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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR JANUARY - JUNE, 1969

By

The Environmental Evaluations Staff
Radiation Protection Department
TECHNICAL SERVICES DIVISION

C. B. Wilson and T. H. Essig, Editors

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52-54	C. D. Corbit	1704H		100H
55.	F. W. Grubb	3717		300
56.	V. V. Johnson	1101N		100N
57.	D. W. Peacock	1760D		100D
58.	O. C. Schroeder	1101N		100N
59.	DUN Files			

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR JANUARY-JUNE, 1969

By

The Environmental Evaluations Staff
Radiation Protection Department
TECHNICAL SERVICES DIVISION

C. B. Wilson and T. H. Essig, Editors

March 1970

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I. INTRODUCTION

This report summarizes data collected during the first six months of 1969 from locations within the Hanford plant boundaries for the routine environmental surveillance program, under the direction of the Environmental Evaluations staff. These environmental data are reported here for the information of the Richland Operations Office of the Atomic Energy Commission and its contractors.

The previous report in this series is BNWL-CC-2026, "Environmental Status of the Hanford Reservation for July-December, 1968." However, to show long-term trends and facilitate comparisons, the graphs in this report show 14 months of data - the current six months and the preceeding eight. The reader may also wish to refer to BNWL-CC-1197-6, "Environmental Status of the Hanford Reservation for November-December, 1967 (Annual Summary)" which contains a complete summary of 1967 data. Ground water data are not included in this report but are presented in BNWL-1123, "Radiological Status of the Ground Water Beneath the Hanford Project, January-June, 1969". Data from offsite sampling locations are no longer presented in a series of monthly reports, but are summarized semiannually in the series "Evaluation of Radiological Conditions in the Vicinity of Hanford for ...". Some data from offsite locations are included in this report for comparison with similar measurements made onsite. The majority of radiochemical analyses presented in this report were performed by the U. S. Testing Company, Inc. on samples collected by Battelle-Northwest.

The term "analytical limit," as used herein, is the concentration at which the laboratory can measure a radionuclide with a precision of ±100 percent at the 90 percent confidence level. The detection limit for a specific radionuclide varies with sample type, sample size, counting time, and the amounts of interfering radionuclides present. The "analytical limits" were chosen to represent upper bounds to these fluctuating detection limits.

II. SURVEILLANCE SUMMARY - JANUARY-JUNE, 1969

A summary of surveillance highlights for the period is given below with references to the page number(s) where more detail on the subject appears.

Columbia River Water

Recurrence of minor oil seepage into the river was noted at 100-N in February; however, sampling of the river at downstream locations indicated only occasional oil concentrations in the river above the detection limit of 0.3 ppm (page 7). Unusually high concentrations of stable elements (Fe, Cl) and radioactive Mn-56 were noted in the river during April and May as a result of the unusually turbid river during the spring runoff. All other results of river analyses were within their expected ranges of variation (page 7).

Swamps, Ditches, and Ponds

Total beta and total alpha concentrations in samples from open waters remained well below the recommended guides of 50,000 pCi/ℓ during the first six months of 1969. Gable, T, and U swamps experienced significant decreases in concentrations compared to those measured the year before (page 15). Results from radiological and biological analyses of samples collected from the 300 Area ponds and trenches remained within the expected range (page 16). Biological measurements on samples collected at the river shoreline seepage area (near the 300 Area) were below the appropriate limits for this stretch of the river (page 5).

Airborne Radioactivity

A general slight increase in total beta and total alpha concentrations in air during the period May-June was attributed to worldwide fallout. Total beta and alpha concentrations slightly exceeding 1 pCi/m^3 and 0.02 pCi/m^3, respectively, occurred at some offsite locations.

General increases in total beta and total alpha activity at two air-sampling locations at the 200-East Area were noted from February to May. These increases were attributed primarily to waste handling and processing operations. The highest beta concentration, 2.6 pCi/m^3, during the first half of the year occurred at the north side of the 200 East Area (page 31). The highest concentration of alpha activity, 0.25 pCi/m^3, was observed on a filter from the east side of 200-East Area following work on the ductwork at the Purex facility PR vault (page 40). Alpha energy analysis indicated ^{239}Pu, and either ^{238}Pu or ^{241}Am. If ^{239}Pu and ^{238}Pu were present in a soluble form, their concentrations at this location temporarily exceeded the Concentration Guides (AECM Chapter 0524) for non-occupationally exposed individuals.

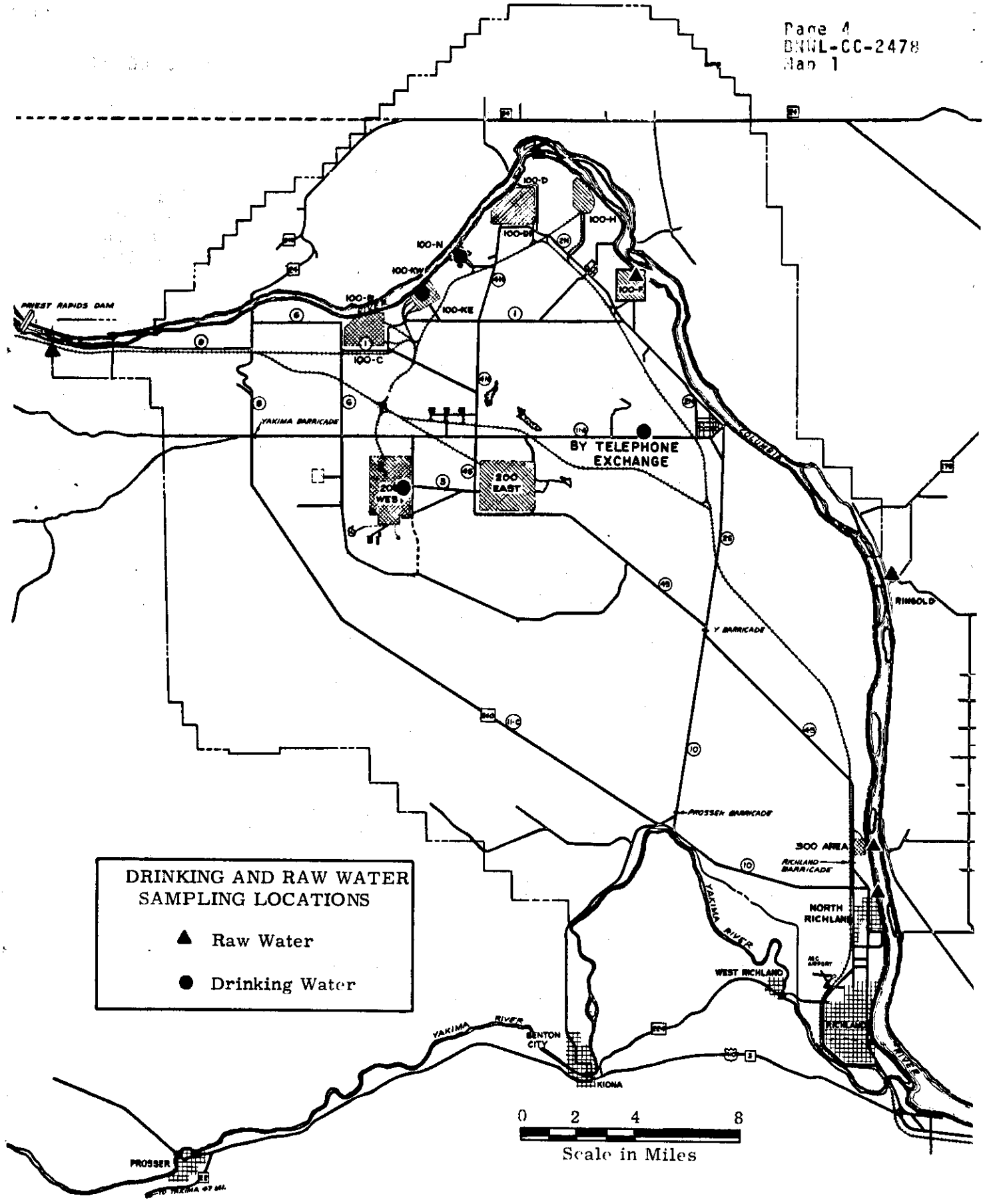
Except for temporary increases associated with brief laboratory releases, iodine concentrations continued to remain at low levels. The maximum ^{131}I concentration noted during the first six months of 1969 was 0.1 pCi/m^3 in the 300 Area during an unusual release from a laboratory building (page 23). The release was of no significance in the environs. For comparison, the maximum ^{131}I concentration during the last half of 1968 was 0.3 pCi/m^3 at a 200 East Area location.

Radiation Surveys

Only one instance of radioactive particulate contamination was found during road surveys. On Route 4S a particle associated with the soil was detected during early June. An activity of 20,000 c/m (GM) at the surface was found, with the major gamma emitter being ^{60}Co (page 47). During March, May, and June, low-level contamination (generally <300 c/m with a maximum of 6,000 c/m GM, surface) was found on control plot 10 on the east perimeter of 200 East Area (page 49). The contamination was associated with waste handling and processing operations.

