depth of 8 feet below existing grade; and analyzed for cesium-137, radium-226 and other gamma emitters, tritium, and strontium-90. If cesium-137 concentration in a surface sample exceeded 7 pCi/g, then all depths were analyzed for alpha emitters and chemical contaminants.

For the HFBR Underground Utilities Project, soil samples were taken, at a minimum, every 30 feet along the length of the piping or duct. In addition, soil samples were collected beneath piping or duct seams, joints and other areas of potential leakage.

Photograph 6 – Collection of FSS core samples during Phase II

3.2.2 Final Status Survey and Sampling Results

As discussed in Appendix B of the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802*, (BNL, July 2010), the 21,500 cpm count rate was determined to approximate a Cs-137 concentration of 23 pCi/g in soil when using the unshielded NaI gamma scintillation detector. The results of the final status radiological walkover survey exhibit count rates below 21,500 cpm for all areas within Phase I (SU-2) and Phase III (SU-1), as shown in Figures 3-1, 3-3, 3-4 and 3-5(A-E). As shown in Figure 3-4, an isolated area within Phase II (SU-3), just north of Building 801, exhibited count rates greater than 21,500 cpm. These elevated results were determined to be the result of radiation emanating from tanks in the basement of Building 801. Additional soil samples were collected in this area to demonstrate that cleanup goals were met.

In addition, individual 1-min. fixed-count measurements were taken with the NaI probe at each of the fixed sample points. The results ranged from 1,597 to 11,888 cpm, excluding the previously discussed area of the Phase II trench adjacent to Building 801, where background radiation levels were as high as 200,000 cpm. Radiological survey forms for gamma walkover and fixed-point readings are provided in Appendix B.

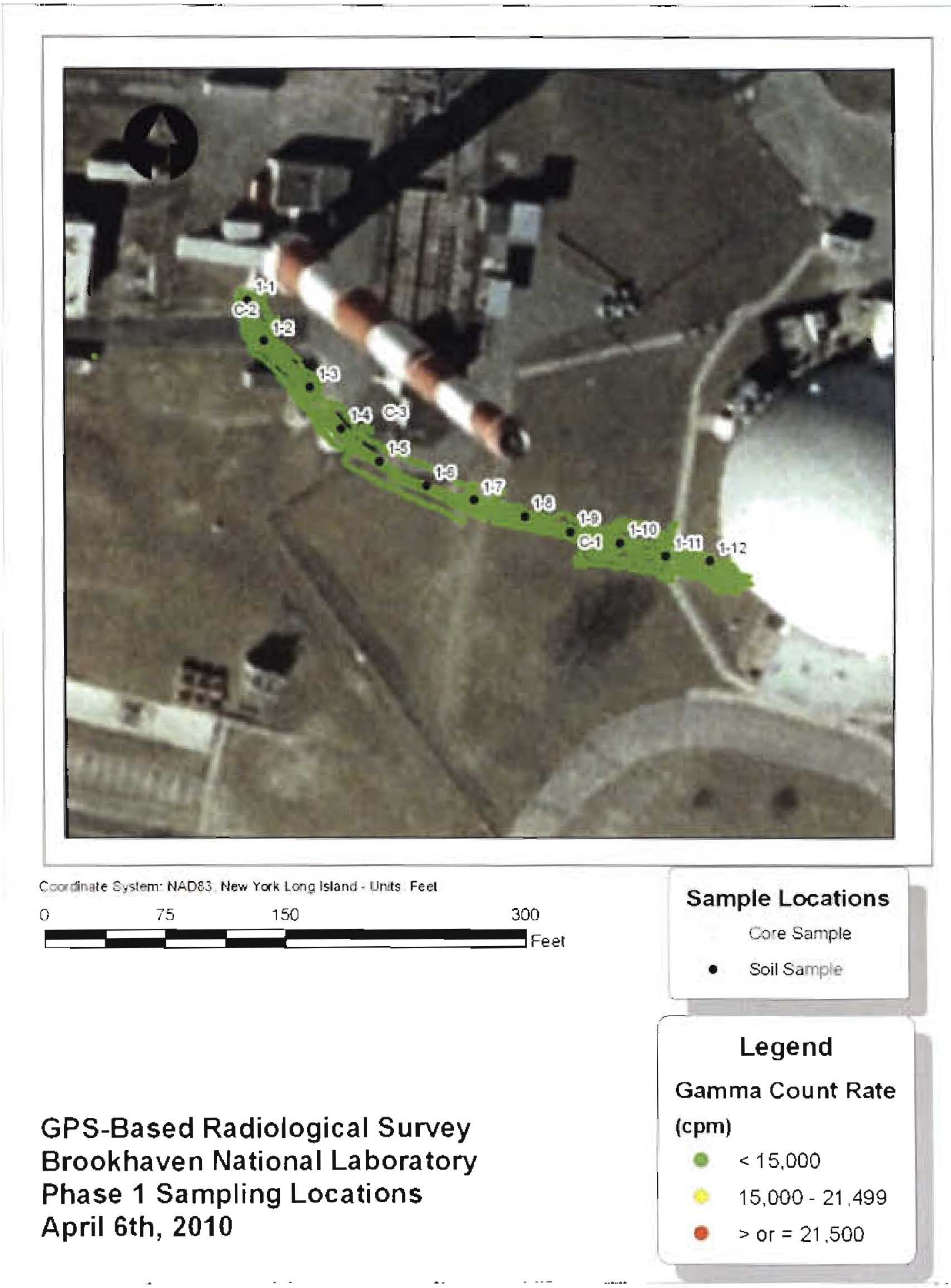


Figure 3-3 – Phase I FSS Sample Locations and Radiological Walkover Survey Results

