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Rockwell Hanford Operations Environmental Surveillance Annual Report

Calendar Year 1983

August 1984

Allen W. Conklin
Robert E. Elder
Vernon G. Johnson
William L. Osborne
Albert G. Law

Prepared for the U.S. Department of Energy
under Contract DE-AC06-77RL01030

Rockwell International
Rockwell Hanford Operations

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Energy Systems Group
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EXECUTIVE SUMMARY

Routine environmental surveillance in the 200 Areas (or Separations Area) and vicinity provides the necessary data to assess the impact of Rockwell Hanford Operations (Rockwell) activities on the environment. Environmental sampling and survey results indicated overall compliance with all applicable U.S. Department of Energy (DOE) guidelines and standards during calendar year 1983. There was no evidence to indicate that any radiological health hazards originated from Separations Area environmental sources during this year.

The environmental surveillance program includes sampling and radiological analysis of ambient air, surface water, groundwater, sediments, soil, vegetation, and animal feces. It also includes external radiation measurements and routine surveys of waste disposal sites, radiologically controlled areas, and roads for evidence of radioactive surface contamination. The 1983 data are summarized below.

1. Annual average ambient air radionuclide concentrations were below DOE Table II Concentration Guides at all locations monitored in the 200 Areas. Most airborne radionuclide concentrations in the Separations Area did not differ significantly from background levels.

2. Water, vegetation, and sediment samples from the open ponds and ditches exhibited no significant increase from 1982 radionuclide levels.

3. Periodic groundwater samples were collected from a network of 112 monitoring wells located near waste storage and liquid waste disposal facilities. Concentrations of specific radionuclides were below DOE Table II Concentration Guidelines with the exception of (1) ^{90}Sr at two inactive disposal sites and (2) tritium in one well monitoring an active PUREX crib. No site exceeded DOE Concentration Guidelines for controlled areas (Table I). A trend of low but increasing ^{90}Sr was noted in one well monitoring Gable Mountain Pond. Actions are underway to discontinue the use of this site. Completion is scheduled for calendar year 1985. As in previous years, elevated nitrate concentrations were observed in the vicinity of several wells at both active and inactive liquid-disposal sites, though no increase has been detected.

4. All samples collected from the 200 Area grid sites (soil, vegetation, and feces) were below Rockwell surface soil contamination standards.

5. External radiation measured at the grid sites indicated no statistically significant contribution to ionizing radiation levels at grid site locations from 200 Area operations. External radiation measurements at ponds and ditches indicated no significant change from 1982.

6. As in previous years, biological transport of radioactive material by animals was observed in 1983; however, as significant sources have been identified, action has been taken, or is underway, to eliminate or isolate them. Biological transport by vegetation has significantly decreased through the surface stabilization and herbicide application programs. No biological transport incident was determined to result in exposure to humans or offsite contamination.

7. Radiation surveys in the 200 Areas resulted in several radiological status changes. These changes involved release from radiological posting requirements, change from Surface Contamination to Underground Radioactive Material, or posting as Surface Contamination.

CONTENTS

Introduction 1

Ambient Air Sampling 5
Summary 5
Discussion 5

Routine Soil, Vegetation, and Fecal Sampling 13
Summary 13
200 Areas Grid Sampling System 13
Vegetation 29

Nonroutine Environmental Sampling 38
Summary 38
Biological Transport of Radionuclides 38
Soil 40

External Radiation 48
Summary 48
Discussion 48

Pond and Ditch Surveillance 57
Summary 57
Water Samples 57
Vegetation 57
Sediment 57

Groundwater Monitoring 65
Summary 65
Discussion 65

Radiological Surveys 93
Summary 93
Roads 93
Ponds and Ditches 96
600 Area Burial Grounds 96
200 Area Waste Sites 96
The BC Cribs Area 98

Radiological Status of the 200 Areas 102
Summary 102
Status Maps 102
Site Status Changes During 1983 102

Bibliography 117

FIGURES:

1. The Separations Area of the Hanford Site 2
2. The 200 East Area 3
3. The 200 West Area 4
4. Ambient Air Sampler Locations in the 200 East Area 6
5. Ambient Air Sampler Locations in the 200 West Area 7
6. Ambient Air Sampler Locations in BC Cribs Area 8
7. The 200 East Area Grid Sampling Sites 14
8. The 200 West Area Grid Sampling Sites 15
9. Grid Sampling Sites Outside 200 Area Perimeter Fences 16
10. Strontium-90 Concentrations in Soil at 200 East Area Sample Sites 21
11. Strontium-90 Concentrations in Soil at 200 West Area Sample Sites 22
12. Cesium-137 Concentrations in Soil at 200 East Area Sample Sites 23
13. Cesium-137 Concentrations in Soil at 200 West Area Sample Sites 24
14. Plutonium-239,240 Concentrations in Soil at 200 East Area Sample Sites 25
15. Plutonium-239,240 Concentrations in Soil at 200 West Area Sample Sites 26
16. The 200 East Area Telemetry Data for 1983 27
17. The 200 West Area Telemetry Data for 1983 28
18. Cesium-137 Concentrations in Vegetation Samples Collected at 200 East Area Grid Sites 32
19. Cesium-137 Concentrations in Vegetation Samples Collected at 200 West Area Grid Sites 33
20. Contaminated Vegetation Sources Inside the 200 East Area 41
21. Contaminated Vegetation Sources Outside the 200 East Area 42
22. Contaminated Vegetation Sources Inside the 200 West Area 43
23. Contaminated Vegetation Sources Outside the 200 West Area 44
24. External Radiation at 200 East Area Grid Sites 53
25. External Radiation at 200 West Area Grid Sites 54
26. PUREX-Related Thermoluminescent Dosimeters 55
27. Log-Normal Probability Plot of Annual Dose Rate for all Thermoluminescent Dosimeter Measurements 56
28. The 200 East Area Pond and Ditch Sample Sites 60
29. The 200 West Area Pond and Ditch Sample Sites 61
30. Groundwater Monitoring Wells in the 200 East Area 66
31. Groundwater Monitoring Wells in the 200 West Area 67
32. Location of 600 Area Monitoring Wells Used in the Separations Area Groundwater Monitoring Program 68

33. Concentration History of Total Alpha in Well 299-E28-21 . . 83
34. Concentration History for Total Beta in Well 299-E33-3 . . . 85
35. Concentration History of Strontium-90 in Well 299-E28-23 86
36. Concentration History of Strontium-90 in Well 699-53-47A 87
37. Concentration History of Tritium in Well 299-E17-9 89
38. Concentration History of Tritium in Well 299-E17-1 90
39. Concentration History for Nitrate in Well 299-E17-1 91
40. The Separations Area Water Table Map 92
41. Roads Surveyed in the Separations Area 95
42. The 600 Area Burial Grounds 97
43. The BC Cribs Controlled Area 100
44. Progress of Cleanup and Stabilization of the BC Cribs Area 101
45. PUREX Posted Outdoor Radiation Areas 103
46. B Plant Posted Outdoor Radiation Areas 104
47. Semiworks Posted Outdoor Radiation Areas 105
48. Redox Posted Outdoor Radiation Areas 106
49. T Plant Posted Outdoor Radiation Areas 107
50. U Plant Posted Outdoor Radiation Areas 108
51. Z Plant Posted Outdoor Radiation Areas 109
52. The 200 East Area Posted Outdoor Radiation Areas 110
53. Posted Outdoor Radiation Areas Outside 200 East Area 111
54. The 200 West Area Posted Outdoor Radiation Areas 112
55. Posted Outdoor Radiation Areas Outside the 200 West Area 113
56. Gable Mountain Pond 114

TABLES:

1. Air Sample Results for 1983 9
2. Summary of 1983 Ambient Air Sample Data: Quarterly Composite Analysis, in pCi/m^3 11
3. Radionuclide Concentrations in Soil Samples at 200 East Area Grid Sites 17
4. Radionuclide Concentrations in Soil Samples at 200 West Area Grid Sites 19
5. Radionuclide Concentrations in Vegetation Samples Collected at the 200 East Area Grid Sites in 1983 30
6. Radionuclide Concentrations in Vegetation Samples Collected at the 200 West Area Grid Sites in 1983 31
7. The 1983 Feces Sample Results from 200 East Area Grid Sites 34
8. The 1983 Feces Sample Results from 200 West Area Grid Sites 36

9. Biological Transport by Pigeons in 1983 45
10. Biologicial Transport Involving Animals in 1983 46
11. Special Soil Samples Collected in 1983 47
12. The 1983 Thermoluminescent Dosimeter Results from 200 East Area 49
13. The 1983 Thermoluminescent Dosimeter Results from 200 West Area 50
14. The 1983 Thermoluminescent Dosimeter Results from the 200 Area Ponds and Ditches 51
15. The 1983 Thermoluminescent Dosimeter Results from PUREX-Related Facilities 52
16. The 200 Areas Ponds and Ditches and Sources of Water 59
17. Summary of 1983 Water Sample Data from Separations Areas Ponds and Ditches 62
18. Radionuclides in Aquatic Vegetation Samples Taken from the Separations Area Ponds and Ditches in 1983 63
19. Radionuclide Concentrations in Sediment Samples from the Separations Area Ponds and Ditches 64
20. Summary of 1983 Groundwater Monitoring Results 69
21. Radionuclide Concentration Guides 82
22. The 1983 Radiological Survey Schedule 94
23. Posting Status Changes in Calendar Year 1983 115

INTRODUCTION

Rockwell Hanford Operations (Rockwell), as a prime contractor of the U.S. Department of Energy (DOE) at the Hanford Site, manages the fuel reprocessing and radioactive waste management facilities in the 200 Areas (or Separations Area) and maintains the retired radioactive dry waste disposal sites in the 600 Area.

The Hanford Site is located within the Pasco Basin in southeast Washington State, approximately 270 km southeast of Seattle and 200 km southwest of Spokane. The 200 Areas are approximately in the center of the Hanford Site, 11 km south of the Columbia River (Fig. 1). The locations of operating facilities, tank farms, solid-waste burial grounds, and liquid disposal sites in the 200 Areas are shown in Figures 2 and 3.

Rockwell conducts an environmental surveillance program in the 200 Areas, the BC Crib Area, and the 600 Area waste-disposal sites to determine the overall impact of site operations on the environment. The program also evaluates the following:

- Compliance with DOE and Rockwell radiation protection requirements
- Adequacy of radioactive-waste containment systems
- Long-term trends of radioactive materials in the environment.

This report describes Rockwell environmental surveillance results and activities during calendar year 1983. Radionuclide concentrations in air and water are compared with the Table II Concentration Guidelines of DOE Order 5480.1, Chapter XI (DOE, 1981), which are guidelines (annual average) for continuous exposure of the general public. In addition, all Rockwell environmental radiation data are compared, where applicable, with background data obtained by the Pacific Northwest Laboratory (PNL) environmental surveillance program (Price et al., 1984).

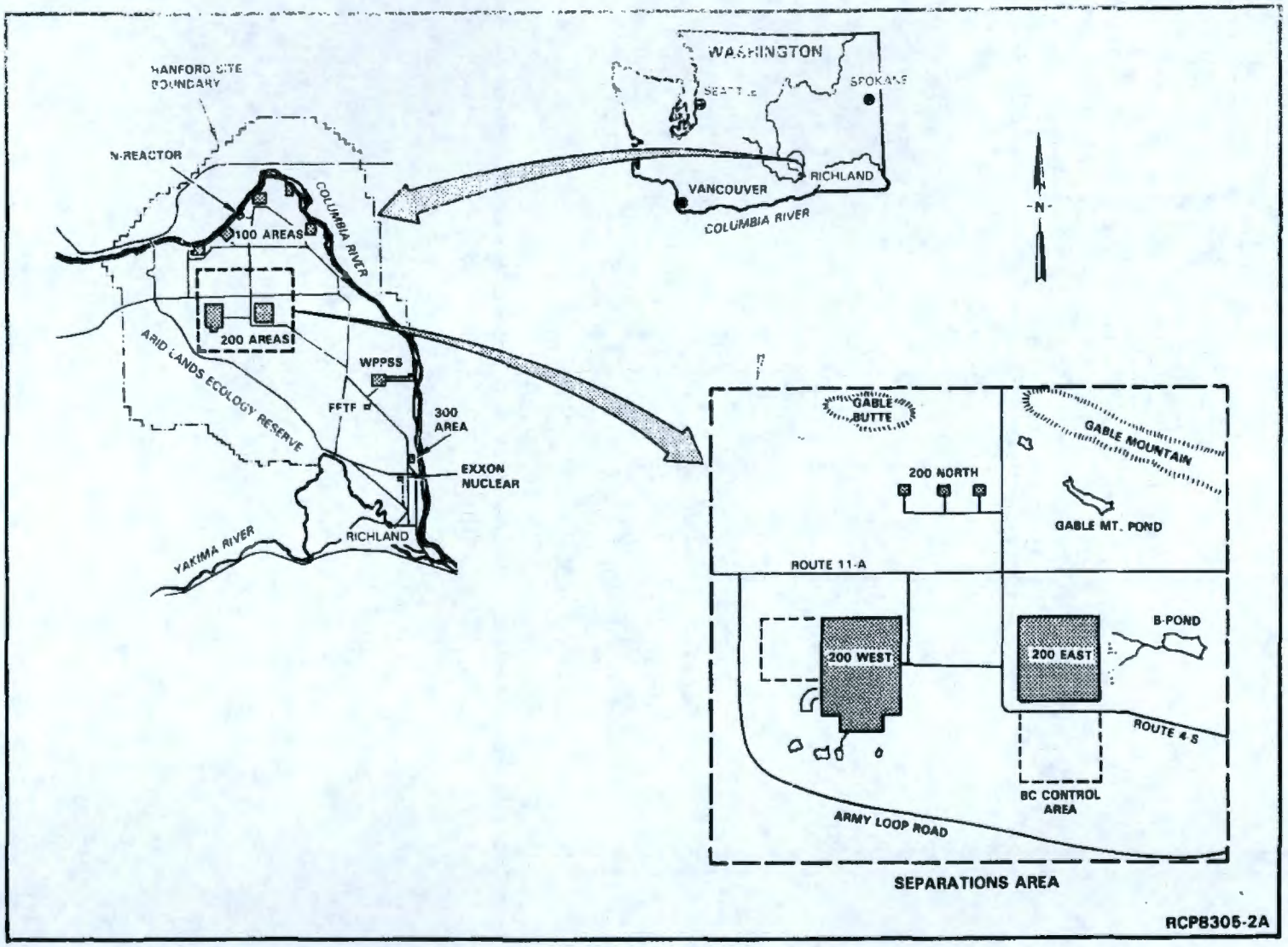


FIGURE 1. The Separations Area of the Hanford Site.

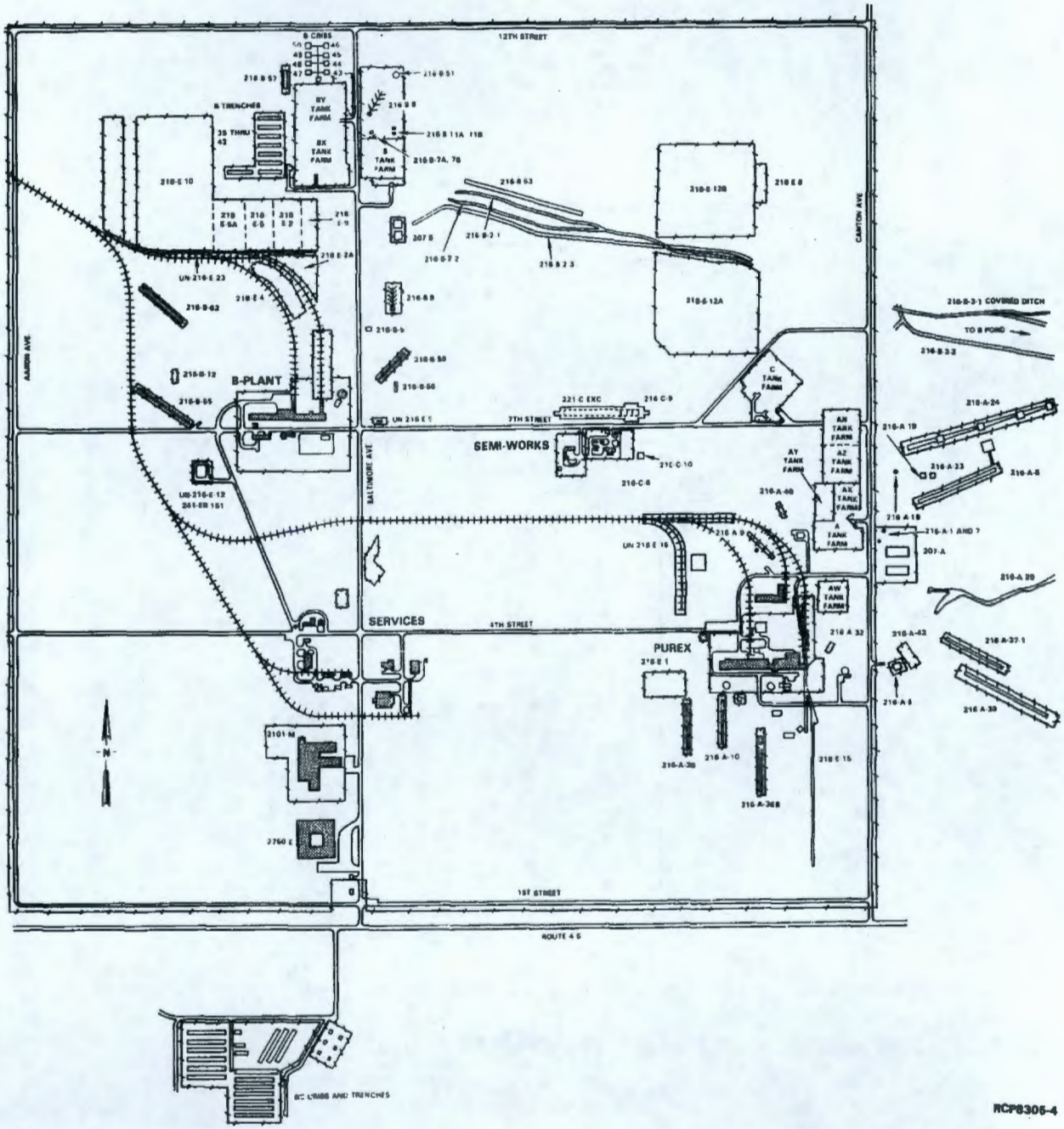


FIGURE 2. The 200 East Area.

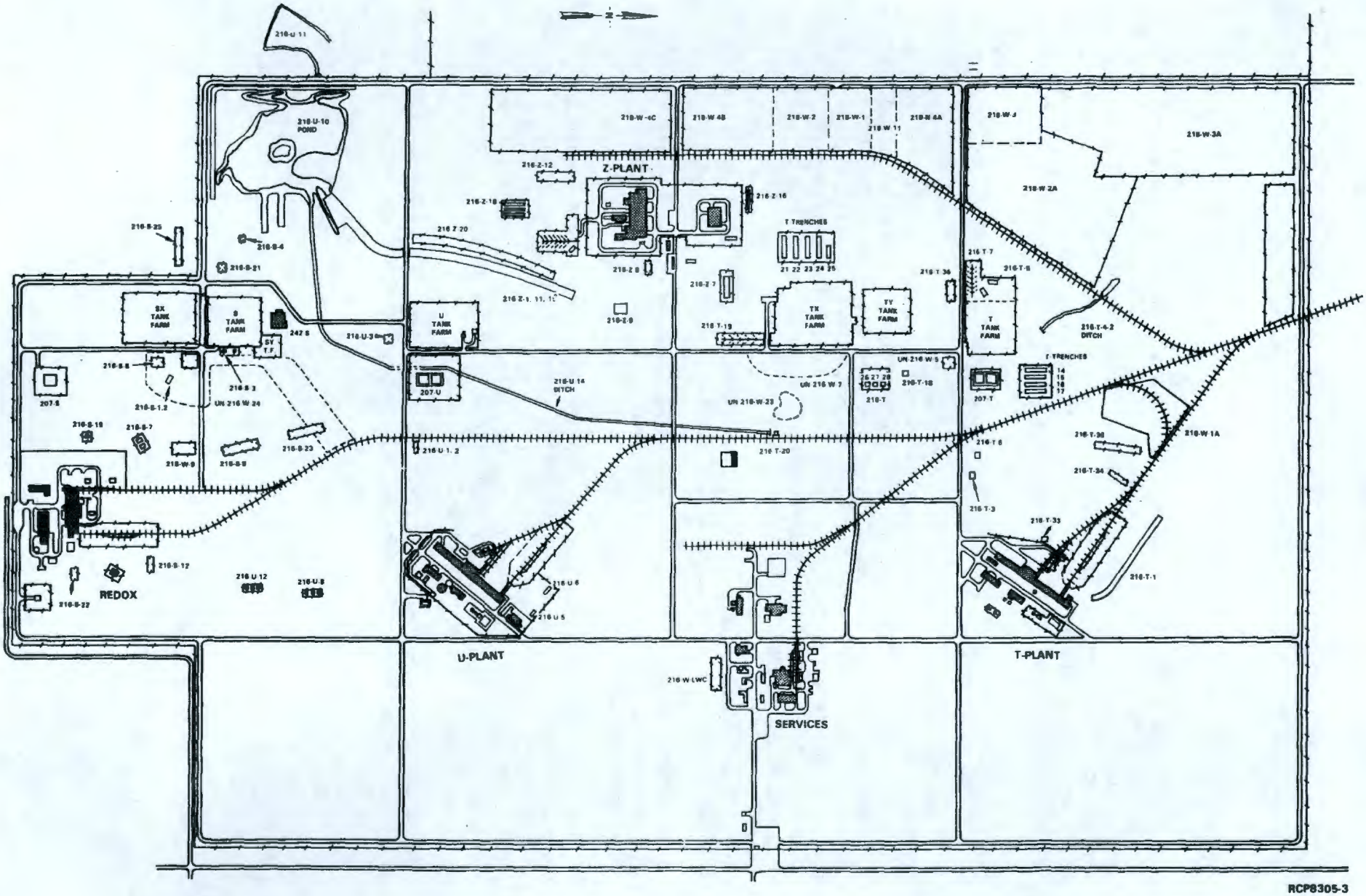


FIGURE 3. The 200 West Area.

AMBIENT AIR SAMPLING

SUMMARY

Ambient air sample data collected in the 200 Areas were compared with the PNL Hanford Site surveillance data, which include perimeter and offsite sample station data (Price et al., 1984). Although airborne radionuclide concentrations at individual sample locations exceeded the PNL perimeter data, none of the ambient air sampling stations recorded annual average radionuclide concentrations that exceeded 0.3% of Table II Guidelines.

DISCUSSION

During 1983, numerous changes were made in the ambient air sampling program. Seven new stations were established to monitor PUREX, Z Plant, and the tank farms. Six stations around the perimeter fences were turned over to Rockwell by PNL as they established new stations farther from the Separations Area. Five stations were eliminated due to stabilization of the potential-source sites that were being monitored. The resulting air sampling network consisted of 32 permanent stations by the end of 1983 compared to 24 in 1982. (Locations are shown in Fig. 4, 5, and 6.)

All air samplers were adjusted to pull 56.6 L/min (2 ft^3/min*) through a 47 mm open-face filter at about 1 m above the ground.

In 1983, another change in the program involved evaluating all air samples counted weekly for total alpha and beta activity, instead of only those near tank farms and facilities.

The particulate filters at each location were collected weekly and counted for gross alpha and beta activity after being held for 1 week to allow natural radioactivity to decay (refer to Table 1 for a summary). Gross alpha and beta measurements do not reflect precise radionuclide concentrations, but are used as indications of total sample activity for a check on operations and for trend analysis.

All filters were then composited quarterly by sample location and analyzed for gamma emitting radionuclides ^{90}Sr, $^{239,240}Pu$ and total uranium (Table 2).

*Air sampler instrumentation requires calibration in cubic feet per minute.

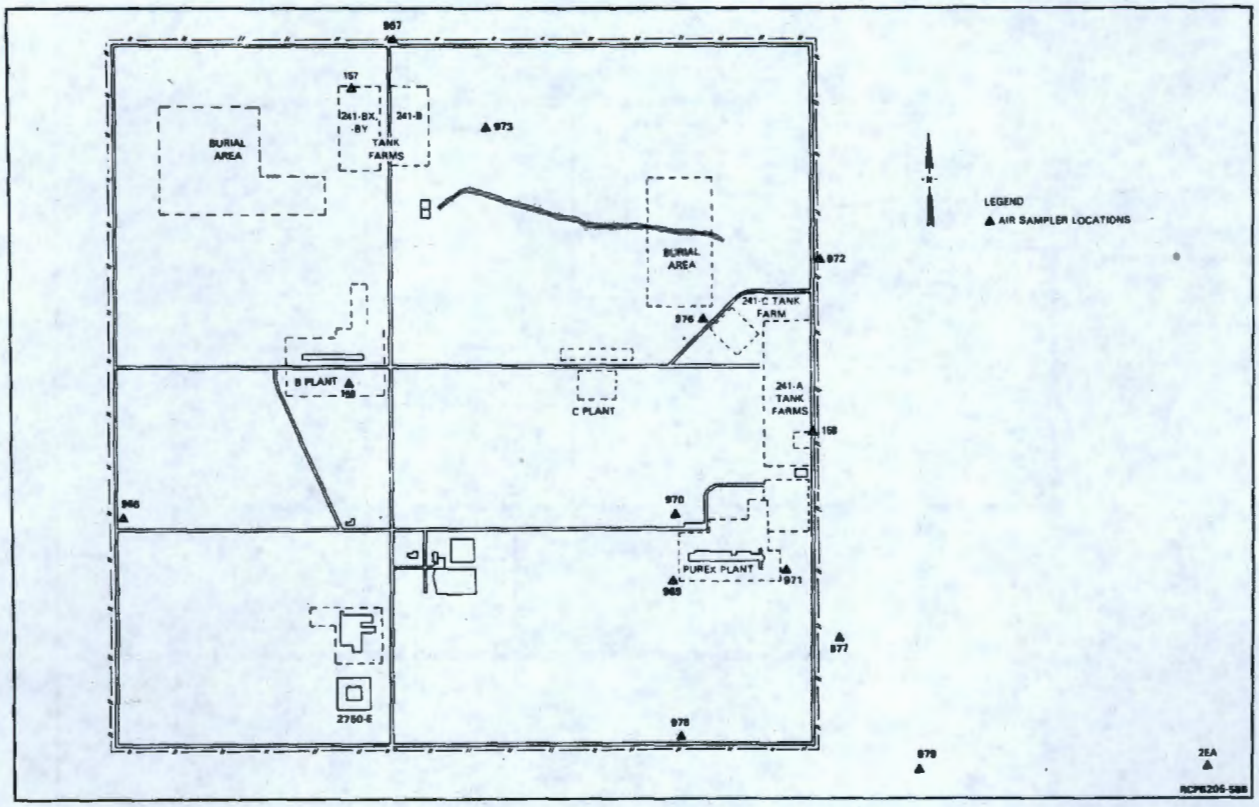


FIGURE 4. Ambient Air Sampler Locations in the 200 East Area.

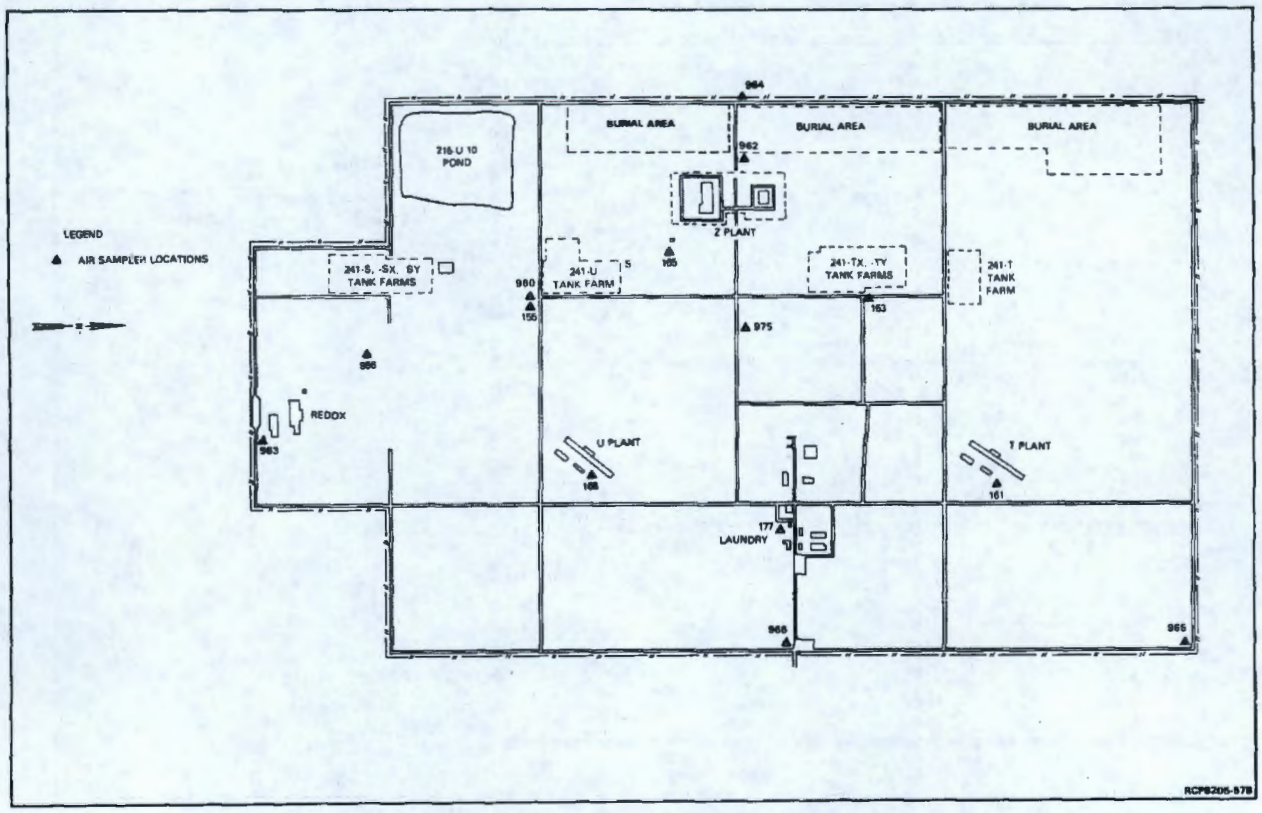


FIGURE 5. Ambient Air Sampler Locations in the 200 West Area.

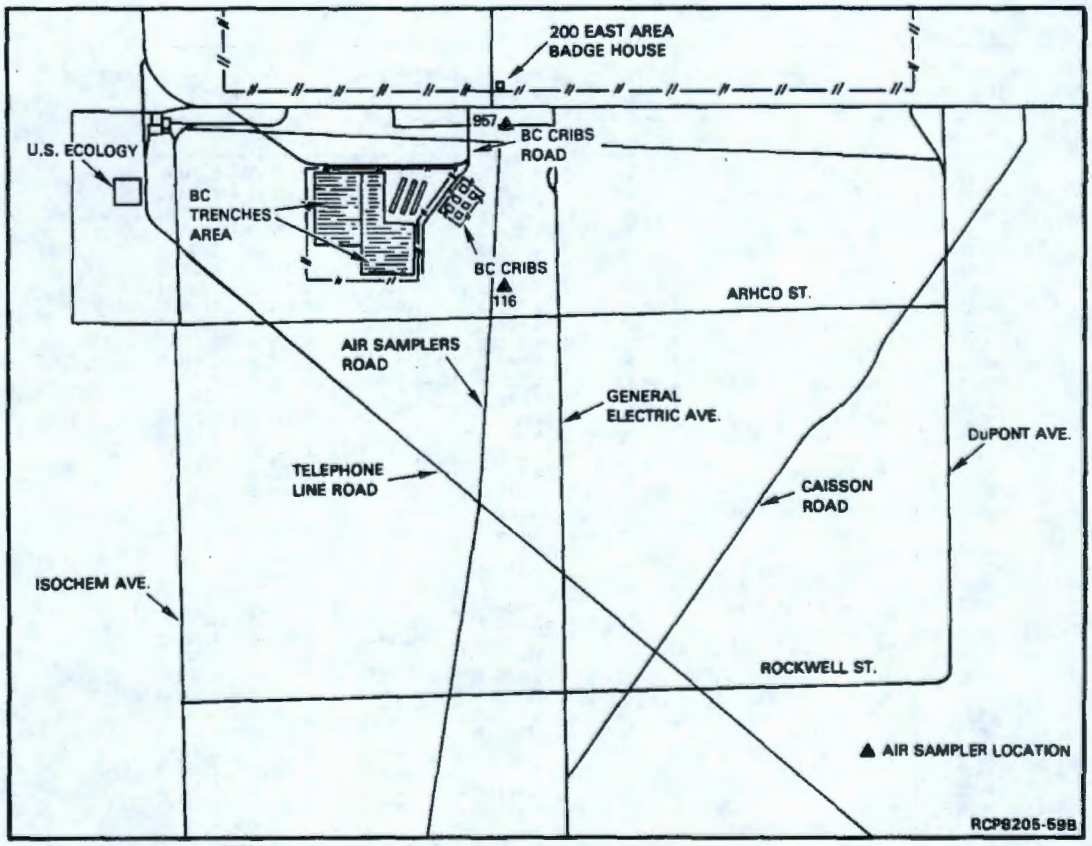


FIGURE 6. Ambient Air Sampler Locations in BC Cribs Area.

TABLE 1. Air Sample Results for 1983. (Sheet 1 of 2)

Map location	Site	Number of samples	Weekly maximum	Weekly minimum	Average ±2S
	Gross Alpha Concentration [pCi/m^3 (x 10E-12 = µCi/mL)]				
N116	B-C Cribs N	33	3.88E-3	-1.40E-3	1.04E-3 ± 2.74E-3
N153	241-TX Tank Farm	21	4.79E-3	-1.11E-4	1.40E-3 ± 2.73E-3
N155	241-U Tank Farm	47	1.16E-2	-7.62E-4	1.59E-3 ± 4.23E-3
N157	241-BY Tank Farm	51	5.15E-3	-7.18E-4	1.17E-3 ± 2.34E-3
N158	241-AX Tank Farm	34	6.70E-3	-5.74E-4	1.50E-3 ± 3.46E-3
N159	B Plant	49	7.01E-3	-8.97E-4	1.05E-3 ± 2.80E-3
N161	T Plant	22	5.68E-3	-1.16E-3	8.55E-4 ± 3.13E-3
N165	216-Z-19 Ditch	42	1.10E-2	-1.00E-3	1.66E-3 ± 4.35E-3
N168	U Plant	41	4.50E-3	-1.12E-3	9.43E-4 ± 3.03E-3
N177	Laundry	21	4.82E-3	-1.00E-3	9.37E-4 ± 3.20E-3
N950	QA Blank	46	5.74E-3	-1.40E-3	3.70E-4 ± 2.97E-3
N956	241-S, SX Tank Farm	18	3.33E-3	-6.70E-4	8.65E-4 ± 2.45E-3
N957	B-C Cribs 1	17	6.76E-3	-2.50E-3	2.09E-3 ± 4.08E-3
N960	Juxtaposed to N155	22	1.11E-2	-1.70E-3	2.04E-3 ± 6.40E-3
N961	Yakima Barricade	50	1.40E-2	-1.20E-3	1.02E-3 ± 4.27E-3
N962	SE corner W-48	33	8.72E-3	-1.06E-3	1.28E-3 ± 3.26E-3
N963	SE of Redox	47	4.75E-3	-1.18E-3	1.32E-3 ± 2.63E-3
N964	W of W-4B	15	5.21E-3	-1.21E-4	1.64E-3 ± 2.81E-3
N965	NE corner 200 West Area	24	5.21E-3	-1.74E-3	1.25E-3 ± 2.74E-3
N966	S of Main Gate 200 West Area	18	3.61E-3	-1.20E-3	1.42E-3 ± 2.57E-3
N967	N of BY/BX Tank Farm	38	9.14E-2	-1.32E-3	3.47E-3 ± 2.95E-2
N968	W gate of 200 East Area	15	3.91E-3	-6.68E-4	1.58E-3 ± 3.04E-3
N969	SW of PUREX	23	8.77E-3	-6.19E-4	1.35E-3 ± 4.22E-3
N970	NW of PUREX	16	1.77E-3	3.09E-5	8.11E-4 ± 1.04E-3
N971	SE of PUREX	21	3.59E-3	-1.95E-3	5.21E-4 ± 3.05E-3
N972	NE of C Tank Farm	17	1.10E-2	-1.40E-3	1.87E-3 ± 5.94E-3
N973	E of B Tank Farm	6	8.57E-3	-1.45E-3	1.08E-3 ± 7.53E-3
N975	E of Z Plant	26	3.09E-3	-1.45E-3	7.53E-4 ± 2.64E-3
N976	2E17, 241-C Tank Farm	14	3.61E-3	-3.99E-4	1.03E-3 ± 2.40E-3
N977	2E30	5	1.50E-3	-8.98E-4	4.83E-4 ± 2.33E-3
N978	2E35	13	2.68E-2	4.08E-5	2.91E-3 ± 1.45E-2
N979	2E36	14	4.66E-3	3.40E-5	1.35E-3 ± 2.87E-3
	Hanford perimeter*				9.0E-4 ± 7.0E-5

*Price et al., 1984.

TABLE 1. Air Sample Results for 1983. (Sheet 2 of 2)

Map location	Site	Number of samples	Weekly maximum	Weekly minimum	Average ±2S
	Gross Beta Concentration [pCi/m^3 (x 10E-12 = µCi/mL)]				
N116	B-C Cribs N	33	7.85E-2	-1.87E-2	2.81E-2 ± 5.06E-2
N153	241-TX Tank Farm	21	3.04E-1	2.12E-2	1.21E-1 ± 1.28E-1
N155	241-U Tank Farm	47	1.43E-1	-1.61E-2	3.08E-2 ± 5.66E-2
N157	241-BY Tank Farm	51	4.15E-1	2.77E-3	5.92E-2 ± 1.27E-1
N158	241-AX Tank Farm	34	1.08E-1	-8.87E-3	3.58E-2 ± 5.45E-2
N159	B Plant	49	1.73E-1	-2.89E-3	3.75E-2 ± 6.79E-2
N161	PUREX	22	1.04E-1	-6.40E-3	2.90E-2 ± 5.32E-2
N165	216-Z-19 Ditch	42	1.17E-1	-1.21E-2	2.96E-2 ± 4.67E-2
N168	U Plant	41	9.92E-2	-8.13E-3	3.07E-2 ± 4.96E-2
N177	Laundry	21	9.63E-2	8.64E-3	3.74E-2 ± 3.98E-2
N950	QA Blank	46	4.92E-2	-3.52E-2	3.03E-3 ± 3.51E-2
N956	241-S, SX Tank Farm	18	9.78E-2	-1.41E-2	3.28E-2 ± 4.78E-2
N957	B-C Cribs 1	17	1.39E-1	4.28E-3	4.90E-2 ± 6.43E-2
N960	Juxtaposed to N155	22	1.11E-1	9.85E-3	4.39E-2 ± 5.18E-2
N961	Yakima Barricade	50	1.07E-1	-1.93E-2	2.78E-2 ± 4.72E-2
N962	SE corner W-4B	33	8.14E-2	-1.71E-2	2.90E-2 ± 4.17E-2
N963	SE of Redox	47	1.03E-1	-1.53E-2	2.67E-2 ± 3.94E-2
N964	W of W-4B	15	6.90E-2	1.69E-2	3.61E-2 ± 3.24E-2
N965	NE corner 200 West Area	24	1.58E+0	-1.43E-2	9.81E-2 ± 6.37E-1
N966	SE of Main Gate 200 West Area	18	6.32E-2	1.55E-2	3.40E-2 ± 2.69E-2
N967	N of BY/BX Tank Farm	38	8.82E-1	-9.11E-3	5.11E-2 ± 2.79E-1
N968	W gate of 200 East Area	15	8.32E-2	8.87E-3	3.42E-2 ± 3.59E-2
N969	SW of PUREX	23	7.65E-2	-1.50E-2	1.79E-2 ± 4.53E-2
N970	NW of PUREX	16	1.27E-1	3.34E-3	2.53E-2 ± 5.91E-2
N971	SE of PUREX	21	7.12E-2	-2.42E-2	1.02E-2 ± 4.49E-2
N972	NE of C Tank Farm	17	9.69E-2	-1.35E-2	2.19E-2 ± 5.86E-2
N973	E of B Tank Farm	6	8.95E-2	-1.06E-2	2.95E-2 ± 8.09E-2
N975	E of Z Plant	26	1.14E-1	-2.09E-2	2.54E-2 ± 6.21E-2
N976	2E17, 241-C Tank Farm	14	9.71E-2	-1.71E-2	3.36E-2 ± 6.42E-2
N977	2E30	5	4.12E-2	1.32E-2	2.56E-2 ± 2.33E-2
N978	2E35	13	8.40E-2	-1.05E-2	2.18E-2 ± 5.59E-2
N979	2E36	14	5.51E-2	-6.10E-3	2.08E-2 ± 3.94E-2
	Hanford perimeter*				2.0E-2 ± 1.0E-3

*Price et al., 1984.

TABLE 2. Summary of 1983 Ambient Air Sample Data: Quarterly Composite Analysis, in pCi/m^3 (x E-12 = µCi/mL).