An increased influx of fallout material was partially responsible for the increased exposure rates measured at most locations during the first half of 1969. The highest average exposure rate measured during the period was 1.9 mR/day at the east side of 200 East Area. Increased exposure rates were also recorded at all 100 Area locations, compared to previous years. This was partially attributed to reactor effluent vapors as well as increased fallout, but readings were influenced by dosimeter reader problems during the early part of 1969 (page 65).

The exposure rates and surface contamination levels at shoreline locations downstream from the operating reactors were below those observed during the last half of 1968 and similar to those observed a year ago. The maximum shoreline exposure rate during the first six months of 1969 was 210 μR/hr observed on the far shore of D Island in March, significantly less than the 400 μR/hr which was observed at Powerline Crossing in December 1968. Radiation levels from shoreline contamination were typically less than 300 c/m; however, a single maximum reading of 5,000 c/m was observed near the Richland water plant pump house in March (page 74).


DRINKING AND RAW WATER
SAMPLING LOCATIONS
Raw Water
Drinking Water
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-KW
100-KE
100-F
100-C
YAKIMA BARRICADE
BY TELEPHONE
EXCHANGE
200
WEST
200
EAST
Y BARRICADE
RINGOLD
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
NORTH
RICHLAND
YAKIMA RIVER
WEST RICHLAND
BENTON
CITY
KIONA
PROSSER
0 2 4 8
Scale in Miles

III. COLUMBIA RIVER WATER

Sampling locations for raw water and drinking water appear in Map 1. On April 25, 1969, "C" reactor was retired.

Raw Water

Columbia River water sampled above the Hanford project at the Priest Rapids Gauge Station is analyzed for comparison with analyses of samples collected below the project.

Concentrations of, ^{3}H, ^{90}Sr, ^{95}Zr-Nb, ^{99}Tc, and ^{106}Ru-Rh as well as total alpha activity were measured in monthly composites of weekly grab samples at Priest Rapids and in monthly composites of weekly integrated samples at Richland. ^{3}H, ^{99}Tc, and ^{106}Ru-Rh could be present in the river at Richland as a result of ground water migration from the 200 Areas as well as a result of worldwide fallout.

In all samples, ^{95}Zr-Nt, ^{99}Tc, and ^{106}Ru-Rh concentrations were at or below the Analytical Limit (A.L.) which is 5 pCi/ℓ in each case. At Richland in June alpha activity was slightly above the analytical limit (1.5 pCi/ℓ, compared to A.L. = 1.0 pCi/ℓ).

Concentrations of ^{90}Sr and ^{3}H at Priest Rapids and Richland are shown in Table 1. Concentrations of total beta activity at Ringold appear in Figure 1.

TABLE 1. Concentrations of ^{3}H and ^{90}Sr at the Priest Rapids Gauge Station and at Richland (January-June, 1969)
(Results in pCi/ℓ)

Month	^{3}H		^{90}Sr	
	P.R.	Richland	P.R.	Richland
January	< 1000	< 1000	< 0.50	< 0.50
February	< 1000	< 1000	< 0.50	0.57
March	2800	2000	< 0.50	0.75
April	1700	< 1000	0.52	< 0.50
May	1100	1600	< 0.50	< 0.50
June	2300	1600	< 0.50	< 0.50

Biological measurements of Columbia River water samples collected semi-monthly from Vernita, 100-F, and North Richland appear in Table 2. The Columbia River from the Washington-Oregon border to Grand Coulee Dam is in Class A according to

TABLE 2

BIOLOGICAL MEASUREMENTS IN THE COLUMBIA RIVER (January-June, 1969)

	Vernita			100-F			North Richland		
Date	Coliform count/ 100 ml	Enterococci count/100 ml	BOD mg/ℓ	Coliform count/ 100 ml	Enterococci count/100 ml	BOD mg/ℓ	Coliform count/ 100 ml	Enterococci count/100 ml	BOD mg/ℓ
1-21-69	2	0	1.8	4	0	1.9	4	0	0.55
2-6-69	4	15	8.0	7	17	6.4	42	15	3.8
2-18-69	11	8	9.4	16	23	9.3	12	15	7.9
3-4-69	2	11	6.9	6	8	4.4	7	14	5.7
3-19-69	4	16	5.2	5	16	4.8	7	14	4.4
4-8-69	12	3	1.0	10	5	1.1	11	5	1.0
4-22-69	12	10	4.9	10	7	3.8	7	6	3.5
5-6-69	5	4	3.0	3	7	3.6	12	10	3.4
5-20-69	10	7	2.4	27	7	4.2	20	10	3.9
6-3-69	23	5	4.3	40	46	3.8	32	183	4.1
6-24-69	40	42	4.2	89	150	3.2	125	110	3.2

the Washington state water quality standards*. For Class A rivers, total coliform organisims shall not exceed median values of 240 per 100 mℓ with less than 20% of the samples exceeding 1000 per 100 mℓ when associated with a fecal source.

Enterococci in addition to coliform are measured as an indication of contaminants of fecal origin.

Recurrence of minor oil seepage into the river bank at 100-N was noted in February. Fuel oil measurements were initiated on special grab and integrated samples downstream from the apparent source. Possible sources were thought to be a fuel oil line with a slow leak or an earth fracture from the severe winter weather which could have released oil trapped from the previous leak of 1967. In April, DUN personnel completed hydrostatic testing of all lines and tanks in their underground oil storage area at 100-N and found no apparent leaks. During this period, weekly samples of river water from 100-F indicated occasional concentrations of fuel oil above the analytical limit of 0.3 ppm, but none exceeded 1.0 ppm. The highest concentration noted was in a special grab sample from 100-D on April 1, 1969, at 3.4 ppm, but subsequent samples indicated <0.5 ppm. Fuel oil sampling was discontinued on July 1 since reported concentrations remained near the analytical limit and no further sightings of oil were reported at 100-N.

Results of chemical analyses of grab samples of river water collected at Vernita and 100-F (above and below the production reactors) as reported by Douglas-United Nuclear are shown in Tables 3 and 4. The higher concentrations of iron observed in April and May at both Vernita and 100-F, and the unusually high chloride ion concentration in April at 100-F were probably a result of the unusually turbid river conditions associated with spring runoff. Special analyses for stable manganese were requested when increased ^{56}Mn concentrations were noted in April. These results also appear in Tables 3 and 4.

---

* A Regulation Relating to Water Quality Standards for Interstate and Coastal Waters of the State of Washington and a Plan for Implementation and Enforcement of such standards. Water Pollution Control Commission, State of Washington. December 4, 1967.

TABLE 3

CHEMICAL CHARACTERISTICS OF COLUMBIA RIVER WATER AT VERNITA

(ppm)

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Mn	Diss O_2	Phth Alk.	M.O. Alk.	Hard-ness	Solids
1-7-69	3	0.01	0.003	22	13	0.02	0.35	NA	12.2	0	55	70	95
1-22	3	0.02	0.010	23	15	0.05	0.30	NA	10.6	1	54	71	93
2-4	3	0.03	0.010	25	15	0.05	0.30	NA	11.6	1	58	75	74
2-18	3	0.07	0.002	24	14	0.14	0.25	NA	10.9	0	52	75	90
3-4	3	0.04	0.003	26	15	0.06	0.15	NA	14.4	2	59	79	105
3-18	4	0.04	0.003	25	16	0.04	0.30	NA	11.8	1	59	80	87
4-8	4	0.20	0.003	29	20	0.03	0.50	NA	10.2	2	67	88	115
4-22	4	0.38	0.002	23	18	0.01	0.75	0.014	11.	0	58	75	102
4-25	NA	NA	NA	NA	NA	NA	0.80	0.017	NA	NA	NA	NA	NA
5-6	4	0.35	0.003	23	19	0.02	0.68	NA	11.2	0	56	74	103
5-20	3	0.22	0.008	21	23	0.05	0.35	NA	10.6	0	56	74	89
6-3	2.3	0.054	0.001	19	10	0.008	0.25	NA	9.7	0	46	58	74
6-24	2.3	0.020	0.012	21	10	0.039	0.55	NA	8.67	1	46	62	81

NA - Not analyzed.