PHASE 2 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 60'

LEGEND

SS = SURFACE SAMPLE

C = CORE SAMPLE

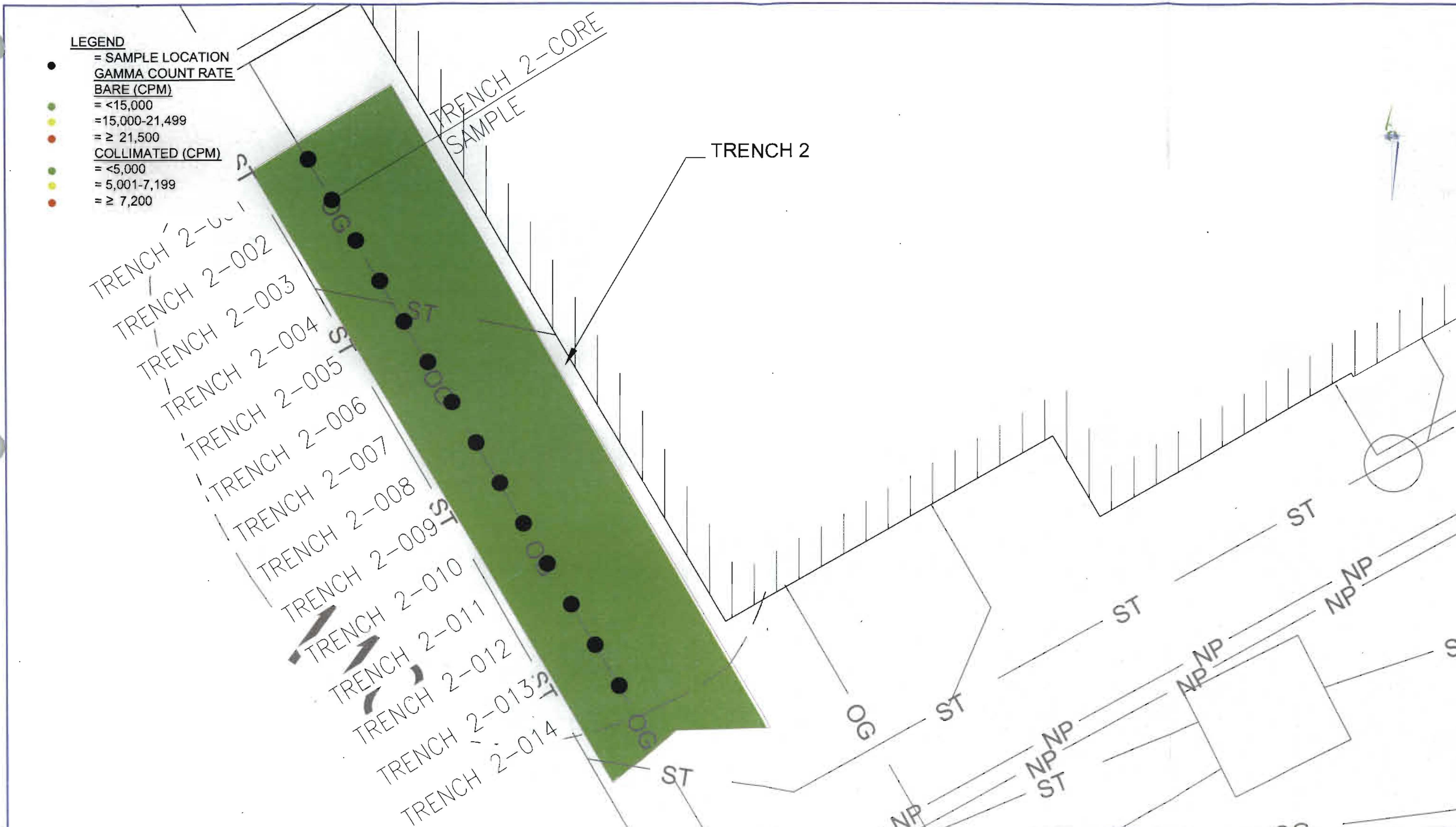
Figure No: 3-4

Date: 02/24/11

PHASE 3, TRENCH 1 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 10'

Figure No: 3-5A
Date: 02/24/11



PHASE 3, TRENCH 2 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 8'

