Attachment AA

Final Status Survey Report #29 Documentation

(UNDER SEPARATE COVER)

FSSR #29

FINAL

COLUMBUS CLOSURE PROJECT CHARACTERIZATION AND FINAL STATUS SURVEY REPORT FOR THE JN-1 B FOUNDATION EXCAVATION

Revision 1
June 16, 2006

Prepared by

ECC & E2 Closure Services
1425 State Route 142 East
West Jefferson, OH 43162

FSSR #29

Contract Number: DE-AC24-04OH20171

FINAL Characterization and Final Status Report for the JN-1 B Excavation Foundation

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Contract Number: DE-AC24-04OH20171

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Contract Number: DE-AC24-04OH20171

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1.0 Introduction

This report contains the final status surveys (FSS) for the JN-1 B foundation excavation located at the Columbus Closure Project (CCP), 1425 State Route 142 East, West Jefferson, OH 43162. Final status surveys were conducted according to the guidance presented in the *Manual for Conducting Surveys in Support of License Termination*, NUREG/CR-5849 (NUREG/CR-5849) (ORAU, 1992) and the *Radiological Characterization and Final Status Plan for Battelle Columbus Laboratories Decommissioning Project, West Jefferson Site*, DD-97-02 (Final Status Plan) (Battelle, 2000). The final status surveys were conducted in December of 2005 and January of 2006 and performed under Work Instruction 2806 (Closure Services, 2004).

The intent of this final status survey report is to provide a complete and unambiguous record of the radiological status of the JN-1 B foundation excavation. Sufficient information and data is provided to enable an independent re-creation and evaluation at some future date of both the survey activities and the reported results for the excavation. Information in this report is also available in referenced technical basis documents, final status survey plans and procedures, and the *Battelle Memorial Institute Columbus Operations, Decommissioning Plan*, DD-93-19 (BMI Decommissioning Plan), and reporting and quality assurance procedures.

To the extent practicable, this final status survey report is presented with minimal information incorporated by reference. This final status survey report has been generated following the comprehensive, annotated outline presented in Chapter 9 of NUREG-5849 (ORAU, 1992).

1.1 Background

On April 16, 1943, BMI, acting through what is now its Battelle Columbus Operations (BCO), entered into Contract No. W-7405-ENG-92 with the Manhattan Engineering District to perform atomic energy research and development (R&D) activities. BCO performed nuclear materials research and development at privately-owned facilities for the Manhattan Engineering District and its successor agencies – the Atomic Energy Commission (AEC), the Energy Research and Development Agency (ERDA), and the Department of Energy (DOE). Research and development continued until 1988 (Battelle, 2003a).

The BCO facilities at the King Avenue Site, Columbus, Ohio, and the West Jefferson North (WJN) and South (WJS) Sites, West Jefferson, Ohio, became partially radiologically contaminated as a result of the R&D activities. Decontamination of the King Avenue and WJS Sites has been completed and activities continue at the WJN site. The DOE, as the successor to the AEC and the Government's earlier work, is the agreed party with predominant liability and responsibility for decontamination and decommissioning (D&D) of the BCO facilities (Battelle, 2003a). The Assistant Secretary for Nuclear Energy of the DOE accepted the decontamination and decommissioning (D&D) of the WJN into the DOE's Surplus Facilities Management Program as a major project (DOE, 1986). The DOE is the

agency funding and managing the cleanup of the WJN (Battelle, 2003a). However, the site is not a DOE-owned facility.

BMI holds U.S. Nuclear Regulatory Commission (NRC) license number SNM-7. BMI has continually operated and conducted D&D activities in full compliance with this NRC license. Decontamination and decommissioning activities under the NRC license have been planned and executed according to the BMI Decommissioning Plan. The BMI Decommissioning Plan for the WJN site does not serve as a declaration to terminate SNM-7, but establishes the criteria for performing D&D activities. The end goal of the BMI Decommissioning Plan is to reach unrestricted use conditions for the site (Battelle, 2003a).

In 2003, the DOE contracted ECC&E2 Closure Services, LLC (Closure Services) to complete the safe removal of the DOE radioactive materials and contamination from the WJN site. Removal of radioactive material will be to levels allowing future use of the site without radiological restrictions as described in the BMI Decommissioning Plan. Closure Services has conducted the characterization and the final status surveys of the JN-1 B foundation excavation demonstrating that the area is available for unrestricted release.

2.0 Site Description

Created in 1984, the Battelle Columbus Decommissioning Project (BCLDP) is a remediation project that includes nine buildings at the King Avenue site and five at the WJN site. The CCP is the successor of the BCLDP. The CCP consists of the decontamination and decommissioning of the 11.7 acre WJN site. The filter bed area and the connecting areas encompass 2.6 acres. Three former research facilities, Buildings JN-1, JN-2, and JN-3, have been demolished, as well as Building JN-6, the guard house. Several outfalls, filter beds, and wells located at the site have also been remediated. **Figure 1** presents a site map for the CCP.

2.1 Area Description

As shown in **Figure 1**, Building JN-1 was located on the eastern portion of the WJN site. Building JN-1 B was the second addition to the JN-1 building and housed the High Energy Cell and a fuel pool and transfer canal. The fuel pool and transfer canal was released from 14 feet below surface grade to its base of 50 feet below surface grade and is presented in a separate report. **Figure 2** details the Building JN-1 B foundation excavation. Two caisson wells used to dewater the land area surrounding the fuel pool during the fuel pool construction are present within the Building JN-1 B foundation area and are included in this report. The caisson wells are 30 inch diameter and approximately 40 feet deep. The caisson wells remain at the site. The excavation of the Building JN-1 B foundation included removal of the building slab and footers, and all rain piping within the footprint. Soils above release criteria were also excavated. The excavation reached depths of approximately 20 feet below surface grade.

Two classifications of areas are used in NUREG-5849 and are termed **affected** or **unaffected.** These classifications are defined as (NRC, 1992):

> **Affected Areas:** Areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). This would normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in spread of contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent to locations where radioactive materials were used, stored, or buried are included in this classification because of the potential for inadvertent spread of contamination.
>
> **Unaffected Areas:** All areas not classified as affected. These areas are not expected to contain residual radioactivity, based on knowledge of site history and previous information.

The Building JN-1 B foundation excavation and the caisson wells are considered to be affected.

3.0 Decommissioning Activities

3.1 Decommissioning Objective

The objective of the final status survey performed on the Building JN-1 B foundation excavation and the caisson wells is to statistically demonstrate that the remediation of the area was successful and that the excavation is free from residual radioactive contamination making it suitable for unrestricted release. **Table 1** presents the surface release criteria as presented in DD-93-02, Rev. 0, "Surface Release Criteria Technical Basis Document," (Battelle, 1993A). **Table 2** presents the volumetric release criteria as presented in DD-93-03, Rev. 0, "Volumetric Release Criteria Technical Basis Document for Battelle Columbus Laboratory Decommissioning Project" (Battelle, 1993B).