TABLE 4

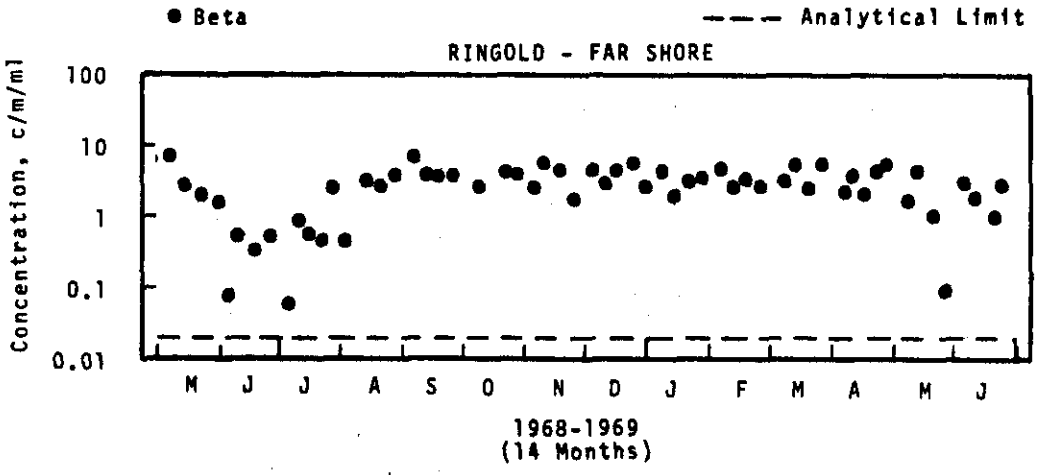
CHEMICAL CHARACTERISTICS OF COLUMBIA RIVER WATER AT 100-F AREA

(ppm)

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Mn	Diss O_2	Phth Alk.	M.O. Alk.	Hard-ness	Solids
1-7-69	4	0.01	0.004	22	12	0.02	0.45	NA	10.3	0	55	73	95
1-22	4	0.02	0.006	22	14	0.03	0.25	NA	NA	1	57	70	85
2-4	3	0.04	0.008	24	16	0.03	0.35	NA	10.9	1	59	74	76
2-18	3	0.08	0.008	26	12	0.15	0.23	NA	10.1	0	56	79	97
3-4	3	0.05	0.003	27	15	0.11	0.30	NA	13.8	3	59	80	102
3-18	4	0.03	0.004	25	19	0.09	0.42	NA	12.2	1	61	80	80
4-8	4	0.14	0.014	22	22	0.07	0.55	NA	9.9	2	62	81	111
4-22	4	0.36	0.001	24	18	0.02	1.55	0.012	12.0	0	62	76	107
4-25	NA	NA	NA	NA	NA	NA	0.85	0.022	NA	NA	NA	NA	NA
5-6	4	0.35	0.002	22	18	0.03	0.68	NA	11.8	0	58	72	100
5-20	3	0.24	0.002	22	14	0.05	0.45	NA	10.6	0	59	68	84
6-3	1.9	0.076	0.004	24	10	0.003	0.30	NA	11.3	0	41	63	68
6-24	2.4	0.018	0.011	21	12	0.039	0.38	NA	12.2	1	46	63	72

NA - Not analyzed.

TOTAL BETA ACTIVITY OF COLUMBIA RIVER WATER (GRAB) SAMPLES
RINGOLD

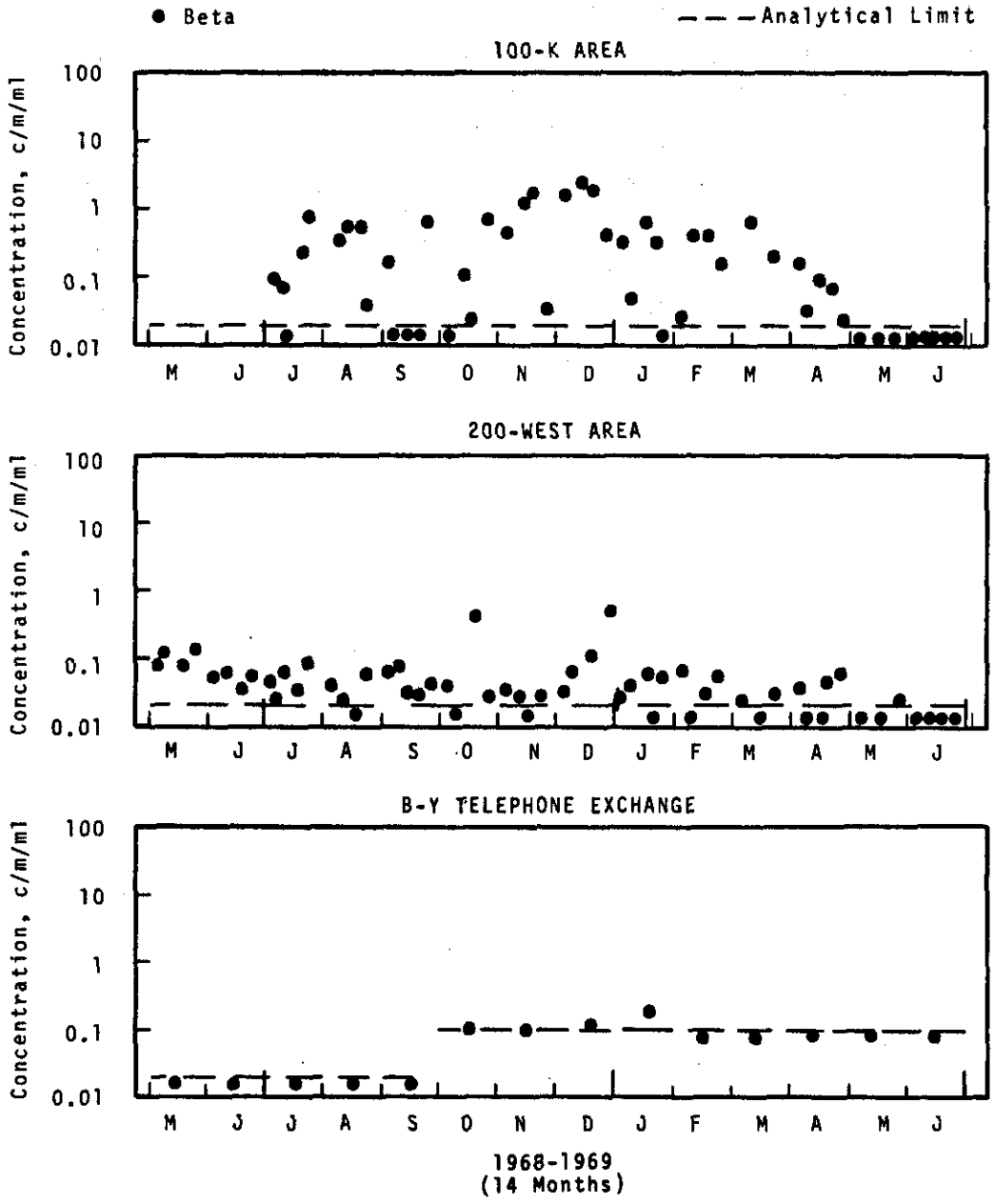


Drinking Water

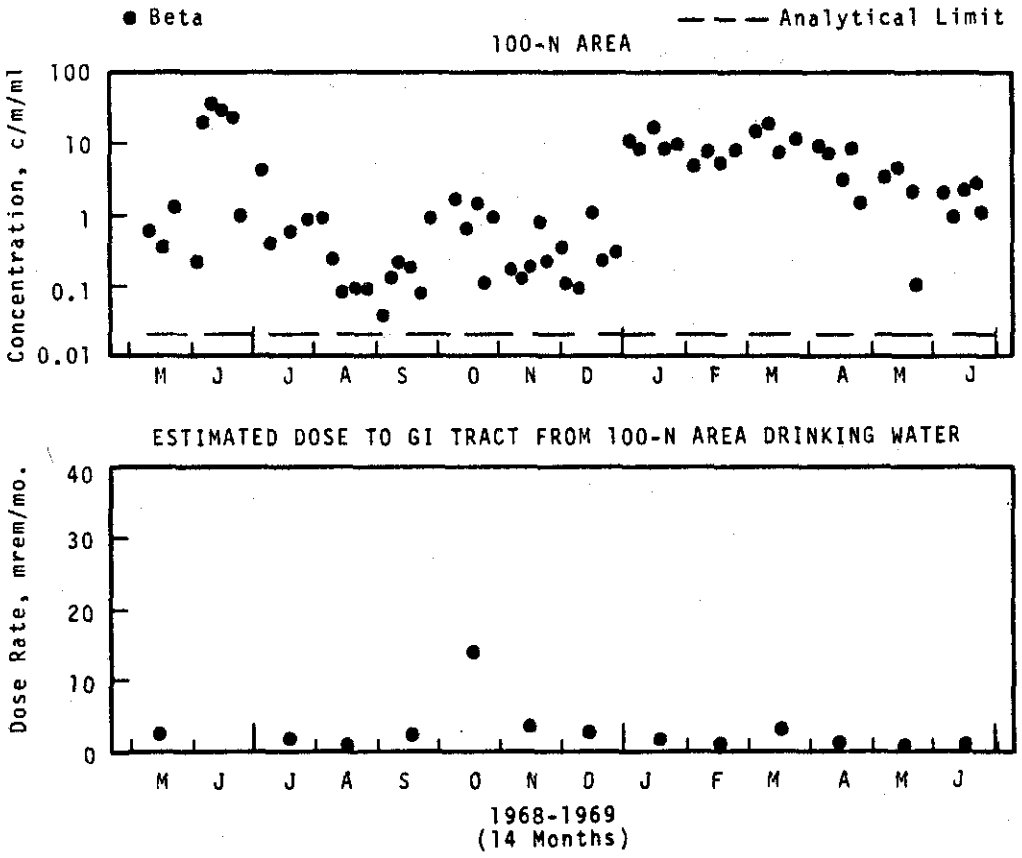
Drinking Water grab samples taken weekly from 100-K, 100-N, and 200-W and monthly from the B-Y telephone exchange were analyzed for total beta activity (Figures 2 and 3). Following the retirement of "C" reactor in April, total beta concentrations in 100-K drinking water decreased to below the analytical limit (.02 c/m/ml).