Figure No: 3-5B

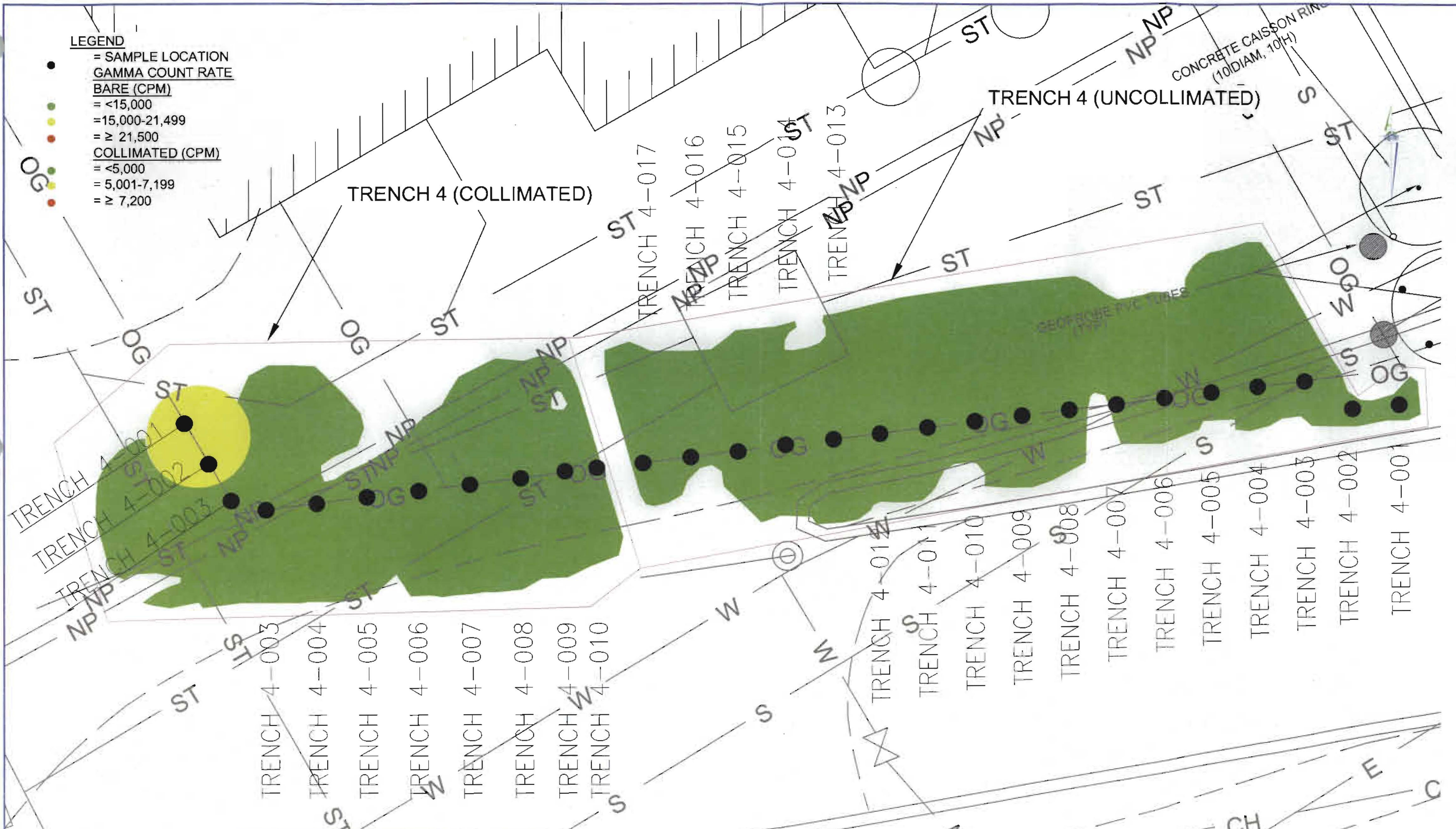
Date: 02/24/11

PHASE 3, TRENCH 3 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 8'