4.0 Final Status Survey Procedures

Planning and implementation of the final status survey of the excavation and the caisson wells adhered to the requirements of the Final Status Survey Plan (Battelle, 2000) and Work Instruction 2806 (CS, 2004)

4.1 Sampling Parameters

Final status soil samples of the Building JN-1 B foundation excavation were obtained from discrete locations within each survey grid. Survey grids were each ten by ten meters, with each grid divided into equal sized quadrants. Final status soil samples were obtained from each of the grid quadrants. Analyses of samples by gamma spectroscopy were performed by the on-site Radioanalytical Laboratory (RAL). Scanning of the caisson wells was performed in one-meter increments in the north, south, east, and western quadrants of the pipes. Alpha and beta measurements as well as alpha only measurements were taken in each of the quadrants of the pipes.

4.2 Major Contaminants Identified

The characterization of the Building JN-1 B foundation excavation soils identified Cesium-137 (Cs-137) as the contaminant of concern. Other radioisotopes present include Cobalt-60 (Co-60), Europium-152 (Eu-152), Eu-154, Americium-241 (Am-241), Strontium-90 (Sr-90), and Plutonium-238 (Pu-238) and 239. Cs-137 is used as a surrogate for the other radioisotopes present in the soils as the Cs-137 activity is predominant over the other radionuclides and Cs-137 possesses one of the lowest cleanup criterion, 15 pCi/g.

Closure Services has consistently utilized Cs-137 as an isotopic surrogate for determining relative concentrations for individual radionuclides contaminants of concern (RCOC). Relative isotopic concentrations for individual RCOC are determined using predetermined ratios of each isotope to Cs-137. Isotopic ratios have been developed for the Building JN-1 Mixture and for the Filter Bed Area. The Building JN-1 Mixture ratio was developed for waste shipping and was based primarily from samples collected within the JN-1 hot cells. The Filter Bed Area ratio was utilized for the final status survey of all areas not associated with JN-1, and surveyed for unrestricted released as of December, 2005. These areas were associated with the sanitation systems leading to and discharging into, and including, the filter bed area. The Building JN-1 and the Filter Bed Area ratios do not accurately reflect the conditions of the subsurface foundation and backyard excavation of Building JN-1. For this reason, an area specific isotopic ratio was developed for the remediation and final status surveys of the Building JN-1 foundation and backyard area.

Table 3 presents the isotopic activity concentrations of samples collected during the remediation of the Building JN-1 foundation, backyard, and the Bog Area. Remediation samples were collected between October and November of 2005. CS Characterization Technicians collected the samples according to Procedures SC-SP-004.2, "Mechanical Collection of Surface and Subsurface Soil Samples in Support of Site Characterization".

Sample integrity protocol and data quality objectives were adhered to throughout the sampling effort. Samples were then screened and transferred to the Onsite Radioanalytical Laboratory (RAL) for analysis. Initially, analysis was for gamma emitting RCOC was performed according to procedure RL-TP-030, Rev. 5, "Gamma Spectrometric Analysis of Laboratory Samples Using Canberra Procount™ Software". The RAL performed analysis for Sr-90 according to procedure RL-TP-035, Rev. 4, "Strontium-90 Analysis by Extraction Chromatograph."

The average, or mathematical mean, and the 95 percent confidence interval were calculated for the ratio of each RCOC to Cs-137. Average values were calculated using the following mathematical equation (USDOC, 1966):

$$X = \frac{1}{n}\sum_{i=1}^{n} X_i$$

Where:

X	=	mathematical mean
n	=	number of samples
Xi	=	sample value (i.e. ratio)

The upper confidence interval of the sample mathematical mean was calculated using the following mathematical equation (USDOC, 1966):

$$X_U = X + t\frac{s}{\sqrt{n}}$$

Where:

X_U	=	upper confidence interval
X	=	mathematical mean
t	=	percentile of the t distribution, $\alpha = 0.05$, df = n-1
s	=	standard deviation
n	=	number of samples

The lower confidence interval of the sample mathematical mean was calculated using the following mathematical equation (USDOC, 1966):

$$X_L = X - t\frac{s}{\sqrt{n}}$$

Where:

X_L	=	lower confidence interval

The confidence interval reports a range of values on either side of the mathematical mean. A significance level of $\alpha = 0.05$ was used to set a confidence level. The confidence level equals $100*(1-\alpha)\%$, or indicating a 95 percent confidence level. This interval was set to contain the true average "95% of the time." The lower confidence interval value, X_L, has been selected as the isotopic ratio value for the Building JN-1 Foundation and Backyard area. The lower confidence level was selected as the conservative representation of the radionuclide ratio to Cs-137.

Activity concentrations for final status survey samples collected for the Building JN-1 foundation and backyard have been calculated using the isotopic ratios as presented in **Table 3**.

Additional radioanalytical sampling was performed in the Building JN-1 B caisson wells, specifically for Sr-90 activity. Scrape samples were obtained from the inside of the east caisson well. Sample results of the scrapings, sample number RL05-4721, indicate Cs-137 levels of 33.5 pCi/g and Sr-90 levels of 4.2 pCi/g. Using these results, the limits for mixed fission products were used for the surface contamination scans of the caisson wells.

4.2.1 Guidelines Established

Table 1 presents the surface contamination guidelines applied for the Building JN-1 B caisson wells. These criteria are provided by DOE Order 5400.5 "Radiation Protection of the Public and Environment," which reference Regulatory Guide 1.86. DOE Order 5400.5 does not define the release levels for nuclides such as transuranics, Ra-226 and Th-230; therefore the CCP adopted the guidance of Regulatory Guide 1.86. Radioanalytical sampling was performed in the Building JN-1 B caisson wells specifically for Sr-90. Sr-90 was detected at a level much less (approximately 8 times) than Cs-137. Given this, the survey data from the caisson wells is compared to **Table 1** values for beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) of 5,000 dpm/100cm^2 average and 15,000 dpm/100 cm^2 maximum.

Table 2 presents the guidelines for residual radioactivity concentrations for soil and solid volumes as applied to the excavation. Criteria for residual radioactivity concentrations in soil are defined in a number of references. DOE Order 5400.5, Section IV.a.2 provides generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232. NRC Guidance has been received by the CCP which contains soil radioactivity concentration guidelines for Co-60, Sr-90, Cs-137, Ra-226, and Ra-228. NRC guidance for soil radioactivity concentration guidelines for natural, enriched and depleted uranium are also utilized. **Table 2** compiles soil residual radioactivity concentration guidelines to be utilized by the CCP. **Table 2** values have been generated primarily from the various reference technical documents and from soil guidelines generated from computer pathway analyses. Pu-241 is calculated by applying a ratio to sum of Pu-238 and Pu-239 (obtained from ORIGEN 2.1 derived values, Battelle, 2003c), resulting in a Cs-137 to Pu-241 ratio of 2.8. Using the ratio from **Table 3** and the Cs-137 to Pu-241 ratio of 2.8, the sum of ratios of radionuclides will meet unity at Cs-137 concentrations of 7.3 pCi/g.