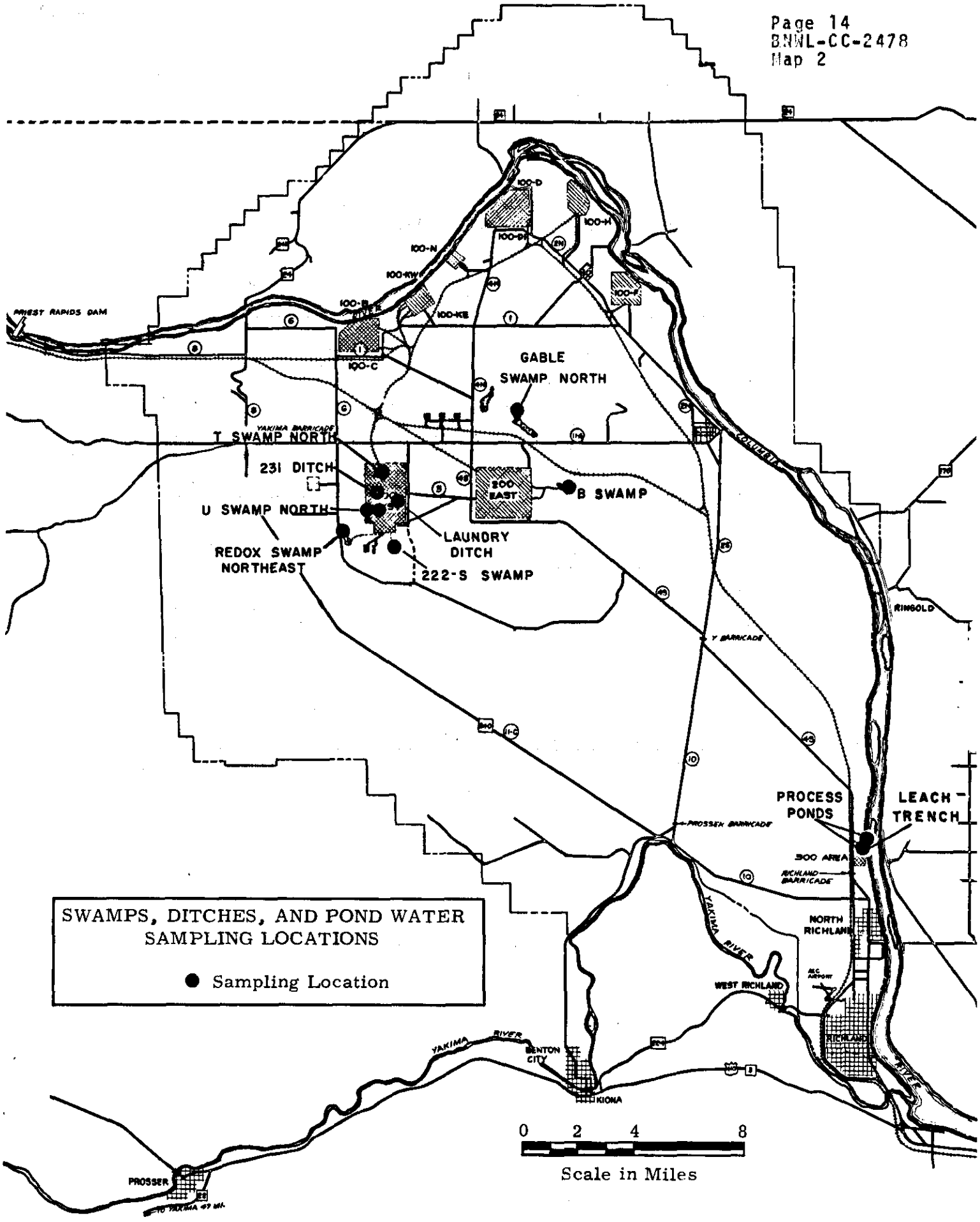
The monthly GI-tract dose from drinking 100-N water (Figure 3) is estimated from monthly isotopic and weekly total beta analyses. The assumed intake of water is 0.93 liters/day, for 5 days/week, and 50 weeks/year. The intake is based on dietary surveys of 3,257 Richland adults that indicate an average local daily water intake of 1.86 liters/day of which one-half is assumed to be at the place of work. During the first six months of 1969, the estimated GI-tract dose from drinking 100-N water was about 9 mrem or 0.6% of the limit for non-occupationally exposed individuals, compared to 13 mrem during the first six months of 1968.

TOTAL BETA ACTIVITY OF DRINKING WATER (GRAB) SAMPLES



TOTAL BETA ACTIVITY OF DRINKING WATER (GRAB) SAMPLES
AND ESTIMATED GI TRACT DOSE




PRIEST RAPIDS DAM
100-D
100-H
100-DR
100-N
100-NW
100-B
100-KE
100-C
100-F
GABLE
SWAMP NORTH
YAKIMA BARRICADE
T SWAMP NORTH
231 DITCH
U SWAMP NORTH
200
EAST
B SWAMP
REDOX SWAMP
NORTHEAST
LAUNDRY
DITCH
222-S SWAMP
COLUMBIA
RINGOLD
Y BARRICADE
PROCESS
PONDS
LEACH
TRENCH
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
YAKIMA RIVER
NORTH
RICHLAND
WEST RICHLAND
RICHLAND
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CITY
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TO YAKIMA 47 MI.
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
● Sampling Location
0 2 4 8
Scale in Miles

IV. SWAMPS, DITCHES, AND PONDS

Water

Open waters near the 200 and 300 Areas which may be used by migratory waterfowl are routinely sampled at the locations shown in Map 2. Grab samples were collected monthly with the exceptions of the 300 Area Process Pond Inlet which is a weekly cumulative sample, and the 231 Ditch Outlet which is a weekly grab sample. Total alpha and total beta concentrations in samples collected during January-June, 1969, were below 50,000 pCi/ℓ, the guide for open waters (AECM, Chapter 0510).

Radiochemical results for the 200 Area surface waste water samples are shown in Figures 4-6. Data for the 300 Area Process Pond include both radiochemical and chemical analyses (Figure 7 and Table 5).

Biological measurements of samples from the 300 Area leaching trench and the river shoreline seepage area are summarized in Table 8.

1. 200 Area Waste Waters

No samples were collected in January at T-Swamp, U-Swamp, Redox Swamp, B-Swamp, or the Laundry Ditch because the swamps were frozen.

Increased total beta concentrations were noted in the 200 West Area 222-S swamp in June. The principal gamma emitter was ^{137}Cs-^{137m}Ba (1500 pCi/ℓ).

^{137}Cs-^{137m}Ba was detected in samples collected from T-Swamp during January, February, and March (1300, 2800, and 530 pCi/ℓ) and those collected from 222-S Swamp in January, March, April, and June (200, 270, 320, and 1500 pCi/ℓ). ^{131}I was detected in a single sample from B-Swamp in February (180 pCi/ℓ). In addition to the previously mentioned radionuclides, the activation products ^{51}Cr and ^{65}Zn were occasionally detectable at concentrations somewhat below those observed in the Columbia River, as expected since river water is the source of cooling water discharged to these ponds.

2. 300 Area Process Pond

Total beta, uranium, nitrate ion, and hexavalent chromium ion concentrations measured in weekly cumulative samples collected near the inlet of the 300 Area process pond appear

in Figure 7. The concentration of uranium is based on a measurement of total alpha. Monthly average fluoride ion measurements appear in Table 5.

TABLE 5. Fluoride Ion Concentrations in the 300 Area Process Pond (January-June, 1969)

Month	F- ppm
January	2.6
February	1.6
March	4.1
April	5.1
May	7.0
June	NA*

*NA - Not Analyzed

3. 300 Area Sanitary Waste

Samples were collected monthly from the 300 Area leach trench and from the river shoreline seepage area. Analyses for coliform, enterococci (fecal bacteria) and BOD (biochemical oxygen demand) are summarized in Table 6.

Game Birds

Game birds that have utilized swamps or ponds receiving low-level radioactive wastes may contain ^{32}P, ^{65}Zn, ^{137}Cs-^{137m}Ba, and other radionuclides. Table 7 shows the results of radioassays of the muscle of ducks collected from Gable Swamp and Redox Swamp in early January. For comparison, the maximum concentration of ^{137}Cs-^{137m}Ba in game birds collected near swamps during December 1968 was 500 pCi/g.

