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**Results of the Independent  
Radiological Verification Survey  
at 4400 Piehl Road, Ottawa Lake,  
Michigan (BTO002)**

**M. E. Murray  
K. S. Brown**

MANAGED BY  
LOCKHEED MARTIN ENERGY SYSTEMS, INC.  
FOR THE UNITED STATES  
DEPARTMENT OF ENERGY

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**HEALTH SCIENCES RESEARCH DIVISION**  
Environmental Restoration and Waste Management Non-Defense Programs  
(Activity No. EX 20 20 01 0; ADS1310AA)

**Results of the Independent Radiological  
Verification Survey at 4400 Piehl Road, Ottawa Lake,  
Michigan (BTO002)**

M. E. Murray, K. S. Brown

Date Issued - April 1996

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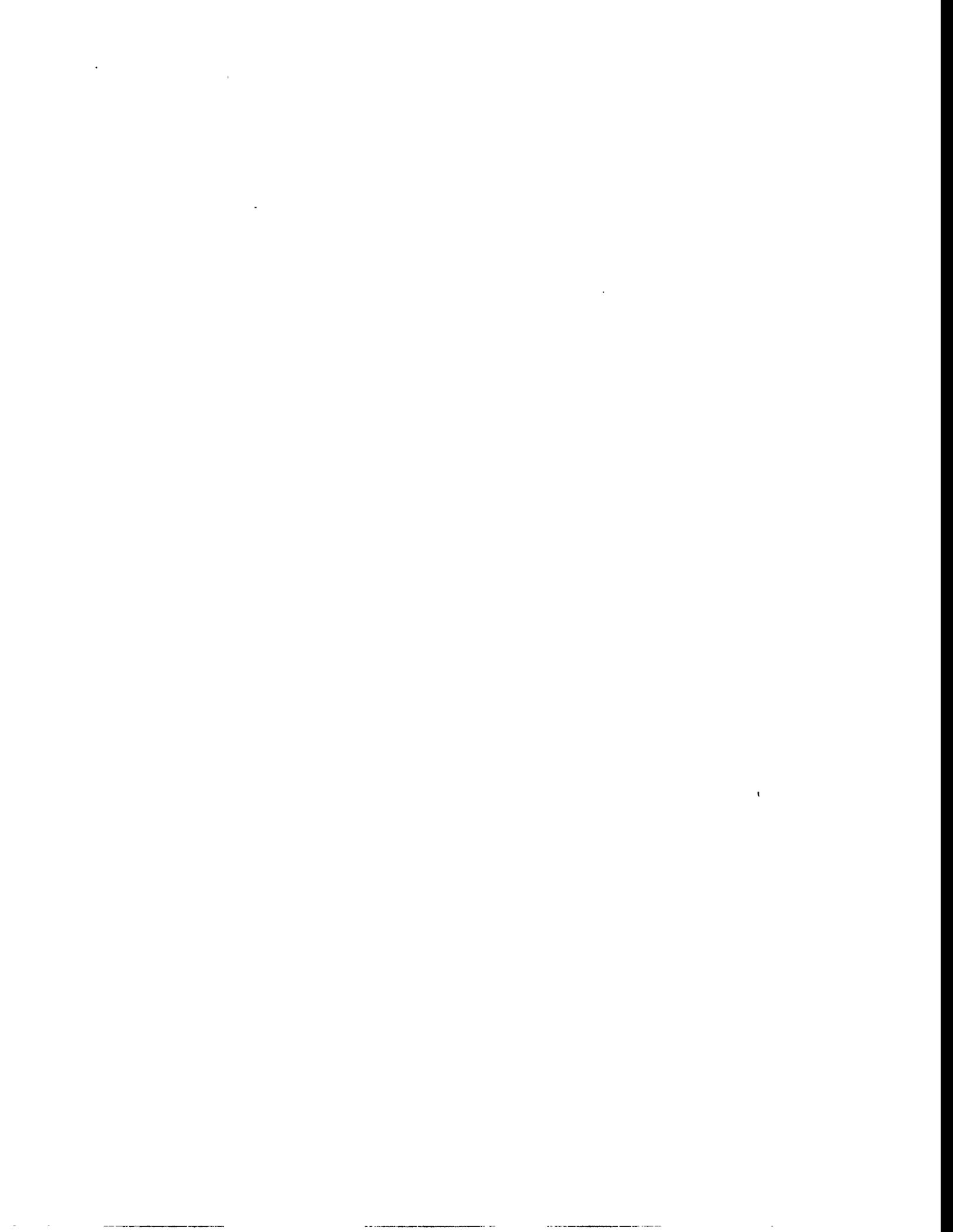
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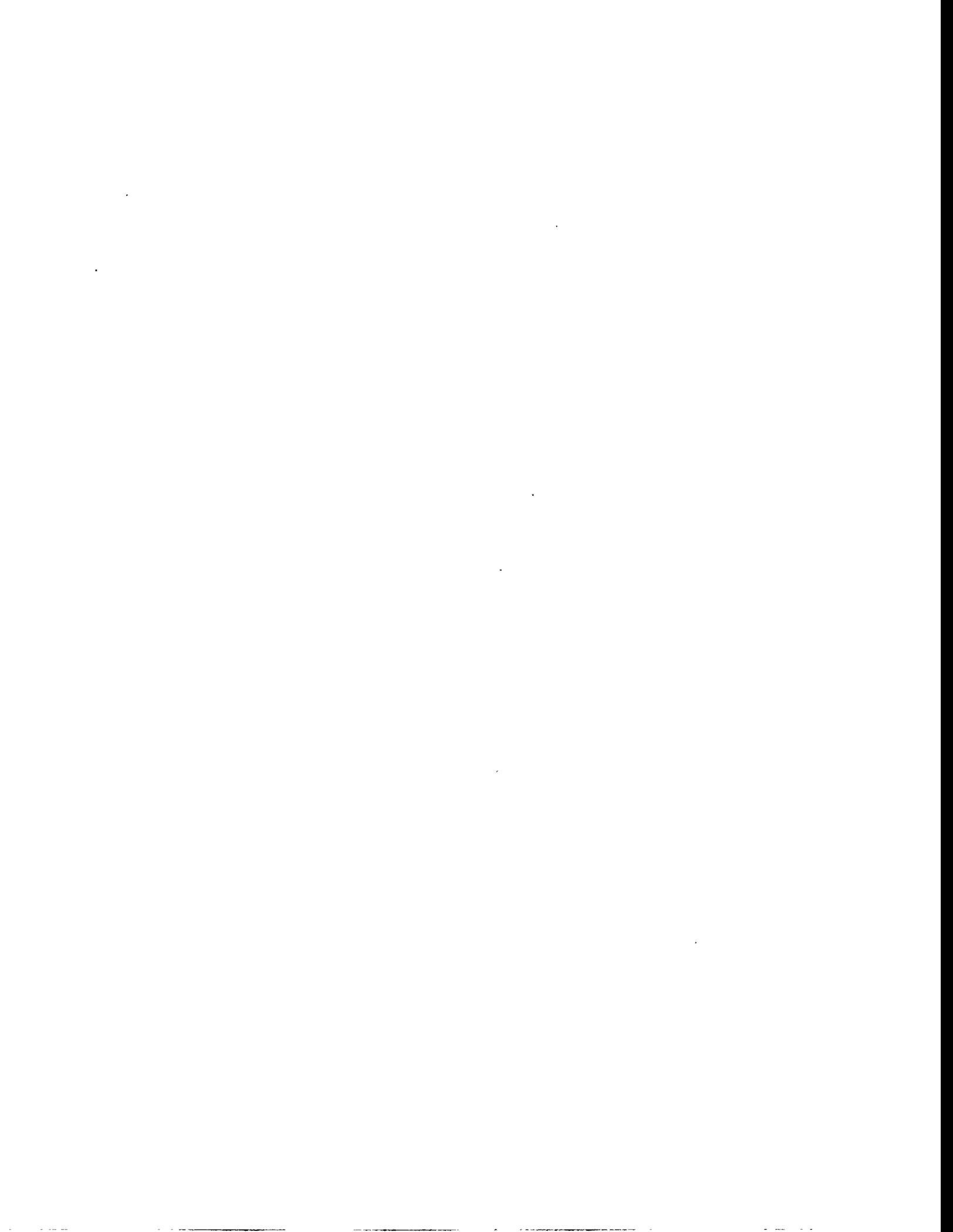
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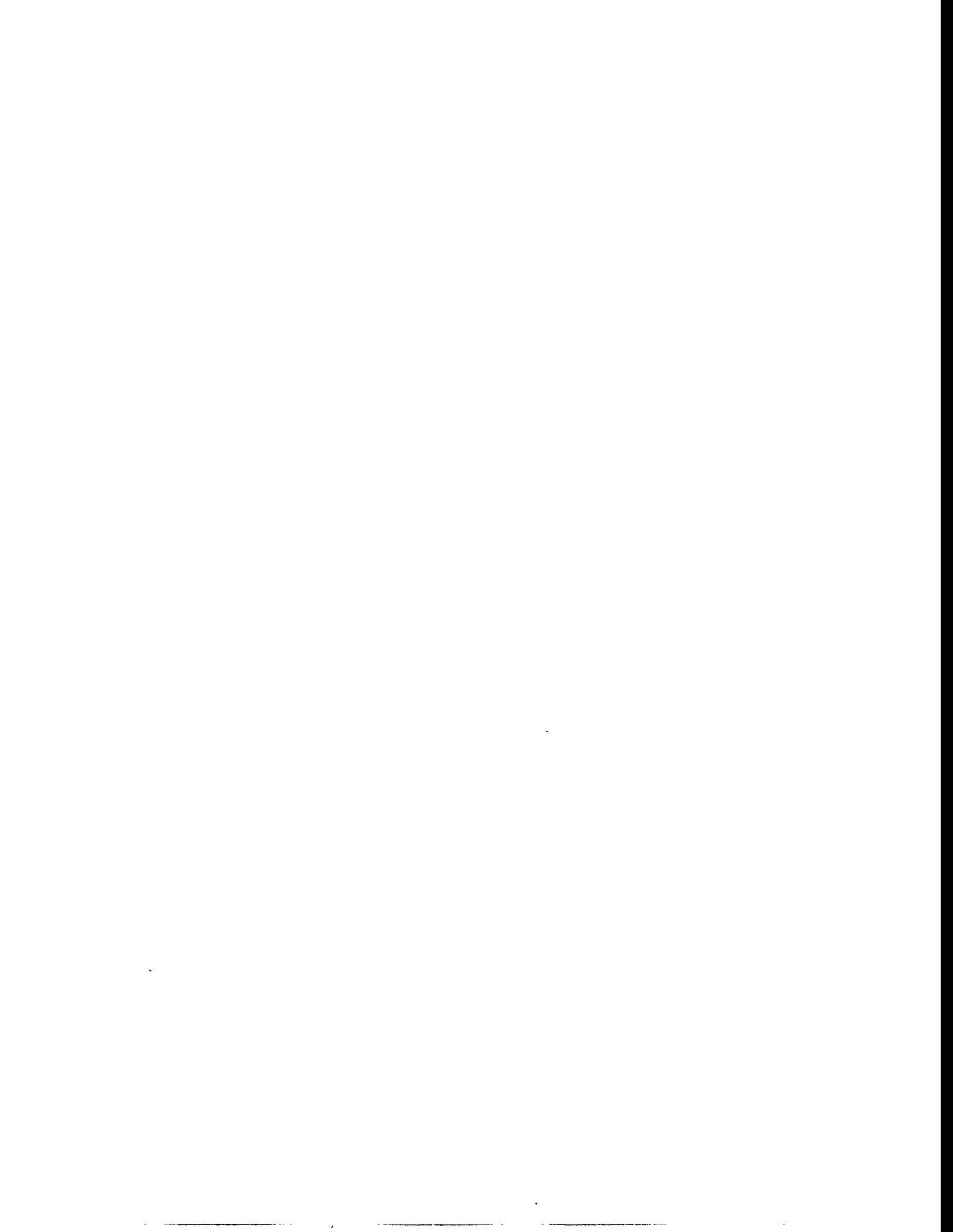
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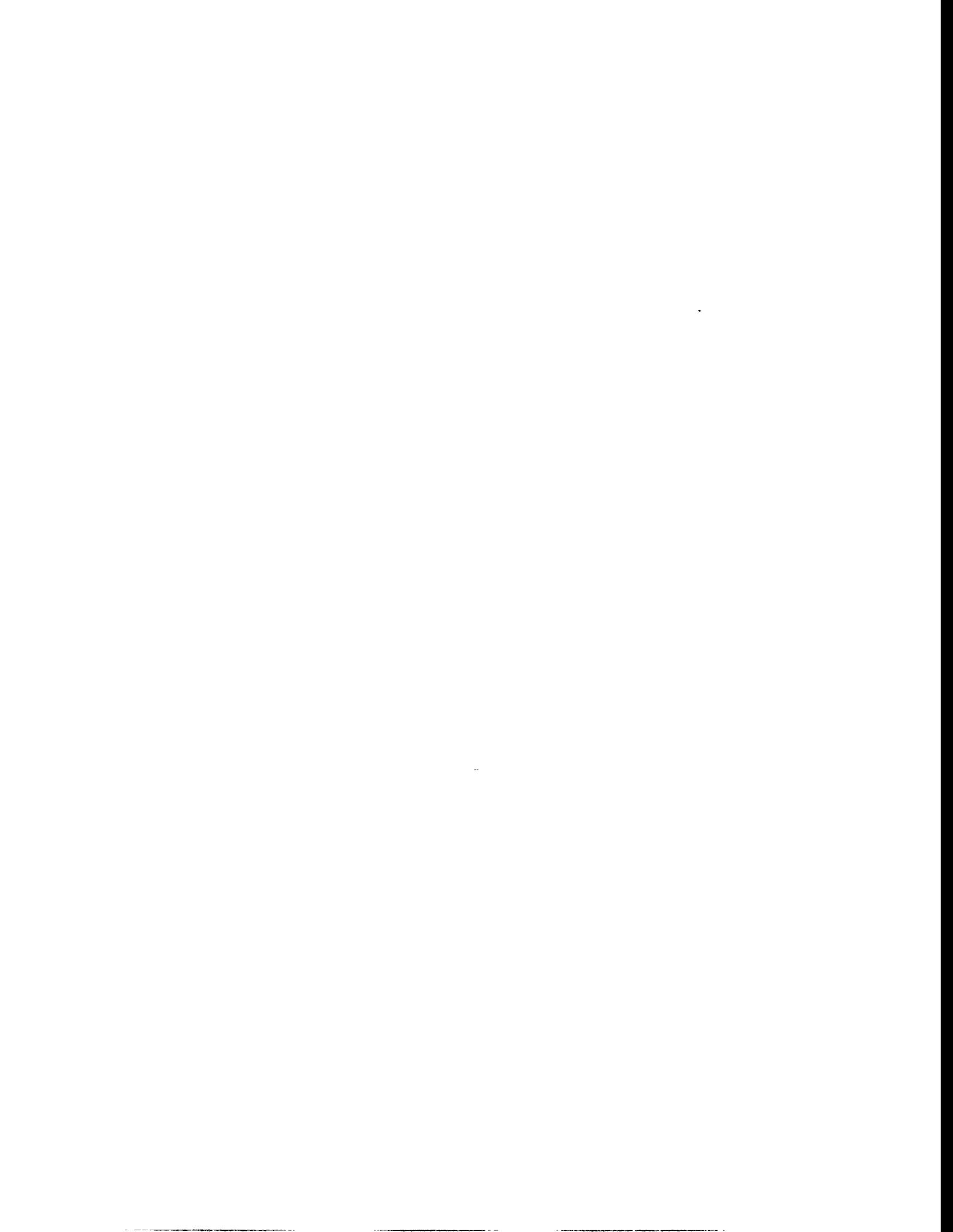
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## **ABSTRACT**

