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**Results of the Post Remedial
Action Survey of Areas 4 Through 10
at the Former Kellex Site in
Jersey City, New Jersey**

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Health and Safety Research Division

RESULTS OF THE POST REMEDIAL ACTION SURVEY OF AREAS 4 THROUGH 10 AT THE FORMER KELLEX SITE IN JERSEY CITY, NEW JERSEY

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RESULTS OF THE POST REMEDIAL ACTION SURVEY OF
AREAS 4 THROUGH 10 AT THE FORMER KELLEX SITE
IN JERSEY CITY, NEW JERSEY

ABSTRACT

A post remedial action survey was conducted at the former Kellex Corporation Research Facility in Jersey City, New Jersey. The Kellex facility was involved in the Manhattan Project, particularly in the area of engineering research in gaseous diffusion for uranium enrichment. As a result of those operations, this site was included by the U.S. Department of Energy (DOE) in their Formerly Utilized Sites Remedial Action Program (FUSRAP). During comprehensive radiological surveys conducted by Oak Ridge National Laboratory in the summer of 1979, ten areas were located with levels of radionuclides in soil in excess of DOE criteria. This report describes the results of radiological surveys conducted in seven of these locations (Areas 4-10) following remedial action. Results of these surveys indicate that remedial action was successful in reducing radioactive contamination in these areas to criteria values established by DOE.

INTRODUCTION

The M. W. Kellogg Company established the Kellex Corporation in 1943 at the intersection of New Jersey Route 440 and Kellogg Street.¹ The purpose of the Kellex facility was to design and construct the first gaseous diffusion uranium enrichment plant under a Manhattan Engineer District (MED) contract. Later, other uranium recovery and decontamination activities took place under MED/Atomic Energy Commission (AEC) contracts.¹ All uranium-related activities were discontinued at the former Kellex site in July 1952.

In June 1953, the VITRO Corporation of America prepared a contamination status report based on a radiological survey of one of the buildings at the former Kellex site.²

Comprehensive radiological surveys of the former Kellex facility were conducted by Oak Ridge National Laboratory (ORNL) in two phases following a preliminary radiological survey by ORNL on October 21, 1976.³ The initial radiological survey was conducted on the eastern portion of the

site in March 1977. The radiological survey on the western portion of the site was completed over the remaining area during the summer of 1979. The results of the ORNL survey are provided in Reference 3.

During these surveys, nine areas of contamination were found. The locations of these nine contaminated areas are schematically located in Fig. 1. A tenth area of contamination was found during decontamination activities in August 1979. The location of this area is also shown in Fig. 1.

Decontamination of Areas 1-3 at this site was conducted by Envirosphere Company (a division of Ebasco Services, Inc.) with construction assistance by Tobar Construction Company during the week ending August 11, 1979.⁴ The results of post remedial radiological survey of Areas 1-3 at the former Kellex site are presented in Reference 4.

Decontamination of Areas 4-9 was conducted by Envirosphere during the period between August 12, 1979, and November 29, 1979 (Area 10 was not decontaminated). The purpose of this report is to document results of the post remedial action survey conducted by ORNL on Areas 4-10.

SURVEY METHODS

The survey at the former Kellex Laboratory site was performed in accordance with the survey plan to characterize the existing radiological status of the Kellex site.³ Comprehensive descriptions of survey methods and instrumentation similar to those and for this survey have been provided in other reports.⁵

All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

For the purposes of this survey, biased soil samples are soil samples collected at specific locations where gamma radiation levels were measured at one and a half to twice the normal New Jersey background level. Composite soil samples are soil samples generated by taking small aliquots of soil at regular intervals over a specified area and mixing the aliquots into a single homogeneous soil sample.

CRITERIA AND BACKGROUND RADIATION LEVELS

Applicable remedial action criteria have been summarized in Table 1. Since no firm or widely accepted criteria for residual radioactivity in soil existed at the time of the remedial action, a reasonable effort was made to reduce the contamination to near background levels. An upper limit for radionuclides ^{232}Th and ^{226}Ra and their precursors in soil was assumed to be 5 pCi/g for any sample of soil (~ 1 lb). The ^{238}U criterion used during the clean-up of the Kellex site was 40 pCi/g in the top 20 cm of soil averaged over 400 m² of area. The normal background levels for the New Jersey area are presented in Table 2. These data are provided for comparison with the survey results.

SURVEY RESULTS

In order to document the location of post-cleanup radiation measurements and residual radionuclide concentrations, a grid system was established in six areas (4-9) as shown in Figs. 1-18. Area 6 consisted of ten smaller contaminated areas which were designated Areas 6A-6J. Area 10 (Fig. 19) was excavated but not grided, and did not warrant any post-cleanup activities; however, soil samples were taken from this area for analysis. Within the borders of each area on these figures, an outline of the portion of that area which was excavated is shown.