TABLE 6

BIOLOGICAL MEASUREMENTS OF SAMPLES COLLECTED AT THE 300 AREA TRENCH AND RIVER SHORELINE SEEPAGE AREA

300 Area Leach Trench

Date	Coliform/100 ml	Enterococci/100 ml	BOD mg/ℓ
1-21-69	55,000	1,800	4.4
2-18	80,000	14,000	4.2
3-19	80,000	1,400	6.6
4-22	9,000	3,200	4.5
5-20	120,000	8,800	4.2
6-24	240,000	13,000	-

River Shoreline Seepage Area

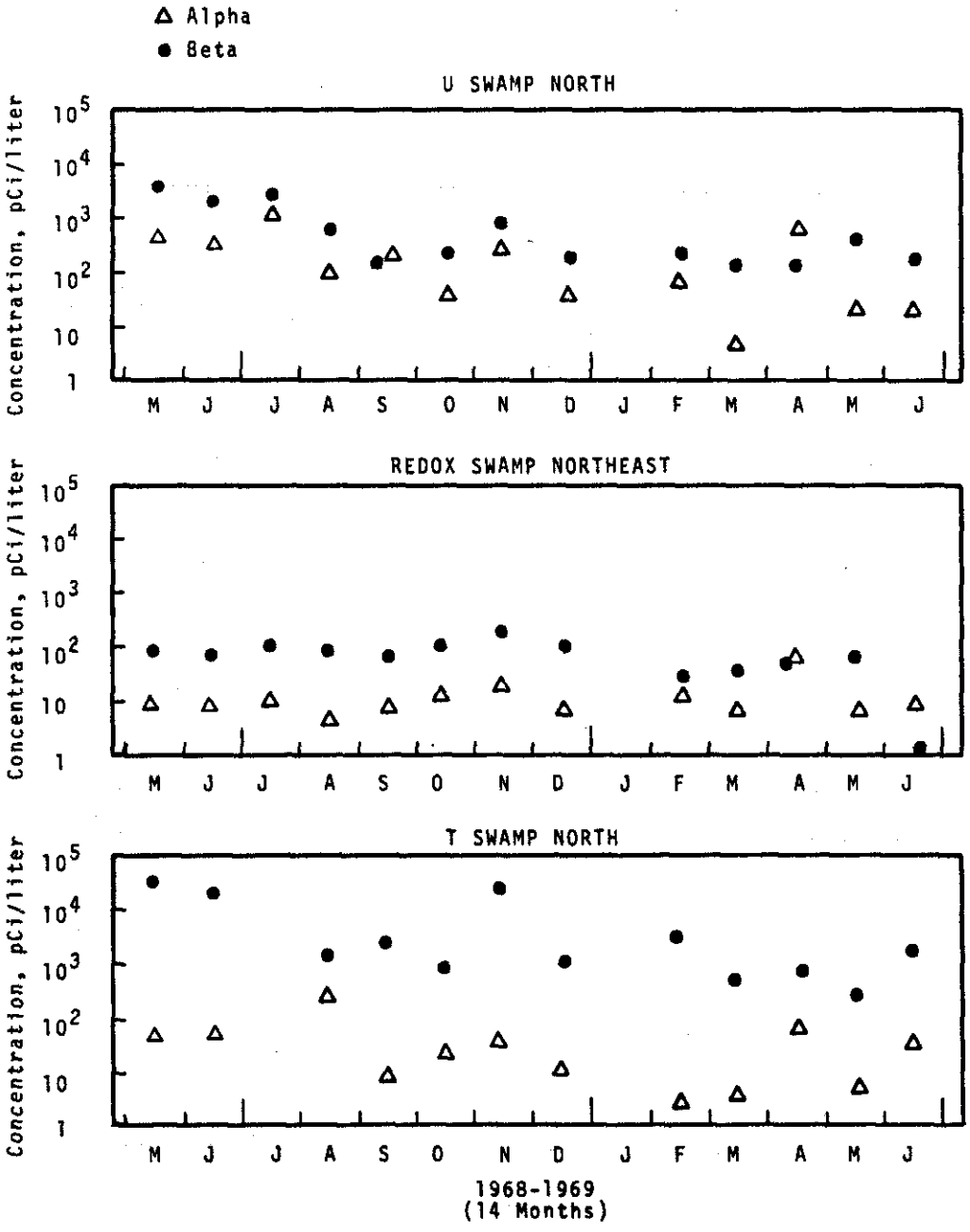
Date	Coliform/100 ml	Enterococci/100 ml	BOD mg/ℓ
1-21-69	2	30	2.0
2-18	50	26	7.3
3-19	10	10	3.2
4-22	10	29	3.6
5-20	20	9	4.4
6-24	120	90	3.4

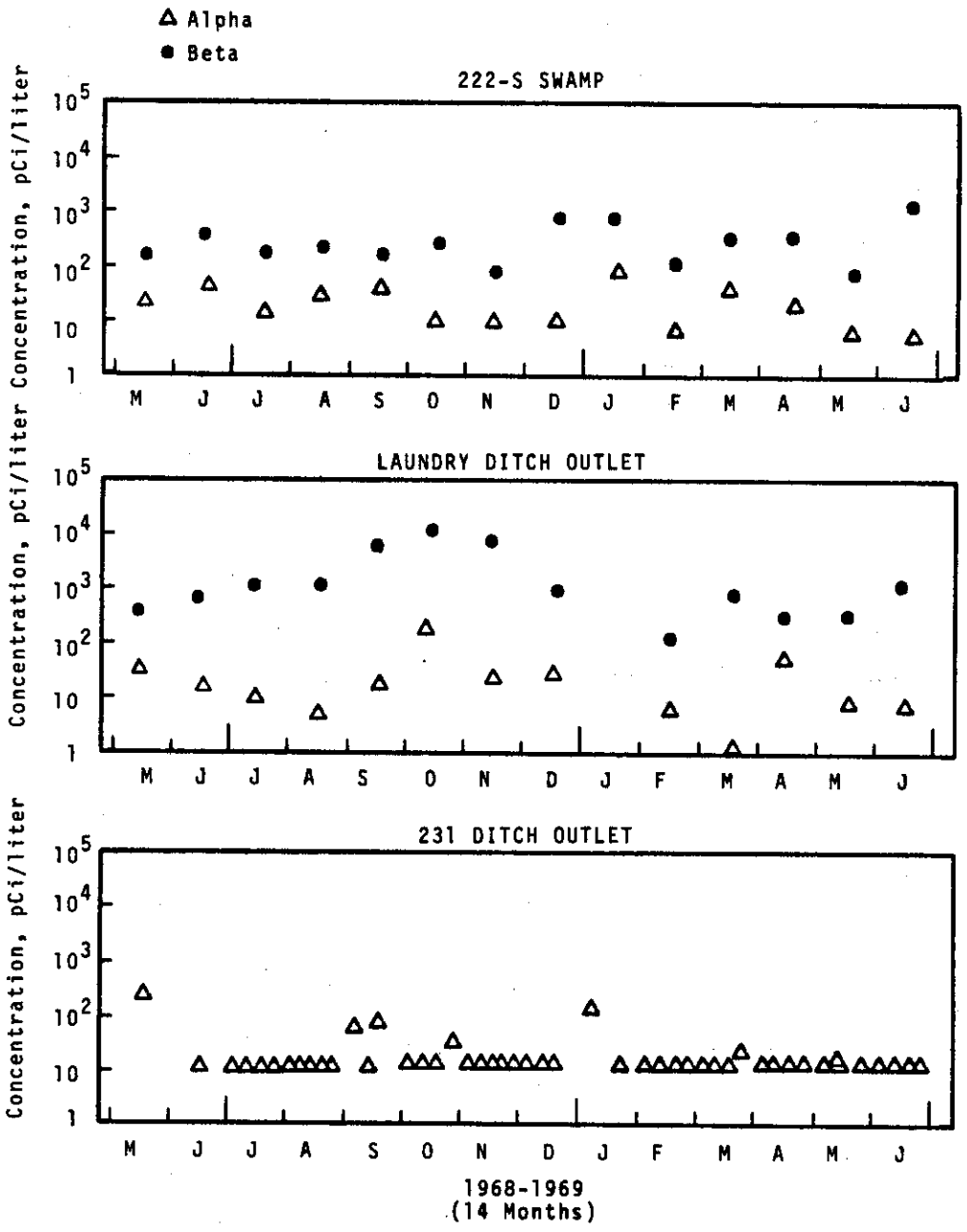
TABLE 7

CONCENTRATIONS OF SELECTED RADIONUCLIDES IN THE MUSCLE OF DUCKS COLLECTED NEAR REDOX SWAMP AND GABLE MOUNTAIN SWAMP
(pCi/g)