At the request of the U.S. Department of Energy (DOE), a team from Oak Ridge National Laboratory (ORNL) conducted an independent radiological verification survey at 4400 Piehl Road, Ottawa Lake, Michigan. The survey was performed in November and December of 1994. The purpose of the survey was to verify that the site was remediated to levels below DOE guidelines for FUSRAP sites.

Results of the independent radiological verification survey at 4400 Piehl Road, Ottawa Lake, Michigan confirm that the residual uranium contamination at the site is below DOE FUSRAP guidelines for unrestricted use.



**Results of the Independent Radiological Verification Survey  
at 4400 Piehl Road, Ottawa Lake,  
Michigan (BTO002)\***

**INTRODUCTION**

During the early and mid-1940s, Baker Brothers, Inc., in Toledo, Ohio, fabricated uranium slugs from processed uranium metals under subcontract to the Manhattan Engineer District (MED). This commercial property consisted of several buildings and grounds covered with either asphalt or concrete, except for a dirt courtyard at the northwest end of the site. Results of a survey by Oak Ridge National Laboratory (ORNL) indicated partial contamination with  $^{238}\text{U}$ , and the Baker property was officially included in the FUSRAP program in 1992.<sup>1</sup> Earlier that year the Baker Brothers assets were liquidated, and the property was divided and sold to two independent companies. One part of the property was resold in the summer of 1992. The new owner contacted ORNL and inquired about the radiological status of his property. Through this conversation it was learned that soil from the former Baker Brothers site may have been moved to a site in Michigan.<sup>2</sup>

In September of 1992 the Measurement Applications and Development Group at ORNL conducted a radiological survey at 4400 Piehl Road, Ottawa Lake, Michigan at the request of the Department of Energy (DOE), since soil had allegedly been hauled to this site from the former Baker property in Toledo, Ohio.<sup>2</sup> The property is in a semirural area approximately 15 miles northwest of Toledo, Ohio. An occupied residence, barn and pond are located on the site of approximately seven acres. Isolated spots of uranium contamination were identified in two general areas located to the northwest and south of the house where transported soil was allegedly placed.<sup>2</sup>

At the request of DOE, a team from ORNL conducted an independent radiological verification survey at 4400 Piehl Road, Ottawa Lake, Michigan. The survey was performed in November and December of 1994. The purpose of the survey was to verify that radioactivity from residues of  $^{238}\text{U}$  was remediated to a level below acceptable DOE guideline levels for FUSRAP sites by Bechtel National, Inc. (BNI). Figure 1 is a diagram of the site overlaid by the grid used by ORNL for remediation activities.