Figure No: 3-5C

Date: 02/24/11

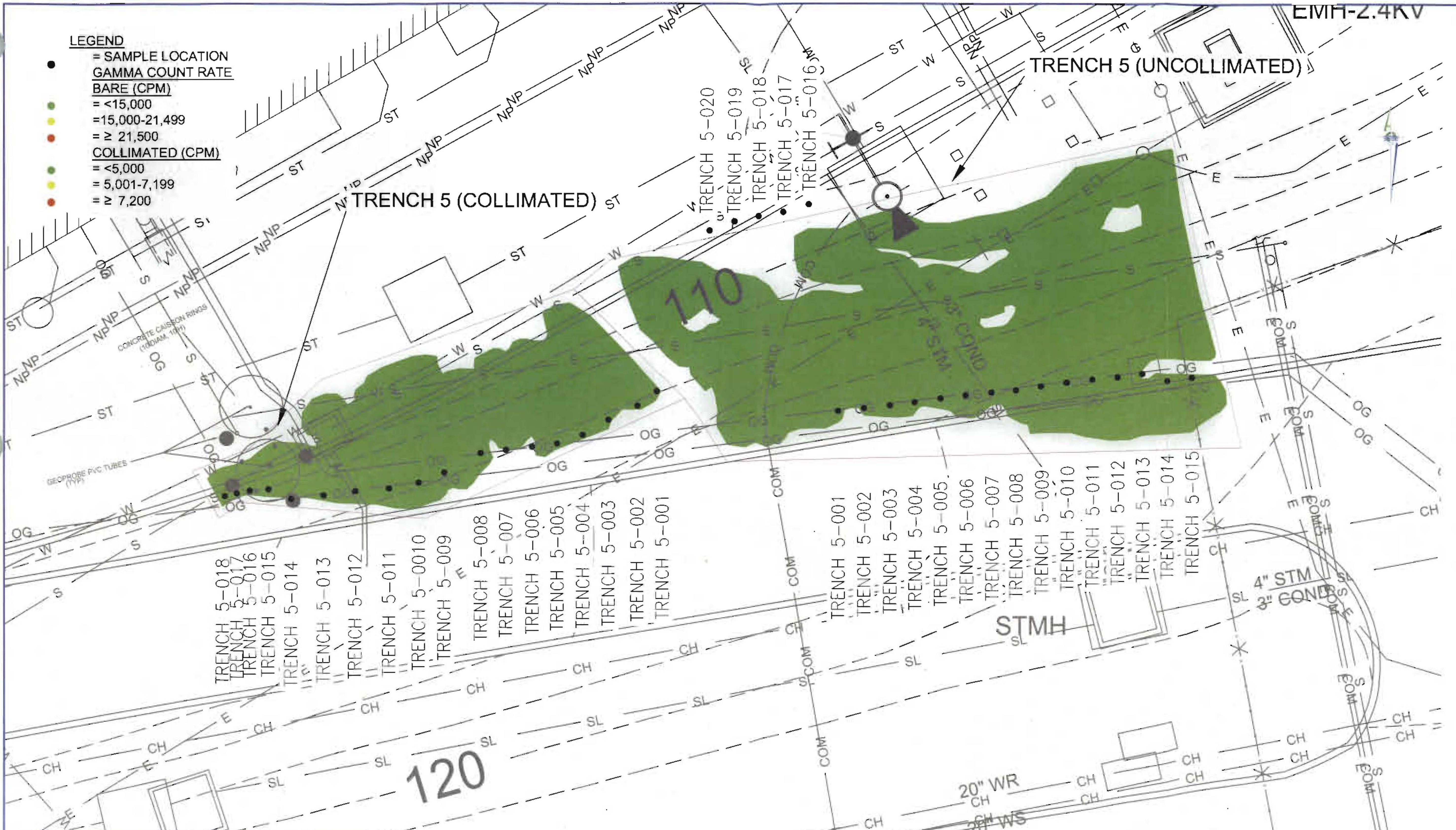


PHASE 3, TRENCH 4 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 8'

Figure No: 3-5D

Date: 02/24/11



PHASE 3, TRENCH 5 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 15'

Figure No:	3-5E
Date:	02/24/11

Soil was collected at a minimum of 16 surface soil sample locations per survey unit as specified in the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802,* (BNL, July 2010). All soil sample results were below the site cleanup goals for Cs-137, Sr-90 and Ra-226, which are 23 pCi/g, 15 pCi/g, and 5 pCi/g, respectively. A summary of the soil sample results is provided in Table 3-2.

Table 3-2 Summary of Surface Soil Sample Results for Radionuclides

	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Ra-226 (pCi/g)
Cleanup Goal	23	15	5
Average	0.04	No samples indicated detectable values (<0.8)	0.35
Maximum	1.0	No samples indicated detectable values (<0.8)	1.0

Notes:
Other radionuclides as listed in Table 3 of the FSP were analyzed for, and no detectable concentrations were found, except for one sample with 0.225 pCi/g Pu-238 As a conservative measure, this value of 0.225 pCi/g was used in the RESRAD calculation. Detection limits for these other radionuclides are less than 20% of their respective cleanup goals.

Chemical results for soil samples analyzed for mercury and lead also indicated that residual soil concentrations for these contaminants are within their respective cleanup goals. A summary of the soil sample results for chemical contaminants is shown in Table 3-3.

Table 3-3 Summary of HFBR Underground Utilities Soil Sample Results for Chemical Contaminants

	Lead (mg/kg)	Mercury (mg/kg)
Cleanup Goal	400	1.84
Average	7.6	0.011
Maximum	15	0 016

Radiological and chemical results for offsite vendor soil sample analysis are provided in Appendix B.

3.2.3 Sign Test and Elevated Measurement Comparison

Since no samples exceeded the cleanup criteria, the SUs do not require testing with the sign test or the elevated measurement comparison.

3.2.4 Post Remediation Dose Assessment

A dose assessment was conducted to evaluate radiological dose impacts from residual radioactive soils remaining following the completion of remediation. The dose assessment for the soil excavation areas was conducted using RESRAD, Version 6.5 (ANL, 2001). The average concentration for each radionuclide was used as input to the model in order to determine the projected dose. Note that the Ra-226 background on BNL property had previously been established to be approximately 0.56 pCi/g (CDM, 1996). Therefore, the average Ra-226 value of 0.35 pCi/g from the HFBR Underground Utilities is below the established background. For determination of acceptable levels of cleanup, the value of 0.35 pCi/g was used as a conservative measure, with no subtraction of background Ra-226 in the soil. However, when performing the post-remediation dose assessment using RESRAD, Ra-226 background is subtracted to obtain a more accurate result of the dose above background.

The RESRAD model was run with "no background subtract" (Ra-226 = 0.35 pCi/g) and with "full background subtract" (Ra-226 ~ 0 pCi/g). Cs-137 was detected at low levels in some samples, and the average soil concentration of 0.04 pCi/g Cs-137 was used in all RESRAD calculations. In addition, one sample indicated 0.225 pCi/g Pu-238. As a conservative measure, this value for Pu-238 was included in all RESRAD calculations.

The assessment considered the radiation dose to a hypothetical future resident (non-farmer) assuming 50 years of institutional control. Additionally a review was performed to determine the length of time necessary to reach the cleanup criteria of 15 mrem per year. The parameters and pathways used in this dose assessment for the HFBR Underground Utilities are shown in the RESRAD summary reports (Appendix C).