Exposure rates were compared to the 5 microRoentgen per hour (µR/hr) above mean background limit listed in DD-97-02, Rev. 0 (Battelle, 2000). Survey measurements are those 1-meter above the ground surface. The calculated mean background exposure rate and the 95 percent confidence intervals used for the CCP open area grounds is 8 ± 2 µR/hr. Compliance to the limit is met when the exposure rate survey is less then or equal to the limits of NUREG-5849. Initial compliance screening is met if individual exposure rates are less than or equal to 13 µR/hr. Further assessment of compliance allows for exposure rates to be averaged of a 100 m^2 grid area to meet the limit of less than or equal to 5 µR/hr above

background at 1-meter above the ground surface. Additionally, exposure rates over any discreet area may not exceed 5 μR/hr above background levels.

Data collected from trench-like culverts located on Battelle property unassociated with site operations indicate a geometry effect, increasing the background exposure rates inside the trenches by 3 to 5 μR/hr. Trench exposure rate measurements must be less than or equal to 18 μR/hr. The same compliance assessment is applied to these measurements as stated above.

5.0 Equipment and Procedures

5.1 Equipment

Direct reading gas proportional survey instruments sensitive to alpha and beta radiation were used to monitor surfaces for residual radioactive materials. Ludlum Model 43-20 gas proportional detectors with Eberline ESP-2 meters were used to scan caisson well surfaces. P-10 gas was supplied via a continuous feed to the detectors. Thin, flat plate thorium-230 and technicium-99 (Tc-99) sources traceable to the National Institute of Standards and Technology (NIST) per requirements of ANSI-N323a, "Radiation Protection Instrumentation Test and Calibration" were used to calibrate the gas proportional instruments for alpha and beta detection, respectively (ANSI, 1997). Tc-99 was used as the calibration source in accordance with Section 4.2.2 of ANSI-N323A which states "the detector shall be calibrated with an energy that is less than or similar to beta energies in the field." (ANSI, 1997) The average beta energy of Tc-99 is 85 KeV, with the average energies of Co-60, Cs-137, and Sr-90 being 95, 156, and 196 KeV, respectively.

Survey instruments sensitive to gamma radiation are used to monitor excavation surfaces for residual radioactive materials. Ludlum Model 44-10 two-inch by two-inch sodium iodide detectors with Eberline ESP-2 meters were used to scan the grounds and excavation. Ludlum Model 19 exposure rate meters were used to obtain μR/hr measurements.

Other instrumentation used in the Onsite Radioanalytical Laboratory (RAL) to support the final status survey includes:

- A VMS based Canberra Procount data acquisition system in conjunction with high purity germanium detectors for gamma spectroscopy of soil samples.
- A Tennelec Model LB5100 Simultaneous Alpha and Beta Gas Proportional Counter to count smear samples.

5.2 Scanning Minimum Detectable Activities

5.2.1 Structure Surface Scanning and Static Measurements

Minimum detectable activities (MDAs) are determined utilizing the data collected for each surface material. The following equation is used to calculate the MDA:

$$MDA = \frac{3 + (4.65 * \sigma_{bkg})}{Eff * T * G}$$

where:

σ_{bkg} = standard deviation of background value = $\sqrt{counts_{bkg}}$

Eff = efficiency of detector

T = time in minutes

G = geometry = $\frac{\text{active probe area in cm}^2}{100}$

The MDA for large, wide area sources was calculated assuming the radioactive source remained under the detector approximately one minute, allowing the MDA for wide-area source scan surveys to approach the MDA reported for a static survey. The beta MDA for a wide-area beta source was calculated at 260 disintegrations per minute per 100 square centimeters (dpm/100 cm^2). The MDA for scans involving point sources were calculated by evaluating the time a point source remained under the detection area, given a worst-case brick background. A beta MDA of 1600 dpm/100 cm^2 was calculated for a point source configuration during a scan survey. The calculated MDAs for alpha scans for wide-area and point sources are 18.5 and 281 dpm/100 cm^2.

5.2.2 Open Grounds Scanning

Scanning measurements were conducted according to SC-OP-004, Rev. 0., Section 5.5, Direct Survey (Scanning). Scanning surveys were performed over the entire surface of the affected grid at a distance of $\leq$ 0.5 cm and a rate not to exceed 5 cm/sec.

Scanning minimum detectable concentrations (MDC_{scan}) is determined to demonstrate that the MDC_{scan} is less than the modified Cs-137 cleanup criteria. The MDC_{scan} is calculated utilizing the methodology described in NUREG-1507 and the background count rate and a default detector response to Cs-137 (NRC, 1998). The equation during the walkover surveys of the CCP incorporates a d' of 1.38 and a surveyor efficiency of 0.5. The ambient background in the area was 12,000 counts per minute (cpm). The following is the calculation of the MDC_{scan} using an un-shielded probe:

b_i = (12,000 cpm) x (1 sec) x (1 min/60 sec) = 200 counts

MDCR = (1.38) x ($\sqrt{200\ counts}$) x (60 sec/1min) = 1170 cpm

$MDCR_{surveyor}$ = 1170 cpm/$\sqrt{0.5}$ = 1650 cpm

MDER = 1650 cpm /(900 cpm/μR/hr) = 1.83 μR/hr

$$MDC_{scan} = (5\,pCi/g) * \frac{1.83\,\mu R/hr}{1.307\,\mu R/hr} = 7.0\,pCi/g$$

5.3 Procedures

The Characterization Team was formally trained and qualified to applicable procedures prior to the initiation of the characterization and final status surveys. Documentation of training is maintained by CCP Project Records.

The following plans and procedures were utilized for the surveys:

DD-93-19, Rev. 5	Decommissioning Plan, Battelle Memorial Institute Columbus Operations
DD-97-02, Rev. 0	Radiological Characterization and Final Status Plan for BCLDP West Jefferson Site
SC-OP-002, Rev. 0	Facility Post-Decontamination Final Status Survey for Baseline Areas
SC-SP-004.2, Rev. 3	Manual and Mechanical Collection of Surface and Subsurface Soil Samples in Support of Site Characterization
HP-OP-100, Rev. 4	Operation and Calibration of the Eberline Model ESP-2 Survey Meter
WI-2806	Excavation and Trench Sampling and Surveys

6.0 Survey Findings

6.1 *Exposure Rate Surveys*

The calculated mean background exposure rate and the 95 percent confidence intervals used for the CCP grounds are 8 ± 2 μR/hr. **Table 4** presents the summary of all sampling and surveys for each area within the JN-1 B foundation excavation. The exposure rate readings for the excavation are presented in **Figure 3**. The exposure rate readings were individually compared to the mean background value of 8 ± 2 μR/hr in demonstrate compliance with the 5 μR /hr above background release criterion (grounds exposure rate surveys must be less than or equal 13 μR/hr to be compliant, while less than or equal to 18 μR/hr for trenches). The one meter measurements in the excavation indicated an average of 7.3 μR/hr. The minimum measurement in the excavation was 5 μR/hr and the maximum measurement was 12 μR/hr.

6.2 *Scanning Measurements*

Scanning measurements were performed with a two inch by two inch sodium iodide detector in accordance with section 6.3.1 of DD-97-02 (Battelle, 2000). Measurements were performed for the entire excavation of the foundation of JN-1 B.