Within the center of each grid block, gamma exposure rates were measured 1 m above the ground and beta gamma dose rates were measured at 1 cm above the ground. Each grid block was scanned at a height of 0-10 cm from the surface to measure the gamma exposure rate. Results of these measurements for the areas 4-9 are presented in Tables 3-18.

Final soil and water samples were returned to ORNL, processed, and analyzed using routine laboratory techniques. Each soil sample was counted with a Ge(Li) spectrometer and the concentration of ^{232}Th and ^{226}Ra was determined using a computer-based multichannel analyzer. Uranium determinations were made by the ORNL Analytical Chemistry Division using a neutron activation technique.⁶ Results of these analyses for soil samples collected in the six decontaminated areas and area 10 are

presented in Tables 19-34. Water sample results and a summary table of soil data are presented in Tables 35 and 36, respectively.

The maximum observed ^{226}Ra concentration over the 5 pCi/g criteria was measured in samples KT13B (9.1 pCi/g) and KT13B1 (13 pCi/g) taken from area 10 at a depth of 46 cm. However, the area is believed to meet the criteria for ^{226}Ra in soil averaged over a 100 m² area.

The major contaminant found in the areas surveyed was ^{238}U which ranged from 1 to 140 pCi/g. Areas which showed no elevated radionuclide concentrations were: 4, 5, 6C, 6E, 6H, 7 and 9. Although Areas 6A, 6B, 6F, 6G, 6I, 6J, 8 and 10 contained some elevated concentration of ^{238}U , these areas did not exceed the guideline value of 40 pCi/g of ^{238}U in the top 20 cm of soil averaged over a 400-m² area.

SIGNIFICANCE OF FINDINGS

Based upon the results of the post-remedial action survey performed by ORNL in Areas 4-10 on the former Kellex site, it appears that the remedial action was successful in reducing radioactive contamination on the site to criteria values established at the time of the post-remedial action survey.

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Fig. 1. Schematic view of property and areas that were excavated during the 1979 post remedial action survey at Kellex.

Fig. 2. View of Area 4.

Fig. 3. View of Area 5.

Fig 4. View of Area 6 and subareas.

ARE A 6A

NO SCALE

Fig. 5. View of Area 6A.

AREA 6B

Fig. 6. View of Area 6B.

Fig. 7. View of Area 6C.

Fig. 8. View of Area 6D.

Fig. 9. View of Area 6D trench areas 1, 2, and 3.

NO SCALE

Fig. 10. View of Area 6E.

Fig. 11. View of Area 6F.

Fig. 12. View of Area 6G.

AREA 6H

Fig. 13. View of Area 6H.

K 361 COMPOSITE

K 362 "

K 363 "

K 364 "

K 365 "

K 366 "

Fig. 14. View of Area 6I.

Fig. 15. View of Area 6J.

Fig. 16. View of Area 7.

Fig. 17. View of Area 8.

Fig. 18. View of Area 9.

AREA 10

NO SCALE

Fig. 19. View of Area 10.

Table 1. A summary of applicable radiation guidelines for the former Kellex site

Mode of exposure	Exposure conditions	Guideline value	Guideline source
1. External gamma radiation ^a	Continuous exposure to individual in general population (whole body)	60 µR/h	Nuclear Regulatory Commission (NRC) - Standards for Protection Against Radiation (10 CFR 20.105)
2. Surface alpha contamination ^a	²²⁶ Ra contamination fixed on surfaces	100 dpm/100 cm ²	NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-product, Source, or Special Nuclear Material (Adapted from NRC Reg. Guide 1.86)
	Removable ²²⁶ Ra contamination	20 dpm/100 cm ²	
3. Surface beta contamination ^a	Removable beta-gamma emitters	1000 dpm/100 cm ²	Same as number 2
4. Beta-gamma dose rates ^a	Average dose rate on an area no greater than 1 m ²	0.20 mrad/h	Same as number 2
	Maximum dose rate in any 100 cm ² area	1.0 mrad/h	Same as number 2
5. Exposure to radon ^a	Maximum permissible concentration of ²²² Rn in air in unrestricted areas	3.0 pCi/L	NRC 10 CFR 20.103, Appendix B, Table II
6. Radionuclides in water ^a	Maximum contaminant level for combined ²²⁶ Ra and ²²⁸ Ra in drinking water	5 pCi/L	EPA Interim Standards 40 CFR 141.15
	Maximum permissible concentration of the following radionuclides in water for unrestricted areas ²²⁶ Ra ²³⁸ U ²³⁰ Th ²¹⁰ Pb	30 pCi/L 40,000 pCi/L 2,000 pCi/L 100 pCi/L	NRC 10 CFR 20.103 Appendix B, Table II
7. Uranium concentration in soil	Average concentration of ²³⁸ U in the top 20 cm of soil averaged over 400 m ² (including background)	40 pCi/g	DOE letter from William E. Mott to Department of Environmental Protection, State of New Jersey dated June 13, 1980

^aThis appendix contains a complete listing of standard.