Map location	Site	Quarters sampled	^{90}Sr			^{137}Cs			$^{239,40}Pu$			U(total)		
			Quarter maximum	Quarter minimum	Annual average ±2S	Quarter maximum	Quarter minimum	Annual average ±2S	Quarter maximum	Quarter minimum	Annual average ±2S	Quarter maximum	Quarter minimum	Annual average ±2S
N116	B-C Cribs N	1,2,3	2.4E-3	2.0E-4	1.0E-3 ± 2.4E-3	5.4E-4	-3.1E-5	1.9E-4 ± 6.1E-4	1.0E-4	4.5E-6	3.9E-5 ± 1.1E-4	5.0E-5	6.4E-6	2.2E-5 ± 4.9E-5
N153	241-TX Tank Farm	1,2,4	7.5E-3	3.3E-3	5.4E-3 ± 4.1E-3	5.2E-2	8.7E-3	2.9E-2 ± 4.3E-2	1.8E-4	2.1E-5	1.0E-4 ± 1.6E-4	7.9E-5	6.6E-6	3.3E-5 ± 8.0E-5
N155	241-U Tank Farm	1,2,3,4	4.1E-4	1.6E-4	3.1E-4 ± 2.2E-4	2.5E-3	4.8E-4	1.3E-3 ± 2.0E-3	5.9E-5	9.4E-6	2.9E-5 ± 4.6E-5	2.7E-4	8.9E-6	8.7E-5 ± 2.4E-4
N157	241-BY Tank Farm	1,2,3,4	1.1E-3	4.4E-4	6.8E-4 ± 5.7E-4	2.3E-2	6.0E-3	1.6E-2 ± 1.4E-2	4.5E-5	2.9E-6	2.4E-5 ± 4.2E-5	3.0E-5	1.4E-6	1.2E-5 ± 2.5E-5
N158	241-AX Tank Farm	1,2,4	1.1E-3	2.9E-4	6.3E-4 ± 8.4E-4	3.2E-2	1.9E-3	5.7E-3 ± 1.0E-2	8.8E-5	1.0E-5	4.2E-5 ± 8.2E-5	2.4E-5	1.4E-5	2.0E-5 ± 1.1E-5
N159	B Plant	1,2,3,4	6.3E-4	1.3E-4	3.5E-4 ± 4.3E-4	9.2E-3	1.5E-3	5.1E-3 ± 8.7E-3	8.0E-5	4.7E-6	3.0E-5 ± 7.0E-5	4.0E-5	8.9E-6	2.4E-5 ± 3.1E-5
N161	T Plant	1,2,3	5.0E-4	2.2E-4	3.7E-4 ± 2.8E-4	7.4E-4	6.4E-4	6.8E-4 ± 1.1E-4	1.1E-4	1.3E-5	5.7E-5 ± 9.5E-5	9.7E-5	5.7E-6	3.6E-5 ± 1.1E-4
N165	216-Z-19 Ditch	1,2,3,4	1.2E-3	3.9E-5	4.4E-4 ± 1.1E-3	3.4E-3	-7.3E-4	1.0E-3 ± 3.5E-3	1.8E-4	3.8E-5	9.7E-5 ± 1.2E-4	2.2E-5	6.2E-6	1.4E-5 ± 1.7E-5
N168	U Plant	1,2,3,4	6.8E-4	6.7E-5	2.8E-4 ± 4.8E-4	1.8E-3	-3.0E-3	2.1E-4 ± 4.4E-3	7.9E-5	4.1E-6	3.0E-5 ± 8.8E-5	1.2E-4	1.6E-5	6.4E-5 ± 9.8E-5
N177	Laundry	1,2	3.1E-4	2.6E-4	2.8E-4 ± 7.1E-5	1.1E-3	9.2E-4	1.0E-3 ± 3.1E-4	1.0E-4	6.2E-5	8.1E-5 ± 5.4E-5	6.2E-5	8.0E-7	3.1E-5 ± 8.7E-5
N950	QA Blank	1,2,3,4	3.2E-4	8.0E-5	1.7E-4 ± 2.2E-4	9.1E-4	-3.0E-4	-1.2E-4 ± 5.7E-4	7.3E-5	1.4E-6	3.1E-5 ± 7.0E-5	5.4E-6	-9.4E-8	1.7E-5 ± 5.0E-5
N951	QA Blank	1,2,3,4	4.9E-4	-1.1E-5	1.5E-4 ± 4.6E-4	3.6E-4	-1.6E-4	8.3E-5 ± 4.2E-4	1.1E-4	0.0E+0	5.1E-5 ± 1.2E-4	4.7E-5	1.8E-6	1.5E-5 ± 4.3E-5
N956	241-S, SX Tank Farm	1,2	2.7E-4	1.3E-4	2.0E-4 ± 2.1E-4	2.6E-3	2.6E-4	1.4E-3 ± 3.3E-3	2.4E-5	2.1E-5	2.2E-5 ± 3.4E-6	4.5E-5	6.0E-6	2.5E-5 ± 5.5E-5
N957	B-C Cribs 1	1,2	2.2E-3	7.2E-5	1.1E-3 ± 3.0E-3	5.9E-4	-4.7E-4	6.2E-5 ± 1.5E-3	1.2E-4	2.0E-5	7.4E-5 ± 1.3E-4	9.3E-4	5.4E-6	4.7E-4 ± 1.3E-3
N980	Replicate by site N155	1,2	3.1E-4	2.7E-4	2.9E-4 ± 6.4E-5	3.3E-3	2.1E-3	2.7E-3 ± 1.7E-3	7.6E-5	4.5E-5	6.0E-5 ± 4.4E-5	2.2E-4	7.7E-5	1.5E-4 ± 2.0E-4
N961	Yakima Barricade	1,2,3,4	3.3E-03	2.2E-4	1.4E-3 ± 2.9E-3	5.5E-4	-1.1E-4	2.0E-4 ± 7.2E-4	2.4E-5	2.8E-6	1.1E-5 ± 1.9E-5	5.6E-5	7.4E-6	2.2E-5 ± 4.5E-5
N962	SE corner W-4B	1,2,3	5.7E-4	3.6E-4	4.7E-4 ± 2.1E-4	2.0E-3	2.3E-4	1.1E-3 ± 1.8E-3	1.8E-4	3.5E-6	7.6E-6 ± 1.9E-4	3.7E-5	4.9E-6	2.0E-5 ± 3.2E-5
N963	SE of Redox	1,2,3,4	5.5E-4	1.2E-4	2.9E-4 ± 3.7E-4	1.7E-3	2.0E-4	8.9E-4 ± 1.4E-3	4.1E-5	6.4E-6	2.4E-5 ± 3.8E-5	3.0E-5	1.4E-6	1.6E-5 ± 3.0E-5
N964	W of W-4B	1,2	4.5E-4	2.6E-4	3.5E-4 ± 2.7E-4	1.2E-3	3.8E-4	7.8E-4 ± 1.1E-3	4.9E-5	3.3E-5	4.1E-5 ± 2.2E-5	9.9E-5	7.1E-6	5.3E-5 ± 1.3E-4
N965	NE corner 200 West Area	1,2,3	1.5E-3	1.8E-4	7.2E-4 ± 1.4E-3	1.0E-2	4.1E-4	3.8E-3 ± 1.1E-2	6.8E-5	7.7E-6	3.9E-5 ± 6.1E-5	1.0E-4	3.7E-6	4.8E-5 ± 1.0E-4
N966	S of Main Gate 200 West Area	1,2	5.6E-4	-6.0E-5	2.4E-4 ± 8.0E-4	1.4E-3	3.3E-4	8.4E-4 ± 1.5E-3	4.0E-5	2.5E-5	3.3E-5 ± 2.1E-5	6.1E-5	1.0E-5	3.6E-5 ± 7.2E-5
N967	N of BY/BX Tank Farm	1,2,3,4	5.8E-3	2.4E-4	1.8E-3 ± 5.4E-3	4.9E-3	1.1E-3	2.6E-3 ± 3.3E-3	3.6E-5	2.0E-6	1.7E-5 ± 3.4E-5	6.0E-5	8.1E-6	2.1E-5 ± 5.2E-5
N968	W gate of 200 East Area	1,2	6.9E-4	2.9E-5	3.6E-4 ± 9.4E-4	1.4E-3	-8.7E-4	2.7E-4 ± 3.2E-3	1.0E-4	2.9E-5	6.5E-5 ± 1.0E-4	6.5E-5	9.6E-6	3.7E-5 ± 7.8E-5
N969	SW of PUREX	2,3,4	5.0E-4	7.3E-5	3.4E-4 ± 4.7E-4	1.4E-3	6.8E-4	1.1E-3 ± 7.9E-4	1.5E-4	6.4E-6	5.6E-5 ± 1.6E-4	7.5E-5	5.7E-6	3.4E-5 ± 7.3E-5
N970	NW of PUREX	2,3,4	1.0E-3	2.7E-4	5.2E-4 ± 8.3E-4	2.2E-3	2.0E-4	1.2E-3 ± 2.0E-3	3.2E-4	5.6E-5	1.1E-4 ± 3.6E-4	8.1E-4	1.7E-5	2.8E-4 ± 9.2E-4
N971	SE of PUREX	2,3,4	1.6E-3	1.7E-4	1.1E-3 ± 1.6E-3	2.0E-4	0.0E+0	6.6E-5 ± 2.3E-4	2.5E-4	1.6E-5	9.8E-5 ± 2.7E-4	9.5E-5	9.0E-6	3.8E-5 ± 8.8E-5
N972	NE of C Tank Farm	2,3,4	1.2E-3	2.3E-4	7.2E-4 ± 1.0E-3	9.9E-4	0.0E+0	4.0E-4 ± 1.0E-3	3.1E-4	3.9E-6	1.1E-4 ± 3.4E-4	5.2E-4	1.2E-5	2.1E-4 ± 5.5E-4
N973	E of B Tank Farm	2,3	2.3E-3	3.3E-4	1.3E-3 ± 2.8E-3	5.0E-3	1.6E-3	3.7E-3 ± 5.9E-3	3.1E-4	4.8E-5	1.8E-4 ± 3.8E-4	2.8E-4	2.0E-5	1.6E-4 ± 3.8E-4
N975	E of Z Plant	2,3,4	8.9E-4	4.3E-4	5.9E-4 ± 5.1E-4	4.0E-4	3.9E-4	4.0E-4 ± 1.2E-5	3.0E-4	1.4E-5	1.3E-4 ± 3.1E-4	3.5E-4	4.3E-5	1.5E-4 ± 3.4E-4
N976	2E17, 241-C Tank Farm	1,2,3,4	6.3E-4	2.2E-4	3.8E-4 ± 3.8E-4	1.1E-3	1.0E-4	7.3E-4 ± 8.8E-4	1.5E-4	3.9E-6	4.3E-5 ± 1.4E-4	3.6E-5	6.1E-6	1.7E-5 ± 2.9E-5
N977	2E30	1,4	2.8E-4	1.8E-4	2.3E-4 ± 1.5E-4	1.1E-3	-1.9E-3	-2.7E-4 ± 3.8E-3	4.4E-6	0.0E+0	2.2E-6 ± 6.2E-6	3.0E-5	9.2E-6	2.0E-5 ± 3.0E-5
N978	2E35	1,3,4	6.3E-4	7.3E-5	2.7E-4 ± 8.2E-4	2.8E-3	8.8E-5	1.2E-3 ± 2.9E-3	3.8E-5	1.4E-6	1.4E-5 ± 4.2E-5	1.4E-4	1.0E-5	5.8E-5 ± 1.6E-4
N979	2E36	3,4	5.9E-5	-1.2E-4	-3.2E-5 ± 2.6E-4	9.9E-4	-1.8E-4	4.1E-4 ± 1.6E-3	2.9E-6	3.6E-7	1.6E-6 ± 3.6E-6	5.3E-6	1.0E-6	5.3E-6 ± 1.1E-5
N980	2EA	1	3.6E-4	3.6E-4	3.6E-4 ± 3.5E-4	-2.7E-4	-2.7E-4	-2.7E-4 ± 8.6E-4	1.3E-4	1.3E-4	1.3E-4 ± 6.6E-5	3.5E-6	3.5E-6	3.5E-6 ± 1.2E-6
	Distant stations[a]		--	--	<DL	--	--	<DL	--	--	3.7E-5 ± 1.1E-5	--	--	<DL
	Perimeter stations[b]		--	--	3.0E-4 ± 2.0E-4	--	--	7.0E-4 ± 5.0E-4	--	--	2.0E-5 ± 1.0E-5	--	--	6.0E-5 ± 3.0E-5
	Table II concentration guides[c]		--	--	3.0E+1	--	--	5.0E+2	--	--	6.0E-2	--	--	3.0E-00

NOTE: DL = Analytical detection limit.

[a]Distant locations include Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.

[b]Perimeter locations include Benton City, Vernita Bridge, Yakima Barricade, Othello, Connell, Richland, Pasco, Prosser Barricade, Berg Ranch, Byers Landing and the 1100 Area.

[c]DOE, 1981.

Strontium-90 Levels

As in 1982, the maximum annual average ^{90}Sr concentration was observed at the 241-TX Tank Farm (Conklin et al., 1983). The average concentration at this location was approximately 13 times the average concentration at Hanford Site perimeter stations, but only 0.02% of Table II Concentration Guidelines. The average ^{90}Sr concentrations at the remaining sample locations were equal to or slightly higher than the Hanford Site perimeter values. These concentrations are attributed to a combination of activities within the tank farms, other 200 Area operations, and from resuspension of low-level contamination in the surface soil.

Cesium-137 Levels

The maximum annual average ^{137}Cs concentration observed was also measured at the 241-TX Tank Farm sampling station. The average ^{137}Cs concentration at that station was approximately 18 times greater than the average Hanford Site perimeter station concentration, but only 0.06% of the Table II Concentration Guidelines. Tank farm operations and elevated concentrations of ^{137}Cs in the nearby soil are believed to be the major contributors of airborne radionuclides at this station. The annual ^{137}Cs concentrations at the remaining stations were equal to or slightly higher than the Hanford Site perimeter values.

Plutonium-239,240 Levels

The $^{239,240}Pu$ annual average air concentrations at all stations were not significantly different than the Hanford perimeter values. The highest concentration (east of 241-B tank farm) was only 5 times the average perimeter concentration, but only 0.001% of Table II Concentration Guidelines.

Uranium Levels

Air concentration levels of uranium at all 200 Area ambient air sampling locations were less than 0.05% of Table II Guidelines in 1983.

ROUTINE SOIL, VEGETATION, AND FECAL SAMPLING

SUMMARY

Surface soil, vegetation, and animal fecal samples are collected annually from 81 grid sampling sites to assess the overall impact of Rockwell operations on the Separations Area biota. Analytical results are compared with background, which is derived from perimeter data collected by the PNL environmental surveillance program (Price et al., 1984). Though soil radionuclide concentrations in many instances exceeded background levels, all sample results were below Rockwell internal surface soil contamination standards (Boothe, 1979). The principal radionuclides observed in the 200 Areas were ^{90}Sr, ^{137}Cs, and $^{239,240}Pu$.

200 AREAS GRID SAMPLING SYSTEM

A grid system of 81 sample sites (40 in and near 200 East Area and 41 in and near 200 West Area) monitors the Separations Area environment (Fig. 7, 8, and 9). Thermoluminescent dosimeters (TLDs) are also located at each site and are discussed in the External Radiation section of this report. No grid sample site is located within a radiologically controlled area.

Soil

During the early summer of 1983, surface soil samples were collected from the Separations Area grid sampling system. Each sample represented a composite of five plugs of soil collected from a 100 m^2 area located at each grid site. Each plug was 2.5 cm in depth by 10 cm in diameter. Radionuclide analysis included gamma energy analysis (GEA), ^{90}Sr, and plutonium isotopic measurements. Data are shown in Table 3 and 4.

In 1979, Rockwell established "derived" surface soil-contamination standards that are based on DOE Table II Concentration Guidelines for air and soil-particle resuspension model estimates for the 200 Areas (Boothe, 1979). These standards represent permissible radionuclide concentrations in the soil above which radiological controls (e.g., posting) are required. These standards are intended for use only within the Separations Area. No samples from the 200 Areas grid sites approached these standards in 1983.

The predominant radionuclides found in the soil samples were naturally occurring ^{40}K, ^{224}Ra and ^{226}Ra, and manmade ^{137}Cs, ^{90}Sr, and $^{239,240}Pu$. Mean concentrations of the artificially produced radionuclides that exceeded soil background levels at the grid sites are illustrated on Figures 10 through 15. Elevated radionuclide concentrations were observed primarily at sites downwind of, or adjacent to processing facilities, tank farms, waste disposal sites, or historical release sites. (See Fig. 16 and 17 for annual wind distribution for the 200 Areas).

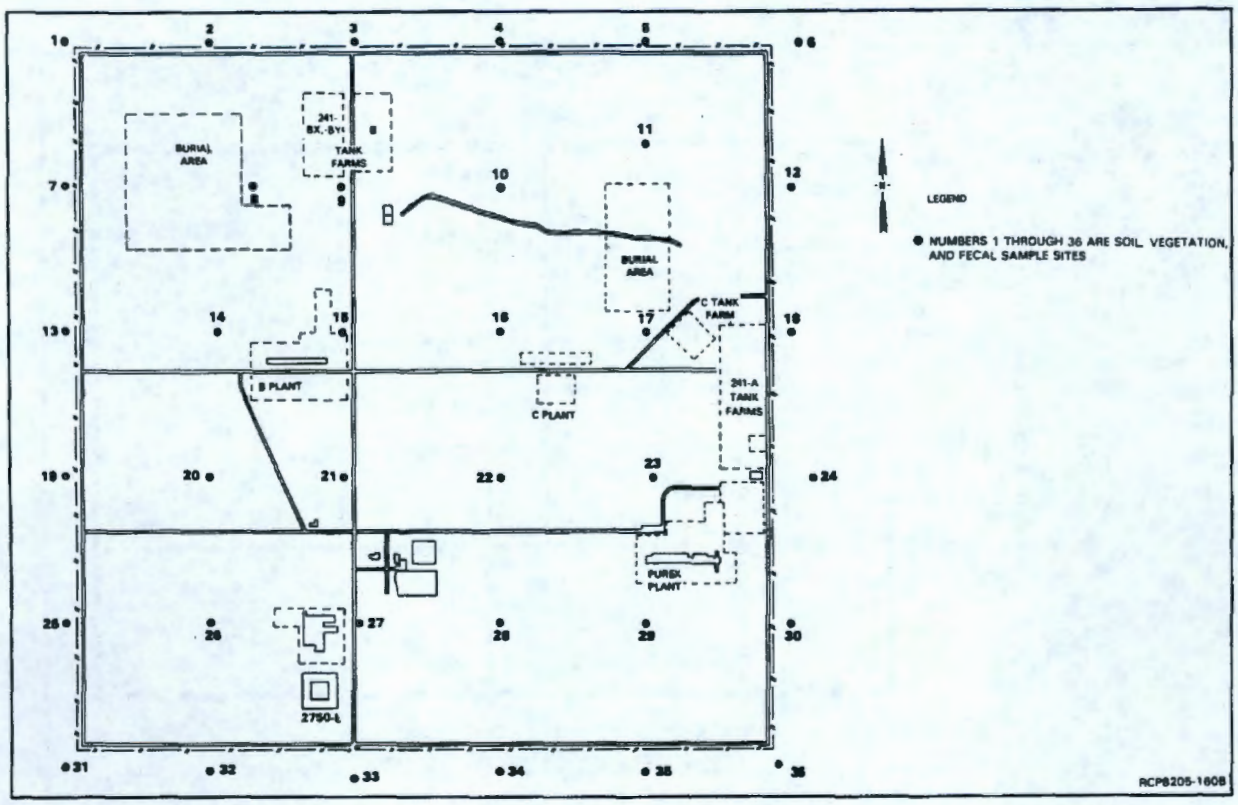


FIGURE 7. The 200 East Area Grid Sampling Sites.

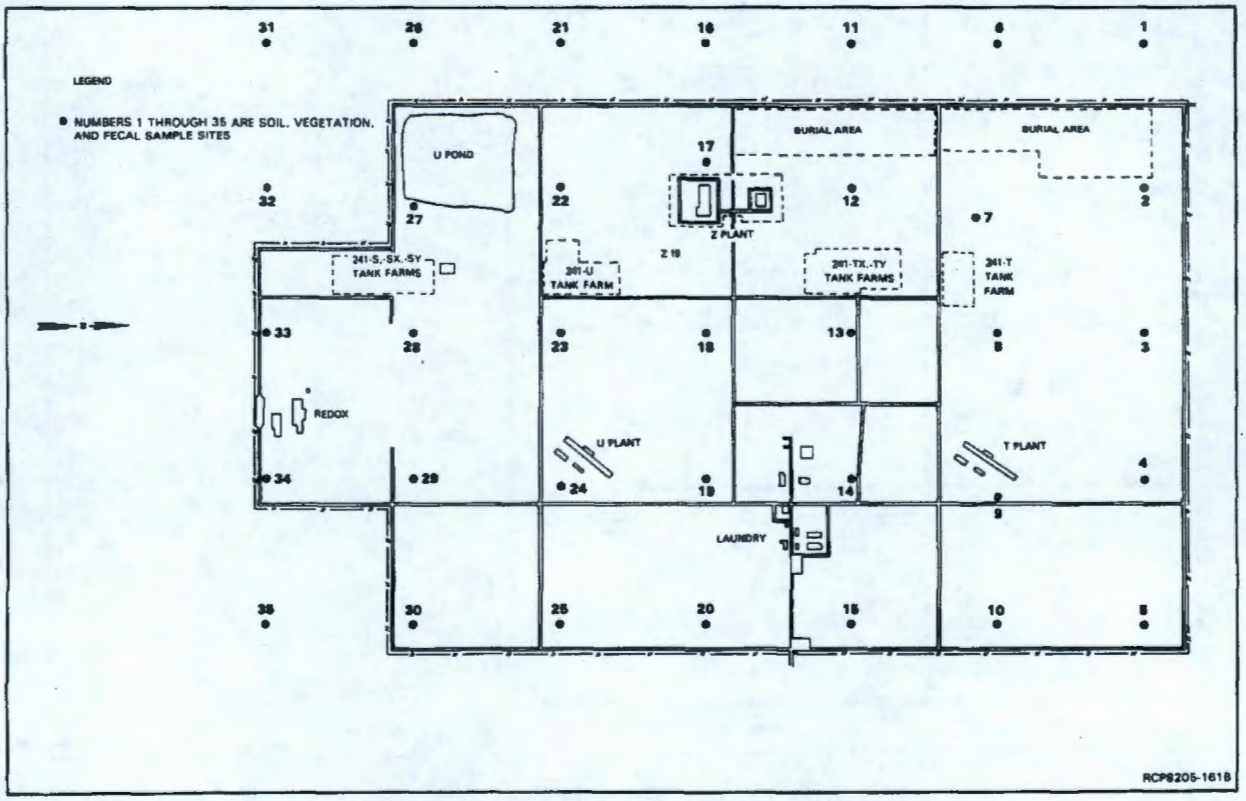


FIGURE 8. The 200 West Area Grid Sampling Sites.

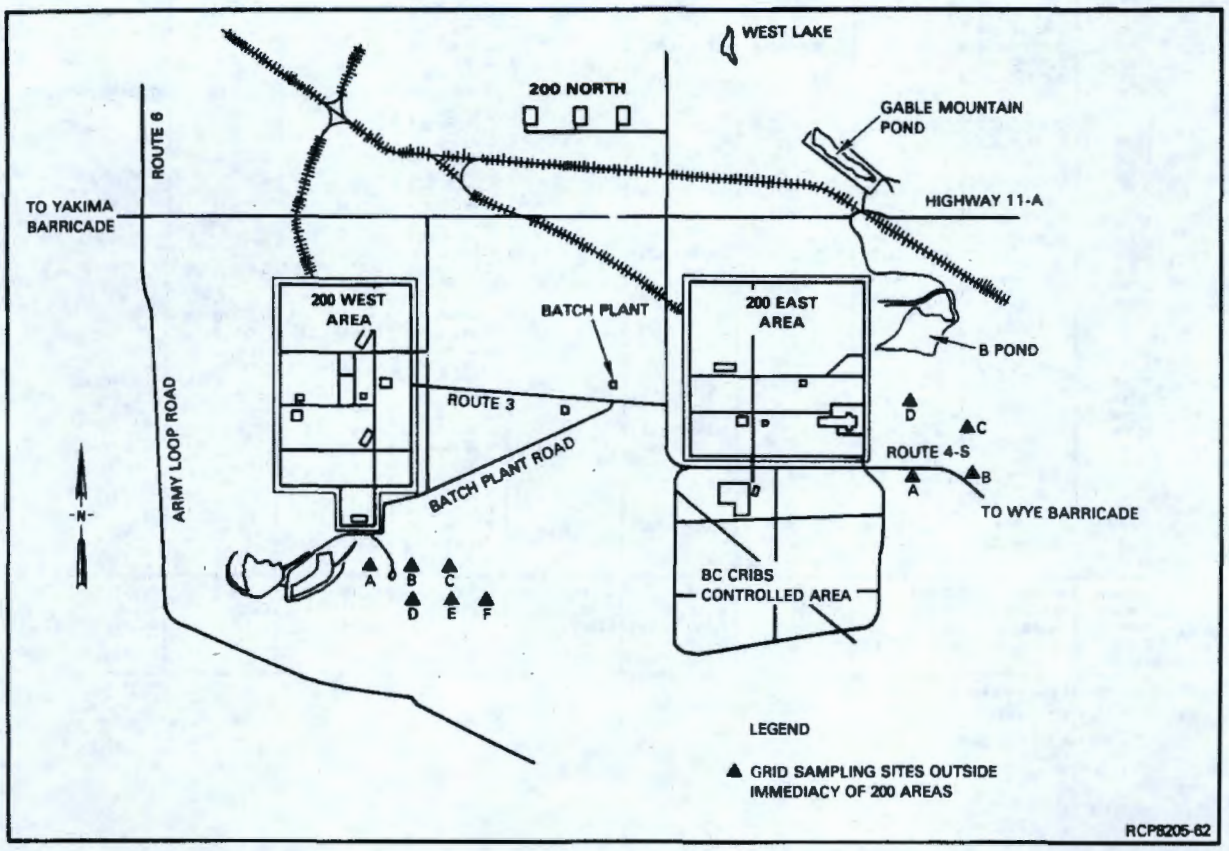


FIGURE 9. Grid Sampling Sites Outside 200 Area Perimeter Fences.

TABLE 3. Radionuclide Concentrations in Soil Samples at 200 East Area Grid Sites (pCi/g). (Sheet 1 of 2)

Map location	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{89}Sr	^{90}Sr	^{95}Nb	^{95}Zr	^{106}Ru
2E1[a]	0.048±0.036							0.084±0.074	
2E1[a]	0.048±0.035				0.099±0.091	0.098±0.031	0.065±0.038		
2E2			0.052±0.043		0.212±0.063	0.047±0.017			
2E3				0.128±0.090	0.793±0.178	0.324±0.051			
2E4		0.053±0.044	0.053±0.039		0.371±0.111	0.357±0.038	0.071±0.053		
2E5					0.094±0.063	0.129±0.023	0.078±0.069		
2E6					0.189±0.050	0.123±0.016			
2E7					0.632±0.103	0.286±0.031			
2E8					0.190±0.054	0.070±0.016	0.118±0.049		
2E9					0.228±0.141	0.887±0.055			
2E10					0.375±0.111	0.324±0.038			
2E11					1.050±0.252	1.910±0.092			
2E12	0.047±0.035		0.043±0.040			2.530±0.128	0.048±0.033		
2E13			0.046±0.039			0.569±0.047		0.103±0.052	
2E14			0.061±0.037			0.507±0.064			
2E15[a]	0.051±0.028					0.548±0.063			
2E15[a]				0.094±0.073		1.360±0.070			
2E16			0.060±0.033	0.093±0.060		2.670±0.145			
2E17						15.900±0.984			
2E18	0.042±0.032					1.060±0.091			
2E19	0.039±0.036		0.068±0.054	0.099±0.072		0.565±0.059			
2E20	0.070±0.034					0.727±0.064			
2E21	0.045±0.041			0.074±0.063		0.515±0.063			
2E22						0.687±0.069	0.073±0.037		0.556±0.292
2E23[a]						0.622±0.072	0.056±0.037		
2E23[a]	0.038±0.029	0.048±0.045	0.045±0.044			0.951±0.085			
2E24[a]	0.056±0.029					1.880±0.132			
2E24[a]						1.350±0.115		0.122±0.065	
2E25		0.035±0.034				0.275±0.050			0.381±0.281
2E26		0.038±0.034	0.085±0.045			0.791±0.090	0.057±0.039		
2E27						0.461±0.052	0.069±0.040		
2E28[a]		0.042±0.041				0.734±0.077			
2E28[a]	0.042±0.032					0.662±0.076			
2E29[a]		0.042±0.035		0.099±0.070		0.579±0.068			
2E29[a]						0.474±0.054	0.027±0.022	0.069±0.066	
2E30[b]									
2E30[b]									
2E31						0.436±0.048		0.072±0.066	
2E32						0.984±0.089	0.044±0.034		
2E33						0.310±0.052			
2E34	0.040±0.022					1.050±0.083			
2E35[a]			0.044±0.036			0.508±0.053			0.365±0.300
2E35[a]						0.537±0.058			
2E36[a]						0.434±0.045			
2E36[a]				0.058±0.047		0.444±0.045			
2EA[a]				0.070±0.064		0.323±0.046			0.288±0.260
2EA[a]						0.416±0.043			
2EB[a]		0.039±0.032				0.306±0.041			
2EB[a]						0.348±0.043			
2EC[a]						0.614±0.058			
2EC[a]				0.093±0.068		0.983±0.083			
2ED[a]	0.041±0.035					0.650±0.065	0.060±0.036		
2ED[a]						0.641±0.060			
Maximum	0.070	0.053	0.085	0.128	0.150	15.900	0.188	0.122	0.556
Minimum	0.038	0.035	0.043	0.058	0.094	0.047	0.027	0.069	0.288
Average	0.046	0.042	0.056	0.090	0.385	0.99	0.064	0.090	0.398
Perimeter[c]						1.03 ±0.58			

[a]Replicate samples collected.

[b]No sample collected.

[c]Price et al., 1984.

TABLE 3. Radionuclide Concentrations in Soil Samples at 200 East Area Grid Sites (pCi/g). (Sheet 2 of 2)

Map location	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu	^{238}Pu	^{239}Pu
2E1[a]		1.720±0.116				0.214±0.099			0.023±0.008
2E1[a]	0.067±0.048	1.330±0.108			0.441±0.164	0.146±0.126		0.01030±0.00400	0.018±0.005
2E2	0.076±0.036	0.157±0.042						0.00208±0.00155	0.003±0.002
2E3	0.084±0.049	11.500±0.308			0.322±0.141			0.01660±0.00717	0.051±0.011
2E4	0.051±0.050	2.920±0.161			0.297±0.180			0.00359±0.00170	0.013±0.003
2E5		1.670±0.114					0.145±0.119	0.00458±0.00304	0.006±0.003
2E6		0.726±0.078				0.157±0.107			0.024±0.008
2E7		1.680±0.125							0.007±0.004
2E8	0.051±0.047	0.171±0.043						0.00194±0.00171	0.004±0.002
2E9		8.260±0.255	0.130±0.077					0.01940±0.00598	0.014±0.005
2E10		3.140±0.160						0.00922±0.00348	0.006±0.003
2E11	0.176±0.072	22.300±0.591		0.756±0.592	0.452±0.233	0.157±0.157		0.01040±0.00398	0.054±0.009
2E12	0.117±0.039	29.600±0.274			0.260±0.143		0.191±0.111	0.00243±0.00108	0.064±0.005
2E13	0.080±0.035	0.352±0.053			0.238±0.109				0.021±0.006
2E14	0.064±0.039	1.460±0.101			0.208±0.137			0.00109±0.00074	0.016±0.003
2E15[a]		1.360±0.094	0.085±0.084		0.216±0.099				0.088±0.007
2E15[a]		1.310±0.088		0.257±0.210			0.130±0.091		0.167±0.025
2E16	0.081±0.039	2.390±0.129						0.00078±0.00045	0.058±0.004
2E17		1.200±0.098		0.339±0.269	0.194±0.104				
2E18	0.066±0.034	8.170±0.231			0.209±0.162				0.013±0.004
2E19		1.740±0.122						0.00136±0.00059	0.026±0.003
2E20		0.677±0.078			0.246±0.120	0.120±0.102		0.00120±0.00060	0.041±0.004
2E21		0.846±0.085						0.00049±0.00048	0.030±0.004
2E22		2.110±0.122		0.239±0.237	0.293±0.155			0.00784±0.00435	0.730±0.042
2E23[a]	0.062±0.046	5.550±0.215			0.323±0.141			0.00680±0.00428	0.094±0.015
2E23[a]		4.210±0.182		0.426±0.301	0.217±0.112			0.00308±0.00276	0.105±0.016
2E24[a]	0.058±0.038	4.900±0.180							0.020±0.005
2E24[a]	0.055±0.040	5.450±0.195			0.229±0.144			0.00114±0.00064	0.035±0.003
2E25		0.591±0.073			0.192±0.146				0.013±0.004
2E26		0.686±0.077							0.014±0.003
2E27	0.050±0.045	0.279±0.053							0.003±0.001
2E28[a]		0.427±0.064	0.148±0.083						0.008±0.002
2E28[a]	0.053±0.042	0.356±0.056	0.136±0.085		0.236±0.155				0.006±0.001
2E29[a]		0.388±0.054							0.009±0.002
2E29[a]	0.096±0.035	0.370±0.051		0.219±0.184				0.00048±0.00036	0.008±0.001
2E30[b]									
2E30[b]									
2E31	0.055±0.044	0.348±0.058		0.257±0.250					0.005±0.002
2E32	0.058±0.046	0.831±0.088						0.00041±0.00037	0.012±0.002
2E33		0.050±0.030							0.002±0.001
2E34	0.085±0.045	0.747±0.076						0.00034±0.00026	0.013±0.002
2E35[a]		0.580±0.068			0.302±0.177				0.010±0.002
2E35[a]		0.878±0.082	0.085±0.077			0.182±0.124			0.113±0.016
2E36[a]		0.501±0.062			0.249±0.111				0.014±0.003
2E36[a]	0.094±0.043	0.568±0.066							0.011±0.003
2EA[a]		0.456±0.064							0.007±0.002
2EA[a]		0.346±0.057							0.004±0.001
2EB[a]	0.085±0.031	0.423±0.061	0.074±0.069						0.029±0.003
2EB[a]	0.117±0.062	0.435±0.073			0.300±0.221	0.227±0.129			0.062±0.005
2EC[a]		1.960±0.125					0.132±0.111	0.00061±0.00057	0.011±0.002
2EC[a]	0.062±0.046	2.720±0.151	0.075±0.051						0.022±0.004
2ED[a]	0.104±0.046	1.580±0.122						0.00209±0.00121	0.032±0.005
2ED[a]	0.097±0.034	1.650±0.119						0.00113±0.00083	0.023±0.004
Maximum	0.176	29.600	0.148	0.756	0.452	0.227	0.191	0.01940	0.730
Minimum	0.050	0.050	0.074	0.219	0.192	0.120	0.130	0.00034	0.002
Average	0.079	2.825	0.105	0.356	0.271	0.172	0.150	0.00438	0.043
Perimeter[c]		0.85 ±0.56							0.019±0.008

[a]Replicate samples collected.

[b]No sample collected.

[c]Price et al., 1984.

TABLE 4. Radionuclide Concentrations in Soil Samples at 200 West Area Grid Sites (pCi/g). (Sheet 1 of 2)

Map location	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{89}Sr	^{90}Sr	^{95}Nb	^{95}Zr	^{106}Ru
ZW1						0.535±0.053			
ZW2						1.190±0.083			
ZW3[a]	0.038±0.037					0.327±0.041			
ZW3[a]						0.459±0.049			
ZW4						0.533±0.051	0.081±0.054		0.641±0.276
ZW5[a]						0.459±0.049			
ZW5[a]						0.450±0.049			
ZW6[a]			0.063±0.045			0.337±0.042	0.072±0.042		
ZW6[a]						0.408±0.063		0.095±0.076	
ZW7		0.050±0.049	0.085±0.037			0.378±0.059			
ZW8	0.040±0.035		0.080±0.046			1.040±0.070			
ZW9	0.059±0.033		0.062±0.039			1.140±0.079			0.406±0.372
ZW10						0.534±0.062			
ZW11		0.064±0.039	0.080±0.033			0.357±0.053		0.129±0.076	
ZW12	0.039±0.037					0.515±0.068	0.087±0.076		
ZW13						1.550±0.080	0.093±0.043		
ZW14						0.338±0.054			
ZW15				0.112±0.074		0.628±0.073			
ZW16						0.629±0.066			
ZW17	0.046±0.031					0.213±0.053			
ZW18				0.073±0.062		0.077±0.031	0.118±0.059		
ZW19		0.071±0.055	0.133±0.040			0.992±0.089	0.069±0.065		
ZW20	0.043±0.042	0.061±0.059				0.355±0.058			
ZW21[a]						0.374±0.050			0.443±0.316
ZW21[a]						0.669±0.072			
ZW22				0.109±0.086		0.907±0.080			
ZW23[a]						2.520±0.130			
ZW23[a]						1.330±0.085	0.143±0.097		
ZW24[a]						0.659±0.066			
ZW24[a]						2.000±0.167			
ZW25						0.762±0.050			
ZW26						1.170±0.083			
ZW27		0.072±0.045				1.630±0.070			
ZW28			0.037±0.035			0.820±0.052			
ZW29[a]						2.680±0.093			
ZW29[a]						0.862±0.053			
ZW30				0.177±0.099		0.623±0.047	0.187±0.104		
ZW31	0.043±0.037					0.355±0.065			
ZW32	0.043±0.024			0.107±0.063		0.662±0.051			
ZW33						0.799±0.055			
ZW34			0.054±0.041			1.840±0.111			0.328±0.303
ZW35		0.093±0.045				0.547±0.045			
ZWA[a]						0.507±0.053	0.173±0.165		0.677±0.315
ZWA[a]						0.150±0.020			
ZWB[a]						0.088±0.021			
ZWB[a]	0.038±0.030					0.160±0.025			
ZWC[a]						0.361±0.038		0.211±0.121	
ZWC[a]						0.340±0.040			
ZWD						0.299±0.043			
ZWE						0.809±0.085			
ZWF						0.352±0.034			
Maximum	0.059	0.093	0.133	0.177	--	2.680	0.187	0.211	0.677
Minimum	0.038	0.050	0.037	0.073	--	0.077	0.069	0.095	0.328
Average	0.043	0.068	0.074	0.116	--	0.740	0.114	0.145	0.499
Perimeter[b]						1.03 ±0.58			

[a]Replicate samples collected.

[b]Price et al., 1984.

TABLE 4. Radionuclide Concentrations in Soil Samples at 200 West Area Grid Sites (pCi/g). (Sheet 2 of 2)

Map location	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu	^{238}Pu	^{239}Pu
ZW1	0.058±0.045	0.627±0.070						0.00125±0.00094	0.015±0.003
ZW2	0.076±0.049	6.950±0.242	0.240±0.158			0.176±0.099	0.247±0.173	0.00323±0.00277	0.917±0.045
ZW3[a]		0.382±0.059				0.142±0.122		0.00068±0.00061	0.019±0.003
ZW3[a]		0.562±0.074						0.00189±0.00149	0.046±0.007
ZW4		1.140±0.101						0.00252±0.00160	0.039±0.006
ZW5[a]	0.068±0.036	0.755±0.075						0.00421±0.00244	0.160±0.015
ZW5[a]		0.604±0.064				0.147±0.130			0.035±0.005
ZW6[a]		0.391±0.057					0.106±0.088	0.00202±0.00098	0.026±0.003
ZW6[a]		0.360±0.056			0.190±0.145				0.017±0.003
ZW7		5.000±0.200			0.160±0.148			0.00243±0.00218	0.028±0.007
ZW8		36.300±0.510				0.124±0.112		0.00295±0.00145	0.052±0.006
ZW9	0.050±0.045	5.310±0.210						0.02280±0.00223	1.870±0.020
ZW10		1.300±0.105						0.00527±0.00127	0.247±0.008
ZW11		0.457±0.062				0.126±0.061	0.106±0.103	0.00245±0.00128	0.065±0.007
ZW12		1.430±0.107		0.304±0.212					0.052±0.013
ZW13		25.300±0.448						0.00398±0.00230	0.142±0.014
ZW14		1.870±0.111	0.135±0.100			0.094±0.085			0.079±0.008
ZW15	0.074±0.044	0.707±0.075				0.094±0.090			0.129±0.012
ZW16		0.484±0.065					0.191±0.127		0.013±0.004
ZW17	0.053±0.040	0.324±0.058			0.182±0.147			0.00171±0.00073	0.061±0.004
ZW18		1.560±0.108			0.151±0.091			0.04260±0.00645	0.903±0.030
ZW19		7.980±0.260				0.124±0.112		0.00710±0.00449	0.473±0.037
ZW20	0.080±0.048	0.918±0.089	0.294±0.216				0.162±0.140		0.078±0.010
ZW21[a]		0.708±0.076			0.180±0.173				0.019±0.005
ZW21[a]		1.000±0.093							0.020±0.006
ZW22		1.060±0.089							0.063±0.014
ZW23[a]		56.600±0.645						0.02540±0.00651	1.140±0.044
ZW23[a]	0.059±0.048	33.100±0.489			0.142±0.131			0.01580±0.00690	0.659±0.044
ZW24[a]		2.760±0.136			0.245±0.143			0.00278±0.00227	0.097±0.013
ZW24[a]	0.088±0.037	4.490±0.177	0.349±0.233		0.235±0.111			0.00310±0.00234	0.108±0.014
ZW25	0.053±0.038	0.706±0.074			0.196±0.141			0.00088±0.00083	0.022±0.004
ZW26		0.592±0.069			0.192±0.139			0.00215±0.00096	0.037±0.004
ZW27		9.970±0.254		0.389±0.364				0.00780±0.00247	0.097±0.009
ZW28		3.850±0.163				0.094±0.090		0.00100±0.00071	0.016±0.003
ZW29[a]		2.120±0.135			0.271±0.171			0.00392±0.00141	0.053±0.005
ZW29[a]		1.730±0.119						0.01040±0.00230	0.044±0.005
ZW30	0.069±0.049	1.240±0.100							0.048±0.007
ZW31		0.487±0.063					0.144±0.105	0.00591±0.00209	0.136±0.010
ZW32		0.693±0.076							
ZW33		2.090±0.129							0.041±0.006
ZW34		1.890±0.115			0.179±0.096			0.25300±0.02270	0.115±0.015
ZW35		0.746±0.078	0.284±0.208					0.00895±0.00320	0.043±0.007
ZWA[a]	0.072±0.056	0.711±0.082			0.147±0.147			0.00112±0.00047	0.024±0.002
ZWA[a]	0.066±0.039	1.040±0.093			0.151±0.139				0.026±0.006
ZWB[a]		0.479±0.062						0.00115±0.00103	0.013±0.004
ZWB[a]	0.092±0.039	0.482±0.065			0.265±0.125			0.00044±0.00039	0.010±0.002
ZWC[a]	0.076±0.037	0.445±0.060				0.157±0.067		0.00060±0.00045	0.015±0.002
ZWC[a]		0.285±0.050					0.113±0.095		0.009±0.002
ZWD	0.084±0.051	0.434±0.066		0.303±0.301	0.299±0.165				0.008±0.003
ZWE		0.449±0.063	0.232±0.182						0.010±0.003
ZWF		0.442±0.063							0.009±0.004
Maximum	0.092	56.600	0.349	0.389	0.271	0.176	0.247	0.25300	1.870
Minimum	0.050	0.285	0.135	0.303	0.142	0.094	0.106	0.00044	0.008
Average	0.070	4.532	0.256	0.332	0.195	0.128	0.153	0.01368	0.167
Perimeter[b]		0.85±0.56							0.019±0.008

[a]Replicate samples collected.

[b]Price et al., 1984.

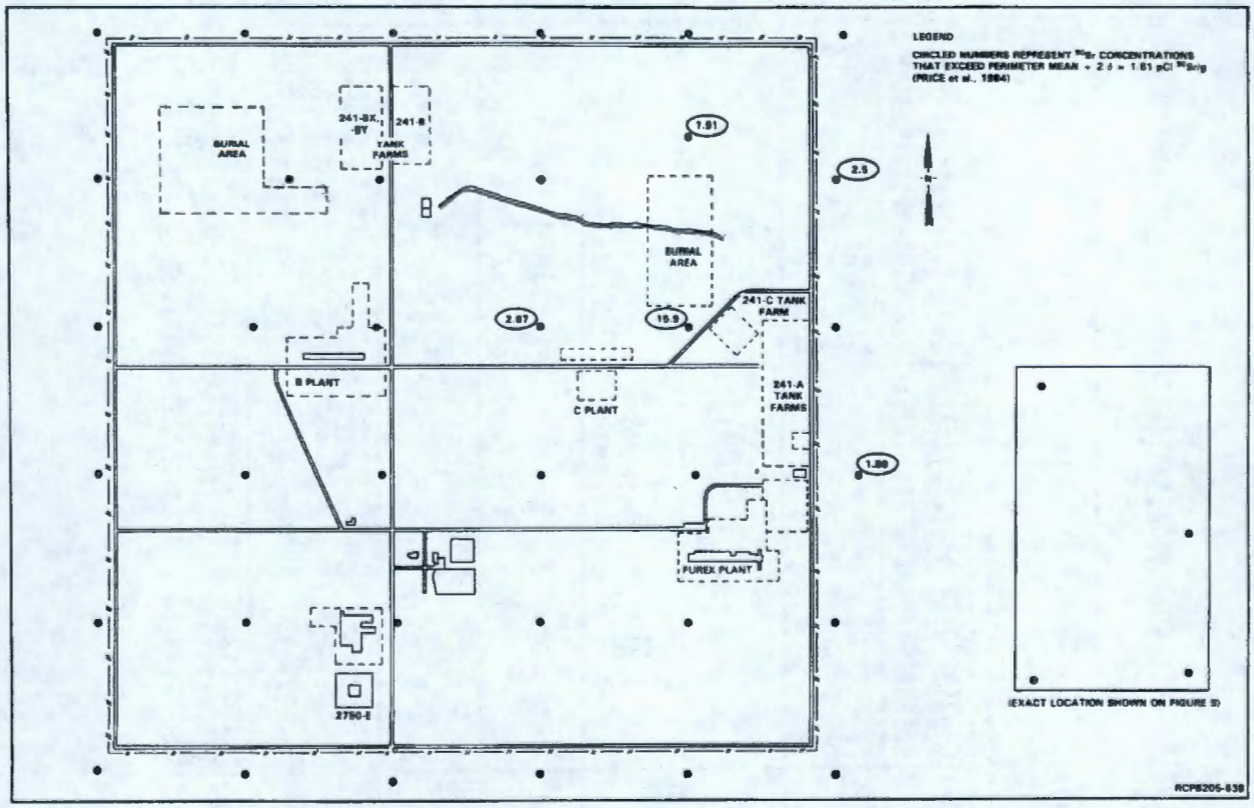


FIGURE 10. Strontium-90 Concentrations in Soil at 200 East Area Sample Sites.

