Final

CLOSEOUT REPORT

High Flux Beam Reactor Underground Utilities Removal
Area of Concern 31

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Upton, New York

August 2011

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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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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.

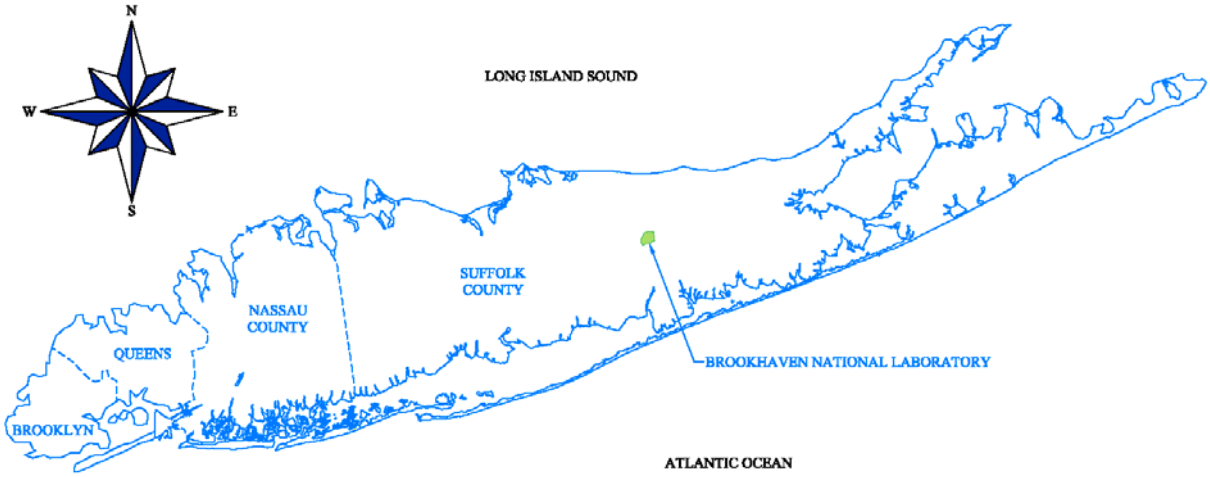


Figure 1-1 Location of Brookhaven National Laboratory

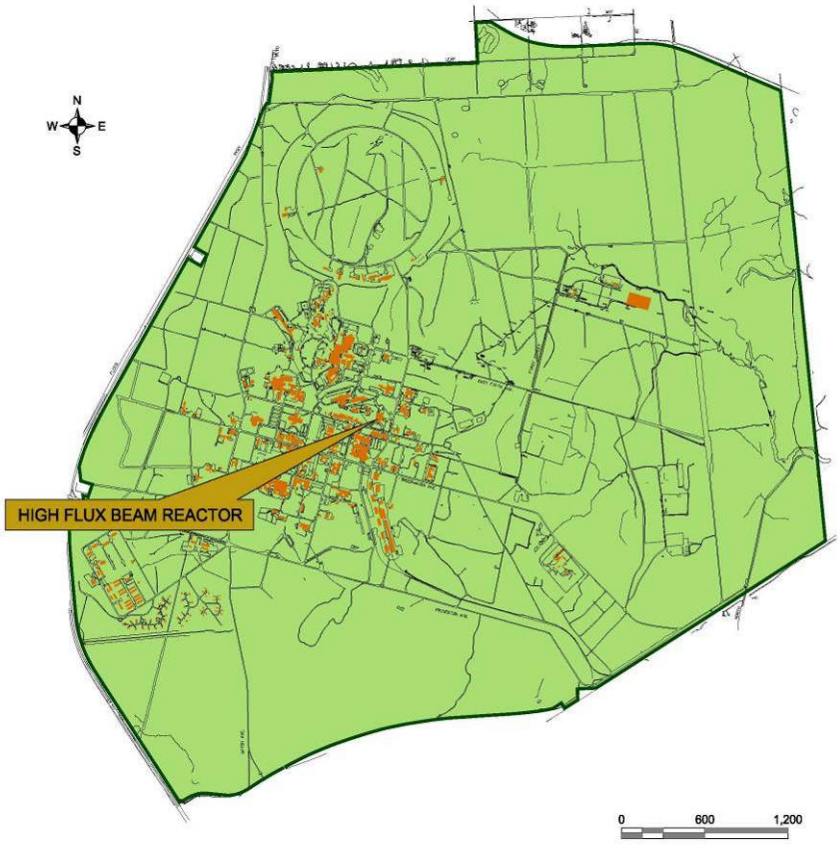


Figure 1-2 HFBR Complex Location at BNL

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.

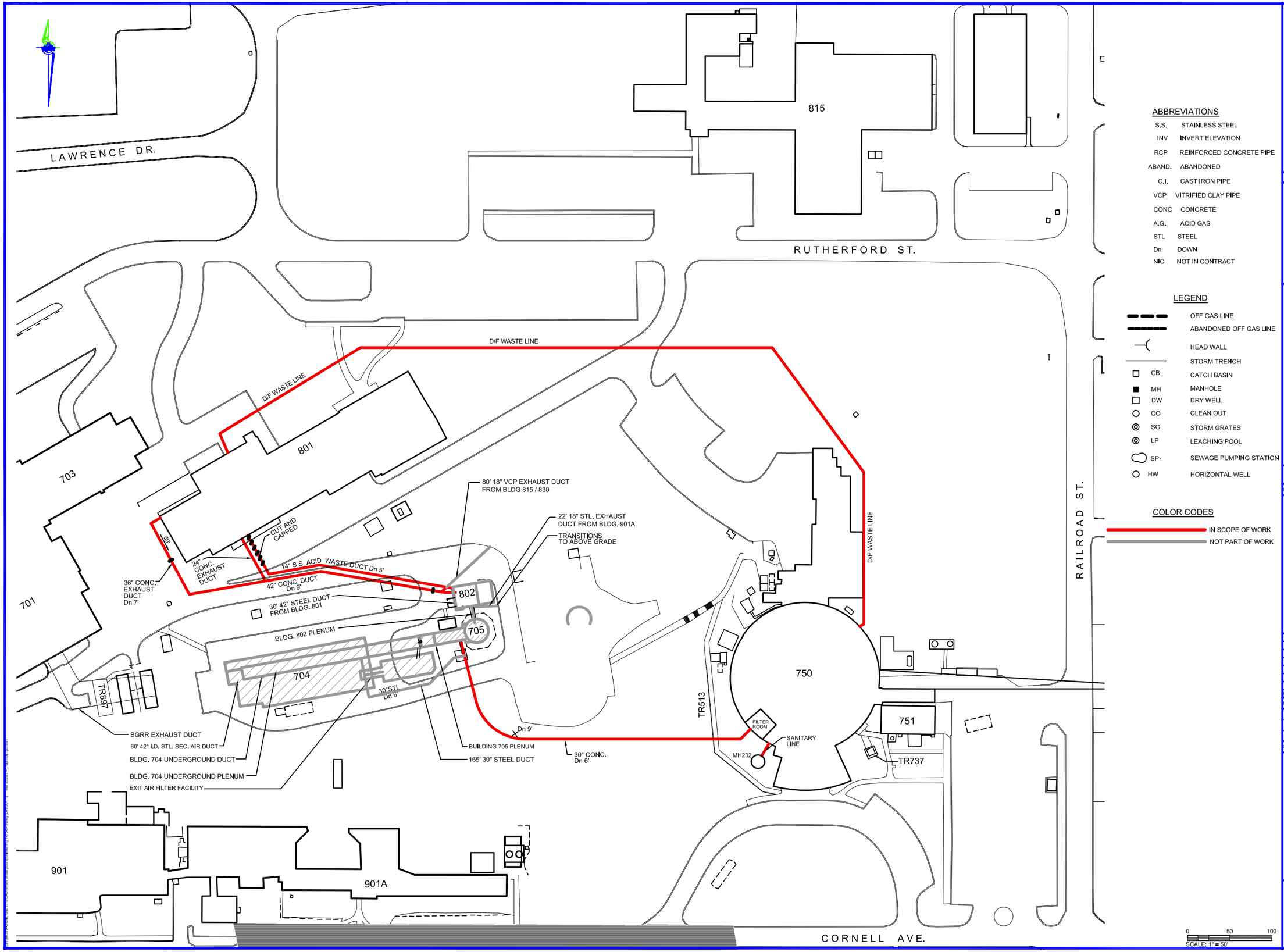
Table 1-1

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.

Figure 1-3 HFBR Underground Utilities Site Plan



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

PWGC

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CONSULTANTS

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-

137. Characterization of the HFBR Underground Utilities, as well as structures and soils within the HFBR complex, is discussed further in the following reports:

- *Preliminary Characterization for Brookhaven National Laboratory High Flux Beam Reactor*, WMG Report 9622 Rev.1 (WMG, September 2000);
- *Brookhaven National Laboratory High Flux Beam Reactor Final Characterization Report* (BNL, September 2001);
- *High Flux Beam Reactor & Balance of Plant Supplemental Characterization Summary* (PWGC, June 2005);
- *Brookhaven National Laboratory High Flux Beam Reactor Characterization Summary Report*, Rev. 0, (Cabrera, March 2005);
- *High Flux Beam Reactor and Balance of Plant Structures Preliminary Assessment/Site Inspection Report* (PWGC, January 2005);
- *Brookhaven National Laboratory Building 705 Stack Resolution of End-State* (PWGC, February 2005)
- *High Flux Beam Reactor: Building 751. Portable Structure 549, Interconnecting Ducts, Selected Components, & Soils Sampling and Analysis* (DAQ, December 2005);
- *Feasibility Study, Brookhaven High Flux Beam Reactor, Decommissioning Project* (BNL, 2006);
- *Proposed Remedial Action Plan for the High Flux Beam Reactor at Brookhaven National Laboratory* (BNL, January 2008); and
- *Final Record of Decision for Area of Concern 31, High Flux Beam Reactor* (BNL, February 2009).

Related remedial activities that have been recently completed or are currently in progress include the removal of the Fan Houses (Buildings 704 and 802) and stabilization of the HFBR (Building 750). These activities will be documented by separate closeout reports.

1.6 BNL Operable Units

As part of remedial efforts at BNL, thirty AOCs were identified and grouped into seven OUs. The seven OUs were subsequently reduced to six OUs as a result of combining OU II and OU VII. In February 2009, AOC 31, comprising the HFBR complex was established.

This report documents completion of remedial actions associated with the HFBR, which is designated as AOC 31. As described in Section 2.1, the cleanup goals established in the OU I ROD were used for the HFBR Underground Utilities Project.

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.

Table 2-1

Radionuclides and Chemical Contaminants of Concern
for the HFBR Stabilization Project

Radionuclides of Concern	Cleanup Value (pCi/g)	Source of Cleanup Goal Value
Cs-137	23	OU I ROD (BNL, 2009)
Sr-90	15	OU I ROD (BNL, 2009)
Ra-226	5	OU I ROD (BNL, 2009)
H-3	424(2)	N/A
Co-60	1,260 (3)	N/A
Eu-152	51 (3)	N/A
Eu-154	180 (3)	N/A
U-235	4.6 (4)	N/A
U-238	4.7 (4)	N/A
Pu-238	57	N/A
Pu-239/Pu-240	35	N/A
Am-241	34	N/A
Chemical Contaminant	Soil Cleanup Level	Source of Cleanup Goal Value
Mercury	1.84 mg/kg	OUI ROD (BNL, 2009)
Lead	400 mg/kg	OUI ROD (BNL, 2009)

Notes:

1. For those nuclides "not referenced," the estimated cleanup levels were not listed in either the OU I ROD nor in other BNL remediation references. If these nuclides were detected, RESRAD was used as described in Section 2.0 of the project FSP to develop the cleanup levels that will meet the 15 mrem/yr criteria.
2. The value is based on a RESRAD evaluation for a resident non-farmer scenario with no decay.
3. The value is based on a RESRAD evaluation for a resident non-farmer scenario with 50 years of decay.
4. Values listed for uranium are based on 4 mrem/yr from groundwater consumption.

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

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

2.3.2 Community Involvement

The community involvement activities conducted for the remedy selection process for the HFBR (including the removal of the HFBR Underground Utilities) included a formal public review of the HFBR Proposed Remedial Action Plan (PRAP). The public comment period began January 10, 2008 and ended March 17, 2008. Two information sessions and a public meeting were held during the public comment period. Public comments received indicate that there is considerable community support for DOE's preferred remedial alternative identified in the PRAP (Alternative C, Phased Decontamination and Dismantlement with Near-Term Control Rod Blades Removal). DOE's responses to public comments and concerns are included in the HFBR ROD Responsiveness Summary.

The implementation of the HFBR Underground Utilities Project using ARRA funds was discussed with the BNL Community Advisory Council on April 15, 2009 and November 12, 2009.

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

activities. Copies of project plans were available onsite at all times for site workers to thoroughly review.

The *Field Sampling Plan for the HFBR Underground Utilities, Building 704 and Building 802* (BNL, June 2010) detailed the data quality objectives (DQOs) and quality assurance (QA) requirements for the FSS. The plan also presented the field screening value (21,500 cpm with unshielded sodium iodide detector) to be used in guiding the excavation and in determining when the excavation was completed.

3.1 HFBR Underground Utilities Removal and Soil Remediation

The removal of the HFBR Underground Utilities and the associated contaminated soil was performed in accordance with the *Remedial Design/Remedial Action Work Plan for the Decontamination and Dismantlement (D&D) for the Stack and Removal of the HFBR Underground Utilities* (BNL, August 2010). Underground piping and ducts were exposed using standard excavation methods. The excavation methods utilized (e.g., sloped excavation, trench boxes, shoring) depended on the depth of excavation, proximity to utilities and efforts to minimize disturbance to adjacent features and structures. Soil handling (e.g., transport, stockpiling and erosion control) and excavation activities were performed in accordance with the *High Flux Beam Reactor Underground Utilities Removal Excavation Plan, Rev 4* (BNL, May 2010). The HFBR Underground Utilities were removed to the penetration outside the associated building wall and all penetrations (Building 801 and Building 750) were sealed. As further discussed in Section 3.3, the HFBR Underground Utilities were cut into segments as they were removed from the trench in order to meet the disposal facility's waste acceptance criteria (WAC).

3.1.1 Phase I

Phase I of the HFBR Underground Utilities Project, completed between March 2010 and July 2010, included the removal of the 30-inch concrete duct between Building 750 and the valve pit adjacent to the Stack. The excavation and removal of the duct was performed over three separate events. The first two events each included the removal of approximately 34 feet of duct. The remaining span of concrete duct (approx. 357 feet) was removed during the third event. Upon removing the duct segments, as well as performing radiological surveys and collecting soils samples (overburden and underlying) as discussed in Section 3.2, the associated excavations were immediately backfilled for the purpose of constructing storm water controls over the affected areas.

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.

3.1.2 Phase II

The D/F Waste Line, which ran between Building 750 and Building 801, was addressed during Phase II of the HFBR Underground Utilities Project between April 2010 and August 2010. The line consisted of a 2-inch stainless steel transfer line and a bitumen coated carbon steel 4-inch line that provided secondary containment.

Grout was injected into the 2-inch line from the low point to the high point to displace accumulated water prior to beginning excavation and extraction. Approximately 100 gallons of water was extracted inside Building 750 where it was added to water that was drained from HFBR systems, solidified with Waste Lock 770 and disposed of as part of the HFBR Stabilization Project.

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), the 2-inch line was accessed and extracted from the 4-inch line by excavating fourteen access trenches in locations without utility line(s) interference. The 4-inch line was cut to expose the 2-inch line. The 2-inch line was cut and then pulled. The 2-inch line was cut in approximate 12-foot lengths as the pull continued. This process was repeated for the 1,100 feet of pipe. Approximately 640 feet of the 4-inch pipe was removed. The balance of the 4-inch pipe was left in place in areas congested with other utilities, under sidewalks or roads, or sufficiently close to buildings to cause undermining. Piping that was left in place was surveyed in accordance with FS-SOP-1005, *Radiological Surveys Required for Release of Materials from Areas Controlled for Radiological Purposes* (BNL, November 2007). Polyvinyl chloride (PVC) standpipes were installed on the segments of 4-inch pipe that were left in the ground for the purpose of grout injection. Grout was injected via the standpipes immediately after the 4-inch pipe segments were backfilled. The locations of the segments of 4-inch secondary pipe that were left in the ground are illustrated on Figure 3-1.

Photograph 3 – Cutting 2-inch stainless steel inner D/F Waste Line

Figure 3-1 4-inch Secondary D/F Waste Line Left in Ground

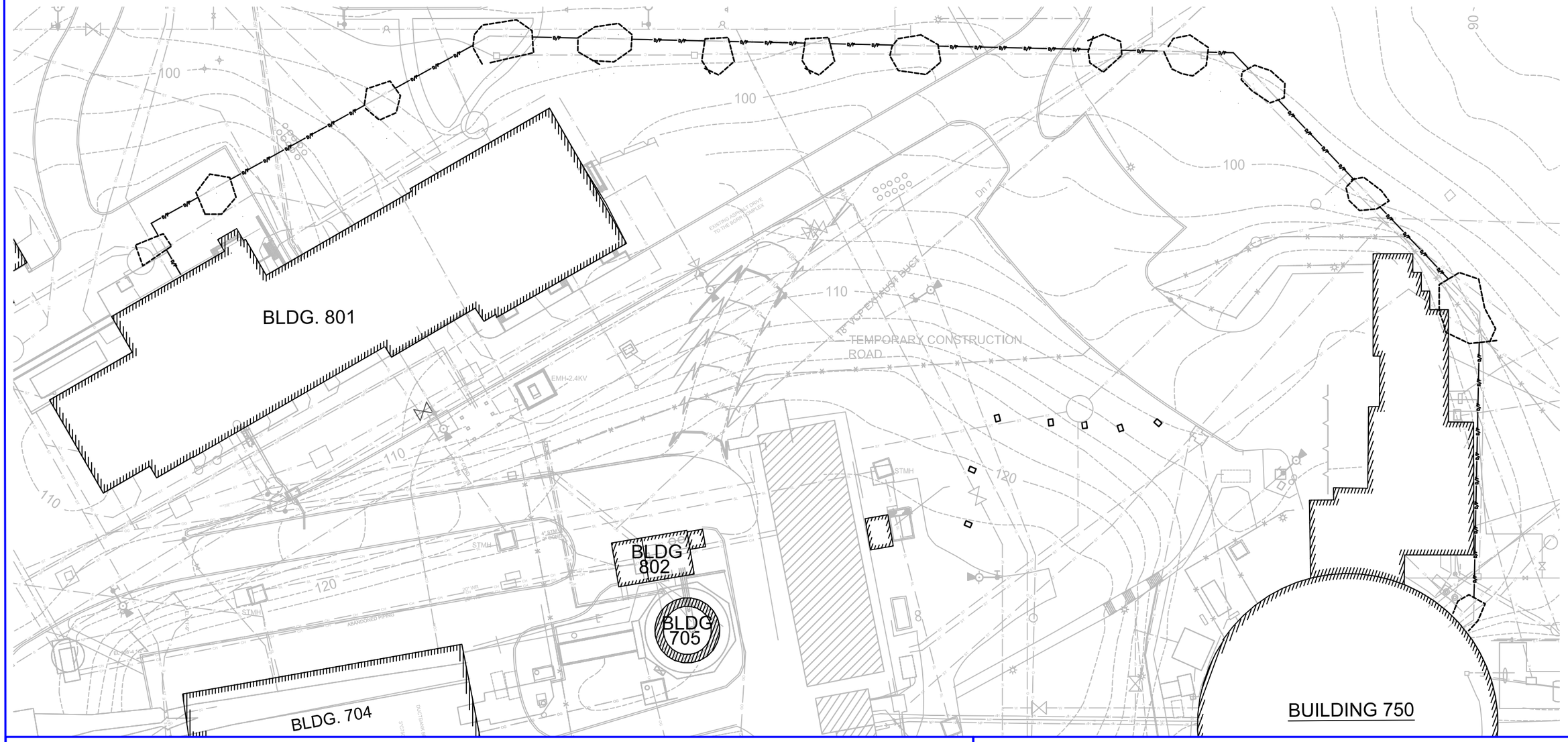
NOTES:

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 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).

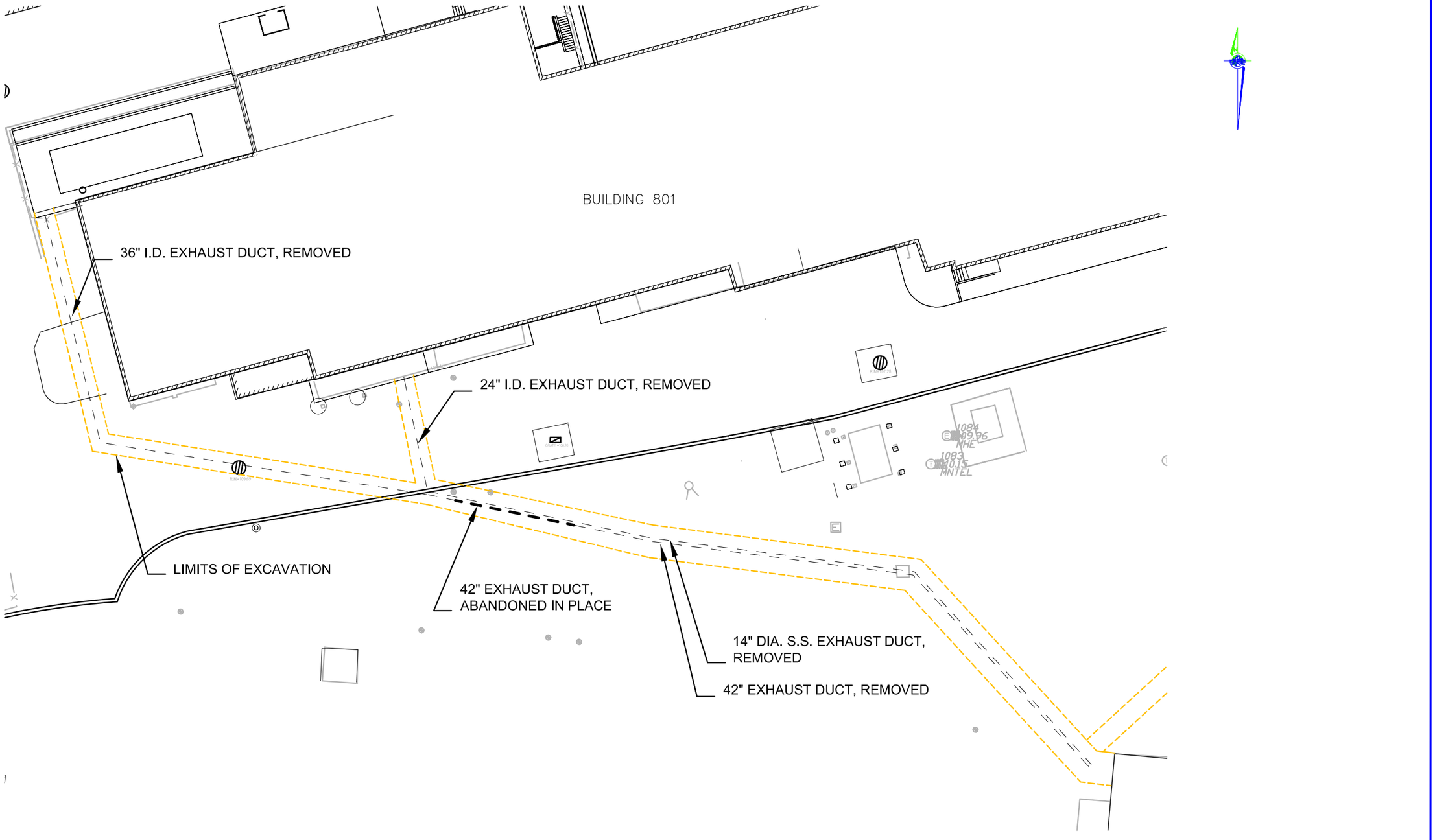
The excavation and removal of the acid waste line and ducts were divided into 5 separate trenches based on the location of joints and duct transitions. The locations of the trenches are discussed further in Section 3.2 and are illustrated on Figures 3-5a through 3-5e.

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,

which extended from each end of the segment of 42-inch duct to grade, were installed upon completion of the radiological survey. The associated trench was then immediately backfilled and grout was injected from grade via the sonotubes. Radiological postings were placed at ground surface above each of the duct ends after the trench was completely backfilled. The location of the remaining 36 feet of 42-inch duct is illustrated on Figure 3-2.

Figure 3-2 Phase III, Trench 5 - 42-inch Duct Left in Ground



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.

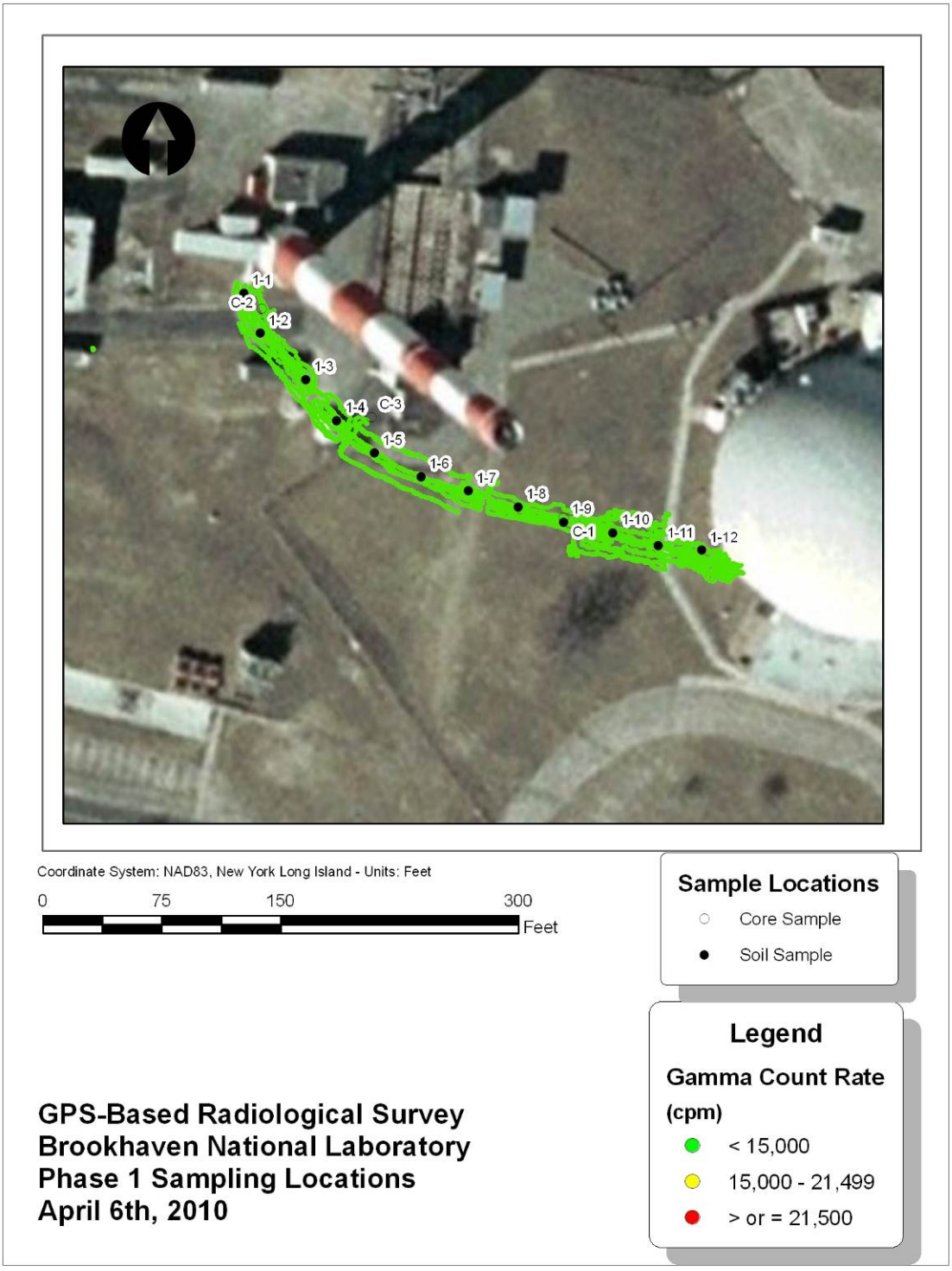
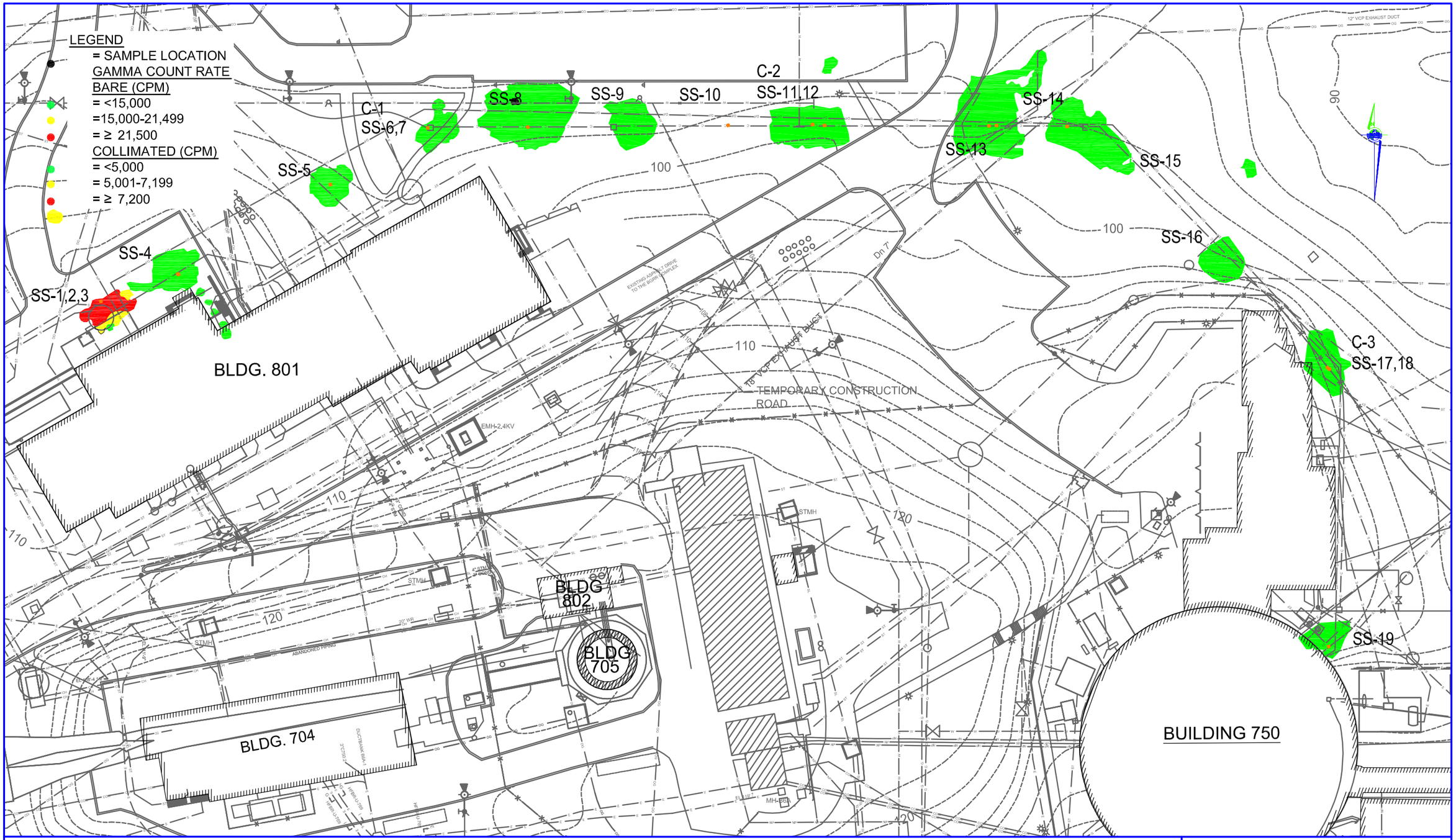


Figure 3-3 – Phase I FSS Sample Locations and Radiological Walkover Survey Results

Figure 3-4 – Phase II FSS Sample Locations and Radiological Walkover Survey Results



PHASE 2 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

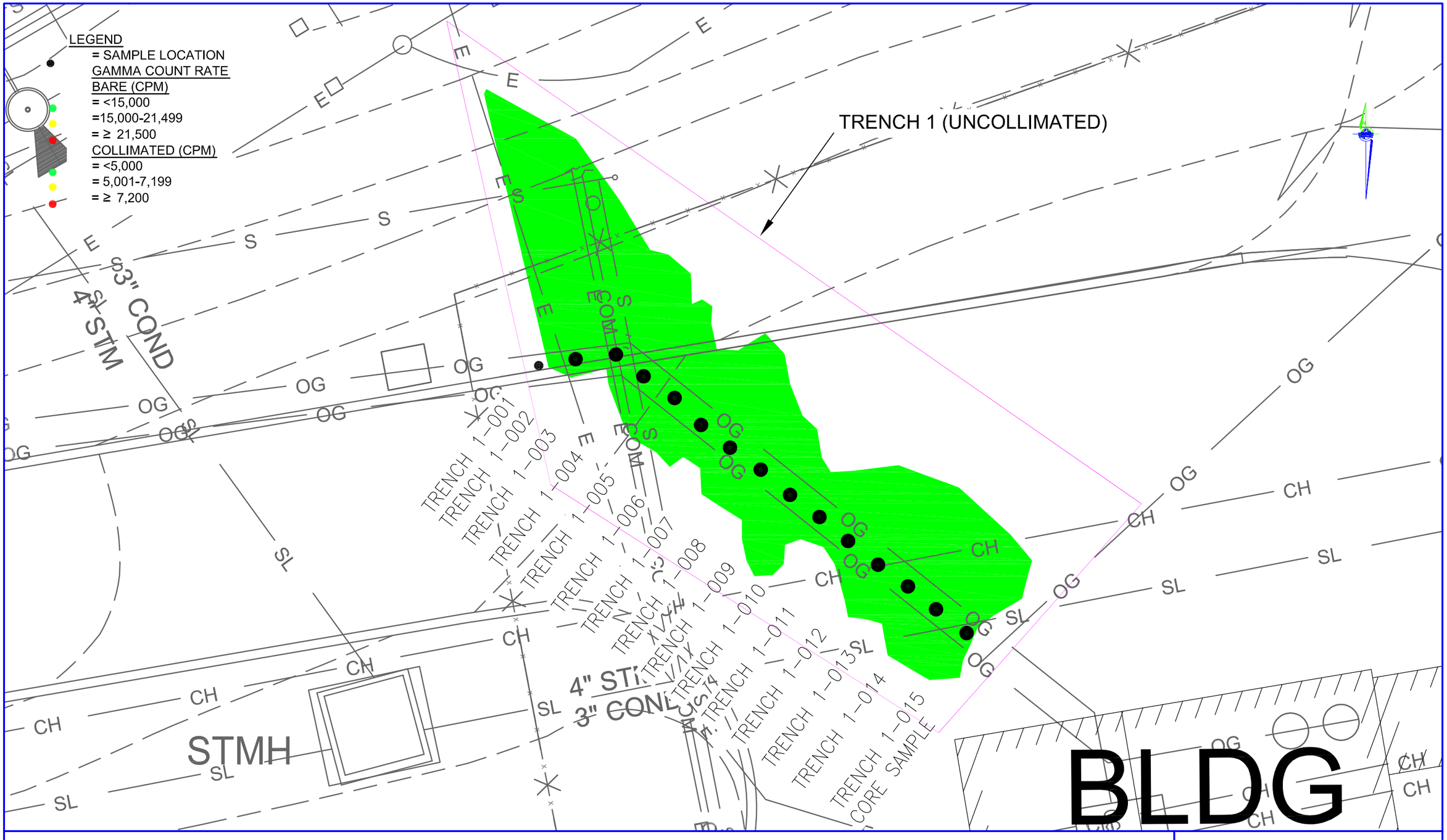
SCALE= 1" = 60'

LEGEND

SS = SURFACE SAMPLE
C = CORE SAMPLE

Figure No:	3-4
Date:	02/24/11

Figure 3-5A – Phase III, Trench 1 FSS Sample Locations and Radiological Walkover Survey Results



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

SCALE= 1" = 10'

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

Figure 3-5B – Phase III, Trench 2 FSS Sample Locations and Radiological Walkover Survey Results

LEGEND

= SAMPLE LOCATION

GAMMA COUNT RATE

BARE (CPM)

= <15,000

=15,000-21,499

= ≥ 21,500

COLLIMATED (CPM)

= <5,000

= 5,001-7,199

= ≥ 7,200

TRENCH 2–CORE SAMPLE

TRENCH 2

TRENCH 2–001

TRENCH 2–002

TRENCH 2–003

TRENCH 2–004

TRENCH 2–005

TRENCH 2–006

TRENCH 2–007

TRENCH 2–008

TRENCH 2–009

TRENCH 2–010

TRENCH 2–011

TRENCH 2–012

TRENCH 2–013

TRENCH 2–014

OG

ST

NP

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

SCALE= 1" = 8'

Figure No: 3-5B

Date: 02/24/11

Figure 3-5C – Phase III, Trench 3 FSS Sample Locations and Radiological Walkover Survey Results

LEGEND

= SAMPLE LOCATION

GAMMA COUNT RATE

BARE (CPM)

= <15,000

=15,000-21,499

= ≥ 21,500

COLLIMATED (CPM)

= <5,000

= 5,001-7,199

= ≥ 7,200

TRENCH 3 (UNCOLLIMATED)

TRENCH 3-001

TRENCH 3-002

TRENCH 3-003

TRENCH 3-004

TRENCH 3-005

TRENCH 3-006

TRENCH 3-007

TRENCH 3-008

TRENCH 3-009

TRENCH 3-010

CONCRETE CAISSON RINGS (10DIAM, 10H)

GEOPROBE PVC (TYP)

ST NP S W OG E

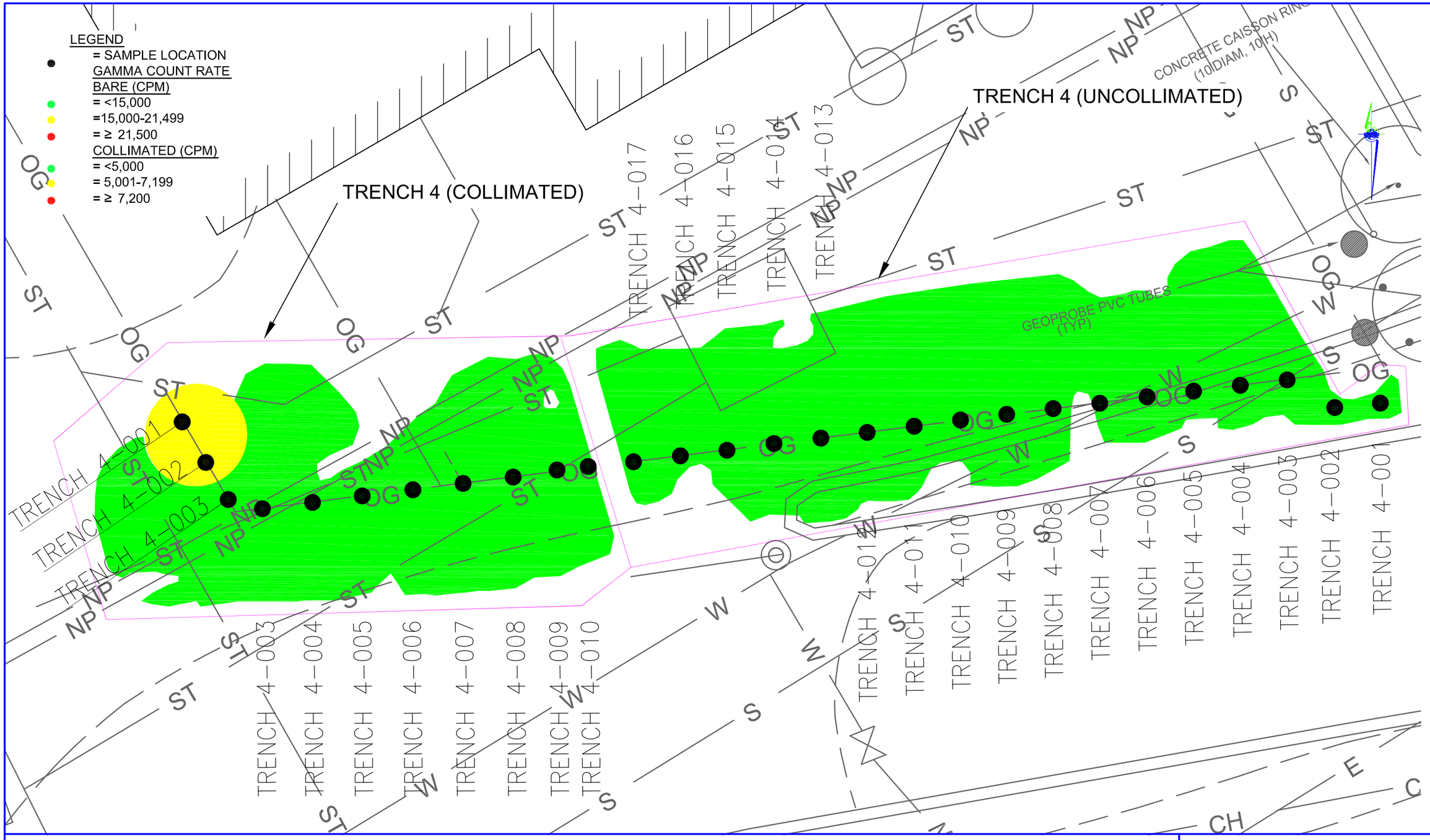
PHASE 3, TRENCH 3 FSS SAMPLE LOCATIONS AND RADIOLOGICAL WALKOVER SURVEY RESULTS

SCALE= 1" = 8'

Figure No: 3-5C

Date: 02/24/11

Figure 3-5D – Phase III, Trench 4 FSS Sample Locations and Radiological Walkover Survey Results



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

SCALE= 1" = 8'

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

Figure 3-5E – Phase III, Trench 5 FSS Sample Locations and Radiological Walkover Survey Results

LEGEND
- = SAMPLE LOCATION

GAMMA COUNT RATE
BARE (CPM)
- = <15,000
- =15,000-21,499
- = ≥ 21,500

COLLIMATED (CPM)
- = <5,000
- = 5,001-7,199
- = ≥ 7,200

TRENCH 5 (COLLIMATED)

TRENCH 5 (UNCOLLIMATED)

EMH-2.4KV

TRENCH 5-020
TRENCH 5-019
TRENCH 5-018
TRENCH 5-017
TRENCH 5-016
TRENCH 5-018
TRENCH 5-017
TRENCH 5-016
TRENCH 5-015
TRENCH 5-014
TRENCH 5-013
TRENCH 5-012
TRENCH 5-011
TRENCH 5-0010
TRENCH 5-009
TRENCH 5-008
TRENCH 5-007
TRENCH 5-006
TRENCH 5-005
TRENCH 5-004
TRENCH 5-003
TRENCH 5-002
TRENCH 5-001
TRENCH 5-001
TRENCH 5-002
TRENCH 5-003
TRENCH 5-004
TRENCH 5-005.
TRENCH 5-006
TRENCH 5-007
TRENCH 5-008
TRENCH 5-009
TRENCH 5-010
TRENCH 5-011
TRENCH 5-012
TRENCH 5-013
TRENCH 5-014
TRENCH 5-015

110

120

STMH

4" STM
3" COND

20" WR

20" WS

CONCRETE CAISSON RINGS (10'DIAM, 10'H)

GEOPROBE PVC TUBES (TYP)

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) was dismantled, the associated contaminated soil was removed and project wastes were disposed.