The decision level value (DLV) for the scanning of open grounds and trenches is set at 18,374 cpm for final status surveys at the CCP. The DLV is the mean background plus the MDA of the scanning instruments. Scanning surveys of an area that exceed the DLV require additional radiological measurements. DD-97-02 requires that soil samples be collected at each location where the DLV is exceeded (Battelle, 2000).

Scanning measurements of the excavation were less than the DLV of 18,374 cpm for open ground surfaces. **Figure 4** presents the results of the scanning survey of the excavation. **Table 4** compiles the scanning surveys with other FSS data.

Scanning of the Building JN-1 B caisson wells was performed using a gas flow proportional counter. The counter was attached to a metal pole to facilitate the survey of the accessible portion of the wells. The following table summarizes the results.

	Alpha and Beta (dpm/100 cm^2)		Alpha only (dpm/100 cm^2)	
Well	Average	Range	Average	Range
East Caisson	2070	710 to 4550	23	-32 to 84
West Caisson	2170	87 to 9440	5	-59 to 85

Two locations present within the west caisson exceeded the 5000 dpm/100 cm^2 average limit for mixed fission products, but were below the 15,000 dpm/100 cm^2 maximum limit. The first location is at the north side at a depth of four meters, with a value of 9440 dpm/100 cm^2. The second location is at the east side at a depth of five meters, with a value of 8740 dpm/100 cm^2.

Each elevated measurement was averaged over a one square meter (m^2) area, as required by Note 3 of **Table 1**. Note 3 states that "measurements of average contamination should not be averaged over an area of more than $1 m^2$." Static measurements taken above, below, and to the sides of each elevated locations were averaged over a 1 m^2. Average static measurements are 3454 dpm/100 cm^2 for the first location and 4224 dpm/100 cm^2 for the second. Both averaged static measurements are below the average mixed fission surface contamination limit of 5000 dpm/100 cm^2. **Figures 5 and 6** present the results of the survey and the calculation of the averaged static measurements.

6.3 Excavation Sampling

Table 4 presents the reported analytical results for Cs-137 in each final status survey soil sample for the Building JN-1 B foundation excavation. **Figure 7** presents the sampling locations and the Cs-137 results for each location. Using the ratio of Cs-137 to other radionuclides, low concentrations of Cs-137 indicate even lower concentrations of other gamma emitting radionuclides of concern. As such, gamma emitting radionuclides of concern, other than Cs-137, are less than corresponding Minimum Detectable Activity (MDA). **Table 5** presents the typical MDAs for the gamma-emitting radionuclides of concern.

Compliance to the cleanup criteria presented in **Table 2** is demonstrated through a "fraction of limit." Section 4.2.1 discusses the application of the "fraction of limit."

When soil sample results begin to approach detected Cs-137 levels above 4 pCi/g, CS applies a "fraction of limit" calculation to verify the original assumptions. No samples within the Building JN-1 B foundation excavation possessed Cs-137 values above 4 pCi/g.

The following is a summary table of the Cs-137 results for the entire area:

Location	Number of Samples	Average (pCi/g)	Standard Deviation (pCi/g)	Range (pCi/g)	Modified Screening Criteria (pCi/g)
JN-1 B Foundation	46	0.66	0.86	-0.01 to 3.54	7.3

7.0 Conclusions

The characterization and final status survey results demonstrate that the radiological endpoint criteria objectives of the NRC-approved Decommissioning Plan have been met for the excavation addressed by this effort. (Battelle, 2003) The scanning measurements for alpha + beta and alpha and the smear survey results obtained from the caisson wells are reported as concentrations less than those listed in **Table 1.** Reported analytical results for media samples obtained from the Building JN-1 B foundation excavation are below the residual radioactivity concentrations for soil and solid volumes as presented in **Table 2.** The final status survey performed on the Building JN-1 B foundation excavation statistically demonstrates that the remediation of the area was successful and that the excavation is free from residual radioactive contamination making the area suitable for unrestricted release.

8.0 References

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Figures

Figure 1
Site Map

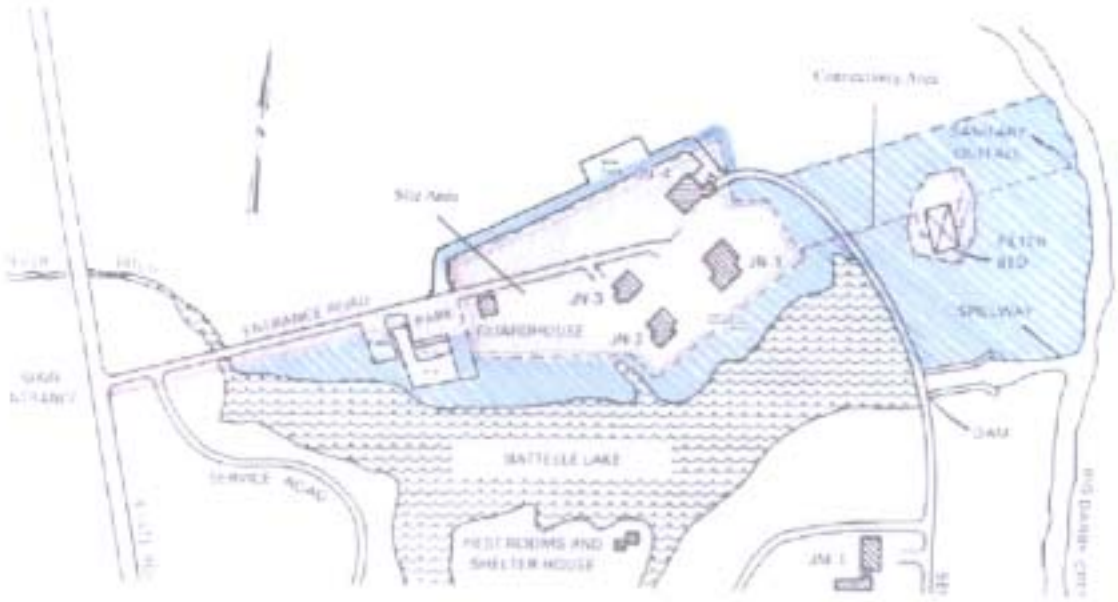
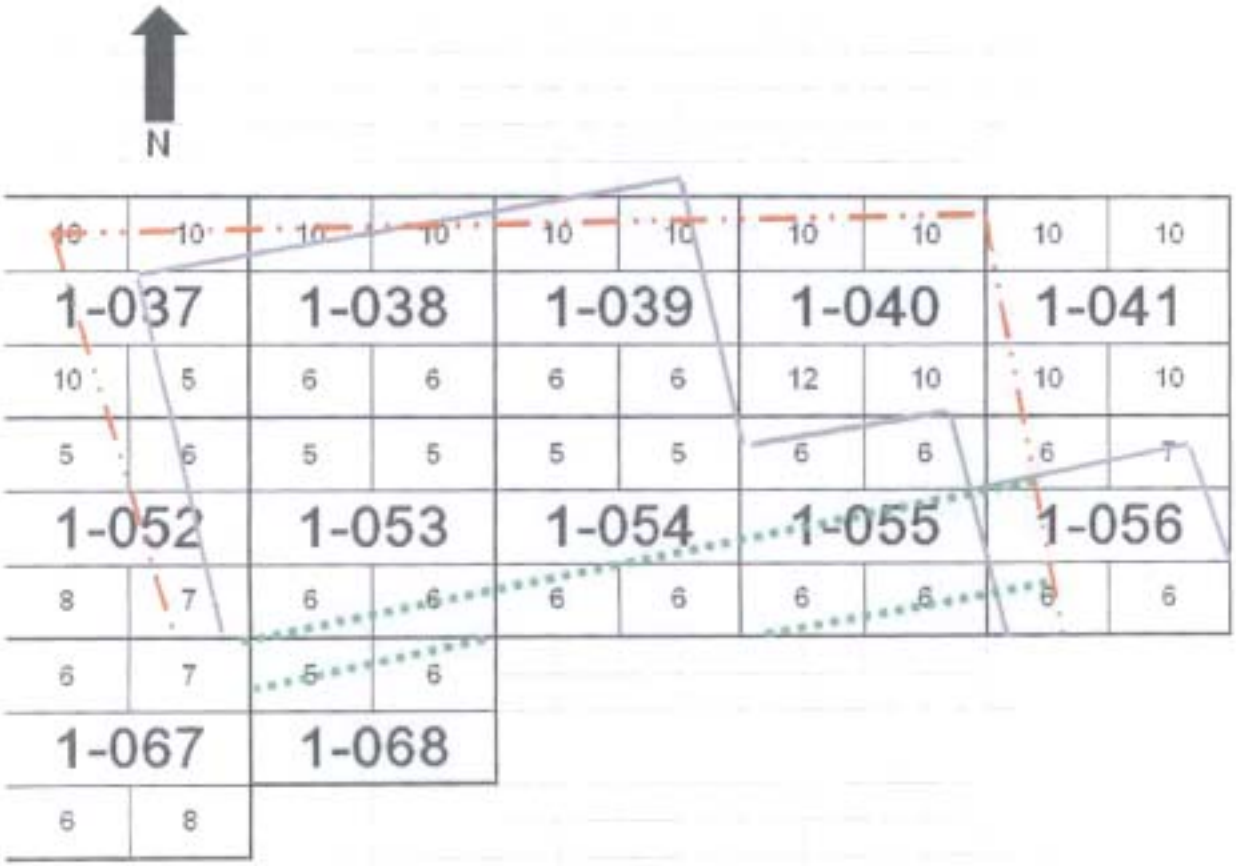