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\*The survey was performed by members of the Measurement Applications and Development Group of the Health Sciences Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

## VERIFICATION PROCEDURES

A description of the typical survey methods and instrumentation providing guidance for the verification survey may be found in *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).<sup>3</sup>

Gamma radiation levels were determined using portable NaI gamma scintillation meters; beta/gamma measurements were made with GM "pancake" probes. Samples were screened in the field laboratory using a gamma spectrometer and a shielded GM tube.

The survey of the property included the following:

- A gamma scan and measurement of beta-gamma radiation levels in the two contaminated areas south of the residence ("front area") and northwest of the residence ("back area") as shown in Fig. 1.
- Sampling and radionuclide analysis of verification systematic and biased samples from the front and back areas. Figure 2 is a diagram of sample locations in the front area south of the residence. Figure 3 is a diagram of sample locations in the back area northwest of the residence. Systematic samples were collected on a 5-meter grid. Biased samples were collected in areas where radiation was detected above background radiation.

A final gamma scan was performed around the perimeter of both areas. In addition to conducting independent radiological surveys, ORNL staff reviewed the radiological survey data resulting from BNI post-remedial action work.

## VERIFICATION SURVEY RESULTS

DOE guidelines are summarized in Table 1. Typical background radionuclide concentrations for the Michigan area are presented in Table 2. These data are provided for comparison with survey results presented in this section. Background concentrations have not been subtracted from radionuclide concentrations measured in soil samples.

Where sample results indicated  $^{238}\text{U}$  concentrations above the guideline, either the contaminated soil was subsequently removed, the "hot spot" criteria were not exceeded, or the average area "100-m<sup>2</sup>" concentration guideline was not exceeded. In most cases, BNI removed the contaminated soil.

The property at 4400 Piehl Road, Ottawa Lake, Michigan was verified to be within DOE guidelines at the end of the verification survey. Results of laboratory analysis of radionuclide concentrations of  $^{238}\text{U}$  in verification systematic and biased soil samples are listed in Table 3.

## CONCLUSIONS

Review of BNI survey results by ORNL, and the independent radiological verification survey by ORNL at 4400 Piehl Road, Ottawa Lake, Michigan, confirm that the site meets the DOE radiological guidelines for unrestricted use.

## REFERENCES

1. R. D. Foley and L. M. Floyd, *Radiological Survey of the Former Baker Brothers, Inc. Site, 2551-2555 Harleau Place, Toledo, Ohio (BTO001)*, ORNL/RASA-90/8, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., March 1992.
2. R. D. Foley and C. A. Johnson, *Radiological Survey Results at 4400 Piehl Road, Ottawa Lake, Michigan (BTO002)*, ORNL/RASA-93/1, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1993.
3. *Measurement Applications and Development Group Guidelines*, ORNL-6782, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., January 1995.

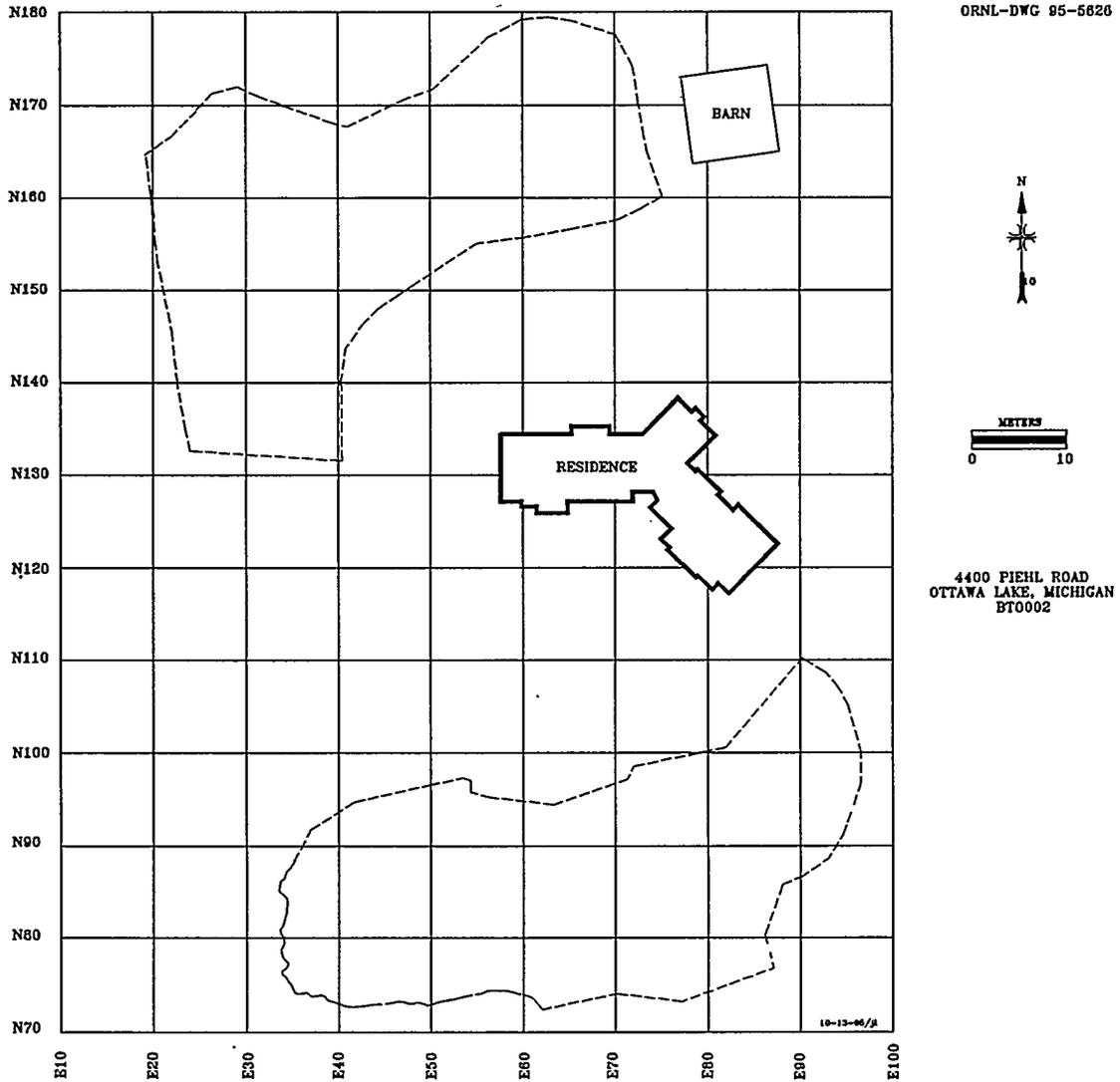
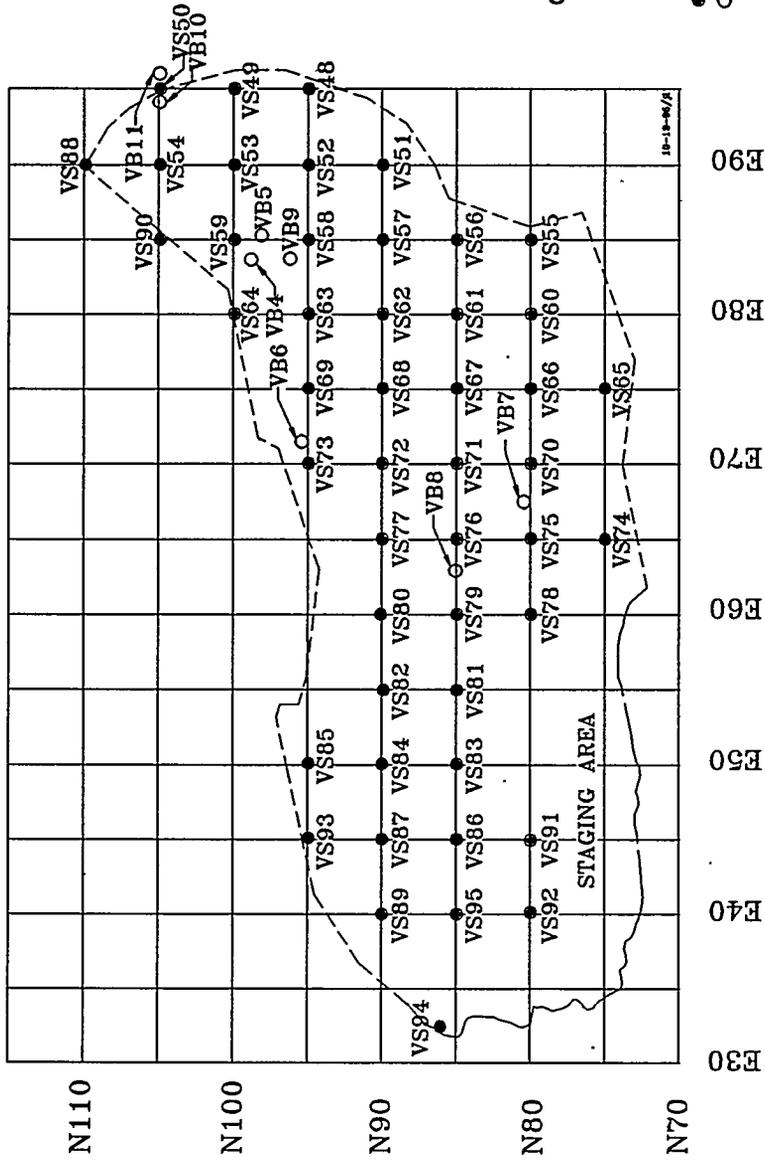