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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APPENDIX A

Field and Data Summaries for Piping and Ducts Left in the Ground

1) Phase I - HFBR Sanitary Line Field and Data Summary
2) Phase II – D/F Waste Line Removal Field and Data Summary
3) Phase III, Trench 5 – 36-inch Duct Radiological Survey Procedure and Results

HFBR UNDERGROUND UTILITIES REMOVAL
PHASE 1 – BUILDING 750 SANITARY SEWER TO MANHOLE 232
SUMMARY OF FIELD SAMPLING
REQUEST TO GROUT IN-PLACE

Introduction

The HFBR Sanitary Sewer line runs from the northwest corner of Building 750 to a central manhole outside the building adjacent to the generator room access. The total length of the line from the Building 750 exterior wall to the Manhole 232 is approximately 26 ft. The sewer serviced restrooms, showers, and sink drains located in Building 750. The RD/RA work plan provides for the management of this line by grouting in-place in the event the line meets specific criteria. The interior and exterior surfaces of the line have been surveyed. Soils surrounding the line have been sampled. The analytical results from these sampling events are provided in this summary. Based on these results the line meets those criteria allowing the line to be grouted and left in place.

Details regarding the performance of this work are provided in the following sections.

Background

The RD/RA Work Plan provides for the management of the sanitary line as follows:

1. Collect soil samples in the vicinity of the sanitary line and MH232 in accordance with the Field Sampling Plan (FSP).
2. Fill the sanitary line with grout, or similar material, in accordance with the task-specific work procedure.
3. Backfill the excavation, restore surface grade, and perform site restoration in accordance with the project Excavation Plan.

The FSP provides the release criteria for piping remaining in place. Piping remaining in place may be released in accordance with RCD-FS-1005, using the following criteria.

1. 100% scan of accessible internal and external surfaces with beta-gamma probe (frisker or larger probe) and with an alpha sensitive probe. Note that sections of exterior surfaces may not be accessible. This is acceptable because the primary concern is activity inside the piping.
2. 100% scan of accessible external surfaces with a NaI probe (2x2) or similar.
3. Interior scan of the length of remaining piping, using 1 x 1 NaI probe or similar gamma sensitive probe. A range of background levels should be developed for comparison purposes, and at any location greater than 2 times background, obtain a sample and analyze as described in item 4 below.
4. The concentration criteria (pCi/g) of Tables 1 and 2 apply in cases where physical material is collected from inside piping. Obtain a sample of the interior surface of the piping; collect at least 50 grams of material if available. Analyze the samples by gamma spectroscopy and for Sr-90. The limits of Tables 1 and 2 will apply to the volumetric material.

Table 1
Radionuclides of Concern for HFBR Underground Utilities

Radionuclides of Concern	Residential Cleanup Value (pCi/g)	Source of Cleanup Goal Value
Cs-137	23	OU I ROD (BNL 2009a)
Sr-90	15	OU I ROD (BNL 2009a)
Ra-226	5	OU I ROD (BNL 2009a)

Table 2
Additional Radionuclides for Evaluation - HFBR Underground Utilities

Additional Radionuclides for Evaluation	Estimated Cleanup Value (pCi/g) [(a)]
H-3	9.6 E+15 (b)
Co-60	1,260
Eu-152	51
Eu-154	180
U-235	4.6 (c)
U-238	4.7 (c)
Pu-238	57
Pu-239/ Pu-240	35
Am-241	34

Notes:

(a) Each value listed in this table is the estimated cleanup value if the individual radionuclide was the only radionuclide present. The demonstration that the site is acceptable would be based on a RESRAD evaluation using all BNL-related radionuclides detected.

(b) The pCi/g value for tritium for both the 15 millirem total dose criterion and the 4 millirem per year groundwater consumption criterion is very high (> 1 E+15) because the calculated dose is close to zero. Tritium, if detected, will be included in the RESRAD evaluation following remediation.

(c) Values listed for uranium are based on 4 millirem per year from groundwater consumption.

Soils Sampling Data Results

Geoprobe samples were collected on alternate sides of the sanitary line on approximate 4-ft centers. Composite samples of 4 ft core intervals were collected and analyzed for the individual radionuclides listed in Tables 1 and 2. These data are summarized and presented in Table 3. Data indicate contamination levels consistent with background.

Table 3
Summary of Radiochemical Data
Geoprobe Soil Samples – Chain of Custody #28535

Parameter	OU1 Action Levels	GP-1							GP-2						GP-3							GP-4							Blind Dup
		0-4'	0-4' dup	4-8'	8-12'	12-16'	16-20'	20-24'	0-4'	4-8'	8-12'	12-16'	16-20'	20-24'	0-4'	0-4' dup	4-8'	8-12'	12-16'	16-20'	20-24'	0-4'	4-8'	8-12'	8-12' dup	12-16'	16-20'	20-24'	
Gross Alpha		21.5	25.2	20.4	5.4	7.9	5.6	11.1	21.8	11.5	20.7	8.3	11.2	6.7	30	NA	22	13.1	7.9	4.3	4.9	28.4	14.9	11.5	7.0	6.9	6.1	6.6	6.6
Gross Beta		25.7	25.1	15.7	8.3	15.6	13.5	15.3	22.1	15.1	19.3	8.6	13.9	9.3	29.6	NA	17.7	12.1	12.4	9.4	11.8	28.9	19.4	12.4	11.7	8.9	14.3	12.6	16.6
Rad Alpha Spec Analysis																													
Americium-241	34	0.028	-0.016	0.0	0.010	0.023	0.043	0.02	0.004	-0.005	0.053	0.05	0.025	0.042	-0.078	0.011	0.008	0.032	0.0007	0.035	0.019	0.044	0.013	0.004	NA	0.011	0.023	0.024	0.031
Plutonium-238		0.059	0.053	-0.069	0.052	0.01	0.047	0.033	0.054	0.082	0.054	0.032	0.006	0.047	0.066	0.058	0.044	0.035	0.035	0.023	0.006	0.045	0.009	0.074	NA	0.030	-0.004	0.096	0.085
Plutonium-239/240	35	0.042	-0.001	-0.03	0.03	0.01	0.007	0.02	0.03	0.02	0.011	0.02	0.004	0.01	0.006	0.021	0.015	0.0250	-0.0059	0.0070	0.0140	-0.0072	0.01	0.031	NA	0.0270	0.0050	0.0050	0.013
Uranium-234		0.24	0.29	0.26	0.33	0.28	0.16	0.21	0.30	0.38	0.174	0.08	0.12	0.17	0.31	0.53	0.23	0.175	0.1770	0.1610	0.23	0.29	0.181	0.165	NA	0.1910	0.1140	0.1560	0.129
Uranium-235/236	4.6	0.01	0.03	0.025	-0.0059	-0.0057	0.00	-0.0028	-0.003	0.027	0.01	0.017	0.027	-0.003	0.01	0.045	0.00	0.027	-0.01	-0.0028	0.0	0.0	0.00	0.02	NA	-0.0054	0.00	0.013	0.00
Uranium-238	4.7	0.30	0.34	0.171	0.24	0.28	0.091	0.177	0.34	0.22	0.22	0.148	0.077	0.127	0.38	0.29	0.173	0.116	0.167	0.168	0.21	0.23	0.136	0.162	NA	0.240	0.135	0.192	0.173
Rad Gamma Spec Analysis																													
Americium-241		-0.016	0.004	-0.023	0.0009	-0.027	0.018	0.043	-0.002	0.004	-0.008	-0.004	0.034	0.097	-0.017	NA	0.043	0.0002	0.0005	0.04	-0.011	0.044	0.01	-0.0004	-0.029	0.039	0.090	-0.009	0.073
Beryllium-7		0.009	-0.04	0.06	0.02	-0.04	0.11	0.04	0.009	0.01	0.06	0.03	0.01	-0.02	-0.04	NA	-0.03	-0.06	-0.09	-0.09	-0.005	0.0	0.0	-0.03	0.08	0.0	-0.08	0.002	0.0
Cesium-134		-0.020	-0.001	0.005	-0.009	-0.01	0.0	-0.0007	-0.008	-0.0003	-0.0002	0.027	0.005	-0.001	-0.015	NA	0.019	-0.012	-0.001	-0.013	0.0004	0.0	-0.004	-0.002	-0.011	-0.001	0.0	-0.012	-0.002
Cesium-137	23	0.167	0.205	0.020	-0.04	0.0	0.0006	0.005	0.136	-0.008	0.004	0.014	-0.009	0.008	0.252	NA	0.19	0.008	0.009	-0.04	0.0	0.34	0.002	0.01	0.0003	-0.018	-0.04	0.0001	0.0
Cobalt-57		0.012	0.009	-0.001	-0.0008	0.020	0.005	0.020	0.017	0.015	0.00002	0.014	0.001	-0.007	-0.007	NA	-0.007	0.036	0.0008	0.007	0.0007	0.017	0.012	-0.006	-0.004	0.002	0.003	-0.004	0.0004
Cobalt-60	1,260	0.004	0.0	-0.005	-0.04	-0.005	0.0	-0.004	-0.006	-0.04	0.0	-0.003	-0.04	0.008	0.011	NA	-0.03	-0.009	0.012	-0.04	-0.0005	0.0	-0.008	0.0	0.002	-0.002	-0.05	0.0	-0.003
Europium-152	51	0.0	0.0	0.0	0.05	0.04	0.0	-0.02	0.0	0.04	0.09	0.06	0.24	0.04	0.15	NA	0.0	-0.10	0.11	0.0	0.09	0.14	0.05	-0.07	0.03	0.0	0.0	-0.07	0.0
Europium-154	180	0.03	0.04	0.1	0.09	-0.07	0.0	-0.04	0.16	0.0	-0.05	-0.02	-0.03	0.01	0.10	NA	-0.10	0.001	0.11	0.03	-0.03	0.05	-0.1	0.0	0.004	0.11	-0.02	0.0	0.0
Europium-155		-0.000003	-0.02	0.0	0.0	0.0202	-0.012	0.008	0.034	0.042	0.011	0.024	0.011	0.012	-0.02	NA	0.009	-0.003	-0.008	-0.012	0.093	0.03	0.015	0.025	0.021	0.015	0.060	0.065	0.038
Manganese-54		0.0002	-0.004	-0.002	0.024	0.008	0.004	0.0007	-0.006	0.0	0.001	0.008	-0.015	-0.005	-0.003	NA	0.008	0.0001	-0.011	0.0008	-0.00006	-0.017	0.0	0.007	0.0	-0.015	-0.00001	0.0004	-0.016
Sodium-22		-0.002	0.0	0.014	0.0	0.006	0.012	0.011	-0.009	0.0	-0.01	-0.0006	0.0	0.023	-0.011	NA	0.0	0.0	-0.002	0.0	0.015	0.0	0.0	0.001	0.012	0.0	-0.02	0.0	-0.007
Zinc-65		-0.03	0.03	0.0	-0.04	0.003	-0.04	0.0	-0.013	0.0	-0.032	0.0	0.0	0.0	-0.03	NA	-0.02	0.011	-0.007	-0.04	-0.06	-0.05	0.0	0.0	-0.012	-0.03	0.0	0.018	0.0
Bismuth-214		0.39	0.54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40		5.4	4.7	4.01	ND	ND	ND	3.91	4.54	ND	3.08	2.95	ND	ND	8.9	NA	ND	ND	ND	ND	5.9	4.71	ND	ND	ND	ND	ND	ND	ND
Lead-212		ND	ND	ND	0.340	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium-90	15	-0.19	-0.11	-0.07	-0.30	0.06	-0.01	0.03	0.14	0.16	-0.10	0.03	-0.19	0.11	-0.02	NA	-0.4	-0.11	-0.17	-0.28	-0.07	0.07	0.09	0.07	-0.03	0.20	-0.18	0.10	-0.04
Rad Liquid Scintillation Analysis																													
Tritium	9.6 E+15	-0.01	-0.05	-0.03	-0.02	0.03	0.01	0.02	-0.05	0.02	-0.06	-0.06	0.03	0.01	0.14	-0.001	0.05	0.25	-0.02	0.12	0.05	-0.03	0.08	0.11	NA	0.02	0.01	0.09	0.21

Notes:

ND – Not Detected

NA – Not Analyzed

All Units are pCi/g

Gamma spec results only reported for those parameters that were recorded during the analysis

External Line Data

The accessible sanitary line exterior surfaces were surveyed. All accessible areas were frisked and a total of 5 tritium smears and 8 disc smears were performed. Three of the tritium smears and five of the disc samples were taken on the outside portion of the pipe inside the Manhole 232. Two of the tritium smears and three of the disc smears were taken inside Building 750 at the Equipment level. The results of these sample analyses are provided in Table 4. Data indicate less than Minimum Detectable Activity (MDA) for all disc samples on both ends of the exposed line. The Manhole 232 pipe surface tritium smears indicated tritium at less than detectable levels. HFBR Equipment Level tritium smears indicated levels consistent with HFBR interior surfaces.

There were no elevated counts above background during direct frisk. Frisking was performed using a Ludlum model 2360 with a 43-93 probe. Background levels during frisking were 0 cpm Alpha and 140 cpm Beta. The pipe interior is free of any matter. There was insufficient material to collect a physical sample for analysis.

Table 4
HFBR Underground Utilities Removal – Phase 1
HFBR Sanitary Sewer – Manhole 232
Sanitary Line Radiological Survey Results

Sample Location	Alpha, dpm	Beta, dpm
Exterior Pipe Surface - MH 232		
Disc 1	<MDA	<MDA
Disc 2	<MDA	<MDA
Disc 3	<MDA	<MDA
Disc 4	<MDA	<MDA
Disc 5	<MDA	<MDA
MDA	15.3	43.9
Tritium 1 Smear	NA	0
Tritium 2 Smear	NA	0
Tritium 3 Smear	NA	0
Exterior Pipe Surface - Inside HFBR		
Disc 1	<MDA	<MDA
Disc 2	<MDA	<MDA
Disc 3	<MDA	<MDA
MDA	9.58	13.87
Tritium 1 Smear	NA	279
Tritium 2 Smear	NA	392
Ludlum 2360 Background	0 cpm	140 cpm

Notes:
MDA – Minimum detectable activity
DPM – Disintegrations per minute
CPM – Counts per minute

Internal Line Data

The interior of the sanitary line was performed using a NaI 2x2 probe. Gamma readings were recorded at 12 inch intervals. Five feet of the line was surveyed from the outside at Manhole 232 toward Building 750. Six feet of line was surveyed from the inside of Building 750 equipment level toward the Manhole 232. In addition, one 100 cm^2 smear was collected from each end of the sanitary line.

These data are summarized and presented in Table 5. These data indicate contamination levels consistent with background.

Table 5
HFBR Underground Utilities Removal – Phase 1
HFBR Sanitary Sewer – Manhole 232
Interior Sanitary Line
NaI Gamma and Smear Survey Results

Sample Location	From MH 232	From Bldg 750
Depth, ft	**Gamma, cpm**	**Gamma, cpm**
1	3300	3500
2	2900	3600
3	2500	3500
4	2500	3000
5	2500	2300
6	N/A	3500
Background	3300	3500
	Alpha, dpm	**Beta,dpm**
Smear 1	<MDA	<MDA
Smear 2	<MDA	<MDA
MDA	9.58	13.87

Notes:
MDA – Minimum detectable activity
CPM – Counts per minute

Summary and Conclusions

Soils surrounding the sanitary line have been sampled and analyzed. Accessible sanitary line exterior surfaces have been frisked and sampled. Accessible sanitary line interior surfaces have been frisked and sampled. In each of the three cases, analytical results indicate contamination levels consistent with background and meet the criteria for grouting and leaving the sanitary line in place.

HFBR UNDERGROUND UTILITIES REMOVAL – PHASE 2
D/F WASTE LINE REMOVAL
FIELD AND DATA SUMMARY

Introduction

This report summarizes and presents data collected for the HFBR Underground Utilities Project, Phase 2, D/F Waste Line Removal. The D/F Waste Line provided the conduit for pumping D/F waste from Building 750 to Building 801. The line consists of a 2-inch stainless steel transfer line and a bitumen coated carbon steel 4-inch line that provided secondary containment. The 2-inch line was grouted to displace any accumulated water prior to beginning excavation and extraction.

The 2-inch line was accessed and extracted from the 4-inch line by excavating eleven (11) access trenches in locations without utility line(s) interference. The 4-inch line was cut to expose the 2-inch line, the 2-inch line cut, and then pulled. The 2-inch line was cut in approximate 12 ft lengths as the pull continued. This process was repeated for the 1100 ft length of pipe. Approximately 640 feet of the 4-inch pipe was removed. The balance of the 4-inch pipe was left in place in areas congested with other utilities, under sidewalks or roads, or sufficiently close to buildings to cause undermining. This pipe will be grouted immediately after trench backfilling. The D/F Waste line removal began on April 19, 2010 and was completed on May 21, 2010.

A series of four rounds of sampling and analyses of the D/F Waste Line have been completed. Surveying and/or sampling and analyses have been performed on the soil overburden (on-site and off-site analysis), 4-inch secondary containment line interior, surface soils in each trench, and sub-trench interval core samples to a depth of 8 ft. Analytical data for each round of sampling is summarized below and provided in the following tables.

Pre-Excavation Soil Overburden Samples – Onsite Analysis

Soil samples of the overburden were taken at intervals of 0-2 ft and 2-4 ft every 50 feet per the Field Sampling Plan (FSP). A total forty-two (42) samples were collected at the twenty one (21) locations over the 1100 ft length of the D/F Waste Line. These individual samples were then analyzed on-site by In Situ Object Counting System (ISOCS) for Cs-137. This method of analysis is less sensitive than the offsite laboratory but is sufficient for screening soil due to the detection limits. Table 1 summarizes the analytical data from the overburden soil samples. These data indicate contamination levels consistent with background.

Pre-Excavation Soil Overburden Samples – Offsite Analysis

Eleven composite samples were prepared from the forty-two overburden samples. Two sets of composites were created based on sample interval, one set representing the 0-2 ft depth and the second representing the 2-4 ft depth. The samples were submitted to an offsite analytical laboratory for radiological analyses. The results of these analyses are summarized and presented in Table 2. Data from the composite overburden samples analyzed by the offsite analytical laboratory indicate contamination levels consistent with background.

Table 1

HFBR Underground Utilities Removal - Phase 2 – D/F Waste Line
Soil Overburden Analytical Results - ISOCS

SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
001	0'-2'	BG
001	2'-4'	BG
002	0'-2'	BG
002	2'-4'	BG
003	0'-2'	0.18
003	2'-4'	BG
004	0'-2'	0.139
004	2'-4'	0.115
005	0'-2'	BG
005	2'-4'	BG
006	0'-2'	BG
006	2'-4'	BG
007	0'-2'	BG
007	2'-4'	BG
008	0'-2'	BG
008	2'-4'	BG
009	0'-2'	BG
009	2'-4'	BG
010	0'-2'	BG
010	2'-4'	BG
011	0'-2'	BG
011	2'-4'	BG
012	0'-2'	BG
012	2'-4'	BG
013	0'-2'	BG
013	2'-4'	BG
014	0'-2'	BG
014	2'-4'	BG
015	0'-2'	BG
015	2'-4'	BG
016	0'-2'	0.11
016	2'-4'	BG
017	0'-2'	BG
017	2'-4'	BG
018	0'-2'	BG
018	2'-4'	BG
019	0'-2'	BG
019	2'-4'	BG
020	0'-2'	0.313
020	2'-4'	0.18
021	0'-2'	0.277
021	2'-4'	BG

Table 2

HFBR Underground Utilities Removal - Phase 2 – D/F Waste Line
Soil Overburden Radiochemical Analytical Results – Offsite Analysis
Chain of Custody # 28721

Parameter	OU1 Action Levels	C1 0'-2' (pCi/g)	C2 0'-2' (pCi/g)	C3 0'-2' (pCi/g)	C4 0'-2' (pCi/g)	C5 0'-2' (pCi/g)	C6 2'-4' (pCi/g)	C7 2'-4' (pCi/g)	C8 2'-4' (pCi/g)	C9 2'-4' (pCi/g)	C10 2'-4' (pCi/g)	C11 2'-4' (pCi/g)
Rad Gamma Spec Analysis												
Actinium-228	NA	0.572	0.87	0.9	1.08	0.993	1.01	0.866	0.85	0.794	0.944	0.852
Beryllium-7	NA	0.0382	0.00582	0.0398	0.025	-0.0111	-0.0179	-0.0263	-0.0193	-0.00648	-0.0287	-0.00187
Bismuth-212	NA	0.778	na	1.15	1.18	1.09	1.01	0.881	0.842	0.933	0.878	1.02
Bismuth-214	NA	0.371	0.531	0.595	0.618	0.582	0.6	0.54	0.526	0.563	0.543	0.546
Cesium-137	23	0.139	0.083	0.0711	0.0622	0.129	0.0451	0.0311	0.0358	0.0353	0.026	0
Cobalt-57	NA	0.000606	0.00355	-0.00411	-0.00213	-0.0022	0.00039	0.0017	0.00275	-0.00159	2.26E-05	0.00236
Cobalt-60	1,260	-0.003	-0.00459	-0.00529	0.00201	-0.000782	0.00421	0.00635	-0.0112	0.00117	-0.00299	0.00129
Lead-212	NA	0.546	0.838	0.888	1	0.882	0.884	0.839	0.891	0.827	0.867	0.823
Lead-214	NA	0.449	0.669	0.676	0.71	0.681	0.719	0.652	0.659	0.647	0.648	0.624
Manganese-54	NA	-0.00121	0.0087	0.000737	-0.00245	0	-0.000617	0.0159	-0.00916	0.0131	0	0.00898
Potassium-40	NA	4.87	7.03	7.53	7.03	6.52	7	6.69	6.7	6.45	6.53	6.47
Radium-226	NA	0.371	0.531	0.595	0.618	0.582	0.6	0.54	0.526	0.563	0.543	0.546
Sodium-22	NA	-0.00381	-0.00211	-0.00547	-0.0119	0.00735	0.00354	0.00432	-0.00941	-0.000273	0.00111	-0.00622
Thallium-208	NA	0.16	0.262	0.3	0.315	0.266	0.304	0.251	0.254	0.258	0.272	0.264
Thorium-228	NA	0.546	0.838	0.888	1	0.882	0.884	0.839	0.891	0.827	0.867	0.823
Rad Gas Flow Proportional Counting												
Strontium-90	15	0.479	-0.312	0.409	-0.0469	-0.114	-0.0831	0.206	0.418	0.0262	0.682	0.164
Rad Liquid Scintillation Analysis												
Tritium	9.6 E+15	-8.26	NA	NA	-14.6	NA	NA	31.1	NA	NA	69.3	-59.5

Notes:
NA – Not Applicable
ND – Non Detect

4-Inch Line Containment Line Interior Survey

Portions of the 4-inch secondary containment line will be grouted in left in place. These sections of line are in areas of high utilities concentration, roads, and sidewalks, or areas where excavation may cause foundation undermining. Three surveys were performed in and around these lines.

An E600 was conveyed through each line and a reading taken every five feet. A total of 167 readings were taken. The range of values for this survey was 800-1,500 counts per minute (cpm) with the exception of the areas adjacent to Building 801. Background levels for Building 801 were 3800 cpm inside the pipe and 24,000 cpm outside. These levels dropped to background levels of 1,500 cpm inside the first three feet of pipe.

The 1x1 meter background outside the pipe ranged from 1,500-2,000 cpm. The inside readings ranged from 800-1,500 cpm.

Masslin smears of the accessible portions of the pipe and the meter were performed. All masslins were less than 1,000 disintegrations (dpm)/large area smear (las).

Final Status Survey

A final status survey (FSS) was performed after the 2-inch and portions of the outer 4-inch D/F Waste Line was removed in accordance with the FSP. The requirements of the FSS included the collection of 19 surface soil samples and the collection of core soil samples to a depth of 8 ft at three locations (C-1, C-2, and C-3). Sample locations are depicted in Figure 1.

The surface samples were submitted to an off-site analytical laboratory for radiological and chemical analyses, and are summarized in Table 3. These data indicate contamination levels consistent with background.

Core soil samples were collected for analysis every 2 ft at the three locations C-1 through C-3. Samples were submitted to an off-site analytical laboratory for radiological and chemical analyses. The results are summarized in Tables 4 and 5 and indicate contamination levels consistent with background.

The FSS walkover included gamma radiation checks in each of the 11 excavation trenches. The results of this survey are presented in Figure 2 and Table 6 and indicate contamination levels consistent with background.

FIG 1 – Phase 2 Underground Utilities Removal

D/F Waste Line Final Status Survey

Surface Sampling and Core Sampling Locations

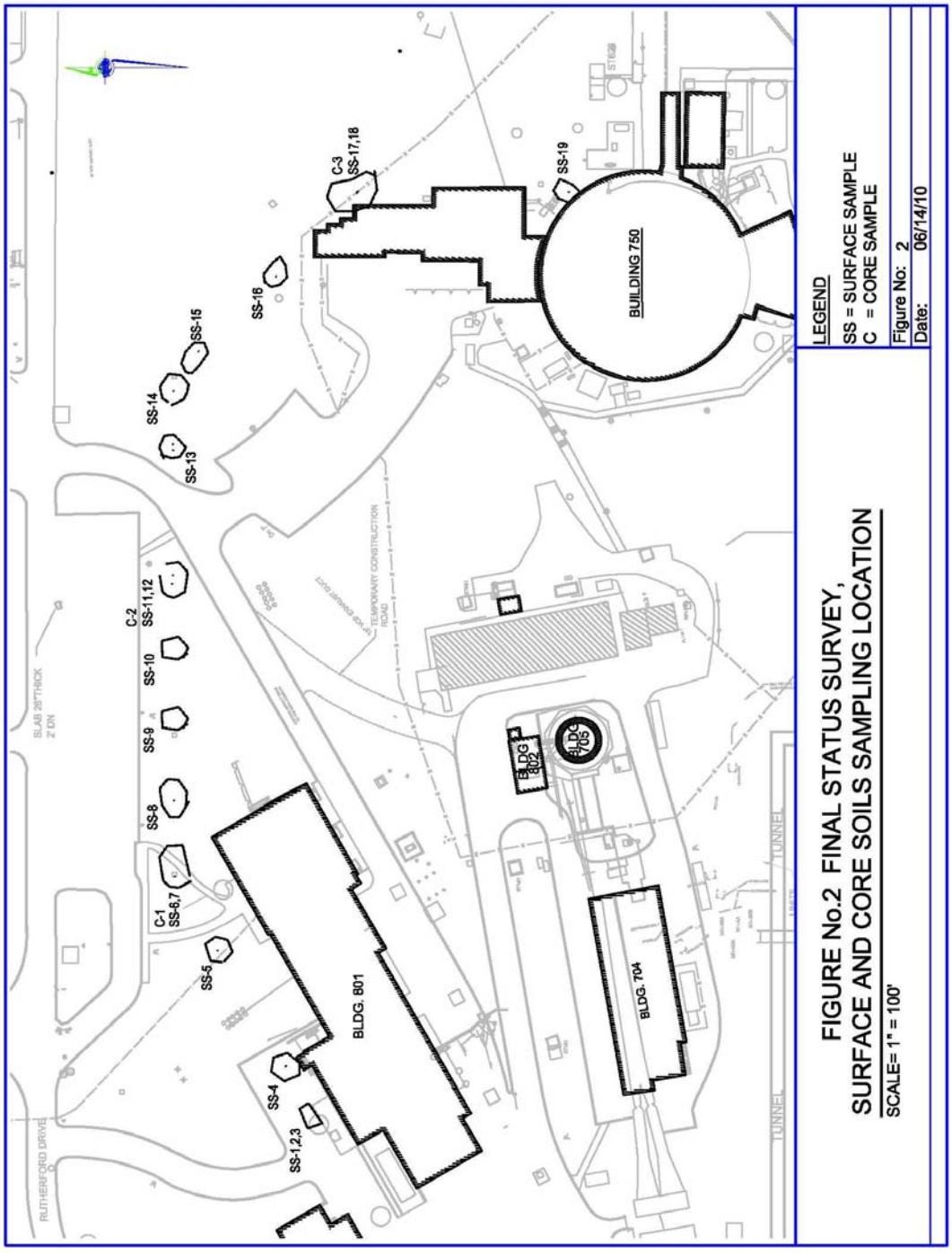


Figure 2 - GPS Based Radiological NaI Detector Survey

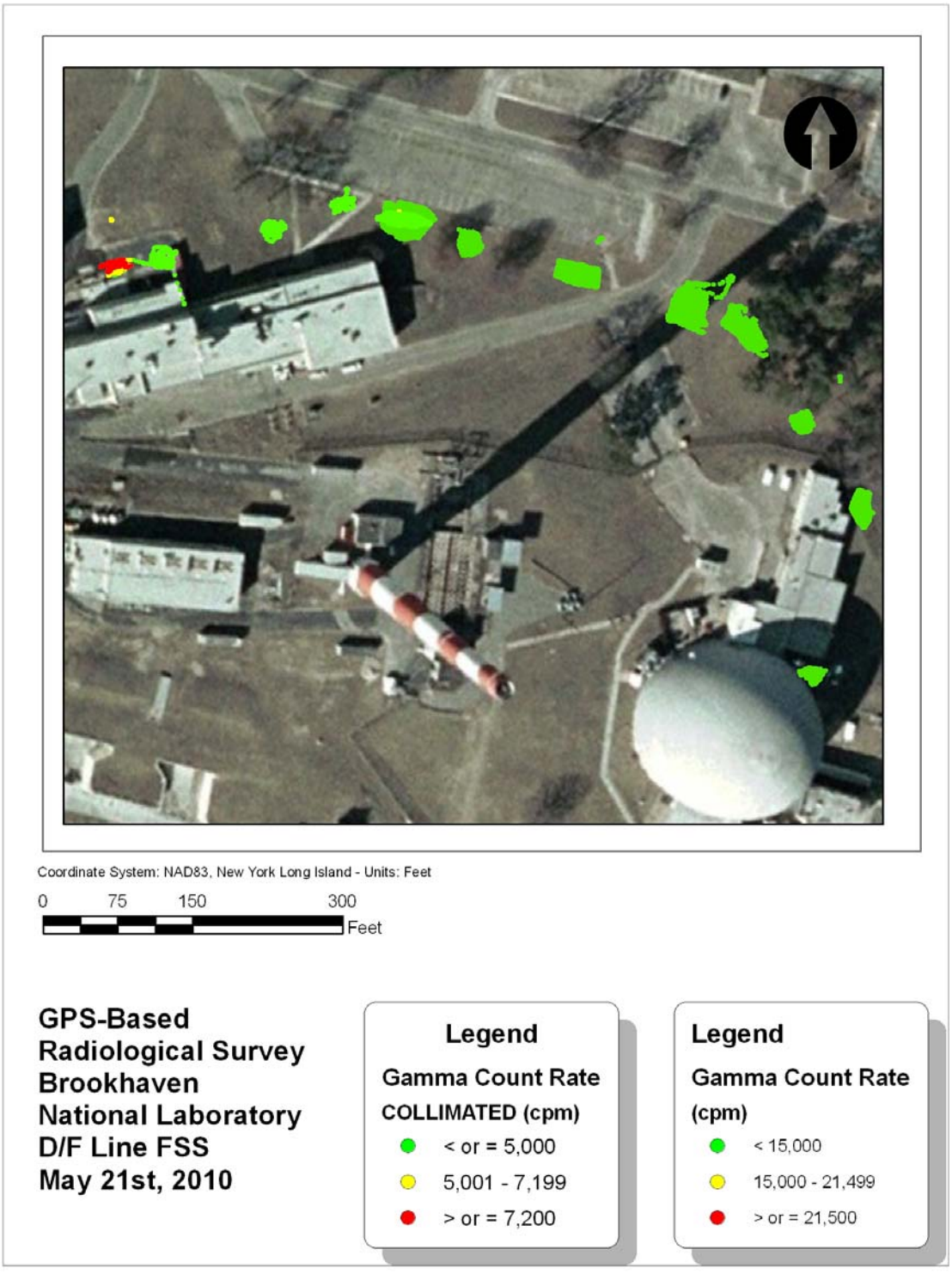


Table 3

HFBR Underground Utilities Removal – Phase 2 – D/F Waste Line Removal
Final Status Survey Surface Soil Samples Radiological Analytical Results
Chain of Custody #28719

Parameter	OU1 Action Levels	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Rad Gamma Spec Analysis																				
Actinium-228	NA	0.553	0.631	0.635	0.406	1.06	0.957	1.08	0.877	0.921	1.05	1.03	0.679	0.814	0.678	0.503	0.707	0.389	0.569	0.382
Beryllium-7	NA	0.00465	0	0.224	0.0247	0.0951	0.0206	-0.021	-0.00649	0.0395	0.34	0.675	0.0858	0.17	0.0536	0.076	0.0401	0.0892	0.134	0.223
Bismuth-212	NA	ND	ND	0.809	ND	0.886	1.07	1.22	1.04	0.924	1.05	1.18	ND	0.83	0.713	ND	0.805	ND	ND	ND
Bismuth-214	NA	0.319	0.403	0.519	0.224	0.653	0.578	0.626	0.548	0.532	0.662	0.599	0.498	0.554	0.467	0.353	0.442	0.223	0.377	0.259
Cesium-137	23	0.693	0.0295	0.00817	0.006	0.0347	0.0294	0.0208	0.000969	0.0186	-0.00537	0.0768	0.0456	0.0294	0.0211	0.0264	0.0289	0.0231	0.0487	0.0935
Cobalt-57	NA	0.00356	0.00289	0.00674	0.00209	-0.000421	0.00318	-0.000606	0.000557	0.00172	-0.00397	0.00222	0.00216	0.00101	-0.000202	0.00109	-0.00622	-0.00188	-0.000431	-0.00125
Cobalt-60	1,260	-0.000141	0.000574	-0.0136	0.00741	-0.00707	-0.0062	-0.000486	-0.000835	0.00176	-0.00603	-0.00695	0.00822	-0.00408	-0.0018	0.000866	-0.00159	-0.00248	6.72E-05	-0.00618
Lead-212	NA	0.542	0.602	0.682	0.407	1.01	0.887	1.04	0.856	0.881	1.05	0.923	0.631	0.717	0.729	0.516	0.709	0.364	0.617	0.32
Lead-214	NA	0.433	0.53	0.588	0.283	0.746	0.666	0.786	0.581	0.63	0.729	0.723	0.479	0.625	0.578	0.394	0.486	0.261	0.378	0.28
Manganese-54	NA	0.0038	-0.00242	0	0.00222	0	0.00606	0.00848	0.00687	0	0	0	0.00877	0.00144	-0.00286	-0.00153	0.012	0.00173	-0.00194	0.000778
Potassium-40	NA	4.39	5.03	7.86	2.98	6.64	6.09	7.44	6.68	6.91	7.27	8.9	7.36	8.23	8.33	6.69	6.12	3.92	4.21	4.2
Radium-226	5	0.319	0.403	0.519	0.224	0.653	0.578	0.626	0.548	0.532	0.662	0.599	0.498	0.554	0.467	0.353	0.442	0.223	0.377	0.259
Sodium-22	NA	-0.00897	-0.00536	3.63E-03	-4.94E-05	0.00302	0.00228	0.00628	-0.00517	-0.00148	-0.0117	-0.00639	0.00143	-0.00265	-0.00328	-0.00128	-0.0122	-0.00118	0.00556	0.00879
Thallium-208	NA	0.155	0.164	2.29E-01	0.107	0.323	0.279	0.301	0.27	0.274	0.319	0.276	0.196	0.25	0.22	0.164	0.219	0.118	0.191	0.115
Thorium-228	NA	0.542	0.602	0.682	0.407	1.01	0.887	1.04	0.856	0.881	1.05	0.923	0.631	0.717	0.729	0.516	0.709	0.634	0.617	0.32
Rad Gas Flow Proportional Counting																				
Strontium-90	15	0.254	0.00507	-0.18	0.78	0.246	0.184	-0.135	-0.207	-0.289	-0.215	-0.0204	0.397	-0.031	-0.114	0.359	0.0813	-0.109	-0.663	-0.218
Rad Liquid Scintillation Analysis																				
Tritium	9.6 E+15	NA	NA	NA	NA	NA	NA	NA	NA	NA	-18.9	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
NA – Not Applicable
ND – Non Detect

Table 4
HFBR Underground Utilities Removal – Phase 2 – D/F Waste Line Removal
Final Status Survey Soil Core Samples Radiological Analytical Results
Chain of Custody #28719

Parameter	OU1 Action Levels	Core 1 **0-2 ft**	Core 1 **2-4 ft**	Core 1 **4-6 ft**	Core 1 **6-8 ft**	Core 2 **0-2 ft**	Core 2 **2-4 ft**	Core 2 **4-6 ft**	Core 2 **6-8 ft**	Core 3 **0-2 ft**	Core 3 **2-4 ft**	Core 3 **4-6 ft**	Core 3 **6-8 ft**	Core 1 **Composite**	Core 2 **Composite**	Core 3 **Composite**
Rad Alpha Spec Analysis																
Americium-241	34	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00954	-0.0345	0.131
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0.0225	0
Plutonium-239/240	35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	-0.027	-0.0237
Uranium-233/234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.743	0.729	0.6280
Uranium-235/236	4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-0.08	-0.02	0.0539
Uranium-238	4.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.598	0.339	0.445
Rad Gamma Spec Analysis																
Actinium-228	NA	0.95	0.558	0.423	0.359	0.625	0.631	0.579	0.858	1.15	0.501	0.438	0.484	0.765	0.854	0.734
Beryllium-7	NA	-0.00357	0.00413	0.474	-0.00536	0.0339	-0.0428	0.0212	0.136	0.0429	0.0161	0.0053	-0.0623	0.105	0.0989	0.0875
Bismuth-212	NA	1.06	ND	ND	ND	0.814	ND	ND	0.734	1.27	ND	ND	ND	ND	0.742	ND
Bismuth-214	NA	0.526	0.354	0.268	0.171	0.468	0.418	0.347	0.51	0.682	0.335	0.226	0.284	0.5	0.519	0.401
Cesium-137	23	-0.00139	-0.000868	-0.000968	-0.00577	-0.00582	-0.00963	-0.00909	-0.0125	0.00571	0.0145	-0.00447	-0.00404	0.0949	0.0607	0.0626
Cobalt-57	NA	0.00183	-0.0006	0.00114	-0.0017	-0.00422	-0.000106	-0.00153	-0.00488	-0.000841	0.000738	-0.00086	-0.00151	0.00205	0.00172	-0.00215
Cobalt-60	1,260	0.00178	-0.0023	-0.00458	-0.00339	-0.00841	-0.00686	0.00758	0.00197	-0.00209	0.000987	-0.00517	0.00303	-0.00406	-0.00395	-0.00283
Lead-210	NA	ND	ND	ND	ND	0.339	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead-212	NA	0.908	0.485	0.424	0.317	0.339	0.611	0.508	0.813	1.17	0.491	0.379	0.488	0.739	0.709	0.675
Lead-214	NA	0.567	0.369	0.318	0.22	0.627	0.476	0.452	0.631	0.809	0.322	0.277	0.318	0.575	0.568	0.525
Manganese-54	NA	0.0114	-0.00594	0.00167	0.00291	0.507	0.00918	-0.00587	0.00214	0.0258	0.00679	0.00418	0.00194	-0.00175	0.0122	0.00254
Potassium-40	NA	5.37	5.23	4.62	2.84	6.65	7.58	7.01	7.62	7.85	3.71	2.43	3.47	6.14	6.54	6.34
Radium-226	5	0.526	0.354	0.268	0.171	0.468	0.418	0.347	0.51	0.682	0.335	0.226	0.284	0.5	0.519	0.401
Sodium-22	NA	-0.00288	0.00346	-5.24E-04	-0.000653	0.000681	0.00179	-0.0026	-0.00303	0.00319	-0.00766	-0.0109	-0.00649	0.001	-0.00658	0.00592
Thallium-208	NA	0.278	0.146	1.20E-01	0.0905	0.191	0.193	0.15	0.246	0.352	0.147	0.116	0.16	0.221	0.227	0.209
Thorium-228	NA	0.908	0.485	0.424	0.317	0.627	0.611	0.508	0.813	1.17	0.491	0.379	0.488	0.739	0.709	0.675
Thorium-234	NA	ND	ND	ND	ND	ND	0.469	ND	ND	0.947	ND	ND	ND	0.538	ND	ND
Rad Gas Flow Proportional Counting																
Strontium-90	15	0.44	0.297	-0.186	0.229	0.636	0.0322	-0.206	0.107	-0.0185	-0.168	-0.00927	0.0333	0.361	-0.237	-0.186
Rad Liquid Scintillation Analysis																
Tritium	9.6 E+15	-19.3	NA	NA	49.1	4.52	NA	NA	-29.5	-17.5	NA	NA	-54.1	-7.95	18.4	-16.4

Notes:
NA – Not Applicable
ND – Non Detect

Table 5

HFBR Underground Utilities Removal – Phase 2 – D/F Waste Line Removal
Final Status Survey Core Soil Samples Chemical Analytical Results
Chain of Custody #28724

Parameter	Site Cleanup Criteria	0-2 ft Composite
Lead	400	8.98
Mercury	1.84	0.0102

Notes: All units are mg/kg

Table 6

HFBR Underground Utilities Removal – Phase 2
D/F Waste Line Removal
Final Status Survey - Gamma Walkover Survey

LOCATION (FT from HFBR)	GAMMA, CPM	GAMMA, CPM	GAMMA, CPM	BACKGROUND GAMMA, CPM
10	5998	NA	NA	NA
190	7237	NA	NA	8106
200	8132	NA	NA	NA
275	8912	NA	NA	NA
390	8737	NA	NA	NA
410	8909	NA	NA	NA
475	9029	10464	NA	10373
575	10292	NA	NA	NA
650	10295	NA	NA	NA
730	11888	NA	NA	NA
840	12065	12327	NA	13684
915	14326	NA	NA	NA
1015	19558	NA	NA	NA
1075	27774	172045	116814	NA

Notes:
Reference Figure 1
Instrument Model Ludlum 2221, NaI detector
CPM – Counts per minute

Estimate of Activity in 42" Off-Gas Pipe

Purpose

Using concrete samples, smears, and gamma readings, estimate the activity remaining in a 40-foot section of 42" ID Off-Gas pipe.