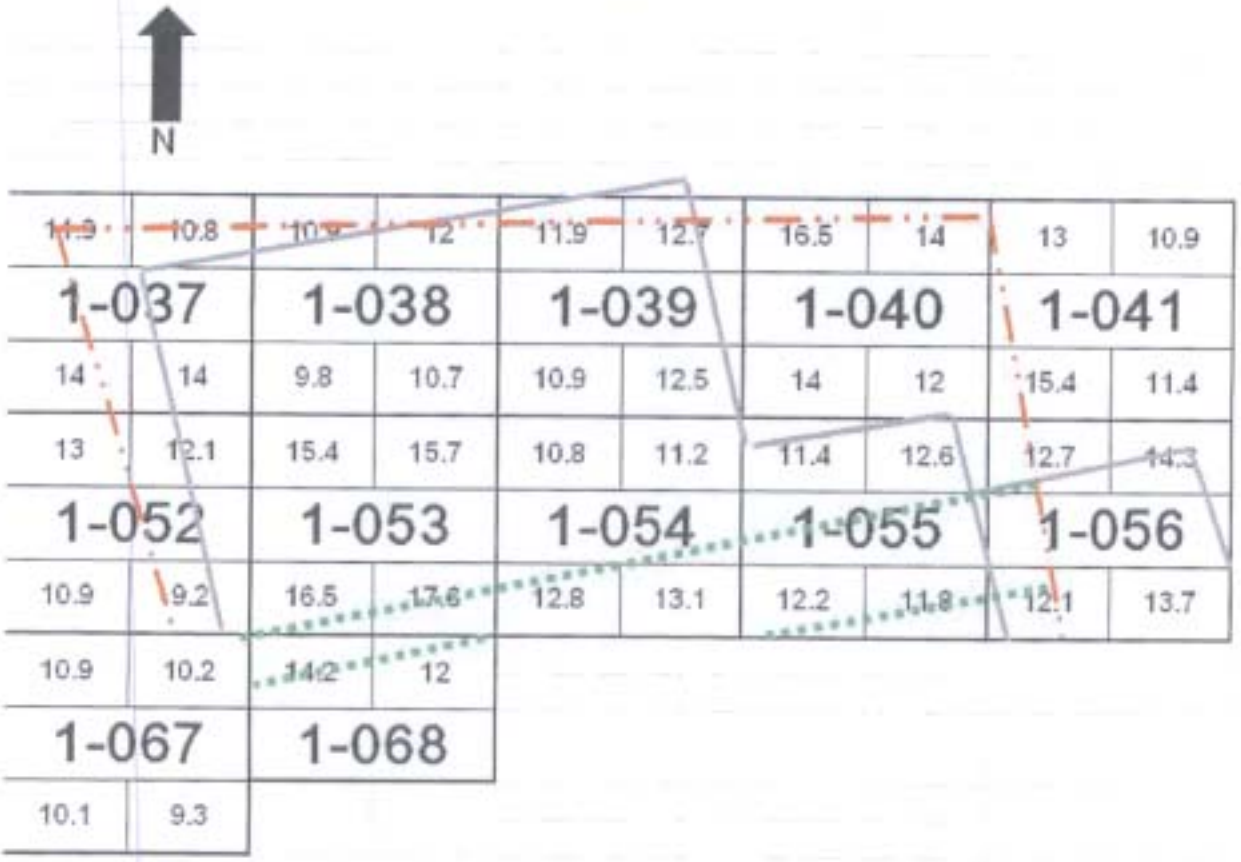
Figure 2
Building JN-1 B Foundation Excavation Map

Figure 3
Building JN-1 B Foundation Excavation Exposure Rates



Survey Results in µR/hr

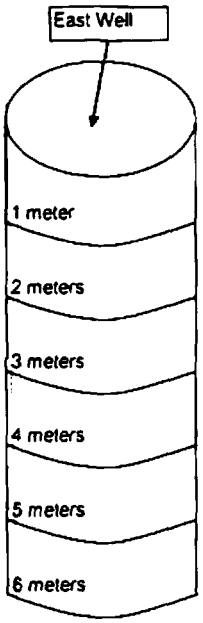
Figure 4
Building JN-1 B Foundation Walkover Scans



Survey results in Kcpm

Figure 5
Building JN-1 B East Caisson Well Survey

JN-1 East Caisson Well

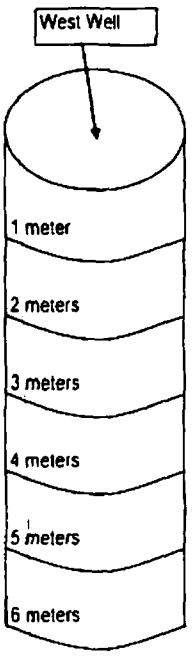


	α+β (dpm/100cm²):				α (dpm/100cm2):			
	North	East	South	West	North	East	South	West
1m	1350	3860	710	1120	47	4	84	11
2m	930	4550	1770	2420	1.8	53	8.1	70
3m	3500	3530	2320	2230	51	3.6	44	4.5
4m	2680	2690	2510	2510	9.5	7.7	1.8	0.5
5m	1960	1040	1870	1480	27	-32	0.5	30
6m	1130	1090	970	1560	18	11	21	66