Table 2. Background radiation levels for the northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure rate at 1 m above floor or ground surface ($\mu\text{R/h}$)	8
Direct alpha activity on indoor floor or wall surface (dpm/100 cm^2)	25
Transferable alpha activity on indoor floor or wall surface (dpm/100 cm^2)	10
Transferable beta-gamma activity on indoor floor or wall surface (dpm/100 cm^2)	20
Beta-gamma dose rate activity on ground, floor, and wall surfaces (mrad/h)	0.01–0.03
Indoor radon concentration (pCi/L) ^α	
Basement	1.7
Upstairs	0.8
Indoor radon daughter concentration (WL) ^α	
Basement	0.008
Upstairs	0.004
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9
^{238}U	0.9
^{226}Ra	0.9

^αReference 7.

Table 3. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 4

Grid ^a point	Grid point measurements		Grid block scan
	Gamma exposure rate at 1 m (μ R/h)	Beta-gamma dose rate at 1 cm (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	7	0.02	10
A2	7	0.02	10
A3	6	0.01	10
A4	6	0.01	10
A5	6	0.02	10
A6	7	0.02	10
A7	7	0.02	10
B1	7	0.02	10
B2	7	0.02	10
B3	7	0.01	10
B4	8	0.02	10
B5	8	0.02	10
B6	8	0.02	10
B7	8	0.02	10
C1	7	0.02	10
C2	7	0.02	10
C3	8	0.02	10
C4	9	0.02	10
C5	8	0.02	10
C6	9	0.03	10
C7	9	0.02	10
D1	8	0.02	10
D2	8	0.02	10
D3	8	0.01	10
D4	8	0.01	10
D5	8	0.02	10
D6	8	0.01	10
D7	9	0.01	10
E1	7	0.02	10
E2	6	0.01	10
E3	6	0.02	10
E4	7	0.01	10
E5	8	0.01	10
E6	7	0.02	10
E7	8	0.02	10

^aSee Fig. 2 for grid location.

Table. 4. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 5

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.01	10
A2	8	0.01	11
A3	8	0.01	10
B1	8	0.01	10
B2	8	0.02	13
B3	8	0.01	9
C1	8	0.01	10
C2	8	0.02	13
C3	8	0.01	9

^aSee Fig. 3 for grid block location.

Table. 5. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6A

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center ($\mu\text{R/h}$)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface ($\mu\text{R/h}$)
A1	7	0.02	10
A2	7	0.02	10
A3	8	0.01	9
A4	7	0.02	8

^aSee Fig. 5. for grid block location.

Table. 6. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6B

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.01	10
B1	8	0.01	10

^aSee Fig. 6 for grid block location.

Table. 7. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6C

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.03	10
A2	8	0.02	9
B1	8	0.01	8
B2	8	0.01	8

^aSee Fig. 7 for grid block location.

Table. 8. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6D

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	10	0.01	10
A2	9	0.01	10
A3	8	0.01	10
A4	8	0.01	11
A5	9	0.01	11
B1	8	0.01	11
B2	9	0.01	10
B3	9	0.01	10
B4	9	0.01	9
B5	9	0.01	11
C1	8	0.01	10
C2	9	0.01	10
C3	9	0.02	11
C4	9	0.02	9
C5	9	0.01	10
D1	9	0.01	11
D2	10	0.01	10
D3	9	0.01	11
D4	9	0.01	9
D5	11	0.01	9
E1	9	0.02	10
E2	9	0.01	10
E3	9	0.01	11
E4	9	0.02	10
E5	9	0.01	10

^aSee Fig. 8 for grid block location.

Table 9. Former Kellex Laboratory: Jersey City, New Jersey
trench survey of decontaminated Area 6D

Trench ^a	Average gamma exposure rate at surface ($\mu\text{R/h}$)	Maximum gamma exposure rate at surface ($\mu\text{R/h}$)	Maximum beta-gamma dose rate (mrad/h)
#1	9	10	0.01
#2	9	13	0.02
#3	10	40 ^b	0.2

^aSee Fig. 9 for schematic of trench areas.