Fig. 1. Diagram of the property at 4400 Piehl Road, Ottawa Lake, Michigan showing remediated areas south and northwest of the residence.



4400 PIEHL ROAD  
OTTAWA LAKE, MICHIGAN  
BT0002

- SYSTEMATIC SOIL SAMPLE
- BIASED SOIL SAMPLE

Fig. 2. Locations of verification systematic and biased samples south of the residence at 4400 Piehl Road, Ottawa Lake, Michigan.

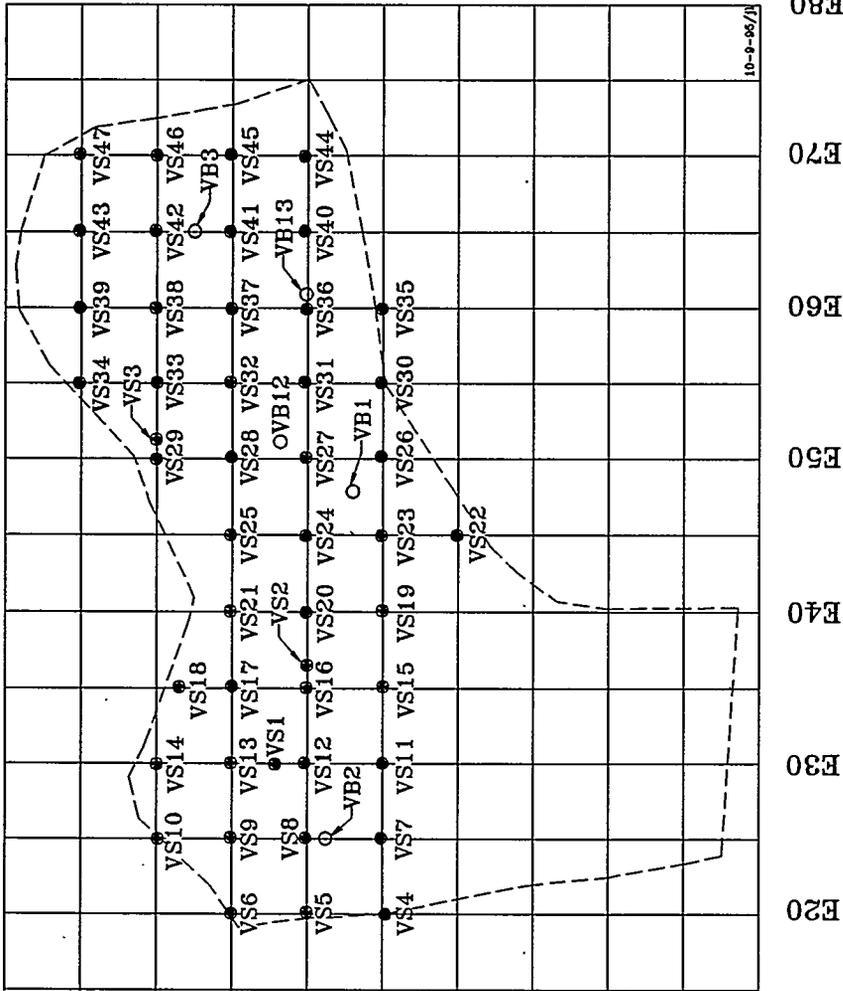
N180

N170

N160

N150

N140



4400 PIEHL ROAD  
OTTAWA LAKE, MICHIGAN  
BT0002

- SYSTEMATIC SOIL SAMPLE
- BIASED SOIL SAMPLE

Fig. 3. Locations of verification systematic and biased samples northwest of the residence at 4400 Piehl Road, Ottawa Lake, Michigan.