ESP-2: 91494
43-20: 92324
Cal. Date: 12-29-05
α bkg: 13 cpm
α+β bkg: 240 cpm
α efficiency: 22.14%
α+β efficiency: 27.45%

Figure 6
Building JN-1 B West Caisson Well Survey

JN-1 West Caisson Well



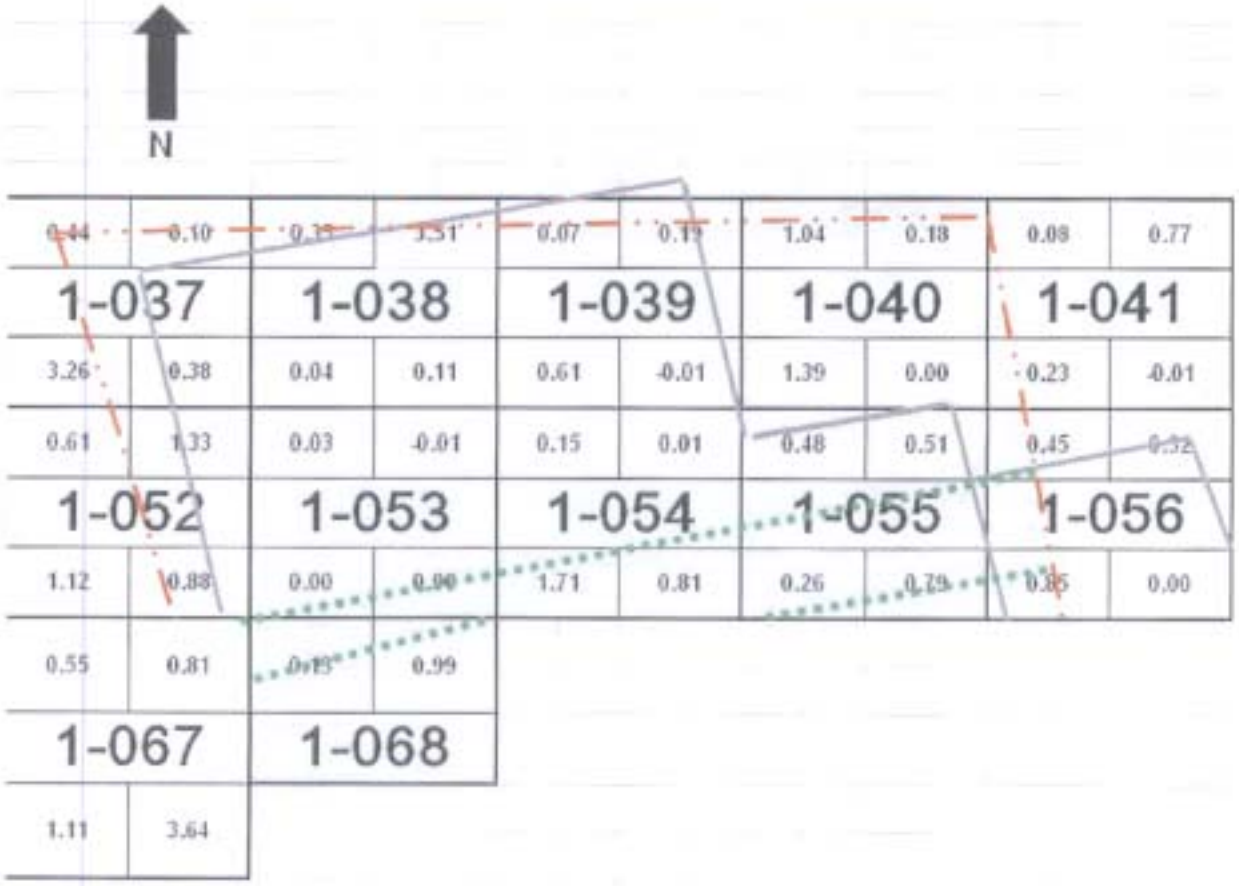
		α+β (dpm/100cm²):				α (dpm/100cm²):			
		North	East	South	West	North	East	South	West
1 meter	1m	870	580	590	3460	-52	85	0	23
2 meters	2m	87	320	2100	1170	-59	54	0	4.5
3 meters	3m	560	870	1000	320	-59	7.7	0	0
4 meters	4m	9440	1870	2360	2190	34	4.5	1.4	30
5 meters	5m	3210	8740	4950	2050	45	-25	1.8	0.5
6 meters	6m	1640	2350	630	680	0	6.8	17	0

ESP-2: 91494
43-20: 92324
Cal. Date: 12-29-05
α bkg: 13 cpm
α+β bkg: 240 cpm
α efficiency: 22.14%
α+β efficiency: 27.45%

Elevated Location #1 = 9440 dpm/100 cm²	
Above	560 cpm/100 cm²
Left	2190 cpm/100 cm²
Right	1870 cpm/100 cm²
Below	3210 cpm/100 cm²
Location	9440 dpm/100 cm²
Average	*3454 dpm/100 cm²*

Elevated Location #2 = 8740 dpm/100 cm²	
Above	1870 dpm/100 cm²
Left	3210 dpm/100 cm²
Right	4950 dpm/100 cm²
Below	2350 dpm/100 cm²
Location	8740 dpm/100 cm²
Average	*4224 dpm/100 cm²*

Figure 7
Building JN-1 B Foundation Excavation Cs-137 Result Summary



Cs-137 results in pCi/g

Tables

Table 1
Surface Contamination Guidelines for BCLDP

Radionuclides [2]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[1]		
	Average [3,4]	*Maximum* [4,5]	*Removable* [4,6]
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	Reserved (100)*	Reserved (300)*	Reserved (20)*
Th-Natural, Sr-90, I-126, I-131, I-133, , Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay product, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others notes above. [7]	5,000	15,000	1,000

(1) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

(2) Where surface contamination by both alpha-and beta-gamma-emitting radionuclides exists, the limits established for alpha-and beta-gamma-emitting radionuclides should apply independently.

(3) Measurements of average contamination should not be averaged over an area of more than 1m^2. For objects of less surface area, the average should be derived for each such object.

(4) The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr and 1.0 mrad/hr., respectively, at 1 cm.

(5) The maximum contamination level applies to an area of not more than 100 cm^2.