The results of the dose assessment are shown below in Table 3-4. The maximum projected annual dose to a resident in Year 50 (0.2 mrem/year) at the HFBR Underground Utilities would be below the annual dose objective (non-farmer) of 15 mrem/year. For a resident with no decay time (Year 0), the maximum projected annual dose (0.6 mrem/year) is also less than 15 mrem/year. The results also indicate that the NYSDEC TAGM 4003 guideline of 10 mrem/yr would be met under each of the two scenarios described above. If background was not subtracted for Ra-226 (use 0.35 pCi/g without background subtract), then the resident non-farmer dose at 50 years would be 5.8 mrem/yr and the resident non-farmer dose at 0 years would be 6.0 mrem/yr.

Table 3-4 Summary of Post-Remediation Dose Assessment Results

	Resident at 50 years	Resident at 0 years
Dose (mrem/yr)	0.2	0 6

3.2.5 Final Status Survey Conclusions

As indicated above, results of the FSS following the completion of the removal of the HFBR Underground Utilities and any associated contaminated soil demonstrates conformance to the site cleanup goals established for the project. The site cleanup goals are also met at year 0 following completion of the remedy, with no decay time.

3.2.6 Final Status Survey Independent Verification

ORISE performed Type A IV for Phase I, Phase II and Phase III (Trench 1 and Trench 5) of the HFBR Underground Utilities Project. Type A IV includes a review of project plans and procedures, as well as review of FSS radiological walkover survey and soil sampling results. Type B IV was performed for Phase III, Trenches 2, 3 and 5. Type B IV includes field verification in addition to the review of project plans, procedures and FSS results. Specifically, the Type B IV included visual inspections, independent radiological walkover surveys and independent soils sampling and analysis. ORISE IV for the HFBR Underground Utilities Project was performed between June 2010 and December 2010. ORISE determined that project cleanup goals were met. Copies of the ORISE reports are included in Appendix D.

3.3 *Waste Management*

3.3.1 Waste Characterization, Handling and Disposal

The waste management strategy, waste characterization, packaging, handling, and storage were performed in accordance with the *Waste Management Plan for the Removal of Radioactive Soil, Piping and Debris from the HFBR Underground Utilities Project* (BNL, November 2009) and BNL Standards Based Management System (SBMS) waste management procedures. Waste generated during the HFBR Underground Utilities Project was characterized as low-level radioactive waste (LLRW) and included soil, concrete/masonry/asphalt debris and steel. Oversized waste was size-reduced to meet the disposal facility's WAC prior to being packaged for disposal. Soil and debris characterization data collected during remedial activities were used to characterize project waste. According to characterization results, the waste shipped met the WAC of the disposal facilities specified below. Waste verification results were submitted to BNL's Waste Management Division. All project waste was shipped via rail to Energy Solutions of Utah (ES).

Waste loading and shipping was initiated in May 2010 and was completed in March 2011. MHF Services provided shipping containers and railcars for transportation of project waste. A project waste summary is provided below in Table 3-5.

Table 3-5

Project Waste Summary

Waste Type	Manifested Volume	Containers	Disposal Facility	Number/Conveyances
Misc. Debris	2,376 ft^3 (LLRW)	5-Intermodal	ES	2-ABC Rail Cars
Misc. Oversized Debris	8,316 ft^3 (LLRW)	16-Intermodal	ES	6-ABC Rail Cars
Soil	2,000 ft^3 (LLRW)	NA	ES	NA

Notes

NA – Not Applicable, soil comingled with debris

It should be noted that approximately 100 gallons of water, displaced from the 2-inch D/F Waste Line during grout injection, was added to water that was drained from HFBR systems as part of the HFBR Stabilization Project. As previously discussed in Section 3.1.2, this water was solidified with Waste Lock 770 and disposed of as part the HFBR Stabilization Project.

Photograph 7 – Packaging project waste in intermodal shipment container

3.3.2 Pollution Prevention and Waste Minimization Opportunities

Waste minimization and pollution prevention methods employed during the HFBR Underground Utilities Project included the judicious use of consumables (Personal Protection Equipment) as well the survey and free release of approximately 460 feet of the 4-inch D/F Waste Line (secondary containment pipe), the 26-foot HFBR sanitary line, and 36 feet of the Phase III 42-inch duct, as discussed in Sections 3.1 and 3.2. In addition, overburden soil was characterized so that the majority of the volume removed could be reused as backfill during site restoration activities.

3.4 Site Restoration

Site restoration, including trench backfilling and compaction, was performed in accordance with the *High Flux Beam Reactor Underground Utilities Removal Excavation Plan, Rev 4* (BNL, May 2010). Disturbed groundwater monitoring wells, sidewalks, curbs and asphalt areas were repaired as necessary. Disturbed grassed areas were seeded with native Long Island grasses. Hydroseeding methods were utilized in accordance with the handling and application requirements provided in project specifications.

Site restoration activities were completed in December 2010. Future site controls are discussed in Section 7.0.