**Table 1. Applicable guidelines for protection against radiation  
(Limits for uncontrolled areas)**

Mode of exposure	Exposure conditions	Guideline value
Total residual surface contamination <sup>a</sup>	<sup>238</sup> U, <sup>235</sup> U, U-natural (alpha emitters)	
	Maximum	15,000 dpm/100 cm <sup>2</sup>
	Average	5,000 dpm/100 cm <sup>2</sup>
	Removable	1,000 dpm/100 cm <sup>2</sup>
Derived concentrations	Total uranium	35 pCi/g <sup>b, c</sup>
Guideline for non-homogeneous contamination (used in addition to the 100-m <sup>2</sup> guideline) <sup>d</sup>	Applicable to locations with an area $\leq 25$ m <sup>2</sup> , with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$ , where $G_A$ = guideline for "hot spot" of area (A) $G_i$ = guideline averaged over a 100-m <sup>2</sup> area

<sup>a</sup>DOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

<sup>b</sup>Memo, J. W. Wagoner II, Director, Off-Site/Savannah River Programs Division, Office of Eastern Area Programs, Office of Environmental Restoration, U.S. DOE, to L. K. Price, Director, Former Sites Restoration Division, Oak Ridge Field Office, U.S. DOE, November 28, 1994.

<sup>c</sup>Since the contaminant was normal uranium, the guideline value for <sup>238</sup>U was 17.5 pCi/g.

<sup>d</sup>DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

*Sources:* Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990, and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U. S. Department of Energy Radiological Control Manual, DOE N 5480.6 (DOE/EH-256T), June 1992.

**Table 2. Average background radiation levels for the Michigan area <sup>a</sup>**

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure rate at ground surface ( $\mu\text{R/h}$ )	no data
Concentration of radionuclides in soil (pCi/g) <sup>b</sup>	
$^{232}\text{Th}$	0.5
$^{226}\text{Ra}$	1.0
$^{238}\text{U}$	0.8

<sup>a</sup>Source: T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

<sup>b</sup>These values represent the average normal radionuclide concentrations in the state of Michigan.

**Table 3. Concentrations of radionuclides in soil verification samples at 4400 Piehl Road, Ottawa Lake, Michigan**

Sample ID <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>238</sup> U	<sup>226</sup> Ra	<sup>232</sup> Th
<i>Systematic samples<sup>c</sup></i>				
VS1	0-15	7.0 ± 1.5	0.4 ± 0.01	0.3 ± 0.02
VS2	0-15	6.0 ± 1.5	0.6 ± 0.1	0.3 ± 0.1
VS3	0-15	0.9 ± 0.3	0.5 ± 0.1	0.3 ± 0.1
VS4	0-15	0.4 ± 0.2	0.4 ± 0.1	0.3 ± 0.1
VS5	0-15	5.0 ± 1.0	0.4 ± 0.1	0.3 ± 0.1
VS6	0-15	0.8 ± 0.3	0.4 ± 0.04	0.2 ± 0.1
VS7	0-15	5.7 ± 0.8	0.4 ± 0.04	0.2 ± 0.1
VS8	0-15	6.5 ± 1.1	0.4 ± 0.04	0.3 ± 0.1
VS9	0-15	2.0 ± 0.2	0.3 ± 0.04	0.3 ± 0.1
VS10	0-15	0.8 ± 0.2	0.3 ± 0.1	0.3 ± 0.1
VS11	0-15	3.7 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
VS12	0-15	1.6 ± 0.4	0.4 ± 0.1	0.3 ± 0.1
VS13	0-15	7.0 ± 2.0	0.4 ± 0.1	0.3 ± 0.1
VS14	0-15	0.6 ± 0.2	0.4 ± 0.1	0.4 ± 0.1
VS15	0-15	10 ± 2	0.5 ± 0.1	0.3 ± 0.1
VS16	0-15	1.5 ± 0.6	1.0 ± 0.1	0.3 ± 0.1
VS17	0-15	9.0 ± 2.0	0.5 ± 0.1	0.3 ± 0.1
VS18	0-15	0.5 ± 0.2	0.5 ± 0.1	0.4 ± 0.1
VS19	0-15	7.0 ± 1.0	0.5 ± 0.1	0.3 ± 0.1
VS20	0-15	10 ± 3	0.7 ± 0.1	0.3 ± 0.1
VS21	0-15	5.3 ± 1.1	0.5 ± 0.1	0.3 ± 0.1
VS22	0-15	0.7 ± 0.3	0.6 ± 0.1	0.4 ± 0.04
VS23	0-15	19 ± 2	0.4 ± 0.1	0.3 ± 0.1
VS24	0-15	5.0 ± 1.0	0.5 ± 0.1	0.3 ± 0.1

Table 3 (continued)