^bThe north end of trench scanned 24–40 $\mu\text{R/h}$.

Table. 10. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6E

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	9	0.01	10
A2	7	0.01	10
B1	9	0.01	9
B2	8	0.02	9

^aSee Fig. 10 for grid block and sample location.

Table. 11. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6F

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	9	0.02	10
A2	9	0.02	10
A3	9	0.01	10
B1	10	0.02	11
B2	10	0.03	11
B3	10	0.02	11
C1	9	0.01	10
C2	9	0.02	11
C3	9	0.02	9

^aSee Fig. 11 for grid block and sample location.

Table. 12. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6G

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.01	10
A2	9	0.01	10
A3	9	0.01	10
B1	9	0.02	8
B2	9	0.01	10
B3	9	0.01	11
C1	8	0.01	10
C2	9	0.01	9
C3	9	0.01	9

^aSee Fig. 12 for grid block and sample location.

Table. 13. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6H

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.01	10
A2	7	0.02	10
B1	7	0.01	10
B2	7	0.01	10

^aSee Fig. 13 for grid block location.

Table. 14. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6I

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center ($\mu\text{R/h}$)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface ($\mu\text{R/h}$)
A1	7	0.02	8
A2	7	0.01	8
A3	7	0.01	7
B1	7	0.01	8
B2	7	0.01	7
B3	7	0.01	7

^aSee Fig. 14 for grid block location.

Table. 15. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 6J

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	9	0.01	9
A2	9	0.02	10

^aSee Fig. 15 for grid block location.

Table. 16. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 7

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	9	0.02	10
A2	8	0.02	9
A3	9	0.02	9
A4	8	0.02	9
A5	7	0.01	9
A6	7	0.01	9
A7	8	0.02	8
A8	8	0.02	9
A9	8	0.02	9
A10	8	0.02	9
B1	8	0.02	10
B2	8	0.01	10
B3	7	0.02	9
B4	7	0.02	10
B5	8	0.02	10
B6	7	0.02	10
B7	7	0.02	8
B8	8	0.01	10
B9	8	0.01	11
B10	8	0.02	10
C1	8	0.02	8
C2	8	0.02	10
C3	8	0.03	11
C4	8	0.02	9
C5	8	0.02	10
C6	8	0.02	10
C7	7	0.02	9
C8	8	0.01	10
C9	8	0.01	9
C10	8	0.02	10
D1	9	0.01	11
D2	8	0.01	10
D3	8	0.02	10
D4	8	0.02	10
D5	9	0.01	10

Table 16. (continued)

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
D6	8	0.01	10
D7	7	0.01	9
D8	8	0.01	9
D9	7	0.01	9
D10	8	0.01	9
E1	8	0.02	10
E2	9	0.02	11
E3	9	0.03	9
E4	8	0.02	12
E5	7	0.02	9
E6	7	0.02	8
E7	7	0.02	8
E8	8	0.02	8
E9	8	0.02	11
E10	9	0.02	12
F1	9	0.02	11
F2	9	0.02	11
F3	8	0.02	10
F4	8	0.02	10
F5	7	0.02	9
F6	7	0.01	8
F7	7	0.02	8
F8	8	0.01	9
F9	8	0.02	10
F10	9	0.02	12
G1	9	0.02	11
G2	9	0.02	11
G3	9	0.02	11
G4	8	0.02	10
G5	8	0.02	10
G6	8	0.02	11
G7	7	0.02	9
G8	8	0.02	10
G9	8	0.01	11
G10	9	0.02	13

Table 16. (continued)

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
H1	9	0.02	11
H2	8	0.02	11
H3	9	0.02	11
H4	9	0.02	11
H5	8	0.02	12
H6	9	0.03	10
H7	8	0.01	10
H8	8	0.02	10
H9	9	0.02	12
H10	9	0.03	11
I1	8	0.01	10
I2	8	0.02	12
I3	9	0.02	12
I4	8	0.02	12
I5	8	0.02	13
I6	9	0.02	12
I7	8	0.02	11
I8	9	0.03	12
I9	9	0.02	12
I10	8	0.02	12
J1	8	0.02	9
J2	7	0.02	11
J3	8	0.02	11
J4	8	0.02	12
J5	9	0.02	11
J6	8	0.02	11
J7	7	0.02	11
J8	8	0.02	10
J9	8	0.02	10
J10	8	0.02	10
Walls of pits inside grid blocks			
D3		0.02	13
D4		0.02	13

Table 16. (continued)

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
D5		0.02	13
D6		0.02	13
D7		0.01	12
D8		0.02	11
D9		0.02	14
E3		0.02	12
E9		0.02	12
F3-F4		0.02	12
F9		0.03	12
G4		0.02	12
G5		0.02	13
G9		0.02	12
H6		0.02	11
H7		0.02	12
H8		0.02	13
H9		0.03	11

^aSee Fig. 16 for grid block location.