Data:

Attachment 1 contains the results of the following survey information:

1. Gamma surveys using a 2" x 2" NaI scintillation detector: surveyed the internal (bottom) surface of the 42" pipe, along the full length (10/11/10 and 10/13/10).
2. Direct frisk of accessible internal surface areas of the piping using a beta-gamma frisker and an alpha probe (10/11/10 - pipe end furthest from Bldg 801, and 10/13/10 - pipe end closest to Bldg 801).
3. A concrete sample of the internal portion of the 42" piping (sample 13 on COC 30427) - analyzed for gamma emitters, alpha emitters, strontium-90, tritium, gross alpha, and gross beta.
4. A set of 4 smears inside the 42" piping (sample 14 on COC 30427) - analyzed for alpha emitters, gross alpha, and gross beta. An additional set of 10 smears analyzed onsite on the Tennelec for gross alpha and gross beta.

Results of Data Collection:

1. Gamma surveys: The results indicate slight increases above background, but not greater than the 21,500 cpm value specified in the Field Sample Plan for excavated areas. Table 1 lists the results, and background count rates were between 8,900 - 10,500 cpm.
2. Direct Frisk: Beta-gamma results indicated 600 - 800 ccpm. Alpha results indicated 0 - 2 ccpm on the 10/13/10 survey, and from 5 - 8 ccpm in the 10/11/10 survey. These results indicate beta-gamma contamination above free release limits, and additional precautions such as fixatives are necessary. Fixatives have been applied to the first 8 feet on both ends of the pipe. In addition, the entire pipe will be filled with grout.
3. Concrete Sample: No alpha emitters, Sr-90, or tritium were detected in the sample. Ra-226 was detected at background levels (0.3 pCi/g), as were K-40 and Th-228. Cs-137 was detected at a level of 0.36 pCi/g, well below the cleanup criteria of 23 pCi/g for soil. Table 2 lists the results of concrete sample analysis.
4. Smear samples: Analysis of smears indicates that there are detectable levels of contamination on the surfaces of the piping. Surveyors noted the presence of a film near the top of the piping that contained higher contamination levels than that on the bottom of the piping. The gross alpha analysis performed by the onsite Tennelec counter is in general agreement with offsite analysis. The gross beta is higher than that expected from the uranium isotopes, and is assumed to be a combination of Cs-137 and Sr-90, based on previous

experience with the underground utilities, and a smear sample of the piping that contained Cs-137 as the only gamma emitter. These assumptions are being checked with additional samples; however, this method provides a conservative estimate of activity. Smear results are shown in Table 3.

Calculation of Total Activity in the Piping:

1. Concrete samples yielded a low concentration of Cs-137 activity (0.36 pCi/g). The Cs-137 total activity is calculated as follows:
    - Total area of internal of pipe = π x 42 in x 480 in x 0.5 in x 16.39 cc/in^3 = 5.19 E+05 cc (assumes 0.5" thick concrete with concentration of 0.36 pCi/g for the 40 ft length of pipe)
    - Activity = 5.19E+05 cc x 1.6 g/cc x 0.36 pCi/g = 3.0 E+5 pCi (0.3 uCi)
2. Smear samples are calculated by using the activity in the 4 smears for each radionuclide detected. This value is divided by 400 cm^2 (4 smears, each 100 cm^2) and then multiplied by the total area of the inside of the piping. This calculation is shown in Table 3. Cs-137 and Sr-90 are estimated to each be 50% of the gross beta value of 1820 pCi.
3. Table 4 summarizes the total activity using both the activity in the solid concrete (0.3 uCi) and the activity on the surface of the piping (23.5 uCi).

Summary:

Based on surveys of the internals of the remaining 40 feet of the 42" concrete pipe, there are approximately 23.8 uCi of activity in the piping. This activity has been immobilized by use of fixatives and will be further immobilized by use of grout within the piping.

Table 1 - NaI Gamma Results inside 42" Concrete Pipe

Distance from pipe end (near Bldg 801)	cpm
2 ft	11,000
4 ft	11,700
6 ft	11,600
8 ft	12,100
10 ft	11,400
12 ft	11,600
14 ft	10,900
16 ft	10,400
18 ft	9,900
20 ft	10,600
22 ft	10,300
Distance from pipe end (away from Bldg 801)	**cpm**
2 ft	9,400
4 ft	10,400
6 ft	9,800
8 ft	9,700
10 ft	9,900
12 ft	9,900
14 ft	10,000
16 ft	10,500
18 ft	10,300
20 ft	9,600
Average	10,524

Table 2 - Concrete Sample Results - 42" Pipe

Nuclide	Concrete (pCi/g)
Am-241	ND
Cu-243/244	ND
Pu-239/240	ND
U-235/236	ND
U-238	ND
Co-60	ND
Ra-226	0.30
Cs-137	0.36
Sr-90	ND
H-3	ND

Table 3 - Smear Results from 42" Concrete Pipe

Nuclide	Smears (pCi)	pCi on pipe per 400 cm^2 *	uCi per ft^2	uCi for entire 440 sq ft of pipe
Am-241	7.98	80	1.85E-04	0.1
Cu-243/244	ND	0	0	0
Pu-239/240	12.2	122	2.83E-04	0.1
U-233/234	221	2210	5.13E-03	2.3
U-235/236	13.3	133	3.09E-04	0.1
U-238	226	2260	5.25E-03	2.3
Cs-137**	910	9100	2.11E-02	9.3
Sr-90**	910	9100	2.11E-02	9.3
Gross Alpha	500	5000	1.16E-02	5.1
Gross Beta	1820	18200	4.23E-02	18.6

ND = Not Detected above the detection limit of the laboratory

* Smears are assumed to be present over an area of 400 cm^2 (4 smears) and are assumed to collect 10% of the actual activity present.

** Results for Cs-137 and Sr-90 were inferred from the gross beta results (50%/50% mix of Cs-137 and Sr-90 assumed)

- Assume 1,820 pCi beta activity from GEL is accurate for 4 smears

- Although some of the activity is due to U-238 (& daughters), assume all is due to only Cs-137 & Sr-90.

- Activity per 400 cm^2 is 1820 pCi on smears; assume 10% collection efficiency of smear, so activity on the 400 cm^2 is 18,200 pCi. For entire 440 ft^2 of piping, this is equal to 18.6 uCi, assumed to be equal Cs-137 & Sr-90.

Table 4 - Total Calculated uCi in 42" Pipe

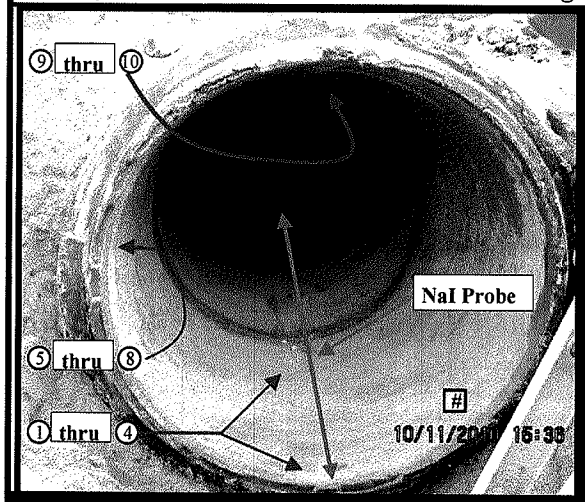
Nuclide	Total Calculated uCi in Pipe
Am-241	0.1
Cu-243/244	0.0
Pu-239/240	0.1
U-233/234	2.3
U-235/236	0.1
U-238	2.3
Cs-137	9.6
Sr-90	9.3
Total	**23.8**

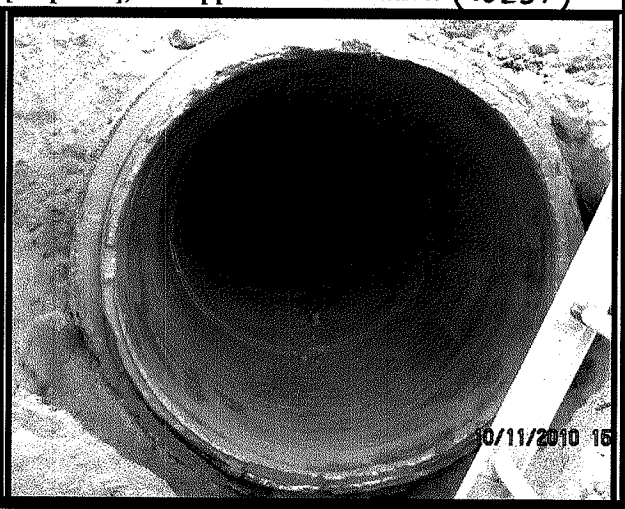
RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☐ Special
☒ RWP# 2010-ERP-007 ☐ WP

Location / Equipment: Below ground 42" off gas p/line.
Date: 10/ 13 /10
Time: 10:30

Survey: Verification of the internal 42 in. off gas pipe line [in place], and application of fixative. (WEST)





Note:

(A) Direct frisks taken on the accessible internal surface area of the pipe using a Lud-3, ranged between 600 ccpm to 800 ccpm [ß & γ].
Direct frisks taken on the same area using a E-600 / α probe, ranged between 0 ccpm to 2 ccpm [α].

(B) Smears taken see page 2 of 2 for results. The smears were taken on the first section of the pipe.
(1) thru (4) taken on the bottom surface of the pipe.
(5) thru (8) taken on the side surface of the pipe.
(9) thru (10) taken on the top surface of the pipe.

(C) Utilizing a LUD-2221 with a 2 x 2 NaI probe, perusal of the internal pipe from edge of the plane [at 2ft. Increments]to a depth of 22ft.. Bkgd. was at 8. 9K cpm and at the plane 10. 9K cpm.

@ 2ft. 11. 0K cpm.	@ 14ft. 10. 9K cpm.
@ 4ft. 11. 7K cpm.	@ 16ft. 10. 4K cpm.
@ 6ft. 11. 6K cpm.	@ 18ft. 9. 9K cpm.
@ 8ft. 12. 1K cpm.	@ 20ft. 10. 6K cpm.
@ 10ft. 11. 4K cpm.	@ 22ft. 10. 3K cpm.
@ 12ft. 11. 6 K cpm.	

INSTRUMENTS

Model #	Serial #	CAL DUE
LB5100S4	32487	07/16/11
LUD-3	74417	08/13/11
LUD-3	44141	01/29/11
E-600	01642	02/22/11
LUD-2221	211780	12/08/10

LEGEND
○ - SMEAR SURVEY LOCATION ▲ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
C̄ - CONTAMINATION * CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
See ASL					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	2330
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Mike Hollander and Sean A. Gully Date: 10/ 13 /10 Reviewed By: [signature] Date: 10/13/10

FS-SOP-1000
Attachment 9. 2

42in. off gas pipe, w. end

Sample Report

Batch ID: 1min. Smear - 201010131020
Group: H
Device: HFBR
Batch Key: 2,330
Selected Geometry: 1/8" Stainless Steel

Count Date: 10/13/201
Count Minutes: 1.0
Count Mode: Simultaneous
Operating Volts: 1350

	Efficiency (%)			Spillover (%)		
Alpha:	28.64	±	0.08	**Alpha to Beta:**	6.13	± 0.00
Beta:	19.84	±	0.07	**Beta to Alpha:**	0.08	± 0.00

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)	(dpm)
20101013102053-H1	Unknown	6.93	4.94	9.45	95.14	21.97	13.64	
20101013102223-H2	Unknown	10.45	6.05	9.45	39.39	14.27	13.64	
20101013102343-H3	Unknown	10.41	6.05	9.45	130.11	25.71	13.64	
20101013102453-H4	Unknown	13.90	6.98	9.45	119.72	24.70	13.64	
20101013102613-H5	Unknown	6.95	4.94	9.45	59.86	17.47	13.64	
20101013102723-H6	Unknown	6.96	4.94	9.45	39.70	14.26	13.64	
20101013102843-H7	Unknown	-0.03	0.01	9.45	50.40	15.94	13.64	
20101013103003-H8	Unknown	10.42	6.05	9.45	99.87	22.55	13.64	
20101013103113-H9	Unknown	522.68	42.79	9.45	1,989.72	101.60	13.64	
20101013103233-H10	Unknown	522.64	42.79	9.45	2,050.20	103.10	13.64	

Reviewed by:

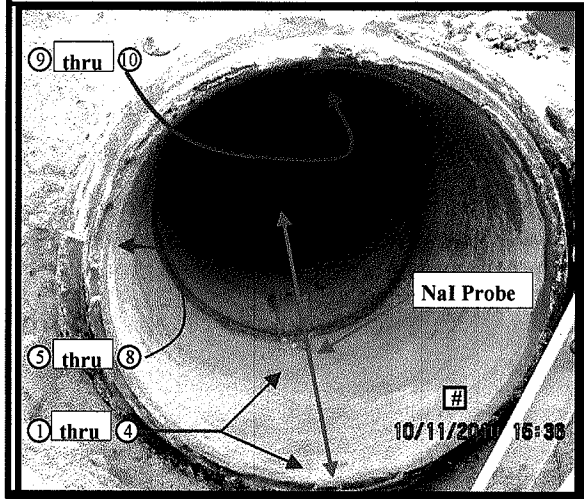
Page 2 of 2

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ Routine ☐ Special
☒ RWP# 2010-ERP-007 ☐ WP

Location / Equipment: Below ground 42" off gas p/line. Date: 10/ 11 /10 Time: 15:30

Survey: Verification of the internal 42 in. off gas pipe line [in place], and application of fixative. (EAST)



Note:

(A) Direct frisks taken on the accessible internal surface area of the pipe using a Lud-3, ranged between 600 ccpm to 800 ccpm [ß & γ].
Direct frisks taken on the same area using a E-600 / α probe, ranged between 6 ccpm to 8 ccpm [α].

(B) Smears taken see page 2 of 2 for results. The smears were taken on the first section of the pipe.
(1) thru (4) taken on the bottom surface of the pipe.
(5) thru (8) taken on the side surface of the pipe.
(9) thru (10) taken on the top surface of the pipe.

(C) Utilizing a LUD-2221 with a 2 x 2 NaI probe, perusal of the internal pipe from the edge of the plane [at 2ft. Increments] to a depth of 18ft.. Bkgd. was at 10. 5K cpm and at the plane 9. 8K cpm.

@ 2ft. 9. 4K cpm.	@ 12ft. 9. 9 K cpm.
@ 4ft. 10. 4K cpm.	@ 14ft. 10. K cpm
@ 6ft. 9. 8K cpm.	@ 16ft. 10. 5K cpm.
@ 8ft. 9. 7K cpm.	@ 18ft. 10. 3K cpm.
@ 10ft. 9. 9K cpm.	@ 20ft. 9. 6K cpm.

INSTRUMENTS

Model #	Serial #	CAL DUE
LB5100S4	32487	07/16/11
LUD-3	74417	08/13/11
LUD-3	44141	01/29/11
E-600	01642	02/22/11
LUD-2221	211780	12/08/10

LEGEND
○ - SMEAR SURVEY LOCATION ▲ - AIR SAMPLE LOCATION
▢ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
See ASL					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, ß-γ, ^{3}H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	2317
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Mike Hollander and Sean A. Gully Date: 10/ 12 /10 Reviewed By: Date: 10/13/10

FS-SOP-1000
Attachment 9. 2

42in. off gas pipe in place

Sample Report

Batch ID:	1min. Smear - 201010111752	**Count Date:**	10/11/2010
Group:	I	**Count Minutes:**	1.0
Device:	HFBR	**Count Mode:**	Simultaneous
Batch Key:	2,317	**Operating Volts:**	1350
Selected Geometry:	1/8" Stainless Steel		

	Efficiency (%)				Spillover (%)			
Alpha:	28.64	±	0.08		**Alpha to Beta:**	6.13	±	0.00
Beta:	19.84	±	0.07		**Beta to Alpha:**	0.08	±	0.00

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)	(dpm)
20101011175244-~~I22~~ 1	Unknown	45.11	12.59	9.45	535.24	52.18	13.64	
20101011180404-~~I21~~ 2	Unknown	52.09	13.52	9.45	539.66	52.42	13.64	
20101011180524-~~I23~~ 3	Unknown	-0.03	0.01	9.45	50.40	15.94	13.64	
20101011180634-~~I24~~ 4	Unknown	24.34	9.24	9.45	184.31	30.67	13.64	
20101011180754-~~I25~~ 5	Unknown	24.29	9.24	9.45	280.07	37.74	13.64	
20101011180904-~~I26~~ 6	Unknown	93.86	18.15	9.45	772.83	62.82	13.64	
20101011181024-~~I27~~ 7	Unknown	41.69	12.10	9.45	404.52	45.39	13.64	
20101011181134-~~I28~~ 8	Unknown	62.53	14.81	9.45	609.29	55.72	13.64	
20101011181254-~~I29~~ 9	Unknown	371.80	36.13	9.45	3,399.04	132.06	13.64	
20101011181404-~~I30~~ 10	Unknown	497.83	41.78	9.45	2,757.94	119.26	13.64	

Page 2 of 2

Reviewed by: _____

APPENDIX B

HFBR Underground Utilities
Final Status Survey Results

1) FSS GEL Data
2) Overburden Soil Data
3) FSS RCT Survey Forms

HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Core and Composite)
Phase I, Survey Unit 2

Parameter	Residential Cleanup Value	287919-C1								287919-C2								287919-C3								28719-SU1		28719-SU2		28719-SU3	
		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																															
Americium-241	NA	-0.000356	U	-0.0638	U	-0.0288	U	-0.000374	U	0.0409	U	-0.0591	U	-0.0895	U	0.0021	U	-0.0511	U	-0.00373	U	-0.0058	U	-0.155	U	0.0124	U	0.0537	U	0.00638	U
Beryllium-7	NA	-0.00625	U	0.0343	U	-0.0594	U	0.0123	U	0.0164	U	-0.0185	U	-0.0194	U	0.0661	U	0.126	U	-0.0238	U	0.0828	U	-0.142	U	0.00179	U	0.0167	U	0.0564	U
Cesium-134	NA	0.0397	J-UI	0.0236	U	0.0268	U	0.0321	J-UI	0.0446	UI	0.0151	U	0.0182	U	0.0151	U	0.0282	U	0.00306	U	0.0111	U	0.0368	DL	0.0369	U	0.0424	UI	0.0226	U
Cesium-137	23	0.0485	J	0.0138	U	0.0113	U	-0.00309	U	-0.00102	U	-0.00613	U	0.00224	U	-0.00141	U	0.041	J	0.0129	U	0.00652	U	-0.00244	U	0.0987	J	0.0497	J	0.0289	J
Cobalt-57	NA	-0.00677	U	0.00456	U	-0.000663	U	0.00324	U	0.000644	U	-0.00344	U	0.00137	U	0.00198	U	0.00414	U	0.00293	U	-0.00384	U	-0.000898	DL	0.00539	U	-0.00813	U	-0.000898	U
Cobalt-60	1,260	0.00901	U	0.00512	U	-0.00122	U	-0.00451	U	-0.00224	U	-0.00898	U	0.0135	U	0.00547	U	-0.017	U	-0.0092	U	0.0193	U	-0.015	U	0.00942	U	-0.00133	U	0.0044	U
Europium-152	NA	-0.0124	U	-0.00117	U	0.0647	J-UI	-0.0119	U	-0.0292	U	-0.0187	U	0.0309	U	-0.0364	U	0.0192	U	0.013	U	-0.00591	U	-0.0076	U	0.00141	U	-0.0188	U	-0.00696	U
Europium-154	NA	-0.00536	U	-0.0099	U	-0.00975	U	0.0131	U	-0.0189	U	-0.0164	U	-0.00141	U	-0.035	U	-0.00592	U	0.0348	U	0.00863	U	-0.0174	U	-0.00402	U	0.0234	U	-0.00399	U
Europium-155	NA	-0.0354	U	0.00841	U	0.0436	U	0.0153	U	0.0136	U	0.00549	U	0.0373	U	0.0359	U	0.0334	U	-0.00066	U	0.0137	U	0.0371	U	0.0445	U	0.0395	U	0.0462	U
Manganese-54	NA	-0.00626	U	-0.00349	U	0.00802	U	0.00286	U	-0.00291	U	-0.00601	U	0.00851	U	0.00095	U	-0.0029	U	0.00932	U	0.0025	U	0.00261	U	-0.00972	U	-0.0029	U	0.00149	U
Radium-226	NA	0.341		0.189		0.211		0.222		0.392		0.167		0.277		0.189		0.238		0.164		0.177		0.152		0.424		0.344		0.366	
Sodium-22	NA	-0.0013	U	-0.0000376	U	-0.00361	U	0.00381	U	-0.00669	U	-0.00559	U	-0.000615	U	-0.00941	U	-0.00153	U	0.00567	U	0.00305	U	-0.00781	U	-0.00176	U	0.00859	U	-0.00849	U
Zinc-65	NA	0.0086	U	0.00181	U	-0.013	U	-0.0217		-0.017	U	-0.000215	U	-0.0669	U	-0.0445	U	-0.0503		-0.043	U	0.016	U	0.0204	U	-0.0102	U	0.00175	U	-0.0127	U
Rad Alpha Spec Analysis																															
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		-0.034	U	0.0268	U	0.124	U
Plutonium 239/240	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		-0.0314	U	-0.0158	U	0.0295	U
Uranium-235/236	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.0929	U	0.00	U	0.0221	U
Uranium-238	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.301	J	0.418	J	0.575	J
Rad Gas Flow Proportional Counting																															
Strontium-90	15	0.0618	U	-0.108	U	-0.428	U	0.591	U	0.255	U	0.688	U	-0.305	U	0.0881	U	-0.0519	U	-0.27	U	-0.309	U	-0.199	U	-0.38	U	-0.0243	U	0.0294	U
Rad Liquid Scintillation Analysis																															
Tritium	NA	30.7	U	35.7	U	36.3	U	53.60	U	31.7	U	34.6	U	18.2	U	13.4	U	47.9	U	57.5	U	65.4	U	46.4	U	27.1	U	44.9	U	18.1	U

Notes:
DL - Below the detection limit
NA - Not Applicable
NR - Not Reported
J - Indicates an estimated concentration
U - Indicates that the compound was analyzed for, but was not detected
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analysis

HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase II, Survey Unit 3

Parameter	Residential Cleanup Value	28724-001 0'-0.5' (pCi/g)		28724-002 0'-0.5' (pCi/g)		28724-003 0'-0.5' (pCi/g)		28724-004 0'-0.5' (pCi/g)		28724-005 0'-0.5' (pCi/g)		28724-006 0'-0.5' (pCi/g)		28724-007 0'-0.5' (pCi/g)		28724-008 0'-0.5' (pCi/g)		28724-009 0'-0.5' (pCi/g)		28724-010 0'-0.5' (pCi/g)		28724-011 0'-0.5' (pCi/g)		28724-012 0'-0.5' (pCi/g)		28724-013 0'-0.5' (pCi/g)		28724-014 0'-0.5' (pCi/g)		28724-015 0'-0.5' (pCi/g)		28724-016 0'-0.5' (pCi/g)		28724-017 0'-0.5' (pCi/g)		28724-018 0'-0.5' (pCi/g)		28724-019 0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																																									
Actinium-228	NA	0.553	U	0.631		0.635		0.406		1.06		0.957		1.08		0.877		0.921		1.05		1.03		0.679		0.814		0.678		0.503		0.707		0.389		0.632		0.382	
Beryllium-7	NA	0.00465	DL	0.00		0.224		0.0247	DL	0.0951	DL	0.0206	DL	-0.021	DL	-0.00649	DL	0.0395	DL	0.34		0.675		0.0858	DL	0.170		0.0536	DL	0.076	DL	0.0401	DL	0.0892	DL	0.0804	DL	0.223	
Bismuth-212	NA	NR		NR		0.809		NR		0.886		1.07		1.22		1.04		0.924		1.05		1.18		NR		0.830		0.713		NR		0.805		NR		NR		NR	
Bismuth-214	NA	0.319		0.403		0.519		0.224		0.653		0.578		0.626		0.548		0.532		0.662		0.599		0.498		0.554		0.467		0.353		0.442		0.223		0.377		0.259	
Cesium-137	23	0.693		0.0295		0.00817	DL	0.006	DL	0.0347		0.0294		0.0208		0.000969	DL	0.0186		-0.00537	DL	0.0768		0.0456		0.0294		0.0211		0.264		0.0289		0.0231		0.0487		0.0935	
Cobalt-57	NA	0.00356	DL	0.00289	DL	0.00674	DL	0.00209	DL	-0.000421	DL	0.00318	DL	-0.000606	DL	0.000557	DL	0.00172	DL	-0.00397	DL	0.00222	DL	0.00216	DL	0.00101	DL	-0.000202	DL	0.00109	DL	-0.00622	DL	-0.00188	DL	-0.000431	DL	-0.00125	DL
Cobalt-60	1,260	-0.000141	DL	0.000574	DL	-0.0136	DL	0.00741	DL	-0.00707	DL	-0.0062	DL	-0.000486	DL	-0.000835	DL	0.00176	DL	-0.00603	DL	-0.00695	DL	0.00822	DL	-0.00408	DL	-0.0018	DL	0.000866	DL	-0.00159	DL	-0.00248	DL	0.0000672	DL	-0.00618	DL
Lead-212	NA	0.542		0.602		0.682		0.407		1.01		0.887		1.04		0.856		0.881		1.05		0.923		0.631		0.717		0.729		0.516		0.709		0.364		0.617		0.320	
Lead-214	NA	0.433		0.530		0.588		0.283		0.746		0.666		0.786		0.581		0.630		0.729		0.723		0.479		0.625		0.578		0.394		0.486		0.261		0.378		0.280	
Manganese-54	NA	0.0038	DL	-0.00242	DL	0.00		0.0022	DL	0.00		0.00606	DL	0.00848	DL	0.00684	DL	0.00		0.00		0.00		0.00877	DL	0.00144	DL	-0.00286	DL	-0.00153	DL	0.012	DL	0.00173	DL	-0.00194	DL	0.0007787	DL
Potassium-40	NA	4.39		5.03		7.86		2.98		6.64		6.09		7.44		6.68		6.91		7.27		8.90		7.36		8.23		8.33		6.69		6.12		3.92		4.21		4.2	
Radium-226	NA	0.319		0.403		0.519		0.224		0.653		0.578		0.063		0.548		0.532		0.662		0.599		0.498		0.554		0.467		0.353		0.442		0.223		0.377		0.259	
Sodium-22	NA	-0.00897	DL	-0.00536	DL	0.00363	DL	-0.0000494	DL	0.00302	DL	0.00228	DL	0.00628	DL	-0.00517	DL	-0.00148	DL	-0.0117	DL	-0.00639	DL	0.00143	DL	-0.00265	DL	-0.00328	DL	-0.00128	DL	-0.0122	DL	-0.00118	DL	0.00556	DL	0.00879	DL
Thallium-208		0.155		0.164		0.229		0.107		0.323		0.279		0.301		0.270		0.274		0.319		0.276		0.196		0.250		0.220		0.164		0.219		0.118		0.191		0.115	
Thorium-228	NA	0.542		0.602		0.682		0.407		1.01		0.887		1.04		0.8560		0.881		1.05		0.923		0.631		0.717		0.729		0.516		0.709		0.364		0.617		0.320	
Rad Gas Flow Proportional Counting																																									
Strontium-90	15	0.254	U	0.00507	U	-0.18	U	0.780	U	0.246	U	0.184	U	-0.135	U	-0.207	U	-0.289	U	-0.215	U	-0.0204	U	0.397	U	-0.031	U	-0.114	U	0.359	U	0.0813	U	-0.109	U	-0.663	U	-0.218	U
Rad Liquid Scintillation Analysis																																									
Tritium	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		-18.9	U	NR		NR		NR		NR		NR		NR		NR		NR		NR	

Notes:
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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Core and Compositie)
Phase II, Survey Unit 3

Parameter	Residential Cleanup Value	28724-020 0'-2' (pCi/g)		28724-021 2'-4' (pCi/g)		28724-022 4'-6' (pCi/g)		28724-023 6'-8' (pCi/g)		28724-024 0'-2' (pCi/g)		28724-025 2'-4' (pCi/g)		28724-026 4'-6' (pCi/g)		28724-027 6'-8' (pCi/g)		28724-028 0'-2' (pCi/g)		28724-029 2'-4' (pCi/g)		28724-030 4'-6' (pCi/g)		28724-031 6'-8' (pCi/g)		28724-032 0'-0.5' (pCi/g)		28724-033 0'-0.5' (pCi/g)		28724-034 0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																															
Antinium-228	NA	0.950		0.558	J	0.423	J	0.359	J	0.625	J	0.631	J	0.579	J	0.858		1.15		0.501	J	0.438	J	0.484	J	0.765	J	0.854		0.734	J
Beryllium-7	NA	-0.00357	DL	0.00413	DL	0.0474	DL	-0.00536	DL	0.0339	DL	-0.0428	DL	0.0212	DL	0.136	UI	0.0429	DL	0.0161	DL	0.0053	DL	-0.0623	DL	0.105	DL	0.0989	DL	0.0875	DL
Bismuth-212	NA	1.06		NR		NR		NR		0.814		NR		NR		0.734		1.27		NR		NR		NR		NR		0.742		NR	
Bismuth-214	NA	0.526		0.354		0.268		0.171	J	0.468		0.418		0.347		0.51		0.682		0.335		0.226		0.284		0.500		0.519		0.401	
Cesium-137	23	-0.0139	DL	-0.000868	DL	-0.000968	DL	-0.00577	U	-0.00582	DL	-0.00963	DL	-0.00909	DL	-0.0125	DL	0.00571	DL	0.0145	DL	-0.00447	DL	-0.00404	DL	0.0949		0.0607		0.0626	
Cobalt-57	NA	0.00183	DL	-0.0006	DL	0.00114	DL	-0.0017	U	-0.00422	U	-0.000106	DL	-0.00153	DL	-0.00488	DL	-0.000841	DL	0.000738	DL	-0.00086	DL	-0.00151	DL	-0.00205	DL	0.00172	DL	-0.00215	DL
Cobalt-60	1,260	0.00178	DL	-0.0023	DL	-0.00458	U	-0.00339	U	-0.00841	DL	-0.00686	DL	0.00758	DL	0.00197	DL	-0.00209	DL	0.000987	DL	-0.00517	DL	0.00303	DL	-0.00406	DL	-0.00395	DL	-0.00283	DL
Lead-210	NA	NR		NR		NR		NR		0.339	J	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Lead-212	NA	0.908		0.485		0.424		0.317		0.627		0.611		0.508		0.813		1.17		0.491		0.379		0.488		0.739		0.709		0.675	
Lead-214	NA	0.567		0.369		0.318		0.220		0.507		0.476		0.452		0.631		0.809		0.322		0.277		0.318		0.575		0.568		0.525	
Manganese-54	NA	0.0114	DL	-0.00594	DL	0.00167	DL	0.00291	DL	0.00274	DL	0.00918	DL	-0.00587	DL	0.00214	DL	0.0258	UI	0.00679	DL	0.00418	DL	0.00194	DL	-0.00175	DL	0.0122	DL	0.00254	DL
Potassium-40	NA	5.37		5.23		4.62		2.84		6.65		7.58		7.01		7.62		7.85		3.71		2.43		3.47		6.14		6.54		6.34	
Radium-226	NA	0.526		0.354		0.268		0.171		0.468		0.418		0.347		0.510		0.682		0.335		0.226		0.284		0.500		0.519		0.401	
Sodium-22	NA	-0.00288	DL	0.00346	DL	-0.000524	DL	-0.000653	DL	0.000681	DL	0.00179	DL	-0.0026	DL	-0.00303	DL	0.00319	DL	-0.00766	DL	-0.0109	DL	-0.00649	DL	0.001	DL	-0.00658	DL	0.00592	DL
Thallium-208	NA	0.278		0.146		0.12		0.0905		0.191		0.193		0.150		0.246		0.35200		0.147		0.116		0.160		0.221		0.227		0.209	
Thorium-228	NA	0.908		0.485		0.424		0.317		0.627		0.611		0.508		0.813		1.17000		0.491		0.379		0.488		0.739		0.709		0.675	
Thorium-234	NA	NR		NR		NR		NR		NR		0.469	J	NR		NR		0.947	J	NR		NR		NR		0.538	J	NR		NR	
Rad Alpha Spec Analysis																															
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.00954	U	-0.0345	U	0.131	U
Plutonium-238	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.00		0.0225	U	0.00	U
Plutonium 239/240	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.00		-0.027	U	-0.0237	U
Uranium-233/234	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.743	J	0.729	J	0.628	J
Uranium-235/236	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		-0.0765	U	-0.0201	U	0.0539	U
Uranium-238	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.598	J	0.339	J	0.445	J
Rad Gas Flow Proportional Counting																															
Strontium-90	15	0.440	U	0.297	U	-0.186	U	0.229	U	0.00636	U	0.0322	U	-0.206	U	0.107	U	-0.0185	U	-0.168	U	-0.00927	U	0.0333	U	0.361	U	-0.237	U	-0.186	U
Rad Liquid Scintillation Analysis																															
Tritium	NA	-19.3	U	NR		NR		49.1	U	4.5	U	NR		NR		-29.5	U	-17.5	U	NR		NR		-54.1	U	-7.95	U	18.4	U	-16.4	U