Sample ID <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>238</sup> U	<sup>226</sup> Ra	<sup>232</sup> Th
VS25	0-15	1.6 ± 0.3	0.4 ± 0.1	0.2 ± 0.1
VS26	0-15	3.0 ± 1.5	0.5 ± 0.1	0.3 ± 0.1
VS27	0-15	7.0 ± 1.5	0.4 ± 0.1	0.3 ± 0.1
VS28	0-15	1.3 ± 0.4	0.4 ± 0.1	0.2 ± 0.1
VS29	0-15	0.5 ± 0.2	0.3 ± 0.1	0.2 ± 0.1
VS30	0-15	0.6 ± 0.2	0.4 ± 0.04	0.3 ± 0.1
VS31	0-15	0.6 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
VS32	0-15	1.8 ± 0.5	0.4 ± 0.04	0.3 ± 0.1
VS33	0-15	1.4 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
VS34	0-15	1.0 ± 0.3	0.5 ± 0.1	0.3 ± 0.1
VS35	0-15	1.3 ± 0.6	0.4 ± 0.04	0.2 ± 0.1
VS36	0-15	4.2 ± 0.7	0.5 ± 0.1	0.4 ± 0.1
VS37	0-15	1.5 ± 0.4	0.4 ± 0.04	0.3 ± 0.1
VS38	0-15	1.6 ± 0.4	0.6 ± 0.1	0.4 ± 0.1
VS39	0-15	1.2 ± 0.5	0.6 ± 0.1	0.2 ± 0.1
VS40	0-15	4.1 ± 0.8	0.4 ± 0.1	0.3 ± 0.1
VS41	0-15	0.5 ± 0.2	0.3 ± 0.04	0.2 ± 0.1
VS42	0-15	1.3 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
VS43	0-15	1.4 ± 0.5	0.5 ± 0.1	0.3 ± 0.1
VS44	0-15	20 ± 1	0.4 ± 0.1	0.3 ± 0.1
VS45	0-15	1.2 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
VS46	0-15	0.6 ± 0.2	0.6 ± 0.1	0.3 ± 0.1
VS47	0-15	3.7 ± 0.6	0.6 ± 0.1	0.2 ± 0.1
VS48	0-15	3.7 ± 0.6	0.5 ± 0.2	0.2 ± 0.1
VS49	0-15	2.2 ± 0.4	0.4 ± 0.1	0.1 ± 0.1

Table 3 (continued)

Sample ID <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>238</sup> U	<sup>226</sup> Ra	<sup>232</sup> Th
VS50	0-15	43 ± 8	0.6 ± 0.1	0.5 ± 0.1
VS51	0-15	5.2 ± 0.6	0.4 ± 0.1	0.4 ± 0.1
VS52	0-15	1.8 ± 0.3	0.7 ± 0.1	0.3 ± 0.1
VS53	0-15	7.3 ± 0.6	0.5 ± 0.1	0.3 ± 0.1
VS54	0-15	5.8 ± 0.6	0.6 ± 0.1	0.1 ± 0.1
VS55	0-15	1.7 ± 0.4	0.2 ± 0.1	0.3 ± 0.2
VS56	0-15	1.8 ± 0.5	0.5 ± 0.2	0.1 ± 0.1
VS57	0-15	19 ± 1	0.7 ± 0.2	0.6 ± 0.2
VS58	0-15	1.8 ± 0.4	0.5 ± 0.1	0.3 ± 0.1
VS59	0-15	1.7 ± 0.4	0.4 ± 0.1	0.1 ± 0.04
VS60	0-15	2.2 ± 0.3	0.6 ± 0.1	0.1 ± 0.03
VS61	0-15	1.7 ± 0.4	0.3 ± 0.1	0.1 ± 0.04
VS62	0-15	17 ± 1	0.6 ± 0.2	0.2 ± 0.1
VS63	0-15	2.1 ± 0.4	0.6 ± 0.1	0.2 ± 0.1
VS64	0-15	1.0 ± 0.3	0.4 ± 0.2	0.2 ± 0.1
VS65	0-15	2.2 ± 0.5	0.3 ± 0.1	<0.2
VS66	0-15	3.4 ± 0.6	0.5 ± 0.2	0.1 ± 0.04
VS67	0-15	1.1 ± 0.3	0.5 ± 0.2	0.2 ± 0.04
VS68A	0-15	1.7 ± 0.4	0.5 ± 0.2	0.1 ± 0.04
VS68B	15-30	1.5 ± 0.4	0.4 ± 0.2	0.1 ± 0.1
VS69A	0-15	3.2 ± 0.5	0.4 ± 0.2	0.1 ± 0.04
VS69B	15-30	1.0 ± 0.3	0.6 ± 0.2	0.2 ± 0.1
VS70	0-15	1.4 ± 0.3	0.4 ± 0.1	0.3 ± 0.1
VS71A	0-15	56 ± 3	0.3 ± 0.2	0.3 ± 0.1
VS71B	15-30	7.0 ± 0.8	0.4 ± 0.1	0.3 ± 0.1
VS72	0-15	3.4 ± 0.5	0.5 ± 0.1	0.5 ± 0.1

Table 3 (continued)

Sample ID <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>238</sup> U	<sup>226</sup> Ra	<sup>232</sup> Th
VS73	0-15	2.8 ± 0.5	0.7 ± 0.2	0.8 ± 0.2
VS74	0-15	4.7 ± 0.5	0.3 ± 0.1	0.2 ± 0.1
VS75	0-15	1.0 ± 0.3	0.3 ± 0.2	0.1 ± 0.1
VS76	0-15	7.8 ± 0.9	0.6 ± 0.2	0.3 ± 0.1
VS77	0-15	2.2 ± 0.4	0.6 ± 0.1	0.2 ± 0.1
VS78	0-15	1.3 ± 0.3	0.3 ± 0.1	0.2 ± 0.1
VS79	0-15	12 ± 2	0.6 ± 0.2	0.6 ± 0.2
VS80	0-15	0.8 ± 0.2	0.5 ± 0.2	0.2 ± 0.1
VS81	0-15	16 ± 1	0.7 ± 0.2	0.4 ± 0.1
VS82	0-15	7.2 ± 0.9	0.4 ± 0.2	0.2 ± 0.1
VS83	0-15	0.5 ± 0.2	0.3 ± 0.1	0.2 ± 0.1
VS84	0-15	1.3 ± 0.3	0.4 ± 0.1	0.4 ± 0.1
VS85	0-15	0.7 ± 0.2	0.4 ± 0.2	0.1 ± 0.03
VS86	0-15	1.5 ± 0.3	0.4 ± 0.1	0.3 ± 0.1
VS87	0-15	1.1 ± 0.3	0.2 ± 0.1	0.1 ± 0.1
VS88	0-15	1.1 ± 0.2	0.4 ± 0.1	0.2 ± 0.1
VS89	0-15	2.0 ± 0.2	0.3 ± 0.1	0.1 ± 0.1
VS90	0-15	1.5 ± 0.4	0.4 ± 0.2	0.2 ± 0.04
VS91	0-15	2.0 ± 0.4	0.4 ± 0.2	0.2 ± 0.04
VS92	0-15	0.8 ± 0.2	0.2 ± 0.1	0.1 ± 0.02
VS93	0-15	6.8 ± 0.8	0.5 ± 0.2	0.3 ± 0.2
VS94	0-15	25 ± 3	0.7 ± 0.1	0.4 ± 0.1
VS95	0-15	6.8 ± 0.8	0.6 ± 0.2	0.4 ± 0.1
<i>Biased samples<sup>d</sup></i>				
B1	0-15	25 ± 3	0.4 ± 0.1	0.3 ± 0.1