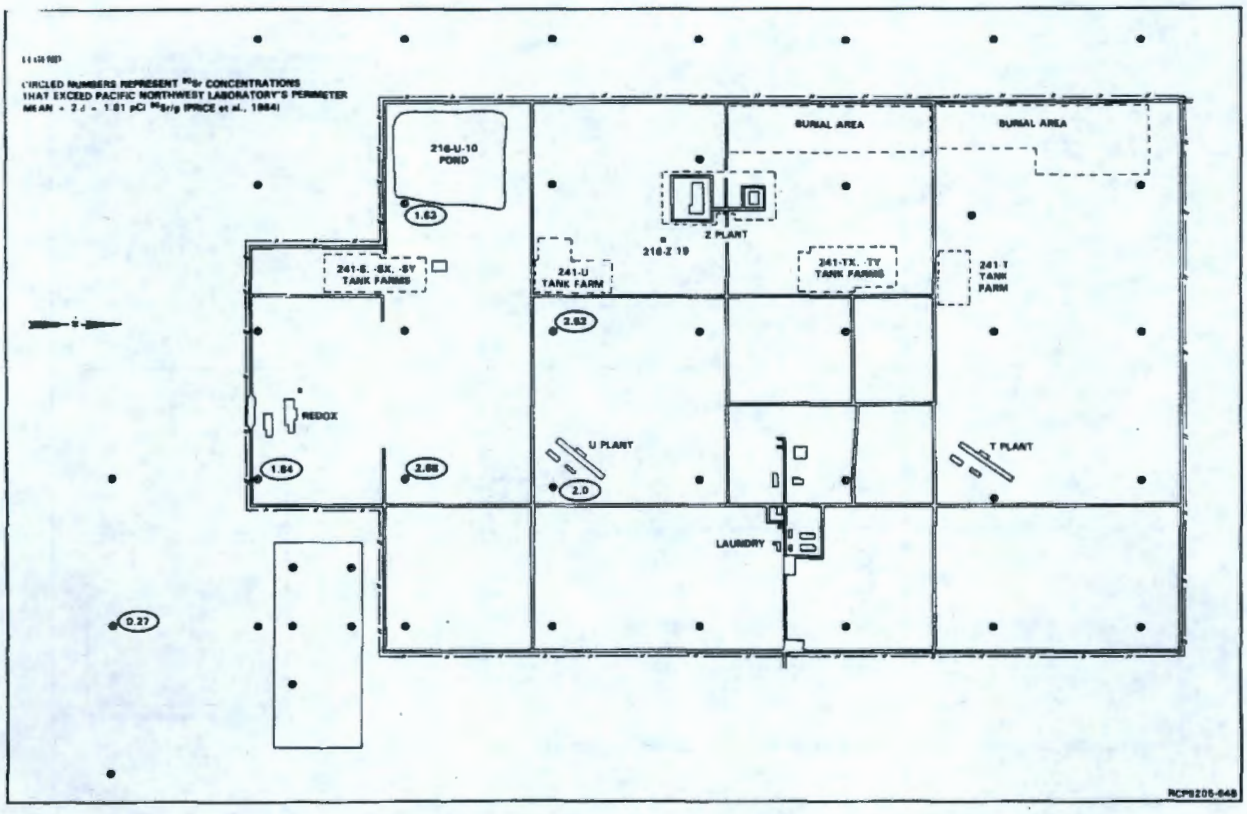


FIGURE 11. Strontium-90 Concentrations in Soil at 200 West Area Sample Sites.

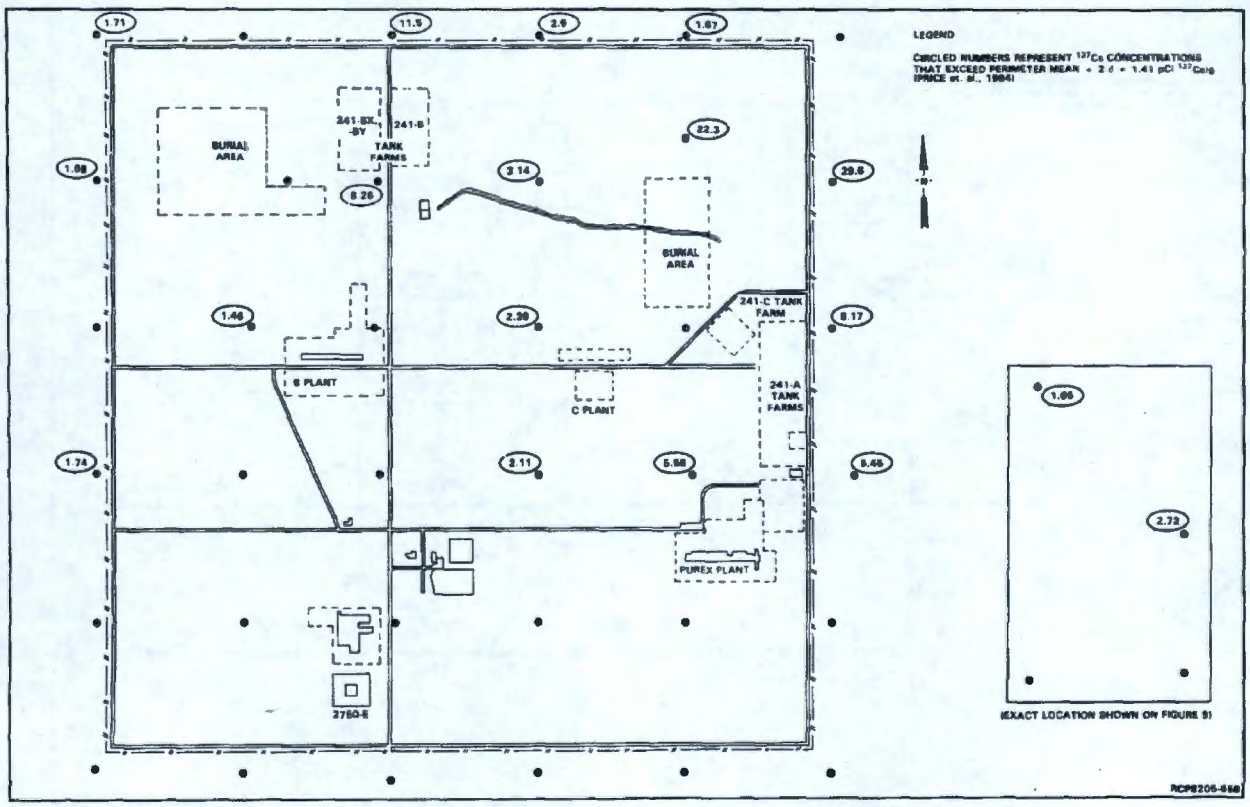


FIGURE 12. Cesium-137 Concentrations in Soil at 200 East Area Sample Sites.

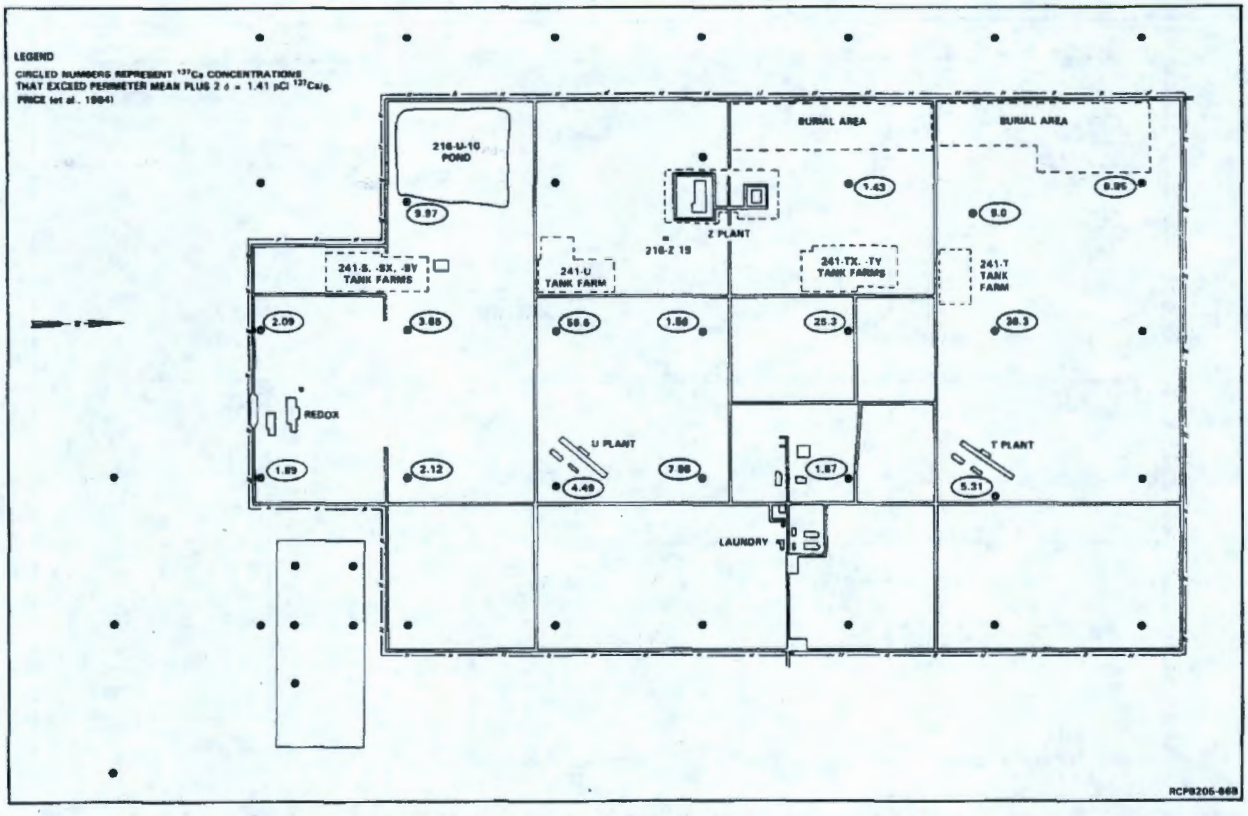


FIGURE 13. Cesium-137 Concentrations in Soil at 200 West Area Sample Sites.

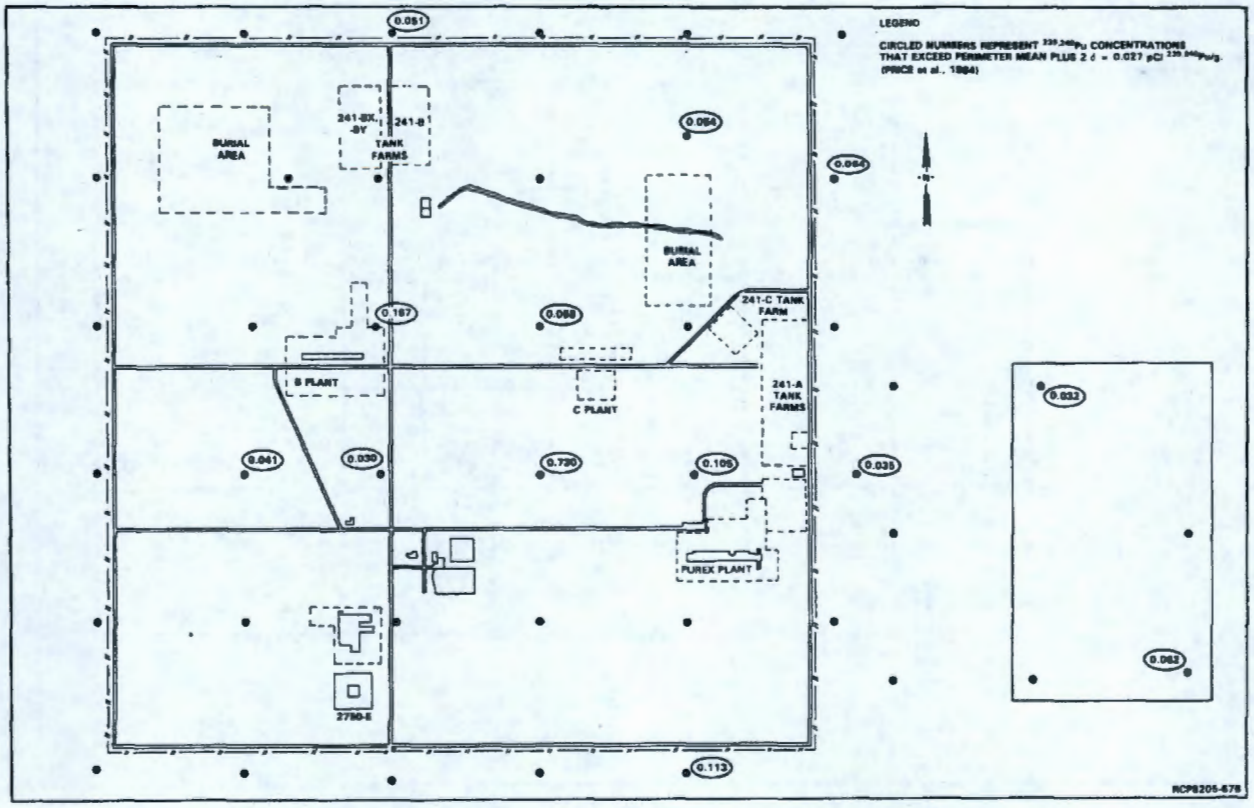


FIGURE 14. Plutonium-239,240 Concentrations in Soil at 200 East Area Sample Sites.

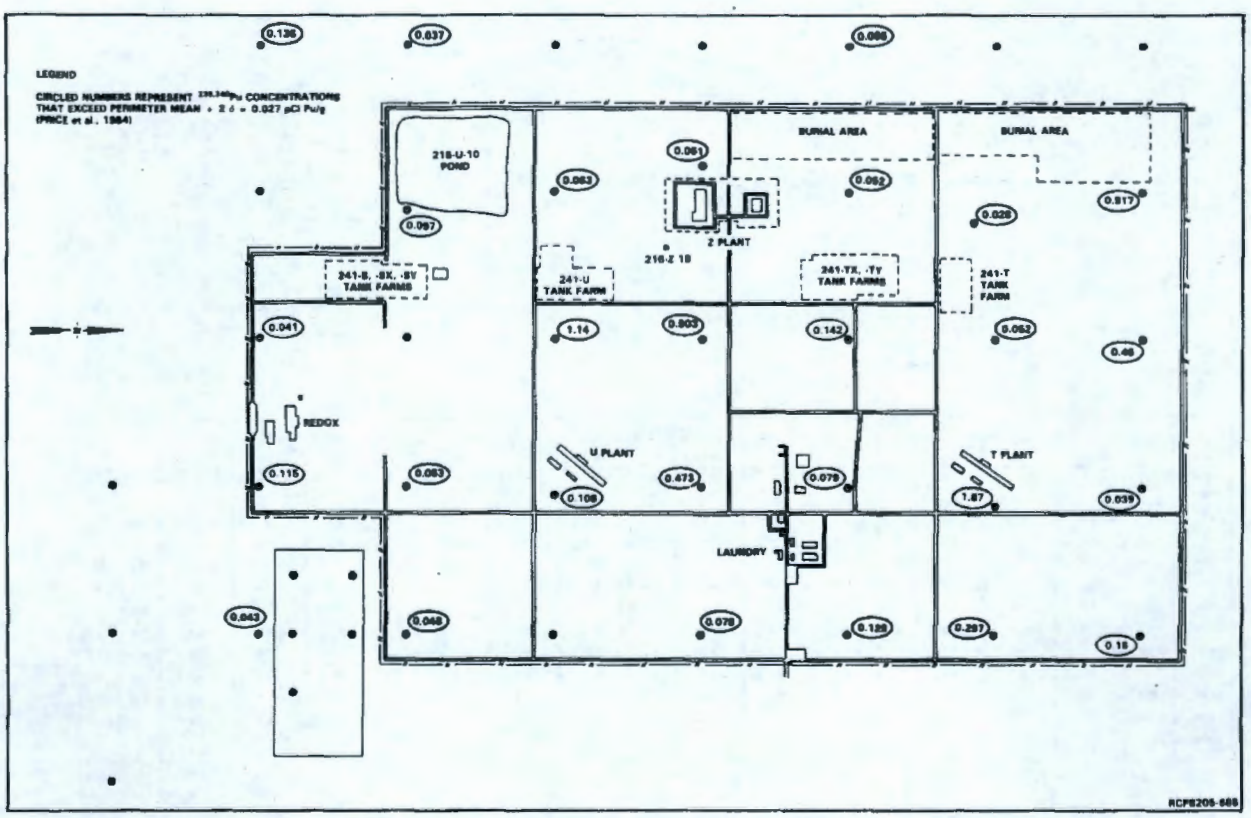
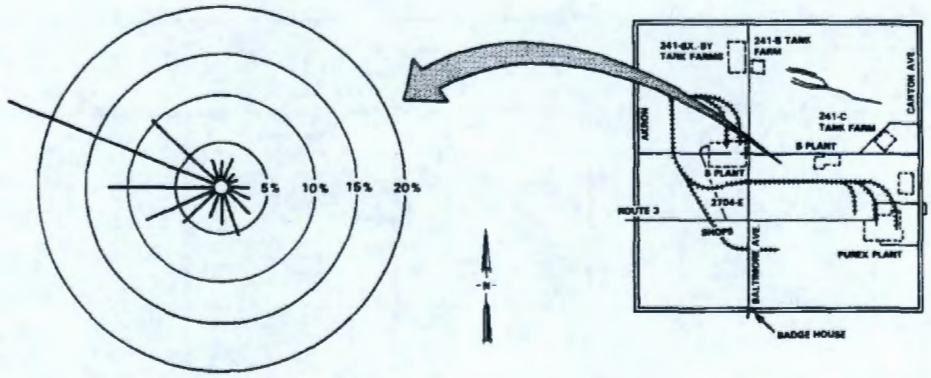


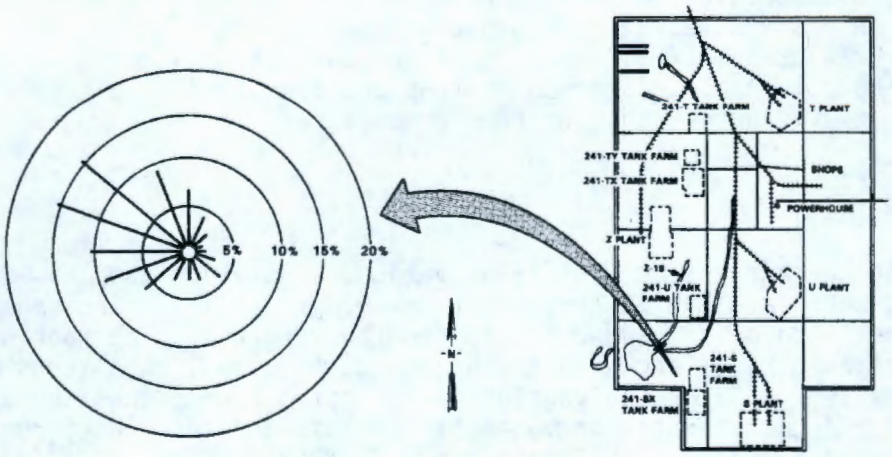
FIGURE 15. Plutonium-239,240 Concentrations in Soil at 200 West Area Sample Sites.



SPEED m/h	DIRECTION																CALM	TOTAL
	NORTH	NORTH-NORTHEAST	NORTHEAST	EAST-NORTHEAST	EAST	EAST-SOUTHEAST	SOUTHEAST	SOUTH-SOUTHEAST	SOUTH	SOUTH-SOUTHWEST	SOUTHWEST	WEST-SOUTHWEST	WEST	WEST-NORTHWEST	NORTHWEST	NORTH-NORTHWEST		
CALM																	2.2	2.2
1-3	1.2	0.9	0.9	1.0	1.4	1.7	1.1	1.2	1.0	1.0	1.3	1.3	1.7	1.9	2.1	1.3	0.0	21.1
4-7	1.2	1.0	0.7	0.7	1.0	1.8	2.4	2.6	1.0	1.3	1.9	2.8	4.9	8.3	4.5	1.8	0.0	30.3
8-12	0.6	0.8	0.3	0.1	0.1	0.2	0.7	1.2	0.9	0.6	1.1	2.7	4.6	9.4	2.2	0.4	0.0	25.1
13-18	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.3	0.3	0.4	1.1	1.3	1.1	3.6	1.0	0.1	0.0	9.6
19-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.2	0.8	0.3	0.0	0.0	2.2
25-31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.4
32-38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GT 46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.1	2.8	2.0	1.8	2.6	3.4	4.3	5.4	4.0	3.5	5.7	8.8	12.6	24.1	10.1	3.6	2.2	100.0
AVERAGE SPEED	5.4	6.0	5.2	3.6	3.6	4.0	5.2	6.1	6.3	7.2	8.4	8.7	7.7	8.9	7.3	4.7		

PS8409-83

FIGURE 16. The 200 East Area Telemetry Data for 1983.



SPEED (MPH)	DIRECTION																CALM	TOTAL
	NORTH	NORTH NORTHEAST	NORTHEAST	EAST-NORTHEAST	EAST	EAST-SOUTHEAST	SOUTHEAST	SOUTH SOUTHEAST	SOUTH	SOUTH-SOUTHWEST	SOUTHWEST	WEST SOUTHWEST	WEST	WEST-NORTHWEST	NORTHWEST	NORTH NORTHWEST		
CALM																	0.3	0.3
1-3	3.1	1.6	1.4	0.9	0.6	1.3	2.1	1.8	1.7	1.6	2.3	3.2	3.7	4.7	3.9	3.2	0.0	37.3
4-7	3.6	1.0	0.9	0.4	0.7	1.2	1.8	1.2	0.9	0.9	1.4	2.7	4.4	8.3	5.4	3.8	0.0	38.7
8-12	0.8	0.7	0.2	0.0	0.0	0.2	0.4	0.2	0.2	0.9	1.4	2.4	2.0	2.3	3.9	1.9	0.0	17.4
13-18	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.8	1.0	0.4	0.3	1.6	0.3	0.0	5.0
19-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.1	0.0	0.4	0.0	0.0	1.0
25-31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
32-38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39-46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GT 46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	7.2	4.2	2.6	1.3	1.3	2.7	4.3	3.2	2.9	3.7	6.0	9.5	10.6	15.5	15.2	9.3	0.3	100.0
AVERAGE SPEED	4.8	4.8	4.3	3.5	3.7	4.1	4.1	3.7	3.8	6.1	6.8	6.9	5.4	5.1	7.2	5.5		

P85405-83

FIGURE 17. The 200 West Area Telemetry Data for 1983.

Cesium-137 concentrations exceeded background levels at most sites in the 200 Areas. The highest concentration was 56.6 pCi ^{137}Cs/g at Site 2W23. This level is approximately 14% of the surface soil contamination standard* of 400 pCi ^{137}Cs/g. There were no significant increases in ^{137}Cs concentrations in the soil from previous years.

Concentrations of ^{90}Sr in soil at most sites exceeded background levels; however, the highest concentration (15.9 pCi ^{90}Sr/g at 2E17) was only about 4% of the soil standard for ^{90}Sr (400 pCi/g).

Soil concentrations of $^{239,240}Pu$ were insignificant in the 200 East Area with only six sites exceeding background levels. The highest level (1.87 pCi Pu/g at Site 2W9) was 3.1% of the surface soil contamination standard (60 pCi Pu/g). These concentrations are attributable to Z Plant plutonium-related operations in the 200 West Area.

VEGETATION

During the early summer of 1983, various vegetation samples were collected, where available, at each of the 81 grid sites. The vegetation samples consisted of stems and leaves from growing plants at each site. The major vegetative types included sagebrush, tumbleweeds, rabbitbrush, and various grasses. All of the vegetation collected from each site was composited and analyzed for gamma-emitting radionuclides. Radionuclide concentrations are listed in Tables 5 and 6. The location of ^{137}Cs concentrations above background are shown in Figures 18 and 19. The maximum ^{137}Cs concentration (1.1 pCi/g) was at Site 2W13, which is adjacent to TX tank farm. The higher radionuclide levels generally were observed downwind of operating facilities.

Animal Feces

When soil and vegetation samples are collected at the 200 Area grid sites, animal feces are also collected within the sampling area. The feces are analyzed as an indicator of radioactive-waste management operations impact on the 200 Area animal population. The predominant type of feces found in 1983 was from the rabbit population. Analytical results are listed in Tables 7 and 8.

The predominant radionuclides detected in feces were naturally occurring ^{40}K, followed by manmade ^{137}Cs. Most feces, however, were below the minimum detection limit for all gamma-emitting radionuclides. The maximum ^{137}Cs concentration (81.5 pCi ^{137}Cs/g) was in rabbit feces collected at Site 2W28, which is adjacent to the 241-S/SX/SY Tank Farms.

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*See soil contamination standard definition on page 13.

TABLE 5. Radionculide Concentrations in Vegetation Samples Collected at the 200 East Area Grid Sites in 1983 (pCi/g).

Map location	^{60}Co	^{95}Nb	^{95}Zr	^{137}Cs	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu
2E1[a]		0.780±0.427						
2E1[a]						1.120±0.004		
2E2								
2E3	0.129±0.129							
2E4								
2E5	0.310±0.181			0.176±0.161				
2E6								
2E7	0.220±0.124							
2E8								
2E9	0.240±0.151				1.280±0.918			
2E10				0.215±0.080				0.195±0.194
2E11			0.554±0.334	0.110±0.084				
2E12	0.274±0.133							
2E13				0.128±0.089				
2E14				0.141±0.127				
2E15[a]								
2E15[a]								
2E16	0.253±0.217					0.551±0.417		
2E17				0.239±0.166			0.389±0.275	
2E18			0.389±0.371	0.107±0.094				
2E19	0.200±0.117							0.281±0.222
2E20								0.513±0.485
2E21	0.128±0.116					0.450±0.200		
2E22				0.203±0.149				
2E23[a]								
2E23[a]					0.794±0.749		0.546±0.441	
2E24[a]				0.450±0.152				
2E24[a]	0.112±0.108		0.447±0.332	0.163±0.076				
2E25		0.366±0.297						
2E26								
2E27		1.200±0.877					1.16±1.11	
2E28[a]	0.156±0.134			0.155±0.140				
2E28[a]					0.624±0.485		0.410±0.409	
2E29						0.742±0.806		
2E29[a]								
2E30[a]								
2E31								
2E32			0.542±0.398		1.050±0.722			
2E33								
2E34							0.411±0.395	
2E35[a]	0.222±0.157							
2E35[a]	0.181±0.163					0.848±0.480		
2E36[a]						0.721±0.481		
2E36[a]	0.160±0.138	0.737±0.544						
2EA[a]								0.548±0.454
2EA[a]				0.234±0.205				
2EB[a]			0.635±0.556					
2EB[a]							0.399±0.398	
2EC[a]				0.140±0.109				
2EC[a]				0.171±0.109				
2ED[a]	0.105±0.090	0.424±0.362		0.164±0.084	0.588±0.513			
2ED[a]						0.540±0.326	0.285±0.263	
Maximum	0.310	1.200	0.635	0.459	1.280	1.120	1.160	0.548
Minimum	0.105	0.366	0.389	0.107	0.588	0.450	0.285	0.195
Average	0.193	0.682	0.513	0.187	0.867	0.710	0.514	0.384
Perimeter[b]				0.014±0.007				

[a]Replicate samples collected.

[b]Price et al., 1984.

TABLE 6. Radionuclide Concentrations in Vegetation Samples Collected at the 200 West Area Grid Sites in 1983 (pCi/g).

Map location	^{60}Co	^{95}Nb	^{95}Zr	^{137}Cs	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu
W1		1.100±0.644	0.607±0.546	0.174±0.130			0.405±0.225	
W2				0.287±0.107			0.325±0.300	
W3[a]						1.440±0.645		
W3[a]							0.387±0.313	
W4			0.651±0.422				0.417±0.241	
W5[a]			0.586±0.568	0.230±0.181		0.627±0.396	0.441±0.319	
W5[a]								
W6[a]	0.119±0.108							
W6[a]								
W7								
W8				0.338±0.170				
W9				0.284±0.218				
W10								
W11	0.201±0.193	0.717±0.293		0.201±0.130		0.800±0.738	0.569±0.434	0.658±0.492
W12				1.110±0.374				
W13	0.305±0.311			0.179±0.144			1.020±0.467	
W14						0.422±0.319		
W15	0.167±0.142							
W16		0.614±0.299						
W17				0.390±0.202			0.457±0.457	
W18				0.238±0.202				
W19				0.168±0.137			0.318±0.318	
W20								
W21[a]	0.284±0.134					0.976±0.840	1.080±0.450	
W21[a]			0.584±0.566			0.565±0.594		
W22	0.173±0.148		0.449±0.383	0.133±0.127		1.550±0.984		
W23[a]	0.329±0.283			1.070±0.340				
W23[a]				0.811±0.299	1.220±0.899			
W24[a]	0.211±0.123			0.146±0.124				
W24[a]				0.128±0.114		0.740±0.468		
W25				0.240±0.168				
W26		0.423±0.311						
W27				1.020±0.179				
W28				0.938±0.565				
W29[a]			0.813±0.497					
W29[a]						1.180±0.767		
W30								
W31				0.260±0.196			0.458±0.449	
W32	0.156±0.115			0.115±0.112				
W33				0.133±0.120				
W34						1.380±0.638		
W35			0.583±0.342	0.287±0.138		0.963±0.534		
WA[a]							0.366±0.338	
WA[a]				0.118±0.096				
WB[a]		0.544±0.319		0.112±0.100				
WB[a]	0.244±0.141	0.973±0.803		0.208±0.138				
WC[a]								
WC[a]								
WD								0.349±0.274
WE						0.514±0.297		
WF								
Maximum	0.305	1.100	0.651	1.110	1.220	1.550	1.080	0.658
Minimum	0.119	0.423	0.449	0.112	1.220	0.422	0.318	0.349
Average	0.227	0.729	0.582	0.358	1.220	0.931	0.520	0.504
Perimeter[b]				0.014±0.007				

[a]Duplicate samples.

[b]Price et al., 1984.

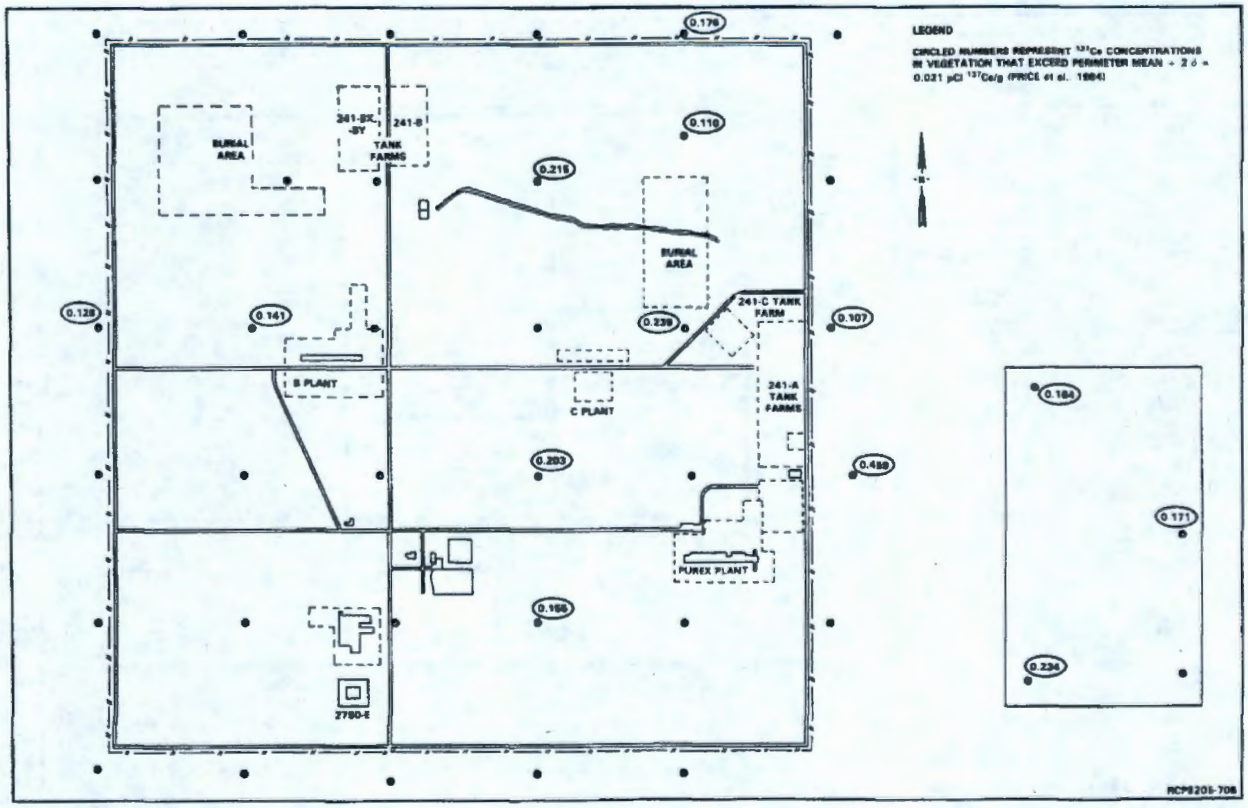


FIGURE 18. Cesium-137 Concentrations in Vegetation Samples Collected at 200 East Area Grid Sites.

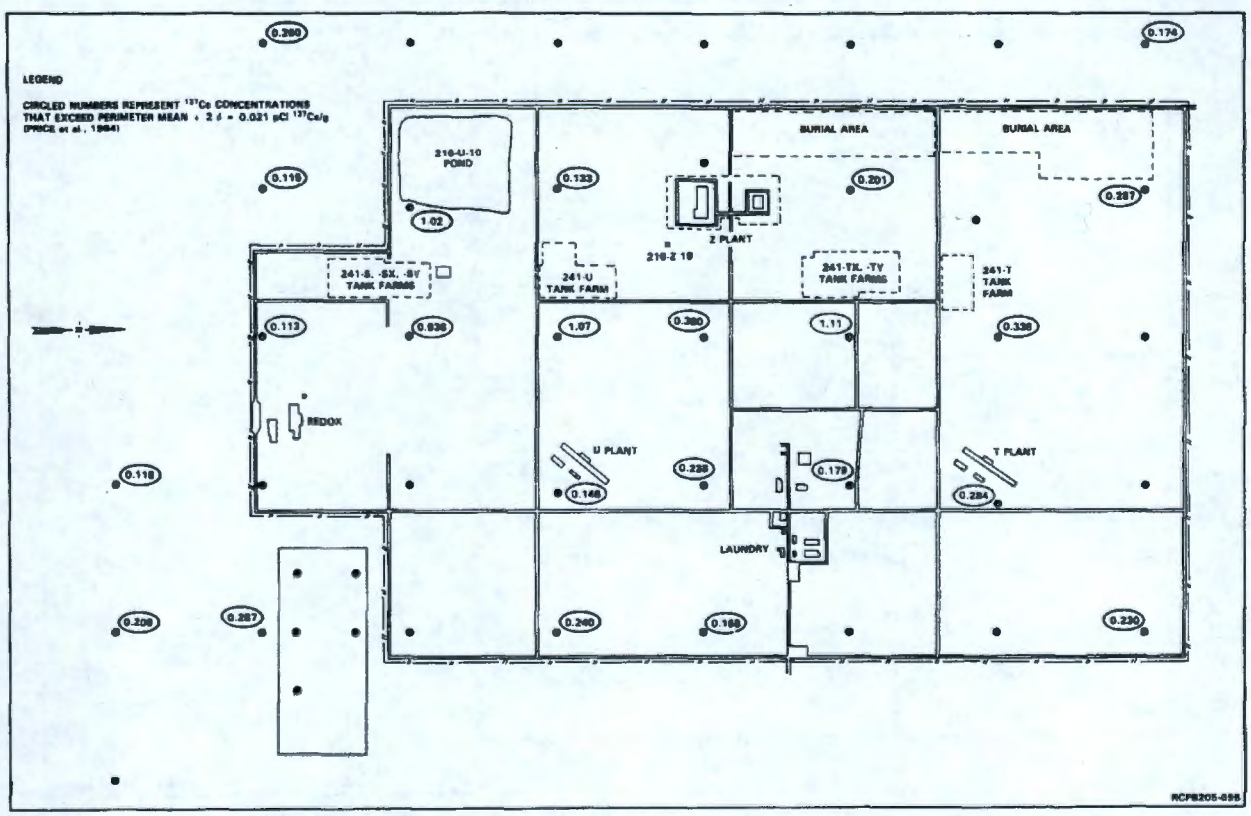


FIGURE 19. Cesium-137 Concentrations in Vegetation Samples Collected at 200 West Area Grid Sites.

TABLE 7. The 1983 Feces Sample Results from 200 East Area Grid Sites (pCi/g Dry Weight). (Sheet 1 of 2)

Map location	Feces type	^{40}K	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{95}Nb	^{95}Zr	^{106}Ru	^{134}Cs
2E1										
2E2										
2E3										
2E4										
2E5										
2E6										
2E7										
2E8	Rab	13.4±4.5			0.609±0.234					
2E9	Rab	14.0±10.2								
2E10	Rab	27.4±10.1						1.250±1.080		
2E11										
2E12	Rab									
2E13	Rab									
2E14	Rab	2.5±1.5								
2E15	Rab	15.9±8.8								
2E16	Rab	18.4±5.9	0.566±0.300							
2E17	Rab									
2E18	Rab	3.8±3.1								
2E19	Rab	3.6±2.7								
2E20	Rab	4.2±2.0								
2E21	Rab									
2E22	Rab					1.320±1.020				
2E23	Rab	14.5±5.1								
2E24	Rab									
2E25	Rab	10.6±3.7								
2E26	Rab	5.2±1.9			0.150±0.129					
2E27	Rab									
2E28	Rab	7.6±3.3					0.436±0.338			
2E29	Rab	2.3±2.2					0.620±0.351	0.513±0.395		0.325±0.196
2E30										
2E31	Rab	10.7±4.6								
2E32	Rab	10.0±3.4								
2E33	Rab									
2E34	Rab									
2E35	Rab								4.790±2.510	0.544±0.308
2E36	Rab	5.2±2.1	0.122±0.093					0.320±0.311		
2EA	Rab	5.8±3.1			0.306±0.193					
2EB	Rab	3.8±1.8			0.172±0.159	0.696±0.393	0.282±0.257			
2EC	Rab						0.284±0.230			0.268±0.169
2ED	Rab	7.4±3.1					0.302±0.245			
Maximum		27.4	0.566	--	0.609	1.320	0.620	1.250	4.790	0.654
Minimum		2.3	0.122	--	0.150	0.696	0.282	0.320	4.790	0.268
Average		9.3	0.344	--	0.309	1.008	0.385	0.694	4.790	0.448

TABLE 7. The 1983 Feces Sample Results from 200 East Area Grid Sites (pCi/g Dry Weight). (Sheet 2 of 2)

Map location	Feces type	^{137}Cs	^{141}Ce	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu	^{224}Ra	^{226}Ra	^{232}Th
2E1										
2E2										
2E3										
2E4										
2E5										
2E6										
2E7										
2E8	Rab	0.336±0.203			2.320±1.060			1.220±0.430		
2E9	Rab	1.160±0.521				2.300±1.660		2.690±1.440	1.970±1.260	
2E10	Rab	1.090±0.426							1.330±0.778	
2E11										
2E12	Rab	0.770±0.609						2.570±1.040		2.470±1.000
2E13	Rab							0.526±0.453	0.423±0.363	0.506±0.436
2E14	Rab	0.106±0.088				0.710±0.367		0.459±0.224		0.442±0.216
2E15	Rab	2.850±0.696						3.470±1.170		
2E16	Rab	0.488±0.335						1.890±0.715		
2E17	Rab				6.510±6.500			3.150±1.710		
2E18	Rab	0.331±0.285	0.632±0.474					0.786±0.392		0.754±0.377
2E19	Rab				1.370±0.827	0.849±0.686		0.513±0.332		0.493±0.319
2E20	Rab									
2E21	Rab	0.252±0.182						2.130±0.619	0.997±0.574	
2E22	Rab							1.860±0.677		
2E23	Rab	0.343±0.241				1.440±1.100		0.781±0.611		
2E24	Rab	1.240±0.733						6.680±2.230		
2E25	Rab					0.734±0.442		0.683±0.318	0.516±0.385	0.657±0.306
2E26	Rab				0.988±0.754			0.342±0.183		0.329±0.176
2E27	Rab	0.427±0.207			1.340±0.946			1.090±0.373		1.050±0.359
2E28	Rab	0.264±0.175						0.883±0.468	0.587±0.513	
2E29	Rab							0.378±0.278		
2E30										
2E31	Rab				1.280±0.738			0.401±0.317	0.598±0.341	0.385±0.305
2E32	Rab	0.960±0.222						1.100±0.371	0.789±0.363	1.060±0.357
2E33	Rab	0.646±0.581			4.120±2.480			3.280±1.490		3.150±1.430
2E34	Rab							1.920±0.815		
2E35	Rab							1.500±0.580		
2E36	Rab					0.719±0.371		0.531±0.247	0.339±0.268	
2EA	Rab					1.210±0.674		0.841±0.429		
2EB	Rab	0.210±0.178		1.230±0.913				0.354±0.332		
2EC	Rab	0.208±0.203						1.030±0.440		
2ED	Rab	0.531±0.201			1.040±0.792		0.329±0.211	0.611±0.214	0.292±0.256	
Maximum		2.850	0.632	1.230	6.510	2.300	0.329	6.680	1.970	3.150
Minimum		0.106	0.632	1.230	0.988	0.710	0.320	0.342	0.292	0.329
Average		0.678	0.632	1.230	2.371	1.137	0.329	1.506	0.784	1.027

TABLE 8. The 1983 Feces Sample Results from 200 West Area Grid Sites (pCi/g Dry Weight). (Sheet 1 of 2)

Map location	Feces type	^{40}K	^{54}Mn	^{58}Co	^{60}Co	^{65}Zn	^{95}Nb	^{95}Zr	^{106}Ru	^{134}Cs
2W1	Rab	5.7±2.9				0.429±0.248				
2W2	Rab	11.4±4.8	0.297±0.253			1.210±0.640	1.290±1.200			
2W3	Rab									
2W4	Rab	7.0±6.3	0.640±0.434					1.560±1.040		
2W5	Rab	8.5±3.0							2.190±1.600	0.192±0.165
2W6	Rab	5.0±2.1								
2W7	Rab	14.3±8.6								
2W8	Rab	16.0±5.2				0.727±0.671				0.711±0.329
2W9	Rab	12.9±8.7					2.740±1.650			
2W10	Rab			1.330±0.847						
2W11	Rab	9.4±4.6				1.470±0.716		1.250±0.967		
2W12	Rab									
2W13	Rab	28.9±15.9						4.250±3.070		
2W14	Rab	16.5±5.8			0.502±0.290			1.290±1.170		
2W15	Rab	8.4±5.3		0.917±0.706	0.572±0.436					
2W16	Rab	7.4±3.0							3.220±1.320	
2W17	Rab	19.1±10.6								
2W18										
2W19										
2W20	Rab			1.140±0.669			2.110±1.420			0.465±0.452
2W21	Rab									0.422±0.205
2W22	Rab	3.7±2.2	0.167±0.147							
2E23										
2W24	Rab	12.9±5.2		0.860±0.460		1.440±0.770				0.576±0.467
2W25	Rab	20.4±14.4								
2W26	Rab	6.6±3.4					0.698±0.635			
2W27	Rab							1.690±1.540		0.630±0.540
2W28	Rab		2.150±1.910			6.210±4.490				
2W29	Rab	41.0±21.7								
2W30	Rab	6.8±3.3	0.210±0.145	0.533±0.259					2.090±1.490	
2W31	Rab	6.7±5.7	0.627±0.358						3.650±2.080	
2W32	Rab	3.9±2.4			0.604±0.302	0.445±0.346				0.242±0.187
2W33	Rab					2.660±1.800				1.640±1.050
2W34	Rab	52.7±18.8		3.090±2.020						
2W35	Rab	13.0±4.9				0.726±0.697				
2WA	Rab						1.160±0.825			
2WB	Rab		0.437±0.355	0.606±0.470						
2WC	Rab									
2WD	Rab	21.8±8.3								
2WE	Rab	9.4±3.2								
2WF	Rab									
Maximum		52.7	2.150	3.090	0.604	6.210	2.740	4.250	3.650	1.640
Minimum		3.7	0.167	0.533	0.502	0.429	0.698	1.250	2.090	0.192
Average		14.2	0.647	1.211	0.559	1.702	1.600	2.008	2.788	0.610

NONROUTINE ENVIRONMENTAL SAMPLING

SUMMARY

In addition to the routine environmental surveillance program, nonroutine special sampling is performed to investigate environmental anomalies, determine the extent of problems identified by the routine program, or ensure compliance with Federal and Rockwell standards.