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HFBR Underground Utilities
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Offsite Soil Radiochemical Analytical Results (Surface)
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Parameter	Residential Cleanup Value	Trench #1													
		30426-001		30426-002		30426-003		30426-004		30426-005		30426-006		30426-007	
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis															
Americium-241	NA	0.0106	U	0.00946	U	0.00554	U	0.0428	U	0.043	J	2.87	J	0.0467	U
Beryllium-7	NA	0.0465	U	-0.0747	U	0.00347	U	-0.107	U	-0.0167	U	0.0631	U	-0.00397	U
Cesium-134	NA	0.0483	UI	0.0134	DL	0.0142	U	0.0354	U	0.0441	UI	0.0378	DL	0.0415	UI
Cesium-137	23	0.0316	J	0.0905	J-UI	0.0247	U	0.0333	J	0.0131	U	0.0151	U	0.00278	U
Cobalt-57	NA	0.00214	U	-0.00232	U	0.00536	U	-0.00373	U	-0.0043	U	-0.00652	DL	0.00736	DL
Cobalt-60	1,260	0.00959	U	-0.000309	U	0.0083	U	-0.00524	U	-0.000945	U	-0.0135	U	-0.0121	U
Europium-152	NA	-0.0142	U	0.00162	U	-0.00248	U	-0.0117	U	-0.00927	U	0.00737	U	0.0102	U
Europium-154	NA	-0.0212	U	-0.00023	U	-0.0121	U	0.0188	U	-0.00558	U	0.0413	U	-0.0313	U
Europium-155	NA	0.044	U	0.0372	U	0.0212	U	0.0321	U	0.0329	U	0.0278	U	0.0451	U
Manganese-54	NA	0.00793	U	0.00855	U	0.00	U	-0.0058	U	0.00219	U	0.0013	U	-0.00411	U
Potassium-40	NA	NR		NR		NR		NR		NR		NR		NR	
Radium-226	NA	NR		NR		NR		NR		NR		NR		NR	
Sodium-22	NA	-0.00713	U	-0.000267	U	-0.00278	U	0.00612	U	-0.0016	U	0.0132	U	-0.0114	U
Thorium-228	NA	NR		NR		NR		NR		NR		NR		NR	
Zinc-65	NA	0.0399	U	0.0781	U	-0.0193	U	-0.00719	U	-0.00991	U	0.219	U	0.00955	U
Rad Gas Flow Proportional Counting															
Strontium-90	15	0.170	U	-0.178	U	-0.169	U	-0.15	U	0.432	U	0.317	U	0.0616	U
Rad Liquid Scintillation Analysis															
Tritium	NA	18.6	U	-11.5	U	-61.3	U	-30.3	U	5.08	U	5.37	U	-57.9	U

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
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Parameter	Residential Cleanup Value	Trench #2																													
		30425-025		30425-026		30425-027		30425-028		30425-029		30425-030		30425-031		30425-032		30425-033		30425-034		30425-035		30425-036		30425-037		30425-038			
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)			
		Rad Gamma Spec Analysis																													
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Beryllium-7	NA	-0.0485	U	0.00729	U	0.0559	U	-0.0479	U	0.164	U	-0.0226	U	0.0444	U	0.0386	U	0.0771	U	0.00541	U	0.127	U	0.101	U	-0.0576	U	-0.0371	U		
Cesium-134	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Cesium-137	23	0.0542	J	0.104	U	-0.00766	U	0.0441	J	0.0277	U	0.0665	J	0.0487	J	0.0292	U	0.0102	U	1.00947	U	0.00166	U	-0.00738	U	0.0325	U	-0.0204	U		
Cobalt-57	NA	0.00243	U	-0.00435	U	-0.00454	U	0.00832	U	0.00315	U	-0.000257	U	0.00556	U	-0.00636	U	-0.00128	U	-0.00752	U	0.00242	U	-0.00322	U	0.00261	U	0.00292	U		
Cobalt-60	1,260	0.0109	U	-0.000936	U	-0.017	U	-0.00051	U	0.00726	U	-0.00695	U	-0.00307	U	0.016	U	-0.0197	U	-0.0357	U	0.131		0.00115	U	-0.00526	U	-0.00162	U		
Europium-152	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-154	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-155	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Manganese-54	NA	0.00668	U	0.00687	U	-0.00369	U	-0.0073	U	0.00496	U	0.00465	U	0.00376	U	0.00367	U	0.00439	U	0.0188	U	0.00975	U	0.00433	U	-0.0139	U	-0.0159	U		
Potassium-40	NA	4.21		4.89		4.74		4.50		5.32		5.18		5.28		5.31		5.11		4.82		3.92		3.98		5.33		4.18			
Radium-226	NA	0.238		0.313		0.387		0.417		0.301		0.318		0.296		0.313		0.341		0.318		0.358		0.197		0.267		0.373			
Sodium-22	NA	0.0171	U	0.00997	U	0.00609		-0.00156		-0.0126	U	-0.00937	U	-0.00178	U	-0.0238	U	-0.0058	U	-0.00124	U	-0.018	U	0.0068	U	0.0111	U	0.023	U		
Thorium-228	NA	0.509		0.470		0.585		0.488		0.577		0.507		0.533		0.560		0.480		0.494		0.392		0.275		0.497		0.650			
Zinc-65	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
		Rad Gas Flow Proportional Counting																													
Strontium-90	15	0.310	U	NR		NR		NR		0.195	U	NR		NR		NR		0.314	U	NR		NR		NR		0.0194	U	NR			
		Rad Liquid Scintillation Analysis																													
Tritium	NA	51.5	U	NR		NR		NR		54.6	U	NR		NR		NR		153	U	NR		NR		NR		25.9	U	NR			

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase III, Survey Unit 1

Parameter	Residential Cleanup Value	Trench #3											
		30425-002		30425-003		30425-004		30425-005		30425-006		30425-007	
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)	
		Rad Gamma Spec Analysis											
Americium-241	NA	NR		NR		NR		NR		NR		NR	
Beryllium-7	NA	-0.134	U	0.279	U	0.163	U	0.00128	U	-0.166	U	-0.0824	U
Cesium-134	NA	NR		NR		NR		NR		NR		NR	
Cesium-137	23	0.0557	J	0.0198	U	0.0598	J	0.0618	J	0.0898	J	0.0816	J
Cobalt-57	NA	-0.000891	U	0.00783	U	-0.00194	U	-0.00614	U	-0.00413	U	0.00435	U
Cobalt-60	1,260	-0.00128	U	-0.000902	U	0.00142	U	0.00133	U	0.00783	U	0.00245	U
Europium-152	NA	NR		NR		NR		NR		NR		NR	
Europium-154	NA	NR		NR		NR		NR		NR		NR	
Europium-155	NA	NR		NR		NR		NR		NR		NR	
Manganese-54	NA	-0.00553	U	-0.00687	U	-0.0151	U	0.0142	U	-0.00146	U	-0.00242	U
Potassium-40	NA	4.85		4.19		4.75		3.78		5.12		5.96	
Radium-226	NA	0.507		0.315		0.294		0.420		0.491		0.448	
Sodium-22	NA	0.0198	U	-0.0171	U	-0.0146	U	0.0153	U	0.00277	U	-0.00941	U
Thorium-228	NA	0.503		0.511		0.537		0.721		0.600		0.586	
Zinc-65	NA	NR		NR		NR		NR		NR		NR	
		Rad Gas Flow Proportional Counting											
Strontium-90	15	NR		0.168	U	NR		0.300	U	NR		NR	
		Rad Liquid Scintillation Analysis											
Tritium	NA	NR		-35.3		NR		208	U	NR		NR	

Notes:
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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase III, Survey Unit 1

Parameter	Residential Cleanup Value	Trench #4																															
		30427-002		30427-003		30427-004		30427-005		30427-006		30427-007		30427-008		30427-009		30427-010		30427-011		30427-012		30529-001		30529-002		30529-003		30529-004			
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)			
Rad Gamma Spec Analysis																																	
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Beryllium-7	NA	-0.084	U	-0.00898	U	0.0925	U	0.191	U	0.0285	U	-0.049	U	0.0137	U	0.0245	U	0.116	U	0.00157	U	-0.0877	U	-0.124	U	0.0524	U	-0.0866	U	-0.00617	U		
Cesium-134	NA	NR		NR		NR		NR		NR		NR	J	NR		NR		NR		NR		NR		NR		NR		NR		NR			
Cesium-137	23	0.0357	U	0.0542	J	0.00768	U	0.0474	J	0.019	U	0.0495		0.00328	U	0.00368	U	0.0363	U	0.0881	J	0.0729	J	0.131		0.0546	J	0.0745	J	0.0621	J		
Cobalt-57	NA	-0.0116	U	0.00752	U	-0.00385	U	-0.000144	U	-0.00379	U	0.00311	U	0.0043	U	-0.00262	U	-0.00145	U	0.00518	U	-0.000948	U	-0.00925	U	-0.00186	U	0.00484	U	-0.0029	U		
Cobalt-60	1,260	0.00884	U	-0.00578	U	-0.00604	U	0.00951	U	0.00688	U	-0.00569	U	-0.0162	U	-0.00562	U	0.0104	U	-0.000378	U	0.000775	U	-0.00263	U	0.0119	U	0.000615	U	0.0175	U		
Europium-152	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-154	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-155	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Manganese-54	NA	0.033	U	-0.0116	U	0.0041	U	0.00664	U	-0.00966	U	-0.0135	U	-0.00107	U	-0.00402		-0.00176	U	0.0118	U	-0.0124	U	0.00803	U	-0.00961	U	0.004	U	-0.00763	U		
Potassium-40	NA	4.44		4.19		3.83		4.49		3.95		3.90		3.46		4.78		3.76		4.18		3.42		4.64		5.53		4.24		4.43			
Radium-226	NA	0.280		0.268		0.213		0.366		0.230		0.193		0.238		0.390		0.362		0.234		0.360		0.329		0.321		0.246		0.341			
Sodium-22	NA	-0.0136	U	0.00093	U	-0.0201	U	-0.0127	U	-0.0183	U	0.00267	U	0.00382	U	0.0118	U	-0.0227		0.00471	U	0.0025	U	-0.0155	U	-0.0124	U	-0.00338	U	-0.00491	U		
Thorium-228	NA	0.436		0.449		0.394		0.492		0.313		0.327		0.418		0.468		0.425		0.522		0.437		0.495		0.555		0.432		0.498			
Zinc-65	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Rad Gas Flow Proportional Counting																																	
Strontium-90	15	0.496	U	NR		NR		NR		0.473	U	NR		NR		NR		0.288	U	NR		NR		0.476	U	NR		NR		NR			
Rad Liquid Scintillation Analysis																																	
Tritium	NA	10.5	U	NR		NR		NR		117	U	NR		NR		NR		12.5	U	NR		NR		0.00	U	NR		NR		NR			

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase III, Survey Unit 1

Parameter	Residential Cleanup Value	Trench #4																															
		30529-005		30529-006		30529-007		30529-008		30529-009		30529-010		30529-011		30529-012		30529-013		30529-014		30529-015		30529-016		30529-017		30529-018		30529-019	
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)	
		Rad Gamma Spec Analysis																															
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Beryllium-7	NA	-0.0585	U	0.0453	U	-0.0654	U	0.046	U	-0.0561	U	-0.00244	U	-0.114	U	-0.085	U	0.157	U	0.0705	U	-0.0138	U	0.202	U	0.023	U	0.111	U	0.075	U		
Cesium-134	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Cesium-137	23	0.0539	J	0.0481	U	0.024	U	0.0354	U	0.0268	U	0.0109	U	0.109		0.110		0.0398	U	0.0662	J	0.0216	U	0.104		0.115		0.0729	J	0.0885	J		
Cobalt-57	NA	0.00787	U	0.00341	U	0.00223	U	-0.0125	U	-0.00372	U	-0.00415	U	-0.00859	U	0.00399	U	-0.011	U	0.00308	U	-0.00807	U	-0.00783	U	-0.00209	U	-0.00561	U	0.00106	U		
Cobalt-60	1,260	0.00089	U	0.00548	U	0.0261	U	0.0184	U	-0.0184	U	-0.00203	U	0.0094	U	0.00433	U	-0.00472	U	0.0084	U	0.00154	U	0.000575	U	0.0217	U	0.00544	U	-0.0126	U		
Europium-152	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-154	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-155	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Manganese-54	NA	0.0108	U	-0.0168	U	0.0173	U	0.00868	U	-0.00177	U	-0.0169	U	-0.000579	U	0.000819	U	0.00849	U	0.000334	U	0.0336	U	-0.0106	U	0.000701	U	0.00709	U	-0.006	U		
Potassium-40	NA	3.34		3.80		4.31		3.80		3.5		3.14		4.12		3.55		3.32		4.51		3.96		4.03		4.09		4.29		5.31			
Radium-226	NA	0.344		0.377		0.379		0.337		0.282	UI	0.295		0.289		0.352		0.269	UI	0.308		0.276		0.352		0.374		0.330		0.440			
Sodium-22	NA	-0.018	U	-0.000529	U	0.00744	U	0.0165	U	-0.00000448	U	-0.015	U	0.0000949	U	0.00289	U	0.000433	U	0.00122	U	0.10	U	0.00109	U	-0.000538	U	-0.000305	U	0.015	U		
Thorium-228	NA	0.450		0.517		0.527		0.476	UI	0.483	U	0.447		0.543		0.443		0.316		0.436		0.410		0.512		0.510		0.446		0.567			
Zinc-65	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
		Rad Gas Flow Proportional Counting																															
Strontium-90	15	NR		0.304	U	NR		NR		NR		NR		-0.227	U	NR		NR		NR		NR		0.418	U	NR		-0.215	U	0.144	U		
		Rad Liquid Scintillation Analysis																															
Tritium	NA	NR		-13.3	U	NR		NR		NR		NR		-96.6	U	NR		NR		NR		NR		-86.1	U	NR		-58.5	U	0.00	U		

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase III, Survey Unit 1

Parameter	Residential Cleanup Value	Trench #5																															
		30540-001		30540-002		30540-003		30540-004		30540-005		30540-006		30540-007		30540-008		30540-009		30540-010		30540-011		30540-012		30540-013		30540-014		30540-015			
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)			
Rad Gamma Spec Analysis																																	
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Beryllium-7	NA	-0.0481	U	0.0809	U	0.0832	U	-0.0488	U	-0.0148	U	0.0222	U	-0.109	U	0.0824	U	-0.0906	U	0.116	U	-0.0193	U	-0.000141	U	0.0463	U	-0.054	U	0.0327	U		
Cesium-134	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Cesium-137	23	0.0875	J	0.702	J	0.0551	J	0.0763	J	0.00715	U	0.00674	U	0.038	J	0.442		0.0613	J	0.0355	J-UI	0.0241	U	0.0617	J	0.0593	J	0.0623	J	0.0621	J		
Cobalt-57	NA	-0.00351	U	-0.00312	U	0.0039	U	0.00222	U	-0.00225	U	0.0078	U	0.0078	U	-0.00214	U	-0.0049	U	-0.000992	U	-0.00442	U	-0.00648	U	-0.000943	U	-0.00139	U	0.00476	U		
Cobalt-60	1,260	-0.00962	U	0.00292	U	0.00174	U	0.00614	U	0.00375	U	-0.00885	U	-0.00425	U	0.00188	U	0.005	U	0.00466	U	-0.00633	U	-0.00468	U	-0.000175		0.00543	U	0.0114	U		
Europium-152	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-154	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Europium-155	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Manganese-54	NA	-0.00343	U	-0.0132	U	0.00182	U	0.0048	U	-0.000755	U	-0.0083	U	-0.00114	U	0.0029	U	0.00911	U	0.0085	U	0.00547	U	0.0232	U	0.00969	U	-0.00109	U	0.0138	U		
Potassium-40	NA	4.75		4.66		5.38		5.55		4.86		3.21		5.04		4.60		4.45		4.43		5.18		5.71		3.99		3.96		4.33			
Radium-226	NA	0.388		0.389		0.372		0.530		0.382		0.291		0.380		0.479		0.498		0.368		0.394		0.422		0.348		0.423		0.280			
Sodium-22	NA	-0.0153	U	0.00428	U	-0.00729	U	0.0000083	U	-0.00684	U	-0.0104	U	-0.00445	U	-0.00267	U	0.0244	U	0.00184	U	-0.00869	U	-0.0118	U	-0.00138	U	0.00375	U	-0.0045	U		
Thorium-228	NA	0.794		0.706		0.730		0.902		0.749		0.606		0.678		0.739		0.767		0.716		0.838		0.835		0.717		0.776		0.462			
Zinc-65	NA	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR			
Rad Gas Flow Proportional Counting																																	
Strontium-90	15	-0.116	U	NR		NR		NR		0.546	U	NR		NR		NR		-0.00859	U	NR		NR		NR		0.521	U	NR		NR			
Rad Liquid Scintillation Analysis																																	
Tritium	NA	-79.7	U	NR		NR		NR		-34.2	U	NR		NR		NR		-136	U	NR		NR		NR		-164	U	NR		NR			

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Surface)
Phase III, Survey Unit 1

Parameter	Residential Cleanup Value	Trench #5																			
		30540-016		30542-001		30542-002		30542-003		30542-004		30542-005		30542-006		30542-007		30542-008		30542-009	
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																					
Americium-241	NA	NR		0.00577	U	-0.00224	U	0.0243	U	0.0576	U	-0.0481	U	0.003	U	-0.0307	U	0.0443	U	0.00208	U
Beryllium-7	NA	-0.0581	U	-0.033	U	0.064	U	-0.00633	U	0.0252	U	0.0547	U	-0.0194	U	-0.0137	U	-0.0398	U	0.012	U
Cesium-134	NA	NR		0.0375	U	0.046	UI	0.0363	J-UI	0.0233	DL	0.0378	U	0.0518	UI	-0.000127	U	0.0434	UI	0.0265	DL
Cesium-137	23	0.0339	J	0.0621	J	0.0121	U	0.0382	J	0.000734	U	-0.00677	U	0.0309	U	0.0139	U	0.0384	J	0.0274	U
Cobalt-57	NA	-0.00476	U	0.000278	U	-0.00394	U	-0.00932	U	-0.00023	U	0.00559	DL	-0.00283	U	-0.00563	U	-0.000965	U	-0.00642	U
Cobalt-60	1,260	0.00022	U	0.00261	U	-0.00517	U	-0.0113	U	0.00664	U	-0.0114	U	0.0029	U	-0.00234	U	0.0134	U	0.0135	U
Europium-152	NA	NR		-0.0161	U	0.017	U	0.0171	U	-0.0121	U	-0.00746	U	0.0181	U	0.00389	U	0.0037	U	-0.0115	U
Europium-154	NA	NR		0.0304	U	-0.0127	U	0.00594	U	-0.00741	U	-0.0253	U	-0.0332	U	-0.0163	U	-0.0248	U	-0.0082	U
Europium-155	NA	NR		0.0279	U	0.0367	U	0.00296	U	0.0684	U	-0.000544	U	0.00833	U	0.0443	U	0.022	U	0.0219	U
Manganese-54	NA	-0.000385	U	-0.011	U	-0.0254	U	0.00805	U	0.0044	U	-0.00359	U	-0.0136	U	0.0103	U	0.000437	U	0.0116	U
Potassium-40	NA	4.95		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Radium-226	NA	0.377		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Sodium-22	NA	-0.0234	U	0.0108	U	-0.0177	U	0.00209	U	-0.0026	U	-0.00832	U	-0.0112	U	-0.00672	U	-0.0128	U	-0.00203	U
Thorium-228	NA	0.747		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Zinc-65	NA	NR		0.0286	U	-0.000976	U	-0.00952	U	0.0417	U	0.0022	U	-0.00877	U	0.0151	U	0.00168	U	-0.0225	U
Rad Gas Flow Proportional Counting																					
Strontium-90	15	NR		0.797	U	0.661	U	0.274	U	0.130	U	0.583	U	0.325	U	0.296	U	-0.0696	U	-0.116	U
Rad Liquid Scintillation Analysis																					
Tritium	NA	NR		-21.3	U	58.3	U	9.85	U	-53.2	U	49.3	U	17.8	U	33.8	U	-26.3	U	4.56	U

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HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results (Core and Composite)
Phase III, Survey Unit 1

Parameter	Residential	Trench #1										Trench #2										Trench #3									
	Cleanup Value	30426-008		30426-009		30426-010		30426-011		30426-014 (Comp)		30425-020		30425-021		30425-022		30425-023		30425-024 (Comp)		30425-010		30425-011		30425-012		30425-013		30425-001 (Comp)	
		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-0.5' (pCi/g)		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-0.5' (pCi/g)		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																															
Americium-241	NA	0.00156	U	0.00756	U	0.00453	U	0.0327	U	0.114	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		-0.0241	U
Beryllium-7	NA	0.0357	U	-0.0558	U	-0.0301	U	0.0421	U	0.0261	U	-0.0142	U	-0.104	U	-0.00593	U	-0.14	U	0.000273	U	0.0573	U	-0.0973	U	-0.0105	U	0.0275	U	-0.0525	U
Cesium-134	NA	0.00863	U	0.021	U	0.0187	U	0.00867	U	0.0271	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Cesium-137	23	0.00632	U	0.000987	U	-0.0124	U	0.00586	U	0.0368	J	0.0474	J	-0.00116	U	0.0258	U	0.00634	U	0.0821	J	0.0559	J	0.00241	U	0.0236	U	0.00162	U	0.0657	J
Cobalt-57	NA	-0.000154	U	0.000352	U	0.00617	U	0.00514	U	0.00257	DL	-0.00966	U	0.0154	U	-0.00183	U	0.000832	U	-0.00222	U	0.00307	U	-0.00206	U	-0.0029	U	-0.00502	U	-0.0039	U
Cobalt-60	1.260	0.00362	U	0.00196	U	-0.000231	U	0.0136	U	0.0115	U	0.0000811	U	-0.0144	U	-0.0122	U	-0.0151	U	0.000969	U	-0.00664	U	-0.00163	U	-0.0174	U	0.00924	U	-0.00149	U
Europium-152	NA	-0.0107	U	0.0164	U	-0.0319	U	-0.0156	U	-0.0217	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Europium-154	NA	-0.0278	U	-0.0142	U	-0.0213	U	-0.0163	U	-0.0259	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Europium-155	NA	0.0261	U	0.0215	U	0.011	U	-0.00218	U	0.033	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Manganese-54	NA	-0.000521	U	0.00832	U	0.000889	U	-0.00283	U	-0.0205	U	0.00981	U	0.00273	U	0.00542	U	-0.00726	U	0.00947	U	0.00531	U	-0.00797	U	-0.0172	U	0.00102	U	0.0221	U
Potassium-40	NA	NR		NR		NR		NR		NR		4.44		6.15		5.65		4.36		4.41		5.84		5.36		3.24		1.75		4.61	
Radium-226	NA	NR		NR		NR		NR		NR		0.374	UI	0.337		0.341		0.280		0.348		0.380		0.313		0.294		0.0739		0.328	
Sodium-22	NA	-0.00967	U	-0.00462	U	-0.0096	U	-0.00827	U	-0.00898	U	0.00329	U	-0.000619	U	-0.00164	U	0.00403	U	-0.00385	U	0.0084	U	-0.00683	U	-0.0204	U	0.0167	U	-0.00567	U
Thorium-228	NA	NR		NR		NR		NR		NR		0.522		0.523		0.341		0.475		0.411		0.580		0.446		0.372		0.153		0.645	
Zinc-65	NA	0.0134	U	0.00737	U	-0.0838	U	-0.0247	U	-0.0156	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Rad Alpha Spec Analysis																															
Americium-241	NA	NR		NR		NR		NR		0.0889	J	NR		NR		NR		NR		0.026	U	NR		NR		NR		NR		-0.0332	U
Curium-243/244	NA	NR		NR		NR		NR		0.0173	U	NR		NR		NR		NR		-0.0125	U	NR		NR		NR		NR		-0.0103	U
Plutonium-238	NA	NR		NR		NR		NR		-0.00999	U	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Plutonium-239/240	NA	NR		NR		NR		NR		0.0158	U	NR		NR		NR		NR		-0.088	U	NR		NR		NR		NR		-0.013	U
Plutonium-241		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Uranium-235/236	NA	NR		NR		NR		NR		0.0448	U	NR		NR		NR		NR		-0.0347	U	NR		NR		NR		NR		0.0637	U
Uranium-238	NA	NR		NR		NR		NR		0.262	U	NR		NR		NR		NR		-0.0655	U	NR		NR		NR		NR		0.233	U
Rad Gas Flow Proportional Counting																															
Strontium-90	15	0.241	U	-0.0516	U	0.323	U	0.712	U	-0.154	U	-0.0611	U	-0.0621	U	0.0412	U	-0.251	U	0.331	U	0.0396	U	-0.015	U	1.02	J	0.112	U	0.230	U
Rad Liquid Scintillation Analysis																															
Tritium	NA	56.5	U	-16.9	U	85.4	U	-29.2	U	61.4	U	41.9	U	4.17	U	121	U	152	U	32.5	U	-4.39	U	4.00	U	56.0	U	0.00	U	-91	U

Parameter	Residential	Trench #4				Trench #5																					
	Cleanup Value	30427-001 (Comp)		30539-020 (Comp)		30540-027		30540-028		30540-029		30540-030		30540-019 (Comp)		30540-020 (Comp)		30542-012 (Comp)		30542-013 (Comp)		30542-014 (Comp)					
		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-2' (pCi/g)		2'-4' (pCi/g)		4'-6' (pCi/g)		6'-8' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)		0'-0.5' (pCi/g)					
Rad Gamma Spec Analysis																											
Americium-241	NA	NR		NR		NR		NR		NR		NR		NR		NR		0.00442	U	0.0433	U	0.00744	U				
Beryllium-7	NA	-0.0187	U	0.034	U	0.116	U	-0.0295	U	-0.0601	U	0.0342	U	0.0903	U	0.0957	U	0.0285	U	-0.0337	U	-0.0419	U				
Cesium-134	NA	NR		NR		NR		NR		NR		NR		NR		NR		0.0251	DL	0.0348	U	0.0488	UI				
Cesium-137	23	0.0305	J	0.0709	J	0.0138	U	0.000283	U	-0.0089	U	-0.00486	U	0.111		0.0489	J	0.0155	U	-0.00578	U	0.00514	U				
Cobalt-57	NA	0.00525	U	0.000857	U	0.00674	U	-0.000733	U	0.003	U	0.00539	U	-0.00355	U	0.0054	U	-0.0105	DL	-0.00167	DL	-0.000929	U				
Cobalt-60	1.260	-0.000995	U	0.00983	U	-0.000203	U	-0.00725	U	-0.0143	U	-0.00278	U	-0.00504	U	-0.00195	U	0.0147	U	0.00638	U	0.00754	U				
Europium-152	NA	NR		NR		NR		NR		NR		NR		NR		NR		0.0266	U	0.0237	U	0.0286	U				
Europium-154	NA	NR		NR		NR		NR		NR		NR		NR		NR		-0.0126	U	0.0307	U	0.011	U				
Europium-155	NA	NR		NR		NR		NR		NR		NR		NR		NR		0.0232	U	0.312	U	0.0397	U				
Manganese-54	NA	-0.00296	U	0.0147	U	-0.000203	U	0.0208	U	-0.00497	U	-0.00521	U	-0.00183	U	-0.00195	U	-0.00988	U	0.00697	U	0.00963	U				
Potassium-40	NA	4.21		4.37		2.78		3.03		3.03		2.71		4.55		4.49		NR		NR		NR					
Radium-226	NA	0.236		0.341		0.254		0.153		0.341		0.182		0.389		0.395		NR		NR		NR					
Sodium-22	NA	0.00112	U	-0.00914	U	0.000156	U	0.00513	U	-0.00609	U	-0.00102	U	-0.00898	U	-0.000216	U	-0.00119	U	0.0119	U	0.00324	U				
Thorium-228	NA	0.397		0.487		0.403		0.254		0.669		0.307		0.728		0.706		NR		NR		NR					
Zinc-65	NA	NR		NR		NR		NR		NR		NR		NR		NR		-0.0454	U	0.0356	U	-0.000548	U				
Rad Alpha Spec Analysis																											
Americium-241	NA	-0.0718	U	0.0465	U	NR		NR		NR		NR		-0.0114	U	0.0204	U	0.00453	U	-0.00947	U	0.0159	U				
Curium-243/244	NA	-0.0108	U	-0.0587	U	NR		NR		NR		NR		-0.0123	U	-0.00604	U	0.012	U	-0.0024	U	0.00783	U				
Plutonium-238	NA	NR		NR		NR		NR		NR		NR		-0.00742	U	0.00	U	NR		NR		NR					
Plutonium-239/240	NA	-0.0115	U	0.0737	U	NR		NR		NR		NR		0.0103	U	0.0306	U	-0.00632	U	0.000522	U	-0.00286	U				
Plutonium-241		NR		NR		NR		NR		NR		NR		NR		NR		NR		0.853	U	-0.897	U				
Uranium-235/236	NA	0.00	U	0.103	U	NR		NR		NR		NR		0.404	U	0.0722	U	0.066	U	-0.0231	U	0.282					
Uranium-238	NA	0.395	U	0.727	U	NR		NR		NR		NR		0.533	J	0.443	J	0.351	J	0.390	J	0.685	J				
Rad Gas Flow Proportional Counting																											
Strontium-90	15	0.400	U	-0.231	U	0.315	U	0.296	U	-0.0597	U	0.033	U	0.224	U	-0.0479	U	-0.0808	U	1.02	U	-0.0464	U				
Rad Liquid Scintillation Analysis																											
Tritium	NA	0.00	U	-86.8	U	-106	U	-91.4	U	-62.3	U	-29.1	U	105	U	-132	U	-63.1	U	-8.24	U	12.3	U				

Notes:
DL - Below the detection limit
NA - Not Applicable
NR - Not Reported
J - Indicates an estimated concentration
U - Indicates that the compound was analyzed for, but was not detected
All units are pCi/g
Gamma Spec results only reported for those parameters that were recorded during the analysis

HFBR Underground Utilities
Final Status Survey
Offsite Metals Data

Parameter	Cleanup Value	Phase 1		Phase 1		Phase 1		Phase 2		Phase 3, Trench #1		Phase 3, Trench #2	
		287919-SU1		287919-SU2		287919-SU3		28724-034		30426-014		30425-024	
Lead	400	7.00		4.68		5.58		8.98		8.15		5.91	
Mercury	1.84	0.00792	J	0.00988	J	0.0111	J	0.0102	J	0.009	J	0.0156	J

Parameter	Cleanup Value	Phase 3, Trench #3		Phase 3, Trench #4			
		30425-001		30427-001		30539-020	
Lead	400	15.0		4.41		10.4	
Mercury	1.84	0.0113	J	0.0101	J	ND	U

Parameter	Cleanup Value	Phase 3, Trench #5									
		30540-019		30540-020		30542-012		30542-013		30542-014	
Lead	400	8.44		6.53		7.24		5.9		8.72	
Mercury	1.84	0.0106	J	0.00501	J	0.0128	J	0.00853	J	0.0158	J

Notes:
ND - Not detected
J - Indicates an estimated concentration
U - Indicates that the compound was analyzed for, but was not detected
All units are mg/kg

HFBR Underground Utilities
Final Status Survey
Offsite Soil Radiochemical Analytical Results
QA/QC

Parameter	Residential Cleanup Value	28719-C-1 DUP 0'-2' (pCi/g)		28719-F-B 0'-0.5' (pCi/g)		28724-035 FB 0'-0.5' (pCi/g)		28724-036 DUP 0'-0.5' (pCi/g)		30426-012 FB 0'-0.5' (pCi/g)		30426-013 DUP 0'-0.5' (pCi/g)		30425-008 DUP 0'-0.5' (pCi/g)		30425-009 FB 0'-0.5' (pCi/g)		30425-018 FB 0'-0.5' (pCi/g)		30425-019 DUP 0'-0.5' (pCi/g)		30540-017 DUP 0'-0.5' (pCi/g)		30540-018 FB 0'-0.5' (pCi/g)		30542-010 DUP 0'-0.5' (pCi/g)		30542-011 FB 0'-0.5' (pCi/g)	
Rad Gamma Spec Analysis																															
Actinium-228	NA	NR		NR		0.911		0.684	J	NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Americium-241	NA	-0.0421	U	-0.0238	U	NR		NR		-0.00209	U	0.0205	U	NR		NR		NR		NR		NR		NR		NR		-0.0386	U	-0.037	U
Beryllium-7	NA	-0.0639	U	0.628		0.457		0.0549	DL	-0.0022	U	0.0705	U	0.110	U	0.105	U	-0.0279	U	0.079	U	-0.012	U	-0.0496	U	0.0277	U	0.085	U
Bismuth-212	NA	NR		NR		0.961		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Bismuth-214	NA	NR		NR		0.604		0.414		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Cesium-134	NA	0.0419	UI	0.0313	U	NR		NR		0.0387	J-UI	0.0313	U	NR		NR		NR		NR		NR		NR		0.0604	UI	0.020	DL
Cesium-137	23	0.0442	J	0.00408	U	0.0442		0.000685	DL	0.347	J-UI	0.0546	J	0.0858	J-UI	0.031	U	-0.00442	U	0.0292	U	0.0389	J	0.788		0.290	J	0.00791	U
Cobalt-57	NA	-0.00137	U	0.00455	U	0.000875	DL	0.00289	DL	-0.00962	U	-0.00655	U	0.00925	U	-0.000127	U	-0.00731	U	0.0057	U	-0.00106	U	0.00676	U	-0.00641	U	0.00593	DL
Cobalt-60	1,260	0.00125	U	-0.00337	U	-0.00628	DL	0.00208	DL	0.0187	U	0.00736	U	-0.0138	U	0.012	U	0.0045	U	-0.00773	U	-0.00786	U	-0.00467	U	-0.00545	U	-0.00813	U
Europium-152	NA	0.0268	U	-0.069	U	NR		NR		0.00227	U	-0.0148	U	NR		NR		NR		NR		NR		NR		-0.0323	U	0.0155	U
Europium-154	NA	0.0169	U	0.00202	U	NR		NR		0.00519	U	-0.0134	U	NR		NR		NR		NR		NR		NR		-0.00568	U	-0.0706	U
Europium-155	NA	0.0185	U	0.00914	U	NR		NR		0.0455	U	0.0513	U	NR		NR		NR		NR		NR		NR		0.0798	J-UI	0.00532	U
Lead-212	NA	NR		NR		0.836		0.661		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Lead-214	NA	NR		NR		0.684		0.481		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Manganese-54	NA	0.00211	U	0.00229	U	0.00173	DL	0.000919	DL	0.0107	U	0.00119	U	0.00136	U	-0.00426	U	0.00448	U	0.00636	U	-0.0014	U	0.0075	U	0.00176	U	0.0144	U
Potassium-40	NA	NR		NR		NR		NR		NR		NR		4.70		4.34		5.17		5.10		4.71		5.83		NR		NR		NR	
Radium-226	NA	0.259		0.403		0.604		0.414		NR		NR		0.576		0.267		0.422		0.283		0.491		0.485		NR		NR		NR	
Sodium-22	NA	0.00858	U	0.000761	U	-0.00414	DL	-0.0033	DL	0.00218	U	-0.00488	U	-0.0247	U	-0.000734	U	-0.0117	U	0.00264	U	-0.0133	U	0.012	U	-0.00291	U	-0.0242	U
Thallium-208	NA	NR		NR		0.281		0.204		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR		NR	
Thorium-228	NA	NR		NR		0.836		0.661		NR		NR		0.658		0.436		0.655		0.499		0.769		0.847		NR		NR		NR	
Zinc-65	NA	-0.0476		-0.0126	U	NR		NR		-0.00282	U	0.0113	U	NR		NR		NR		NR		NR		NR		-0.054	U	-0.00204	U
Rad Gas Flow Proportional Counting																															
Strontium-90	15	-0.165	U	0.239	U	0.237	U	0.360	U	0.436	U	-0.0168	U	0.315	U	0.395	U	0.0587	U	0.250	U	0.0388	U	0.532	U	0.347	U	0.465	U
Rad Liquid Scintillation Analysis																															
Tritium	NA	31.2	U	36.1	U	-10.2	U	-44.5	U	14.5	U	-48.7	U	-37.4	U	15.6	U	20.2	U	-16.7	U	-10.8	U	-59.5	U	-75.1	U	-6.64	U

Notes:

DL - Below the dectection limit

NA - Not Applicable

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysi

HFBR Underground Utilities Removal - Phase 1 - 30 inch Duct
Soil Overburden Analytical Results
ISOCS Cs-137
Chain of Custody # 28657

COC	DATE	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28657	2/23/2010	1	30 inch duct overburden	0.136
28657	2/23/2010	2	30 inch duct overburden	0.223
28657	2/23/2010	3	30 inch duct overburden	0.228
28657	2/23/2010	4	30 inch duct overburden	0.155
28657	2/23/2010	5	30 inch duct overburden	0.183
28657	2/23/2010	6	30 inch duct overburden	0.1397
28657	2/23/2010	7	30 inch duct overburden	BG
28657	2/23/2010	8	30 inch duct overburden	0.121
28657	2/23/2010	9	30 inch duct overburden	BG
28657	2/23/2010	10	30 inch duct overburden	BG
28657	2/23/2010	11	30 inch duct overburden	0.141
28657	2/23/2010	12	30 inch duct overburden	0.214
28657	2/23/2010	13	30 inch duct overburden	0.227

Notes:
BG - Result equal to bacground concentrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

HFBR Underground Utilities Removal - Phase 1 - 30 inch Duct
Soil Overburden Radiochemical Analytical Results
Chain of Custody # 28656

Parameter	OU1 Action Levels[(1)]	28656-001 (pCi/g)		28656-002 (pCi/g)		28656-003 (pCi/g)		28656-004 (pCi/g)	
Rad Alpha Spec Analysis									
Americium-241	34	0.124	U	0.0849	U	-0.0345	U	-0.0215	U
Plutonium-238	57	-0.0128	U	-0.0316	U	0.00	U	0.00	U
Plutonium-239/240	35	0.00	U	0.00	U	0.00	U	0.0551	U
Uranium-233/234		0.19	U	0.156	U	0.692	J	0.305	U
Uranium-235/236	4.6	-0.0226	U	0.145	U	0.0879	U	0.00	U
Uranium-238	4.7	0.380	J	0.692	J	2.47		0.341	U
Rad Gamma Spec Analysis									
Americium-241		-0.041	U	0.0503	U	0.0008	U	-0.081	U
Beryllium-7		-0.00278	U	0.0571	U	0.019	U	-0.0586	U
Cesium-134		0.0209	J-UI	0.0169	U	0.0287	J-UI	0.0279	J-UI
Cesium-137	23	0.0232	J	0.0209	J	0.0641	J	0.0657	J-UI
Cobalt-57		-0.00116	U	0.00504	U	0.00214	U	0.0000106	U
Cobalt-60	1,260	-0.000791	U	0.00502	U	0.00708	U	0.00614	U
Europium-152	51	-0.0204	U	0.000988	U	-0.0122	U	-0.0419	U
Europium-154	180	-0.0265	U	-0.028	U	-0.00473	U	0.00445	U
Europium-155		-0.00224	U	0.0266	U	0.0304	J-UI	0.0251	U
Manganese-54		0.00426	U	0.00106	U	0.00856	U	0.00221	U
Sodium-22		-0.0111	U	-0.0103	U	-0.0047	U	0.000797	U
Zinc-65		0.0096	U	0.0426	J-UI	-0.000357	U	-0.0146	U
Rad Gas Flow Proportional Counting									
Alpha		8.51		11.9		7.40		13.8	
Strontium-90	15	-0.353	U	0.178	U	-0.465	U	-0.0242	U
Rad Liquid Scintillation Analysis									
Tritium	9.6 E+15	-144	U	-90.6	U	-65.8	U	-57.5	U

Notes:
-1

DL - Below the dectection limit

ND - Not detected

J - Indicates an estimated concentration

U - Indicates that the compound was analyzed for, but was not detected

UI -

Bold/Shaded text denotes concentrations exceeding OU1 Action Levels.