Photograph 8 – Backfilling Phase II Trench

4.0 CHRONOLOGY OF EVENTS

The following table lists a chronology of the main remedial events associated with the HFBR:

Table 4-1 Chronology of Remedial Events for the HFBR Underground Utilities

Date	Remedial Event
April 2009	HFBR ROD finalized
August 2010	RD/RA Work Plan for the D&D of the Stack and Removal of the HFBR Underground Utilities finalized.
2010	The HFBR underground utilities and associated contaminated soils were removed and disposed; and the associated FSS and IV were performed.
2010-Ongoing	The Fan Houses (Buildings 704 & 802) were dismantled. the associated contaminated soil was removed and project wastes were disposed.
2010-Ongoing	The Stack (Building 705) silencer baffles were removed.

5.0 PERFORMANCE STANDARDS & QUALITY CONTROL

As discussed in Section 3.2.2, the average concentrations for Cs-137, Sr-90, and Ra-226 in soil were below the cleanup goals of 23 pCi/g, 15 pCi/g, and 5 pCi/g, respectively. The calculated radiological doses from all radioisotopes were also below the levels stipulated in the HFBR ROD. In addition, concentrations of mercury and lead in soil were below the cleanup goals of 1.84 mg/kg and 400 mg/kg, respectively.

Physical and radiological inspections were conducted on both incoming and outgoing intermodal containers. Inspections were also conducted on excavations, trench boxes and storm water control measures during excavation operations. Field sampling procedures were reviewed periodically.

Quality control/quality assurance (QA/QC) samples were collected in accordance with the *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010). Field duplicates were collected at a frequency of one per twenty soil samples and analyzed for the radiological and chemical contaminants of concern. QA/QC results are summarized with the FSS results provided in Appendix B.

6.0 FINAL INSPECTION AND CERTIFICATIONS

As described in Section 3.3.6, the IV was performed by ORISE upon the completion of the FSS performed by ERP. Based on the results of the FSS, an evaluation of the dose from the remaining activity in the vicinity of the HFBR Underground Utilities was performed using RESRAD; results were within the design criteria described in Section 2.2.

There was strict adherence to industrial safety and radiological safety precautions during the HFBR Underground Utilities Project. Work was performed under written and approved procedures, and any potentially hazardous steps were highlighted in the procedure to ensure understanding and compliance. Job Risk Assessments (JRAs) were developed and approved for the stabilization work. Radiological safety and oversight was provided by Radiological Control Technicians (RCTs), and all work was performed under a RWP.

6.1 Industrial Hygiene Oversight & Monitoring

IH oversight and monitoring was conducted by ERP personnel in accordance with ERP procedures. The JRA identified hazards associated with each of the tasks identified and specified the required controls for each hazard. A designated Site Health and Safety Officer was onsite during cleanup activities to ensure controls were in place as specified in the JRA, including the use of safety equipment, safe work practices and asbestos controls during the cutting of the steam line. IH monitoring included confined space monitoring and mercury vapor monitoring.

6.2 Radiological Oversight & Monitoring

Radiological oversight and monitoring for the HFBR Underground Utilities Project was conducted by BNL RCTs in accordance with the project RWP (2010-ERP-007). Thermoluminescent dosimeters (TLDs) were worn by each individual entering the posted Soil Contamination Areas and Contamination Areas. The radiation exposure estimate and actual radiation exposures for the project is less than 10 mrem, far less than the administrative control level dose value of 100 mrem. In addition, radiological monitoring included air sampling. All general area air sample results were below 0.5 derived air concentrations (DAC). Workers entering the posted contamination areas were also required to have a whole body count prior to and upon completion of work on the HFBR Underground Utilities Project.

Equipment used during the HFBR Underground Utilities Project was also monitored for radiological contamination. All equipment that was released from the work zone was surveyed in accordance with FS-SOP-1005, *Radiological Surveys Required For Release of Materials from Areas Controlled For Radiological Purposes* (BNL, November 2007).

7.0 OPERATION AND MAINTENANCE ACTIVITIES

The BNL Land Use Controls Management Plan will be revised to include the HFBR Underground Utilities, and the BNL site utility drawings will be updated.

The *HFBR Long Term Surveillance and Maintenance Manual* will be prepared to include the post remediation monitoring and maintenance activities for the HFBR Underground Utilities area. These activities will include institutional controls (land use controls, notifications and restrictions, work planning controls such as digging permits, and government ownership). The topsoil cover, placed during site restoration, will also be inspected for signs of erosion.

Brookhaven Science Associates (BSA) will perform operation and maintenance activities. In addition to maintaining institutional controls for the HFBR Underground Utilities area, BSA will ensure that that routine monitoring/inspections are performed. DOE will ensure enforcement of all institutional controls.

8.0 SUMMARY OF PROJECT COSTS

The HFBR Underground Utilities Project was performed with ARRA. The project cost approximately $3,162,570 to complete. The original estimate cost for the HFBR Underground Utilities Project was $2,622,200. The additional cost was associated with the additional project personnel and equipment that were required to complete the project within ARRA time constraints.