Table. 17. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 8

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	7	0.02	11
A2	7	0.02	11
A3	7	0.02	11
A4	7	0.02	11
A5	6	0.02	11
A6	7	0.02	11
A7	7	0.02	11
A8	7	0.02	11
A9	7	0.02	11
A10	6	0.01	11
B1	7	0.01	11
B2	7	0.03	11
B3	8	0.02	11
B4	7	0.01	11
B5	7	0.01	11
B6	7	0.02	11
B7	8	0.02	11
B8	7	0.02	11
B9	6	0.01	11
B10	7	0.01	11
C1	7	0.01	11
C2	8	0.01	11
C3	8	0.01	11
C4	7	0.01	11
C5	8	0.02	11
C6	8	0.02	11
C7	8	0.02	11
C8	8	0.02	11
C9	8	0.02	11
C10	7	0.01	11
D1	7	0.02	11
D2	8	0.01	11
D3	8	0.01	11
D4	7	0.02	11
D5	8	0.01	11
D6	8	0.02	11
D7	8	0.01	11

Table 17. (continued)

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
D8	8	0.01	11
D9	8	0.02	11
D10	8	0.02	11

^aSee Fig. 17 for grid block location.

Table. 18. Former Kellex Laboratory: Jersey City, New Jersey
grid survey for decontaminated Area 9

Grid ^a block	Grid block measurements		Grid block scan
	Gamma exposure rate at 1 m above center (μ R/h)	Beta-gamma dose rate at 1 cm above center (mrad/h)	Average gamma exposure rate 0-3 in. above surface (μ R/h)
A1	8	0.01	10
A2	7	0.01	10
A3	8	0.01	10
A4	8	0.01	10
B1	8	0.01	10
B2	7	0.01	10
B3	8	0.01	10
B4	9	0.01	10
C1	7	0.01	10
C2	7	0.01	10
C3	7	0.01	10
C4	8	0.01	10

^aSee Fig. 18 for grid block location.

Table 19. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 4

Sample Number	Grid block ^a location	Sample ^b type	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-46	A1-A6, B1-B6, C1-C6, D1-D6	Composite	0-8	1.5	2.6±0.3	1.3±0.08

^aArea from which sample was collected is shown in Fig. 2.

^bThe composite was comprised of aliquots of soil from each grid block indicated, and mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

Table 20. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 5

Sample Number ^a	Grid block location ^b	Sample type	Depth (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-390	E2 (trench)	Biased ^d	0-30	1.5	1.9±5	2.0±7.2
K-391	E2 (trench)	Biased	30-60	2.2	2.4±0.1	2.7±0.2
K-392	E2 (trench)	Biased	60-183	1.7	2.4±0.3	1.7±0.2
K-393	E2 (trench)	Biased	183-732	1.7	1.6±5.1	1.3±0.7

^aSamples were taken from the same location at different depths.

^bSample locations are shown in Fig. 3.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dSamples were taken from locations showing maximum gamma exposure rates.

Table 21. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6A

Sample Number	Grid block ^a location	Sample ^b type	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-355	A1	Composite	0-8	2.2	1.4±0.08	2.3±0.09
K-356	A2	Composite	0-8	1.6	1.4±0.03	3.2±0.06
K-357	A3	Composite	0-8	8.3	1.2±0.6	2.8±0.3
K-358	A4	Composite	0-8	2.1	1.5±1	3.6±0.8

^aAreas from which samples were collected are shown in Fig. 5.

^bThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

Table 22. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6B

Sample Number	Grid block ^a location	Sample ^b type	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-367	A1	Composite	0-8	16	e	e
K-368	B2	Composite	0-8	13	e	e

^aAreas from which samples were collected are shown in Fig. 6.

^bThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^eAnalysis for this radionuclide was not performed.

Table 23. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6C

Sample Number	Grid block ^a location	Sample ^b type	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-380	A1	Composite	0-8	9.5	<i>e</i>	<i>e</i>
K-381	A2	Composite	0-8	1.8	<i>e</i>	<i>e</i>
K-382	B1	Composite	0-8	1.5	<i>e</i>	<i>e</i>
K-383	B2	Composite	0-8	8.9	<i>e</i>	<i>e</i>

^aAreas from which samples were collected are shown in Fig. 7.

^bThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^eAnalysis for this radionuclide was not performed.

Table 24. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6D

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K384	A1	Biased ^d	0-8	2.6	e	e
K385	A4	Biased	0-8	2.8	e	e
K386	B1	Biased	0-8	15	e	e
K387	B4	Biased	0-8	4.3	e	e
K388	B5	Biased	0-8	4.8	e	e
K389	D1	Biased	0-8	12	e	e
K399	Trench #1	Composite ^f	0-8	3.3	1.5±0.03	1.5±0.06
K401	Trench #2	Composite	0-8	30	1.2±0.08	1.1±0.03
K403	Trench #3	Composite	0-8	7.8	1.3±0.4	1.6±0.13
K405	Trench #3 (north end)	Biased	0-8	140	e	e

^aAreas from which samples were collected are shown in Figs. 8 and 9.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dSamples were taken from locations showing elevated gamma measurements.

^eAnalysis for this radionuclide was not performed.

^fComposite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

Table 25. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6E

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-342	A2	Biased ^d	0-8	24	^e	^e
K-188	A1, A2, B1, B2	Composite ^f	0-8	12	2.1±0.06	1.9±0.2

^aAreas from which samples were collected are shown in Fig. 10.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dSample was taken from location showing elevated gamma measurements.

^eAnalysis for this radionuclide was not performed.

^fComposite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

Table 26. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6F

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-409	A1-A3, B1-B3, C1-C3	Composite ^d	0-8	21	<i>e</i>	<i>e</i>
K-378	B2	Biased ^f	0-8	70	<i>e</i>	<i>e</i>
K-379	B3	Biased	0-8	50	<i>e</i>	<i>e</i>

^aAreas from which samples were collected are shown in Fig. 11.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^eAnalysis for this radionuclide was not performed.

^fSamples were taken from location showing elevated gamma measurements.

Table 27. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6G

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-345	A1	Composite ^d	0-8	70	e	e
K-346	A2	Composite	0-8	5.3	e	e
K-347	A3	Composite	0-8	12	e	e
K-348	B1	Composite	0-8	1.7	e	e
K-349	B2	Composite	0-8	20	e	e
K-350	B3	Composite	0-8	20	e	e
K-351	C1	Composite	0-8	24	e	e
K-352	C2	Composite	0-8	13	e	e
K-353	C3	Composite	0-8	7.6	e	e
K-343	A1	Biased ^f	0-8	60	e	e
K-344	A2	Biased	0-8	50	e	e

^aAreas from which samples were collected are shown in Fig. 12.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquotes were mixed into a single homogeneous sample.

^eAnalysis for this radionuclide was not performed.

^fSamples were taken from locations showing elevated gamma exposure rates.

Table 28. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6H

Sample Number	Grid block ^a location	Sample ^b type	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-166	A1, A2, B1, B2	Composite	0-8	11	1.3±0.04	1.3±0.04

^aArea from which sample was collected is shown in Fig. 13.

^bThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

Table 29. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 61

Sample Number	Grid block ^a location	Sample type ^b	Depth ^c (cm)	Radionuclide concentration (pCi/g) ^d		
				²³⁸ U	²²⁶ Ra	²³² Th
K-361	A1	Composite	0-8	5.7	1.6±0.09	1.7±0.3
K-362	A2	Composite	0-8	2.7	1.2±0.05	1.3±0.1
K-363	A3	Composite	0-8	1.3	0.84±0.02	0.91±0.09
K-364	B1	Composite	0-8	11	1.6±0.04	1.7±0.06
K-365	B2	Composite	0-8	3	6.6±0.3	1.2±0.2
K-366	B3	Composite	0-8	1.1	0.69±0.1	0.86±0.06

^aAreas from which samples were collected are shown in Fig. 14.

^bThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^cA depth of 0-8 cm was considered a surface sample.

^dIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

Table 30. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 6J

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-184	A1, A2	Composite ^d	0-8	5.2	<i>e</i>	<i>e</i>
K-354	A1	Biased ^f	0-8	41	<i>e</i>	<i>e</i>

^aAreas from which samples were collected are shown in Fig. 15.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^eAnalysis for this radionuclide was not performed.

^fSample was taken from location showing elevated gamma exposure rate.