All units are pCi/g

Gamma Spec results only reported for those parameters that were recorded during the analysis

HFBR Underground Utilities Removal - Phase 2 – D/F Waste Line
Soil Overburden Analytical Results - ISOCS

SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
001	0'-2'	BG
001	2'-4'	BG
002	0'-2'	BG
002	2'-4'	BG
003	0'-2'	0.18
003	2'-4'	BG
004	0'-2'	0.139
004	2'-4'	0.115
005	0'-2'	BG
005	2'-4'	BG
006	0'-2'	BG
006	2'-4'	BG
007	0'-2'	BG
007	2'-4'	BG
008	0'-2'	BG
008	2'-4'	BG
009	0'-2'	BG
009	2'-4'	BG
010	0'-2'	BG
010	2'-4'	BG
011	0'-2'	BG
011	2'-4'	BG
012	0'-2'	BG
012	2'-4'	BG
013	0'-2'	BG
013	2'-4'	BG
014	0'-2'	BG
014	2'-4'	BG
015	0'-2'	BG
015	2'-4'	BG
016	0'-2'	0.11
016	2'-4'	BG
017	0'-2'	BG
017	2'-4'	BG
018	0'-2'	BG
018	2'-4'	BG
019	0'-2'	BG
019	2'-4'	BG
020	0'-2'	0.313
020	2'-4'	0.18
021	0'-2'	0.277
021	2'-4'	BG

HFBR Underground Utilities Removal - Phase 2 – D/F Waste Line
Soil Overburden Radiochemical Analytical Results – Offsite Analysis
Chain of Custody # 28721

Parameter	OU1 Action Levels	C1 0'-2' (pCi/g)	C2 0'-2' (pCi/g)	C3 0'-2' (pCi/g)	C4 0'-2' (pCi/g)	C5 0'-2' (pCi/g)	C6 2'-4' (pCi/g)	C7 2'-4' (pCi/g)	C8 2'-4' (pCi/g)	C9 2'-4' (pCi/g)	C10 2'-4' (pCi/g)	C11 2'-4' (pCi/g)
Rad Gamma Spec Analysis												
Actinium-228	NA	0.572	0.87	0.9	1.08	0.993	1.01	0.866	0.85	0.794	0.944	0.852
Beryllium-7	NA	0.0382	0.00582	0.0398	0.025	-0.0111	-0.0179	-0.0263	-0.0193	-0.00648	-0.0287	-0.00187
Bismuth-212	NA	0.778	na	1.15	1.18	1.09	1.01	0.881	0.842	0.933	0.878	1.02
Bismuth-214	NA	0.371	0.531	0.595	0.618	0.582	0.6	0.54	0.526	0.563	0.543	0.546
Cesium-137	23	0.139	0.083	0.0711	0.0622	0.129	0.0451	0.0311	0.0358	0.0353	0.026	0
Cobalt-57	NA	0.000606	0.00355	-0.00411	-0.00213	-0.0022	0.00039	0.0017	0.00275	-0.00159	2.26E-05	0.00236
Cobalt-60	1,260	-0.003	-0.00459	-0.00529	0.00201	-0.000782	0.00421	0.00635	-0.0112	0.00117	-0.00299	0.00129
Lead-212	NA	0.546	0.838	0.888	1	0.882	0.884	0.839	0.891	0.827	0.867	0.823
Lead-214	NA	0.449	0.669	0.676	0.71	0.681	0.719	0.652	0.659	0.647	0.648	0.624
Manganese-54	NA	-0.00121	0.0087	0.000737	-0.00245	0	-0.000617	0.0159	-0.00916	0.0131	0	0.00898
Potassium-40	NA	4.87	7.03	7.53	7.03	6.52	7	6.69	6.7	6.45	6.53	6.47
Radium-226	NA	0.371	0.531	0.595	0.618	0.582	0.6	0.54	0.526	0.563	0.543	0.546
Sodium-22	NA	-0.00381	-0.00211	-0.00547	-0.0119	0.00735	0.00354	0.00432	-0.00941	-0.000273	0.00111	-0.00622
Thallium-208	NA	0.16	0.262	0.3	0.315	0.266	0.304	0.251	0.254	0.258	0.272	0.264
Thorium-228	NA	0.546	0.838	0.888	1	0.882	0.884	0.839	0.891	0.827	0.867	0.823
Rad Gas Flow Proportional Counting												
Strontium-90	15	0.479	-0.312	0.409	-0.0469	-0.114	-0.0831	0.206	0.418	0.0262	0.682	0.164
Rad Liquid Scintillation Analysis												
Tritium	9.6 E+15	-8.26	NA	NA	-14.6	NA	NA	31.1	NA	NA	69.3	-59.5

Notes:
NA – Not Applicable
ND – Non Detect

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/04/2010-C**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	080410-009	1218	PHASE 3 HFBR U/G UTIL STOCKPILE 1	BACKGROUND
2	080410-010	1163	PHASE 3 HFBR U/G UTIL STOCKPILE 2	BACKGROUND
3	080410-011	1235	PHASE 3 HFBR U/G UTIL STOCKPILE 3	^{137}Cs (0.08 pCi/gm) + BACKGROUND
4	080410-012	1019	PHASE 3 HFBR U/G UTIL STOCKPILE 4	^{137}Cs (0.05 pCi/gm) + BACKGROUND
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4 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/05/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	080510-001	868	PHASE 3 ASPHALT - NORTH	BACKGROUND
2	080510-002	980	PHASE 3 ASPHALT - SOUTH	BACKGROUND
3	080510-003	1141	PHASE 3 O/B PARK LOT #1	BACKGROUND
4	080510-004	1139	PHASE 3 O/B PARK LOT #2	BACKGROUND
5	080510-005	1112	PHASE 3 O/B PARK LOT #3	BACKGROUND
6	080510-006	1170	PHASE 3 O/B PARK LOT #4	BACKGROUND
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6 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/06/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	080610-001	868	PHASE 3 ASPHALT - NORTH RECOUNT	BACKGROUND
2	080610-002	980	PHASE 3 ASPHALT - SOUTH RECOUNT	BACKGROUND
3	080610-003	1141	PHASE 3 O/B PARK LOT #1RECOUNT	137Cs (0.14 pCi/gm) + BACKGROUND
4	080610-004	1139	PHASE 3 O/B PARK LOT #2 RECOUNT	137Cs (0.16 pCi/gm) + BACKGROUND
5	080610-005	1112	PHASE 3 O/B PARK LOT #3 RECOUNT	137Cs (0.20 pCi/gm) + BACKGROUND
6	080610-006	1170	PHASE 3 O/B PARK LOT #4 RECOUNT	137Cs (0.09 pCi/gm) + BACKGROUND
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6 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/13/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	081310-001	665	BLDG. 801 - S. SIDE ASPHALT PAD	^{137}Cs (0.62 pCi/gm) + BACKGROUND
2	081310-002	905	BLDG. 801 - S. SIDE ASPHALT PAD	^{137}Cs (0.95 pCi/gm) + BACKGROUND
3	081310-003	826	BLDG. 801 - S. SIDE CONCRETE RAMP	BACKGROUND
4	081310-004	805	BLDG. 801 - S. SIDE CONCRETE RAMP	BACKGROUND
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4 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/18/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	081810-002	1084	HFBR U/G UTIL PH-3 SU1-1	BACKGROUND
2	081810-003	1104	HFBR U/G UTIL PH-3 SU1-1 OVERBURDEN 1	BACKGROUND
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2 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/25/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	082310-001	1258	PHASE 3 UNKNOWN LEAKING PIPE	BACKGROUND
2	082510-001	1011	PHASE 3 OVERBURDEN SOIL	BACKGROUND
3	082510-002	1092	PHASE 3 OVERBURDEN SOIL	BACKGROUND
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3 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **11/10/2010-B**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	111010-002	897	PHASE 3 TRENCH 1 OVERBURDEN 01	BACKGROUND
2	111010-003	1063	PHASE 3 TRENCH 1 OVERBURDEN 02	BACKGROUND
3	111010-004	995	PHASE 3 TRENCH 1 OVERBURDEN 03	BACKGROUND
4	111010-005	960	PHASE 3 TRENCH 1 OVERBURDEN 04	BACKGROUND
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4 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/08/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	090810-001	1002	PHASE 3 U/G UTIL TRENCH 2 (0 -2')	^{137}Cs (0.04 pCi/gm) + BACKGROUND
2	090810-002	1183	PHASE 3 U/G UTIL TRENCH 2 (0 -2') FIELD DUP.	BACKGROUND
3	090810-003	901	PHASE 3 U/G UTIL TRENCH 2 (2 - 4')	BACKGROUND
4	090810-004	1162	PHASE 3 U/G UTIL TRENCH 2 (4 -6')	BACKGROUND
5	090810-005	927	PHASE 3 U/G UTIL TRENCH 2 (6 -8')	^{137}Cs (0.04 pCi/gm) + BACKGROUND
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5 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/09/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	090910-001	1058	PHASE 3 TRENCH 3 S #4	BACKGROUND
2	090910-002	1100	PHASE 3 TRENCH 3 S #5	BACKGROUND
3	090910-003	1086	PHASE 3 TRENCH 3 S #6	BACKGROUND
4	090910-004	1070	PHASE 3 TRENCH 3 S #7	BACKGROUND
5	090910-005	1161	PHASE 3 TRENCH 3 S #8	BACKGROUND
6	090910-006	1111	PHASE 3 TRENCH 3 S #9	BACKGROUND
7	090910-007	1078	PHASE 3 TRENCH 3 S #9 DUP.	^{137}Cs (0.04 pCi/gm) + BACKGROUND
8	090910-008	1086	PHASE 3 TRENCH 3 S #10 (0-2')	^{137}Cs (0.07 pCi/gm) + BACKGROUND
9	090910-009	1131	PHASE 3 TRENCH 3 S #10 (2-4')	BACKGROUND
10	090910-010	1292	PHASE 3 TRENCH 3 S #10 (4-6')	BACKGROUND
11	090910-011	1115	PHASE 3 TRENCH 3 S #10 (6-8')	BACKGROUND
12	090910-012	1066	PHASE 3 TRENCH 3 FIELD BLANK	BACKGROUND
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12 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/21/2010-B**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	092110-013	1067	PHASE 3 TRENCH 4 O'BURDEN 001	BACKGROUND
2	092110-014	969	PHASE 3 TRENCH 4 O'BURDEN 002	BACKGROUND
3	092110-015	1043	PHASE 3 TRENCH 4 O'BURDEN 003	BACKGROUND
4	092110-016	966	PHASE 3 TRENCH 4 O'BURDEN 004	^{137}Cs (0.11 pCi/gm) + BACKGROUND
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4 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/16/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	091610-001	1146	PHASE 3 TRENCH #4 001	BACKGROUND
2	091610-002	1295	PHASE 3 TRENCH #4 002	BACKGROUND
3	091610-003	1175	PHASE 3 TRENCH #4 003	BACKGROUND
4	091610-004	1112	PHASE 3 TRENCH #4 004	BACKGROUND
5	091610-005	1134	PHASE 3 TRENCH #4 005	BACKGROUND
6	091610-006	1144	PHASE 3 TRENCH #4 006	BACKGROUND
7	091610-007	1048	PHASE 3 TRENCH #4 007	BACKGROUND
8	091610-008	1092	PHASE 3 TRENCH #4 008	BACKGROUND
9	091610-009	1108	PHASE 3 TRENCH #4 009	BACKGROUND
10	091610-010	1055	PHASE 3 TRENCH #4 010	BACKGROUND
11	091610-011	1130	PHASE 3 TRENCH #4 011	BACKGROUND
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11 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **10/16/2010-B**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	101610-005	1319	BLD. 811 PH3 TRCH 5 O'BURDEN - 001	BACKGROUND
2	101610-006	1237	BLD. 811 PH3 TRCH 5 O'BURDEN - 002	^{137}Cs (0.06 pCi/gm) + BACKGROUND
3	101610-007	1228	BLD. 811 PH3 TRCH 5 O'BURDEN - 003	BACKGROUND
4	101610-008	1327	BLD. 811 PH3 TRCH 5 O'BURDEN - 004	^{137}Cs (0.05 pCi/gm) + BACKGROUND
5	101610-009	1275	BLD. 811 PH3 TRCH 5 O'BURDEN - 005	BACKGROUND
6	101610-010	1233	BLD. 811 PH3 TRCH 5 O'BURDEN - 006	^{137}Cs (0.04 pCi/gm) + BACKGROUND
7	101610-011	1242	BLD. 811 PH3 TRCH 5 O'BURDEN - 007	BACKGROUND
8	101610-012	1187	BLD. 811 PH3 TRCH 5 O'BURDEN - 008	BACKGROUND
9	101610-013	1305	BLD. 811 PH3 TRCH 5 O'BURDEN - 009	BACKGROUND
10	101610-014	1358	BLD. 811 PH3 TRCH 5 O'BURDEN - 010	BACKGROUND
11	101610-015	1382	BLD. 811 PH3 TRCH 5 O'BURDEN - 011	BACKGROUND
12	101610-016	1404	BLD. 811 PH3 TRCH 5 O'BURDEN - 012	BACKGROUND
13	101610-017	1320	BLD. 811 PH3 TRCH 5 O'BURDEN - 013	BACKGROUND
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13 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **10/06/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	100610-001	1008	PHASE 3 TRENCH 5 OVERBURDEN 001	BACKGROUND
2	100610-002	955	PHASE 3 TRENCH 5 OVERBURDEN 002	BACKGROUND
3	100610-003	977	PHASE 3 TRENCH 5 OVERBURDEN 003	^{137}Cs (0.07 pCi/gm) + BACKGROUND
4	100610-004	1090	PHASE 3 TRENCH 5 OVERBURDEN 004	BACKGROUND
5	100610-005	1032	PHASE 3 TRENCH 5 OVERBURDEN 005	BACKGROUND
6	100610-006	1021	PHASE 3 TRENCH 5 OVERBURDEN 006	BACKGROUND
7	100610-007	1232	PHASE 3 TRENCH 5 OVERBURDEN 007	BACKGROUND
8	100610-008	1173	PHASE 3 TRENCH 5 OVERBURDEN 008	BACKGROUND
9	100610-009	1180	PHASE 3 TRENCH 5 OVERBURDEN 009	BACKGROUND
10	100610-010	1123	PHASE 3 TRENCH 5 OVERBURDEN 010	BACKGROUND
11	100610-011	1035	PHASE 3 TRENCH 5 OVERBURDEN 011	BACKGROUND
12	100610-012	905	PHASE 3 TRENCH 5 OVERBURDEN 012	BACKGROUND
13	100610-013	859	PHASE 3 TRENCH 5 OVERBURDEN 013	^{137}Cs (0.01 pCi/gm) + BACKGROUND
14	100610-014	959	PHASE 3 TRENCH 5 OVERBURDEN 014	BACKGROUND
15	100610-015	975	PHASE 3 TRENCH 5 OVERBURDEN 015	BACKGROUND
16	100610-016	893	PHASE 3 TRENCH 5 OVERBURDEN 016	^{137}Cs (0.09 pCi/gm) + BACKGROUND
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16 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **10/07/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	100710-001	1066	PHASE 3 TRENCH 5 OVERBURDEN 017	BACKGROUND
2	100710-002	930	PHASE 3 TRENCH 5 OVERBURDEN 018	BACKGROUND
3	100710-003	939	PHASE 3 TRENCH 5 OVERBURDEN 019	BACKGROUND
4	100710-004	1075	PHASE 3 TRENCH 5 OVERBURDEN 020	BACKGROUND
5	100710-005	921	PHASE 3 TRENCH 5 OVERBURDEN 021	BACKGROUND
6	100710-006	954	PHASE 3 TRENCH 5 OVERBURDEN 022	BACKGROUND
7	100710-007	1029	PHASE 3 TRENCH 5 OVERBURDEN 023	BACKGROUND
8	100710-008	1039	PHASE 3 TRENCH 5 OVERBURDEN 024	BACKGROUND
9	100710-009	1048	PHASE 3 TRENCH 5 OVERBURDEN 025	BACKGROUND
10	100710-010	1012	PHASE 3 TRENCH 5 OVERBURDEN 026	BACKGROUND
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10 SAMPLES TOTAL

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL
☑ RWP # ERP-2010-007 ☐ WP #

LOCATION & EQUIPT. **HFBR U/G Utilities**

DATE: **4/14/2010** TIME: **0900**

FSS Gamma Walkover Survey after 425' of 30" concrete duct removed.

Performed GPS Gamma Walkover survey of the HFBR U/G Utilities Trench. 100% walkover of trench bottom and 25% walkover of trench slopes/ walls.

Collected (24) samples during the excavation/ duct removal of the trench, which were all ≤ Bkgd using on-site ISOCS. Of those (24), (12) were used as FSS Samples.

Created (3) composite samples using aliquots from (12) sample locations in "Phase 1".

Collected core samples from (3) locations. (4) samples per core @ 2' intervals down to 8'. (Example: 0'-2', 2'-4' etc.)

All samples/ cores sent to off-site lab for analysis unless otherwise noted.
See attached map for GPS walkover coverage and sample/ core locations.

Samples: 1-1, 1-2 etc.
Cores: C-1, C-2, C-3

NaI 1min. Static Counts

Sample #	Gamma cpm
C-1	6256
C-2	5784
C-3	5999
1-1	6014
1-2	6122
1-3	6087
1-4	5981
1-5	6125
1-6	6058
1-7	6221
1-8	6199
1-9	6145
1-10	6066
1-11	5985
1-12	6004

NaI Gamma Bkg: **6213 cpm**

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	149942	2/15/2011
N/A	N/A	N/A

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm^2) (α, β-γ) ^{3}H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By A. Merkel **Date: 4/14/2010** **Reviewed By:** _____ **Date:** _____

HFBR Underground Utilities - Phase 1 - 30 inch Duct
Soil and Concrete Analytical Results – ISOCS

COC	Matrix	SAMPLE NUMBER	Cs-137 (pCi/g)
28927	Soil	1	0.179
28927	Soil	2	ND
28927	Soil	3	0.142
28927	Soil	4	0.062
28927	Soil	5	ND
28927	Soil	6	ND
28716	Soil	007	ND
28716	Soil	008	ND
28716	Soil	009	ND
28716	Soil	010	ND
28927	Concrete	10	ND

Duct Joint Soil Analytical Results - ISOCS

COC	Date	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28927	3/17/2010	007	Duct Joint 0	0.156
28927	3/17/2010	008	Duct Joint 1	0.101
28927	3/17/2010	009	Duct Joint 2	ND
28716	3/24/2010	1-4	Duct Joint 3	ND
28716	3/24/2010	1-5	Duct Joint 1	ND
28717	3/25/2010	J-1	Duct Joint 4	ND
28717	3/25/2010	J-2	Duct Joint 5	0.06
28717	3/25/2010	J-3	Duct Joint 6	ND
28717	3/25/2010	J-4	Duct Joint 7	0.097
28717	3/25/2010	J-5	Duct Joint 8	0.067
28717	3/25/2010	J-6	Duct Joint 9	ND
28717	3/25/2010	J-7	Duct Joint 10	ND
28718	4/1/2010	J-8	Duct Joint 11	ND
28718	4/1/2010	J-9	Duct Joint 12	ND
28718	4/1/2010	J-10	Duct Joint 13	ND
28718	4/1/2010	J-11	Duct Joint 14	ND
28718	4/1/2010	J-12	Duct Joint 15	ND
28718	4/1/2010	J-13	Duct Joint 16	ND
28718	4/2/2010	J-14	Duct Joint 17	ND
28718	4/2/2010	J-15	Duct Joint 18	ND
28718	4/2/2010	J-16	Duct Joint 19	ND
28718	4/5/2010	J-17	Duct Joint 20	0.09
28718	4/5/2010	J-18	Duct Joint 21	ND
28718	4/5/2010	J-19	Duct Joint 22	ND

Notes:

ND – not detected

Soil sample numbering system changed during course of sample collection

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

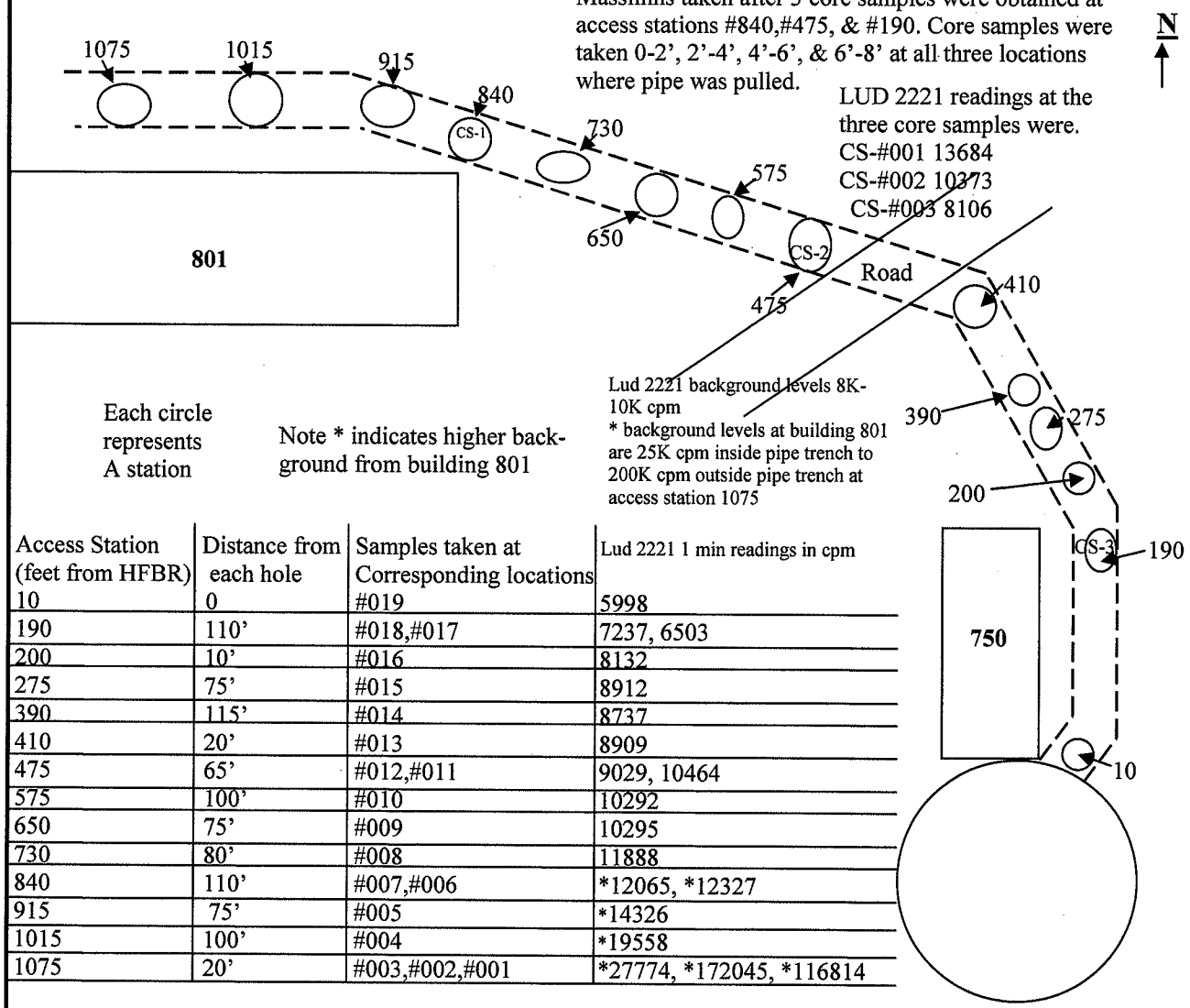
REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☐ RWP # ☐ WP #

LOCATION & EQUIPT. HFBR U/G Utilities
DATE: 5/13/2010 **TIME:** 1630

Phase 2 Job Coverage Final Status Surveys

Masslinns taken after 3 core samples were obtained at access stations #840,#475, & #190. Core samples were taken 0-2', 2'-4', 4'-6', & 6'-8' at all three locations where pipe was pulled.

LUD 2221 readings at the three core samples were.
CS-#001 13684
CS-#002 10373
CS-#003 8106



Each circle represents A station

Note * indicates higher back-ground from building 801

Lud 2221 background levels 8K-10K cpm
* background levels at building 801 are 25K cpm inside pipe trench to 200K cpm outside pipe trench at access station 1075

Access Station (feet from HFBR)	Distance from each hole	Samples taken at Corresponding locations	Lud 2221 1 min readings in cpm
10	0	#019	5998
190	110'	#018,#017	7237, 6503
200	10'	#016	8132
275	75'	#015	8912
390	115'	#014	8737
410	20'	#013	8909
475	65'	#012,#011	9029, 10464
575	100'	#010	10292
650	75'	#009	10295
730	80'	#008	11888
840	110'	#007,#006	*12065, *12327
915	75'	#005	*14326
1015	100'	#004	*19558
1075	20'	#003,#002,#001	*27774, *172045, *116814

INSTRUMENT

Model #	Serial #	CAL DUE
LUD-3	72487	12/17/10
LUD 2221	211780	12/8/10
N/A	N/A	N/A
N/A	N/A	N/A

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					→

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	All <1K	5.	All <1K
2.	↓	6.	↓
3.	↓	7.	↓
4.	↓	8.	↓

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.	↓	10.	↓	17.	↓
4.	↓	11.	↓	18.	↓
5.	↓	12.	↓	19.	↓
6.	↓	13.	↓	20.	↓
7.	↓	14.	↓	21.	↓

Surveyed By S. Schultz/Zamora **Date:** 5/13/2010 **Reviewed By:** **Date:**

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL FSS
☐ RWP # ☐ WP #

LOCATION & EQUIPT. HFBR UNDERGROUND UTIL. SAMPLES
DATE: 01 5/13/10 **TIME** 1600

INSTRUMENT		
MODEL #	SERIAL #	CAL DUE
Ludlum 2221	211780	12/8/10
Ludlum 3	5662	4/13/11
N/A	N/A	N/A

NOTE: SURVEY PERFORMED ON EACH MARINELLI SAMPLE CONTAINER
LUDLUM 2221 W/ Na' DETECTOR (2X2)
BKGD = 7041 CPM. (1 MINUTE STATIC COUNT)

NOTE: SAMPLE #001 – 6964 CPM
002 – 7078 CPM
003 – 7003 CPM
004 – 6975 CPM
005 – 8256 CPM
006 – 7925 CPM
007 – 7141 CPM
008 – 7298 CPM
009 – 7256 CPM
010 – 7236 CPM
011 – 7457 CPM
012 – 7433 CPM
013 – 8087 CPM
014 – 8045 CPM
015 – 7243 CPM
016 – 7621 CPM
017 – 7290 CPM
018 – 7002 CPM
019 – 7200 CPM
FIELD BLANK – 7008 CPM
COMPOSITE #1 – 7101 CPM
#2 – 7156 CPM
#3 – 7484 CPM

CORE SAMPLES CS-002
0-2' 7271 CPM
2'-4' 7369 CPM
4'-6' – 7114 CPM
6'-8' – 7239 CPM

CORE SAMPLES CS-001
0-2' – 7389 CPM
2'-4' – 7373 CPM
4'-6' – 7326 CPM
6'-8' – 7247 CPM

CORE SAMPLES -CS 003
0-2' – 7237 CPM
2'-4' – 6847 CPM
4'-6' – 6730 CPM
6'-8' – 6462 CPM

NOTE: LAS TAKEN ON ALL EXTERIOR SURFACES OF THE MARINELLI S. NO ELEVATED ACTIVITY WAS DETECTED

NOTE: SAMPLES WERE MARKED & TOPS SECURED W/ TAPE PLACED IN COOLERS PENDING DISPOSITION

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
C - CONTAMINATION * CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By [signature] **Date:** 5/13/10 **Reviewed By:** [signature] **Date:** 5/17/10

HFBR Underground Utilities - Phase 2
D/F Waste Line Soils Analytical Results
ISOCS Cs-137

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28721	C-1	Phase II Composites	BG
28927	C-2	Phase II Composites	BG
28927	C-3	Phase II Composites	BG
28927	C-4	Phase II Composites	BG
28927	C-5	Phase II Composites	BG
28927	C-6	Phase II Composites	BG
28927	C-7	Phase II Composites	BG
28927	C-8	Phase II Composites	BG
28927	C-9	Phase II Composites	BG
28927	C-10	Phase II Composites	BG
28927	C-11	Phase II Composites	BG
28927	1	Phase II 0'-2'	BG
28927	2	Phase II 0'-2'	BG
28927	3	Phase II 0'-2'	0.18
28927	4	Phase II 0'-2'	0.139
28927	5	Phase II 0'-2'	BG
28927	6	Phase II 0'-2'	BG
28927	7	Phase II 0'-2'	BG
28927	8	Phase II 0'-2'	BG
28927	9	Phase II 0'-2'	BG
28927	10	Phase II 0'-2'	BG
28927	11	Phase II 0'-2'	BG
28927	12	Phase II 0'-2'	BG
28927	13	Phase II 0'-2'	BG
28927	14	Phase II 0'-2'	BG
28927	15	Phase II 0'-2'	BG
28927	16	Phase II 0'-2'	0.11
28927	17	Phase II 0'-2'	BG
28927	18	Phase II 0'-2'	BG
28927	19	Phase II 0'-2'	BG
28927	20	Phase II 0'-2'	0.313
28927	21	Phase II 0'-2'	0.277

Notes:
BG - Result equal to background concentrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

HFBR Underground Utilities - Phase 2
D/F Waste Line Soils Analytical Results
ISOCS Cs-137

COC	SOIL SAMPLE NUMBER	SAMPLE LOCATION	Cs-137 (pCi/g)
28927	1	Phase II 2'-4'	BG
28927	2	Phase II 2'-4'	BG
28927	3	Phase II 2'-4'	BG
28927	4	Phase II 2'-4'	BG
28927	5	Phase II 2'-4'	BG
28927	6	Phase II 2'-4'	BG
28927	7	Phase II 2'-4'	BG
28927	8	Phase II 2'-4'	BG
28927	9	Phase II 2'-4'	BG
28927	10	Phase II 2'-4'	BG
28927	11	Phase II 2'-4'	BG
28927	12	Phase II 2'-4'	BG
28927	13	Phase II 2'-4'	BG
28927	14	Phase II 2'-4'	BG
28927	15	Phase II 2'-4'	BG
28927	16	Phase II 2'-4'	BG
28927	17	Phase II 2'-4'	BG
28927	18	Phase II 2'-4'	BG
28927	19	Phase II 2'-4'	BG
28927	20	Phase II 2'-4'	0.18
28927	21	Phase II 2'-4'	BG

Notes:
BG - Result equal to background concentrations
Bold/Shaded text denotes concentrations exceeding site cleanup criteria

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. HFBR u/g utilities phase 3

DATE: 11/18/10 TIME: 1100

Phase 3 Trench #1 FSS Survey

Trench 1

COC # 30426

Sample No.	1 Min. Gamma
001	8591
002	8925
003	7552
004	7557
005	6495
006	6117
007	6152
008	5972
009	6233
010	5418
011	5386
012	7035
013	6337
014	7304
015	6936

Counts taken un-collimated.
Also performed NaI walk-over survey. (See attached map)
Soil samples taken every ~ 4' (from north to south) in trench where 42"duct & 14" acid lines were removed.
Sample locations are pink flags shown in pictures on page #2 .

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	211780	12/08/10
Ludlum 2221	133877	07/28/11

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: D.DOVE Date: 11/18/10 Reviewed By: Date: 11/19/10

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

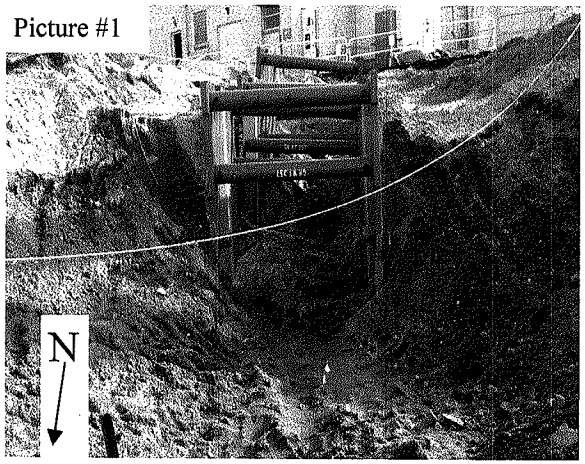
REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. HFBR u/g utilities phase 3

DATE: 11/18/10 **TIME:** 1100

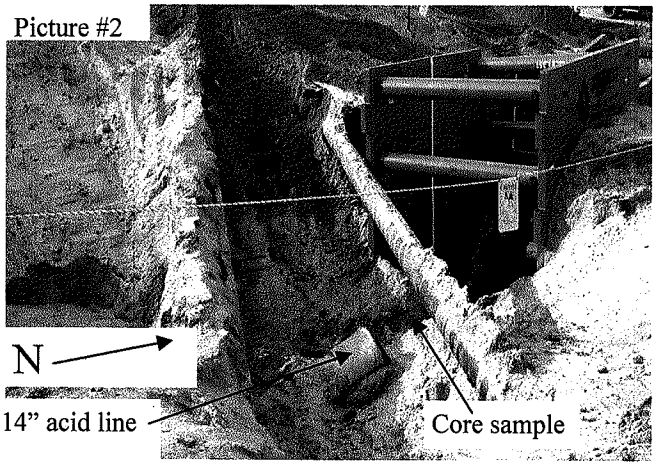
Phase 3 Trench #1 FSS Survey Picture Map

Picture #1



Picture #1 is taken from north side of trench facing southeast, bldg. 802 can be seen at top of picture.

Picture #2



Picture #2 is taken from southeast side of trench facing northwest towards building 801

Performed NaI walk-over survey. (See attached map)
Soil samples taken every ~ 4' (from north to south) in trench where 42"duct & 14" acid lines were removed.
Sample locations are pink flags shown in pictures .

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	211780	12/08/10
Ludlum 2221	133877	07/28/11

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: D.DOVE **Date: 11/18/10** **Reviewed By:** **Date: 11/19/10**

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **11/18/2010-A**

M. ROBLES - 631 708-6343

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	111810-001	889	PH-3 TR-1 BLANK	BACKGROUND
2	111810-002	1054	PH-3 TR-1 FSS 001	BACKGROUND
3	111810-003	1004	PH-3 TR-1 FSS 002	BACKGROUND
4	111810-004	1088	PH-3 TR-1 FSS 003	BACKGROUND
5	111810-005	1206	PH-3 TR-1 FSS 004	BACKGROUND
6	111810-006	1088	PH-3 TR-1 FSS 005	BACKGROUND
7	111810-007	1128	PH-3 TR-1 FSS 006	BACKGROUND
8	111810-008	1112	PH-3 TR-1 FSS 007	BACKGROUND
9	111810-009	1089	PH-3 TR-1 FSS 008	BACKGROUND
10	111810-010	1142	PH-3 TR-1 FSS 009	BACKGROUND
11	111810-011	1089	PH-3 TR-1 FSS 010	BACKGROUND
12	111810-012	1020	PH-3 TR-1 FSS 011	BACKGROUND
13	111810-013	1002	PH-3 TR-1 FSS 012	^{241}Am (1.42 pCi/gm) + BACKGROUND
14	111810-014	963	PH-3 TR-1 FSS 013	BACKGROUND
15	111810-015	1030	PH-3 TR-1 FSS 014	BACKGROUND
16	111810-016	1168	PH-3 TR-1 FSS 0 - 2' CORE	BACKGROUND
17	111810-017	1120	PH-3 TR-1 FSS 2 - 4' CORE	BACKGROUND
18	111810-018	1173	PH-3 TR-1 FSS 4 - 6' CORE	BACKGROUND
19	111810-019	1127	PH-3 TR-1 FSS 6 - 8' CORE	BACKGROUND
20	111810-020	1151	PH-3 TR-1 FSS DUPLICATE	BACKGROUND
21				
22				
23				
24				
25				

20 SAMPLES TOTAL

ASL Prefix No. N/A

Page 1 of 1

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30426

Requires EDD ☑ DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE HOLLAND/ER	Name: DAN DOUE	Name: GEL
Life No: N6455 Ext. 4539	Contact: EP RCT	Address: 2040 SAVAGE Rd.
Acct. No: 65296/65298 Dept: EP	Phone: x4424	City: CHARLESTON St: S.C. Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHAFFER
1 hollandem@bnl.gov	Sampler: SAME	Phone:
2 Lockwood@bnl.gov		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HI BR U/G UTILITIES PHASE 3	ANDY LOCKWOOD	JOHN MARSEANO

Comments:

Type LID	Type UID	Smp	Coll	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description	Cont. Vol./Units	Cont. Type	# of Cont	Preservative	Alpha/Beta	Tritium	Gamma	Strontium -90	524.2	624	Nuclide-specific Alpha	PCBs	Metals
	001	E	G	BNL/PHASE3/HWY	0-0.5	11/18/10	1050	S	PHASE 3 TRENCH #1 SURFACE 002	500ml	P		NONE		✓	✓	✓					
	002	↓	↓	↓	↓	↓	1054	↓	004	↓	↓	↓	↓		✓	✓	✓					
	003						1058		006						✓	✓	✓					
	004						1102		008						✓	✓	✓					
	005						1108		010						✓	✓	✓					
	006						1110		012						✓	✓	✓					
	007				↓		1114		014						✓	✓	✓					
	008				0-2'		1026		PHASE 3 TRENCH #1 CORE 0-2'						✓	✓	✓					
	009				2-4'		1030		2-4'						✓	✓	✓					
	010				4-6'		1036		4-6'						✓	✓	✓					
	011				6-8'		1040		6-8'						✓	✓	✓					
	012				0-0.5'		1100		PHASE 3 TRENCH #1 FIELD BLANK						✓	✓	✓					
	013	E			0-0.5'		1051		FIELD DUP #002						✓	✓	✓					
	014	↓	C	↓	0-0.5'	11/18/10	1105	↓	COMPOSITE	↓	↓	↓	↓		✓	✓	✓			✓		✓

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print MIKE HOLLAND 11/18/10 1300	Print	Print
Signature	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print	Print	Print
Signature	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ☑ Disposal by Lab
☐ Archive For ____ Months

Data Package: ☐ Full ☑ Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
☑ 7 Days ☐ Other ( )

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. Phase 3 SU-1

DATE: 9-1-2010 **TIME:** 1000

HFBR U/G Util. Phase 3 trench #2

Trench #2

COC # 30425

Sample No.	GPS Coordinate	1 Min. Gamma	Post 1 Min. Gamma
001	Not Available	2999	N/A
002	Not Available	3017	N/A
003	Not Available	4287	N/A
004	Not Available	3955	N/A
005	Not Available	3365	N/A
006	Not Available	3856	N/A
007	Not Available	2987	N/A
008	Not Available	2846	N/A
009	Not Available	2658	N/A
010	Not Available	3101	N/A
011	Not Available	3087	N/A
012	Not Available	3669	N/A
013	Not Available	3387	N/A
014	Not Available	2994	N/A

Performed Collimated NaI Walk-Over Survey. No GPS was done due to satellite Coverage. **NaI results: (2000 ~ 6000 cpm Gamma) Took 0~6" soil samples every 4' (From North to South) inside trench.**

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	149942	2-15-2011
Ludlum 2221	138377	7-28-11
N/A		
N/A		

LEGEND

○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

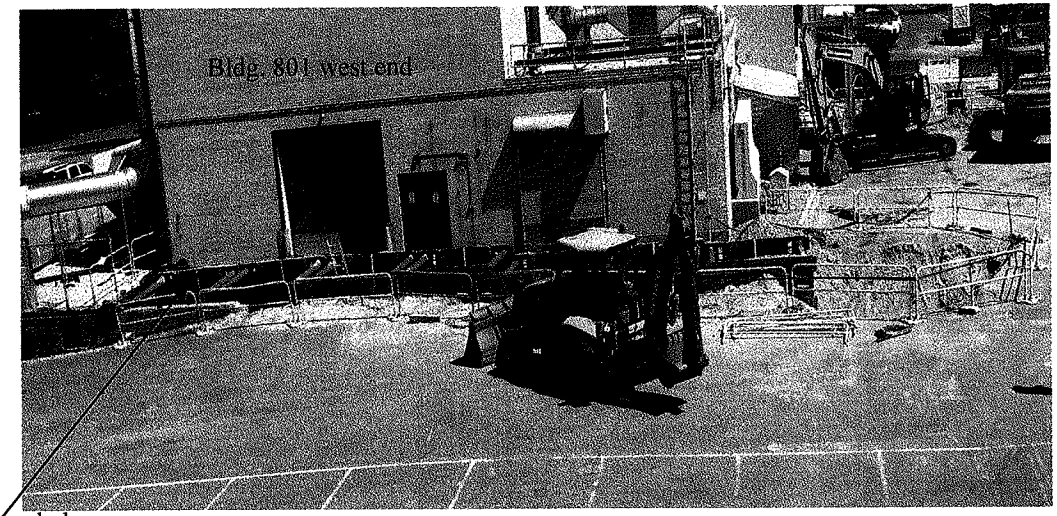
Surveyed By Merkel/ Schultz **Date:** 9-1-2010 **Reviewed By:** **Date:** 9/7/10

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☐ SPECIAL FSS
☑ RWP # 2010-erp-007 ☐ WP #

LOCATION & EQUIPT. Phase 3 hfbr u/g utilities
DATE: 9/1/2010 **TIME:** 1000

Trench #2 FSS



Surface samples # 001-014 taken starting at north end of trench and then every 4 feet thereafter.

Core sample obtained at north end of trench approximately 4 feet from duct exit from building.

Trench is approximately 10 feet deep.