Biological samples (animal and vegetation) were collected wherever transport of radioactivity was found or suspected. An effective herbicide spray program has considerably reduced radionuclide transport by tumbleweeds.

BIOLOGICAL TRANSPORT OF RADIONUCLIDES

Biological transport of radionuclides can involve the following processes:

- Upward movement of subsurface radioactive waste to the surface by physiological plant processes
- Dispersion of such plants by wind to previously uncontaminated areas (secondary transport)
- Contaminated feces and urine deposited by animals that have gained access to waste sites and ingested radioactive materials
- Contaminated animals themselves which have ingested radioactive materials directly or from eating other contaminated animals
- Nests built by animals and insects using contaminated materials.

Transport by Vegetation

Several sites in the 200 Areas environment are known or suspected sources of contaminated vegetation. Tumbleweeds and other annuals absorb radionuclides through the root system, die, break off, and migrate via prevailing and high winds. Though tumbleweed is the principal plant type involved in biological transport, other species such as sagebrush, rabbitbrush, and locoweed may also be included (Price and Rickard, 1973). Vertical transport of radioactivity by plant processes continued as a concern in 1983, though the problem has decreased considerably due to decreased plant root intrusion following herbicide application. Areas where contaminated vegetation was known to grow by the end of 1983, or where it has been a problem in the past resulting in surface contamination, include

TABLE 8. The 1983 Feces Sample Results from 200 West Area Grid Sites (pCi/g Dry Weight). (Sheet 2 of 2)

Map location	Feces type	^{137}Cs	^{141}Ce	^{144}Ce	^{152}Eu	^{154}Eu	^{155}Eu	^{244}Ra	^{226}Ra	^{232}Th
2W1	Rab	1.840±0.305				0.637±0.486		0.689±0.320		
2W2	Rab							1.830±0.617		
2W3	Rab									
2W4	Rab							2.840±0.906		
2W5	Rab							0.772±0.343		
2W6	Rab	0.110±0.110			0.737±0.456			0.551±0.252	0.543±0.282	
2W7	Rab				2.940±2.380					
2W8	Rab	0.890±0.345					1.070±1.060	2.530±0.780		
2W9	Rab	1.510±0.512								
2W10	Rab									
2W11	Rab				1.510±0.913			2.650±0.630		
2W12	Rab	1.170±0.328						0.677±0.412		
2W13	Rab	35.700±2.340					3.730±3.070			
2W14	Rab									
2W15	Rab	0.666±0.267						1.280±0.814	1.280±0.800	
2W16	Rab				1.840±0.951	1.150±0.558		1.120±0.360		
2W17	Rab									
2W18										
2W19										
2W20	Rab									
2W21	Rab				1.070±0.675			1.530±0.509		
2W22	Rab							0.768±0.366		
2W23										
2W24	Rab	0.512±0.448			2.290±1.520					
2W25	Rab							3.010±1.400		
2W26	Rab	2.660±0.423						0.552±0.521	0.595±0.520	
2W27	Rab	15.900±1.520						2.080±1.050	1.990±1.110	
2W28	Rab	81.500±5.180								
2W29	Rab					11.600±6.160		9.840±4.840	5.440±4.700	9.450±4.650
2W30	Rab							0.979±0.428	0.681±0.411	
2W31	Rab	0.783±0.306								
2W32	Rab	0.507±0.205								
2W33	Rab	1.790±1.030						4.510±1.360		
2W34	Rab							5.900±2.730	3.760±2.510	
2W35	Rab				1.890±1.010			2.060±0.621	1.180±0.686	
2WA	Rab	0.228±0.209						0.951±0.540	1.580±0.514	
2WB	Rab							1.260±0.738		
2WC	Rab							1.440±0.589		
2WD	Rab							1.230±0.750	1.870±0.955	
2WE	Rab									
2WF	Rab					0.751±0.543		0.572±0.329		
Maximum		81.500	--	--	2.940	11.600	3.730	9.840	5.440	9.450
Minimum		0.110	--	--	0.737	0.637	1.070	0.551	0.543	9.450
Average		9.718	--	--	1.754	3.535	2.400	2.065	1.892	9.450

NONROUTINE ENVIRONMENTAL SAMPLING

SUMMARY

In addition to the routine environmental surveillance program, nonroutine special sampling is performed to investigate environmental anomalies, determine the extent of problems identified by the routine program, or ensure compliance with Federal and Rockwell standards.

Biological samples (animal and vegetation) were collected wherever transport of radioactivity was found or suspected. An effective herbicide spray program has considerably reduced radionuclide transport by tumbleweeds.

BIOLOGICAL TRANSPORT OF RADIONUCLIDES

Biological transport of radionuclides can involve the following processes:

- Upward movement of subsurface radioactive waste to the surface by physiological plant processes
- Dispersion of such plants by wind to previously uncontaminated areas (secondary transport)
- Contaminated feces and urine deposited by animals that have gained access to waste sites and ingested radioactive materials
- Contaminated animals themselves which have ingested radioactive materials directly or from eating other contaminated animals
- Nests built by animals and insects using contaminated materials.

Transport by Vegetation

Several sites in the 200 Areas environment are known or suspected sources of contaminated vegetation. Tumbleweeds and other annuals absorb radionuclides through the root system, die, break off, and migrate via prevailing and high winds. Though tumbleweed is the principal plant type involved in biological transport, other species such as sagebrush, rabbitbrush, and locoweed may also be included (Price and Rickard, 1973). Vertical transport of radioactivity by plant processes continued as a concern in 1983, though the problem has decreased considerably due to decreased plant root intrusion following herbicide application. Areas where contaminated vegetation was known to grow by the end of 1983, or where it has been a problem in the past resulting in surface contamination, include

the solid-waste burial grounds, liquid-disposal cribs and trenches, and surface ponds and ditches (see Fig. 20 through 23). Areas contaminated in 1983 by windblown tumbleweeds are listed below.

- Outside Perimeter Fence of 241-C Tank Farm: Contaminated tumbleweeds and fragments (to 30,000 counts per minute (cpm) (with a P-11 probe) on an Eberline Model BNW-1 count rate meter) were found along the outside fence of 241-C tank farm. The exact source is not known. The weeds were removed for disposal. (See No. 1 on Fig. 20.)

- 218-E-12B Stabilized Burial Ground: The tumbleweeds found at this site (to 4,000 cpm) were believed to originate from the active portion of this burial ground. The weeds were removed immediately. (See No. 2 on Fig. 20.)

- 241-TX/TY Tank Farm Perimeter: Contaminated tumbleweeds (to 3,000 cpm) were found along the south fence line of this tank farm. The source was believed to be 216-Z-7 crib. The area was cleaned. (See No. 3 on Fig. 22.)

- 207-S Retention Basin: Old tumbleweeds found here (to 2,500 cpm) were believed to originate from the Redox Pond Area before herbicide spraying was begun. The weeds remain within a radiologically controlled area. (See No. 4 on Fig. 22.)

- Environment Northeast of 200 East Area: Three contaminated areas northeast of 200 East Area were found by PNL Radiation Protection Technologists. Contaminated tumbleweeds found at that time ranged from 700 to 30,000 cpm and were picked up immediately by Rockwell Decontamination and Decommissioning personnel. The source was one of the 200 East Area Waste sites. (See No. 5 on Fig. 21.)

Past analyses of tumbleweeds indicated that ^{90}Sr was the principal radionuclide taken up by the plants (Conklin et al., 1982); however, sagebrush analyzed from the 216-S-5 crib contained primarily ^{137}Cs (1,900 pCi/g vs 200 pCi ^{90}Sr/g). The presence of contaminated vegetation remains a nuisance problem (though less than in previous years), but poses no significant radiological health hazard to Rockwell employees nor to the general public.

As sites are stabilized and the herbicide spray program continues, the tumbleweed biological transport problem decreases.

Transport by Animals

In 1983, several incidents of biological transport involving animals were discovered during routine radiological surveys and during investigations. As in 1981 and 1982, the prevalent vector involved pigeons (Conklin et al., 1982; Conklin et al., 1983). Many incidents relate back to the 204-S Waste Unloading Facility, which was decommissioned in 1983; however,

due to the relatively short biological half-lives of most radionuclides involved, concentrations were significantly less than in birds analyzed during the previous 2 yr (see Table 9). Other pigeons were traced back to Semiworks in the 200 East Area, where access to radioactive contamination inside the facility was discovered. All access holes were blocked off in 1983 to prevent future intrusion.

Other biological transport incidents involved mice, swallows, snakes, and unidentified small birds (see Table 10).

SOIL

Special soil sampling may be performed when it is suspected that Rockwell surface soil contamination standards are being exceeded or when an area is to be released from radiation area posting. In 1983, areas sampled included the surface of 216-A-8 Crib, areas around 216-B-3 and 216-A-25 Ponds, and the UN-216-W-4 unplanned release site. Except for the surface of 216-A-8 Crib, which is appropriately posted as Surface Contamination, no soil standard was exceeded in these special samples (See Table 11).

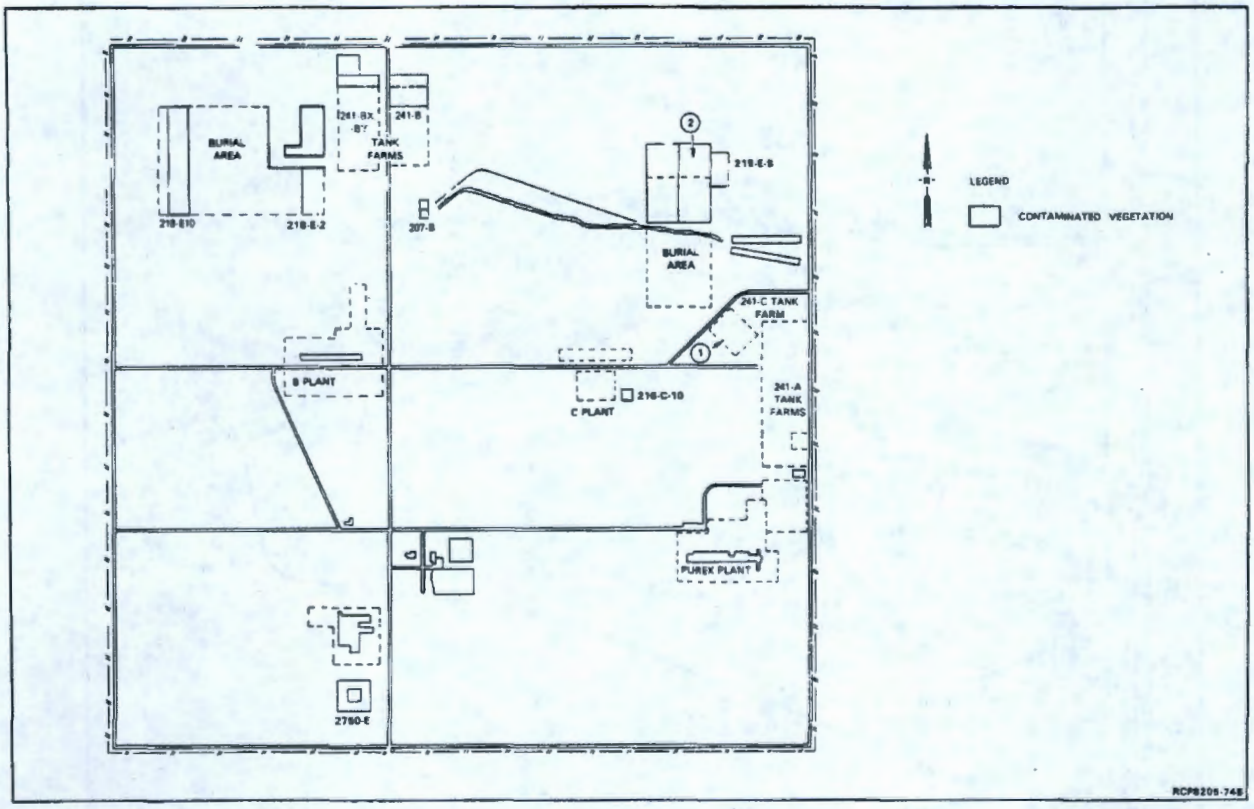


FIGURE 20. Contaminated Vegetation Sources Inside the 200 East Area.

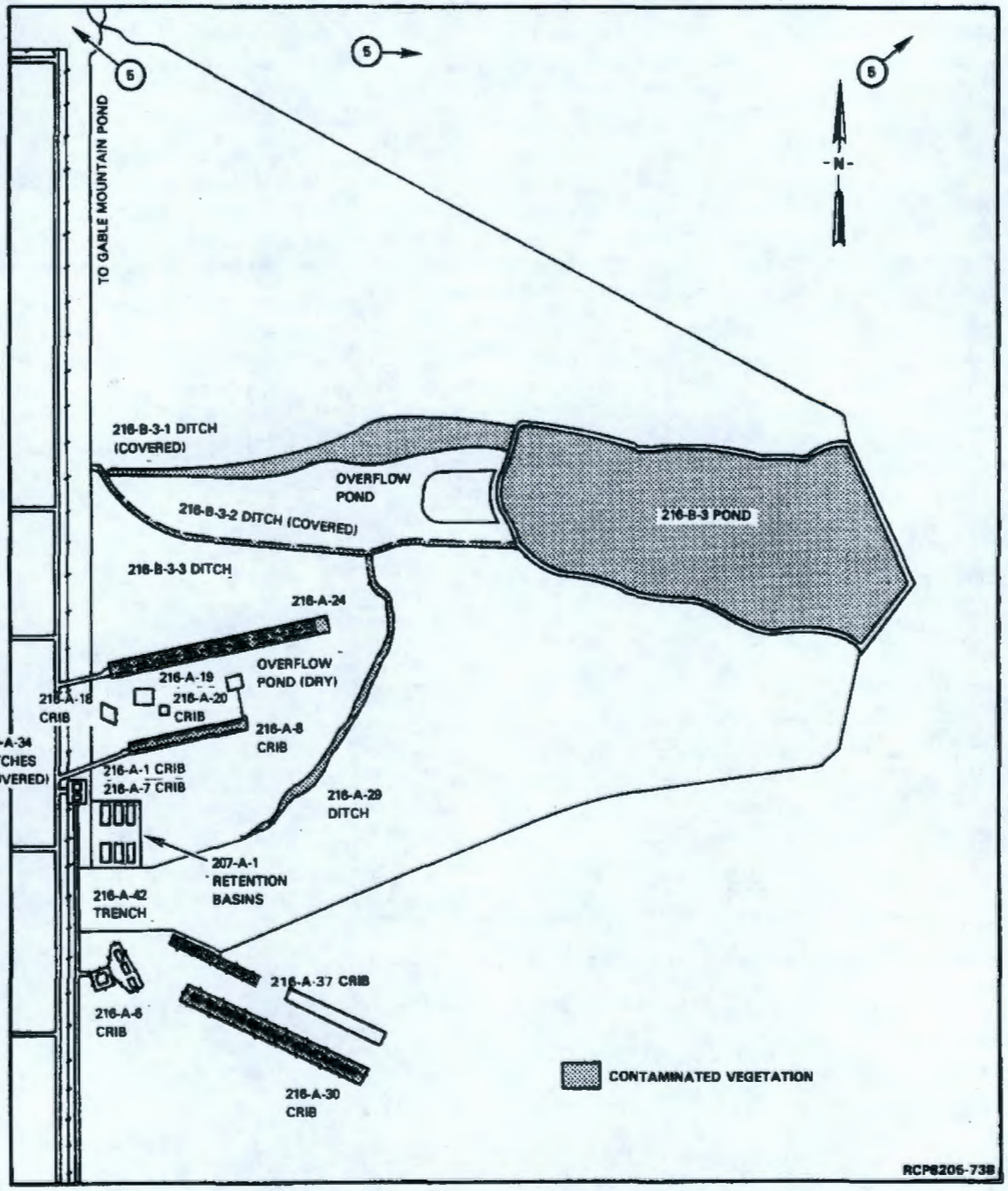


FIGURE 21. Contaminated Vegetation Sources Outside the 200 East Area.

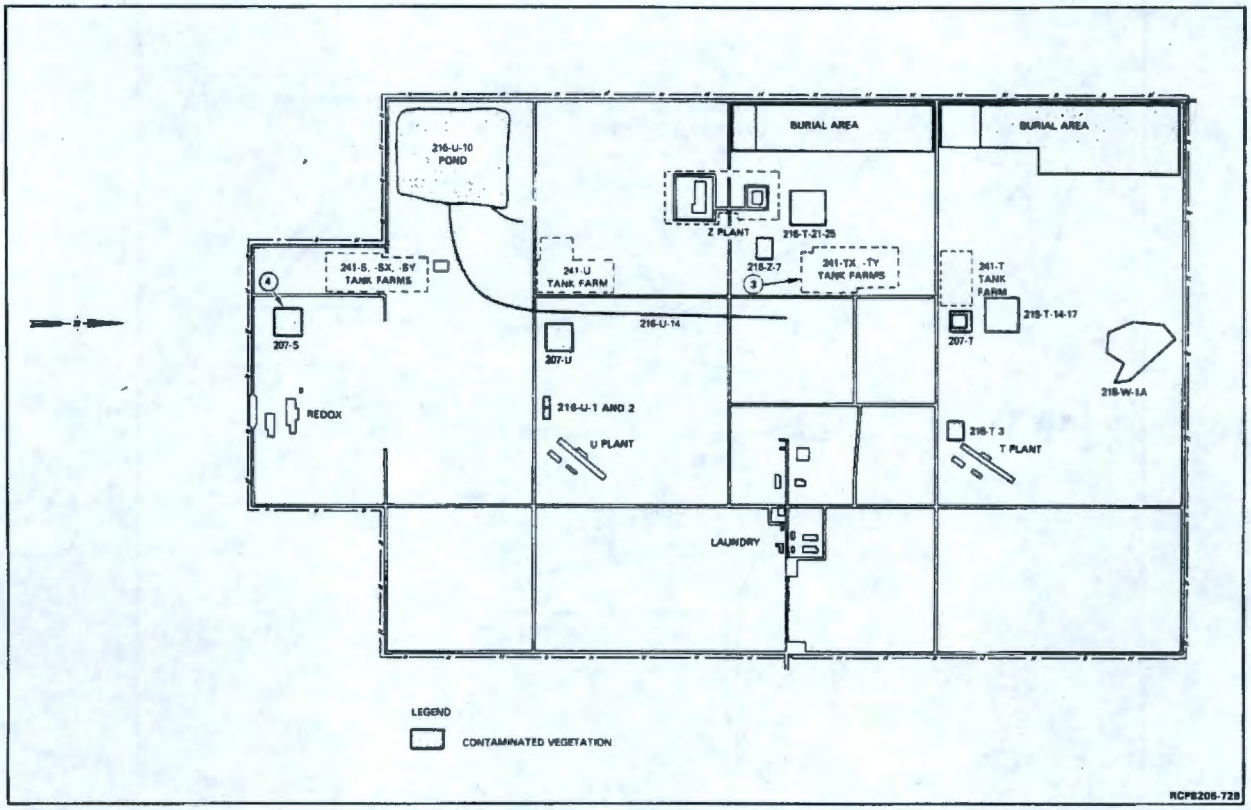


FIGURE 22. Contaminated Vegetation Sources Inside the 200 West Area.

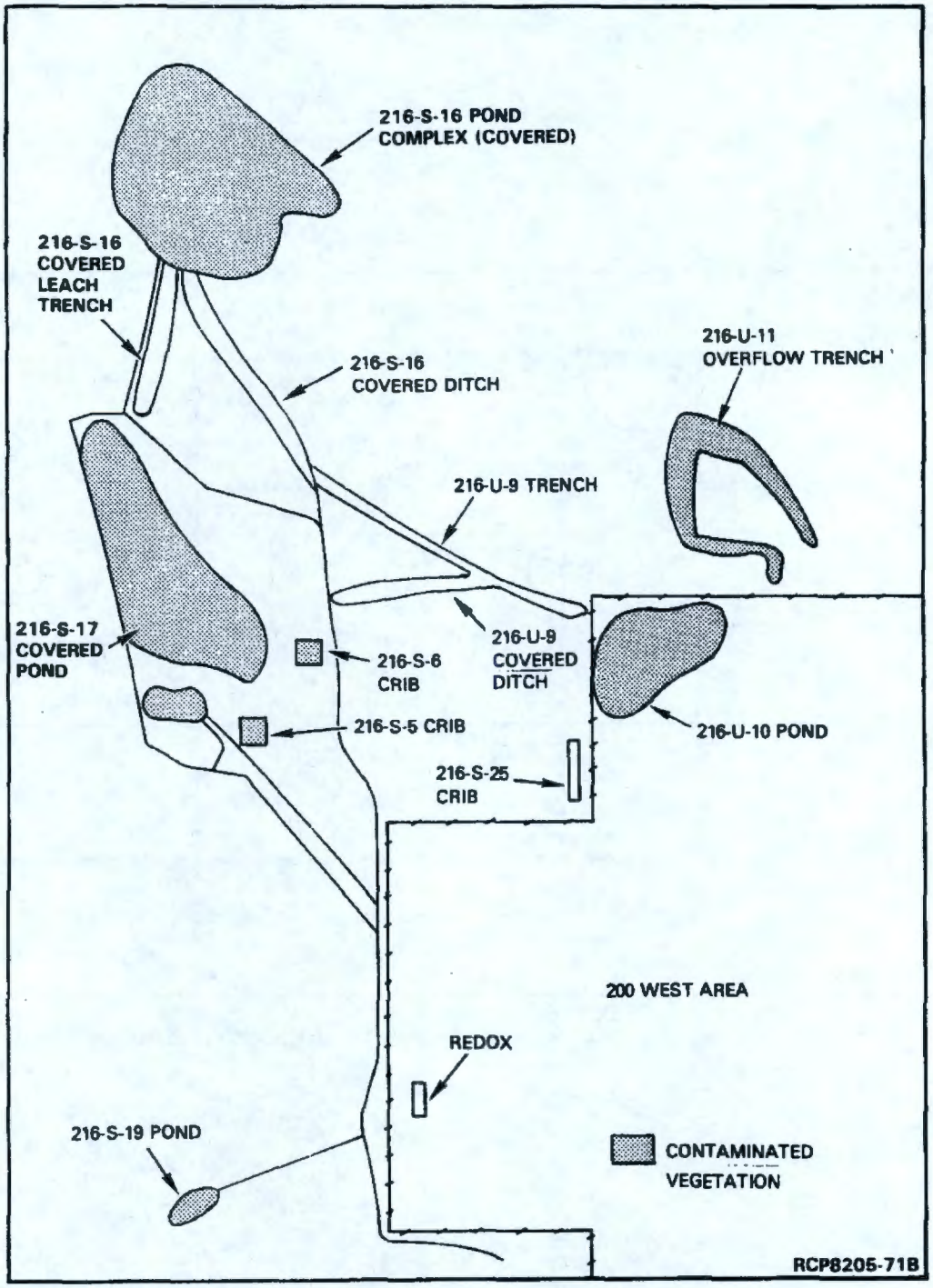


FIGURE 23. Contaminated Vegetation Sources Outside the 200 West Area.

TABLE 9. Biological Transport by Pigeons in 1983 (Concentrations in pCi/g Dry Weight).

Vector	Location	Beta-gamma activity (P-11 probe)	^{60}Co	^{90}Sr	^{125}Sb	^{134}Cs	^{137}Cs	^{154}Eu	^{155}Eu	^{239}Pu	^{241}Am
Pigeon (skin)[a]	202-S roof	950 cpm	b	0.84	b	b	430	b	b	0.16	b
Pigeon nest	202-S roof	4,000 cpm	5.8	c	29	91	1,400	19	9.1	2.3	6.8
Pigeon (whole carcass)	202-S roof	20,000 cpm	b	3,200	b	b	1.8	b	b	0.13	b
Pigeon (skin)	276-C	30,000 cpm	b	5,500	b	b	12	b	b	0.64	b
Pigeon (skin)	271-T roof	300 cpm	b	3.6	b	b	510	b	b	0.43	b
Pigeon feces	2714-U	>100,000 cpm	0.1	1.9	b	b	17,000	b	0.4	8,700	25,000
Pigeon (skin)	276-C	>100,000 cpm	b	3,100	b	b	52	b	b	1.1	c
Pigeon (skin)	276-C	500 cpm	b	95	b	b	36	b	b	0.4	b
Pigeon feces	276-C	1,500 cpm	b	3,400	b	b	5.0	b	b	2.2	b
Pigeon feces	276-C	-	b	320	b	b	10.0	b	b	0.72	b
Pigeon (skin)	271-T roof	400 cpm	b	220	b	b	78.0	b	b	3.0	b
Pigeon (skin)	271-T roof	400 cpm	b	48	b	b	0.3	b	b	c	c
Pigeon feces	231-Z	-	b	220	b	b	6.6	b	b	0.3	c
Pigeon nest	202-S	-	b	c	64	290	4,500	52	36	2.3	c
Pigeon (skin)	271-U	-	b	33	b	9.5	180	b	b	c	c

[a]Most pigeons were divided into skin and feathers, carcass, and gastro-intestinal tract prior to analysis. The portion with highest radionuclide concentration is reported.

[b]Less than detection limits.

[c]No analysis.

TABLE 10. Biological Transport Involving Animals in 1983 (Concentrations in pCi/g Dry Weight).

Vector	Date	Description	^{60}Co	^{90}Sr	^{125}Sb	^{134}Cs	^{137}Cs	^{154}Eu	^{155}Eu	^{239}Pu	241
Goldfish No. 1[a]	02/04/83	Fish were killed in Gable Mountain Pond following a release of fire retardant foam. Radionuclides in fish from sediment contaminated by past releases. No external reading.	b	c	b	b	65	b	b	b	c
Goldfish No. 2[a]	02/04/83	Same as above.	b	0.1	b	b	22	b	b	b	c
Pigeons	03/02/83 through 05/01/83	See Table 9.	-	-	-	-	-	-	-	-	-
Mouse	05/12/83	Contaminated mouse captured at 241-BX Tank Farm. External survey reading is not available. Source is tank farm or nearby waste site.	b	4,100	b	b	6,800	b	b	0.4	c
Mouse	05/19/83	Contaminated mouse captured outside of fence line of Vent Station (900 cpm). Source is Vent Station pit or French drain.	b	790	b	b	71	b	b	0.17	b
Bull snake	06/22/83	Found alive in 241-A Tank Farm, 25,000 cpm, 2 mRad/h. Source probably 241-A or nearby tank farm.	6.6	3,600	b	3.8	24,000	b	b	7.4	6.
Bird feathers	07/11/83	Contaminated feathers found by the dock at 271-U, 2,000 cpm. Old feathers, source may have been 204-S.	b	33	b	9.5	180	b	b	b	c
Swallow nest	07/18/83	Found at B Plant. 20,000 cpm. Source unknown.	b	8,700	b	b	38,000	b	b	39	c
Swallow nest	08/05/83	Found at PUREX railroad tunnel. 5,000 cpm. Had eggs. Source unknown.	3.6	2,000	b	b	46	b	5.3	0.3	c
Swallow eggs	08/05/83	Same as above.	b	59	b	b	9.2	b	b	5.7	b
Swallow nest	10/26/83	Nest and feces found inside 221-B condensor room, 40,000 cpm. Source unknown.	b	21,000	b	b	5,800	b	b	0.6	b
Swallow feces	10/26/83	Same as above.	b	4,900	b	b	20,000	b	b	0.8	b
Rabbit feces	11/18/83	Found at 211-S, 3,000 cpm. Source probably now-decommissioned sump outside 204-S.	12	3,960	57	110	4,600	15	b	99	23

[a]Though not regarded as biological transport incidents, this information is important since these fish are consumed by raptors on the Hanford Site.

[b]Less than detectable.

[c]No analysis.

TABLE 11. Special Soil Samples Collected in 1983 (Concentration in pCi/g Dry Weight).

Location		Date	^{90}Sr	^{137}Cs	^{239}Pu	^{241}Am
216-A-8		03/30/83	180	6,500	1.5	a
216-B-3 Pond overflow	1	07/18/83	a	13	6.1	a
	2		63	a	0.8	a
	3		78	a	1.7	a
	4		79	18	1.1	a
216-A-25 Pond area	1	09/12/83	140	b	b	b
	2		13	b	b	b
	3		0.7	b	b	b
	4		58	b	b	b
	5		2.0	b	b	b
	6		200	b	b	b
	7		0.8	b	b	b
	8		0.6	b	b	b
	9		a	b	b	b
	10		a	b	b	b
UN-216-W-4	1	10/17/83	b	b	3	b
	2		b	b	0.4	b

[a]Less than detection limits.

[b]No analysis.

EXTERNAL RADIATION

SUMMARY

External radiation levels were measured using TLDs at all grid sampling sites, water sampling sites and, beginning in 1983, at PUREX-related tank farms and active cribs. The highest annual radiation level measured in 1983 was at the 216-U-10 Pond (3,806 mrem/yr), which is within a radiologically controlled area. The highest radiation level outside a radiologically controlled area (1,488 mrem/yr) was at a new site along the fence line of 241-A tank farm. The radiation level outside the tank farm is attributed to tank farm operations within the controlled area. There were no significant changes in radiation levels from last year.

DISCUSSION

The dosimeters employed consisted of three chips of calcium-fluoride/manganese (Harshaw TLD-400) encased in an opaque capsule lined with 0.025 cm of tantalum and 0.005 cm of lead. Each capsule was placed in a translucent, waterproof, plastic vial. The vial was mounted by an extended clamp 1 m above the ground on a steel post. The TLDs were in accordance with guidelines of the American National Standards Institute (1975).

The TLD data are presented in Tables 12, 13, 14, and 15. The location of TLDs at the grid sites are represented on Figures 24 and 25. The TLDs at the ponds and ditches are located at the water-sampling locations (see Pond and Ditch Surveillance Section). The PUREX-related TLDs are on Figure 26.

A log-normal probability plot of the annual dose rate for all TLD measurements is shown in Figure 27. Two population groups can be identified. The first group, though higher than background (believed to be due to overall contributions from the Separations Area), is not considered to be significant. The second group ranges from approximately 100 to 463 mrem/yr, with two sites to almost 4,000 mrem/yr and 1,500 mrem/yr. The levels are attributed to fission products in the soil (primarily ^{137}Cs), 200 Area operations, and nearby radiation sources (tank farms, operating facilities, and waste sites).

TABLE 12. The 1983 Thermoluminescent Dosimeter Results from 200 East Area.

Map location	Site	Dose rate (mrem/yr)		
		Yearly* maximum	Yearly* minimum	Measured total
2E 1	200 East Area NW	117.6	64.8	86.2
2	241-BY Tank Farm NW	132.0	73.2	98.3
3	241-B, -BY Tank Farm N	200.4	106.8	148.2
4	241-B, -BY Tank Farm NE	147.6	80.4	113.2
5	E-12B N	132.0	42.0	90.9
6	200 East Area NE	118.8	67.2	88.9
7	E-10 W	108.0	62.4	88.6
8	E-10 E	118.8	70.8	91.9
9	241-BX Tank Farm S	192.0	106.8	152.2
2E 10	B-63 N	172.8	97.2	131.8
11	E-12B N	133.2	74.4	100.3
12	E-12B E	117.6	69.6	89.7
13	200 East Area W	106.8	61.2	79.8
14	B Plant W	115.2	66.0	87.8
15	B Plant NE	546.0	144.0	245.3
16	221-C Excavation NW	120.0	67.2	87.8
17	241-C Tank Farm W	139.2	80.4	104.2
18	241-C Tank Farm E	150.0	84.0	112.3
19	200 East Area W	112.8	60.0	83.1
2E 20	B Plant SSW	108.0	60.0	82.3
21	B Plant SSE	112.8	64.8	86.4
22	Semiworks SSE	120.0	69.6	91.6
23	PUREX N	164.4	90.0	121.2
24	PUREX NE	153.6	85.2	113.3
25	200 East Area W	104.4	57.6	78.7
26	2101-M W	112.8	61.2	83.7
27	2101-M E	109.2	56.4	78.7
28	284-E Powerhouse SE	110.4	58.8	83.6
29	PUREX S	104.4	56.4	79.0
2E 30	PUREX SE	105.6	57.6	83.0
31	U.S. Ecology N	105.6	54.0	79.3
32	B-C Cribs NW	110.4	55.2	82.4
33	200 East Area S	106.8	57.6	79.6
34	200 East Area S	115.2	58.8	86.2
35	200 East Area S	106.8	56.4	80.9
36	200 East Area SE	109.2	52.8	80.2
2E A	200 East Area SE	99.6	54.0	77.6
B	200 East Area SE	126.0	57.6	85.0
C	200 East Area SE	116.4	57.6	86.1
D	216-A-29 Ditch E	127.2	66.0	93.8

NOTE: Background ranged from 62 to 73 mrem/yr (Price et al., 1984).
*Monthly dose rates normalized to annual dose rates equivalent.

TABLE 13. The 1983 Thermoluminescent Dosimeter Results from 200 West Area.

Map location	Site	Dose rate (mrem/yr)		
		Yearly* maximum	Yearly* minimum	Measured total
2W 1	200 West Area NW	110.4	68.4	84.1
2	216-T-4 Pond N	169.2	94.8	130.1
3	W-1A N	112.8	63.6	83.3
4	T Plant N	106.8	63.6	82.2
5	200 West Area NE	109.2	62.4	83.8
6	200 West Area W	105.6	63.6	80.4
7	W-2A E	128.4	74.4	99.9
8	241-T Tank Farm E	256.8	151.2	193.0
9	Near 291-T-1 Stack	126.0	72.0	95.9
2W 10	200 West Area NE	104.4	62.4	83.5
11	200 West Area W	103.2	60.0	78.3
12	W-1 E	114.0	69.6	92.2
13	241-TX Tank Farm E	214.8	124.8	168.4
14	284-W Powerhouse N	102.0	58.8	77.6
15	200 West Area E	111.6	64.8	85.5
16	200 West Area W	106.8	63.6	80.6
17	Z Plant W	115.2	66.0	88.4
18	216-U-14 Ditch W	115.2	64.8	87.5
19	284-W Powerhouse S	109.2	66.0	82.4
2W 20	200 West Area E	111.6	63.6	84.0
21	200 West Area W	109.2	61.2	83.1
22	Z Plant S	120.0	66.0	88.4
23	241-U Tank Farm E	270.0	158.4	210.5
24	U Plant SE	109.2	64.8	83.6
25	200 West Area E	103.2	60.0	79.9
26	200 West Area W	111.6	63.6	85.2
27	U Pond SE	285.6	156.0	220.7
28	241-SX Tank Farm E	128.4	80.4	97.3
29	U Plant S	116.4	67.2	87.0
2W 30	200 West Area SE	109.2	61.2	78.4
31	200 West Area SW	105.6	61.2	79.2
32	200 West Area S	110.4	62.4	81.2
33	207-S Retention Basin SE	120.0	76.8	89.8
34	REDOX ESE	105.6	64.8	79.1
35	200 West Area SE	111.6	62.4	81.4
2W A	216-S-19 Pond W	110.4	62.4	84.8
B	200 West Area SE	104.4	60.0	79.3
C	200 West Area SE	104.4	58.8	78.9
D	200 West Area SE	109.2	61.2	80.9
E	200 West Area SE	104.4	57.6	78.1
F	200 West Area SE	100.8	60.0	78.2

NOTE: Background ranged from 62 to 73 mrem/yr (Price et al., 1984).
*Monthly dose rates normalized to annual dose rates equivalent.

TABLE 14. The 1983 Thermoluminescent Dosimeter Results from the 200 Area Ponds and Ditches.

Site	Dose rate (mrem/yr)		
	Yearly* maximum	Yearly* minimum	Measured total
216-U-14 Ditch	331.2	214.8	271.5
216-Z-19 Ditch	109.2	55.2	78.6
216-U-10 Pond, north side	5,012.4	2,712.0	3,805.7
216-B-63 Ditch	127.2	68.4	93.2
216-A-29 Ditch	130.8	72.0	93.1
216-B-3-3 Ditch	267.6	157.2	210.2
Gable Mountain Pond inlet	147.6	55.2	96.3
Gable Mountain Pond north	129.6	56.4	87.1
West Lake	93.6	46.8	67.1
216-S-19 Pond	208.8	75.6	107.8

NOTE: Background ranged from 62 to 73 mrem/yr (Price et al., 1984).

*Monthly dose rates normalized to annual dose rates equivalent.

TABLE 15. The 1983 Thermoluminescent Dosimeter Results from PUREX-Related Facilities.

Site	Dose rate (mrem/yr)		
	Yearly* maximum	Yearly* minimum	Measured total
216-U-12 Crib No. 1	97.0	70.8	80.5
216-U-12 Crib No. 2	102.6	67.2	79.3
216-A-36B Crib No.1	97.1	60.0	74.3
216-A-36B Crib No. 2	96.1	60.0	73.4
216-A-10 Crib No. 1	95.6	66.0	75.9
216-A-10 Crib No. 2	97.7	67.0	76.8
PUREX No. 1	96.0	63.6	76.7
PUREX No. 2	109.4	74.4	87.6
PUREX No. 3	94.0	63.6	74.6
241-A Tank Farm No. 1	516.8	152.4	269.2
241-A Tank Farm No. 2	281.6	152.4	192.2
241-A Tank Farm No. 3	400.2	93.6	204.9
241-A Tank Farm No. 4	122.8	81.6	93.9
241-A Tank Farm No. 5	102.1	70.8	81.3
241-A Tank Farm No. 6	115.4	67.2	89.1
241-A Tank Farm No. 7	228.5	74.4	132.3
241-A Tank Farm No. 8	455.8	292.9	347.7
241-A Tank Farm No. 9	577.1	370.9	463.1
241-A Tank Farm No. 10	5,760.0	331.2	1,487.6
241-A Tank Farm No. 11	141.6	88.8	114.2
241-A Tank Farm No. 12	126.2	67.2	98.6
241-A Tank Farm No. 13	130.6	67.2	97.9
216-B-55 Crib No. 1	121.6	74.4	89.4
216-B-55 Crib No. 2	95.8	64.3	75.6
216-B-62 Crib No. 1	94.5	63.6	77.1
216-B-62 Crib No. 2	101.4	67.2	81.2
216-A-30 Crib No. 1	113.5	67.2	80.6
216-A-30 Crib No. 2	104.2	65.9	76.3
216-A-37-1 Crib No. 1	116.0	67.2	82.9
216-A-37-1 Crib No. 2	115.8	67.8	82.8
216-A-8 Crib No. 1	167.3	108.0	123.8
216-A-8 Crib No. 2	169.8	108.0	126.9

NOTE: Background ranged from 62 to 73 mrem/yr (Price et al., 1984).

*Monthly dose rates normalized to annual dose rates equivalent.

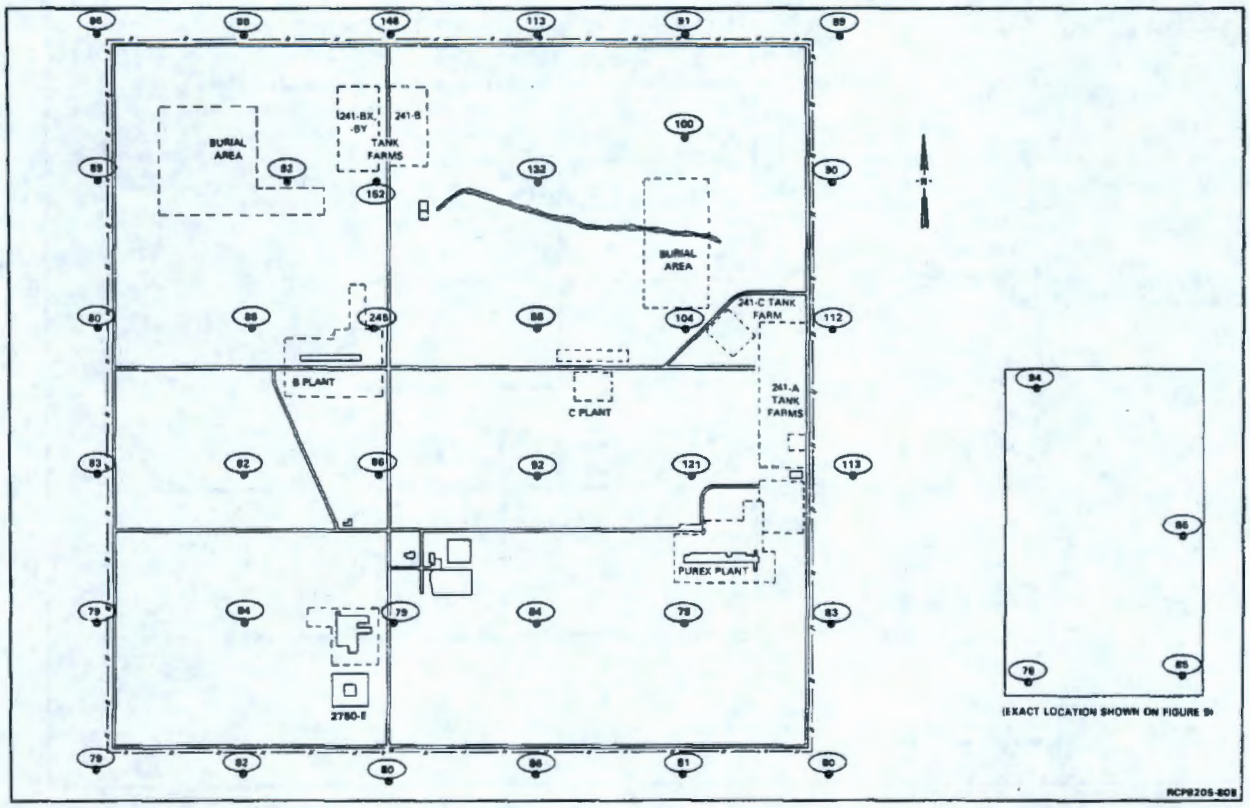


FIGURE 24. External Radiation at 200 East Area Grid Sites.