The costs for the HFBR Stabilization Project included the following details:

Engineering and planning	$ 286,140
Removal/Remediation & Site Restoration	$ 2,518,992
Independent Verification (ORISE)	$ 60,159
Waste Transportation and Disposal	$ 287,996
Project Closeout	$ 9,282
Total Cost	$ 3,162,570

9.0 OBSERVATIONS AND LESSONS LEARNED

The following is a summary of the lessons learned from this project and the corrective actions for future projects:

- The sharing of physical resources between two or more projects requires careful coordination to ensure workers are not exposed to hazards that have not been identified or adequately analyzed. For example, as a payload operator from the HFBR Underground Utilities Project prepared to dump metal waste into a 20-yard dumpster that was originally staged for the HFBR Stabilization Project, an HFBR Job Supervisor asked the operator if he had verified the dumpster to be clear of personnel. The operator indicated that he had not. HFBR Stabilization Project personnel regularly entered this dumpster through a walk-in door to deposit scrap office equipment. The HFBR Underground Utilities Project personnel had discussed the need to dump their waste into the dumpster with the pay loader at their tailgate safety meeting that morning without being aware that HFBR Stabilization Project personnel periodically entered the dumpster. The HFBR Stabilization Project personnel were immediately briefed regarding the situation and the dumpster was posted with caution tape and a sign reading "Caution, No Entry Without a Spotter." The HFBR Underground Utilities Project Manager participated in the briefing and explained that no dumping would take place into the dumpster without first notifying HFBR Stabilization Project personnel and verifying the dumpster to be clear of personnel. In addition, HFBR JRAs were updated to require the posting at the entry of dumpsters and require a spotter to be present when personnel physically enter a dumpster. Note that this lesson learned was also documented in the closeout report for the HFBR Stabilization Project.
- Placing a pallet of 94 pound cement bags onto the same level as the mixer hopper enabled the bags to be rolled instead of lifted by workers, and therefore reduced the potential for back injury.
- A worker pinched his finger while working with a reciprocating saw. The worker was replacing a saw blade and inadvertently pressed the trigger, which trapped his finger between the release device and the blade guard. The associated corrective action included confirming that power tools are disconnected from their power source prior to changing blades or bits, and assuring a review of the project JSA and/or JRA prior to using power tools.
- A worker cut his forearm with a razor knife while attempting to cut a tie wrap. The corrective action included ensuring that the proper tool is used for the associated task. In this incident, a pair of side cutters or wire cutters should've been used.
- To prevent heating and melting of the blade teeth on a reciprocating saw when cutting stainless steel piping, setting the saw at a low speed was effective.

- When installing trench boxes with slings, several measures provided additional control, adequate lift and prevented damage to the slings:
  - Attach two shackles at separate points of the box.
  - Use slings with protective covers.
  - Configure slings to achieve an angle of 45 to 60 degrees while keeping them as short as possible.
  - Ensure that a trench box expert is onsite to supervise the installation.
- Abandoned piping and wires were encountered during excavation work. To prevent this in the future, there should be a thorough review of old utility drawings and increased communication between project personnel and BNL Plant Engineering.
- Size reducing stainless steel pipe using the bucket of the excavator proved ineffective. Instead, crushing the pipe by driving over it slowly with the excavator track was found to be a safe and effective method.
- Injecting grout into the 2-inch D/F Waste Line from the low point to the high point, as described in Section 3.1.2, was effective in both stabilizing contamination inside the pipe prior to cutting and displacing/removing approximately 100 gallons of contaminated water that was trapped at a low point.
- The removal of the 2-inch D/F Waste Line via access trenches that were excavated at selected locations, as described in Section 3.1.2, proved to be an effective way to avoid disturbing roadways and several mature trees. Additionally, project wastes were minimized by removing the entire contaminated 2-inch primary line while leaving the majority of the 4-inch secondary line in the ground.

10.0 PROTECTIVENESS

Removal of the HFBR Underground Utilities and associated contaminated soil is protective of human health and the environment. These actions have also minimized the potential for the migration of contaminants into the underlying groundwater.

10.1 Facility Review Disposition Project Issues

The Facility Review Disposition Project (FRDP) was initiated in 1998 to resolve the issues identified during the preceding BNL Facility Review Project. The completion of the HFBR Underground Utilities Project satisfies the closure requirements associated with the FRDP issues summarized in Table 10-1.

Table 10-1 HFBR Underground Utilities Project FRDP Issues Summary

BNL I.D. #	SCDHS I.D. #	Building	BNL Issue Description	Resolution
841	N/A	750	Exhaust Ducts – Ducts may be susceptible to rain water intrusion.	The ducts were removed.
2550	0560	750	Underground Piping - Exit air duct from HFBR to filters could have had water intrusion.	The duct was removed.
562	N/A	802	There are four underground piping systems that are associated with Bldg 802 – Includes the Acid and Non-Acid Ventilation Systems, the sample port systems for the Vent Systems and water lines that ran to 704 and 701.	The piping systems/ducts were removed.

11.0 FIVE YEAR REVIEW

Five-year reviews will be conducted to determine whether the remedy implemented continues to be protective of human health and the environment. These reviews will be performed in accordance with the *Comprehensive Five-Year Review Guidance, OSWER No. 9355.7-03B-P* (EPA, June 2001). Remedy implementation at the HFBR, including the removal of the HFBR Underground Utilities, was discussed in the *Five Year Review Report for Brookhaven National Laboratory Superfund Site* (BNL, March 2011). The HFBR complex will be included in the next sitewide five year review in 2016.

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REFERENCES

ANL, 2001. *User's Manual for RESRAD Version 6*, Environmental Assessment Division, Argonne National Laboratory, ANL/EAD-4, July 2001.

BNL, *BGRR and HFBR Decommissioning Projects FRDP Issue Summary Table*

BNL, 1992. Interagency Agreement, May 1992.