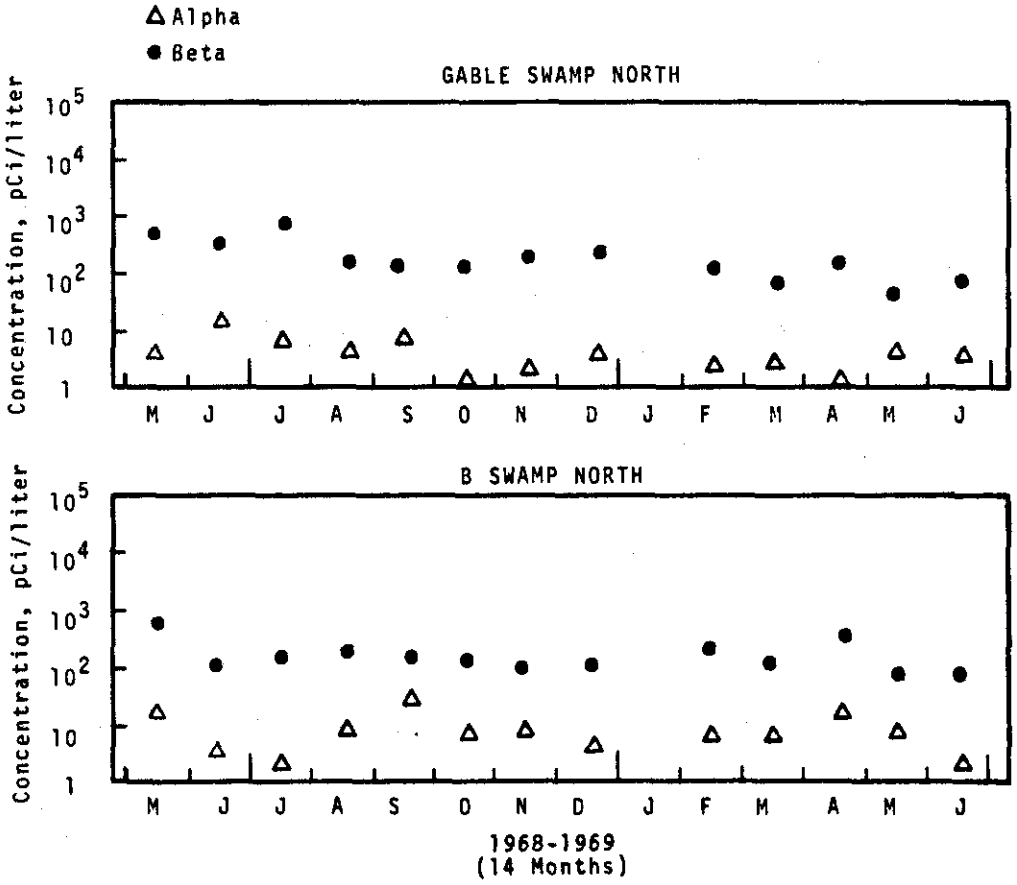
Date	Species	^{32}P	^{40}K	^{65}Zn	^{134}Cs	^{137}Cs-^{137m}Ba
Redox Swamp						
1-3-69	Ruddy Duck	2.5	<4.0	<0.62	<1.4	70.
1-3-69	Ruddy Duck	80.	5.2	<0.44	5.4	390
Gable Mountain Swamp						
1-3-69	Bufflehead	97.	5.4	<0.52	5.2	390
1-3-69	Bufflehead	9.2	5.0	<0.57	5.7	420
1-3-69	Bufflehead	6.1	4.9	<0.74	4.2	290
1-3-69	Gr. Winged Teal	5.2	<2.6	<0.41	8.4	380
1-3-69	Gr. Winged Teal	40.	4.6	<0.41	1.6	130

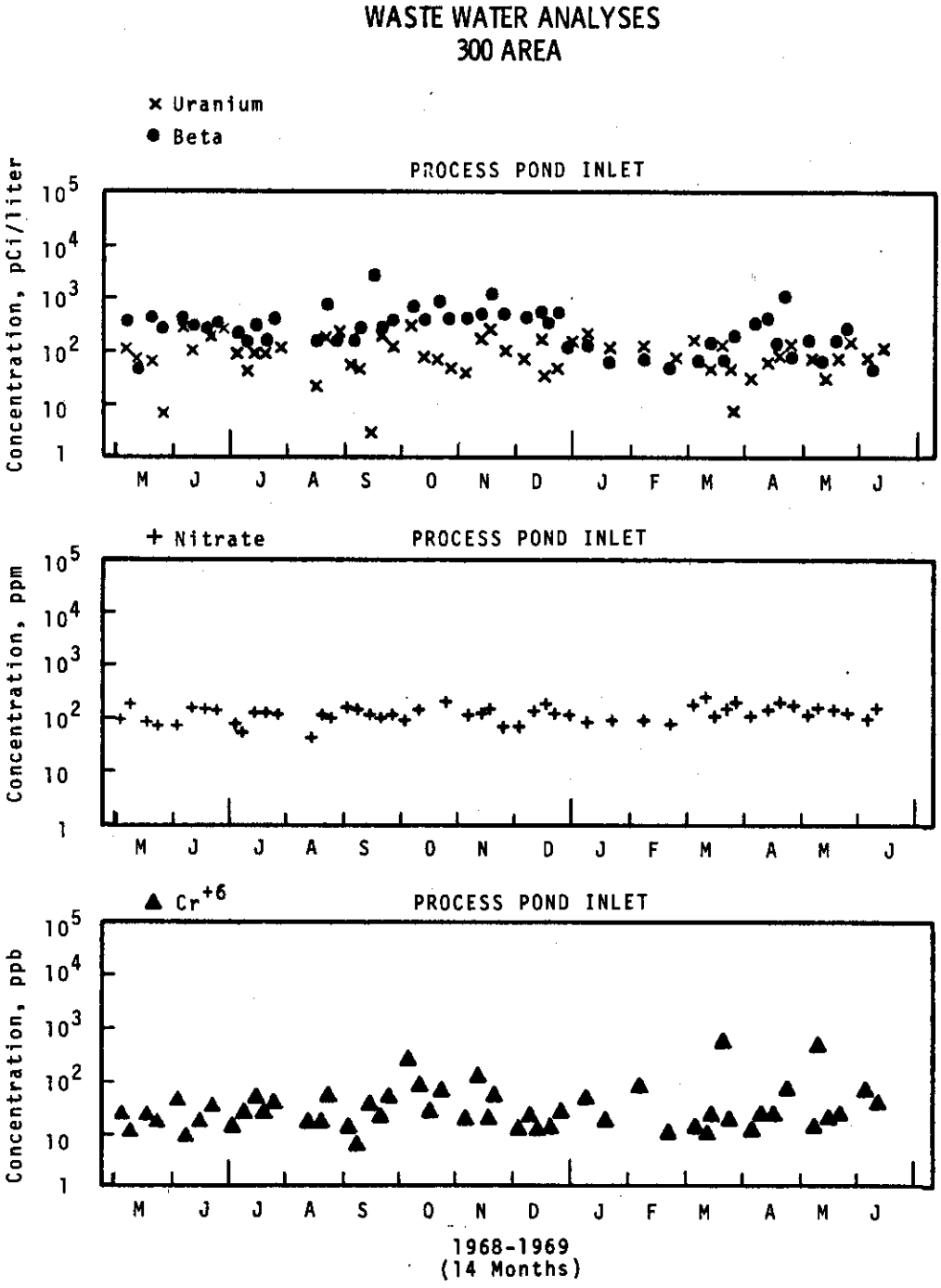
RADIOACTIVITY OF WASTE WATER SAMPLES
200-WEST AREA




RADIOACTIVITY OF WASTE WATER SAMPLES
200-WEST AREA
Δ Alpha
● Beta
222-S SWAMP
LAUNDRY DITCH OUTLET
231 DITCH OUTLET
Concentration, pCi/liter
10^5
10^4
10^3
10^2
10
1
M J J A S O N D J F M A M J
1968-1969
(14 Months)

RADIOACTIVITY OF WASTE WATER SAMPLES
200-EAST AREA




WASTE WATER ANALYSES
300 AREA
× Uranium
● Beta
PROCESS POND INLET
Concentration, pCi/liter
10^5
10^4
10^3
10^2
10
1
M J J A S O N D J F M A M J
+ Nitrate
PROCESS POND INLET
Concentration, ppm
▲ Cr^{+6}
PROCESS POND INLET
Concentration, ppb
1968-1969
(14 Months)

V. AIRBORNE RADIOACTIVITY

Results of routine sampling of the atmosphere for radioactivity at 20 locations within the Hanford Reservation (Map 3) are shown in Figures 9-19. (Sampling for chemical pollutants in the atmosphere is conducted and reported by Hanford Environmental Health Foundation.)

The sampling equipment sheltered in small buildings designated "614", draws air at a flow rate of 1.5 cfm through HV-70 filter paper and then through a solution of NaOH for radioiodine collection. The normal sampling period is one week. The gross beta activity of particulates collected on the filter paper during the sampling period (calculated as ^{90}Sr-Y) is reported as total beta.

In January, radioiodine measurements on the 200-West West Center sample were discontinued. The 300 Area sampling location was moved from a south-central to a west-central location in late March. The 100-N Area sampling location was moved from the middle of N Area to the north side of WPPSS area southwest of N Area in mid-April. At the end of June, the sampling location at the old Hanford townsite was discontinued.

During January and February, some samples were not collected because of equipment difficulties due to extremely cold weather.

Iodine-131

During the period January-June, 1969, several transient increases in ^{131}I were observed. The maximum offsite ^{131}I concentration was 0.1 pCi/m^3 measured at Byers Landing (across from the 300 Area) on January 20-28, 1969, following a transient increase in ^{131}I releases from a laboratory building. The maximum onsite ^{131}I concentration was also 0.1 pCi/m^3 and was measured inside the 300 Area during the period June 2 through June 6, 1969. This high value was also the result of an increased release from a 300 Area laboratory facility. These releases did not result in any measurable increases in radiation doses to the thyroids of local residents. Other transient increases of a lesser magnitude were noted at scattered onsite locations throughout the six-month period.

Total Beta

A month-by-month summary of transient changes in total beta activity is given below. Table 8 shows Concentration Guides for selected radionuclides in air. Table 9 contains results of gamma scans on environmental air filters, and Table 10 shows the average ^{131}I and particulate total beta activity in air at various locations.