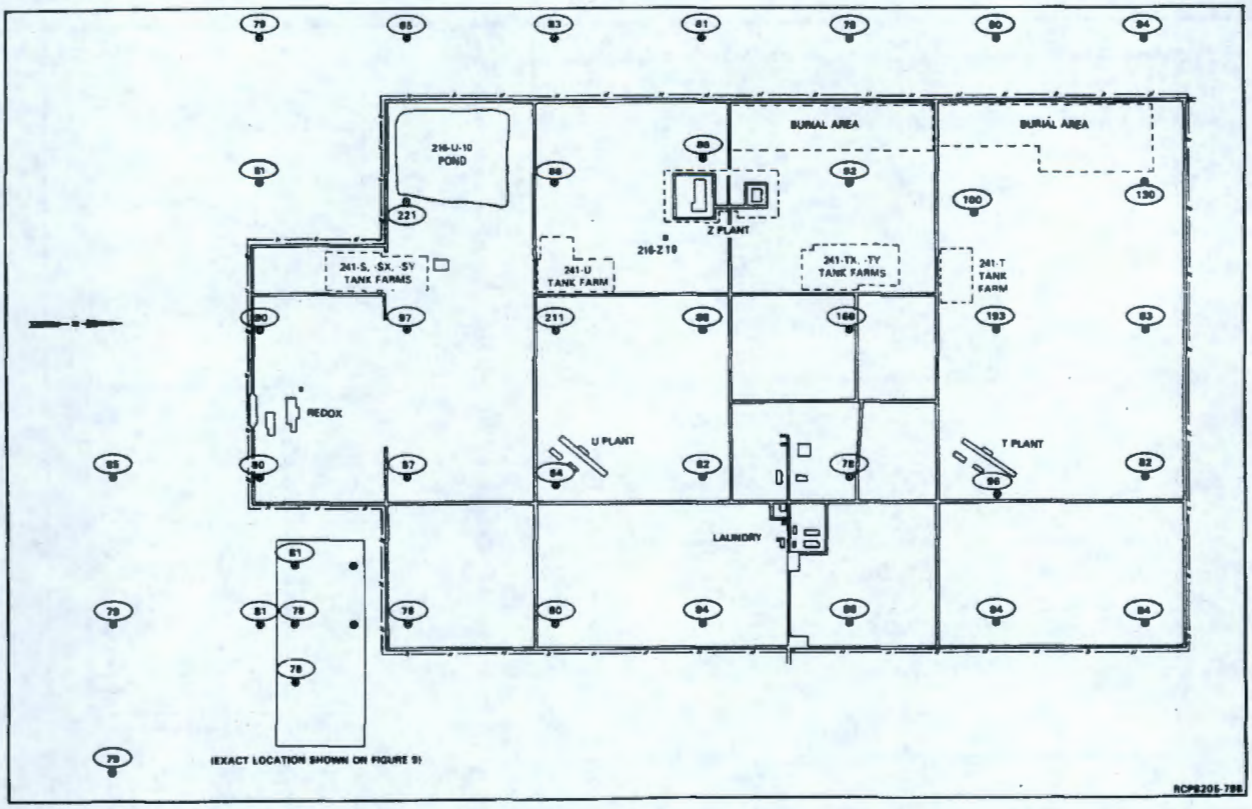


FIGURE 25. External Radiation at 200 West Area Grid Sites.

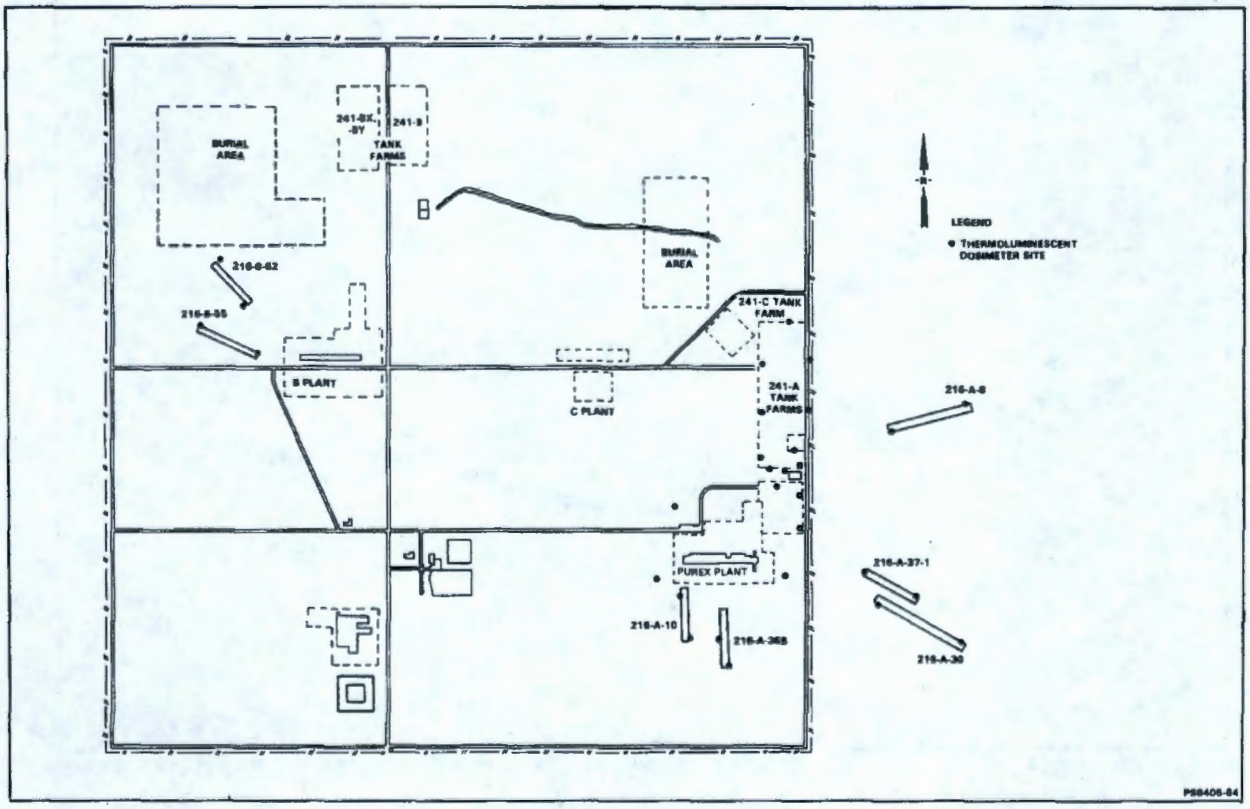


FIGURE 26. PUREX-Related Thermoluminescent Dosimeters.

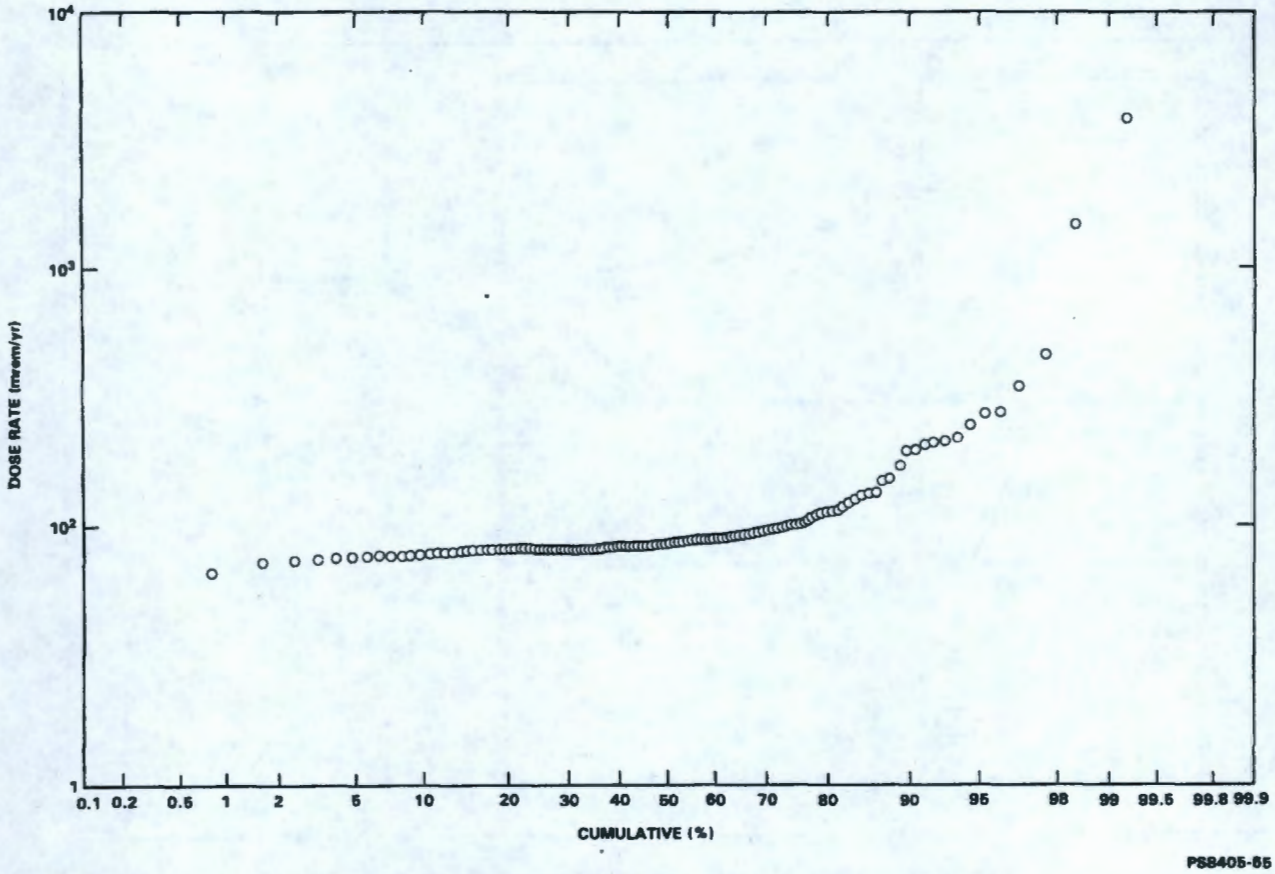


FIGURE 27. Log-Normal Probability Plot of Annual Dose Rate for all Thermoluminescent Dosimeter Measurements.

POND AND DITCH SURVEILLANCE

SUMMARY

Water, sediment, and aquatic vegetation samples collected at ponds and ditches during 1983 exhibited radionuclide concentrations comparable to data reported in 1982 (Conklin et al., 1983). The Separations Area ponds and ditches and their sources are listed on Table 16. Locations are shown in Figures 28 and 29.

WATER SAMPLES

One-liter water samples were collected weekly from each open pond and ditch. These weekly samples were composited monthly and analyzed for total beta, total alpha, ^{90}Sr, and gamma-emitting radionuclides (Table 17). Cesium-137 and ^{90}Sr concentrations were well below Table II Concentration Guidelines for water. Beta concentrations at 216-T-4-2 Ditch exceeded Table II Concentration Guidelines, but were only 5.5% of Table I Concentration Guidelines. Radionuclide concentrations in all other ponds and ditches were below DOE guidelines.

VEGETATION

Vegetation samples are collected annually from open ponds and ditches to determine root uptake of the radionuclides. Samples were collected in the early summer of 1983 and consisted of growing stems and leaves of the more abundant species growing at each site. The vegetation was analyzed for gamma-emitting radionuclides, ^{90}Sr, $^{239,240}Pu$, and ^{241}Am (Table 18). Concentrations of ^{137}Cs and $^{239,240}Pu$, were higher than background levels in vegetation collected at the Hanford perimeter sites (Price et al., 1984). The highest $^{239,240}Pu$ concentration (5.0 pCi/g) was found at 216-S-19 Pond. The highest ^{137}Cs concentration (60 pCi/g) was at 216-A-25 Pond inlet and again at 216-S-19. The ^{90}Sr concentration was highest at 216-T-4 Ditch (28 pCi/g). All ^{241}Am concentrations were below the detection limits. All radionuclides present were the result of past operations and releases.

SEDIMENT

Sediment samples are collected annually from the water sampling locations in the ponds and ditches to measure radionuclide accumulation in the sediment. This sampling is intended to show trends rather than indicate radionuclide inventory. Samples of sediment were taken in the early summer of 1983 and analyzed for gamma-emitting radionuclides, ^{90}Sr, $^{239,240}Pu$, and ^{241}Am. Each sample consisted of a composite of five plugs of sediment, each 2.5 cm deep by 900 cm^2. Results of radioanalysis are listed in Table 19.

The highest concentrations of ^{60}Co (148.9 pCi/g) was found in the 216-U-14 Ditch and is attributed to past effluents from the Laundry Facility. Concentrations of ^{54}Mn and ^{154}Eu were also detected in the sediment of this ditch. The highest concentration of ^{137}Cs (690 pCi/g) was found at 216-T-4 and is attributed to past operations.

Radionuclide concentrations in the sediments in 1983 were comparable to 1982 (Conklin et al., 1983).

TABLE 16. The 200 Areas Ponds and Ditches and Sources of Water.

Pond or ditch	Location	Source
216-B-3 (B Pond)	Figure 28	Cooling water (216-B-2 Ditch) PUREX chemical sewer (216-A-29 Ditch) 200 East Area powerhouse (pipe)
216-B-3-3 Ditch	Figure 28	Cooling water from PUREX and B Plant
216-B-63 Specific retention ditch	Figure 28	B Plant chemical sewer (pipe)
216-A-25 Pond (Gable Mountain Pond)	Figure 28	PUREX cooling water (pipe) 244-AR Vault cooling water (pipe) 242-A steam condensate (pipe) 242-A cooling water (pipe)
216-T-4 Ditch	Figure 29	221-T and 224-T waste water (ditch)
216-U-10 Pond (U Pond)	Figure 29	200 West Area laundry waste (until 216-W-LWC was activated) 200 West Area powerhouse (216-U-14 Ditch) 242-S steam condensate (216-U-14 Ditch) 242-S cooling water (216-U-14 Ditch) 224-U chemical sewer (pipe) 221-U and 224-U cooling water (pipe)
216-S-19 Pond (222-S Laboratory)	Figure 29	222-S Laboratory waste water (pipe)
216-N-8 Pond (West Lake)	Figure 28	Groundwater seepage basin (does not receive liquid discharges)
216-A-29 Ditch (Snow's Canyon)	Figure 28	PUREX chemical sewer

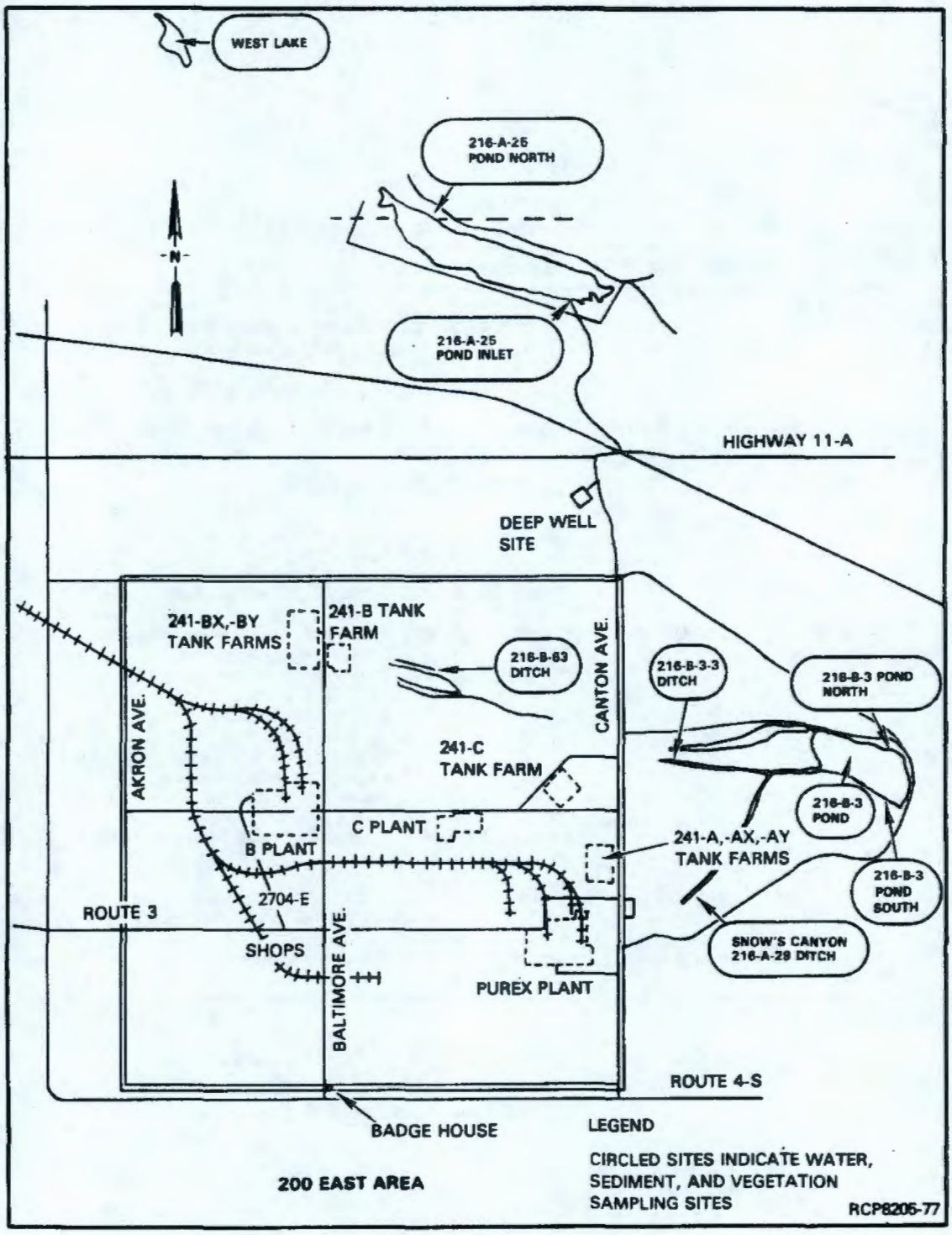


FIGURE 28. The 200 East Area Pond and Ditch Sample Sites.

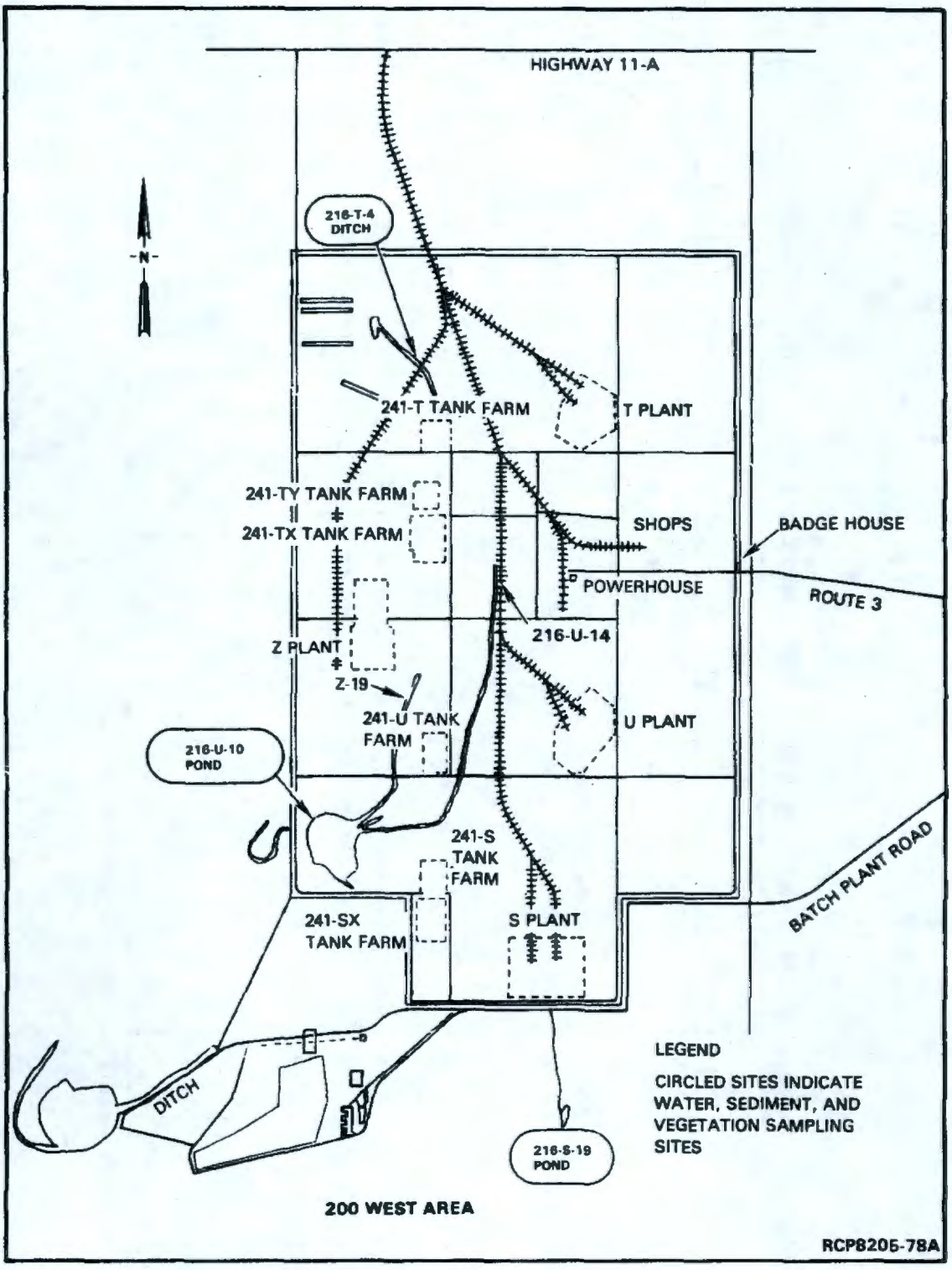


FIGURE 29. The 200 West Area Pond and Ditch Sample Sites.

TABLE 17. Summary of 1983 Water Sample Data from Separations Areas Ponds and Ditches (pCi/mL).

Site No.	Sample site	Total beta			Total alpha			^{137}Cs			$^{89,90}Sr$		
		Maximum	Minimum	Average ±2S	Maximum	Minimum	Average ±2S	Maximum	Minimum	Average ±2S	Maximum	Minimum	Average ±2S
RM3	216-T-4-2 Ditch	5.300	0.032	0.548±3.156	0.012	0.0009	0.004±0.0067	6.000	0.039	0.815±4.190	0.033	0.001	0.013±0.025
RM4	216-U-14 Ditch	0.080	0.017	0.049±0.089	0.003	0.0024	0.002±0.0002	0.060	0.060	0.060	0.004	0.004	0.004
RM6	216-U-10 Pond	2.205	0.058	0.296±1.268	0.023	0.0058	0.012±0.0093	0.170	0.032	0.072±0.082	0.033	0.003	0.012±0.017
RM14	216-S-19 Pond	0.116	0.009	0.034±0.059	0.032	0.0015	0.008±0.0177	0.050	0.050	0.050	0.010	0.010	0.010
RM18	216-B-63 specific retention ditch	0.070	0.011	0.035±0.033	0.028	0.0010	0.005±0.0153	0.060	0.032	0.047±0.028	0.025	0.007	0.017±0.019
RM20	216-A-29 Ditch (Snow's Canyon)	9.064	0.005	1.093±5.370	0.594	0.0009	0.081±0.3539	0.780	0.030	0.152±0.554	0.020	0.002	0.011±0.012
RM21	216-B-3-3 Ditch	0.508	0.006	0.099±0.302	0.014	0.0011	0.003±0.0073	0.450	0.050	0.193±0.446	0.020	0.003	0.013±0.015
RM22	216-B-3 Pond N	0.150	0.012	0.056±0.086	0.038	0.0015	0.008±0.0208	0.053	0.030	0.045±0.018	0.050	0.004	0.019±0.036
RM23	216-B-3 Pond S	0.108	0.016	0.042±0.053	0.012	0.0012	0.004±0.0063	0.600	0.044	0.163±0.489	0.022	0.000	0.009±0.020
RM24	216-A-25 Pond inlet (Gable Mountain)	0.250	0.018	0.063±0.132	0.013	0.0004	0.004±0.0082	0.130	0.037	0.062±0.073	0.038	0.002	0.015±0.025
RM25	216-A-25 Pond outfall (Gable Mountain)	0.340	0.021	0.116±0.199	0.014	0.0017	0.006±0.0094	0.265	0.006	0.092±0.157	0.034	0.001	0.010±0.020
RM26	216-B-3 Pond overflow	0.023	0.012	0.017±0.016	0.004	0.0013	0.003±0.0036						
RM53	216-N-8 Pond (West Lake)							0.760	0.035	0.159±0.496	0.020	0.008	0.014±0.010
	Table I guidelines*			10.0			100.0			400.0			10.0
	Table II guidelines*			0.3			5.0			20.0			0.3

*DOE, 1981 (beta guideline based on ^{90}Sr; alpha guideline based on $^{239,240}Pu$).

TABLE 18. Radionuclides in Aquatic Vegetation Samples Taken from the Separations Area Ponds and Ditches in 1983 (pCi/g Dry Weight).

Sample site	^{40}K	^{137}Cs	^{90}Sr	$^{239,240}Pu$	^{241}Am
216-S-19 Pond	173	60.0	1.4	5.0	<4
216-T-4 Ditch	87	22.0	28.0	1.2	<11
216-U-14 Ditch	181	27.0	3.5	1.0	<10
216-B-63 Ditch	70	3.2	10.0	0.9	<16
216-B-3 Pond North	41	1.4	1.4	0.2	<5
216-B-3 Pond South	29	4.3	2.5	0.3	<10
216-B-3-3 Ditch	698	22.0	0.7	1.2	<96
216-B-3-3 Ditch (replicate)	45	18.0	0.7	0.7	<7
216-A-25 Pond inlet	78	60.0	2.6	0.9	<6
216-A-25 Pond North	40	2.4	8.0	<0.5	<6
West Lake	65	<2	0.6	<0.2	<5
West Lake (replicate)	31	<2	0.3	2.8	<3
216-U-10 Pond	29	59.0	1.6	0.6	<3
216-A-29 Ditch	2,400	22.0	4.8	0.8	<6

NOTE: No standard deviation is available.

TABLE 19. Radionuclide Concentrations in Sediment Samples from Separations Area Ponds and Ditches (pCi/g Dry Weight).

Sample site	^{40}K	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{155}Eu	$^{239,240}Pu$	^{241}Am
216-S-19 Pond	25	a	a	69.0	80.0	a	220.0	260.0
216-T-4 Ditch	23	a	26.0	4.2	690.0	a	6.0	0.32
216-U-14 Ditch	11	5.0	130.0	72.0	11.0	5.8	2.4	<7.0
216-B-63 Ditch	19	a	a	19.0	100.0	a	5.3	<5.0
216-B-3 Pond North	23	a	a	0.7	116.0	a	1.3	<5.0
216-B-3 Pond South	23	a	a	63.0	348.0	a	2.2	<5.0
216-B-3-3 Ditch	31	a	a	<0.8	480.0	a	2.0	<0.2
216-B-3-3 replicate	29	a	a	<0.7	15.0	a	1.1	<5.0
216-A-25 Pond inlet	25	a	a	2.8	140.0	a	1.9	<0.3
216-A-25 Pond North	21	a	a	0.81	442.0	a	0.6	<0.3
West Lake	28	a	a	<0.6	0.9	a	2.5	<7.0
West Lake replicate	32	a	a	1.1	0.6	a	2.0	<6.0
216-U-10 Pond	24	a	4.0	2.7	266.0	a	66.0	68.0
216-A-29 Ditch	28	a	a	0.5	15.0	a	19.0	<9.0
200 Area soil standards[b]	-	-	300.0	400.0	400.0	-	60.0	300.0

NOTE: No standard deviation is available.

[a]Less than detectable

[b]Boothe, 1979.

GROUNDWATER MONITORING

SUMMARY

Periodic groundwater samples were collected from a network of 112 monitoring wells located near waste storage and liquid-waste disposal facilities. Concentrations of specific radionuclides were below DOE Table II Concentration Guidelines with the exception of (1) ^{90}Sr in two wells monitoring the inactive 216-B-5 reverse well and the 216-S-1 and 216-S-2 Cribs and (2) tritium in one well monitoring the 216-A-36B Crib that receives PUREX ammonia-scrubber waste. Elevated ^{90}Sr was noted in one well monitoring Gable Mountain Pond. A study was requested to determine the extent of this occurrence. As in previous years, elevated nitrate concentrations were observed in the vicinity of several wells at both active and inactive disposal sites.

DISCUSSION

The groundwater monitoring network for 1983 consisted of 112 wells in the unconfined aquifer underlying the liquid-waste disposal sites and tank farms in the Separations Area. Monitoring well locations are shown in Figures 30, 31, and 32. Active disposal sites were sampled monthly while inactive sites were sampled quarterly, semiannually, or annually depending on disposal site history. Most of the monitoring wells were equipped with dedicated submersible pumps; a few wells were sampled by bailing. Samples were collected for Rockwell by PNL and were analyzed by U.S. Testing Laboratory. A summary of analytical methods and quality control results for calendar year 1983 are included in the PNL environmental surveillance report for 1983 (Price et al., 1984). Routine analytical parameters for 1983 included ^{3}H, ^{90}Sr, ^{137}Cs, ^{106}Ru, ^{60}Co, total or gross alpha, gross beta, and nitrate. Results of the monitoring program for 1983 are summarized in Table 20. The DOE Concentration Guidelines for water in uncontrolled areas (Table II, DOE, 1981) are listed in Table 21.

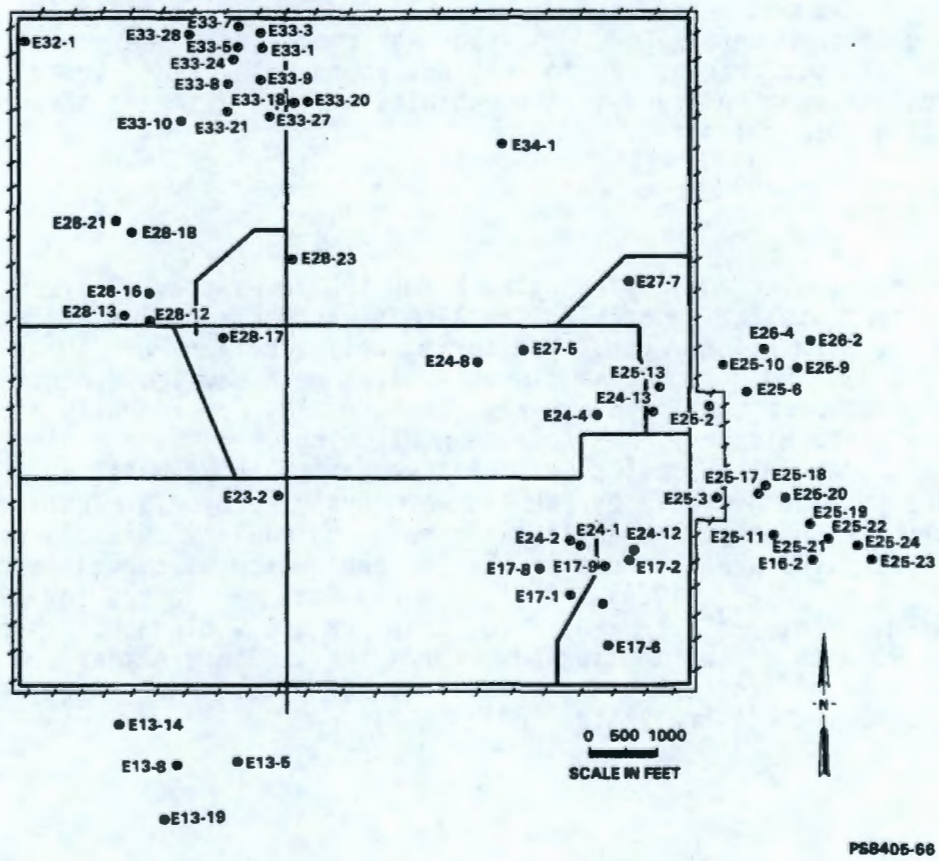


FIGURE 30. Groundwater Monitoring Wells in the 200 East Area.

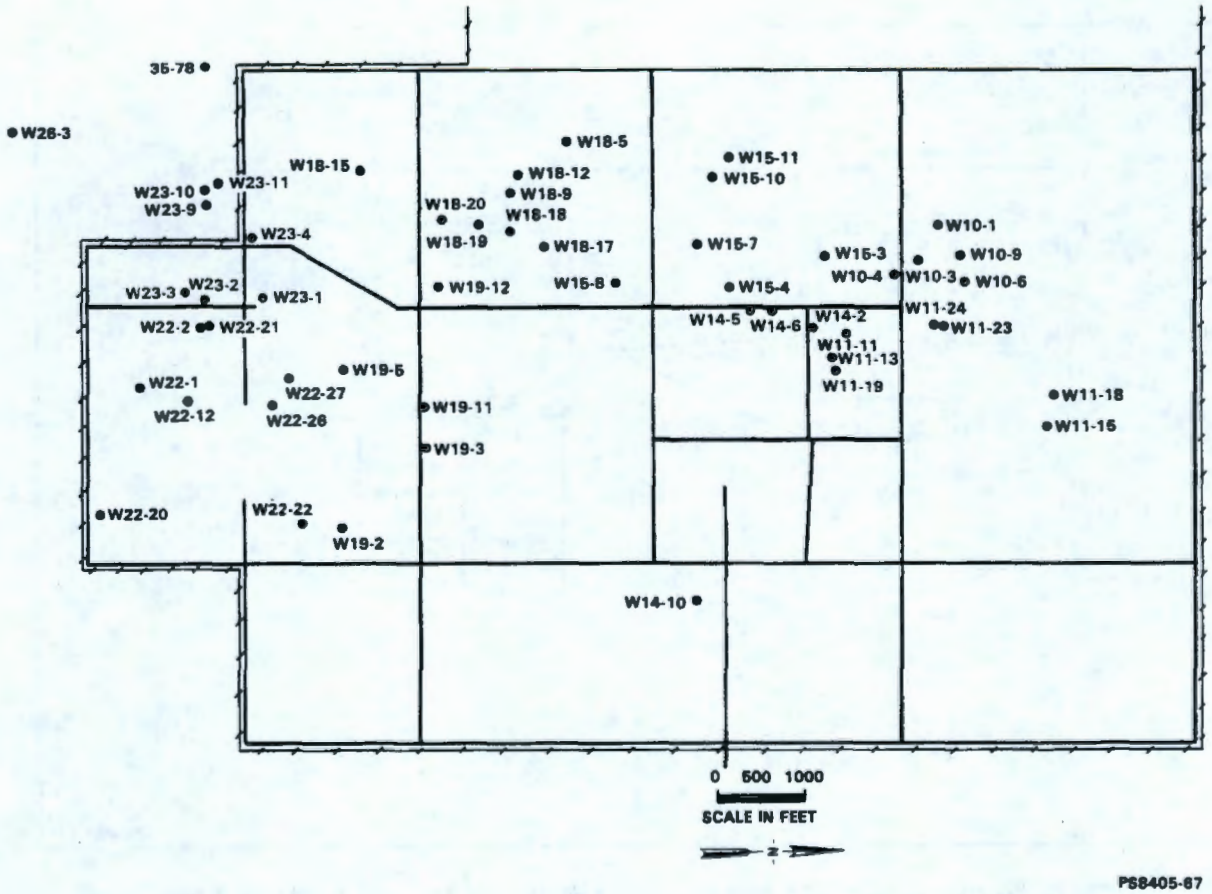


FIGURE 31. Groundwater Monitoring Wells in the 200 West Area.

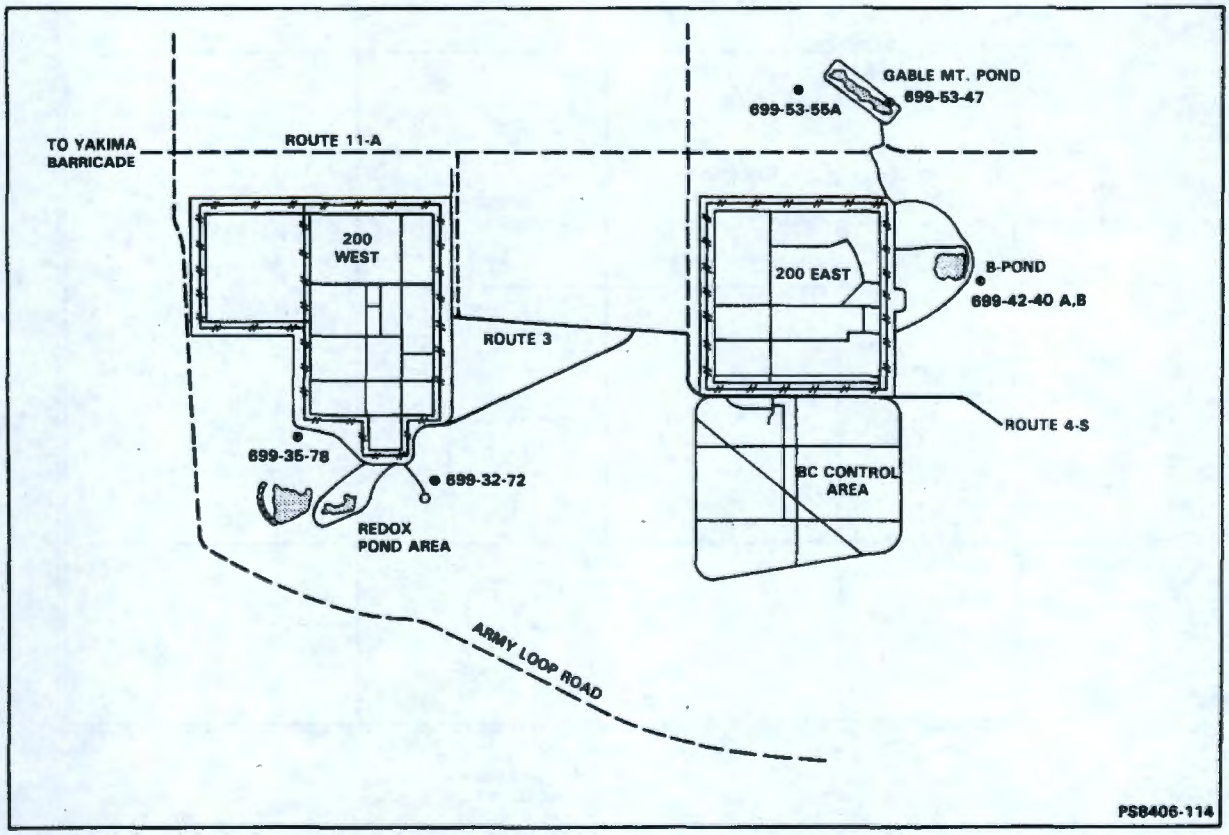


FIGURE 32. Location of 600 Area Monitoring Wells Used in the Separations Area Groundwater Monitoring Program (Calendar Year 1983).