Collimated walkover survey performed. No GPS was done due to lack of satellite coverage in trench. NAI gamma walkover results were 2000-6000 cpm on bottom of trench and trench box walls. Background established prior to walkover also ranged from 2000-6000 cpm along trench.

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum-2221	149942	2-15-2011
Ludlum-2221	138377	7/28/11
↑	↑	↑
N/A	N/A	N/A

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					→

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.	↓	6.	↓
3.	↓	7.	↓
4.	↓	8.	↓

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.	↓	10.	↓	17.	↓
4.	↓	11.	↓	18.	↓
5.	↓	12.	↓	19.	↓
6.	↓	13.	↓	20.	↓
7.	↓	14.	↓	21.	↓

Surveyed By Merkel/Schultz **Date:** 9/1/2010 **Reviewed By:** **Date:** 9/7/10

ASL Prefix No. MA

Page 1 of 3

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 33425

Requires EDD ☑ DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE HOLLANDER	Name: STONE SCHULTZ	Name: GEL
Life No: N6455 Ext. 4839	Contact: ERD RCT	Address: 2040 SAVAGE Rd.
Acct. No: C5296/C5299 Dept: ERP	Phone: X4424	City: CHARLESTON St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHAEFER
1 HOLLANDER@BNL.GOV	Sampler: SAME	Phone: 843-769-7356 X4505
2 MDUKE@BNL.GOV		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HFBR U/G UTILITIES PHASE 3	M. PIZZUTO	MIKE DUKE

Comments:

Type¹				Sample Information					Additional Sample Information					Analysis Requested											
LID	UID	Smp	Coll	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description	Cont. Vol./Units	Cont. Type	# of Cont	Preservative	Alpha/Beta	Tritium	Gamma	Strontium 90	524.2	624	Nuclide-specific Alpha	PCBs	Metals			
	001	E	C	BNL/PHASE 3	0-0.5	9/10/10	1100	S	COMPOSITE SAMPLES 1-9 TRENCH 3	300ml	P	1	NONE		✓	✓	✓			✓		✓				
	002		G			9/2/10	0910		PHASE 3 TRENCH 3 SAMPLE #1							✓	✓									
	003						0905		#2						✓	✓	✓									
	004						~~0900~~ 0900		#3							✓	✓									
	005					9/9/10	1014		PHASE 3 TRENCH 3 SAMPLE #6						✓	✓	✓									
	006						1018		#8							✓	✓									
	007						1022		#9							✓	✓									
	008						1024		PHASE 3 TRENCH 3 FIELD DUP.						✓	✓	✓									
	009						1026		FIELD BLANK						✓	✓	✓									
	010				0-2'		1028		CORE						✓	✓	✓									
	011	E	G		2-4'	9/9/10	1034		CORE						✓	✓	✓									
	012				4-6		1038		CORE						✓	✓	✓									
	013				6-8		1044		CORE						✓	✓	✓									
	014	E	G	BNL/PHASE 3	7'	9/11/10	1330	S	PHASE 3 24" PINK CONCRETE						✓	✓	✓			✓						

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print MIKE HOLLANDER 9/13/10 1330	Print	Print
Signature	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print	Print	Print
Signature	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ☑ Disposal by Lab
☐ Archive For ____ Months

Data Package: ☐ Full ☑ Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
☑ 7 Days ☐ Other ( )

BNL F 3101D

Distribution WHITE (1) - Stays with Sample; PINK (2) - Lab or Other GREEN (3) - Returned to Client with Report GOLDENROD (4) - Field Copy - (Sampler)

Page 2 of 3

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30425

...ix No. N/A

Requires EDD ☑ DQL _____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE HOWARD	Name: STEVE SCHULZ	Name: GEL
Life No: N6455 Ext. 4839	Contact: EP RCT	Address: 2040 SAVAGE RD
Acct. No: 65296/65299 Dept: EP	Phone: X4424	City: CHARLESTON St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHARPE
1 HOWARD2@BNL.GOV	Sampler: STEVE	Phone: 843-769-7356 X1505
2 MDUKE@BNL.GOV		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HFBR U/G UTILITIES PHASE 3	M. PIZZUTO	MIKE DUKE

Comments:

Type LID	Type UID	Smp	Coll	Sample Information: Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Additional Sample Information: Name/Description	Cont. Vol./Units	Cont. Type	# of Cont	Preservative	Analysis Requested: Alpha/Beta	Tritium	Gamma	Strontium 90	524.2	624	Nuclide-specific Alpha Am-241, Pu-238,239,240	PCBs	Metals MERCURY, LEAD
	015	E	G	BNL/PHASE 3	7'	9/8/10	1500	E	(4) SMEARS FROM 24" DUCT	400cm²	P	4	NONE	✓						✓		
	016	E	G	BNL/HFBR	0-0.5	9/8/10	1045	S	HFBR SU-8 REMEDIATED SPOT	500ml	P	1	NONE		✓	✓	✓			✓		
	017	E	C	BNL/HFBR	0-0.5	9/8/10	1040	S	COMPOSITE OF (3) SAMPLES SURROUNDING SU-8	500ml	P	1	NONE		✓	✓	✓			✓		
	018	E	G	BNL/PHASE 3	0-0.5	9/8/10	1115	S	FIELD BLANK PHASE 3 TRENCH 2	500ml	P	1			✓	✓	✓					
	019	E	G	BNL/PHASE 3	0-3'	9/7/10	1605	S	FIELD DUP ↓ 3 TRENCH 2		P	1			✓	✓	✓					
	020	E	G	↓	0-2'	9/7/10	1540	S	PHASE 3 TRENCH #2 CORE		P	1			✓	✓	✓					
	021				2-4'		1545	S			P	1			✓	✓	✓					
	022				4-6'		1600	S			P	1			✓	✓	✓					
	023	↓	↓	↓	6-8'	↓	1604	S	↓	↓	P	1	↓		✓	✓	✓					
	024	E	C	BNL/PHASE 3	0-0.5	9/30/10	1145	S	COMPOSITE OF (4) SAMPLES FROM #2	500ml	P	1	NONE		✓	✓	✓			✓		✓
	025	E	G	↓ PHASE 3	0-0.5	9/30/10	1430	S	PHASE 3 TRENCH #2 0-4'		P	1			✓	✓	✓					
		E	G				1435	S	4-8'							✓						
	027	E	G				1440	S	8-12'							✓						
	028	E	G	↓	↓	↓	1445	S	12-16'	↓	↓	↓	↓			✓						

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print MIKE HOWARD 9/30/10 1430	Print	Print
Signature	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print	Print	Print
Signature	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ☑ Disposal by Lab
☐ Archive For _____ Months

Data Package: ☐ Full ☑ Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
☑ 7 Days ☐ Other ( )

BNL F 3101D

Distribution WHITE (1) - Stays with Sample; PINK (2) - Lab or Other GREEN (3) - Returned to Client with Report GOLDENROD (4) - Field Copy - (Sampler)

Chain of Custody No. 30425

Page 3 of 3

Matrix No. NA

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # ____________

P.O. # ____________

Requires EDD ☒ DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: Mike Holhager	Name: Steve Schultz	Name: GEL
Life No: W6455 Ext. 4839	Contact: EAP RCT	Address: 2040 Savage Rd.
Acct. No: 65296/65299 Dept: EAP	Phone: X4424	City: Charleston St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: [illegible]
1 [illegible] @ bnl.gov	Sampler: SHMS	Phone: 843-769-7386 X4505
2 mduke @ bnl.gov		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HFBR u/g utilities Phase 3	M. Pizzulli	Mike Duke

Comments:

LID	UiD	Smp	Coll	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description	Cont. Vol./Units	Cont. Type	# of Cont	Preservative	Alpha/Beta	Tritium	Gamma	Strontium	524.2	624	Nuclide-specific Alpha	PCBs	Metals		
	029	E	G	BNL/Phase 3	0-0.5	8/31/10	~~1445~~ 1450	S	Phase 3 Trench #2 16'-20'	500ml	P	1	None		✓	✓	✓							
	030	↓	↓	↓	↓	↓	~~1445~~ 1455	↓	↓ 20-24'	↓	↓	↓	↓			✓								
	031	↓	↓	↓	↓	↓	~~1450~~ 1500	↓	↓ 24'-28'	↓	↓	↓	↓			✓								
	032	↓	↓	↓	↓	↓	1505	↓	↓ 28'-32'	↓	↓	↓	↓			✓								
	033	↓	↓	↓	↓	↓	1510	↓	↓ 32'-36'	↓	↓	↓	↓		✓	✓	✓							
	034	↓	↓	↓	↓	↓	1515	↓	↓ 36'-40'	↓	↓	↓	↓			✓								
	035	↓	↓	↓	↓	↓	1520	↓	↓ 40'-44'	↓	↓	↓	↓			✓								
	036	↓	↓	↓	↓	↓	1525	↓	↓ 44'-48'	↓	↓	↓	↓			✓								
	037	↓	↓	↓	↓	↓	1530	↓	↓ 48'-52'	↓	↓	↓	↓		✓	✓	✓							
	038	↓	↓	↓	↓	↓	1535	↓	↓ 52'-56'	↓	↓	↓	↓			✓								

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print Mike Holhager [illegible]	Print	Print
Signature [signature]	Signature	Signature
1 Received By/Date/Time	**2 Received By/Date/Time**	**3 Received By/Date/Time**
Print [illegible]	Print	Print
Signature [illegible]	Signature	Signature

Contractor Lab Sample Disposal:
- ☐ Return To Client ☒ Disposal by Lab
- ☐ Archive For ____ Months

Data Package: ☐ Full ☒ Summary

Turn-Around Time Required:
- ☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
- ☒ 7 Days ☐ Other ( )

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/31/2010-B**

P. SULLIVAN - 631 897-3202

TRENCH #2

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	083110-020	1129	PHASE 3 SU1 (0 - 4')	BACKGROUND
2	083110-021	1191	PHASE 3 SU1 (4 - 8')	BACKGROUND
3	083110-022	1130	PHASE 3 SU1 (8 - 12')	BACKGROUND
4	083110-023	1097	PHASE 3 SU1 (12 - 16')	BACKGROUND
5	083110-024	1258	PHASE 3 SU1 (16 - 20')	BACKGROUND
6	083110-025	1112	PHASE 3 SU1 (20 - 24')	BACKGROUND
7	083110-026	1142	PHASE 3 SU1 (24 - 28')	BACKGROUND
8	083110-027	1125	PHASE 3 SU1 (28 - 32')	BACKGROUND
9	083110-028	1073	PHASE 3 SU1 (32 - 36')	BACKGROUND
10	083110-029	1082	PHASE 3 SU1 (36 - 40')	BACKGROUND
11	083110-030	1135	PHASE 3 SU1 (40 - 44')	BACKGROUND
12	083110-031	1278	PHASE 3 SU1 (44 - 48')	BACKGROUND
13	083110-032	1156	PHASE 3 SU1 (48 - 52')	^{137}Cs (0.08 pCi/gm) + BACKGROUND
14	083110-033	1112	PHASE 3 SU1 (52 - 56')	BACKGROUND
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

P. Sull 08/31/2010

14 SAMPLES TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/08/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	090810-001	1002	PHASE 3 U/G UTIL TRENCH 2 (0 -2')	^{137}Cs (0.04 pCi/gm) + BACKGROUND
2	090810-002	1183	PHASE 3 U/G UTIL TRENCH 2 (0 -2') FIELD DUP.	BACKGROUND
3	090810-003	901	PHASE 3 U/G UTIL TRENCH 2 (2 - 4')	BACKGROUND
4	090810-004	1162	PHASE 3 U/G UTIL TRENCH 2 (4 -6')	BACKGROUND
5	090810-005	927	PHASE 3 U/G UTIL TRENCH 2 (6 -8')	^{137}Cs (0.04 pCi/gm) + BACKGROUND
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

5 SAMPLES TOTAL

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. Phase 3

DATE: 9-09-2010 **TIME:** 1600

HFBR U/G Util. Phase 3 trench #3

Trench #3

COC # 30425

Sample No.	GPS Coordinate	1 Min. Gamma	Post 1 Min. Gamma
001	Not Available	N/A	N/A
002	Not Available	N/A	N/A
003	Not Available	N/A	N/A
004	Not Available	8058	N/A
005	Not Available	7782	N/A
006	Not Available	8418	N/A
007	Not Available	9557	N/A
008	Not Available	8613	N/A
009	Not Available	8591	N/A
010	Not Available	N/A	N/A

Performed NaI Walk-Over Survey.
Soil samples 1-9 taken at 0.5'
Sample 10 was a core sample location and taken at 0'-2', 2-4', 4-6', 6-8'
Samples taken every 4' (From North to South) inside trench in line with pipe that was removed from south side of Bldg. 801
Note: samples 1,2, & 3 have no static count due to being obtained from excavator bucket due to no access in trench for safety reasons.
Map of sample locations is on page 2.

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	149942	2-15-2011
Ludlum 2221	138377	7-28-11
N/A		
N/A		

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Daniel Dove **Date:** 9-09-2010 **Reviewed By:** **Date:** 9/15/10

Coordinate System: NAD83, New York Long Island - Jnits: Feet

0 25 50 100 150 200

Feet

Legend

Gamma Count Rate (cpm)

- < 15,000
- 15,000 - 21,499
- ≥ 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
FSS HFBR Phase 3 Trench 3
September 9, 2010

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. PHASE 3 HFBR PIPE REMOVAL

DATE: 9/02/10 **TIME:** 0900

24" PIPE DUCT

Survey taken in trench number 3 on the south side of building 801. the section of the trench that was walked over is from building 801 to the chilled water lines in trench number 3. From this section we also Took 3 soil samples (waiting for results). The walkover survey results were background levels of 12K cpm. This section has been marked with orange temporary fencing and backed filled.

INSTRUMENT

Model #	Serial #	CAL DUE
LUD 2221	211780	12-8-10
N/A	N/A	N/A
↓	↓	↓

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) (α) (β-γ) ^{3}H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By SCHULTZ **Date:** 9/02/10 **Reviewed By:** [signature] **Date:** 9/3/10

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/02/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	090210-001	1196	PHASE 3 BLD. 801 SS TRENCH #3	BACKGROUND
2	090210-002	1264	PHASE 3 BLD. 801 SS TRENCH #3	BACKGROUND
3	090210-003	1256	PHASE 3 BLD. 801 SS TRENCH #3	BACKGROUND
4				
5				
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25				

P. Sull 09/02/2010 **3 SAMPLES TOTAL**

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/09/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	090910-001	1058	PHASE 3 TRENCH 3 S #4	BACKGROUND
2	090910-002	1100	PHASE 3 TRENCH 3 S #5	BACKGROUND
3	090910-003	1086	PHASE 3 TRENCH 3 S #6	BACKGROUND
4	090910-004	1070	PHASE 3 TRENCH 3 S #7	BACKGROUND
5	090910-005	1161	PHASE 3 TRENCH 3 S #8	BACKGROUND
6	090910-006	1111	PHASE 3 TRENCH 3 S #9	BACKGROUND
7	090910-007	1078	PHASE 3 TRENCH 3 S #9 DUP.	^{137}Cs (0.04 pCi/gm) + BACKGROUND
8	090910-008	1086	PHASE 3 TRENCH 3 S #10 (0-2')	^{137}Cs (0.07 pCi/gm) + BACKGROUND
9	090910-009	1131	PHASE 3 TRENCH 3 S #10 (2-4')	BACKGROUND
10	090910-010	1292	PHASE 3 TRENCH 3 S #10 (4-6')	BACKGROUND
11	090910-011	1115	PHASE 3 TRENCH 3 S #10 (6-8')	BACKGROUND
12	090910-012	1066	PHASE 3 TRENCH 3 FIELD BLANK	BACKGROUND
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

12 SAMPLES TOTAL

P. Sull 09/09/2010

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **08/30/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	083010-001	1182	PHASE 3 SU1 - 001	BACKGROUND
2	083010-002	1225	PHASE 3 SU1 - 002	BACKGROUND
3	083010-003	1176	PHASE 3 SU1 - 003	BACKGROUND
4				
5				
6				
7				
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22				
23				
24				
25				

3 SAMPLES TOTAL

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. Phase 3

DATE: 9-16-2010 TIME: 0900

HFBR U/G Util. Phase 3 trench #4

Trench #4

COC # 30427

Sample No.	GPS Coordinate	1 Min. Gamma	Post 1 Min. Gamma
001	Not Available	1792	N/A
002	Not Available	1843	N/A
003	Not Available	1902	N/A
004	Not Available	1938	N/A
005	Not Available	1597	N/A
006	Not Available	1637	N/A
007	Not Available	1667	N/A
008	Not Available	1678	N/A
009	Not Available	1728	N/A
010	Not Available	1712	N/A
011	Not Available	1747	N/A

Performed NaI Walk-Over Survey.
Soil samples 1-11 taken at 0.5'
Samples taken every 4' (From North to Southwest) inside trench in line with pipe that was removed from south side of Bldg. 801
Note:
Map of sample locations is on page 2.

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	149942	2-15-2011
Ludlum 2221	138377	7-28-2011
N/A	→	→
N/A	→	→

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	Field Analysis % DAC
N/A	→	→	→	→	→

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.	↓	6.	↓
3.	↓	7.	↓
4.	↓	8.	↓

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.	↓	10.	↓	17.	↓
4.	↓	11.	↓	18.	↓
5.	↓	12.	↓	19.	↓
6.	↓	13.	↓	20.	↓
7.	↓	14.	↓	21.	↓

Surveyed By Daniel Dove Date: 9-16-2010 Reviewed By: Date: 9/20/10

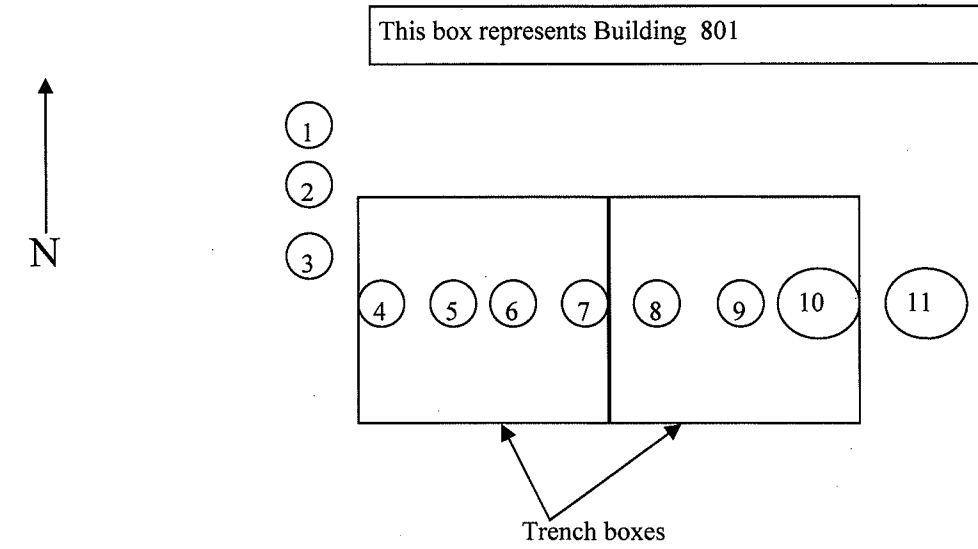
RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. Phase 3 Trench 2

DATE: 9-16-2010 **TIME:** 0900

HFBR U/G Util. Phase 3 trench #3 COC# 30425



Samples 1-4 were taken from area where 36" pipe/ duct was removed samples 5-11 were taken where 42" pipe/duct was removed . Samples were collected every 4' (From North To South then easterly direction)
Note:approximate distance From bldg. 801 to sample #1 is 12' SE from corner of building. Samples 4-11 are approximately 35' south of building 801.

INSTRUMENT

Model #	Serial #	CAL DUE
n/a	n/a	n/a
n/a	n/a	n/a
N/A →		
N/A →		

LEGEND
○ - SOIL SAMPLE LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Daniel Dove **Date:** 9-16-2010 **Reviewed By:** **Date:** 9/20/10

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ____ ■ SPECIAL FSS
☒ RWP # ERP-2010-007 ☐ WP # ____

LOCATION & EQUIPT. HFBR u/g utilities phase 3

Date 09/16/10 **TIME:** 09:00

Trench #4 west

NORTH ←

INSTRUMENT

Model #	Serial #	CAL DUE
L-2221	144942	2-15-11
L-2221	211780	12/8/10
Lud-3	70090	5/19/11
E-600	01642	2/22/11

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
C - CONTAMINATION * CONTACT
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A →					→

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.		5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	NA	8.	NA	15.	
2.		9.		16.	
3.		10.			
4.		11.		18.	
		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Hollander /Dove ____ **Date:** 9/16/10 **Reviewed By:** ____ **Date:** 9/20/10

Coordinate System: NAD83, New York Long Island - Units: Feet

0 25 50 100 150 200

Feet

Legend

Gamma Count Rate

COLLIMATED (cpm)

- ● ≤ 5,000
- ○ 5,001 - 7,199
- ● ≥ 7,200

GPS-Based Radiological Survey
Brookhaven National Laboratory
Trench 4 of Phase 3
September 16, 2010

ASL Prefix No. N/A

Page 1 of _____

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30427

Requires EDD ☑ DQL _____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE Hollinger	Name: DAN DOVE	Name: GEL
Life No: N6455 Ext. 4539	Contact: ERP RCT	Address: 2040 SAVAGE Rd
Acct. No: 65296/65299 Dept: ERP	Phone: x4424	City: CHARLESTON St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHALFANT
1 Hollinger@bnl.gov	Sampler: SAME	Phone: 843-769-7356 x4505
2 MDUKE@bnl.gov		Email/Fax:
Project Name: HFBR U/G UNIT. TIES/PHASE 3	Project Manager: M. PIZZUTO	Field Engineer: MIKE DUKE

Comments:

Type LID	Type UID	Smp	Coll	Sample Information: Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Additional Sample Information: Name/Description	Cont. Vol/Units	Cont. Type	# of Cont	Preservative	Analysis Requested: Alpha/Beta	Tritium	Gamma	Strontium -90	524.2	624	Nuclide-specific Alpha U-238, 238, Pu-239,240	PCBs	Metals TCLP LEAD
	001	E	C	BNL/PHASE 3	0-0.5	9/17/10	1000	S	COMPOSITE SAMPLES #1-11	500 mL	P	1	NONE		✓	✓	✓			✓		✓
	002	E	G		0-0.5	9/16/10	0900		PHASE 3 TRENCH #4 SAMPLE #1						✓	✓	✓					
	003						0904		2							✓						
	004						0908		3							✓						
	005						0911		4							✓						
	006						0915		5						✓	✓	✓					
	007						0919		6							✓						
	008						0923		7							✓						
	009						0927		8							✓						
	010						0930		9						✓	✓	✓					
	011						0934		10							✓						
	012						0938		11							✓						
	013	E	G	BNL/PHASE 3	10'	9/15/10	1345	C	PHASE 3 42" PIPE CONCRETE	500 mL	P	1	NONE		✓	✓	✓			✓		
	ON	E	C	BNL/PHASE 3	10'	9/15-9/16/10	1400	E	PHASE 3 42" PIPE I/S SMEARS (4)	400 cm²	P	4	NONE	✓						✓		

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print MIKE Hollinger 9/17/10	Print	Print
Signature 1135	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print Dan Melo 9/17/10	Print	Print
Signature 1135	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ● Disposal by Lab
☐ Archive For _____ Months

Data Package: ☐ Full ● Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
● 7 Days ☐ Other ( )

BNL F 3101D

Distribution WHITE (1) - Stays with Sample; PINK (2) - Lab or Other · GREEN (3) - Returned to Client with Report GOLDENROD (4) - Field Copy - (Sampler)

Sample Report

Batch ID:	1min. Smear - 20100913133O	**Count Date:**	9/13/2010
Group:	A	**Count Minutes:**	1.0
Device:	HFBR	**Count Mode:**	Simultaneous
Batch Key:	2,217	**Operating Volts:**	1350
Selected Geometry:	1/8" Stainless Steel		

Background (cpm)			Efficiency (%)			Spillover (%)		
Alpha Rate:	0.30 ± 0.10		**Alpha:**	28.64 ± 0.08		**Alpha to Beta:**	6.13 ± 0.00	
Beta Rate:	8.33 ± 0.53		**Beta:**	19.84 ± 0.07		**Beta to Alpha:**	0.08 ± 0.00	

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)	(dpm)
20100913133053-A1	Unknown	-1.03	0.35	15.84	-36.87	5.70	62.29	
20100913133223-A2	Unknown	23.32	9.24	15.84	132.32	29.95	62.29	
20100913133343-A3	Unknown	44.15	12.59	15.84	372.38	46.02	62.29	
20100913133453-A4	Unknown	5.88	4.95	15.84	98.59	26.81	62.29	
20100913133613-A5	Unknown	126.99	21.25	15.84	2,189.38	106.62	62.29	
20100913133723-A6	Unknown	12.81	6.99	15.84	203.81	35.39	62.29	
20100913133843-A7	Unknown	16.33	7.82	15.84	153.10	31.60	62.29	

Composite Smear

COPY

Reviewed by: D. Dore

Sample Report

Batch ID: 1min. Smear - 201009141528
Group: E
Device: HFBR
Batch Key: 2,224
Selected Geometry: 1/8" Stainless Steel

Count Date: 9/14/2010
Count Minutes: 1.0
Count Mode: Simultaneous
Operating Volts: 1350

Background (cpm)			Efficiency (%)			Spillover (%)		
Alpha Rate:	0.30 ± 0.10		**Alpha:**	28.64 ± 0.08		**Alpha to Beta:**	6.13 ± 0.00	
Beta Rate:	8.33 ± 0.53		**Beta:**	19.84 ± 0.07		**Beta to Alpha:**	0.08 ± 0.00	

Sample ID	Sample Type	Alpha (dpm)	Unc	Alpha MDA (dpm)	Beta (dpm)	Unc	Beta MDA (dpm)	(dpm)
20100914152849-E1	Unknown	9.40	6.06	15.84	42.84	20.96	62.29	
20100914153019-E2	Unknown	2.43	3.51	15.84	33.38	19.70	62.29	
20100914153139-E3	Unknown	9.38	6.06	15.84	83.16	25.35	62.29	
20100914153249-E4	Unknown	291.77	32.22	15.84	7,536.92	197.46	62.29	— COMPOSITE SMEAR
20100914153409-E5	Unknown	16.38	7.82	15.84	52.31	22.14	62.29	
20100914153519-E6	Unknown	-1.04	0.35	15.84	-16.71	11.58	62.29	
20100914153639-E7	Unknown	-1.03	0.35	15.84	-26.79	9.12	62.29	
20100914153759-E8	Unknown	-1.03	0.35	15.84	-26.79	9.12	62.29	
20100914153909-E9	Unknown	-1.03	0.35	15.84	-31.83	7.61	62.29	
20100914154029-E10	Unknown	-1.04	0.35	15.84	-16.71	11.58	62.29	

Copy

Reviewed by: D. Dow

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/15/2010-B**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	091510-003	529	PHASE 3 42" DUCT (INSIDE)	^{137}Cs (0.40 pCi/gm) + BACKGROUND
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

P. Sull 09/15/10

1 SAMPLE TOTAL

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **09/16/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	091610-001	1146	PHASE 3 TRENCH #4 001	BACKGROUND
2	091610-002	1295	PHASE 3 TRENCH #4 002	BACKGROUND
3	091610-003	1175	PHASE 3 TRENCH #4 003	BACKGROUND
4	091610-004	1112	PHASE 3 TRENCH #4 004	BACKGROUND
5	091610-005	1134	PHASE 3 TRENCH #4 005	BACKGROUND
6	091610-006	1144	PHASE 3 TRENCH #4 006	BACKGROUND
7	091610-007	1048	PHASE 3 TRENCH #4 007	BACKGROUND
8	091610-008	1092	PHASE 3 TRENCH #4 008	BACKGROUND
9	091610-009	1108	PHASE 3 TRENCH #4 009	BACKGROUND
10	091610-010	1055	PHASE 3 TRENCH #4 010	BACKGROUND
11	091610-011	1130	PHASE 3 TRENCH #4 011	BACKGROUND
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

P. Sull 09/16/2010

11 SAMPLES TOTAL

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ☒ SPECIAL FSS
☒ RWP # 2010-ERP-007 ☐ WP #

LOCATION & EQUIPT. Phase 3

DATE: 9-24-2010 TIME: 1500

HFBR U/G Util. Phase 3 trench #4 **COC # 30539**

Sample No.	GPS Coordinate	1 Min. Gamma	Post 1 Min. Gamma
001	Not Available	8794	N/A
002	Not Available	8346	N/A
003	Not Available	7432	N/A
004	Not Available	7823	N/A
005	Not Available	7127	N/A
006	Not Available	7753	N/A
007	Not Available	6779	N/A
008	Not Available	6729	N/A
009	Not Available	7857	N/A
010	Not Available	7409	N/A
011	Not Available	6428	N/A
012	Not Available	7499	N/A
013	Not Available	7070	N/A
014	Not Available	7685	N/A
015	Not Available	8257	N/A
016	Not Available	8303	N/A
017	Not Available	8214	N/A

Performed NaI Walk-Over Survey.
Soil samples 1-17 taken at 0.5'
Samples taken every 4' (From East to West) inside trench in line with pipe that was removed from south side of Bldg. 801
See page 2 for picture of area, Orange flags in picture show sample locations

INSTRUMENT

Model #	Serial #	CAL DUE
Ludlum 2221	149942	2-15-2011
Ludlum 2221	138377	7-28-2011
N/A		
N/A		

LEGEND
○ - SMEAR SURVEY LOCATION △ - AIR SAMPLE LOCATION
☐ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCATION
XXXY / ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	N/A	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	See	8.	Attached	15.	Results
2.	Batch	9.	Number	16.	N/A
3.		10.		17.	
4.		11.		18.	
5.		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Daniel Dove Date: 9-24-2010 Reviewed By: Date: 9/30/10

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ____ ■ SPECIAL FSS
☒ RWP # ERP-2010-007 ☐ WP # ____

LOCATION & EQUIPT. HFBR u/g utilities phase 3

Date 09/24/10 **TIME:** 1500

Trench #4 west

NORTH →

All samples were frisked & masslinned. All were ≤ or equal to bkgd. Bkgd. On Lud-3 was 100 cpm, Bkgd. On E-600 was 0 cpm. Sample locations are shown on map with orange flags.

INSTRUMENT

Model #	Serial #	CAL DUE
L-2221	144942	2-15-11
L-2221	211780	12/8/10
Lud-3	70090	5/19/11
E-600	01642	2/22/11

LEGEND
○ - SMEAR SURVEY LOCATION ▲ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
C̄ - CONTAMINATION * CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	CIK/LAS	5.	N/A
2. 3.		6.	
		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β,γ, ³H

1.	NA	8.	NA	15.	NA
2.		9.		16.	
3.		10.			
4.		11.		18.	
		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By: Hollander /Dove **Date:** 9/24/10 **Reviewed** **Date:** 9/29/10

ERP GAMMA ANALYSIS SUMMARY

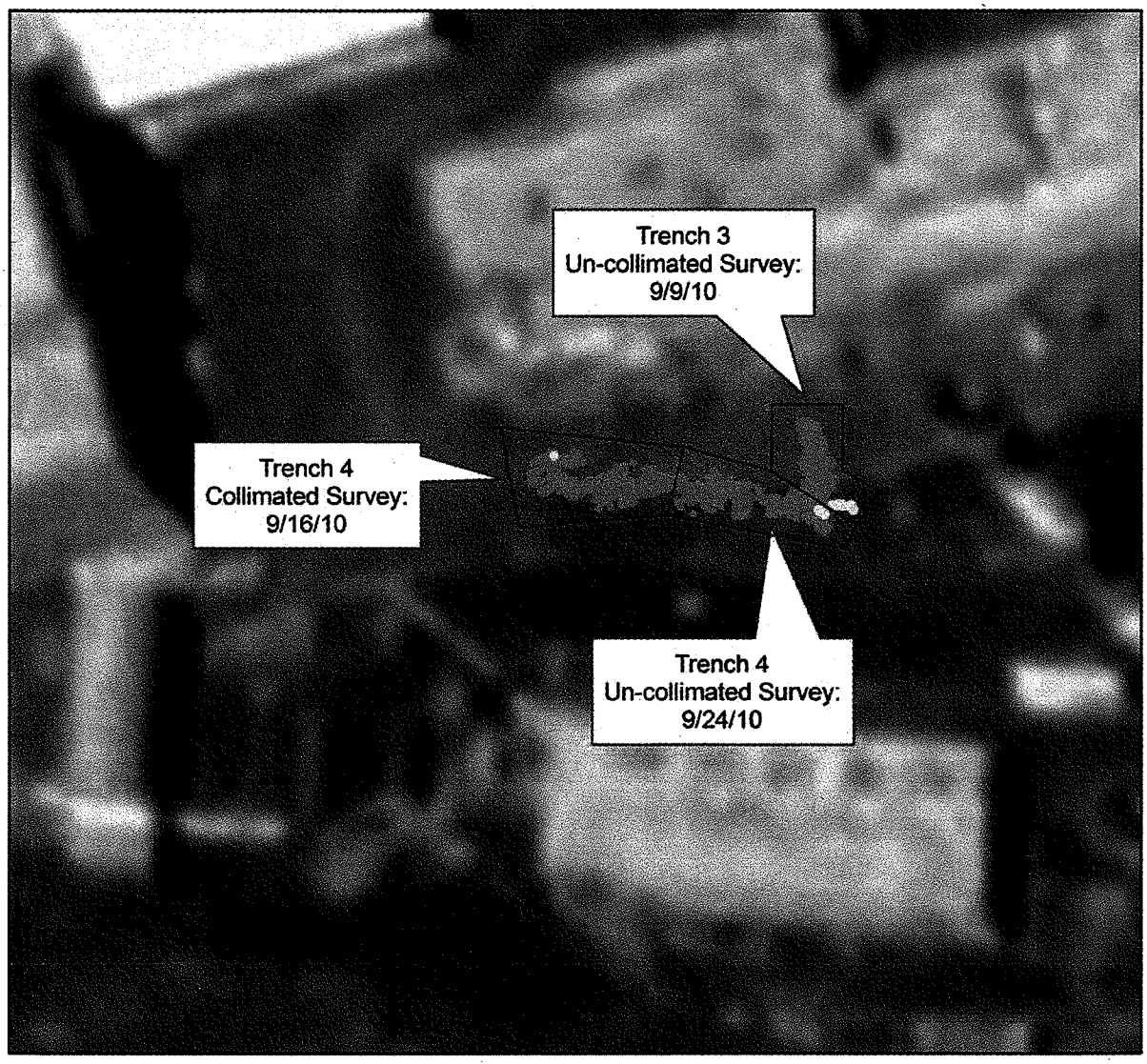
C.O.C. # N/A

COUNT DATE: **09/25/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	092510-001	1057	PHASE 3 TRENCH 4 FSS-001	BACKGROUND
2	092510-002	1019	PHASE 3 TRENCH 4 FSS-002	BACKGROUND
3	092510-003	1081	PHASE 3 TRENCH 4 FSS-003	^{137}Cs (0.06 pCi/gm) + BACKGROUND
4	092510-004	1077	PHASE 3 TRENCH 4 FSS-004	BACKGROUND
5	092510-005	1099	PHASE 3 TRENCH 4 FSS-005	BACKGROUND
6	092510-006	1069	PHASE 3 TRENCH 4 FSS-006	BACKGROUND
7	092510-007	1057	PHASE 3 TRENCH 4 FSS-007	BACKGROUND
8	092510-008	907	PHASE 3 TRENCH 4 FSS-008	BACKGROUND
9	092510-009	1033	PHASE 3 TRENCH 4 FSS-009	BACKGROUND
10	092510-010	1089	PHASE 3 TRENCH 4 FSS-010	BACKGROUND
11	092510-011	1052	PHASE 3 TRENCH 4 FSS-011	BACKGROUND
12	092510-012	1062	PHASE 3 TRENCH 4 FSS-012	BACKGROUND
13	092510-013	1055	PHASE 3 TRENCH 4 FSS-013	BACKGROUND
14	092510-014	1036	PHASE 3 TRENCH 4 FSS-014	BACKGROUND
15	092510-015	1039	PHASE 3 TRENCH 4 FSS-015	BACKGROUND
16	092510-016	973	PHASE 3 TRENCH 4 FSS-016	BACKGROUND
17	092510-017	1057	PHASE 3 TRENCH 4 FSS-017	^{137}Cs (0.05 pCi/gm) + BACKGROUND
18	092510-018	978	PHASE 3 TRENCH 4 FSS-017 DUPLICATE	BACKGROUND
19	092510-019	966	PHASE 3 TRENCH 4 FIELD BLANK	BACKGROUND
20				
21				
22				
23				
24				
25				

19 SAMPLES TOTAL



Coordinate System: NAD83, New York Long Island - Units: Feet

0 25 50 100 150 200 Feet

Legend

Gamma Count Rate

BARE (cpm)

- < 15,000
- 15,000 - 21,499
- ≥ 21,500

COLLIMATED (cpm)

- ≤ 5,000
- 5,001 - 7,199
- ≥ 7,200

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 3 Trench 4 - FINAL
September 24, 2010

ASL Prefix No. N/A

Page 1 of 2

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30539

Requires EDD ☑ DQL _____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE HOLLINGSHEAD	Name: DAN DOVE	Name: GEL
Life: No: N6455 Ext. 4839	Contact: ERP RCT	Address: 2040 SAVAGE RD
Acct. No: 63296/63299 Dept: ERP	Phone: X 4424	City: CHARLESTON St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHAFFER
1 HOLLINGSH@BNL.GOV	Sampler: SAME	Phone: 843-769-7376 X4505
2 MDUKE@BNL.GOV		Email/Fax:
Project Name: HFBR 46 UTILITIES PHASE III	Project Manager: M. PIZZUTO	Field Engineer: MIKE DUKE

Comments:

Type				Sample Information					Additional Sample Information					Analysis Requested												
LID	UID	Smp	Coll	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description	Cont. Vol./Units	Cont. Type	# of Cont.	Preservative	Alpha/Beta	Tritium	Gamma	Strontium 90	524.2	624	Nuclide-specific Alpha	PCBs	Metals			
	001	E	G	BNL/PHASE 3	0-0.5	9/24/10	1540	S	PHASE 3 TRENCH 4	500ml	P	1	NONE		✓	✓	✓									
	002						1542									✓										
	003						1545									✓										
	004						1547									✓										
	005						1550									✓										
	006						1552								✓	✓	✓									
	007						1554									✓										
	008						1557									✓										
	009						1600									✓										
	010						1603									✓										
	011						1606								✓	✓	✓									
	012						1610									✓										
	013						1612									✓										
	014						1614									✓										

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print MIKE HOLLINGSHEAD 9/27/10 1300	Print	Print
Signature	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print R. Mufe 9/27/10	Print	Print
Signature Federal Exp 1300	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ☑ Disposal by Lab
☐ Archive For _____ Months

Data Package: ☐ Full ☑ Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
☑ 7 Days ☐ Other ( )

RADIOLOGICAL SURVEY FORM
FS-SOP-1000

REASON FOR SURVEY
☐ ROUTINE ____ ☐ SPECIAL ____
■ RWP # 2010-erp-007 ☐ WP # ____

LOCATION & EQUIPT. HFBR U/G Utilities | **Date** 11/03/10 | **TIME:** 14:00

Phase 3 trench 5 FSS (final)

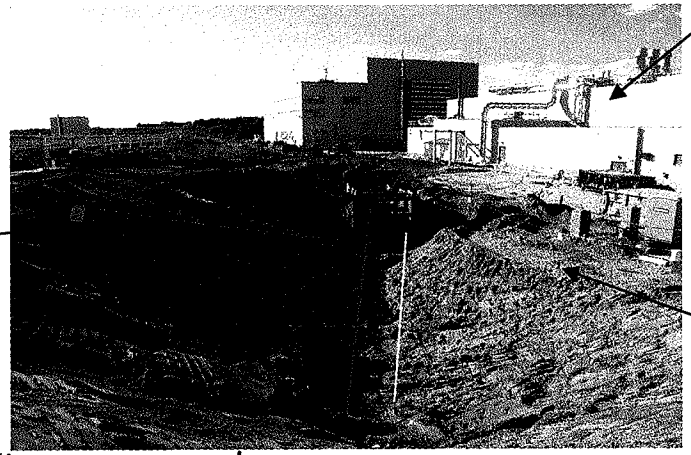
Performed remainder of trench 5 FSS .....20 soil samples obtained at 0-0.5 foot depth.....Gamma Walkover performed w/ trimble backpack unit w/ 2x2 probe uncollimated. All samples and mat'l masslined clean out of area.