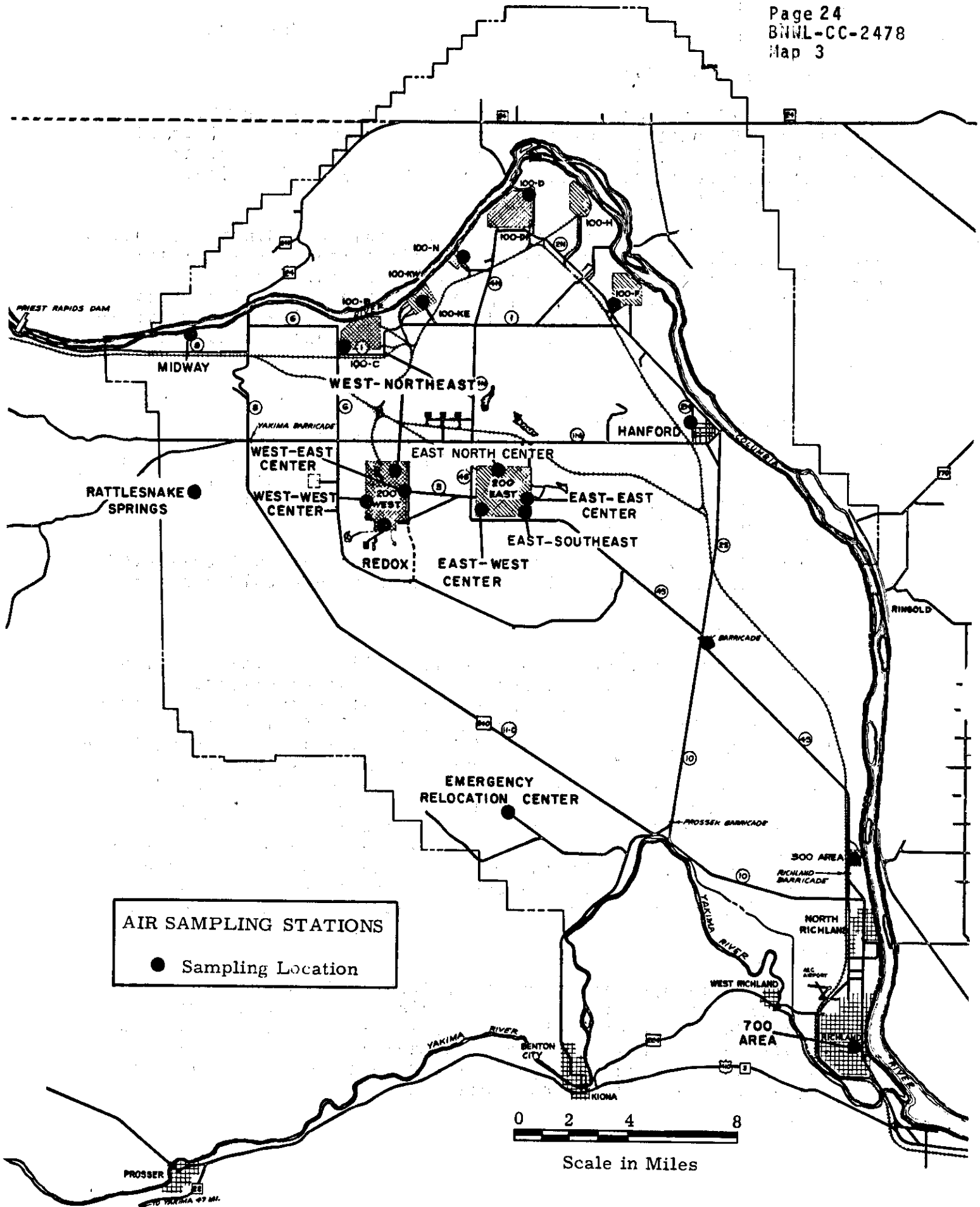

PRIEST RAPIDS DAM
MIDWAY
100-D
100-H
100-N
100-RW
100-F
100-KE
100-C
WEST-NORTHEAST
YAKIMA BARRICADE
HANFORD
COLUMBIA R.
WEST-EAST CENTER
EAST NORTH CENTER
RATTLESNAKE SPRINGS
WEST-WEST CENTER
200 WEST
200 EAST
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
RINGOLD
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
YAKIMA RIVER
NORTH RICHLAND
WEST RICHLAND
700 AREA
RICHLAND
BENTON CITY
KIONA
PROSSER
AIR SAMPLING STATIONS
Sampling Location
0 2 4 8
Scale in Miles

TABLE 8

CONCENTRATION GUIDES FOR SELECTED RADIONUCLIDES IN AIR FOR INDIVIDUALS IN UNCONTROLLED AREAS*
(pCi/m^3)

Radionuclide	^{90}Sr	^{95}Zr	^{106}Ru	^{131}I	^{134}Cs	^{137}Cs	^{140}Ba	^{144}Ce	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Am	U-Nat.
Most Restrictive CG	30	1000	200	100	400	500	1000	200	0.07	0.06	0.06	0.2	2
Insoluble or Soluble	(S)	(I)	(I)	(S)	(I)	(I)	(I)	(I)	(S)	(S)	(S)	(S)	(I)

NOTE: For a mixture of unknown radionuclides with no alpha emitters nor with ^{227}Ac present, the corresponding CG is 1 pCi/m^3.

* AEC Appendix 0524, Annex A, Table II, Column 1, (approved November 8, 1968). These Concentration Guides are for individuals. For the general population, the appropriate Concentration Guide would be one-third of the listed values.

TABLE 9

GAMMA EMITTERS MEASURED ON SELECTED AIR FILTERS (January-June, 1969)
(pCi/m^3)

Inclusive Dates		^{95}Zr-Nb	^{106}Ru-Rh	^{131}I	^{134}Cs	^{137}Cs-^{137m}Ba	^{140}Ba-La	^{144}Ce-Pr
100-K								
1-20	1-27	-	0.079	-	-	0.009	-	-
1-27	2-24	0.008	-	-	-	0.014	0.42	-
2-24	3-24	0.025	0.15	-	-	0.009	-	-
3-24	4-28	0.034	0.10	-	-	<0.006	-	0.076
4-28	5-26	0.15	0.34	<0.05	-	0.009	-	0.24
5-26	6-23	0.32	0.42	0.03	-	0.025	0.22	0.61
200 EEC								
1-20	1-27	-	0.12	-	-	0.12	-	-
1-27	2-17	0.078	-	-	-	0.23	0.55	0.26
2-17	2-24	0.13	<0.20	<0.15	-	0.28	0.49	0.44
2-24	3-6	0.065	<0.46	<0.27	0.52	0.18	-	-
3-6	3-10	0.058	<0.09	<0.16	<0.07	0.44	-	0.27
3-10	3-17	0.38	<0.20	<0.16	<0.16	0.72	2.8	<0.32
3-17	3-25	0.062	-	-	-	0.064	-	-
3-25	4-28	0.050	0.41	-	-	0.055	-	<0.09
4-28	5-12	0.22	0.51	-	-	0.053	-	<0.32
5-12	5-26	0.245	0.60	<0.045	-	0.056	-	0.21
5-26	6-23	0.34	0.56	<0.016	-	<0.067	-	0.27
200 ESE								
3-3	3-6	<0.025	<0.44	< 0.26	<0.41	-	-	-

TABLE 9 (Continued)

Inclusive Dates		^{95}Zr-Nb	^{106}Ru-Rh	^{131}I	^{134}Cs	^{137}Cs-^{137m}Ba	^{140}Ba-La	^{144}Ce-Pr
200 ENC								
3-3	3-6	0.18	0.63	<0.20	<0.42	-	-	-
3-10	3-17	0.17	<0.20	<0.16	0.18	2.0	-	0.69
3-24	4-1	0.42	<0.17	<0.096	<0.13	0.99	3.2	0.27
4-14	4-21	0.073	<0.21	-	-	1.2	-	0.45
4-21	4-28	0.16	<0.20	-	-	1.1	-	<0.32
5-5	5-12	0.47	<0.20	<0.14	-	2.4	-	1.2
5-12	5-19	0.43	0.20	0.49	-	0.97	-	0.63
200 WWC								
5-5	5-12	0.25	0.64	-	-	<0.028	-	<0.32
Rattlesnake Springs								
1-16	1-22	-	0.099	-	-	<0.008	-	-
1-22	2-26	0.004	-	-	-	0.007	0.28	-
2-26	3-26	0.015	0.17	-	-	<0.007	-	-
3-26	4-30	0.041	0.11	-	-	<0.006	-	0.067
4-30	5-28	0.12	0.33	-	-	<0.007	-	0.17
5-28	6-25	0.25	0.47	<0.038	-	<0.007	-	0.76
Hanford								
3-10	3-17	0.45	<0.20	<0.18	-	<0.029	<0.39	<0.32
Ringold								
1-21	1-28	-	<0.049	-	-	0.008	-	-
1-28	2-25	0.009	-	-	-	-	0.066	-
2-25	3-25	0.014	0.077	-	-	<1.0	-	-
3-25	4-15	0.49	-	<4.9	-	<1.0	-	-
4-15	4-29	0.022	<0.053	-	-	<0.007	-	<0.084
4-29	5-27	0.068	0.15	-	-	<0.010	-	<0.11
5-27	6-24	0.20	0.37	<0.041	-	<0.007	-	<0.31

TABLE 9 (Continued)

Inclusive Dates	^{95}Zr-Nb	^{106}Ru-Rh	^{131}I	^{134}Cs	^{137}Cs-^{137m}Ba	^{140}Ba-La	^{144}Ce-Pr
Byers Landing							
1-20 1-28	-	0.056	-	-	<0.004	-	-
1-28 2-24	0.005	-	-	-	0.009	0.31	-
2-24 3-24	0.018	0.094	-	-	<0.007	-	-
3-24 4-28	0.040	0.10	-	-	<0.007	-	0.078
4-28 5-26	0.16	0.44	<0.041	-	<0.007	-	0.22
5-26 6-23	0.28	0.53	<0.044	-	0.009	-	<0.31
Washtucna							
12-4-68 2-24*	0.006	0.045	<0.034	-	0.004	0.070	<0.036
Eltopia							
3-19 3-26	0.022	<0.20	-	-	<0.029	0.72	-

* Also a peak at 60 keV was observed and was attributed to fallout.