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 1 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area										
	MAX		4.05E-1	1.59E+0						
299-E13-5	AVE		9.46E-2	4.81E-1						
(216-B-18)	MIN		3.80E-3	0.00E-1[a]						
	MAX		3.84E-2				7.67E-3	8.19E-3	1.78E-2	
299-E13-8	AVE		2.22E-2				2.86E-3	2.32E-3	6.70E-3	
(216-B-21)	MIN		1.10E-2				0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		3.73E-2							
299-E13-14	AVE		1.42E-2							
(216-B-29)	MIN		0.00E-1[a]							
	MAX		2.95E-2							
299-E13-19	AVE		2.05E-2							
(216-B-28)	MIN		5.11E-3							
	MAX		4.32E-2		2.98E-3	7.06E-3	6.06E-3	5.95E-3	6.05E-3	
299-E16-2	AVE		1.57E-2		1.24E-3	1.67E-3	1.31E-3	1.29E-3	1.49E-3	
(216-A-30)	MIN		3.33E-2		4.40E-4	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		3.96E-2	5.06E+2	2.12E-2	2.45E-2	1.05E-2	9.32E-3	4.58E-2	
299-E17-1	AVE		2.69E-2	2.37E+2	1.49E-2	4.29E-3	1.80E-3	3.10E-3	1.51E-2	
(216-A-10)	MIN		1.12E-2	1.06E+2	1.04E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	4.54E-2	3.56E-1	6.09E+2	6.86E-2					
299-E17-2	AVE	3.14E-2	1.17E-1	4.76E+2	3.99E-2					
(216-A-27)	MIN	1.62E-2	5.31E-2	2.68E+2	2.20E-2					
	MAX	1.14E-1	1.63E-1	5.70E+2	3.99E-2	8.23E-2	1.42E-2	1.08E-2	4.28E-2	
299-E17-5	AVE	1.39E-2	4.59E-2	5.01E+2	2.48E-2	1.04E-2	3.90E-3	2.47E-3	1.36E-2	7.69E-3[b]
(216-A-36B)	MIN	1.54E-3	9.99E-3	3.81E+2	1.90E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		7.21E-1	1.05E+0	9.30E-4					
299-E17-6	AVE		7.26E-2	4.98E-1	6.00E-4					
(216-A-36)	MIN		4.48E-3	0.00E-1[a]	2.20E-4					

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 2 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area (contd)										
	MAX		2.43E-1	2.17E+2	2.28E-2	1.41E-3	1.63E-2	1.19E-2	4.88E-2	
299-E17-8	AVE		4.16E-2	2.83E+1	9.89E-3	2.82E-4	5.35E-3	3.57E-3	9.76E-3	
(216-A-38)	MIN		9.59E-3	6.95E+0	2.20E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		8.47E-2	1.06E+4	1.45E-1	1.08E-2	2.08E-2	1.02E-1	2.35E-2	
299-E17-9	AVE	1.19E-3[b]	4.09E-2	7.02E+3	1.06E-1	4.24E-3	5.43E-3	2.18E-3	4.97E-3	
(216-A-36A)	MIN		1.57E-2	1.00E+3	1.20E-2	4.06E-4	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX									
299-E23-2	AVE		1.22E-2[b]	2.25E+0[b]	1.36E-3[b]					
(200 East Area)	MIN									
	MAX		6.47E-2	1.82E+2	3.04E-2	6.57E-3	1.23E-2	1.12E-2	4.11E-2	
299-E24-1	AVE		3.65E-2	1.33E+2	1.68E-2	1.99E-3	4.38E-3	4.79E-3	1.97E-2	
(216-A-5)	MIN		1.22E-2	7.37E+1	1.02E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	2.85E-3	5.65E-2	4.49E+2	2.57E-2	1.04E-2	9.21E-3	8.05E-3	7.94E-2	
299-E24-2	AVE	1.07E-3	3.40E-2	1.69E+2	1.73E-2	3.57E-3	2.71E-3	2.48E-3	2.20E-2	1.13E-3[b]
(216-A-10)	MIN	0.00E-1[a]	1.70E-2	5.77E+1	8.80E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		2.25E-1	2.74E+1	1.99E-2	3.04E-3	3.24E-3	2.13E-4	3.94E-2	
299-E24-4	AVE		3.87E-2	2.03E+1	1.04E-2	1.52E-3	1.48E-3	5.32E-5	1.38E-2	
(216-A-9)	MIN		0.00E-1[a]	1.58E+1	7.75E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		5.19E-2	1.47E+1	2.12E-2		9.31E-3	7.82E-3	6.76E-2	
299-E24-8	AVE		2.50E-2	9.71E+0	9.53E-3		2.17E-3	1.81E-3	6.30E-3	
(216-C-5)	MIN		0.00E-1[a]	6.20E+0	6.20E-3		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		1.18E-1	1.11E+3	7.50E-2					
299-E24-12	AVE	4.38E-2[b]	8.57E-2	1.01E+3	5.67E-2					1.95E-2[b]
(216-A-31)	MIN		6.18E-2	8.52E+2	3.78E-2					
	MAX		2.50E-2							
299-E24-13	AVE		1.50E-2							
(241-A)	MIN		1.04E-2							

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 3 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area (contd)										
	MAX			7.70E+1	6.64E-3					
299-E25-2	AVE		1.14E-2[b]	4.07E+1	5.67E-3			6.60E-3[b]		
(216-A-1)	MIN			2.75E+1	4.70E-3					
	MAX		3.99E-2							
299-E25-3	AVE		2.34E-2							
(216-A-6)	MIN		2.35E-3							
	MAX	3.75E-3	4.06E-2	2.56E+2	4.21E-3	3.67E-3	1.28E-2	3.68E-3	4.34E-2	
299-E25-6	AVE	9.01E-4	1.82E-2	2.16E+2	1.53E-3	1.08E-3	3.00E-3	1.12E-3	3.95E-3	
(216-A-8)	MIN	0.00E-1[a]	0.00E-1[a]	1.84E+2	3.10E-4	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	4.62E-3	4.83E-2	5.88E+2		1.79E-3	9.01E-3	4.67E-3	6.73E-2	
299-E25-9	AVE	1.32E-3	1.28E-2	9.18E+1	5.16E-3[b]	4.77E-4	2.33E-3	1.51E-3	1.50E-2	
(216-A-8)	MIN	0.00E-1[a]	7.78E-4	4.13E+0		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	9.23E-3	1.99E-2				7.82E-3	6.19E-3	3.57E-2	1.23E-2
299-E25-10	AVE	2.70E-3	1.22E-2				1.65E-3	2.84E-3	2.01E-2	3.03E-3
(216-A-18,19,20)	MIN	1.19E-4	0.00E-1[a]				0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]
	MAX		3.48E-2	5.65E+1	7.50E-3	7.53E-3	9.35E-3	5.61E-3	3.50E-2	
299-E25-11	AVE		1.13E-2	2.99E+1	4.99E-3	2.81E-3	2.33E-3	2.33E-3	1.39E-2	
(216-A-30)	MIN		0.00E-1[a]	1.65E+1	3.07E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		1.78E-1							
299-E25-13	AVE		5.04E-2							
(241-AX)	MIN		5.95E-3							
	MAX		1.79E-2	5.63E+1	3.58E-3					
299-E25-17	AVE		1.14E-2	4.77E+1	1.42E-3	5.35E-4[b]	3.17E-3[b]	2.81E-3[b]	1.67E-2[b]	
(216-A-37-1)	MIN		5.42E-3	3.83E+1	4.40E-4					
	MAX		6.15E-2	2.06E+2	3.52E-2					
299-E25-18	AVE		2.20E-2	1.78E+2	2.60E-2	3.81E-3[b]	2.03E-3[b]	2.26E-3[b]	3.53E-2[b]	
(216-A-37-1)	MIN		0.00E-1[a]	1.61E+2	1.73E-2					

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 4 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area (contd)										
	MAX		4.62E-2	5.61E+2	1.37E-1					
299-E25-19	AVE		2.75E-2	4.30E+2	1.15E-1	2.78E-3[b]	4.23E-4[b]	5.07E-3[b]	4.93E-3[b]	
(216-A-37-1)	MIN		1.19E-2	3.10E+2	1.00E-1					
	MAX		6.52E-2	2.22E+3	1.02E+0	4.48E-3	5.61E-3	2.26E-3	2.95E-2	
299-E25-20	AVE		2.38E-2	1.82E+3	3.70E-1	2.34E-3	1.97E-3	1.04E-3	2.47E-2	
(216-A-37-1)	MIN		2.88E-4	1.00E+3	3.21E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	2.03E-2	
	MAX		3.31E-2	2.22E+1	7.88E-3					
299-E25-21	AVE		1.28E-2	2.12E+1	5.97E-3	2.82E-3[b]	4.73E-4[b]	3.38E-3[b]	0.00E-1[a]	
(216-A-37-2)	MIN		2.99E-3	2.05E+1	3.84E-3					
	MAX		3.60E-2	6.49E+1	3.09E-2					
299-E25-22	AVE		1.85E-2	3.14E+1	1.36E-2	3.04E-3[b]	5.47E-3[b]	1.29E-3[b]	1.16E-2[b]	
(216-A-37-2)	MIN		7.85E-3	1.20E+1	5.70E-3					
	MAX		4.50E-2	2.20E+0	4.14E-3					
299-E25-23	AVE		3.04E-2	1.45E+0	2.78E-3	0.00E-1[a]	2.29E-3[b]	2.70E-3[b]	3.28E-3[b]	
(216-A-37-2)	MIN		1.59E-2	9.50E-1	7.50E-4					
	MAX		5.14E-2	2.42E+0	5.50E-3					
299-E25-24	AVE		2.88E-2	1.63E+0	2.53E-3	3.20E-3[b]	4.17E-3[b]	0.00E-1[a]	6.55E-3[b]	
(216-A-37-2)	MIN		1.81E-2	9.59E-1	1.49E-3					
	MAX		1.92E-2	8.24E+0	8.85E-3					
299-E26-2	AVE		1.18E-2	5.32E+0	6.45E-3					
(216-A-24)	MIN		2.53E-4	3.82E+0	4.40E-3					
	MAX		1.34E-2	3.61E+1	7.00E-3					
299-E26-4	AVE		9.30E-3	2.56E+1	5.68E-3					
(216-A-24)	MIN		4.87E-3	1.87E+1	4.20E-3					
	MAX		1.61E-1				1.46E-2	9.69E-3	3.90E-2	
299-E27-5	AVE		5.21E-2				4.41E-3	4.15E-3	9.75E-3	
(216-C-10)	MIN		0.00E-1[a]				0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 5 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
				200 East Area (contd)						
	MAX		8.35E-2	1.18E+2			1.56E-2	4.48E-3	3.57E-2	
299-E28-12	AVE		2.79E-2	6.78E+1			3.29E-3	1.17E-3	7.89E-3	
(216-B-55)	MIN		0.00E-1[a]	7.34E+0			0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		3.63E-2	7.33E+1			1.02E-2	8.01E-3	8.29E-2	
299-E28-13	AVE		1.57E-2	1.29E+1			2.33E-3	1.95E-3	1.21E-2	
(216-B-55)	MIN		0.00E-1[a]	5.51E+0			0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		2.54E-1							
299-E28-16	AVE		8.25E-2							
(216-B-12)	MIN		1.17E-2							
	MAX									
299-E28-17	AVE	1.19E-2[b]								
(216-B-10A/B)	MIN									
	MAX	2.51E-1	1.77E-1	1.09E+2	6.33E-1	8.98E-3	1.21E-2	8.24E-3	5.01E-2	
299-E28-18	AVE	1.68E-1	9.07E-2	7.64E+1	3.36E-1	2.68E-3	2.45E-3	2.02E-3	9.85E-3	1.67E-2[b]
(216-B-62)	MIN	1.11E-1	5.66E-2	4.70E+1	1.38E-1	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	1.34E-1	1.03E-1	7.35E+1	4.26E-1	3.51E-2	1.26E-2	8.95E-3	3.38E-2	
299-E28-21	AVE	7.16E-2	6.15E-2	5.68E+1	2.33E-1	5.44E-3	2.85E-3	2.32E-3	6.82E-3	
(216-B-62)	MIN	2.22E-4	4.23E-2	4.65E+1	1.53E-1	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX									
299-E28-23	AVE	4.32E-2[b]	2.28E+1[b]	2.82E+0[b]	1.97E-2[b]	1.20E+1[b]	3.66E+0[b]	1.20E-3[b]	2.69E-2[b]	
(216-B-5)	MIN									
	MAX									
299-E32-1	AVE		3.91E-2[b]	4.31E+0[b]	3.10E-2[b]					
(200 East Area)	MIN									
	MAX									
299-E33-1	AVE		3.57E-1[b]				2.52E-3[b]	5.28E-2[b]	1.15E-3[b]	
(216-B-43)	MIN									

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 6 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area (contd)										
299-E33-3 (216-B-44,45,46)	MAX AVE MIN		3.11E+0[b]	8.89E+0[b]		1.30E-3[b]	1.26E-2[b]	8.49E-1[b]	7.33E-2[b]	
299-E33-5 (216-B-47)	MAX AVE MIN		8.46E-1[b]				4.54E-3[b]	1.00E-1[b]	1.79E-2[b]	
299-E33-8 (216-B-41)	MAX AVE MIN		1.62E-1[b]				2.78E-3[b]	4.72E-3[b]	2.76E-2[b]	
299-E33-9 (241-BY)	MAX AVE MIN		2.32E-1[b]	2.12E+0[b]	2.56E-1[b]	4.05E-3[b]	7.78E-3[b]	2.93E-2[b]	6.69E-3[b]	
299-E33-18 (216-B-7A,7B)	MAX AVE MIN		4.14E-2[b]			3.31E-3[b]	2.00E-3[b]	2.83E-3[b]		
299-E33-20 (241-B)	MAX AVE MIN		5.22E-2[b]			6.50E-3[b]				
299-E33-21 (216-B-36)	MAX AVE MIN		4.17E-3[b]				2.18E-3[b]	2.35E-3[b]	2.67E-2[b]	
299-E33-24 (216-B-57)	MAX AVE MIN		2.86E-1[b]				4.67E-3[b]	1.85E-2[b]	3.70E-2[b]	
299-E33-26 (216-B-61)	MAX AVE MIN		8.18E-1[b]				7.16E-3[b]	8.31E-2[b]	7.80E-3[b]	

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 7 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 East Area (contd)										
299-E33-27 (241-BX)	MAX									
	AVE		1.28E+0[b]	4.77E+1[b]			1.39E+0[b]	1.31E-2[b]	8.03E-2[b]	
	MIN									
299-E34-1 (216-B-63)	MAX		1.27E-1	4.57E+1	2.70E-2		7.43E-3	7.09E-3	3.59E-2	
	AVE		2.61E-2	4.34E+0	9.42E-3		2.05E-3	2.37E-3	1.32E-2	
	MIN		0.00E-1[a]	5.60E-2	2.80E-3		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
200 West Area										
299-W10-1 (216-T-5)	MAX		4.14E-2							
	AVE		2.98E-2							
	MIN		1.96E-2							
299-W10-3 (216-T-32)	MAX	2.56E-2	6.51E-2							
	AVE	1.86E-2	5.88E-2							
	MIN	1.19E-2	4.84E-2							
299-W10-4 (216-T-36)	MAX		1.50E-1				1.86E-2	2.49E-2	1.01E-2	
	AVE		1.05E-1	3.30E+1[b]			8.26E-3	1.58E-2	2.02E-3	
	MIN		7.24E-2				3.00E-3	5.19E-3	0.00E-1[a]	
299-W10-8 (241-T)	MAX	3.18E-3	1.15E-1				1.02E-2	1.98E-2	6.53E-2	
	AVE	2.15E-3	9.04E-2				3.42E-3	1.41E-2	3.00E-2	
	MIN	1.54E-3	7.85E-2				0.00E-1[a]	4.46E-3	0.00E-1[a]	
299-W10-9 (241-T)	MAX	8.00E-3	1.58E-1				1.70E-2	2.75E-2	6.45E-2	
	AVE	3.91E-3	9.27E-2				3.97E-3	1.46E-2	1.82E-2	
	MIN	1.78E-3	6.34E-2				0.00E-1[a]	5.96E-3	0.00E-1[a]	
299-W11-11 (216-T-8)	MAX	9.34E-3	1.65E-1				1.46E-2	9.85E-3		
	AVE	3.77E-3	1.12E-1	3.40E+1[b]			3.98E-3	7.85E-3		
	MIN	1.19E-3	8.29E-2				0.00E-1[a]	6.15E-3		

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 8 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 West Area (contd)										
	MAX									
299-W11-13	AVE		1.03E-1[b]	1.02E+2[b]	1.87E-1[b]					
(200 West Area)	MIN									
	MAX		7.15E-2							
299-W11-15	AVE		4.98E-2							
(216-T-34)	MIN		2.98E-2							
	MAX		1.53E-1							
299-W11-18	AVE		1.23E-1		4.00E-3[b]					
(216-T-35)	MIN		1.06E-1							
	MAX	7.00E-3	1.69E-1				8.83E-3	1.94E-2	1.96E-2	
299-W11-23	AVE	3.30E-3	1.01E-1				3.02E-3	1.55E-2	3.92E-3	
(241-T)	MIN	0.00E-1[a]	7.04E-2				0.00E-1[a]	1.12E-2	0.00E-1[a]	
	MAX	2.73E-3	1.17E-1				3.52E-3	2.27E-2	2.74E-2	
299-W11-24	AVE	1.50E-3	9.88E-2				1.39E-3	1.50E-2	1.08E-2	
(241-T)	MIN	6.22E-4	8.38E-2				0.00E-1[a]	1.05E-2	0.00E-1[a]	
	MAX									
299-W14-2	AVE	3.92E-3[b]	7.89E-2[b]	2.86E+2[b]						
(216-T-26,27,28)	MIN									
	MAX		2.08E-2	5.71E+1						
299-W14-5	AVE		1.31E-2	2.87E+1						
(241-TX)	MIN		8.07E-4	1.27E+1						
	MAX		2.77E-2							
299-W14-6	AVE		1.61E-2							
(241-TX)	MIN		1.09E-3							
	MAX	3.14E-2	3.97E-2		3.78E-1	5.29E-3	1.60E-2	1.12E-2	3.92E-2	
299-W14-10	AVE	3.69E-3	1.04E-2		2.91E-1	1.36E-3	3.90E-3	2.28E-3	1.24E-2	
(216-W-LWC)	MIN	0.00E-1[a]	0.00E-1[a]		4.20E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 9 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 West Area (contd)										
	MAX		5.75E-2				1.16E-2	1.41E-2	2.47E-2	
299-W15-3	AVE		5.30E-2				4.76E-3	1.12E-2	1.07E-2	
(241-TY)	MIN		4.91E-2				0.00E-1[a]	6.36E-3	0.00E-1[a]	
	MAX		4.38E-2	9.71E+2	9.43E-1					
299-W15-4	AVE		2.28E-2	9.06E+2	8.78E-1					
(216-T-19)	MIN		8.35E-3	8.04E+2	8.23E-1					
	MAX	2.73E-3	1.90E-2		1.38E-2					
299-W15-6	AVE	1.56E-3	1.14E-2		8.89E-3					
(216-Z-9)	MIN	9.49E-4	6.28E-3		5.30E-3					
	MAX	7.11E-4	2.22E-1		1.79E-1		1.39E-3	5.03E-2	3.91E-2	
299-W15-7	AVE	3.85E-4	1.00E-1		1.22E-1		5.24E-4	2.63E-2	1.52E-2	
(216-Z-7)	MIN	0.00E-1[a]	2.67E-2		8.40E-2		0.00E-1[a]	6.71E-3	0.00E-1[a]	
	MAX	2.73E-3	1.92E-1							
299-W15-10	AVE	1.33E-3	6.05E-2		1.68E-1[b]					
(216-Z-16)	MIN	0.00E-1[a]	1.50E-2							
	MAX	3.20E-3	5.51E-2		3.54E-1					
299-W15-11	AVE	2.29E-3	3.43E-2		3.01E-1					
(216-Z-16)	MIN	1.54E-3	2.07E-2		2.57E-1					
	MAX	2.73E-3	4.46E-2							
299-W18-5	AVE	9.49E-4	1.77E-2							
(216-Z-12)	MIN	0.00E-1[a]	6.97E-3							
	MAX	2.49E-3	3.01E-2		3.14E-2					
299-W18-9	AVE	1.28E-3	1.16E-2		1.26E-2					
(216-Z-8)	MIN	6.24E-4	4.50E-3		2.88E-3					
	MAX	3.36E-3	3.76E-2	1.72E+0	1.64E-2					1.35E-3
299-W18-12	AVE	2.08E-3	1.22E-2	8.30E-1	5.02E-3					9.46E-4
(216-Z-18)	MIN	0.00E-1[a]	0.00E-1[a]	1.10E-1	5.30E-4					6.19E-4

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 10 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 West Area (cont'd)										
	MAX	3.34E-1	6.93E-2	3.20E+0	5.30E-3		3.47E-2	9.02E-3	7.43E-2	
299-W18-15	AVE	6.88E-2	3.70E-2	6.69E-1	1.12E-3		5.23E-3	3.56E-3	1.40E-2	1.80E-2[b]
(216-U-10)	MIN	9.49E-4	1.06E-2	0.00E-1[a]	3.50E-4		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	5.72E-3	4.91E-2	5.77E-1	4.90E-3		8.83E-3	2.25E-3	7.81E-2	
299-W18-17	AVE	1.89E-3	1.69E-2	2.71E-1	2.85E-3		2.79E-3	1.10E-3	3.54E-2	
(216-Z-20)	MIN	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	1.80E-3		0.00E-1[a]	0.00E-1[a]	8.38E-3	
	MAX	4.15E-4	1.57E-1	1.67E+0	2.70E-3		4.85E-3	4.49E-3	1.18E-2	
299-W18-18	AVE	1.04E-4	1.21E-1	6.88E-1	1.64E-3		2.74E-3	1.55E-3	4.82E-3	
(216-Z-20)	MIN	0.00E-1[a]	5.58E-1	2.74E-1	9.07E-4		1.41E-3	0.00E-1[a]	0.00E-1[a]	
	MAX	5.60E-3	3.18E-2	1.10E+1	3.10E-3		6.46E-3	1.04E-2	3.08E-2	
299-W18-19	AVE	1.09E-3	1.36E-2	2.98E+0	7.94E-4		1.93E-3	2.27E-3	4.55E-3	
(216-Z-20)	MIN	0.00E-1[a]	0.00E-1[a]	6.30E-2	6.20E-5		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	6.25E-3	4.94E-2	9.50E+0	5.30E-3		1.23E-2	9.14E-3	8.85E-2	
299-W18-20	AVE	2.23E-3	1.40E-2	2.67E+0	1.57E-3		2.40E-3	2.02E-3	1.56E-2	
(216-Z-20)	MIN	0.00E-1[a]	0.00E-1[a]	2.61E-1	4.40E-4		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		7.92E-2	9.31E+1	4.39E-1					2.05E-3
299-W19-2	AVE		4.72E-2	7.38E+1	2.55E-1					1.20E-3
(216-U-8)	MIN		2.39E-2	6.18E+1	1.82E-1					5.47E-4
	MAX	9.65E-2	1.76E-1	3.16E-1	3.23E-2		0.00E-1[a]	3.88E-3	1.92E-2	3.55E-2
299-W19-3	AVE	4.26E-2	1.14E-1	1.92E-1	2.36E-2		0.00E-1[a]	1.90E-3	7.70E-3	2.83E-2
(216-U-1&2)	MIN	3.20E-3	3.12E-2	8.10E-2	1.50E-2		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	2.38E-2
	MAX		1.45E-2	9.79E-1	5.89E-3					
299-W19-5	AVE		9.82E-3	7.44E-1	3.29E-3					
(216-S-23)	MIN		3.34E-3	3.96E-1	1.77E-3					
	MAX	1.18E-2		2.21E+0	3.65E-2		3.09E-3	7.46E-3	1.93E-2	
299-W19-11	AVE	5.34E-3		1.08E+0	2.75E-2		7.72E-4	2.24E-3	1.49E-2	
(216-U-1)	MIN	5.69E-4		4.19E-1	1.79E-2		0.00E-1[a]	0.00E-1[a]	7.61E-3	

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 11 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 West Area (contd)										
299-W19-12 (241-U)	MAX									
	AVE	6.13E-3[b]	2.03E-2[b]	1.13E-1[b]	3.22E-2[b]		2.88E-3[b]	2.63E-3[b]	1.05E-3[b]	2.82E-3[b]
	MIN									
299-W22-1 (216-S-1)	MAX									
	AVE	7.39E-3[b]	5.56E-1[b]	3.54E+1[b]	1.41E-2[b]	3.04E-1[b]	3.40E-4[b]	1.77E-3[b]		
	MIN									
299-W22-2 (216-S-1&2)	MAX									
	AVE	5.49E-3[b]	9.67E-2[b]	9.92E-1[b]	1.60E-2[b]	2.21E-3[b]	2.15E-3[b]	1.38E-3[b]	2.37E-2[b]	
	MIN									
299-W22-12 (216-S-7)	MAX									
	AVE		3.45E-2[b]	4.40E+2[b]	5.37E-3[b]	1.39E-3[b]				
	MIN									
299-W22-20 (216-S-20)	MAX		1.31E-1			5.10E-3				
	AVE		7.52E-2	3.62E+2[b]		1.27E-3				
	MIN		5.43E-2			0.00E-1[a]				
299-W22-21 (216-S-13)	MAX	4.57E-2	1.65E-1		1.91E-2	4.50E-3	3.10E-3	3.74E-3	2.81E-2	
	AVE	2.57E-2	1.35E-1		1.33E-2	2.29E-3	9.33E-4	9.35E-4	1.76E-2	
	MIN	0.00E-1[a]	1.20E-1		7.51E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
299-W22-22 (216-U-12)	MAX	3.75E-3	2.18E-2	1.50E+2	9.20E-3	5.52E-3	9.76E-3	1.71E-3	2.29E-2	5.66E-3
	AVE	9.42E-4	1.17E-2	2.02E+1	1.97E-3	1.75E-3	1.80E-3	2.52E-4	4.64E-3	1.57E-3
	MIN	0.00E-1[a]	0.00E-1[a]	2.37E+0	1.80E-4	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]
299-W22-26 (216-S-9)	MAX									
	AVE		2.08E-2[b]	2.81E+2[b]		9.30E-4[b]	5.17E-4[b]	2.72E-3[b]	1.10E-2[b]	
	MIN									
299-W22-27 (216-S-9)	MAX									
	AVE		2.00E-2[b]	7.01E+2[b]	9.48E-3[b]					
	MIN									

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 12 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
200 West Area (contd)										
	MAX									
299-W23-1	AVE		1.27E-2[b]							
(216-S-3)	MIN									
	MAX									
299-W23-2	AVE		6.54E-3[b]							
(241-SX)	MIN									
	MAX									
299-W23-3	AVE		1.75E-2[b]							
(241-SX)	MIN									
	MAX	3.51E-2	3.86E-2	3.39E+0	2.70E-3					2.09E-2
299-W23-4	AVE	2.91E-2	2.73E-2	2.08E+0	1.11E-3					1.59E-2
(216-S-21)	MIN	2.54E-2	1.36E-2	6.03E-1	4.40E-4					1.37E-2
	MAX	2.26E-2	3.34E-2	4.25E+1		8.26E-3	1.93E-3	4.49E-3	3.40E-2	
299-W23-9	AVE	9.62E-3	1.38E-2	2.58E+1		2.52E-3	5.12E-4	1.05E-3	8.24E-3	
(216-S-25)	MIN	5.93E-4	1.86E-3	4.59E-1		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX		3.39E-2	3.15E+2		8.47E-3	9.51E-3	4.49E-3	6.81E-2	
299-W23-10	AVE		1.56E-2	8.18E+1		1.47E-3	2.40E-3	1.55E-3	2.72E-2	
(216-S-25)	MIN		0.00E-1[a]	6.67E-1		0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	4.20E-1	6.31E-2	1.83E+2			7.49E-3	8.32E-3	3.43E-2	
299-W23-11	AVE	4.92E-2	2.43E-2	2.44E+1			1.68E-3	2.13E-3	4.10E-3	6.72E-2[b]
(216-S-25)	MIN	3.11E-3	0.00E-1[a]	7.87E-1			0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	1.91E-3	2.02E-2	8.64E-1						
299-W26-3	AVE	9.87E-4	7.53E-3	6.25E-1	9.72E-4[b]					
(216-S-6)	MIN	5.93E-4	0.00E-1[a]	7.00E-2						

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 20. Summary of 1983 Groundwater Monitoring Results. (Sheet 13 of 13)

Well (sites monitored)	Sampling frequency	Total alpha (pCi/mL)	Total beta (pCi/mL)	Tritium (pCi/mL)	Nitrate (mg/L)	^{90}Sr (pCi/mL)	^{137}Sr (pCi/mL)	^{60}Co (pCi/mL)	^{106}Ru (pCi/mL)	Uranium (pCi/mL)
				600 Area						
	MAX	5.82E-3	3.95E-2	1.20E+2	5.00E-4					
699-32-72	AVE	8.33E-4	8.52E-3	1.14E+2	2.55E-4			5.13E-3[b]		
	MIN	0.00E-1[a]	0.00E-1[a]	1.10E+2	1.40E-4					
	MAX	3.90E-2	5.59E-2	2.91E+0			6.63E-3	5.96E-3	4.18E-2	1.85E-2
699-35-78	AVE	2.50E-2	1.73E-2	6.30E-1	6.67E-4[b]		1.62E-3	2.34E-3	1.32E-2	1.15E-2
	MIN	8.06E-3	8.56E-3	3.44E-3			0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	3.58E-3
	MAX		1.59E-1	2.24E+2	1.06E-2	5.13E-3	5.67E-3	3.84E-3	4.55E-2	6.24E-3
699-42-40A	AVE		2.61E-2	1.81E+2	6.88E-3	1.06E-3	8.14E-4	7.56E-4	1.21E-2	2.12E-3
(216-B-3)	MIN		0.00E-1[a]	9.49E+0	3.07E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	4.22E-4
	MAX		3.44E-1	2.48E+2	1.59E-2	2.77E-2	9.17E-3	8.16E-3	4.23E-2	
699-42-40B	AVE		3.76E-2	1.91E+2	1.18E-2	3.16E-3	2.17E-3	1.91E-3	6.54E-3	
(216-B-3)	MIN		0.00E-1[a]	9.22E+0	5.13E-3	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	9.23E-3	9.90E-2			5.07E-2	6.12E-3	1.04E-2	4.93E-2	
699-53-47	AVE	1.57E-3	5.59E-2			3.23E-2	2.00E-3	2.47E-3	6.67E-3	
(216-A-25)	MIN	0.00E-1[a]	3.63E-2			2.13E-2	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX	3.49E-3	7.10E-2			5.01E-3	1.25E-2	6.57E-3	8.88E-2	
699-53-55A	AVE	1.27E-3	1.73E-2			8.16E-4	4.04E-3	2.47E-3	2.35E-2	
	MIN	3.56E-4	2.32E-3			0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	0.00E-1[a]	
	MAX			4.00E-1						
699-54-57	AVE			1.15E-1	2.38E-4[b]					
	MIN			0.00E-1[a]						

[a]Negative analytical values appear as zeros.

[b]Three values or less, no maximum or minimum calculated.

TABLE 21. Radionuclide Concentration Guides.

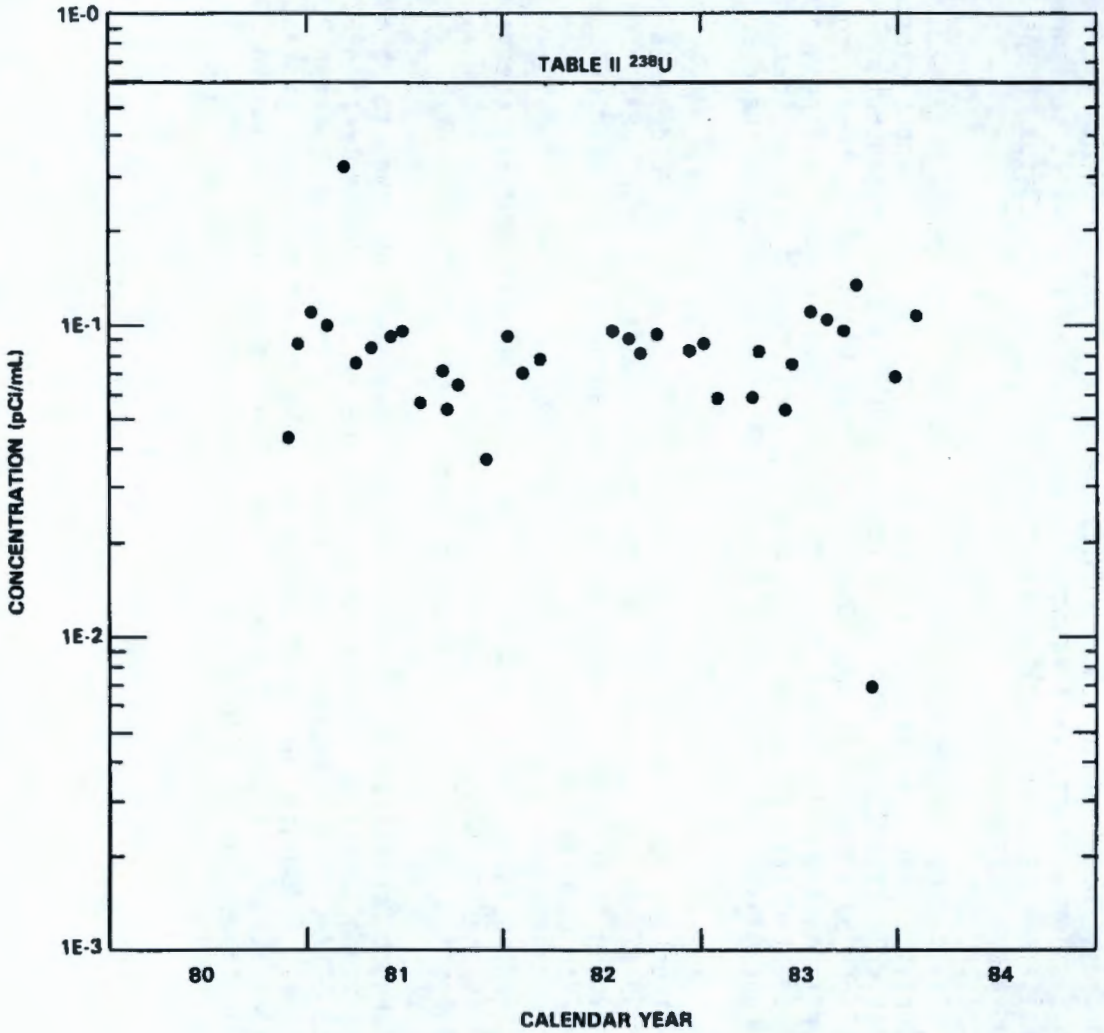
Parameter	Table II Concentration Limits (pCi/mL)
Total alpha	0.03*
Total beta	0.03*
^{90}Sr	0.30
^{60}Co	30
^{137}Cs	20
^{106}Ru	10
^{3}H	3,000
Total uranium	0.6

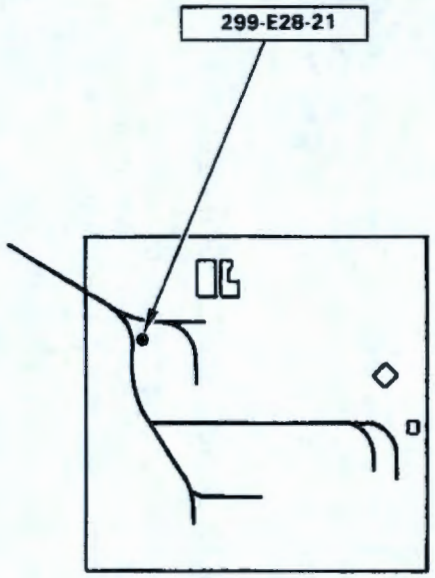
NOTE: Table II (uncontrolled area), Column 2 (water), Attachment XI-1, DOE Order 5480.1, (DOE, 1981).

*The Concentration Guide for "unidentified" activity is 0.03 pCi/mL when no other information is available for the sample (or monitoring site).

Total Alpha

Samples collected from 47 wells were analyzed for total alpha activity. Significant alpha contamination was detected only at the 216-B-62 Crib. The two wells at this crib (299-E28-21 and 299-E28-18) showed consistently elevated alpha activity. A concentration history plot of well 299-E28-21 is shown in Figure 33. An expanded plot showing analytical uncertainty in relationship to the Table II Concentration Guide for unidentified alpha emitter is shown in Figure 33. The isotopic composition of the previously unidentified alpha activity has been shown to consist of the natural isotopes of uranium (^{234}U, ^{235}U, and ^{238}U). Recent effluent data, as well as past disposal records for the 216-B-62 Crib (1973 to present), suggest that little if any uranium has been discharged to this crib. Thus, the elevated alpha activity in wells 299-E28-18 and 299-E28-21 is apparently a result of pre-1973 liquid-waste disposal activities and is not associated with current B Plant operations, though those operations continue to provide a driving force for existing crib contamination.





PS8405-68

FIGURE 33. Concentration History of Total Alpha in Well 299-E28-21 (216-B-62 Crib). Background Total Alpha is approximately 10 pCi/L.

Uranium

Total uranium analyses were performed on water samples collected from 15 wells of the groundwater monitoring network. None of the wells exhibited concentrations greater than the Table II value of 0.6 pCi/mL.

Strontium-90, Total Beta, and Gamma Emitting Radionuclides

Total beta (Tβ) analyses were performed on samples collected from 110 wells. As in previous years, elevated Tβ was observed in wells at the 216-B-43/50 Cribs and near the adjacent 241-BY Tank Farm (wells 299-E33-1, -3, -5, -8, and -9). The highest value, 3,110 pCi/L for well 299-E33-3, was comparable to results obtained in prior years (see Fig. 34). The occurrence of elevated Tβ at this inactive crib site is due to disposal of "high salt" liquid waste from U Plant during 1954 to 1955. The waste consisted of scavenged tributyl phosphate supernatant from the uranium recovery process. Mixed fission products were associated with this waste. Wells monitoring this site are sampled annually to document the long-term status of the groundwater contamination.

Elevated concentrations of Tβ were also found in well 299-E28-23, which monitors the inactive 216-B-5 reverse well. This is due to the elevated ^{90}Sr at this site (12.0 pCi/mL), which exceeds Table II Concentration Guidelines by a factor of 40. However, this is within the normal range for this well as shown in Figure 35. The 216-B-5 reverse well was the subject of a recent characterization study (Smith, 1980) that concluded that the ^{90}Sr contamination is restricted to the immediate vicinity of the disposal well.

Strontium-90 slightly exceeded Table II Concentration Guidelines in well 299-W22-1, which monitors the inactive 216-S-1/S-2 Crib. Elevated ^{90}Sr is expected at this crib, which was also the subject of a characterization study (Van Luik and Smith, 1982).

Samples collected from 69 wells were analyzed by gamma-ray spectrometry for ^{137}Cs, ^{60}Co, and ^{106}Ru. None of the samples exceeded the Table II Concentration Guidelines for these radionuclides.

The concentration of ^{90}Sr in well 699-53-47A was observed to be on a rising trend (See Fig. 36) although below the Table II Concentration Guide of 0.3 pCi/mL. This well monitors the 216-A-25 Pond (Gable Mountain Pond). An investigation was initiated to evaluate the extent of ^{90}Sr migration in the vicinity of the pond. (Gable Mountain Pond received an estimated 500 Ci of ^{90}Sr in 1964 along with other fission products).

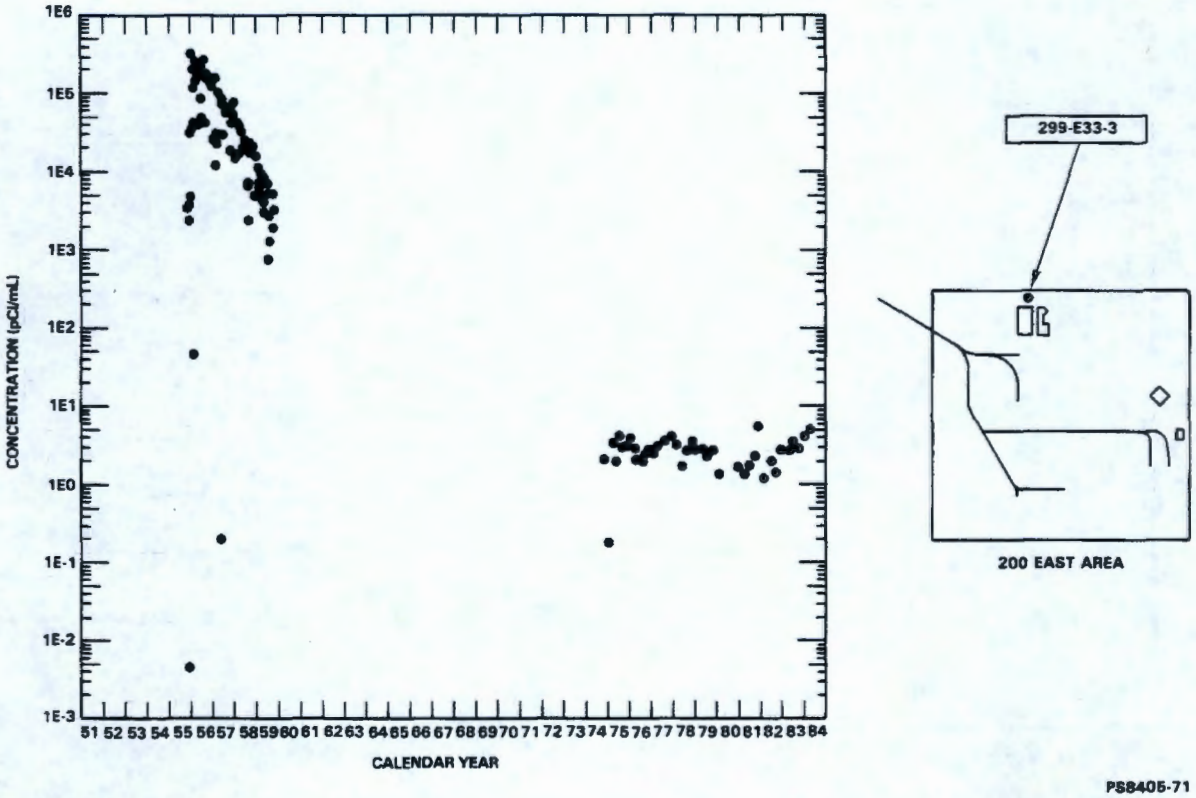


FIGURE 34. Concentration History for Total Beta in Well 299-E33-3.

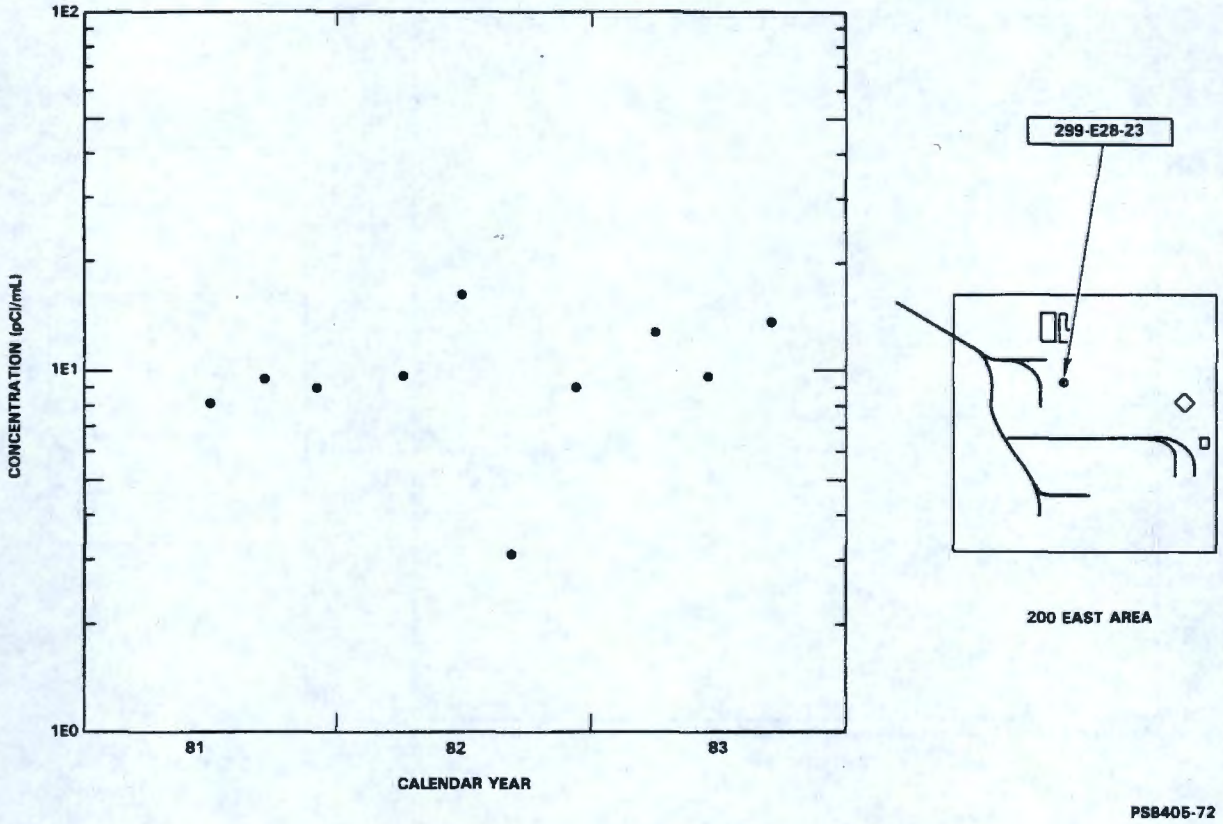
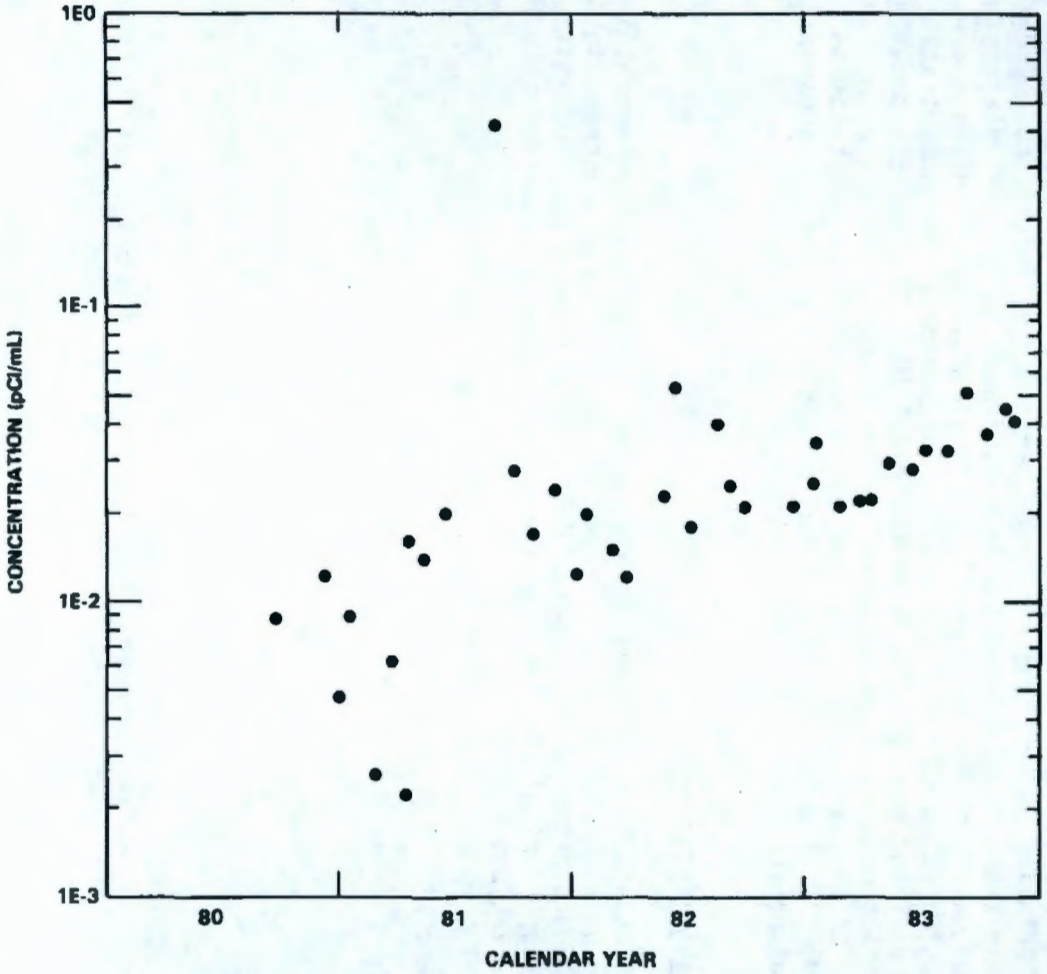
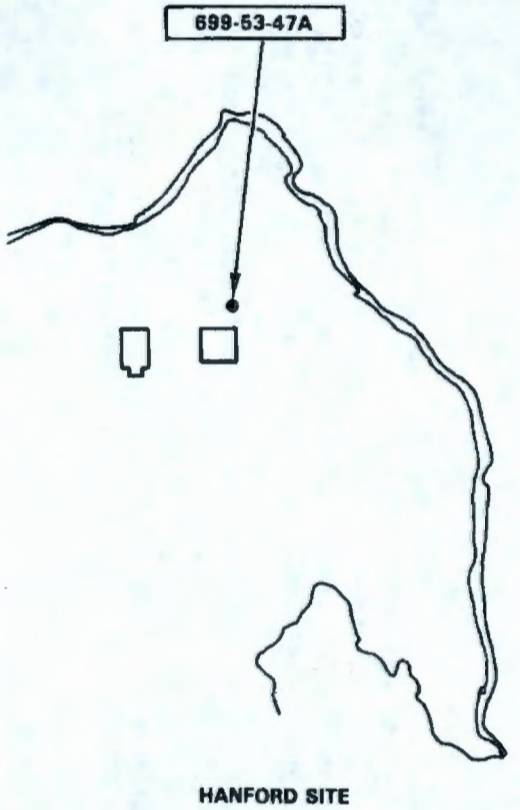


FIGURE 35. Concentration History of Strontium-90 in Well 299-E28-23.





PS8405-73

FIGURE 36. Concentration History of Strontium-90 in Well 699-53-47A.