Table 31. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 7

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-100	A1-A10, B1-B1 C1-C10	Composite ^d	0-8	9.4	1.5±0.04	1.6±0.08
K-101	A1	Systematic ^e	0-8	4.4	f	f
K-102	A2	Systematic	0-8	3.3	f	f
K-103	A3	Systematic	0-8	1.9	f	f
K-104	A4	Systematic	0-8	5.4	f	f
K-105	B1	Systematic	0-8	14	f	f
K-106	B2	Systematic	0-8	2.6	f	f
K-107	B3	Systematic	0-8	13	f	f
K-108	B4	Systematic	0-8	27	f	f
K-109	C1	Systematic	0-8	5.2	f	f
K-110	C2	Systematic	0-8	1.3	f	f
K-111	C3	Systematic	0-8	5.4	f	f
K-112	C4	Systematic	0-8	2.4	f	f

^aAreas from which samples were collected are shown in Fig. 16.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^eApproximately 400 g of soil were taken from the center of each grid block.

^fAnalysis for this radionuclide was not performed.

Table 32. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 8

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-114	A1-A5, D1-D5	Composite ^d	0-8	16.3	0.9±0.048	1.0±0.056
K-115	A6-A10, D6-D10	Composite	0-8	15.5	0.9±0.04	0.9±0.04
K-116	A1	Systematic ^e	0-8	16.2	f	f
K-339	A2	Systematic	0-8	1.1	f	f
K-118	A3	Systematic	0-8	34.7	f	f
K-119	A4	Systematic	0-8	10.6	f	f
K-120	A5	Systematic	0-8	30.7	f	f
K-121	A6	Systematic	0-8	7.7	f	f
K-122	A7	Systematic	0-8	25.2	f	f
K-340	A8	Systematic	0-8	51 ^g	f	f
K-124	A9	Systematic	0-8	20.2	f	f
K-125	A10	Systematic	0-8	1.1	f	f
K-126	B1	Systematic	0-8	34.3	f	f
K-127	B2	Systematic	0-8	8.4	f	f
K-128	B3	Systematic	0-8	12.5	f	f
K-129	B4	Systematic	0-8	19.6	f	f
K-130	B5	Systematic	0-8	7.7	f	f
K-131	B6	Systematic	0-8	21.7	f	f
K-132	B7	Systematic	0-8	22.9	f	f
K-133	B8	Systematic	0-8	12.8	f	f
K-134	B9	Systematic	0-8	2.1	f	f
K-135	B10	Systematic	0-8	0.6	f	f
K-136	C1	Systematic	0-8	4.2	f	f
K-137	C2	Systematic	0-8	5.1	f	f

Table 32. (continued)

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-138	C3	Systematic	0-8	4.9	<i>f</i>	<i>f</i>
K-139	C4	Systematic	0-8	13.6	<i>f</i>	<i>f</i>
K-140	C5	Systematic	0-8	5.9	<i>f</i>	<i>f</i>
K-141	C6	Systematic	0-8	9.8	<i>f</i>	<i>f</i>
K-341	C7	Systematic	0-8	14.7	<i>f</i>	<i>f</i>
K-143	C8	Systematic	0-8	7.3	<i>f</i>	<i>f</i>
K-144	C9	Systematic	0-8	10.5	<i>f</i>	<i>f</i>
K-145	C10	Systematic	0-8	3.0	<i>f</i>	<i>f</i>
K-146	D1	Systematic	0-8	4.9	<i>f</i>	<i>f</i>
K-147	D2	Systematic	0-8	2.6	<i>f</i>	<i>f</i>
K-148	D3	Systematic	0-8	5.3	<i>f</i>	<i>f</i>
K-149	D4	Systematic	0-8	16.6	<i>f</i>	<i>f</i>
K-150	D5	Systematic	0-8	3.0	<i>f</i>	<i>f</i>
K-151	D6	Systematic	0-8	3.8	<i>f</i>	<i>f</i>
K-152	D7	Systematic	0-8	10.4	<i>f</i>	<i>f</i>
K-153	D8	Systematic	0-8	4.9	<i>f</i>	<i>f</i>
K-154	D9	Systematic	0-8	1.5	<i>f</i>	<i>f</i>
K-155	D10	Systematic	0-8	2.3	<i>f</i>	<i>f</i>
K-157	B2, C2, D2 (within trench)	Biased ^h	0-8	15.4	1.0±0.04	1.06±0.06
K-160	A5, B5, C5, D5 (within trench)	Biased	0-8	19.3	1.0±0.04	1.02±0.04

^aAreas from which samples were collected are shown in Fig. 17.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

^eApproximately 400 g of soil were taken from the center of each grid block.

^fAnalysis for this radionuclide was not performed.

^gContaminated soil probably spilled over into the sampling area during excavation.

^hSamples were taken from locations showing elevated gamma exposure rates.