Uncollimated 2x2 readings below at sample points 1-20

1—6900	6—7394	11—8626	16—9442
2—6948	7—7682	12—9447	17—9272
3—7467	8—8407	13—9036	18—9667
4—7136	9—8595	14—9224	19—9569
5—6723	10—9247	15—8879	20—11440

42" concrete duct and 14" s.s. acid line removed from this trench. Trench is approx. 80 feet long.

Samples 1-15 inside posted SCA going west to east and starting inside third trench box. Orange line is 42" duct and yellow line is acid line i/s trench.



INSTRUMENT

Model #	Serial #	CAL DUE
Trimble	138377	7/28/11
L-2221	211780	12/08/10
Lud-3	44141	1/29/11
N/A		

LEGEND
○ - SMEAR SURVEY LOCATION ▲ - AIR SAMPLE LOCATION
□ - MASSLINN SURVEY LOCATION # - DIRECT FRISK LOCA-
C̄ - CONTAMINATION ✻ CONTACT
XXXY/ZZZ XXX = contact reading Y = radiation type ZZZ = reading @ 30cm

AIRBORNE ACTIVITY SURVEY

Sample #	Duration	Flow Rate	Field Analysis cpm	Field Analysis µCi/cc	% DAC
N/A					

DOSE RATE (HIGHEST)

CONTACT READING	N/A
GENERAL AREA READING	N/A

MASSLINN SURVEY RESULTS (in dpm)

1.	<1k	5.	N/A
2.		6.	
3.		7.	
4.		8.	

SMEAR SURVEY RESULTS (dpm/100cm²) α, β-γ, ³H

1.	NA	8.	NA	15.	N/A
2.		9.		16.	
3.		10.			
4.		11.		18.	
		12.		19.	
6.		13.		20.	
7.		14.		21.	

Surveyed By Hollander **Date:** 11/03/10 **Reviewed By:** **Date:** 11-5-10

FS-SOP-1000
Attachment 9.2

Coordinate System: NAD83, New York Long Island - Units: Feet

0 75 150 300 450 600

Feet

Legend

Gamma Count Rate

BARE (cpm)

- < 15,000
- 15,000 - 21,499
- ≥ 21,500

GPS-Based Radiological Survey
Brookhaven National Laboratory
Phase 3 Trench 5 (FSS)
November 3, 2010

ERP GAMMA ANALYSIS SUMMARY

C.O.C. # N/A

COUNT DATE: **11/03/2010-A**

P. SULLIVAN - 631 897-3202

LINE #	SAMPLE #	WEIGHT (GRAMS)	SAMPLE DESCRIPTION / LOCATION	RESULTS
1	110310-001	940	PHASE 3 TRENCH 5 FSS 001	BACKGROUND
2	110310-002	907	PHASE 3 TRENCH 5 FSS 002	BACKGROUND
3	110310-003	867	PHASE 3 TRENCH 5 FSS 003	BACKGROUND
4	110310-004	942	PHASE 3 TRENCH 5 FSS 004	BACKGROUND
5	110310-005	988	PHASE 3 TRENCH 5 FSS 005	BACKGROUND
6	110310-006	998	PHASE 3 TRENCH 5 FSS 006	BACKGROUND
7	110310-007	1072	PHASE 3 TRENCH 5 FSS 007	BACKGROUND
8	110310-008	1009	PHASE 3 TRENCH 5 FSS 008	^{137}Cs (0.08 pCi/gm) + BACKGROUND
9	110310-009	1006	PHASE 3 TRENCH 5 FSS 009	BACKGROUND
10	110310-010	989	PHASE 3 TRENCH 5 FSS 010	BACKGROUND
11	110310-011	948	PHASE 3 TRENCH 5 FSS 011	BACKGROUND
12	110310-012	980	PHASE 3 TRENCH 5 FSS 012	BACKGROUND
13	110310-013	1005	PHASE 3 TRENCH 5 FSS 013	BACKGROUND
14	110310-014	1126	PHASE 3 TRENCH 5 FSS 013 DUPLICATE	BACKGROUND
15	110310-015	947	PHASE 3 TRENCH 5 FSS 014	BACKGROUND
16	110310-016	984	PHASE 3 TRENCH 5 FSS 015	BACKGROUND
17	110310-017	896	PHASE 3 TRENCH 5 FSS 016	BACKGROUND
18	110310-018	895	PHASE 3 TRENCH 5 FSS 017	BACKGROUND
19	110310-019	960	PHASE 3 TRENCH 5 FSS 018	BACKGROUND
20	110310-020	957	PHASE 3 TRENCH 5 FSS 019	BACKGROUND
21	110310-021	905	PHASE 3 TRENCH 5 FSS 020	BACKGROUND
22	110310-022	761	PHASE 3 TRENCH 5 FSS FIELD BLANK	^{137}Cs (0.16 pCi/gm) + BACKGROUND
23				
24				
25				

22 SAMPLES TOTAL

ASL Prefix No. N/A

Page 1 of 1

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30542

Requires EDD ☑ DQL ____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: Mike Hollander	Name: Mike Hollander	Name: GEL
Life No: N6455 Ext. 4539	Contact: ERD RCS	Address: 2040 Savage Rd
Acct. No: 65296/65277 Dept: ERD	Phone: x4539 — 508 273 5663	City: Charleston St: S.C. Zip: 29407
Email Reports To:	Email/Fax:	Contact: Heather Simmons
1 hollander@bnl.gov	Sampler: Same	Phone:
2 Lockwood@bnl.gov		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HFBR U/G Utilities Phase 3	Mike Bebe	John Marsicano

Comments:

Type				Sample Information					Additional Sample Information					Analysis Requested										
LID	UID	Smp	Coll	Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Name/Description	Cont. Vol./Units	Cont. Type	# of Cont.	Preservative	Alpha/Beta	Tritium	Gamma	Strontium – 90	524.2	624	Nuclide-specific Alpha U-233, 234/230, 232	PCBs	Metals LEAD ONLY		
	001	G	G	Bulkhead Mouse	0-0.5	11/3/10	1250	S	Phase 3 Trench 5 Sample 1	500 ml	P	1	none		✓	✓	✓						✓		
	002						1300		3						✓	✓	✓						✓		
	003						1305		5						✓	✓	✓						✓		
	004						1310		7						✓	✓	✓						✓		
	005						1314		11						✓	✓	✓						✓		
	006						1320		13						✓	✓	✓						✓		
	007						1325		15						✓	✓	✓						✓		
	008						1330		17						✓	✓	✓						✓		
	009						1340		19						✓	✓	✓						✓		
	010						1332		Field Dup (13)						✓	✓	✓						✓		
	011						1345		Field Blank						✓	✓	✓								
	012						1-15		Composite 1-8						✓	✓	✓				✓		✓		
	013						1718		Composite 9-15						✓	✓	✓				✓		✓		
	014						1730		Composite 16-20						✓	✓	✓				✓		✓		

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print Mike Hollander 11/4/10 1259	Print	Print
Signature	Signature	Signature
1 Received By/Date/Time	2 Received By/Date/Time	3 Received By/Date/Time
Print 11/4/10	Print	Print
Signature 1700	Signature	Signature

Contractor Lab Sample Disposal:
☐ Return To Client ● Disposal by Lab
☐ Archive For _____ Months

Data Package: ☐ Full ● Summary

Turn-Around Time Required:
☐ Rush (1 Day) ☐ 14 Days ☐ 30 Days
● 7 Days ☐ Other ( )

BNL F 3101D

Distribution WHITE (1) - Stays with Sample; PINK (2) - Lab or Other GREEN (3) - Returned to Client with Report GOLDENROD (4) - Field Copy - (Sampler)

ASL Prefix No. N/A

Page 2 of 2

BROOKHAVEN NATIONAL LABORATORY

Carrier/Waybill # _____

P.O. # _____

Chain of Custody No. 30539

Requires EDD ■ DQL _____

SAMPLING CHAIN OF CUSTODY

Analysis Requested By	Sampling Contractor	Analytical Laboratory
Name: MIKE Hollander	Name: DAN DOVE	Name: GEL
Life No: N6455 Ext. 4839	Contact: ERP PCT	Address: 2040 SAVAGE Rd.
Acct. No: 65296/65399 Dept: ERP	Phone: x 4424	City: CHARLESTON St: SC Zip: 29407
Email Reports To:	Email/Fax:	Contact: HEATHER SHAFFER
1 hollander@bnl.gov	Sampler: SAME	Phone: 843 - 769-7376 x4505
2 mduke@bnl.gov		Email/Fax:
Project Name:	Project Manager:	Field Engineer:
HFBR U/G Utilities PHASE III	M. PIZZUTO	MIKE DUKE

Comments: SAMPLES 021, 22, 023 PLEASE PERFORM ADD'L METAL ANALYSIS (COPPER, ZINC, NICKEL)

Type LID	Type UID	Smp	Coll	Sample Information: Site ID/Bldg/Life #	Depth/RWP	Date	Time	Matrix	Additional Sample Information: Name/Description	Cont. Vol./Units	Cont. Type	# of Cont	Preservative	Analysis Requested: Alpha/Beta	Tritium	Gamma	Strontium 90	524.2	624	Nuclide-specific Alpha (235, 238, Pu, 239/240)	PCBs	Metals (LEAD, MERCURY)
	015	C	G	BNL/PHASE 3	0-0.5	9/24/10	1618	S	PHASE 3 TRENCH 4	500 ml	P	1	NONE		J	J						
	016						1620					1			J	J						
	017						1622					1			J							
	018						1624					1			J	J	J					
	019						1635					1			J	J	J					
	020	E	C			9/27/10	0930		Composite	500 ml		1			J	J	J			J		J
	021	E	G	HFBR Tank Farm	0-2'	9/24/10	1505	S	HFBR Transfer SUB CORE		P	1	NONE		J	J	J					J
	022	E			2-4'		1515					1			J	J	J					J
	023	E			4-6'		1525					1			J	J	J					J

1 Relinquished By/Date/Time	2 Relinquished By/Date/Time	3 Relinquished By/Date/Time
Print Mikki Hollander 9/27/10	Print	Print
Signature 1300	Signature	Signature
1 Received By/Date/Time	**2 Received By/Date/Time**	**3 Received By/Date/Time**
Print R. Mike 9/27/10	Print	Print
Signature 1300	Signature	Signature

Contractor Lab Sample Disposal:
- ☐ Return To Client
- ■ Disposal by Lab
- ☐ Archive For _____ Months

Data Package: ☐ Full ■ Summary

Turn-Around Time Required:
- ☐ Rush (1 Day)
- ☐ 14 Days
- ☐ 30 Days
- ■ 7 Days
- ☐ Other ( )

Appendix C

HFBR Underground Utilities
RESRAD Summary Reports

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Pu-238 (Source: FGR 12)	1.513E-04	1.513E-04	DCF1(11)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(12)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(13)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(14)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(15)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(16)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(17)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(18)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(5)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(6)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(7)
B-1	U-234	1.320E-01	1.320E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(5)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(6)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(7)
D-1	U-234	2.830E-04	2.830E-04	DCF3(8)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34				
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(6,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(6,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(6,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract

File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	4.000E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Pu-238	2.250E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E-03	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Sr-90	9.000E-02	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	6.230E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.889E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.471E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.618E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.574E-02	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.082E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.349E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.614E-03	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.380E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.000E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-05	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

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Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	4.000E-02
Thickness:	5.00 meters	Pu-238	2.250E-01
Cover Depth:	0.00 meters	Ra-226	1.000E-03
		Sr-90	9.000E-02

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	5.521E-01	5.621E-01	5.901E-01	5.939E-01	1.609E-01	6.930E-02	1.528E-02	1.034E-02
M(t):	3.681E-02	3.747E-02	3.934E-02	3.959E-02	1.073E-02	4.620E-03	1.018E-03	6.891E-04

Maximum TDOSE(t): 6.025E-01 mrem/yr at t = 9.17 ñ 0.02 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.172E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.356E-02	0.1055	1.806E-08	0.0000	0.000E+00	0.0000	5.551E-03	0.0092	0.000E+00	0.0000	0.000E+00	0.0000	5.240E-05	0.0001
Pu-238	1.994E-05	0.0000	1.448E-03	0.0024	0.000E+00	0.0000	5.795E-02	0.0962	0.000E+00	0.0000	0.000E+00	0.0000	2.188E-02	0.0363
Ra-226	6.556E-03	0.0109	2.578E-07	0.0000	0.000E+00	0.0000	6.224E-03	0.0103	0.000E+00	0.0000	0.000E+00	0.0000	1.048E-04	0.0002
Sr-90	8.068E-04	0.0013	1.295E-06	0.0000	0.000E+00	0.0000	2.225E-01	0.3693	0.000E+00	0.0000	0.000E+00	0.0000	2.798E-04	0.0005
Total	7.095E-02	0.1177	1.450E-03	0.0024	0.000E+00	0.0000	2.922E-01	0.4850	0.000E+00	0.0000	0.000E+00	0.0000	2.232E-02	0.0370

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.172E+00 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.114E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.546E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.917E-02	0.1148
Pu-238	5.160E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.789E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.131E-02	0.1349
Ra-226	1.581E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.145E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.290E-02	0.0214
Sr-90	1.999E-01	0.3318	0.000E+00	0.0000	0.000E+00	0.0000	1.565E-02	0.0260	0.000E+00	0.0000	0.000E+00	0.0000	4.392E-01	0.7288
Total	1.999E-01	0.3318	0.000E+00	0.0000	0.000E+00	0.0000	1.565E-02	0.0260	0.000E+00	0.0000	0.000E+00	0.0000	6.025E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.878E-02	0.1427	2.238E-08	0.0000	0.000E+00	0.0000	6.879E-03	0.0125	0.000E+00	0.0000	0.000E+00	0.0000	6.494E-05	0.0001
Pu-238	2.147E-05	0.0000	1.559E-03	0.0028	0.000E+00	0.0000	6.239E-02	0.1130	0.000E+00	0.0000	0.000E+00	0.0000	2.356E-02	0.0427
Ra-226	6.591E-03	0.0119	1.588E-07	0.0000	0.000E+00	0.0000	4.711E-03	0.0085	0.000E+00	0.0000	0.000E+00	0.0000	4.705E-05	0.0001
Sr-90	1.271E-03	0.0023	2.039E-06	0.0000	0.000E+00	0.0000	3.505E-01	0.6347	0.000E+00	0.0000	0.000E+00	0.0000	4.407E-04	0.0008
Total	8.666E-02	0.1570	1.561E-03	0.0028	0.000E+00	0.0000	4.244E-01	0.7687	0.000E+00	0.0000	0.000E+00	0.0000	2.411E-02	0.0437

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.335E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.869E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.572E-02	0.1553
Pu-238	2.736E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.753E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.753E-02	0.1585
Ra-226	7.214E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.626E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.135E-02	0.0206
Sr-90	1.429E-02	0.0259	0.000E+00	0.0000	0.000E+00	0.0000	1.067E-03	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	3.675E-01	0.6657
Total	1.429E-02	0.0259	0.000E+00	0.0000	0.000E+00	0.0000	1.067E-03	0.0019	0.000E+00	0.0000	0.000E+00	0.0000	5.521E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.695E-02	0.1369	2.187E-08	0.0000	0.000E+00	0.0000	6.720E-03	0.0120	0.000E+00	0.0000	0.000E+00	0.0000	6.344E-05	0.0001
Pu-238	2.130E-05	0.0000	1.547E-03	0.0028	0.000E+00	0.0000	6.189E-02	0.1101	0.000E+00	0.0000	0.000E+00	0.0000	2.337E-02	0.0416
Ra-226	6.587E-03	0.0117	1.711E-07	0.0000	0.000E+00	0.0000	4.901E-03	0.0087	0.000E+00	0.0000	0.000E+00	0.0000	5.422E-05	0.0001
Sr-90	1.209E-03	0.0022	1.941E-06	0.0000	0.000E+00	0.0000	3.336E-01	0.5934	0.000E+00	0.0000	0.000E+00	0.0000	4.194E-04	0.0007
Total	8.477E-02	0.1508	1.549E-03	0.0028	0.000E+00	0.0000	4.071E-01	0.7242	0.000E+00	0.0000	0.000E+00	0.0000	2.391E-02	0.0425

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	3.946E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.794E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.374E-02	0.1490
Pu-238	8.148E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.535E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.683E-02	0.1545
Ra-226	4.775E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.319E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.154E-02	0.0205
Sr-90	4.161E-02	0.0740	0.000E+00	0.0000	0.000E+00	0.0000	3.205E-03	0.0057	0.000E+00	0.0000	0.000E+00	0.0000	3.800E-01	0.6760
Total	4.161E-02	0.0740	0.000E+00	0.0000	0.000E+00	0.0000	3.205E-03	0.0057	0.000E+00	0.0000	0.000E+00	0.0000	5.621E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.008E-02	0.1188	1.991E-08	0.0000	0.000E+00	0.0000	6.120E-03	0.0104	0.000E+00	0.0000	0.000E+00	0.0000	5.777E-05	0.0001
Pu-238	2.062E-05	0.0000	1.498E-03	0.0025	0.000E+00	0.0000	5.993E-02	0.1016	0.000E+00	0.0000	0.000E+00	0.0000	2.263E-02	0.0383
Ra-226	6.572E-03	0.0111	2.165E-07	0.0000	0.000E+00	0.0000	5.593E-03	0.0095	0.000E+00	0.0000	0.000E+00	0.0000	8.066E-05	0.0001
Sr-90	9.920E-04	0.0017	1.592E-06	0.0000	0.000E+00	0.0000	2.736E-01	0.4637	0.000E+00	0.0000	0.000E+00	0.0000	3.440E-04	0.0006
Total	7.766E-02	0.1316	1.500E-03	0.0025	0.000E+00	0.0000	3.452E-01	0.5851	0.000E+00	0.0000	0.000E+00	0.0000	2.311E-02	0.0392

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.323E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.637E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.626E-02	0.1292
Pu-238	2.928E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.029E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.408E-02	0.1425
Ra-226	5.598E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.034E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.225E-02	0.0208
Sr-90	1.322E-01	0.2241	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-02	0.0175	0.000E+00	0.0000	0.000E+00	0.0000	4.175E-01	0.7075
Total	1.322E-01	0.2241	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-02	0.0175	0.000E+00	0.0000	0.000E+00	0.0000	5.901E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.234E-02	0.1050	1.772E-08	0.0000	0.000E+00	0.0000	5.444E-03	0.0092	0.000E+00	0.0000	0.000E+00	0.0000	5.139E-05	0.0001
Pu-238	1.981E-05	0.0000	1.439E-03	0.0024	0.000E+00	0.0000	5.757E-02	0.0969	0.000E+00	0.0000	0.000E+00	0.0000	2.174E-02	0.0366
Ra-226	6.553E-03	0.0110	2.654E-07	0.0000	0.000E+00	0.0000	6.339E-03	0.0107	0.000E+00	0.0000	0.000E+00	0.0000	1.092E-04	0.0002
Sr-90	7.744E-04	0.0013	1.242E-06	0.0000	0.000E+00	0.0000	2.136E-01	0.3596	0.000E+00	0.0000	0.000E+00	0.0000	2.686E-04	0.0005
Total	6.969E-02	0.1173	1.440E-03	0.0024	0.000E+00	0.0000	2.829E-01	0.4764	0.000E+00	0.0000	0.000E+00	0.0000	2.216E-02	0.0373

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.251E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.647E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.784E-02	0.1142
Pu-238	5.588E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.127E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.077E-02	0.1360
Ra-226	1.831E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.327E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.302E-02	0.0219
Sr-90	2.018E-01	0.3398	0.000E+00	0.0000	0.000E+00	0.0000	1.585E-02	0.0267	0.000E+00	0.0000	0.000E+00	0.0000	4.323E-01	0.7279
Total	2.018E-01	0.3399	0.000E+00	0.0000	0.000E+00	0.0000	1.585E-02	0.0267	0.000E+00	0.0000	0.000E+00	0.0000	5.939E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.446E-02	0.1520	6.950E-09	0.0000	0.000E+00	0.0000	2.136E-03	0.0133	0.000E+00	0.0000	0.000E+00	0.0000	2.016E-05	0.0001
Pu-238	1.436E-05	0.0001	1.043E-03	0.0065	0.000E+00	0.0000	4.173E-02	0.2594	0.000E+00	0.0000	0.000E+00	0.0000	1.575E-02	0.0979
Ra-226	6.400E-03	0.0398	4.631E-07	0.0000	0.000E+00	0.0000	9.326E-03	0.0580	0.000E+00	0.0000	0.000E+00	0.0000	2.250E-04	0.0014
Sr-90	1.067E-04	0.0007	1.713E-07	0.0000	0.000E+00	0.0000	2.944E-02	0.1830	0.000E+00	0.0000	0.000E+00	0.0000	3.702E-05	0.0002
Total	3.098E-02	0.1926	1.043E-03	0.0065	0.000E+00	0.0000	8.263E-02	0.5136	0.000E+00	0.0000	0.000E+00	0.0000	1.604E-02	0.0997

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.278E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.144E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.662E-02	0.1654
Pu-238	2.121E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.475E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.856E-02	0.3640
Ra-226	1.963E-04	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	1.431E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.616E-02	0.1005
Sr-90	2.778E-02	0.1727	0.000E+00	0.0000	0.000E+00	0.0000	2.182E-03	0.0136	0.000E+00	0.0000	0.000E+00	0.0000	5.954E-02	0.3701
Total	2.800E-02	0.1740	0.000E+00	0.0000	0.000E+00	0.0000	2.198E-03	0.0137	0.000E+00	0.0000	0.000E+00	0.0000	1.609E-01	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.593E-03	0.1096	2.158E-09	0.0000	0.000E+00	0.0000	6.631E-04	0.0096	0.000E+00	0.0000	0.000E+00	0.0000	6.259E-06	0.0001
Pu-238	9.614E-06	0.0001	6.974E-04	0.0101	0.000E+00	0.0000	2.790E-02	0.4027	0.000E+00	0.0000	0.000E+00	0.0000	1.054E-02	0.1520
Ra-226	6.213E-03	0.0897	5.123E-07	0.0000	0.000E+00	0.0000	1.002E-02	0.1446	0.000E+00	0.0000	0.000E+00	0.0000	2.549E-04	0.0037
Sr-90	8.965E-06	0.0001	1.438E-08	0.0000	0.000E+00	0.0000	2.473E-03	0.0357	0.000E+00	0.0000	0.000E+00	0.0000	3.109E-06	0.0000
Total	1.382E-02	0.1995	6.979E-04	0.0101	0.000E+00	0.0000	4.106E-02	0.5925	0.000E+00	0.0000	0.000E+00	0.0000	1.080E-02	0.1558

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.666E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.960E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.265E-03	0.1193
Pu-238	3.167E-05	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	2.259E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.918E-02	0.5654
Ra-226	3.449E-04	0.0050	0.000E+00	0.0000	0.000E+00	0.0000	2.515E-05	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	1.686E-02	0.2432
Sr-90	2.327E-03	0.0336	0.000E+00	0.0000	0.000E+00	0.0000	1.828E-04	0.0026	0.000E+00	0.0000	0.000E+00	0.0000	4.994E-03	0.0721
Total	2.706E-03	0.0390	0.000E+00	0.0000	0.000E+00	0.0000	2.104E-04	0.0030	0.000E+00	0.0000	0.000E+00	0.0000	6.930E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.554E-07	0.0000	1.862E-13	0.0000	0.000E+00	0.0000	5.723E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.402E-10	0.0000
Pu-238	5.120E-07	0.0000	2.799E-05	0.0018	0.000E+00	0.0000	1.119E-03	0.0732	0.000E+00	0.0000	0.000E+00	0.0000	4.218E-04	0.0276
Ra-226	4.897E-03	0.3206	4.168E-07	0.0000	0.000E+00	0.0000	8.096E-03	0.5300	0.000E+00	0.0000	0.000E+00	0.0000	2.085E-04	0.0136
Sr-90	2.220E-14	0.0000	3.562E-17	0.0000	0.000E+00	0.0000	6.123E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.700E-15	0.0000
Total	4.899E-03	0.3206	2.841E-05	0.0019	0.000E+00	0.0000	9.215E-03	0.6032	0.000E+00	0.0000	0.000E+00	0.0000	6.303E-04	0.0413

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.226E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.015E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.145E-07	0.0000
Pu-238	2.343E-05	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	1.705E-06	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	1.594E-03	0.1044
Ra-226	4.467E-04	0.0292	0.000E+00	0.0000	0.000E+00	0.0000	3.258E-05	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	1.368E-02	0.8956
Sr-90	5.609E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.406E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.220E-11	0.0000
Total	4.701E-04	0.0308	0.000E+00	0.0000	0.000E+00	0.0000	3.428E-05	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	1.528E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.452E-12	0.0000	1.549E-18	0.0000	0.000E+00	0.0000	4.761E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.495E-15	0.0000
Pu-238	4.394E-07	0.0000	5.469E-07	0.0001	0.000E+00	0.0000	2.187E-05	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	7.744E-06	0.0007
Ra-226	3.637E-03	0.3519	3.096E-07	0.0000	0.000E+00	0.0000	6.013E-03	0.5817	0.000E+00	0.0000	0.000E+00	0.0000	1.548E-04	0.0150
Sr-90	3.879E-25	0.0000	6.224E-28	0.0000	0.000E+00	0.0000	1.070E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.345E-25	0.0000
Total	3.638E-03	0.3519	8.565E-07	0.0001	0.000E+00	0.0000	6.035E-03	0.5838	0.000E+00	0.0000	0.000E+00	0.0000	1.626E-04	0.0157

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.218E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.957E-12	0.0000
Pu-238	8.758E-06	0.0008	0.000E+00	0.0000	0.000E+00	0.0000	6.381E-07	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	4.000E-05	0.0039
Ra-226	4.583E-04	0.0443	0.000E+00	0.0000	0.000E+00	0.0000	3.343E-05	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	1.030E-02	0.9961
Sr-90	9.371E-23	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.361E-24	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.086E-22	0.0000
Total	4.670E-04	0.0452	0.000E+00	0.0000	0.000E+00	0.0000	3.407E-05	0.0033	0.000E+00	0.0000	0.000E+00	0.0000	1.034E-02	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	2.143E+00	2.093E+00	1.906E+00	1.696E+00	6.654E-01	2.066E-01	1.786E-05	1.489E-10
Pu-238	Pu-238	1.840E-09	7.158E-10	7.101E-10	6.876E-10	6.605E-10	4.789E-10	3.203E-10	1.285E-11	2.310E-13
Pu-238	Pu-238	1.000E+00	3.890E-01	3.859E-01	3.737E-01	3.590E-01	2.602E-01	1.741E-01	6.986E-03	1.255E-04
Pu-238	U-234	1.000E+00	1.017E-07	3.141E-07	1.212E-06	2.434E-06	1.559E-05	3.803E-05	9.864E-05	4.589E-05
Pu-238	Th-230	1.000E+00	3.360E-13	2.233E-12	2.781E-11	9.896E-11	2.009E-09	6.847E-09	6.364E-08	1.067E-07
Pu-238	Ra-226+D	1.000E+00	5.101E-15	7.592E-14	3.400E-12	2.329E-11	2.349E-09	1.643E-08	8.983E-07	3.281E-06
Pu-238	Pb-210+D	1.000E+00	6.173E-15	1.851E-14	1.677E-13	1.262E-12	4.428E-10	5.185E-09	6.847E-07	2.967E-06
Pu-238	äDSR(j)		3.890E-01	3.859E-01	3.737E-01	3.590E-01	2.603E-01	1.741E-01	7.086E-03	1.778E-04
Ra-226+D	Ra-226+D	1.000E+00	1.123E+01	1.122E+01	1.120E+01	1.116E+01	1.090E+01	1.058E+01	8.345E+00	6.202E+00
Ra-226+D	Pb-210+D	1.000E+00	1.190E-01	3.203E-01	1.056E+00	1.857E+00	5.262E+00	6.274E+00	5.337E+00	4.095E+00
Ra-226+D	äDSR(j)		1.135E+01	1.154E+01	1.225E+01	1.302E+01	1.616E+01	1.686E+01	1.368E+01	1.030E+01
Sr-90+D	Sr-90+D	1.000E+00	4.084E+00	4.222E+00	4.639E+00	4.803E+00	6.616E-01	5.549E-02	1.356E-10	2.317E-21

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	7.000E+00	7.165E+00	7.868E+00	8.844E+00	2.254E+01	7.259E+01	8.398E+05	1.007E+11
Pu-238	3.856E+01	3.887E+01	4.014E+01	4.179E+01	5.763E+01	8.614E+01	2.117E+03	8.438E+04
Ra-226	1.322E+00	1.299E+00	1.224E+00	1.152E+00	9.281E-01	8.899E-01	1.096E+00	1.457E+00
Sr-90	3.673E+00	3.553E+00	3.234E+00	3.123E+00	2.267E+01	2.703E+02	1.106E+11	*1.365E+14

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 9.17 ñ 0.02 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin) (pCi/g)	G(i,tmin) (pCi/g)	DSR(i,tmax) (pCi/g)	G(i,tmax) (pCi/g)
Cs-137	4.000E-02	0.000E+00	2.143E+00	7.000E+00	1.729E+00	8.674E+00
Pu-238	2.250E-01	0.000E+00	3.890E-01	3.856E+01	3.614E-01	4.151E+01
Ra-226	1.000E-03	101.5 ñ 0.2	1.686E+01	8.899E-01	1.290E+01	1.163E+00
Sr-90	9.000E-02	9.36 ñ 0.02	4.881E+00	3.073E+00	4.879E+00	3.074E+00

Summary : UG util-Res-Non-Farm-2000m2-BKG subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-BKG SUB.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide	Parent	THF(i)	DOSE(j,t), mrem/yr							
(j)	(i)	t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	8.572E-02	8.374E-02	7.626E-02	6.784E-02	2.662E-02	8.265E-03	7.145E-07	5.957E-12
Pu-238	Pu-238	1.840E-09	1.611E-10	1.598E-10	1.547E-10	1.486E-10	1.077E-10	7.208E-11	2.892E-12	5.196E-14
Pu-238	Pu-238	1.000E+00	8.753E-02	8.683E-02	8.408E-02	8.077E-02	5.856E-02	3.917E-02	1.572E-03	2.824E-05
Pu-238	äDOSE(j)		8.753E-02	8.683E-02	8.408E-02	8.077E-02	5.856E-02	3.917E-02	1.572E-03	2.824E-05
U-234	Pu-238	1.000E+00	2.289E-08	7.067E-08	2.726E-07	5.476E-07	3.509E-06	8.557E-06	2.219E-05	1.033E-05
Th-230	Pu-238	1.000E+00	7.561E-14	5.025E-13	6.256E-12	2.227E-11	4.520E-10	1.541E-09	1.432E-08	2.401E-08
Ra-226	Pu-238	1.000E+00	1.148E-15	1.708E-14	7.650E-13	5.241E-12	5.285E-10	3.697E-09	2.021E-07	7.382E-07
Ra-226	Ra-226	1.000E+00	1.123E-02	1.122E-02	1.120E-02	1.116E-02	1.090E-02	1.058E-02	8.345E-03	6.202E-03
Ra-226	äDOSE(j)		1.123E-02	1.122E-02	1.120E-02	1.116E-02	1.090E-02	1.058E-02	8.345E-03	6.202E-03
Pb-210	Pu-238	1.000E+00	1.389E-15	4.165E-15	3.773E-14	2.840E-13	9.962E-11	1.167E-09	1.541E-07	6.676E-07
Pb-210	Ra-226	1.000E+00	1.190E-04	3.203E-04	1.056E-03	1.857E-03	5.262E-03	6.274E-03	5.337E-03	4.095E-03
Pb-210	äDOSE(j)		1.190E-04	3.203E-04	1.056E-03	1.857E-03	5.262E-03	6.274E-03	5.337E-03	4.096E-03
Sr-90	Sr-90	1.000E+00	3.675E-01	3.800E-01	4.175E-01	4.323E-01	5.954E-02	4.994E-03	1.220E-11	2.086E-22

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide	Parent	THF(i)	S(j,t), pCi/g							
(j)	(i)	t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	4.000E-02	3.908E-02	3.558E-02	3.166E-02	1.242E-02	3.855E-03	3.328E-07	2.769E-12
Pu-238	Pu-238	1.840E-09	4.140E-10	4.107E-10	3.977E-10	3.820E-10	2.769E-10	1.851E-10	7.406E-12	1.325E-13
Pu-238	Pu-238	1.000E+00	2.250E-01	2.232E-01	2.161E-01	2.076E-01	1.505E-01	1.006E-01	4.025E-03	7.200E-05
Pu-238	äS(j):		2.250E-01	2.232E-01	2.161E-01	2.076E-01	1.505E-01	1.006E-01	4.025E-03	7.200E-05
U-234	Pu-238	1.000E+00	0.000E+00	6.348E-07	3.113E-06	6.079E-06	2.516E-05	4.003E-05	4.242E-05	1.966E-05
Th-230	Pu-238	1.000E+00	0.000E+00	2.862E-12	7.063E-11	2.780E-10	6.131E-09	2.110E-08	1.968E-07	3.298E-07
Ra-226	Pu-238	1.000E+00	0.000E+00	4.135E-16	5.116E-14	4.041E-13	4.570E-11	3.239E-10	1.777E-08	6.475E-08
Ra-226	Ra-226	1.000E+00	1.000E-03	9.994E-04	9.970E-04	9.941E-04	9.707E-04	9.422E-04	7.427E-04	5.515E-04
Ra-226	äS(j):		1.000E-03	9.994E-04	9.970E-04	9.941E-04	9.707E-04	9.422E-04	7.427E-04	5.516E-04
Pb-210	Pu-238	1.000E+00	0.000E+00	3.195E-18	1.931E-15	2.965E-14	1.359E-11	1.539E-10	1.516E-08	5.994E-08
Pb-210	Ra-226	1.000E+00	0.000E+00	3.058E-05	1.434E-04	2.653E-04	7.625E-04	8.949E-04	7.376E-04	5.478E-04
Pb-210	äS(j):		0.000E+00	3.058E-05	1.434E-04	2.653E-04	7.625E-04	8.949E-04	7.376E-04	5.478E-04
Sr-90	Sr-90	1.000E+00	9.000E-02	8.565E-02	7.025E-02	5.484E-02	7.559E-03	6.349E-04	1.572E-12	2.747E-23

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 5.52 seconds

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(1)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(3)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(4)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(5)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(6)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(7)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(8)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(9)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(10)
A-1	Pu-238 (Source: FGR 12)	1.513E-04	1.513E-04	DCF1(11)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(12)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(13)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(14)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(15)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(16)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(17)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(18)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(2)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(5)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(6)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(7)
B-1	U-234	1.320E-01	1.320E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(2)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(5)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(6)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(7)
D-1	U-234	2.830E-04	2.830E-04	DCF3(8)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(2,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(2,3)
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(6,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(6,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)
D-5				
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(6,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
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Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	2.000E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	2.500E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	5.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	5.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	5.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	4.000E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Pu-238	2.250E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Ra-226	3.500E-01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Sr-90	9.000E-02	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(6)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.300E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.400E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.900E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	6.230E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	4.600E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.230E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.660E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.300E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.400E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.000E+04	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	4.800E-03	2.000E-02	---	HGWT

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone b parameter	4.900E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.800E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	0.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.660E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.300E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.400E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.900E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	5.000E+03	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.800E+02	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.889E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	5.500E+02	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.471E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.618E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	3.000E+00	3.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.574E-02	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.082E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.349E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.614E-03	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	4.380E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.000E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-05	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	2000.00 square meters	Cs-137	4.000E-02
Thickness:	5.00 meters	Pu-238	2.250E-01
Cover Depth:	0.00 meters	Ra-226	3.500E-01
		Sr-90	9.000E-02

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
TDOSE(t):	4.513E+00	4.591E+00	4.866E+00	5.138E+00	5.802E+00	5.952E+00	4.790E+00	3.604E+00
M(t):	3.009E-01	3.061E-01	3.244E-01	3.425E-01	3.868E-01	3.968E-01	3.194E-01	2.403E-01

Maximum TDOSE(t): 5.954E+00 mrem/yr at t = 93.6 ñ 0.2 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.358E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	8.824E-03	0.0015	2.507E-09	0.0000	0.000E+00	0.0000	7.706E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	7.274E-06	0.0000
Pu-238	1.012E-05	0.0000	7.344E-04	0.0001	0.000E+00	0.0000	2.939E-02	0.0049	0.000E+00	0.0000	0.000E+00	0.0000	1.109E-02	0.0019
Ra-226	2.183E+00	0.3666	1.787E-04	0.0000	0.000E+00	0.0000	3.500E+00	0.5878	0.000E+00	0.0000	0.000E+00	0.0000	8.879E-02	0.0149
Sr-90	1.232E-05	0.0000	1.978E-08	0.0000	0.000E+00	0.0000	3.399E-03	0.0006	0.000E+00	0.0000	0.000E+00	0.0000	4.274E-06	0.0000
Total	2.192E+00	0.3681	9.131E-04	0.0002	0.000E+00	0.0000	3.533E+00	0.5934	0.000E+00	0.0000	0.000E+00	0.0000	9.990E-02	0.0168

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.358E+01 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.897E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.130E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.605E-03	0.0016
Pu-238	3.070E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.186E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.126E-02	0.0069
Ra-226	1.164E-01	0.0195	0.000E+00	0.0000	0.000E+00	0.0000	8.485E-03	0.0014	0.000E+00	0.0000	0.000E+00	0.0000	5.896E+00	0.9903
Sr-90	3.199E-03	0.0005	0.000E+00	0.0000	0.000E+00	0.0000	2.513E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.866E-03	0.0012
Total	1.196E-01	0.0201	0.000E+00	0.0000	0.000E+00	0.0000	8.739E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	5.954E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.878E-02	0.0175	2.238E-08	0.0000	0.000E+00	0.0000	6.879E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	6.494E-05	0.0000
Pu-238	2.147E-05	0.0000	1.559E-03	0.0003	0.000E+00	0.0000	6.239E-02	0.0138	0.000E+00	0.0000	0.000E+00	0.0000	2.356E-02	0.0052
Ra-226	2.307E+00	0.5112	5.559E-05	0.0000	0.000E+00	0.0000	1.649E+00	0.3653	0.000E+00	0.0000	0.000E+00	0.0000	1.647E-02	0.0036
Sr-90	1.271E-03	0.0003	2.039E-06	0.0000	0.000E+00	0.0000	3.505E-01	0.0777	0.000E+00	0.0000	0.000E+00	0.0000	4.407E-04	0.0001
Total	2.387E+00	0.5289	1.617E-03	0.0004	0.000E+00	0.0000	2.068E+00	0.4583	0.000E+00	0.0000	0.000E+00	0.0000	4.053E-02	0.0090

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.335E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.869E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.572E-02	0.0190
Pu-238	2.736E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.753E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.753E-02	0.0194
Ra-226	2.525E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.619E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.972E+00	0.8802
Sr-90	1.429E-02	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	1.067E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	3.675E-01	0.0814
Total	1.431E-02	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	1.069E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	4.513E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.695E-02	0.0168	2.187E-08	0.0000	0.000E+00	0.0000	6.720E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	6.344E-05	0.0000
Pu-238	2.130E-05	0.0000	1.547E-03	0.0003	0.000E+00	0.0000	6.189E-02	0.0135	0.000E+00	0.0000	0.000E+00	0.0000	2.337E-02	0.0051
Ra-226	2.305E+00	0.5022	5.989E-05	0.0000	0.000E+00	0.0000	1.715E+00	0.3737	0.000E+00	0.0000	0.000E+00	0.0000	1.898E-02	0.0041
Sr-90	1.209E-03	0.0003	1.941E-06	0.0000	0.000E+00	0.0000	3.336E-01	0.0727	0.000E+00	0.0000	0.000E+00	0.0000	4.194E-04	0.0001
Total	2.384E+00	0.5192	1.609E-03	0.0004	0.000E+00	0.0000	2.118E+00	0.4613	0.000E+00	0.0000	0.000E+00	0.0000	4.283E-02	0.0093