Tritium

Samples collected from 70 wells were analyzed for tritium. Water samples from only one well (299-E17-9) exceeded Table II Concentration Guidelines; this well monitors the 216-A-36B Crib. As illustrated in Figure 37, tritium samples from this well have decreased over the last year and are just slightly over Table II Guidelines.

With the startup of PUREX in October 1983, concentrations in groundwater beneath PUREX cribs were expected to increase. An example of this may be observed in the 216-A-10 Crib (well 299-E17-1), which receives process condensate waste from PUREX. A rise in tritium concentration may be observed in the latter part of 1983, as shown in Figure 38.

Nitrate

Water samples from 14 of 65 wells sampled for nitrate exceeded the Federal Drinking Water Standard* of 45 parts per million (ppm). Like tritium, nitrate is highly mobile in groundwater and serves as a useful tracer of water movement. The only discernible trends in nitrate are the possible increases at the PUREX cribs. For example, the concentration history plot for well 299-E17-1 at the 216-A-10 Crib (Fig. 39) shows an increased concentration near the end of the year. An increase in nitrate is expected at this site due to resumed operation of PUREX which commenced in October 1983. The "spike" in nitrate for 1982 (Fig. 39) was apparently the result of prestartup testing and flushing operations.

Water Table Maps

Assistance in evaluating the direction of groundwater movement is provided by water-table maps. The map of the 200 Areas presented in Figure 40 was prepared in December 1983. Groundwater flows perpendicular to the contour lines of the map from regions of higher groundwater elevation to lower elevations.

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*Drinking Water Standard is used for comparison only. It is not a required standard onsite.

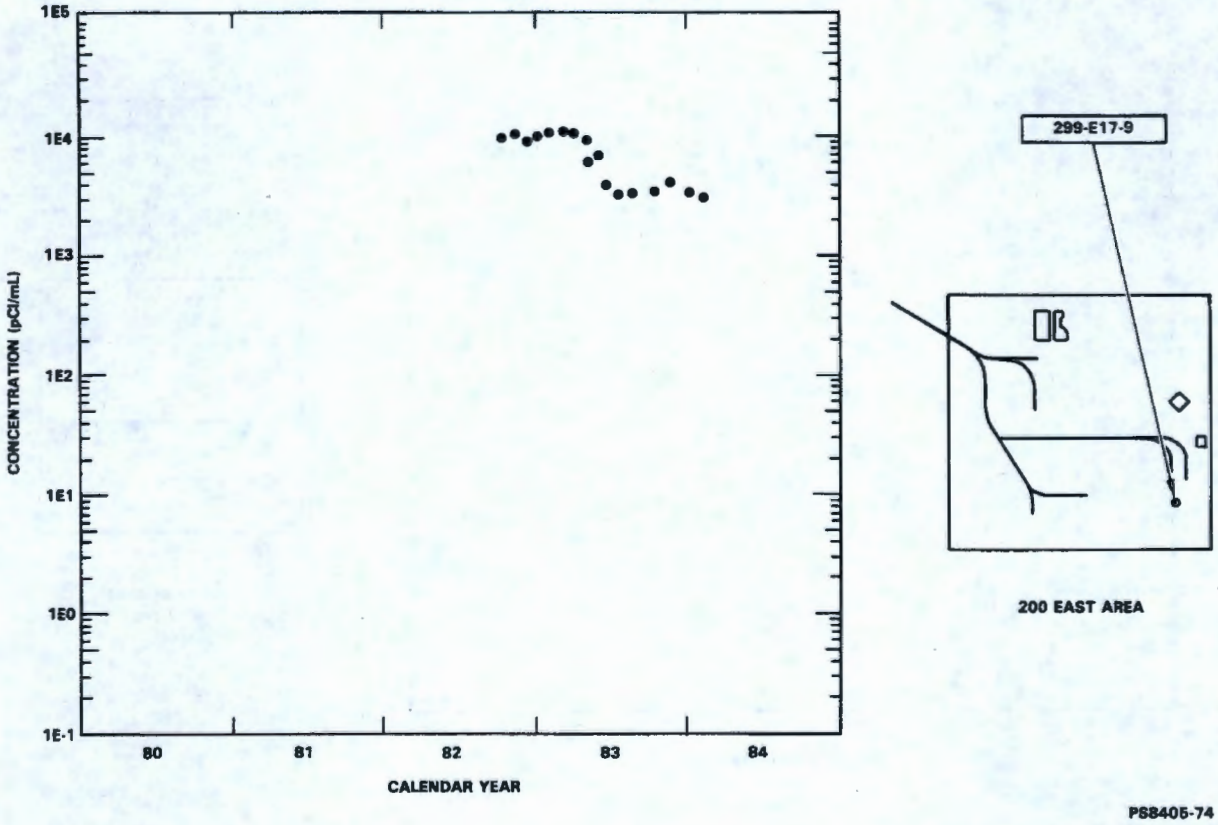


FIGURE 37. Concentration History of Tritium in Well 299-E17-9.

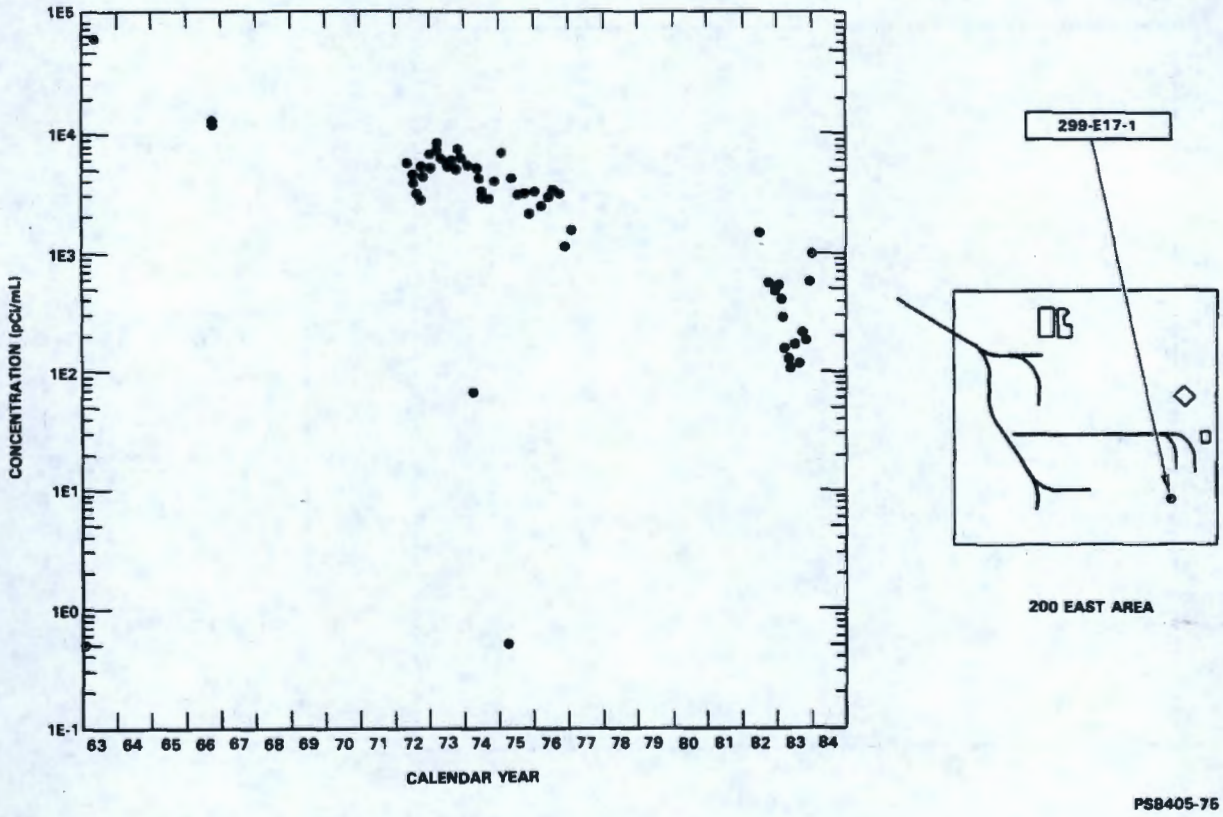


FIGURE 38. Concentration History of Tritium in Well 299-E17-1 (216-A-10 which Receives PUREX Process Condensate).

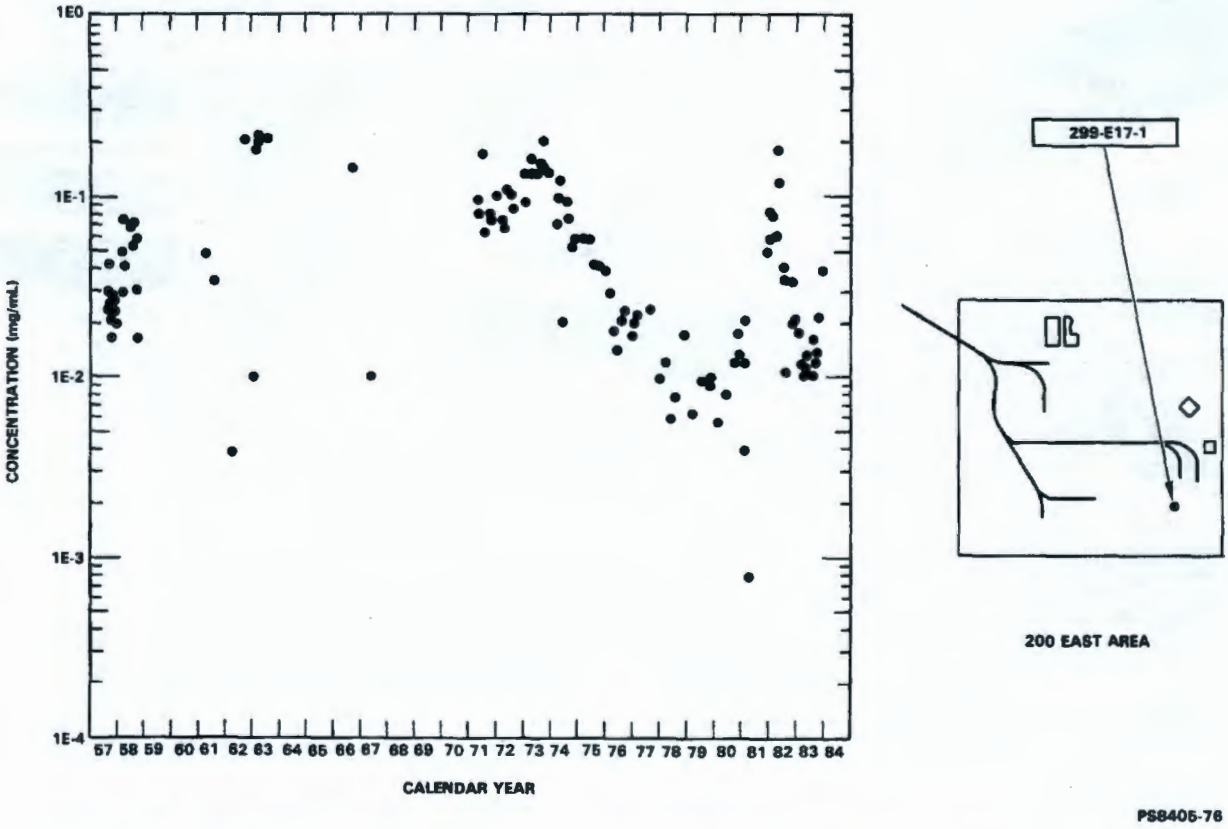
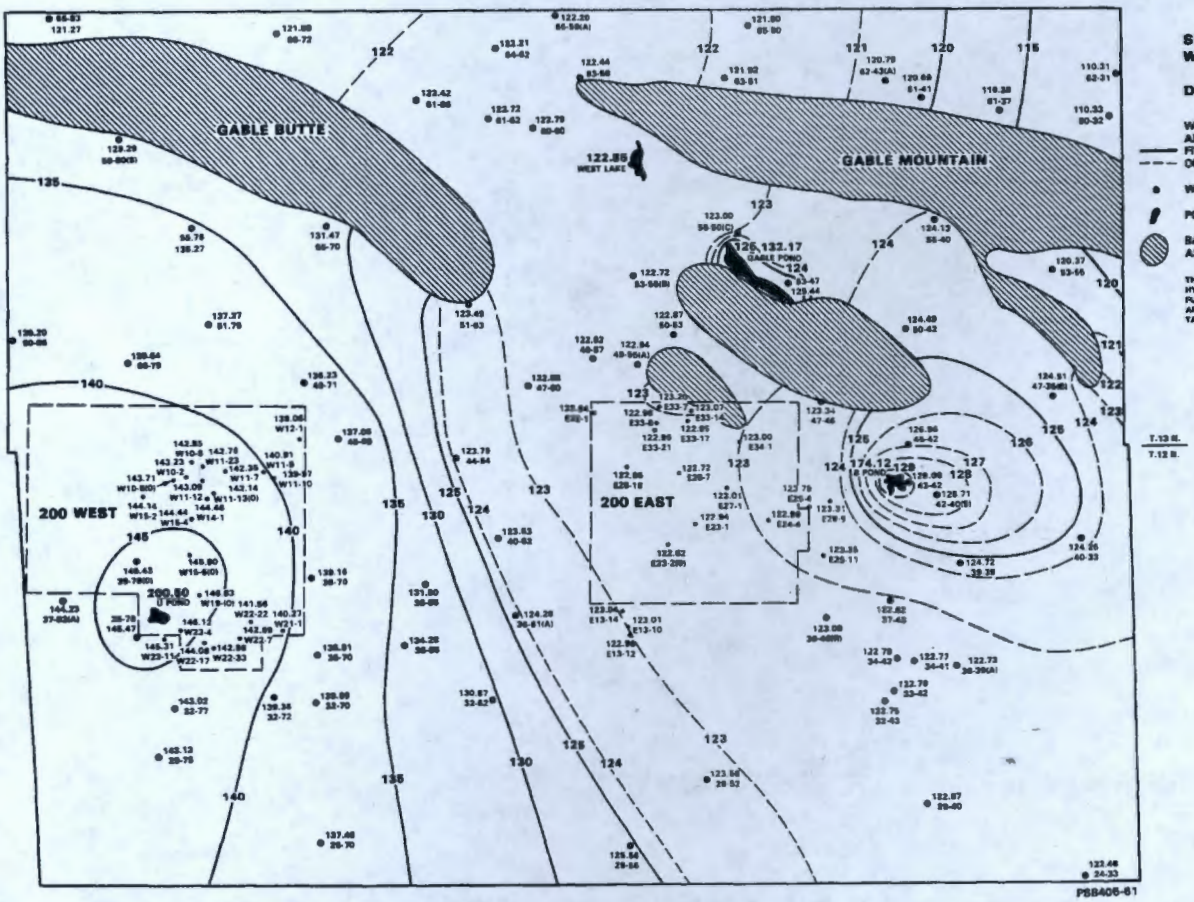


FIGURE 39. Concentration History for Nitrate in Well 299-E17-1 (216-A-10 Crib). The spike in 1982 is attributed to prestartup testing and flushing operations at PUREX.



SEPARATIONS AREA WATER TABLE MAP

DECEMBER 1983

WATER-TABLE CONTOURS IN METERS ABOVE MEAN SEA LEVEL (m-MSL)
FIVE-METER CONTOUR
ONE-METER CONTOUR

WELLS USED IN PREPARATION OF MAP

PONDS, WATER SURFACE ELEVATION (m-MSL)

BASALT OUTCROPS ABOVE WATER TABLE, AS INFERRED 12/1982

THE SEPARATIONS AREA WATER-TABLE MAP IS PREPARED BY THE HYDROGEOLOGY UNIT OF THE RESEARCH AND ENGINEERING FUNCTION OF ROCKWELL HANFORD OPERATIONS. THIS MAP IS AN ENLARGED SECTION OF THE HANFORD RESERVATION WATER-TABLE MAP, SHEET H-2-36366, REVISION 16.

FIGURE 40. The Separations Area Water Table Map.

RADIOLOGICAL SURVEYS

SUMMARY

Radiological surveys are conducted on road surfaces; 200 East, 200 West, and 600 Area waste sites; facility outdoor areas; and the BC controlled area on a bimonthly, quarterly, semiannual, or annual basis (see Table 22 for 1983 survey schedule). These surveys are designed to (1) identify trends in radiation levels and contamination in radiation areas, (2) determine the adequacy of containment of underground radioactive material, and (3) detect movement of radioactive material from radiation areas or radioactive spills that might otherwise go undetected. These surveys also provide continuous information on the current radiological status of the environment.

ROADS

A beta-gamma detector, mounted approximately 50 cm above the ground on the underside of a truck, is used to survey the road surfaces. The detector consists of four 1B85 Geiger-Mueller tubes connected to a count rate meter in the cab of the truck. All frequently traveled blacktop and improved roads in and around the 200 Areas are surveyed bimonthly to detect radioactive material spills. Other roads are surveyed quarterly, except the roads around Gable Mountain Pond and B Pond where travel is infrequent and there is little probability of contamination (Fig. 41). Other roads on the Hanford Site are surveyed by PNL.

In 1983, road surveys detected two contaminated areas. Contamination to over 100,000 cpm was detected on Route 3 near the 200 Area Fire Station. The road was temporarily blocked until cleanup was completed that same day (see No. 1 on Fig. 41). The other roadway found to be contaminated (spotty to 60,000 cpm) was in the BC controlled area (see No. 2 on Fig. 41). Since the area already was a radiologically controlled area, no further corrective action was required.

TABLE 22. The 1983 Radiological Survey Schedule.

Interval	Areas Scheduled for Survey
Bimonthly	Surveys of all paved and improved road surfaces inside 200 Areas
Quarterly	200 Areas outside perimeter roads UN-216-W-5 (23rd and Camden) Route 3 and 4-S from 200 West to 200 East hill 216-B-55 and 216-B-62 Cribs 216-T-30 Catch Tank between Buildings 222-T and 221-T 216-A-8, -A-10, -A-30, -A-36B, and -A-37-1 Cribs BC Cribs controlled area roads and fire breaks 216-U-12 Crib 216-B-2-1 and -B-2-2 Ditches (backfilled) UN-216-W-23
Semiannually	BC Cribs, Trenches, and ground plots Gable Mountain Pond and B Pond perimeter roads Vent station on east/west cross-country transfer line
Annually	216-T-14 through -17, and -21 through -25 Trenches Roofs of 202-S, 222-S, 276-S, 221-U, 231-Z, 221-T, and 200 East powerhouse 216-B-35 through -42 Trenches Inside stabilized burial grounds in 200 Areas Nonstabilized burial grounds in 200 Areas Burial Grounds in 600 Area Underground pipeline to B-3-3 Ditch from B-2-3 Ditch Outdoor areas at PUREX, 244-AR Vault, B Plant, and Semiworks All tank farm perimeters Shorelines of Gable Mountain Pond, West Lake, 216-B-3 Pond, 216-U-10 Pond, 216-S-19 Pond, and 216-T-4 Pond All ditch banks, backfilled ditches, cribs, trenches, and drains not covered quarterly or semiannually Outdoor areas of Laundry, REDOX, and 222-S, -U, -T, and -Z Plants 216-S-16 and -17 covered pond surfaces All unplanned release sites not surveyed quarterly 216-N, -P, and -R Waste Sites Retention basins inside 200 Areas

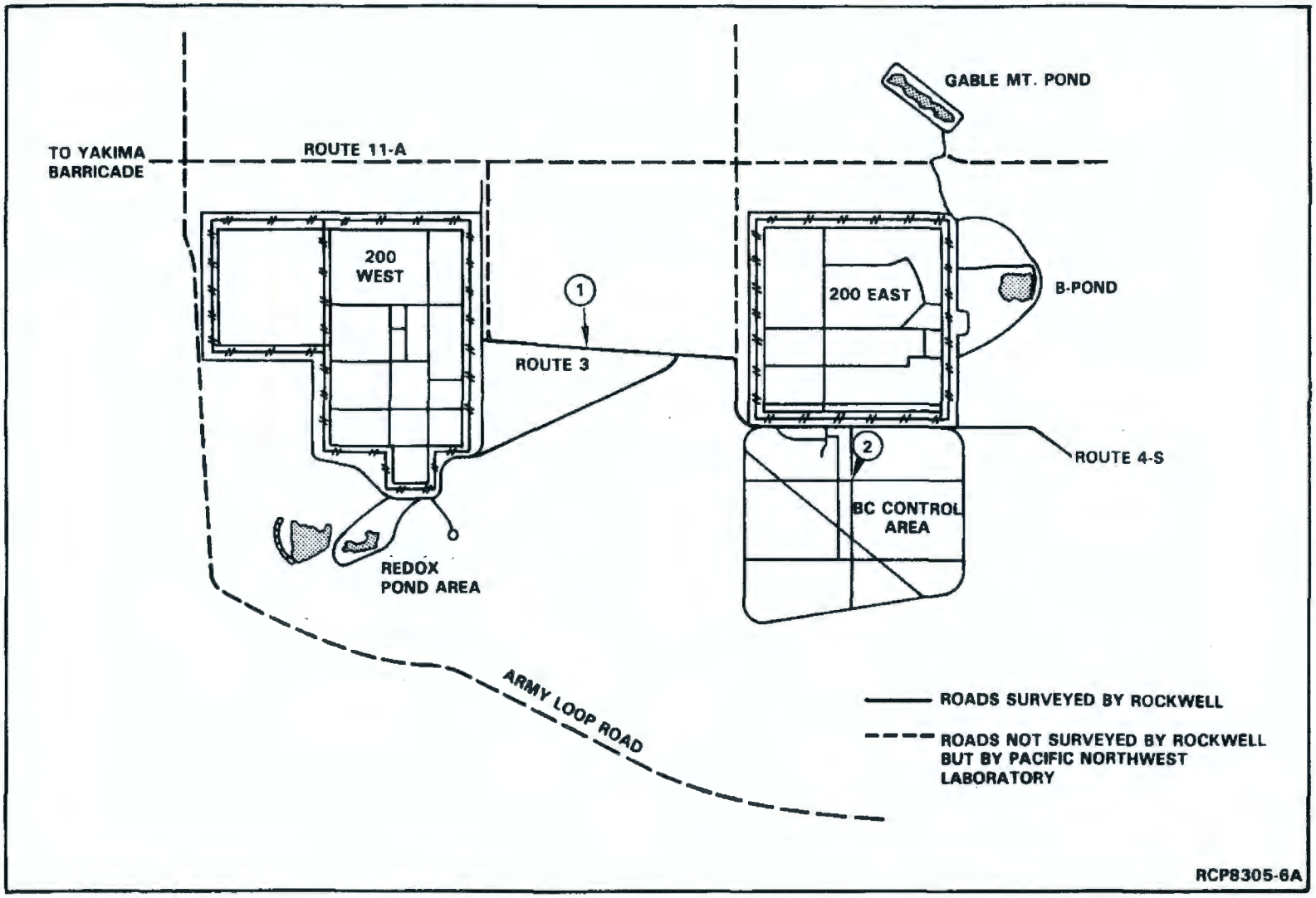


FIGURE 41. Roads Surveyed in the Separations Area.

PONDS AND DITCHES

All open pond and ditchbanks are surveyed routinely to detect any contamination from liquid effluents and contamination carried by wind from other sources. Surfaces of covered ponds and ditches are surveyed to detect the uncovering of contamination or vertical transport of radioactive contamination by plants. These surveys are performed with a P-11 mica window probe attached to an Eberline Model BNW-1 count rate meter.

Sites where vegetation has transported contamination to the surface are discussed in the "Biological Transport" section of this report.

The shoreline around U Pond was found to be fairly uniformly contaminated, with levels ranging from 3,500 to 6,000 cpm and spots to 100,000 cpm. However, since this contamination is covered by vegetation, there is little probability of transport out of the radiologically controlled area.

600 AREA BURIAL GROUNDS

The 600 Area burial grounds (formerly 300 Area burial grounds) are inactive sites that once received uranium, plutonium, and fission product waste from the 300 Area (Maxfield, 1979). Surveys are conducted yearly in the 600 Area waste sites to detect any changes in radiological conditions since the previous year (Fig. 42). No conditions requiring immediate corrective action were found; however, the 618-10 Burial Ground was surface stabilized and revegetated in 1983. The posting was then changed from Surface Contamination to Underground Radioactive Material.

200 AREA WASTE SITES

The waste-disposal sites in the 200 Areas received (or continue to receive) waste from the Separations Area chemical processing operations (see Fig. 2 and 3). The perimeters and much of the ground surface are surveyed, as are exposed risers, equipment, deep-rooted vegetation, and signs of animal activity. The most significant findings during 1983 are listed below.

- 216-B-2-1 and 216-B-2-2 Covered Ditches: Tumbleweeds that were contaminated to 4,000 cpm were found growing along the edge of the covered ditches. The site was initially stabilized in 1973 (Maxfield, 1979). The weeds were removed before migration could occur.

- 216-T-30 Catch Tank: This area is the site of two unplanned releases in the 1950s (Maxfield, 1979). Radioactivity detected in the last year ranged from 1,000 to 40,000 cpm and was attributed to both surface contamination and a subsurface source.

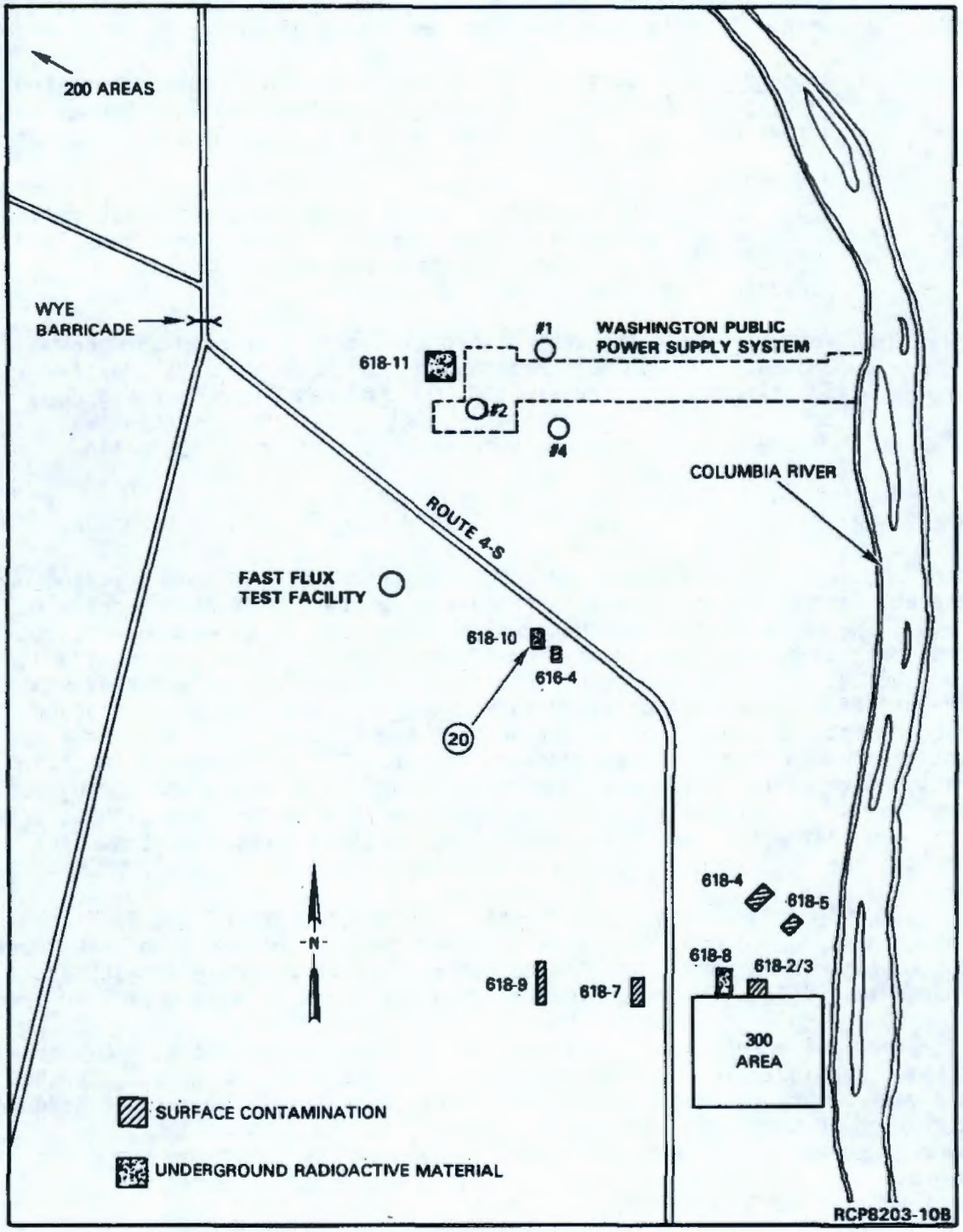


FIGURE 42. The 600 Area Burial Grounds.

- UN-216-W-23: Surface contamination to 60,000 cpm and a dose rate of 100 mrad/h were found at this site of an old transfer line leak. Interim stabilization was completed in 1983.

- 216-A-8 Crib: Surface contamination to 40,000 cpm and growing rabbitbrush (contaminated to 55,000 cpm) have been found on this active crib. The site is posted as a Surface Contamination Area.

- 216-A-24 Crib: Surface contamination to 60,000 cpm was found in 1983. This crib is inactive, once having received radioactive condensate from waste-storage tanks in 200 East Area (Maxfield, 1979). This site is appropriately posted as a Surface Contamination Area.

- Vent Station: The vent station is located halfway between 200 East and 200 West Areas along the cross-country transfer line. Spotty contamination (to 100,000 cpm) was found on the ground in and around the site perimeter. All loose contamination was removed. The area remains posted as Surface Contamination.

THE BC CRIBS AREA

The BC controlled area is a 1,000-hectare region located just south of the 200 East Area with spotty-to-fairly-large areas of surface contamination. The BC Cribs and Trenches, which occupy approximately 20 hectares of the controlled area, were used from 1956 to 1967 as a waste-disposal site for the 200 Areas and 300 Areas (Fig. 43). Shallow dirt cover over waste in the backfilled trenches provided easy access for animals and vegetation. The original spread of contamination from the BC Crib and Trench area apparently resulted from animals burrowing into the 216-B-28 Trench, ingesting radioactive salts, and depositing contaminated feces and urine throughout the area. The surface was also contaminated locally when plant roots grew into the radioactive waste and transported radionuclides to the surface through the plant tissue (Maxfield, 1979).

In 1964, steps were taken to stabilize the surface of the BC Trenches. The original burrow on the 216-B-28 Trench that was believed to have caused the contamination spread was filled and the trench was covered with asphalt (Maxfield, 1979). The remaining trenches were covered with gravel in 1969.

Vertical transport of radionuclides by tumbleweeds and possibly by wind erosion continued to increase the activity found over the cribs, trenches, and control area. Changes from one survey to the next indicated a gradual migration of that activity from the established radiation zones. In 1979, special survey plots (6 by 6 m) were established to determine trends in migration of contamination (see Fig. 43). Each plot is surveyed semiannually for evaluation.

In 1983, plot surveys indicated the same levels of contamination as in previous years. No new contamination was detected in the plots along the outer fringe of the control area; this indicates that migration of contamination was not found to be a problem in 1983.

Surveys of the cribs and trenches up to 1981 found that general contamination, primarily from tumbleweeds, was present. Corrective action was initiated in 1981 to surface stabilize the Cribs and Trenches 216-B21, -22, -23, -27, and -28, as well as remove most of the contamination from the remainder of the trenches. Cleanup of the controlled area was also begun at that time.

In 1982, surface stabilization of the cribs and trenches was completed and an additional portion of the controlled area was cleaned and released unconditionally from Radiological Controlled Area posting. The progress of the work performed in this area is illustrated in Figure 44.

Since completion of stabilization, no contamination has been detected on the cribs or trenches.

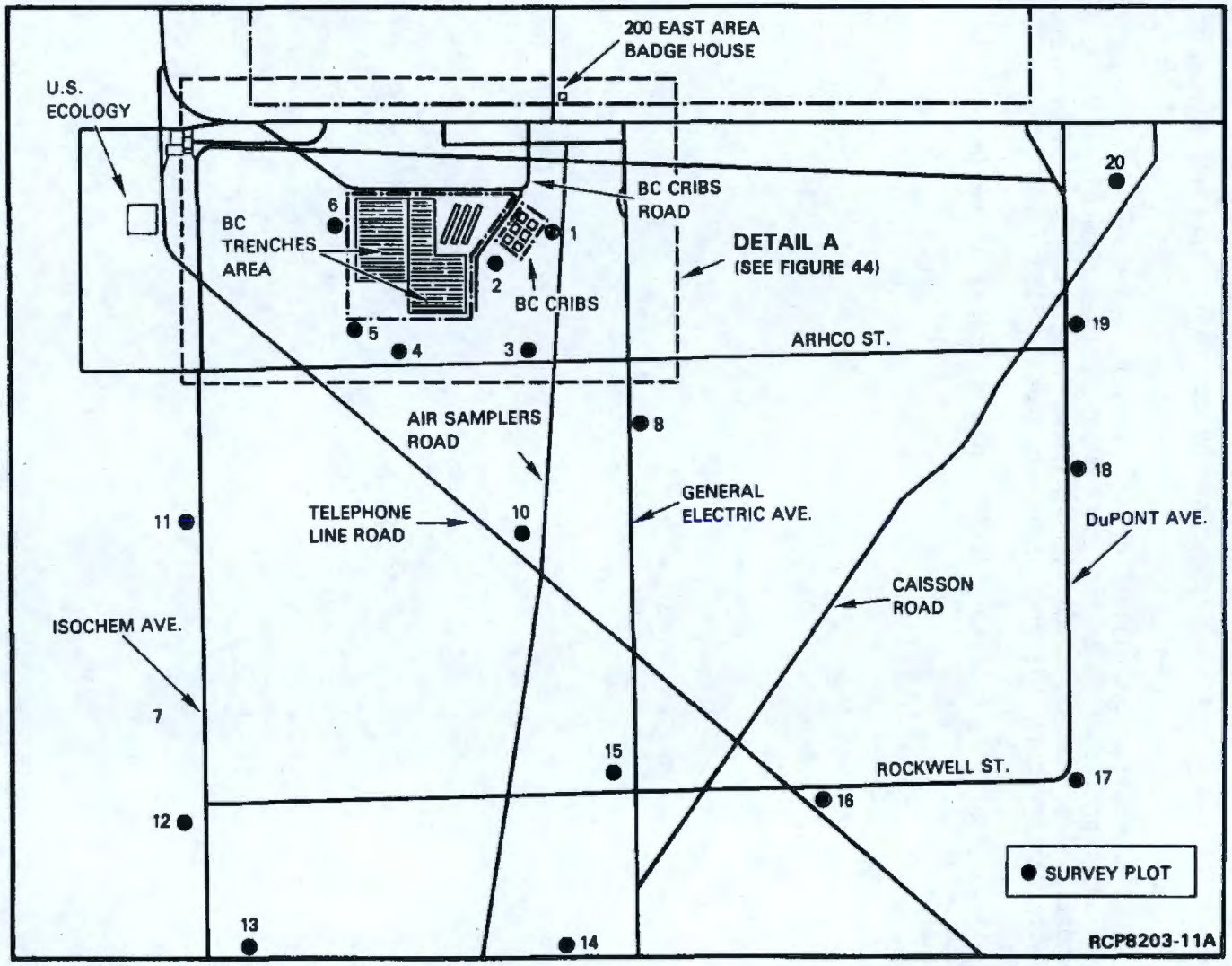


FIGURE 43. The BC Cribs Controlled Area.

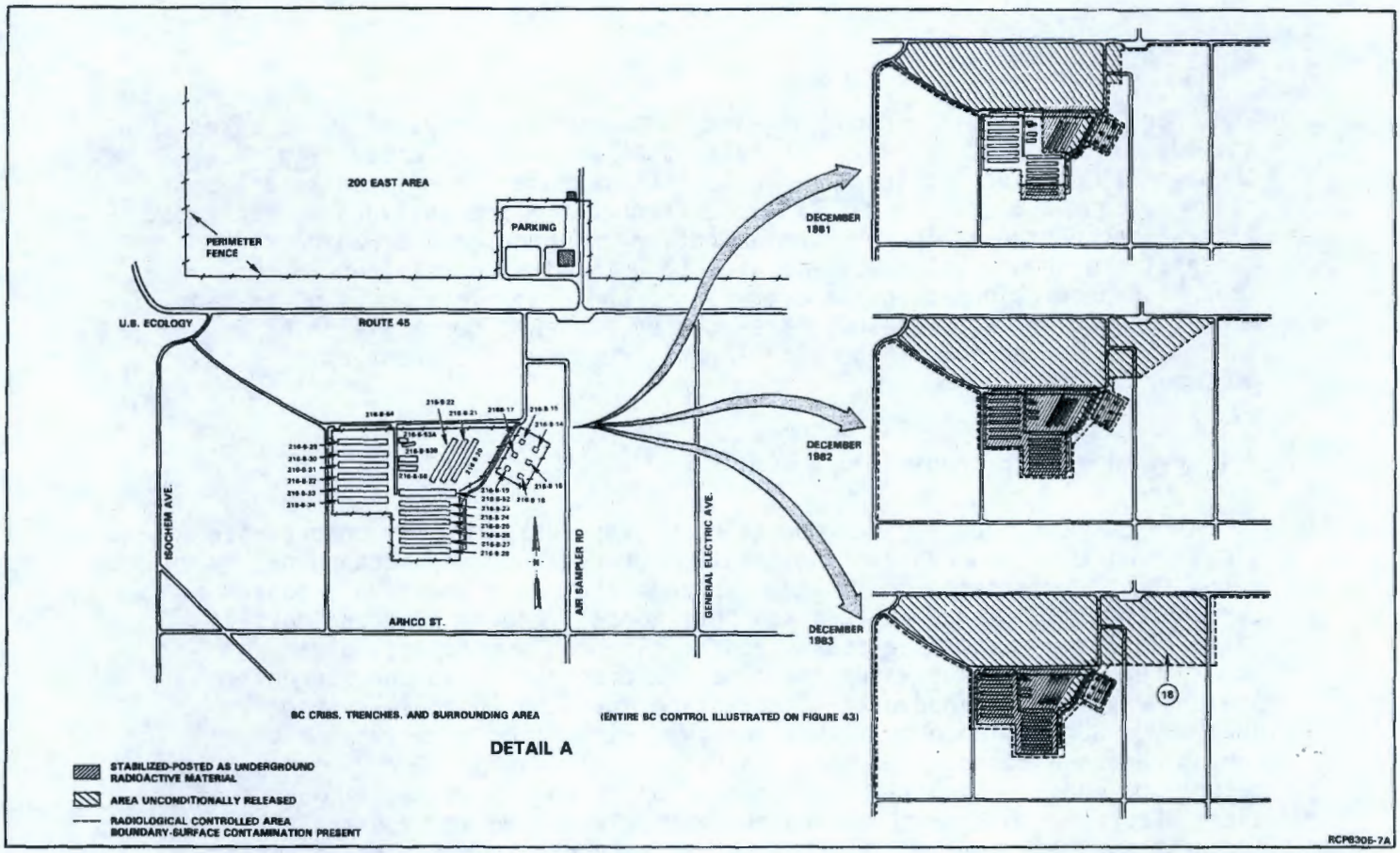


FIGURE 44. Progress of Cleanup and Stabilization of the BC Cribs Area.

RADIOLOGICAL STATUS OF THE 200 AREAS

SUMMARY

An integral part of the Rockwell environmental surveillance program involves maintaining current information on the radiological status of the Separations Area environment, including changes that may affect operations or require additional surveillance.

STATUS MAPS

Maps are maintained depicting the radiological status of waste sites and outdoor radiation areas. Facility outdoor radiation areas (Fig. 45 through 51), active and inactive waste sites, unplanned release sites, and other outdoor radiation areas (Fig. 52 through 55) are included on the maps. Also, areas posted as Surface Contamination and Underground Radioactive Material are shown. The maps are used to determine surveillance needs, impact of excavations or other operations, and possible sources of environmental contamination. All maps are updated at least quarterly or as information is received. The maps in this report are current as of December 31, 1983.

SITE STATUS CHANGES DURING 1983

The surface radiological condition of various sites may change with time. Most changes involve stabilization or cleanup, and subsequent reposting or unconditional release of areas that were previously posted as Surface Contamination. Waste sites that contain underground radioactive material, and were surface stabilized or cleaned, were reposted as Underground Radioactive Material. The placement of permanent markers to prevent any future, inadvertent excavation into the waste is currently underway. Surveillance is maintained over such sites to ensure that contamination does not resurface via biological transport or by other natural or manmade conditions. Areas unconditionally released consist of sites where the contamination was present only on the surface and all contamination was removed; therefore, the site poses no future potential radiological problems. Surveillance of these sites is discontinued unless the possibility of recontamination from another source exists.

Some sites were posted as Surface Contamination in 1983 due to the discovery of previously undetected contamination or because of contamination from other sources.

Changes made in 1983 are listed in Table 23 and locations shown in Figures 42 through 56.

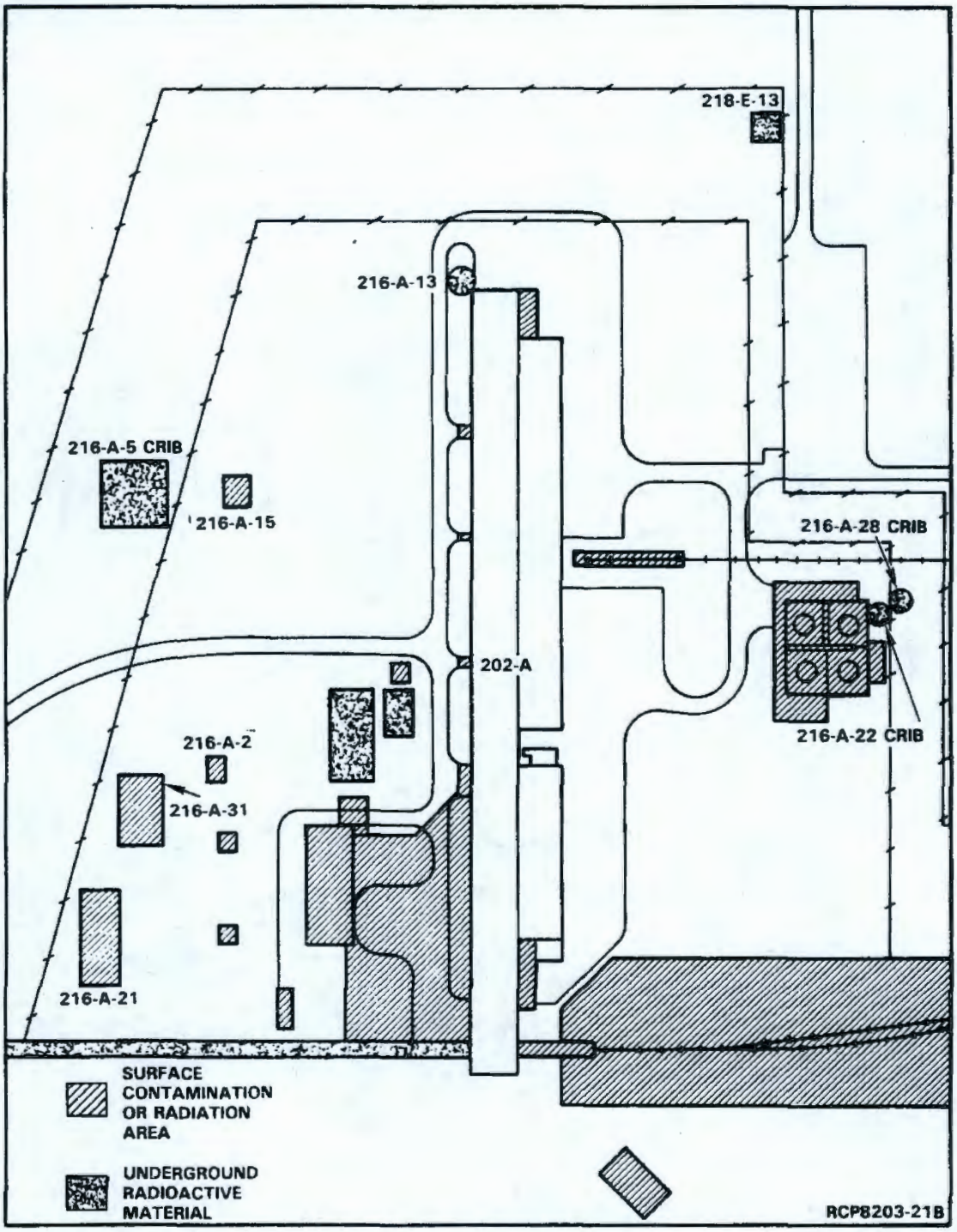


FIGURE 45. PUREX Posted Outdoor Radiation Areas.