Table 3 (continued)

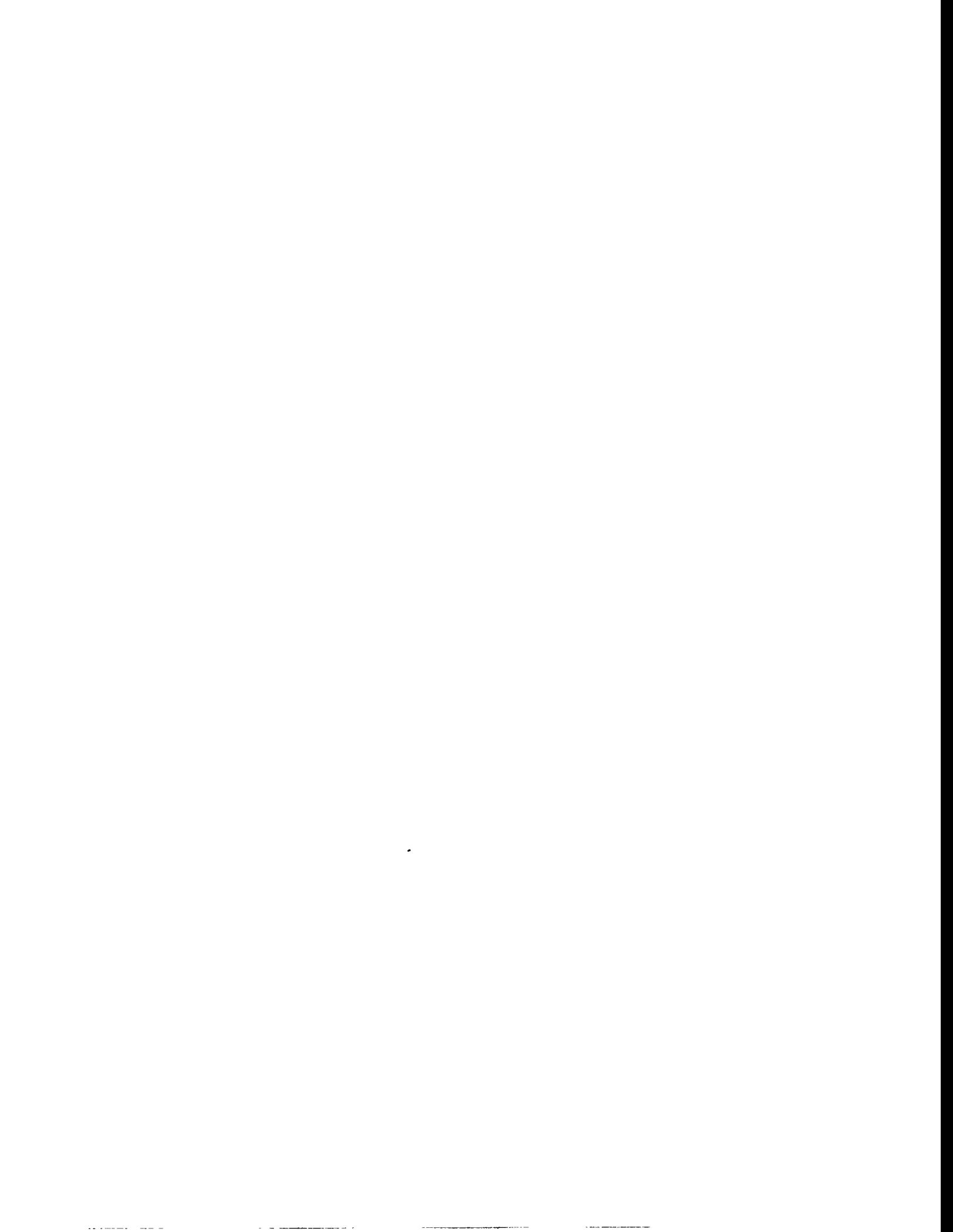
Sample ID <sup>a</sup>	Depth (cm)	Radionuclide concentration (pCi/g) <sup>b</sup>		
		<sup>238</sup> U	<sup>226</sup> Ra	<sup>232</sup> Th
B2	0-15	110 ± 30	0.4 ± 0.1	0.3 ± 0.1
B3	0-15	6.6 ± 1.2	0.4 ± 0.1	0.3 ± 0.1
B4	0-15	2.6 ± 0.5	0.5 ± 0.1	0.3 ± 0.1
B5	0-15	19 ± 1	0.5 ± 0.1	0.3 ± 0.1
B6	0-15	29 ± 2	0.6 ± 0.1	0.3 ± 0.1
B7	0-15	19 ± 2	0.3 ± 0.1	0.2 ± 0.1
B8	0-15	39 ± 5	0.6 ± 0.1	0.3 ± 0.1
B9	0-15	31 ± 1	0.5 ± 0.1	0.2 ± 0.1
B10	0-10	14 ± 1	0.5 ± 0.1	0.1 ± 0.1
B11	0-17	10 ± 2	0.7 ± 0.2	0.4 ± 0.1
B12	0-15	2.0 ± 0.3	0.6 ± 0.1	0.3 ± 0.1
B13	0-15	7.7 ± 0.6	0.6 ± 0.2	0.5 ± 0.1

<sup>a</sup>Sample locations are shown in Figs. 2 and 3.

<sup>b</sup>Indicated counting error is at the 95% confidence level ( $\pm 2\sigma$ ).

<sup>c</sup>Systematic samples are taken at locations irrespective of gamma exposure rates. Sample values above guidelines, when averaged with surrounding samples, indicated concentrations within DOE guidelines.

<sup>d</sup>Biased samples are taken from areas with elevated gamma exposure rates. Where sample results indicated <sup>238</sup>U concentrations above the guideline, either the contaminated soil was subsequently removed, the "hot spot" criteria were not exceeded, or the average area "100-m<sup>2</sup>" concentration guideline was not exceeded. In most cases, BNI removed the contaminated soil.



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