(6) The amount of removable material per 100 cm^2 of surface area should be determined by wiping and area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

(7) This category of radionuclides includes mixed fission products, including the Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

* Regulatory Guide 1.86

Table 2
BCLDP GUIDELINES FOR RESIDUAL
RADIOACTIVITY CONCENTRATIONS FOR SOIL AND SOLID VOLUMES

Radionuclide[a]	King Avenue Concentration (pCi/g)[b]	West Jefferson Concentration (pCi/g)[b]
Natural Uranium	10[1]	na[c]
Enriched Uranium	30[1]	30[1]
Depleted Uranium	35[1]	35[1]
Ac-227	19	19
Am-241	na[c]	30[4]
Am-243	na	30[4]
Ce-144	na	2,100
Cm-243	na	0.79
Cm-244	na	1.0
Co-60	8[2]	8[2]
Cs-134	na	33
Cs-137	15[2]	15[2]
C-14	940	940
Eu-152	na	36
Eu-154	na	32
Eu-155	na	1,800
Fe-55	na	2.7E+07
H-3[d]	41,000	38,000
I-129	na	13
Mn-54	na	61
Ni-59	na	1.3E+07
Ni-63	na	4.9E+06
Np-237	na	0.58
Pa-231	18	18
Pb-210	140	na
Pu-238	na	25[4]
Pu-239	na	25[4]
Pu-240	na	25[4]
Pu-241	na	25[4]
Pu-242	na	25[4]

Radionuclide[a]	King Avenue Concentration (pCi/g)[b]	West Jefferson Concentration (pCi/g)[b]
Ra-226 (0-15 cm of soil)	5[2,3]	na
Ra-226 (>15 cm of soil)	15[2,3]	na
Ra-228	5[2,3]	na
Ru-106	na	180
Sb-125	na	118
Sm-151	na	6,700
Sr-90	5[2]	5[2]
Th-228	29	na
Th-230	5[3]	na
Th-232	5[3]	na

Table 2 Notes and References

Notes:

a. Activity concentrations above natural background concentrations. Where more than one radionuclide is present, the sum of the ratios of the individual radionuclide concentrations to their respective concentration limits shall not exceed 1.

b. Concentrations for which no specific reference is cited have been derived from RESRAD calculations and are the more restrictive values calculated for soil deposition at a depth of 5 meters.

c. Indicates that this radionuclide is not expected to be found at the indicated site.

d. Difference in tritium activity concentrations are due to the difference in depths of the water tables at two sites. The water table depth at King Avenue is deeper than that at West Jefferson.

References:

1. Options 1 and 2 of the Branch Technical Position, "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations" (46 FR 52061, October 23, 1981).

2. NRC Memorandum, "Acceptable Cleanup Criteria and Practices for Decontamination and Decommissioning (License No. SNM-7)" dated April 17, 1992, to Harley L. Toy, License Coordinator and Manager, Nuclear Sciences, Battelle Memorial Institute from J.W.N. Hickey, Chief, Fuel Cycle Safety Branch, Division of Industrial and Medical Nuclear Safety, Office of Nuclear Material Safety and Safeguards.

3. DOE Order 5400.5, "Radiation Protection of the Public and the Environment".

4. NRC Policy and Guidance Directive FC83-23, "Termination of Byproduct, Source, and Special Nuclear Material Licenses".

Table 3

JN-1 and Bog Area Cesium-137 Surrogate Analysis Data & Modified Cs-137 Screening Criteria

Sample #	pCi/g Cs-137	Fraction Cs-137 Lim	pCi/g Co-60	Fraction Co-60 Lim	pCi/g Eu-152	Fraction Eu-152 Lim	pCi/g Eu-154	Fraction Eu-154 Lim	pCi/g Am-241	Fraction Am-241 Lim	pCi/g Sr-90	Fraction Sr-90 Lim	pCi/g Pu-238	Fraction Pu-238 Lim	pCi/g Pu-239	Fraction Pu-239 Lim
RL05-2744	10.50	0.70	0.20	0.03	0.07	0.00	0.06	0.00	0.27	0.01	2.29	0.46	0.10	0.00	0.05	0.00
RL05-2745	16.30	1.09	0.46	0.06	0.07	0.00	0.09	0.00	-0.20	-0.01	1.97	0.39	0.20	0.01	0.17	0.01
RL05-2746	5.52	0.37	0.19	0.02	0.05	0.00	0.03	0.00	0.30	0.01	0.83	0.17	0.12	0.00	0.05	0.00
RL05-2747	6.43	0.43	0.20	0.03	0.10	0.00	0.03	0.00	-0.08	0.00	1.11	0.22	0.05	0.00	0.01	0.00
RL05-2748	18.30	1.22	0.56	0.07	0.14	0.00	0.07	0.00	0.36	0.01	1.34	0.27	0.14	0.01	0.08	0.00
RL05-2750	18.40	1.23	1.30	0.16	0.11	0.00	0.10	0.00	0.09	0.00	10.90	2.18	0.80	0.03	0.38	0.02
RL05-2751	12.90	0.86	0.40	0.05	0.07	0.00	0.03	0.00	-0.10	0.00	1.73	0.35	0.14	0.01	0.09	0.00
RL05-3012	16.10	1.07	0.19	0.02	0.15	0.00	0.09	0.00	-0.04	0.00	9.13	1.83	1.06	0.04	0.32	0.01
RL05-3014	4.40	0.29	0.01	0.00	0.05	0.00	0.04	0.00	-0.19	-0.01	0.91	0.18	0.05	0.00	0.01	0.00
RL05-3015	25.60	1.71	0.70	0.09	0.22	0.01	0.17	0.01	0.42	0.01	13.30	2.66	0.77	0.03	0.32	0.01
RL05-3017	15.70	1.05	0.38	0.05	0.04	0.00	0.02	0.00	-0.33	-0.01	8.15	1.63	0.62	0.02	0.33	0.01
RL05-3294	15.80	1.05	0.45	0.06	0.02	0.00	0.04	0.00	0.28	0.01	2.34	0.47	0.05	0.00	0.08	0.00
RL05-3296	8.10	0.54	0.27	0.03	-0.04	0.00	0.01	0.00	-0.28	-0.01	2.81	0.56	0.03	0.00	0.10	0.00
RL05-3297	43.20	2.88	0.75	0.09	-0.01	0.00	0.09	0.00	0.05	0.00	3.10	0.62	0.08	0.00	0.12	0.00
RL05-3300	19.50	1.30	0.49	0.06	0.03	0.00	0.04	0.00	-0.06	0.00	2.87	0.57	0.07	0.00	0.24	0.01
RL05-4049	19.50	1.30	0.26	0.03	0.11	0.00	0.11	0.00	0.36	0.01	1.22	0.24	0.98	0.04	0.31	0.01
RL05-4084	13.90	0.93	0.58	0.07	0.08	0.00	0.09	0.00	0.28	0.01	2.79	0.56	0.17	0.01	0.13	0.01
RL05-4085	19.90	1.33	0.30	0.04	0.09	0.00	0.11	0.00	0.47	0.02	5.37	1.07	0.36	0.01	0.12	0.00
RL05-4100	7.47	0.50	0.15	0.02	0.05	0.00	0.10	0.00	0.38	0.01	1.44	0.29	0.22	0.01	0.52	0.02
RL05-4101	7.05	0.47	0.04	0.00	-0.10	0.00	0.04	0.00	-0.01	0.00	0.55	0.11	0.54	0.02	0.93	0.04
RL05-4153	7.15	0.48	0.09	0.01	-0.02	0.00	-0.04	0.00	-0.03	0.00	2.24	0.45	0.13	0.01	0.53	0.02
RL05-4158	12.80	0.85	0.45	0.06	0.08	0.00	0.02	0.00	0.17	0.01	10.50	2.10	0.55	0.02	0.28	0.01
RL05-4159	7.56	0.50	0.24	0.03	0.02	0.00	-0.02	0.00	0.19	0.01	10.30	2.06	0.80	0.03	0.23	0.01
RL05-4161	11.00	0.73	0.25	0.03	0.08	0.00	0.08	0.00	0.07	0.00	9.45	1.89	0.77	0.03	0.24	0.01
RL05-4162	19.50	1.30	0.25	0.03	0.10	0.00	0.05	0.00	0.18	0.01	5.28	1.06	0.31	0.01	0.15	0.01
Average	14.50	0.97	0.37	0.05	0.06	0.00	0.06	0.00	0.10	0.00	4.48	0.90	0.36	0.01	0.23	0.01