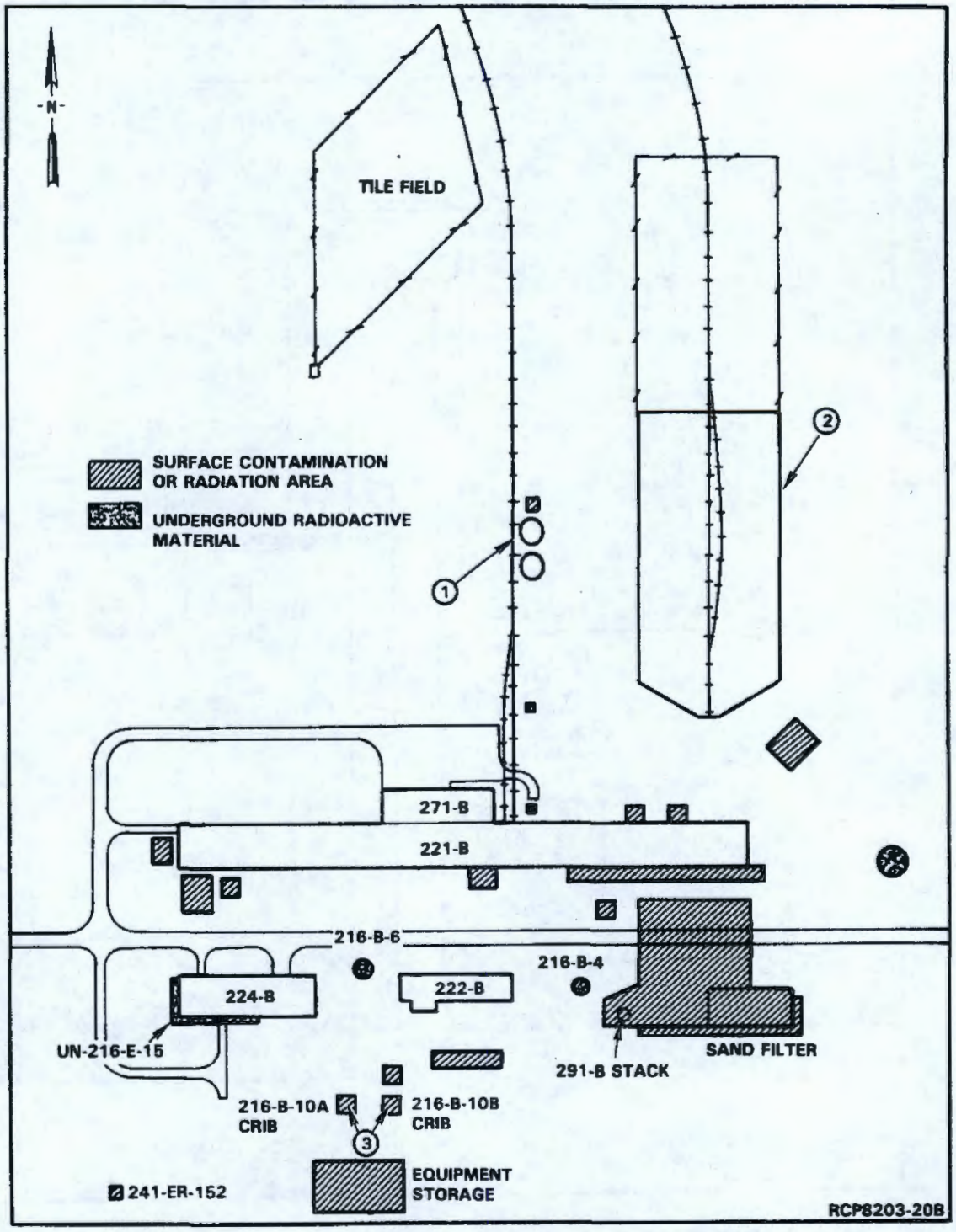


FIGURE 46. B Plant Posted Outdoor Radiation Areas.

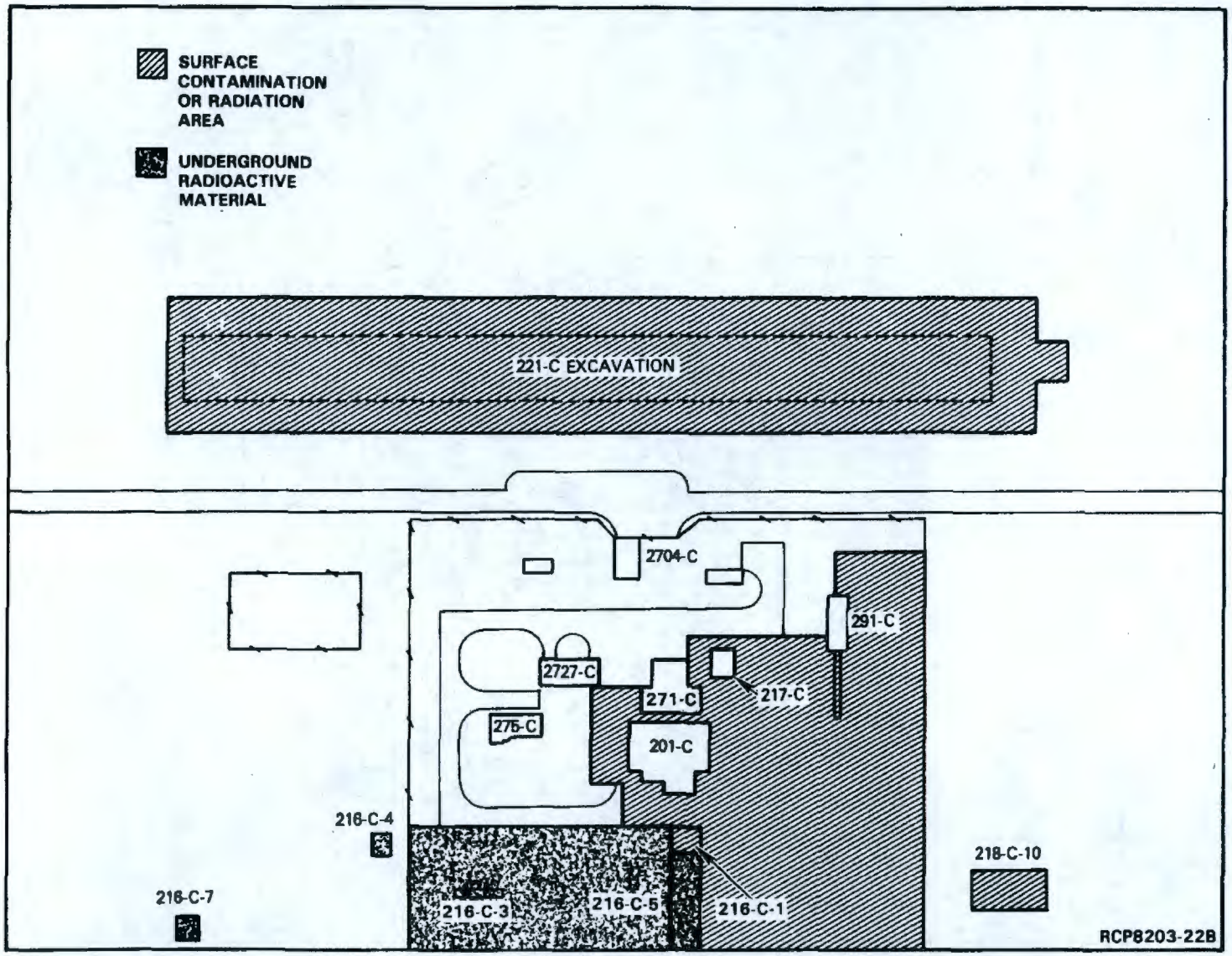


FIGURE 47. Semiworks Posted Outdoor Radiation Areas.

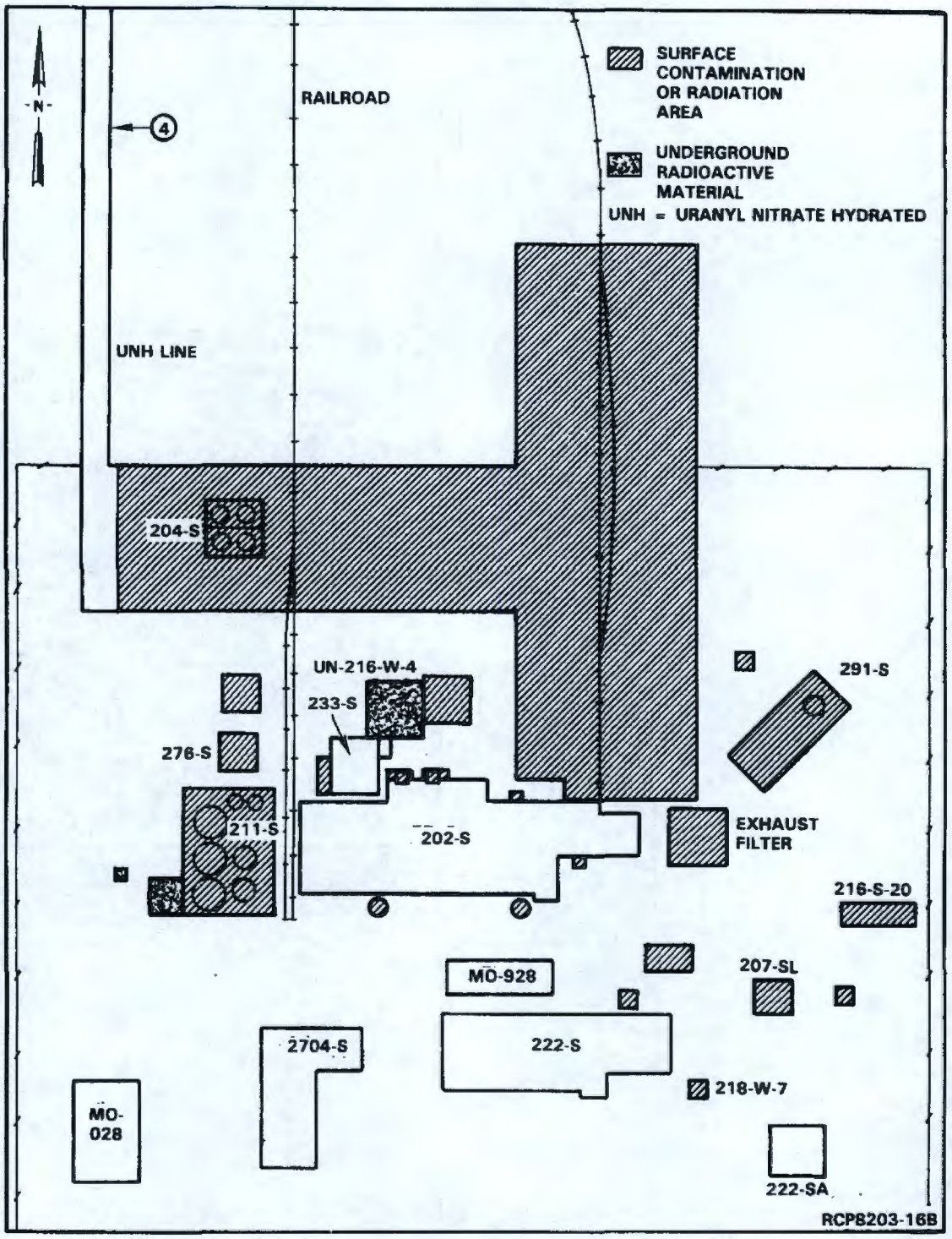


FIGURE 48. Redox Posted Outdoor Radiation Areas.

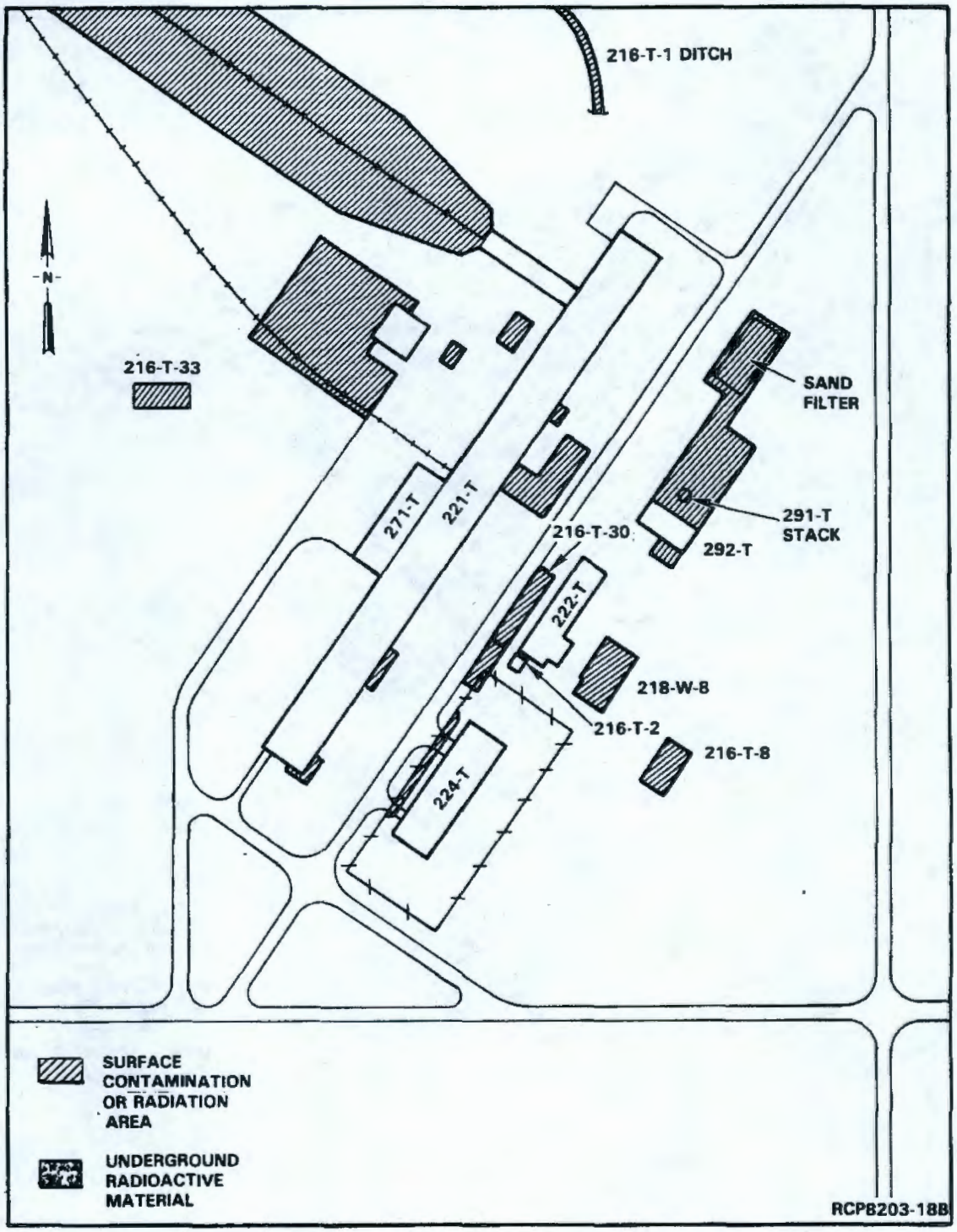


FIGURE 49. T Plant Posted Outdoor Radiation Areas.

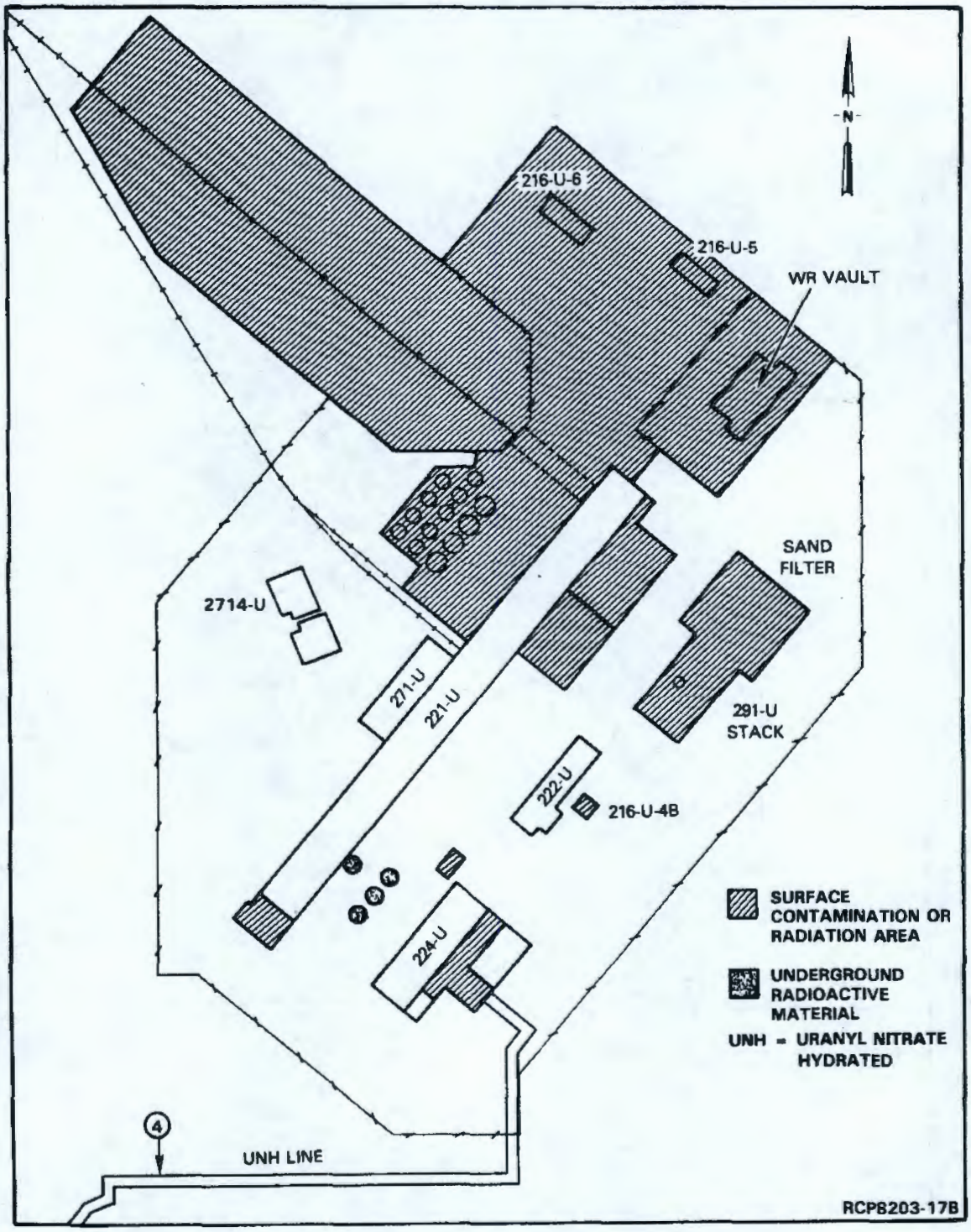


FIGURE 50. U Plant Posted Outdoor Radiation Areas.

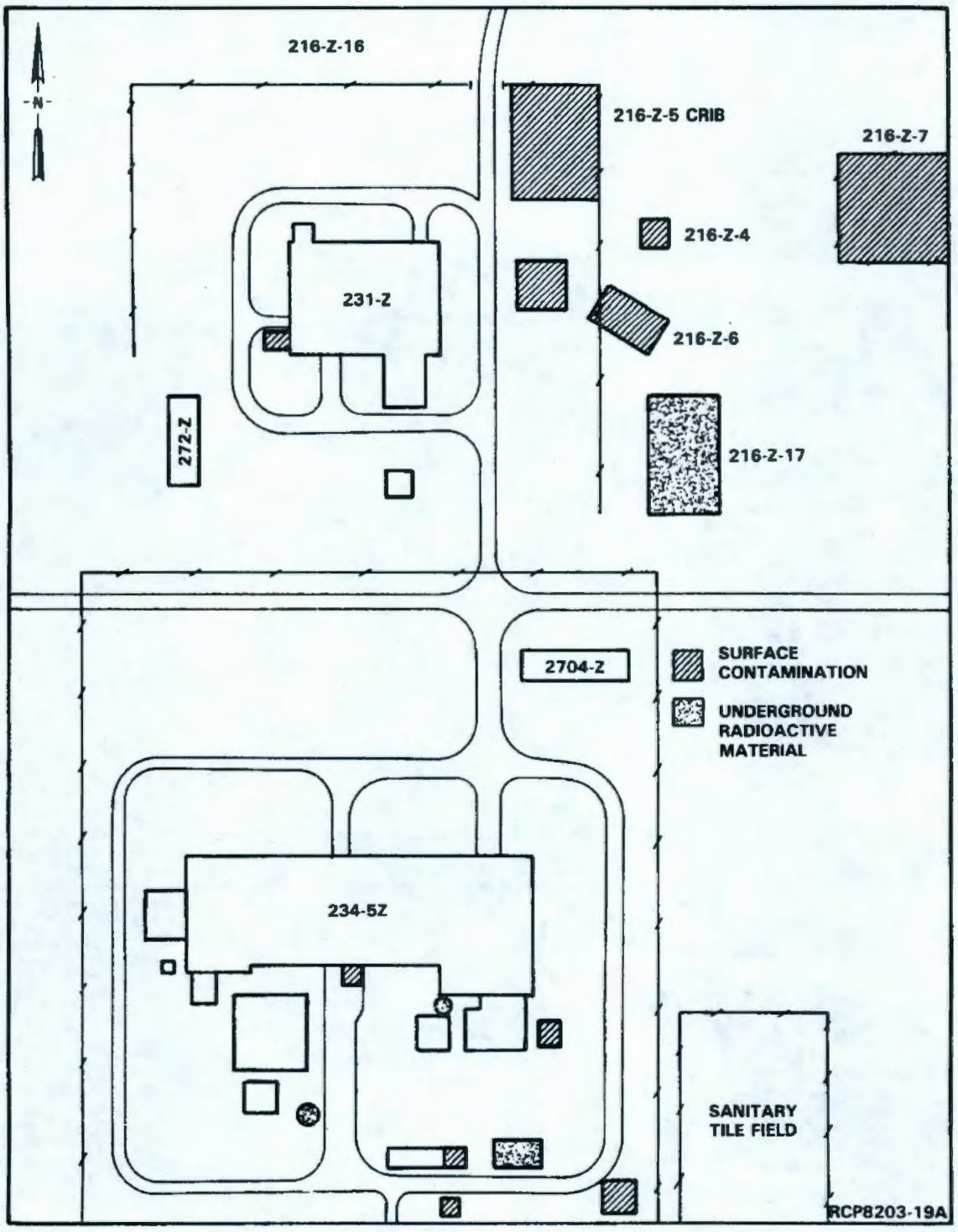


FIGURE 51. Z Plant Posted Outdoor Radiation Areas.

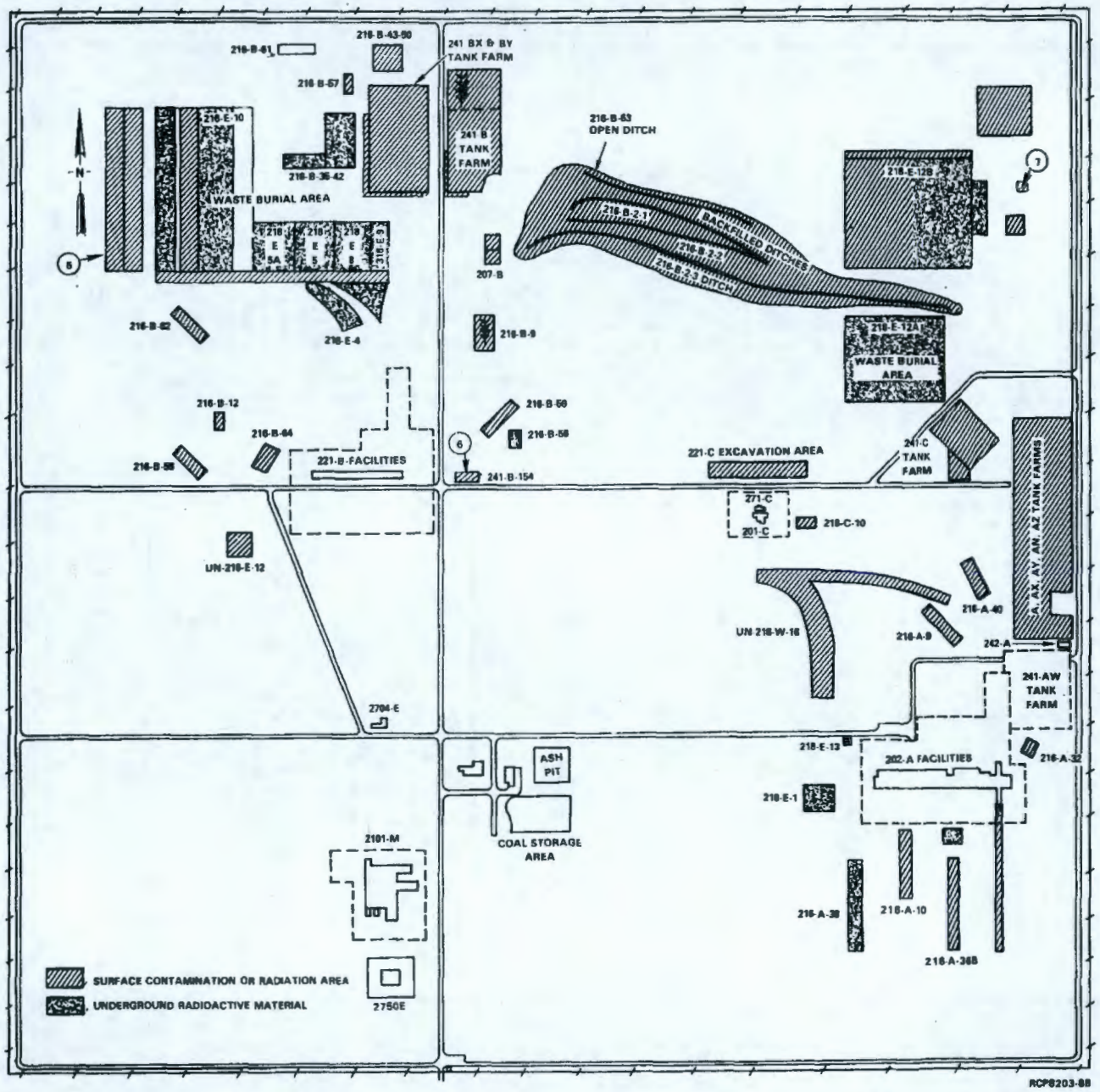


FIGURE 52. The 200 East Area Posted Outdoor Radiation Areas.

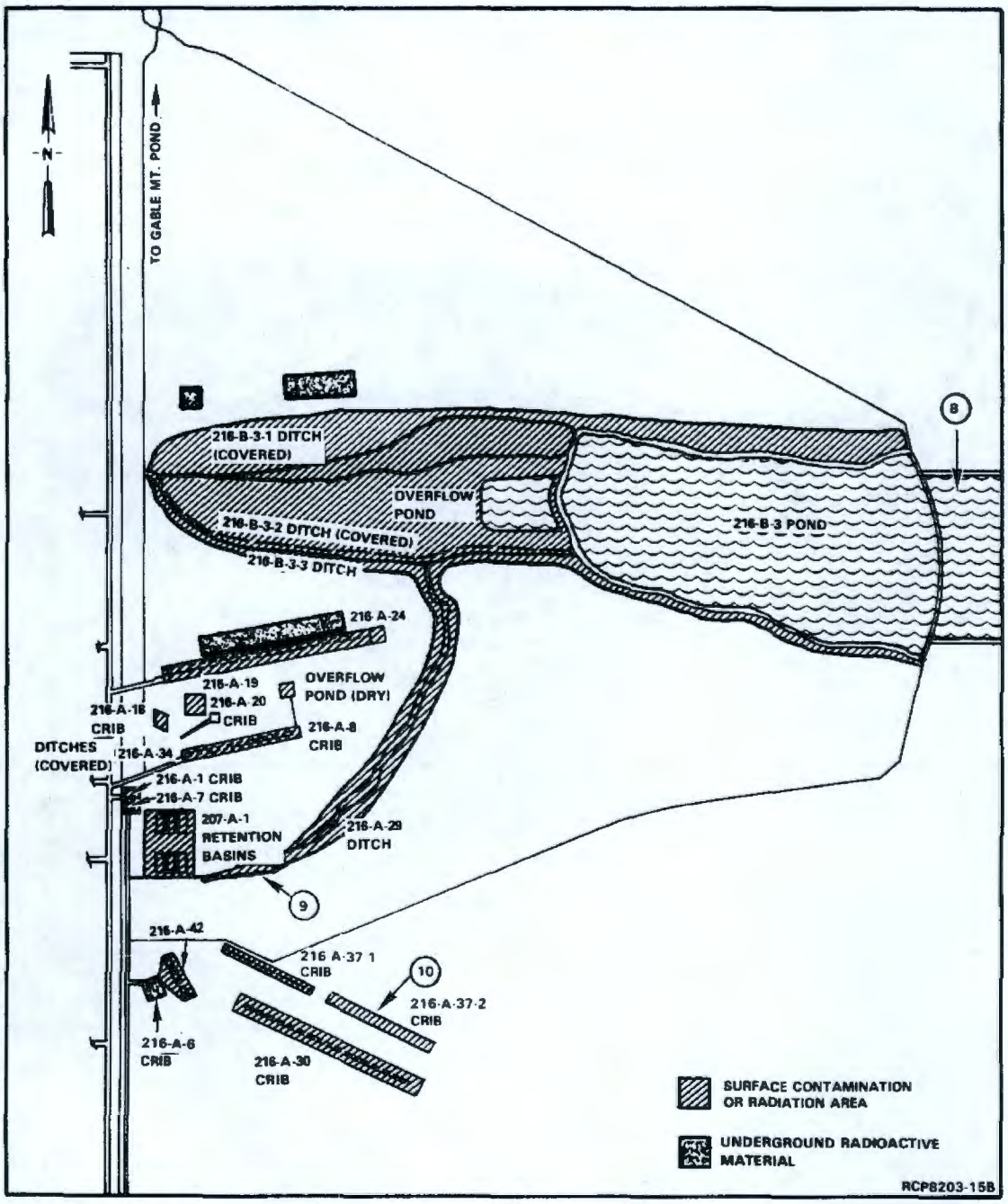


FIGURE 53. Posted Outdoor Radiation Areas Outside 200 East Area.

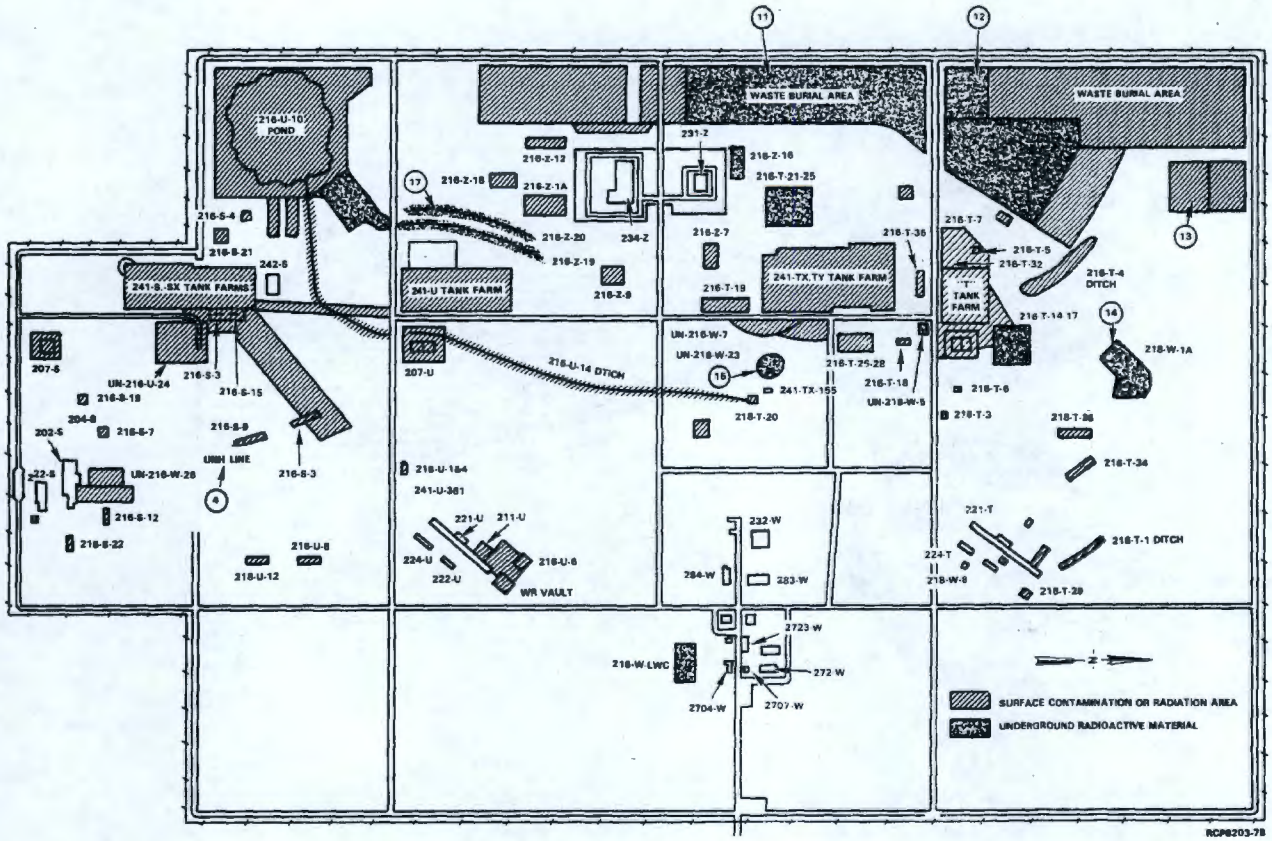


FIGURE 54. The 200 West Area Posted Outdoor Radiation Areas.

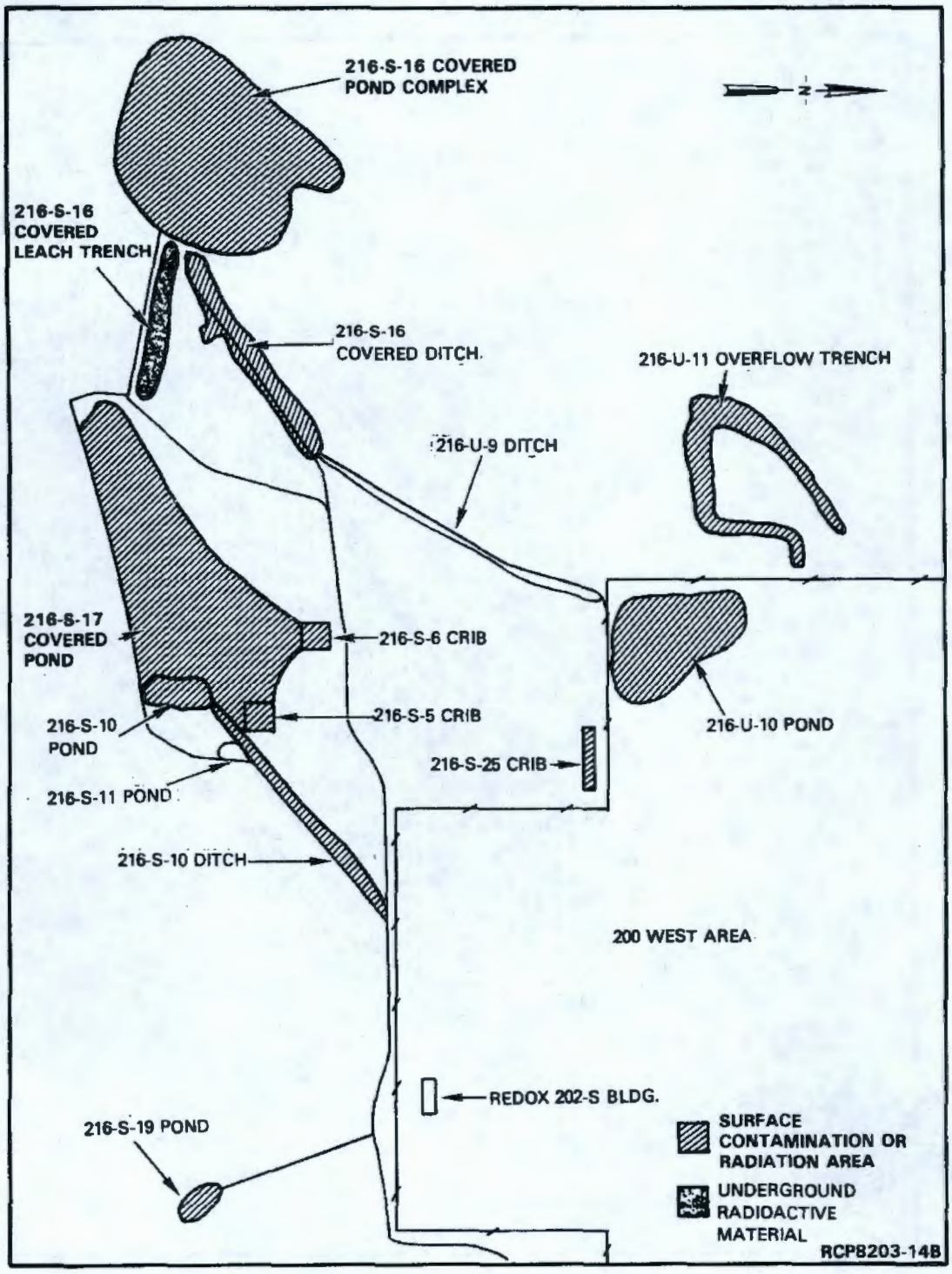


FIGURE 55. Posted Outdoor Radiation Areas Outside the 200 West Area.

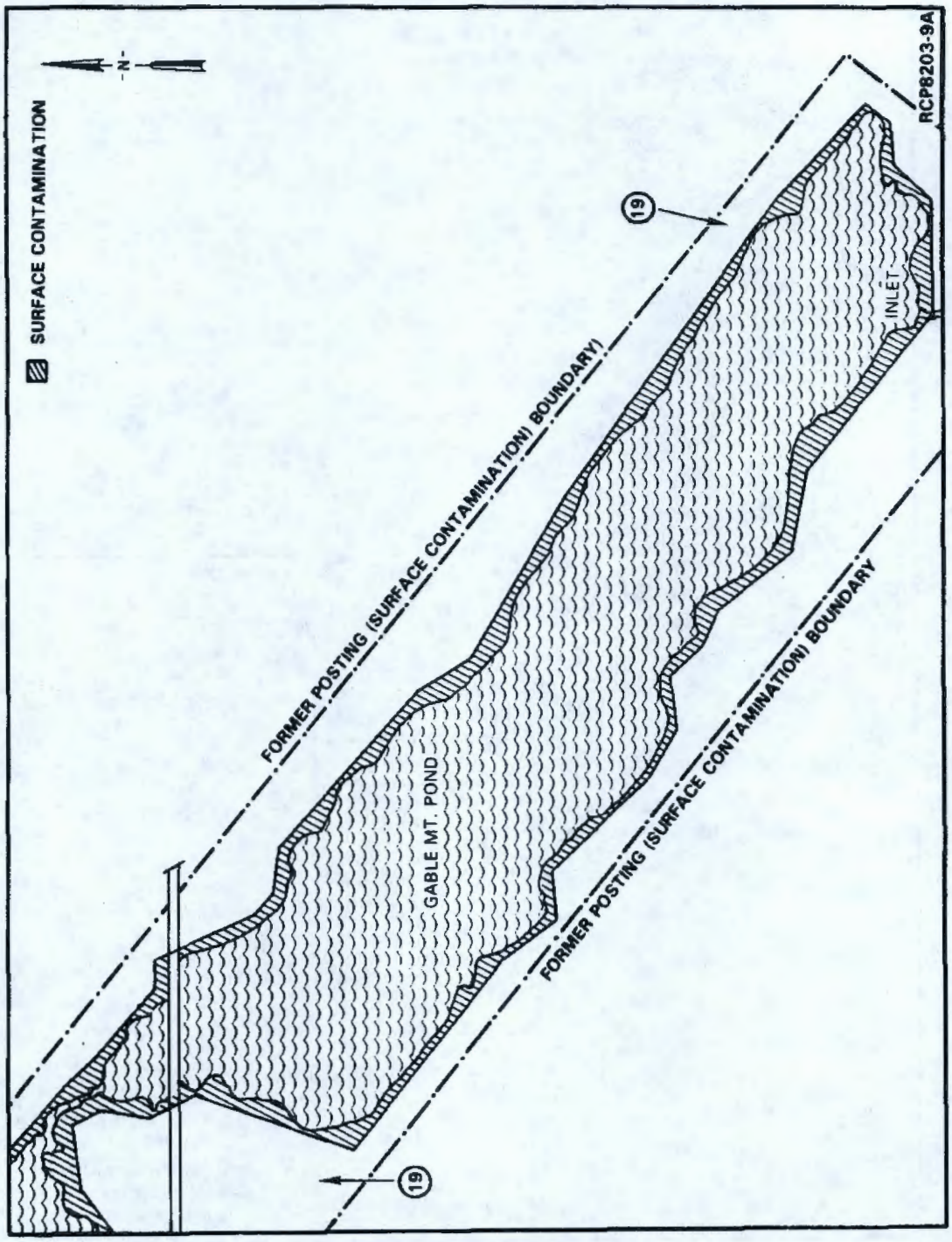


FIGURE 56. Gable Mountain Pond.

TABLE 23. Posting Status Changes in Calendar Year 1983. (Sheet 1 of 2)

Location	Status change	See circled no.	Figure
Cask storage north of B Plant	Radiation Area to released	1	46
B Plant railroad cut	Radiation Area to released	2	46
216-B-10A and 10B Cribs	Surface Contamination to Underground Radioactive Material	3	46
UNH Line	Surface Contamination to Released	4	48, 54
218-E-10 Burial Ground expansion	Posted as Surface Contamination	5	52
UN-216-E-5 (partial)	Surface Contamination to Released	6	52
Burning Pit	Surface Contamination to Released	7	52
B Pond Expansion	Posted as Surface Contamination	8	53
216-A-29 Spur	Surface Contamination to Released	9	53
216-A-37-2 Crib (new)	Posted as Underground Radioactive Material	10	53
218-W-4A Burial Ground	Surface Contamination to Underground Radioactive Material	11	54
218-W-11 Burial Ground	Surface Contamination to Underground Radioactive Material	11	54
218-W-1 Burial Ground	Surface Contamination to Underground Radioactive Material	11	54
218-W-4 Burial Ground	Surface Contamination to Underground Radioactive Material	11	54

TABLE 23. Posting Status Changes in Calendar Year 1983. (Sheet 2 of 2)

Location	Status change	See circled no.	Figure
218-W-4B Burial Ground (partial)	Surface Contamination to Underground Radioactive Material	11	54
218-W-3 Burial Ground	Surface Contamination to Underground Radioactive Material	12	54
218-W-3A Burial Ground expansion	Posted as Surface Contamination	13	54
218-W-1A Burial Ground	Surface Contamination to Underground Radioactive Contamination	14	54
UN-216-W-23 Unplanned Release Site	High Radiation Area to Underground Radioactive Contamination	15	54
216-Z-20 Crib risers	Underground Radioactive Material to Surface Contamination	17	54
BC Control Area (6 acres)	Control Area to Released	18	44
Gable Mountain Pond Area (91 acres)	Surface Contamination to Released	19	56
618-10 Burial Ground	Surface Contamination to Underground Radioactive Material	20	42

NOTE: UNH = uranyl nitrate hydrated.

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