BNL, 1996. BNL Final Remedial Investigation/Risk Assessment – Final Report, Operable Unit I/VI, CDM Federal Programs Corp., June 1996.

BNL, 1999. *Record of Decision, Operable Unit I and Radiologically Contaminated Soils*, August 1999.

BNL, 2001a, *Brookhaven National Laboratory High Flux Beam Reactor Final Characterization Report*, September 2001.

BNL, 2001b. FS-SOP-1040, *Airborne Radioactivity Sampling and Analysis*, December 2001.

BNL, 2003a. EM-SOP-601, *Collection of Soil Samples, Rev. 1*, March 2003.

BNL, 2003b. EM-SOP-200, *Collection and Frequency of Field Quality Control Samples*, March 2003.

BNL, 2006a. FS-SOP-4027, *Entry/Egress Requirements for Areas Controlled for Radiological Purposes*, June 2006.

BNL, 2006b. *Feasibility Study, Brookhaven High Flux Beam Reactor, Decommissioning Project*, 2006.

BNL, 2007. FS-SOP-1005, *Radiological Surveys Required for Release of Materials from Areas Controlled for Radiological Purposes*, November 2007.

BNL, 2009a. *Final Record of Decision for Area of Concern 31, High Flux Beam Reactor*, February 2009.

BNL, 2009b. *Waste Management Plan for Removal of Radioactive Soil, Piping and Debris from the HFBR Underground Utilities D&D Project*, November 2009.

BNL, 2010a. *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802*, June 2010.

BNL, 2010b. *Closeout Report for the Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-Located Piping)* June 2010.

BNL, 2010. *High Flux Beam Reactor Underground Utilities Removal Excavation Plan, Rev 4*, May 2010.

BNL, 2011. *Five Year Review Report for Brookhaven National Laboratory Superfund Site*, March 2011

BNL, *HFBR Long Term Surveillance and Maintenance Manual* (as revised).

CDM, 1996. *Final Remedial Investigation and Risk Assessment Report for Operable Unit I/VI*, 1996.

CDM, 1999. *Final Feasibility Study Report for Operable Unit I Radiologically Contaminated Soils*, 1999.

Cabrera, 2005. *Brookhaven National Laboratory High Flux Beam Reactor Characterization Summary Report*, Rev. 0, March 2005.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Title 42, U.S. Code, Sec. 9620 et seq.

DAQ, Inc., 2005. *High Flux Beam Reactor: Building 751. Portable Structure 549, Interconnecting Ducts, Selected Components, & Soils Sampling and Analysis Report*, December 2005.

Department of Energy, DOE Order 5400.5, *Radiation Protection of the Environment and the Public*, as amended.

EPA, 1997. *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination* (OSWER Directive 9200.14-18), 1997.

EPA, 2000a. *Close Out Procedures for National Priorities List Sites* (OSWER Directive 9320.2-09A-P), January 2000.

EPA, 2000b. *Multi-Agency Radiological Survey and Site Investigation Manual*, Revision 1, August 2000.

EPA, 2001. *Comprehensive Five-Year Review Guidance* (OSWER Directive 9355.7-03B-P), June 2001.

NYSDEC, 1993. *New York State Department of Environmental Conservation TAGM 4003: Cleanup Guideline for Soils Contaminated with Radioactive Materials*, September, 1993.

NYSDEC, 2006. *Subpart 375-6: Remedial Program Cleanup Objectives*, 6NYCRR Part 375, December 14, 2006.

ORISE, 2010a, *Project-Specific Type A Verification for the High Flux Beam Reactor Underground Utilities Removal Phase 1, 30-In. Duct Removal, Brookhaven National Laboratory, Upton, NY* (DCN:5098-SR-01-0), June 25, 2010.

ORISE, 2010b, *Project-Specific Type A Verification for the High Flux Beam Reactor Underground Utilities Removal Phase 2, D/F Waste Line Removal, Brookhaven National Laboratory, Upton, NY* (DCN:5098-SR-02-0), July 9, 2010.

ORISE, 2010c, *Project-Specific Type A Verification for the High Flux Beam Reactor Underground Utilities Removal Phase 3 Trench 5, Brookhaven National Laboratory, Upton, NY* (DCN:5098-LR-02-0), November 3, 2010.

ORISE, 2010d, *Project-Specific Type A Verification for the High Flux Beam Reactor Underground Utilities Removal Phase 3: Trenches 2, 3, and 4, Brookhaven National Laboratory, Upton, NY* (DCN:5098-LR-02-0), November 15, 2010.

ORISE, 2010e, *Project-Specific Type A Verification for the High Flux Beam Reactor Underground Utilities Removal Phase 3 Trench 1, Brookhaven National Laboratory, Upton, NY* (DCN:5098-SR-05-0), December 15, 2010.

PWGC, 2005a. *High Flux Beam Reactor and Balance of Plant Structures Preliminary Assessment/Site Inspection Report*, January 2005.

PWGC, 2005b *Brookhaven National Laboratory Building 705 Stack Resolution of End-State*, February 2005.

PWGC, 2005c, *High Flux Beam Reactor & Balance of Plant Supplemental Characterization Summary*, June 2005.

RESRAD, Residual Radioactive Material Guideline Computer Code.

WMG, 2000, *Preliminary Characterization for Brookhaven National Laboratory High Flux Beam Reactor*, WMG Report 9622 Rev.1, September 2000