Table 33. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 9

Sample Number	Grid block ^a location	Sample type	Depth ^b (cm)	Radionuclide concentration (pCi/g) ^c		
				²³⁸ U	²²⁶ Ra	²³² Th
K-98	A1-A4, B1-B4, C1-C4	Composite ^d	0-8	1	1.7±0.04	1.2±0.06

^aArea from which sample was collected is shown in Fig. 18.

^bA depth of 0-8 cm was considered a surface sample.

^cIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^dThe composite was comprised of aliquots of soil from each grid block indicated; aliquots were mixed into a single homogeneous sample.

Table 34. Results of soil samples taken during the 1979 post remedial action radiological survey at Area 10

Sample	Grid block ^a location	Sample type	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
				²³⁸ U	²²⁶ Ra	²³² Th
KT13A ^c	7+15, 520R	Biased ^d	0-30	1.6	1.7±0.05	1.6±0.07
KT13B	7+15, 520R	Biased	30-46	4.6	9.1±0.2	4.05±0.1
KT13B1	7+15, 520R	Biased	30-46	5.2	13±0.3	4.9±0.1
KT13C	7+15, 520R	Biased	182	0.55	0.52±0.04	0.66±0.04
K395	7+21, 520R	Biased	91	0.4	0.5±0.06	0.6±0.08
K396	7+15, 526R	Biased	91	1.09	1.04±0.1	0.76±0.1
K397	7+9, 520R	Biased	91	0.91	0.6±0.09	0.72±0.06
K398	7+15, 514	Biased	91	2.7	2.6±0.05	2.4±8

^aGrid block locations are shown in Fig. 1

^bIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^cSamples were taken from the same location at different depths.

^dSamples were taken from locations showing maximum gamma exposure rates.

Table 35. Radionuclide concentrations in water samples taken November 1979

Sample	Radionuclide concentrations (pCi/L) ^a			
	²¹⁰ Pb	²²⁶ Ra	²³⁰ Th	²³⁸ U
KW5	$<4.5 \times 10^{-3}$	$<5 \times 10^{-4}$	$4.5 \times 10^{-5} \pm 4.5 \times 10^{-5}$	1±1
KW6	$4.5 \times 10^{-3} \pm 0.01$	$<5 \times 10^{-4}$	$<4.5 \times 10^{-5}$	2±2
KW7	$4.5 \times 10^{-3} \pm 0.01$	$<5 \times 10^{-4}$	$4 \times 10^{-4} \pm 4 \times 10^{-4}$	$2 \times 10^{-4} \pm 2 \times 10^{-4}$
RCGW ^b	100	30 ^c	2,000	40,000

^aIndicated errors associated with these concentrations are two standard deviations (95% confidence level).

^bRadionuclide concentration guideline values for ground water taken from 10 CFR 20.

^cThe EPA drinking water standard for radium is 5 pCi/L, including ²²⁶Ra and ²²⁸Ra.

Table 36. Summary of soil data collected during post decontamination activities at the former Kellex Laboratory site

Area	Sample ^a	Grid block location	Average radionuclide concentration (pCi/g)			Maximum ²³⁸ U concentration (pCi/g)
			²³⁸ U	²²⁶ Ra	²³² Th	
4	K-46	A-E	1.5	2.6	1.3	1.5
5	K-391	Trench E2	1.8	2.1	1.9	2.2
6A	K-357	A3	3.6	1.4	3	8.3
6B	K-367	A1	14.5	<i>c</i>	<i>c</i>	16
6C	K-380	A1	5.4	<i>c</i>	<i>c</i>	9.5
6D	K-386	b1	6.9	<i>c</i>	<i>c</i>	15
6D	K-399	Trench #1	3.3	1.5	1.5	1.5
6D	K-401	Trench #2	30	1.2	1.1	30 ^b
6D	K-403	Trench #3	7.8	1.3	1.6	140 ^b
6E	K-188	A-B	12	2.1	1.9	12 ^b
6F	K-378	B2	21	<i>c</i>	<i>c</i>	70
6G	K-345	A1	19.2	<i>c</i>	<i>c</i>	70
6H	K-166	A-C	11	1.3	1.3	11 ^b
6I	K-364	B1	4.1	2.1	1.3	11
6J	K-354	A1	5.2	<i>c</i>	<i>c</i>	40
7	K-108	B4	7.1	<i>c</i>	<i>c</i>	30
8	K-340	A8	12	<i>c</i>	<i>c</i>	50
9	K-338	B4	1.03	1.7	1.2	1.1
10	KT13B1	7+15, 520R	2.1	3.6	1.9	5.2

^aRefer to Figs. 2-19 for sample location.

^bOnly one sample was taken in area.

^cAnalysis of radionuclide concentration was not performed.

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