Limits		X_L Cs-137 Ratios	
Cs-137	15 pCi/g		
Co-60	8 pCi/g	Cs/Co-60	35.7
Eu-152	36 pCi/g	Cs/Eu-152	76.1
Eu-154	32 pCi/g	Cs/Eu-154	225.1
Am-241	30 pCi/g	CsAm-241	78.9
Sr-90	5 pCi/g	Cs/Sr-90	4.1
Pu-238	25 pCi/g	Cs/Pu-238	57.5
Pu-239	25 pCi/g	Cs/Pu-239	83.1
Pu-241	25 pCi/g	Cs/Pu-241	2.8

	Activity (pCi/g) = Cs-137/Ratio	Limits (pCi/g)	Fraction
Cs-137	7.30	15	0.487
Co-60	0.20	8	0.026
Eu-152	0.10	36	0.003
Eu-154	0.03	32	0.001
Am-241	0.09	30	0.003
Sr-90	1.78	5	0.356
Pu-238	0.13	25	0.005
Pu-239	0.09	25	0.004
Pu-241	2.61	25	0.104
		Sum	0.99

Table 4
Building JN-1 B Survey and Sampling Results

Sample ID	Location	Collection Date	Walkover Scan (Results in cpm)	Exposure Rate (Results in µR/hr)	Cs-137 Content (Results in pCi/g)
RL05-0099-4538	Grid 1-037 NW	1/6/2006	11900	10	0.44
RL06-0100-4539	Grid 1-037 NE	1/6/2006	10800	10	0.10
RL05-4223-3954	Grid 1-037 SW	12/19/2005	14000	10	3.26
RL05-4222-3953	Grid 1-037 SE	12/19/2005	14000	5	0.38
RL06-0101-4540	Grid 1-038 NW	1/6/2006	10900	10	0.35
RL05-4224-3955	Grid 1-038 NE	12/19/2005	12000	10	3.51
RL06-0102-4541	Grid 1-038 SW	1/6/2006	9800	6	0.04
RL06-0103-4542	Grid 1-038 SE	1/6/2006	10700	6	0.11
RL06-0104-4543	Grid 1-039 NW	1/6/2006	11900	10	0.07
RL06-0230-4675	Grid 1-039 NE	1/10/2006	12700	10	0.19
RL06-0105-4544	Grid 1-039 SW	1/6/2006	10900	6	0.61
RL06-0106-4545	Grid 1-039 SE	1/6/2006	12500	6	-0.01
RL06-0107-4546	Grid 1-040 NW	1/4/2006	16500	10	1.04
RL06-0235-4694	Grid 1-040 NE	1/11/2006	14000	10	0.18
RL06-0236-4695	Grid 1-040 SW	1/11/2006	14000	12	1.39
RL06-0108-4547	Grid 1-040 SE	1/4/2006	12000	10	0.00
RL06-0231-4676	Grid 1-041 NW	1/10/2006	13000	10	0.08
RL06-0109-4548	Grid 1-041 NE	1/4/2006	10900	10	0.77
RL06-0110-4549	Grid 1-041 SW	1/4/2006	15400	10	0.23
RL06-0111-4550	Grid 1-041 SE	1/6/2006	11400	10	-0.01
RL06-0112-4551	Grid 1-052 NW	12/19/2005	13000	5	0.61
RL06-0113-4552	Grid 1-052 NE	1/6/2006	12100	6	1.33
RL06-0114-4553	Grid 1-052 SW	12/19/2005	10900	8	1.12

Sample ID	Location	Collection Date	Walkover Scan (Results in cpm)	Exposure Rates (Results in µR/hr)	Cs-137 Content (Results in pCi/g)
RL06-0115-4554	Grid 1-052 SE	12/19/2005	9200	7	0.88
RL05-4656-4272	Grid 1-053 NW	12/8/2005	15400	5	0.03
RL05-4657-4273	Grid 1-053 NE	12/8/2005	15700	5	-0.01
RL05-4658-4274	Grid 1-053 SW	12/8/2005	16500	6	0.00
RL05-4659-4275	Grid 1-053 SE	12/8/2005	17600	6	0.00
RL06-0116-4555	Grid 1-054 NW	1/6/2006	10800	5	0.15
RL06-0117-4556	Grid 1-054 NE	1/6/2006	11200	5	0.01
RL06-0118-4557	Grid 1-054 SW	1/6/2006	12800	6	1.71
RL06-0119-4558	Grid 1-054 SE	1/6/2006	13100	6	0.81
RL06-0120-4559	Grid 1-55 NW	1/6/2006	11400	6	0.48
RL06-0121-4560	Grid 1-55 NE	1/6/2006	12600	6	0.51
RL06-0122-4561	Grid 1-55 SW	1/6/2006	12200	6	0.26
RL06-0123-4562	Grid 1-55 SE	1/6/2006	11800	6	0.79
RL06-0124-4563	Grid 1-56 NW	1/6/2006	12700	6	0.45
RL06-0125-4564	Grid 1-56 NE	1/6/2006	14300	7	0.32
RL06-0126-4565	Grid 1-56 SW	1/6/2006	12100	6	0.85
RL06-0232-4677	Grid 1-56 SE	1/10/2006	13700	6	0.00
RL06-0127-4566	Grid 1-67 NW	12/19/2005	10900	6	0.55
RL06-0128-4567	Grid 1-67 NE	1/6/2006	10200	7	0.81
RL06-0129-4568	Grid 1-67 SW	1/6/2006	10100	6	1.11
RL06-0130-4569	Grid 1-67 SE	12/19/2005	9300	8	3.54
RL06-0131-4570	Grid 1-68 NW	12/19/2005	14200	5	0.13
RL06-0132-4571	Grid 1-68 NE	12/19/2005	12000	6	0.99

Table 5
MDA of Gamma-Emitting Radionuclides of Concern

Cs-137 MDA (pCi/g)	Co-60 MDA (pCi/g)	Eu-152 MDA (pCi/g)	Eu-154 MDA (pCi/g)	Am-241 MDA (pCi/g)
0.024 +/- 0.013	0.022 +/- 0.012	0.067 +/- 0.030	0.055 +/- 0.039	0.451 +/- 0.30