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	3.946E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.794E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.374E-02	0.0182
Pu-238	8.148E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.535E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.683E-02	0.0189
Ra-226	1.671E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.162E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.040E+00	0.8801
Sr-90	4.161E-02	0.0091	0.000E+00	0.0000	0.000E+00	0.0000	3.205E-03	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	3.800E-01	0.0828
Total	4.178E-02	0.0091	0.000E+00	0.0000	0.000E+00	0.0000	3.217E-03	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	4.591E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.008E-02	0.0144	1.991E-08	0.0000	0.000E+00	0.0000	6.120E-03	0.0013	0.000E+00	0.0000	0.000E+00	0.0000	5.777E-05	0.0000
Pu-238	2.062E-05	0.0000	1.498E-03	0.0003	0.000E+00	0.0000	5.993E-02	0.0123	0.000E+00	0.0000	0.000E+00	0.0000	2.263E-02	0.0047
Ra-226	2.300E+00	0.4727	7.577E-05	0.0000	0.000E+00	0.0000	1.958E+00	0.4023	0.000E+00	0.0000	0.000E+00	0.0000	2.823E-02	0.0058
Sr-90	9.920E-04	0.0002	1.592E-06	0.0000	0.000E+00	0.0000	2.736E-01	0.0562	0.000E+00	0.0000	0.000E+00	0.0000	3.440E-04	0.0001
Total	2.371E+00	0.4873	1.575E-03	0.0003	0.000E+00	0.0000	2.297E+00	0.4721	0.000E+00	0.0000	0.000E+00	0.0000	5.126E-02	0.0105

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+00 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.323E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.637E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.626E-02	0.0157
Pu-238	2.928E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.029E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.408E-02	0.0173
Ra-226	1.959E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	1.412E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.288E+00	0.8813
Sr-90	1.322E-01	0.0272	0.000E+00	0.0000	0.000E+00	0.0000	1.033E-02	0.0021	0.000E+00	0.0000	0.000E+00	0.0000	4.175E-01	0.0858
Total	1.342E-01	0.0276	0.000E+00	0.0000	0.000E+00	0.0000	1.047E-02	0.0022	0.000E+00	0.0000	0.000E+00	0.0000	4.866E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.234E-02	0.0121	1.772E-08	0.0000	0.000E+00	0.0000	5.444E-03	0.0011	0.000E+00	0.0000	0.000E+00	0.0000	5.139E-05	0.0000
Pu-238	1.981E-05	0.0000	1.439E-03	0.0003	0.000E+00	0.0000	5.757E-02	0.0112	0.000E+00	0.0000	0.000E+00	0.0000	2.174E-02	0.0042
Ra-226	2.293E+00	0.4464	9.288E-05	0.0000	0.000E+00	0.0000	2.219E+00	0.4318	0.000E+00	0.0000	0.000E+00	0.0000	3.822E-02	0.0074
Sr-90	7.744E-04	0.0002	1.242E-06	0.0000	0.000E+00	0.0000	2.136E-01	0.0416	0.000E+00	0.0000	0.000E+00	0.0000	2.686E-04	0.0001
Total	2.357E+00	0.4587	1.533E-03	0.0003	0.000E+00	0.0000	2.495E+00	0.4856	0.000E+00	0.0000	0.000E+00	0.0000	6.027E-02	0.0117

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.251E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.647E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.784E-02	0.0132
Pu-238	5.588E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.127E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.077E-02	0.0157
Ra-226	6.408E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	4.646E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	4.557E+00	0.8869
Sr-90	2.018E-01	0.0393	0.000E+00	0.0000	0.000E+00	0.0000	1.585E-02	0.0031	0.000E+00	0.0000	0.000E+00	0.0000	4.323E-01	0.0841
Total	2.082E-01	0.0405	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-02	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	5.138E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.446E-02	0.0042	6.950E-09	0.0000	0.000E+00	0.0000	2.136E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	2.016E-05	0.0000
Pu-238	1.436E-05	0.0000	1.043E-03	0.0002	0.000E+00	0.0000	4.173E-02	0.0072	0.000E+00	0.0000	0.000E+00	0.0000	1.575E-02	0.0027
Ra-226	2.240E+00	0.3861	1.621E-04	0.0000	0.000E+00	0.0000	3.264E+00	0.5626	0.000E+00	0.0000	0.000E+00	0.0000	7.877E-02	0.0136
Sr-90	1.067E-04	0.0000	1.713E-07	0.0000	0.000E+00	0.0000	2.944E-02	0.0051	0.000E+00	0.0000	0.000E+00	0.0000	3.702E-05	0.0000
Total	2.265E+00	0.3904	1.205E-03	0.0002	0.000E+00	0.0000	3.337E+00	0.5753	0.000E+00	0.0000	0.000E+00	0.0000	9.458E-02	0.0163

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	4.278E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.144E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.662E-02	0.0046
Pu-238	2.121E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.475E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.856E-02	0.0101
Ra-226	6.871E-02	0.0118	0.000E+00	0.0000	0.000E+00	0.0000	5.007E-03	0.0009	0.000E+00	0.0000	0.000E+00	0.0000	5.657E+00	0.9751
Sr-90	2.778E-02	0.0048	0.000E+00	0.0000	0.000E+00	0.0000	2.182E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	5.954E-02	0.0103
Total	9.652E-02	0.0166	0.000E+00	0.0000	0.000E+00	0.0000	7.191E-03	0.0012	0.000E+00	0.0000	0.000E+00	0.0000	5.802E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	7.593E-03	0.0013	2.158E-09	0.0000	0.000E+00	0.0000	6.631E-04	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	6.259E-06	0.0000
Pu-238	9.614E-06	0.0000	6.974E-04	0.0001	0.000E+00	0.0000	2.790E-02	0.0047	0.000E+00	0.0000	0.000E+00	0.0000	1.054E-02	0.0018
Ra-226	2.175E+00	0.3654	1.793E-04	0.0000	0.000E+00	0.0000	3.506E+00	0.5890	0.000E+00	0.0000	0.000E+00	0.0000	8.920E-02	0.0150
Sr-90	8.965E-06	0.0000	1.438E-08	0.0000	0.000E+00	0.0000	2.473E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	3.109E-06	0.0000
Total	2.182E+00	0.3666	8.767E-04	0.0001	0.000E+00	0.0000	3.537E+00	0.5943	0.000E+00	0.0000	0.000E+00	0.0000	9.975E-02	0.0168

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.666E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.960E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.265E-03	0.0014
Pu-238	3.167E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.259E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.918E-02	0.0066
Ra-226	1.207E-01	0.0203	0.000E+00	0.0000	0.000E+00	0.0000	8.803E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	5.900E+00	0.9912
Sr-90	2.327E-03	0.0004	0.000E+00	0.0000	0.000E+00	0.0000	1.828E-04	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.994E-03	0.0008
Total	1.231E-01	0.0207	0.000E+00	0.0000	0.000E+00	0.0000	8.988E-03	0.0015	0.000E+00	0.0000	0.000E+00	0.0000	5.952E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	6.554E-07	0.0000	1.862E-13	0.0000	0.000E+00	0.0000	5.723E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.402E-10	0.0000
Pu-238	5.120E-07	0.0000	2.799E-05	0.0000	0.000E+00	0.0000	1.119E-03	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	4.218E-04	0.0001
Ra-226	1.714E+00	0.3578	1.459E-04	0.0000	0.000E+00	0.0000	2.834E+00	0.5916	0.000E+00	0.0000	0.000E+00	0.0000	7.297E-02	0.0152
Sr-90	2.220E-14	0.0000	3.562E-17	0.0000	0.000E+00	0.0000	6.123E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.700E-15	0.0000
Total	1.714E+00	0.3578	1.739E-04	0.0000	0.000E+00	0.0000	2.835E+00	0.5918	0.000E+00	0.0000	0.000E+00	0.0000	7.339E-02	0.0153

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.226E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.015E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.145E-07	0.0000
Pu-238	2.343E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.705E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.594E-03	0.0003
Ra-226	1.563E-01	0.0326	0.000E+00	0.0000	0.000E+00	0.0000	1.140E-02	0.0024	0.000E+00	0.0000	0.000E+00	0.0000	4.789E+00	0.9997
Sr-90	5.609E-12	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.406E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.220E-11	0.0000
Total	1.564E-01	0.0326	0.000E+00	0.0000	0.000E+00	0.0000	1.140E-02	0.0024	0.000E+00	0.0000	0.000E+00	0.0000	4.790E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	5.452E-12	0.0000	1.549E-18	0.0000	0.000E+00	0.0000	4.761E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.495E-15	0.0000
Pu-238	4.394E-07	0.0000	5.469E-07	0.0000	0.000E+00	0.0000	2.187E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.744E-06	0.0000
Ra-226	1.273E+00	0.3532	1.083E-04	0.0000	0.000E+00	0.0000	2.105E+00	0.5839	0.000E+00	0.0000	0.000E+00	0.0000	5.419E-02	0.0150
Sr-90	3.879E-25	0.0000	6.224E-28	0.0000	0.000E+00	0.0000	1.070E-22	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.345E-25	0.0000
Total	1.273E+00	0.3532	1.089E-04	0.0000	0.000E+00	0.0000	2.105E+00	0.5840	0.000E+00	0.0000	0.000E+00	0.0000	5.420E-02	0.0150

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.218E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.957E-12	0.0000
Pu-238	8.758E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.381E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.000E-05	0.0000
Ra-226	1.604E-01	0.0445	0.000E+00	0.0000	0.000E+00	0.0000	1.170E-02	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	3.604E+00	1.0000
Sr-90	9.371E-23	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.361E-24	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.086E-22	0.0000
Total	1.604E-01	0.0445	0.000E+00	0.0000	0.000E+00	0.0000	1.170E-02	0.0032	0.000E+00	0.0000	0.000E+00	0.0000	3.604E+00	1.0000

*Sum of all water independent and dependent pathways.

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	2.143E+00	2.093E+00	1.906E+00	1.696E+00	6.654E-01	2.066E-01	1.786E-05	1.489E-10
Pu-238	Pu-238	1.840E-09	7.158E-10	7.101E-10	6.876E-10	6.605E-10	4.789E-10	3.203E-10	1.285E-11	2.310E-13
Pu-238	Pu-238	1.000E+00	3.890E-01	3.859E-01	3.737E-01	3.590E-01	2.602E-01	1.741E-01	6.986E-03	1.255E-04
Pu-238	U-234	1.000E+00	1.017E-07	3.141E-07	1.212E-06	2.434E-06	1.559E-05	3.803E-05	9.864E-05	4.589E-05
Pu-238	Th-230	1.000E+00	3.360E-13	2.233E-12	2.781E-11	9.896E-11	2.009E-09	6.847E-09	6.364E-08	1.067E-07
Pu-238	Ra-226+D	1.000E+00	5.101E-15	7.592E-14	3.400E-12	2.329E-11	2.349E-09	1.643E-08	8.983E-07	3.281E-06
Pu-238	Pb-210+D	1.000E+00	6.173E-15	1.851E-14	1.677E-13	1.262E-12	4.428E-10	5.185E-09	6.847E-07	2.967E-06
Pu-238	äDSR(j)		3.890E-01	3.859E-01	3.737E-01	3.590E-01	2.603E-01	1.741E-01	7.086E-03	1.778E-04
Ra-226+D	Ra-226+D	1.000E+00	1.123E+01	1.122E+01	1.120E+01	1.116E+01	1.090E+01	1.058E+01	8.345E+00	6.202E+00
Ra-226+D	Pb-210+D	1.000E+00	1.190E-01	3.203E-01	1.056E+00	1.857E+00	5.262E+00	6.274E+00	5.337E+00	4.095E+00
Ra-226+D	äDSR(j)		1.135E+01	1.154E+01	1.225E+01	1.302E+01	1.616E+01	1.686E+01	1.368E+01	1.030E+01
Sr-90+D	Sr-90+D	1.000E+00	4.084E+00	4.222E+00	4.639E+00	4.803E+00	6.616E-01	5.549E-02	1.356E-10	2.317E-21

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	7.000E+00	7.165E+00	7.868E+00	8.844E+00	2.254E+01	7.259E+01	8.398E+05	1.007E+11
Pu-238	3.856E+01	3.887E+01	4.014E+01	4.179E+01	5.763E+01	8.614E+01	2.117E+03	8.438E+04
Ra-226	1.322E+00	1.299E+00	1.224E+00	1.152E+00	9.281E-01	8.899E-01	1.096E+00	1.457E+00
Sr-90	3.673E+00	3.553E+00	3.234E+00	3.123E+00	2.267E+01	2.703E+02	1.106E+11	*1.365E+14

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 93.6 ñ 0.2 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin) (pCi/g)	G(i,tmin) (pCi/g)	DSR(i,tmax) (pCi/g)	G(i,tmax) (pCi/g)
Cs-137	4.000E-02	0.000E+00	2.143E+00	7.000E+00	2.401E-01	6.247E+01
Pu-238	2.250E-01	0.000E+00	3.890E-01	3.856E+01	1.834E-01	8.180E+01
Ra-226	3.500E-01	101.5 ñ 0.2	1.686E+01	8.899E-01	1.685E+01	8.904E-01
Sr-90	9.000E-02	9.36 ñ 0.02	4.881E+00	3.073E+00	7.629E-02	1.966E+02

Summary : UG util-Res-Non-Farm-2000m2-no bkg subtract
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\UG UTIL-RES-NON-FARM-2000M2.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	8.572E-02	8.374E-02	7.626E-02	6.784E-02	2.662E-02	8.265E-03	7.145E-07	5.957E-12
Pu-238	Pu-238	1.840E-09	1.611E-10	1.598E-10	1.547E-10	1.486E-10	1.077E-10	7.208E-11	2.892E-12	5.196E-14
Pu-238	Pu-238	1.000E+00	8.753E-02	8.683E-02	8.408E-02	8.077E-02	5.856E-02	3.917E-02	1.572E-03	2.824E-05
Pu-238	äDOSE(j)		8.753E-02	8.683E-02	8.408E-02	8.077E-02	5.856E-02	3.917E-02	1.572E-03	2.824E-05
U-234	Pu-238	1.000E+00	2.289E-08	7.067E-08	2.726E-07	5.476E-07	3.509E-06	8.557E-06	2.219E-05	1.033E-05
Th-230	Pu-238	1.000E+00	7.561E-14	5.025E-13	6.256E-12	2.227E-11	4.520E-10	1.541E-09	1.432E-08	2.401E-08
Ra-226	Pu-238	1.000E+00	1.148E-15	1.708E-14	7.650E-13	5.241E-12	5.285E-10	3.697E-09	2.021E-07	7.382E-07
Ra-226	Ra-226	1.000E+00	3.930E+00	3.928E+00	3.919E+00	3.907E+00	3.815E+00	3.704E+00	2.921E+00	2.171E+00
Ra-226	äDOSE(j)		3.930E+00	3.928E+00	3.919E+00	3.907E+00	3.815E+00	3.704E+00	2.921E+00	2.171E+00
Pb-210	Pu-238	1.000E+00	1.389E-15	4.165E-15	3.773E-14	2.840E-13	9.962E-11	1.167E-09	1.541E-07	6.676E-07
Pb-210	Ra-226	1.000E+00	4.165E-02	1.121E-01	3.695E-01	6.501E-01	1.842E+00	2.196E+00	1.868E+00	1.433E+00
Pb-210	äDOSE(j)		4.165E-02	1.121E-01	3.695E-01	6.501E-01	1.842E+00	2.196E+00	1.868E+00	1.433E+00
Sr-90	Sr-90	1.000E+00	3.675E-01	3.800E-01	4.175E-01	4.323E-01	5.954E-02	4.994E-03	1.220E-11	2.086E-22

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	5.000E+00	1.000E+01	5.000E+01	1.000E+02	5.000E+02	1.000E+03
Cs-137	Cs-137	1.000E+00	4.000E-02	3.908E-02	3.558E-02	3.166E-02	1.242E-02	3.855E-03	3.328E-07	2.769E-12
Pu-238	Pu-238	1.840E-09	4.140E-10	4.107E-10	3.977E-10	3.820E-10	2.769E-10	1.851E-10	7.406E-12	1.325E-13
Pu-238	Pu-238	1.000E+00	2.250E-01	2.232E-01	2.161E-01	2.076E-01	1.505E-01	1.006E-01	4.025E-03	7.200E-05
Pu-238	äS(j):		2.250E-01	2.232E-01	2.161E-01	2.076E-01	1.505E-01	1.006E-01	4.025E-03	7.200E-05
U-234	Pu-238	1.000E+00	0.000E+00	6.348E-07	3.113E-06	6.079E-06	2.516E-05	4.003E-05	4.242E-05	1.966E-05
Th-230	Pu-238	1.000E+00	0.000E+00	2.862E-12	7.063E-11	2.780E-10	6.131E-09	2.110E-08	1.968E-07	3.298E-07
Ra-226	Pu-238	1.000E+00	0.000E+00	4.135E-16	5.116E-14	4.041E-13	4.570E-11	3.239E-10	1.777E-08	6.475E-08
Ra-226	Ra-226	1.000E+00	3.500E-01	3.498E-01	3.490E-01	3.479E-01	3.397E-01	3.298E-01	2.599E-01	1.930E-01
Ra-226	äS(j):		3.500E-01	3.498E-01	3.490E-01	3.479E-01	3.397E-01	3.298E-01	2.599E-01	1.930E-01
Pb-210	Pu-238	1.000E+00	0.000E+00	3.195E-18	1.931E-15	2.965E-14	1.359E-11	1.539E-10	1.516E-08	5.994E-08
Pb-210	Ra-226	1.000E+00	0.000E+00	1.070E-02	5.020E-02	9.286E-02	2.669E-01	3.132E-01	2.582E-01	1.917E-01
Pb-210	äS(j):		0.000E+00	1.070E-02	5.020E-02	9.286E-02	2.669E-01	3.132E-01	2.582E-01	1.917E-01
Sr-90	Sr-90	1.000E+00	9.000E-02	8.565E-02	7.025E-02	5.484E-02	7.559E-03	6.349E-04	1.572E-12	2.747E-23

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 5.25 seconds

Appendix D

HFBR Underground Utilities
ORISE IV Reports

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

June 25, 2010

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Avenue, Bldg. 464
Upton, NY 11973

SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100
PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 1, 30-IN DUCT REMOVAL, BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK
DCN: 5098-SR-01-0

Dear Ms. Kneitel,

Oak Ridge Institute for Science and Education (ORISE) has reviewed the project documentation and data for the High Flux Beam Reactor (HFBR) Underground Utilities removal Phase 1 30-in duct removal at Brookhaven National Laboratory (BNL) in Upton, New York. The Brookhaven Survey Group (BSG) has completed removal and performed Final Status Survey (FSS) of the 30-in exhaust gas duct between Bldg. 750 to the exhaust gas valve pit adjacent to the stack. Sample results have been submitted as required to demonstrate that the cleanup goals of 15 mrem/yr above background to a resident in 50 years have been met. Several rounds of sampling were performed as specified in the Field Sampling Plan (FSP) (BNL 2010a).

It is the policy of the U.S. Department of Energy (DOE) to perform independent verifications of decontamination and decommissioning activities conducted at DOE facilities. ORISE has been designated as the organization responsible for this task at the HFBR. ORISE together with DOE determined that a Type A verification of the exhaust duct was appropriate based upon the minimal potential for residual radioactivity in the area.

The removal of underground utilities is being performed in three stages to decommission the HFBR facility and support structures. Phase 1 includes the removal of 425 feet of the 30-in duct from Bldg. 750 to the valve pit adjacent to the stack. Because of the historical use of the 30-in duct, the potential for contamination of the soil surrounding the duct and the structure itself is minimal based on preliminary sample results (BNL 2010a).

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ORISE reviewed the BNL FSP and identified comments for consideration (ORISE 2010). BNL prepared a revised FSP that addressed each ORISE comment adequately (BNL 2010a). ORISE referred to the revised Phase 1 30-in duct removal FSP FSS data to conduct the Type A verification and determine whether the intent of the criteria specified for the FSS have been met. ORISE determined that the FSP and data summary provided sufficient information to support data collection and analytical evaluation. The FSP provided sufficient information related to the selection of field instrumentation with sensitivity to meet the scan Minimum Detectable Concentrations (MDCs). Additionally, ORISE determined that the FSP appropriately addressed scan coverage, measurements, and analytical requirements for soil and duct samples collected for the contaminants of concern, Cs-137, Sr-90, and Ra-226, lead, and mercury. The data summary provided by BNL demonstrated that the FSP was being implemented as designed (BNL 2010b).

BNL performed five rounds of sampling and analysis to meet FSS objectives specified in the FSP. This included sampling soils around the duct at depths to 8 ft, soil overburden, soil around the duct and duct joints, and interior duct surfaces. The surface gamma walk-over scans covered 100% of the duct line between Bldg. 750 to the pit adjacent to the Stack. Static measurements were shown to be collected at systematic increments along the area of concern. The primary contaminants of concern were determined to be well below cleanup goals and notably were below background concentration levels.

It is therefore the opinion of ORISE that BNL has provided sufficient evidence to satisfy the cleanup goals as prescribed in the Operable Unit I Record of Decision (BNL 1999) based upon the FSP specified for this project. Please contact me at (865) 576-5321 or Tim Vitkus at (865) 576-5073 should you have any questions or need additional information provided.

Sincerely,

Phyllis C. Weaver
Health Physicist Survey Projects Leader
Oak Ridge Institute for Science and Education

PCW:ds

Enclosure

cc: T. Vitkus, ORISE/IEAV
File/5098

Distribution approval and concurrence:	Initials	Date
Technical Management Team Member	AT for Tim Vitkus	6/25/10

ENCLOSURE

PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 1, 30-IN DUCT REMOVAL, BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK —REFERENCES—

Brookhaven National Laboratory (BNL). Record of Decision, Operable Unit I and Radiologically Contaminated Soils. Upton, NY; August 1999.

Brookhaven National Laboratory (BNL). High Flux Beam Reactor Decommissioning Project, Field Sampling Plan HFBR Underground Utilities, Bldgs. 704 and 802. Upton, NY; June 2010a.

Brookhaven National Laboratory (BNL). HFBR Underground Utilities Removal—Phase 1 30-in Duct Removal Data Summary. Upton, NY; June 2010b.

Oak Ridge Institute for Science and Education (ORISE). Document Review—Comments on the Field Sampling Plan, HFBR Underground Utilities, Building 704 and Building 802, Brookhaven National Laboratory. Oak Ridge, TN; May 20, 2010.

July 9, 2010

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Avenue, Bldg. 464
Upton, NY 11973

**SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100
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, NEW YORK DCN: 5098-SR-02-0**

Dear Ms. Kneitel,

Oak Ridge Institute for Science and Education (ORISE) has reviewed the project documentation and data for the High Flux Beam Reactor (HFBR) Underground Utilities removal Phase 2; the D/F Waste Line removal at Brookhaven National Laboratory (BNL) in Upton, New York. The Brookhaven Survey Group (BSG) has completed removal and performed the final status survey (FSS) of the D/F Waste Line that provided the conduit for pumping waste from Building 750 to Building 801. Sample results have been submitted as required to demonstrate that the cleanup goals of 15 mrem/yr above background to a resident in 50 years have been met. Four rounds of sampling, from pre-excavation to final status survey (FSS), were performed as specified in the Field Sampling Plan (FSP) (BNL 2010a).

It is the policy of the U.S. Department of Energy (DOE) to perform independent verifications of decontamination and decommissioning activities conducted at DOE facilities. ORISE has been designated as the organization responsible for this task at the HFBR. ORISE together with DOE determined that a Type A verification of the D/F Waste Line was appropriate based on its method of construction and upon the minimal potential for residual radioactivity in the area.

The removal of underground utilities is being performed in three stages in the process to decommission the HFBR facility and support structures. Phase 2 of this project included the grouting and removal of 1100 feet of 2-inch pipe and 640 feet of 4-inch pipe that served as the D/F Waste Line. Based on the pre-excavation sample results of the soil overburden, the potential for contamination of the soil surrounding the pipe is minimal (BNL 2010a).

ORISE reviewed the BNL FSP and identified comments for consideration (ORISE 2010). BNL prepared a revised FSP that addressed each ORISE comment adequately (BNL 2010a). ORISE referred to the revised Phase 2 D/F Waste Line removal FSP FSS data to conduct the Type A verification and determine whether the intent of the criteria specified for the FSS have been met. ORISE determined that the FSP and data summary provided sufficient information to support a Type A analytical evaluation. The FSP provided sufficient information related to the selection of field instrumentation with sensitivity to meet the scan minimum detectable concentrations (MDCs). Additionally, ORISE determined that the FSP appropriately addressed scan coverage, measurements, and analytical requirements for soil and duct samples collected for the contaminants of concern, Cs-137, Sr-90, and Ra-226, lead, and mercury.

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The Phase 2 D/F Waste Line Removal Data Summary provided by BNL demonstrated that the FSP was being implemented as designed (BNL 2010b). However, ORISE respectfully submits the following comments for your consideration.

> **Page 4; paragraph 2; sentence 3:** The statement is not specific about the source of the high radioactivity reported on the outside of the pipe. As written it appears that there could be something related to the pipe contributing to high radioactivity instead of identifying Building 801(or contents thereof) as the significant contributor to high activity. Please clarify.
>
> **Page 4; paragraph 3:** Is this the background reading at the 3-foot distance on the pipe that is referred to in the previous paragraph? Please clarify.

Removal of the line required the excavation of the overburden to depths of 8 feet, then scanning, and sampling of the excavation; coreholes were installed to determine the depth of contamination, if present; and the interior pipe surfaces were scanned. The surface gamma walk-over scans covered 100% of each excavated area. Portions of the D/F Waste Line were not excavated because doing so could have negatively impacted operational utilities and structures such as sidewalks, roads, or buildings. Static measurements were shown to be collected at systematic increments along the areas of concern. The primary contaminants of concern (Cs-137, Sr-90, and Ra-226) were determined to be well below cleanup goals and notably below background concentration levels.

It is therefore the opinion of ORISE that BNL has provided sufficient evidence to demonstrate compliance with the cleanup goals as prescribed in the Operable Unit I Record of Decision (BNL 1999) based upon the FSP specified for this project.

Please contact me at 865.576.5321 or Tim Vitkus at 865.576.5073 should you have any questions or need additional information provided.

Sincerely,

Phyllis C. Weaver
Health Physicist/Project Manager
Oak Ridge Institute for Science and Education

PCW:jc

Enclosure

cc: File/5098

Electronic Distribution: T. Vitkus, ORISE/IEAV

Distribution approval and concurrence:	Initials
Technical Management Team Member	TV

REFERENCES

Brookhaven National Laboratory (BNL). Record of Decision, Operable Unit I and Radiologically Contaminated Soils. Upton, NY; August 1999.

Brookhaven National Laboratory . High Flux Beam Reactor Decommissioning Project, Field Sampling Plan HFBR Underground Utilities, Bldgs. 704 and 802. Upton, NY; June 2010a.

Brookhaven National Laboratory. HFBR Underground Utilities Removal—Phase 2 D/F Waste Line Removal Data Summary. Upton, NY; June 2010b.

Oak Ridge Institute for Science and Education (ORISE). Document Review—Comments on the Field Sampling Plan, HFBR Underground Utilities, Building 704 and Building 802, Brookhaven National Laboratory. Oak Ridge, TN; May 20, 2010.

December 15, 2010

Ms. Lisa Santoro
U.S. Department of Energy
Brookhaven Site Office
53 Bell Avenue, Bldg. 464
Upton, NY 11973

SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100
PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 3 TRENCH 1, BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK
DCN: 5098-SR-05-0

Dear Ms. Santoro,

The Oak Ridge Institute for Science and Education (ORISE) has reviewed the project documentation and data for the High Flux Beam Reactor (HFBR) Underground Utilities removal Phase 3; Trench 1 at Brookhaven National Laboratory (BNL) in Upton, New York. The Brookhaven Survey Group (BSG) has completed removal and performed Final Status Survey (FSS) of the 42-inch duct and 14-inch line in Trench 1 from Building 801 to the Stack. Sample results have been submitted as required to demonstrate that the cleanup goal of ≤15 mrem/yr above background to a resident in 50 years has been met. Four rounds of sampling, from pre-excavation to FSS, were performed as specified in the Field Sampling Plan (FSP) (BNL 2010a).

It is the policy of the U.S. Department of Energy (DOE) to perform independent verifications of decontamination and decommissioning activities conducted at DOE facilities. ORISE has been designated as the organization responsible for this task for the HFBR Underground Utilities. ORISE, together with DOE, determined that a Type A verification of Trench 1 was appropriate based on recent verification results from Trenches 2, 3, 4, and 5, and the minimal potential for residual radioactivity in the area.

The removal of underground utilities has been performed in three stages to decommission the HFBR facility and support structures. Phase 3 of this project included the removal of at least 200 feet of 36-inch to 42-inch duct from the west side to the south side of Building 801, and the 14-inch diameter Acid Waste Line that spanned from 801 to the Stack within Trench 1. Based on the pre-excavation sample results of the soil overburden, the potential for contamination of the soil surrounding the pipe is minimal (BNL 2010a).

ORISE reviewed the gamma spectroscopy results for 14 FSS soil samples, four core samples, and one duplicate sample collected from Trench 1. Sample results for the radionuclides of concern were below the established cleanup goals. However, in sample PH-3 TR-1 FSS 012, the spectra identified Americium-241 (Am-241) at a concentration of 1.42 pCi/g (BNL 2010b). Although this concentration is low, Am-241 has typically not been specified as a project contaminant. The ORISE

Laboratory Manager reviewed spectra provided by the laboratory that performed the analysis for BSG and determined that the analyzing laboratory sufficiently met industry standard.

ORISE reviewed the BNL FSP and identified comments for consideration (ORISE 2010). BNL prepared a revised FSP that resolved each ORISE comment adequately (BNL 2010a). ORISE referred to the revised HFBR Underground Utilities FSP FSS data to conduct the Type A verification and determine whether the intent of the cleanup goals for the FSS have been met. ORISE determined that the FSP and data summary provided sufficient information to support a Type A analytical evaluation. The FSP provided sufficient information related to the selection of field instrumentation with sensitivity to meet the scan Minimum Detectable Concentrations (MDCs). Additionally, ORISE determined that the FSP appropriately addressed scan coverage, measurements, and analytical requirements for soil and duct samples collected for the contaminants of concern, cesium-137, strontium-90, and radium-226.

Removal of the duct and line required the excavation of the overburden to depths of at least eight feet and greater. BSG scanned and sampled the trench in accordance with the FSP. The surface gamma walk-over scans covered 100% of the accessible excavated area (BNL 2010c). Soil samples were shown to be collected at systematic increments, every four feet, where the duct and line where previously oriented in the trench. Concentrations for the primary contaminants of concern were analyzed on-site and determined to be well below cleanup goals. Notably, sample concentrations were at or below sample background (BNL 2010b).

It is therefore the opinion of ORISE that BNL has provided sufficient evidence to satisfy the cleanup goals specified in the FSP for this project (BNL 2010a). Please contact me via my information listed below or Phyllis Weaver at 865.576.5321 should you have any questions or need additional information.

Sincerely,

Evan M. Harpenau
Health Physicist/Assistant Project Manager
Survey Projects

EMH:jc

Enclosure

cc: S. Roberts, ORISE/IEAV
T. Vitkus, ORISE/IEAV
File/5098
T. Knietel, BNL/DOE
P. Weaver, ORISE/IEAV

Distribution approval and concurrence:	Initials
Technical Review	

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PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 3 TRENCH 5, BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK
REFERENCES

Brookhaven National Laboratory (BNL). High Flux Beam Reactor Decommissioning Project, Field Sampling Plan HFBR Underground Utilities, Bldgs. 704 and 802. Upton, NY; June 2010a.

BNL. Email from L. Santoro (BNL) to E. Harpenau (ORISE); *Summary 10.18.10-A*, November 19, 2010b.

BNL. Email from L. Santoro (BNL) to E. Harpenau (ORISE); *Phase 3 Trench 1 Final Status Survey*, November 19, 2010c.

Oak Ridge Institute for Science and Education (ORISE). Document Review—Comments on the Field Sampling Plan, HFBR Underground Utilities, Building 704 and Building 802, Brookhaven National Laboratory. Oak Ridge, TN; May 20, 2010.

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 15, 2010

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Ave., Building 464
Upton, NY 11973

SUBJECT: DOE CONTRACT NO. DE-AC05-06OR23100
SUMMARY AND RESULTS LETTER REPORT— INDEPENDENT VERIFICATION OF THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PROJECT, PHASE 3: TRENCHES 2, 3, AND 4 BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK
DCN: 5098-LR-02-0

Dear Ms. Kneitel:

Oak Ridge Institute for Science and Education (ORISE) personnel visited the Brookhaven National Laboratory (BNL) on September 7 through September 10, 2010, and September 20 through September 24, 2010. ORISE performed visual inspections, conducted independent measurement, and sampling of Trenches 2, 3, and 4, which are part of Phase 3 for the High Flux Beam Reactor (HFBR) Underground Utilities Removal Project. Trenches 2 and 3 were addressed during the first visit and Trench 4 during the second visit to BNL.

Spatial orientation to Building 801 and minimal survey area inside Trenches 2 and 3 limited satellite reception and the ability to utilize a global positioning system (GPS) as real-time data capture for the gamma scan surveys in these trenches. However, Trench 4 provided suitable conditions in which gamma scan data could be collected using the GPS.

ORISE performed high-density gamma scans of accessible surface areas using shielded sodium iodide detectors coupled to ratemeter-scalers with audible output. Scans for Trench 2 ranged from 4,000 to 22,000 gross counts per minute (cpm); Trench 3 from 3,000 to 5,000 gross cpm and Trench 4 from 2,600 to 9,500 gross cpm. ORISE personnel flagged the area where the elevated counts were observed in Trench 2 for further investigation. Additional scan evaluations were performed on remaining pipes and associated end-caps in the trenches with no elevated activity detected.

Eleven judgmental soil samples (5098M0041 through 5098M0051) were obtained throughout Trenches 2, 3, and 4. The sample locations were selected based on count rates observed during the scan survey or because of contamination potential from pipeline removal activities. ORISE personnel judgmentally selected the location for sample M0043 in response to the 22,000 cpm observed during the scan survey, and to ascertain whether the elevated counts were a result of soil

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contamination or radioactive shine from the trench's spatial orientation to the Target Room in Building 801. Gamma spectroscopy results of radionuclide concentrations in the soil ranged from 0.01 to 0.09 picocuries per gram (pCi/g) for cesium-137 and 0.22 to 0.49 pCi/g for radium-226. Radium-226 concentrations were considered to be in equilibrium with and derived from lead-214. Results for strontium-90 ranged from -0.27 to 0.87 pCi/g in the trenches. All concentrations for the radionuclides of concern were less than 10% of the respective cleanup goal.

A full verification survey report will follow at the completion of the HFBR Underground Utilities Removal Project. Please contact me at 865.241.8793 or Phyllis Weaver at 865.576.5321 should you have any questions.

Sincerely,

Evan M. Harpenau
Health Physicist/Assistant Project Manager
Survey Projects

EMH:fr

Enclosure

c: File/5098

electronic distribution: S. Roberts, ORISE T. Vitkus, ORISE
P. Weaver, ORISE

Distribution approval and concurrence:	Initials
Technical Review	
Laboratory Review	RDC
Quality Review	

November 3, 2010

Ms. Terri Kneitel
U.S. Department of Energy
Brookhaven Site Office
53 Bell Avenue, Bldg. 464
Upton, NY 11973

SUBJECT: **DOE CONTRACT NO. DE-AC05-06OR23100**
PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 3 TRENCH 5, BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK
DCN: 5098-SR-04-0

Dear Ms. Kneitel,

The Oak Ridge Institute for Science and Education (ORISE) has reviewed the project documentation and data for the High Flux Beam Reactor (HFBR) Underground Utilities removal Phase 3; Trench 5 at Brookhaven National Laboratory (BNL) in Upton, New York. The Brookhaven Survey Group (BSG) has completed removal and performed Final Status Survey (FSS) of the concrete duct from Trench 5 from Building 801 to the Stack. Sample results have been submitted as required to demonstrate that the cleanup goal of ≤15 mrem/yr above background to a resident in 50 years has been met. Four rounds of sampling, from pre-excavation to FSS, were performed as specified in the Field Sampling Plan (FSP) (BNL 2010a).

It is the policy of the U.S. Department of Energy (DOE) to perform independent verifications of decontamination and decommissioning activities conducted at DOE facilities. ORISE has been designated as the organization responsible for this task for the HFBR Underground Utilities. ORISE, together with DOE, determined that a Type A verification of Trench 5 was appropriate based on recent verification results from Trenches 2, 3, and 4, and the minimal potential for residual radioactivity in the area.

The removal of underground utilities is being performed in three stages to decommission the HFBR facility and support structures. Phase 3 of this project included the removal of at least 200 feet of 36-inch to 42-inch pipe from the west side to the south side of Building 801, and the 14-inch diameter Acid Waste Line that spanned from 801 to the Stack within Trench 5. Based on the pre-excavation sample results of the soil overburden the potential for contamination of the soil surrounding the pipe is minimal (BNL 2010a).

ORISE reviewed the BNL FSP and identified comments for consideration (ORISE 2010). BNL prepared a revised FSP that resolved each ORISE comment adequately (BNL 2010a). ORISE referred to the revised HFBR Underground Utilities FSP FSS data to conduct the Type A

verification and determine whether the intent of the cleanup goals for the FSS have been met. ORISE determined that the FSP and data summary provided sufficient information to support a Type A analytical evaluation. The FSP provided sufficient information related to the selection of field instrumentation with sensitivity to meet the scan Minimum Detectable Concentrations (MDCs). Additionally, ORISE determined that the FSP appropriately addressed scan coverage, measurements, and analytical requirements for soil and duct samples collected for the contaminants of concern, Cs-137, Sr-90, and Ra-226.

Removal of the line required the excavation of the overburden to depths of at least 8 feet and greater. BSG scanned and sampled the trench in accordance with the FSP. The surface gamma walk-over scans covered 100% of accessible excavated area (BNL 2010b). Soil samples were shown to be collected at systematic increments along the area of concern. Concentrations for the primary contaminants of concern were analyzed on-site and determined to be well below cleanup goals. Notably, sample concentrations were at or below sample background (BNL 2010c and d).

It is therefore the opinion of ORISE that BNL has provided sufficient evidence to satisfy the cleanup goals specified in the FSP for this project (BNL 2010a). Please contact me at my information listed below or Tim Vitkus at (865) 576-5073 should you have any questions or need additional information provided.

Sincerely,

Phyllis C. Weaver
Health Physicist/Survey Projects Manager
Oak Ridge Institute for Science and Education

PCW:bf

Enclosure

cc: T. Vitkus, ORISE/IEAV
File/5098

Distribution approval and concurrence:	Initials	Date
Technical Management Team Member		11/3/2010

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PROJECT-SPECIFIC TYPE A VERIFICATION FOR THE HIGH FLUX BEAM REACTOR UNDERGROUND UTILITIES REMOVAL PHASE 3 TRENCH 5, BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK
REFERENCES

Brookhaven National Laboratory. High Flux Beam Reactor Decommissioning Project, Field Sampling Plan HFBR Underground Utilities, Bldgs. 704 and 802. Upton, NY; June 2010a.

Brookhaven National Laboratory. Email from A. Lockwood (BNL) to P. Weaver (ORISE); *Phase 3 Trench 5 Final Status Survey*, October 22, 2010b.

Brookhaven National Laboratory. Email from A. Lockwood (BNL) to P. Weaver (ORISE); *Summary 10.19.10-B*, October 22, 2010c.

Brookhaven National Laboratory. Email from A. Lockwood (BNL) to P. Weaver (ORISE); *Summary 10.21.10-A*, October 25, 2010d.

Oak Ridge Institute for Science and Education (ORISE). Document Review—Comments on the Field Sampling Plan, HFBR Underground Utilities, Building 704 and Building 802, Brookhaven National Laboratory. Oak Ridge, TN; May 20, 2010.