TABLE 10

AVERAGE ^{131}I AND PARTICULATE TOTAL BETA CONCENTRATIONS IN THE ATMOSPHERE
(pCi/m^3)

	^{131}I					Total Beta				
Location	1965	1966	1967	1968	Jan-June 1969	1965	1966	1967	1968	Jan-June 1969
100 Areas[1]	0.03	0.20	0.02	0.02	0.01	0.44	0.29	0.34	0.30	0.29
200 Areas[2]	0.14	0.10	0.09	0.03	0.02	0.80	0.58	0.41	0.28	0.39
Other On-Plant[3] Locations	0.05	0.20	0.04	0.02	0.02	0.34	0.24	0.26	0.20	0.24

1. 100-B, K, N, D, and F during 1969.

2. 200 West: Northeast, Redox, West Center, East Center; and 200 East: West Center, Southeast, North Center, and East Center during 1969.

3. Midway, Rattlesnake Springs, Emergency Relocation Center, Wye Barricade, Hanford, and 300 Area during 1969.

General increases in total beta activity in the air in 200 East Area in March through April resulted primarily from waste handling and processing operations. The maximum total beta concentration on a weekly filter (2.5 pCi/m^3) occurred at 200 East North Center in mid-March. Total beta activity was generally lower during January-March than during April-June at locations other than 200 East Area. As a result of increased fallout, monthly average total beta concentrations for June ranged from 0.4 to 0.6 pCi/m^3 at most locations. Exceptions were averages for two onsite locations in the 200 East Area (1. and 0.7 pCi/m^3) and the averages for two offsite locations (Washtucna and Moses Lake), both 0.9 pCi/m^3.

February:

At 200-East North Center in early February, a somewhat higher than usual concentration of total beta activity in the atmosphere was noted (0.76 pCi/m^3 on a filter removed 2-3-69). It was thought to be due to waste handling practices.

In late February, unusual beta and alpha activity were noted on a particulate filter from 200-East East Center (1.4 pCiβ/m^3 and 0.023 pCiα/m^3 on the filter removed 2-24-69) following the cleaning of the 152A diversion box at the A waste tank farm. The principal gamma emitters were ^{140}Ba-La, ^{144}Ce-Pr ^{137}Cs-Ba, ^{95}Zr-Nb, and ^{131}I (0.54, 0.44, 0.30, 0.14, and 0.02 pCi/m^3, respectively).

March:

Higher total beta activity at 200-East North Center and 200-East East Center in early March (0.62 and 0.56 pCi/m^3, respectively during 2-24 to 3-3-69) was attributed to the spread of a fine powder from contaminated equipment near the 200-East North Center sampling location on 2-25-69.

In early March, special gamma scans of particle filters were requested following a particulate release at Purex stack. ^{106}Ru-Rh and ^{95}Zr-Nb were detected on the 200-East North Center filter and ^{95}Zr-Nb, ^{134}Cs, and ^{137}Cs-^{137m}Ba were detected on the 200-East East Center filter removed on March 6, 1969. Low-level activity [300 c/m (GM) maximum] was detected on a control plot (page 50).

Increased concentrations of airborne particulate radioactivity continued to be observed at 200-East Area with the highest concentrations occurring in mid-March at 200-East North Center (2.5 pCi/m^3 during 3-10 to 3-17-69).

These increases were associated primarily with waste handling and processing operations.

Major gamma emitters detected on the 200-East North Center filter were ^{137}Cs, ^{95}Zr-Nb, ^{106}Ru-Rh, ^{144}Ce-Pr, ^{134}Cs, and ^{131}I with concentrations of 2.0, 2.0, 1.0, 0.99, 0.36, and 0.14 pCi/m^3 respectively. These represent 0.4, 0.2, 0.5, 0.5, 0.09, and 0.14 percent of the Concentration Guides for individuals in uncontrolled areas (Table 8).

April:

The maximum gross beta activity reported was at 200-East North Center (1.4 pCi/m^3 during 4-14 to 4-21-69) with the major gamma emitter being ^{137}Cs (1.2 pCi/m^3).

May:

Continued elevated gross beta concentrations of airborne particulates on the north side of 200 East Area were observed, accompanied by a gradual increase in alpha activity. These were attributed to tank farm operations in the 200 East Area. The highest gross beta concentration at any location during the first six months was at 200-East North Center (2.6 pCi/m^3 during 5-5 to 5-12-69) with the major gamma emitters being ^{137}Cs (2.4 pCi/m^3), ^{144}Ce-Pr (1.2 pCi/m^3) and ^{95}Zr-Nb (0.47 pCi/m^3).

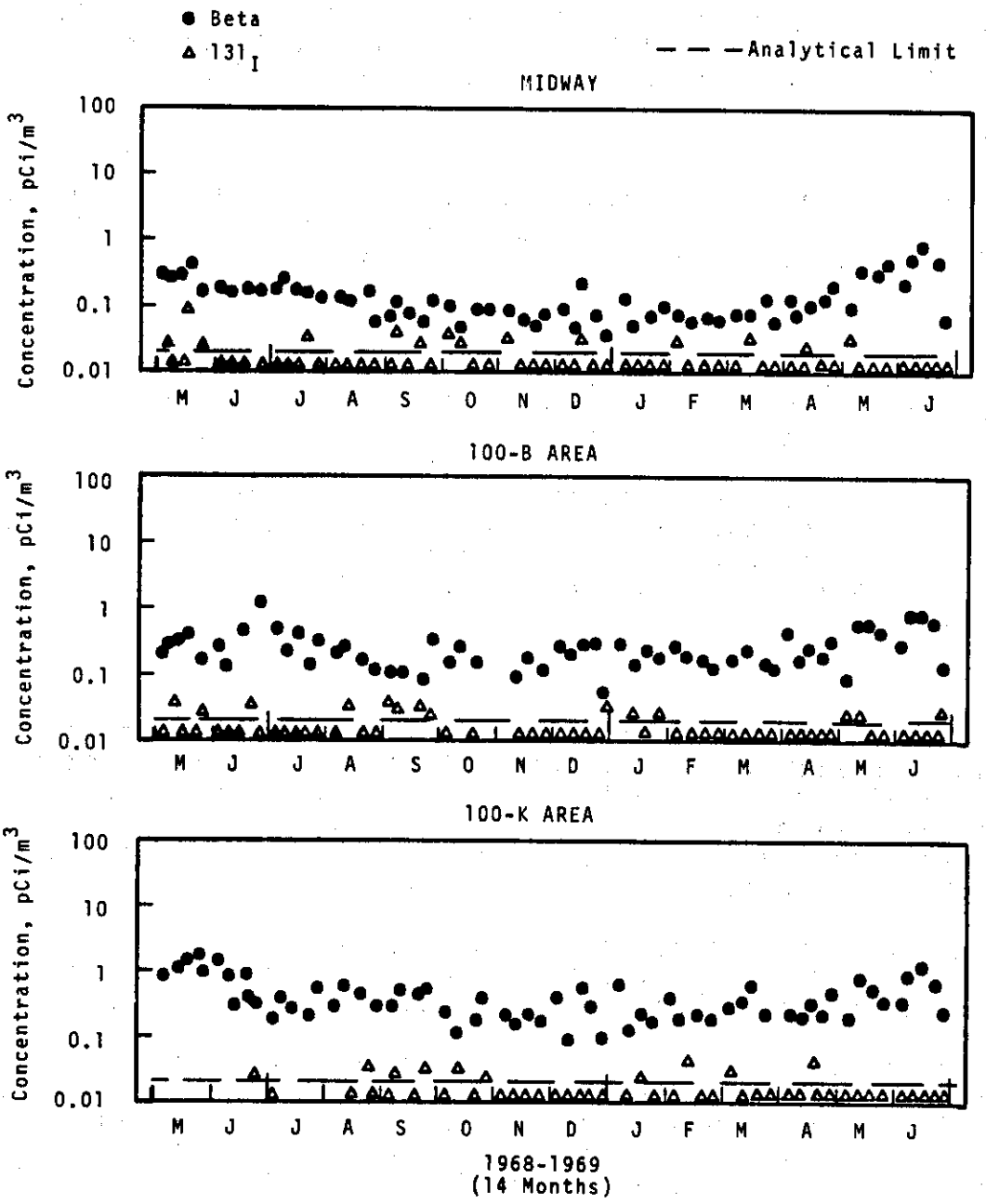
June:

Particulate radioactivity from worldwide fallout continued to increase with total beta concentrations slightly exceeding 1 pCi/m^3 at some offsite locations. At the majority of locations, maximum values were in the range 0.7 to 1.0 pCi/m^3. These are somewhat higher concentrations attributed to fallout than observed in recent years.

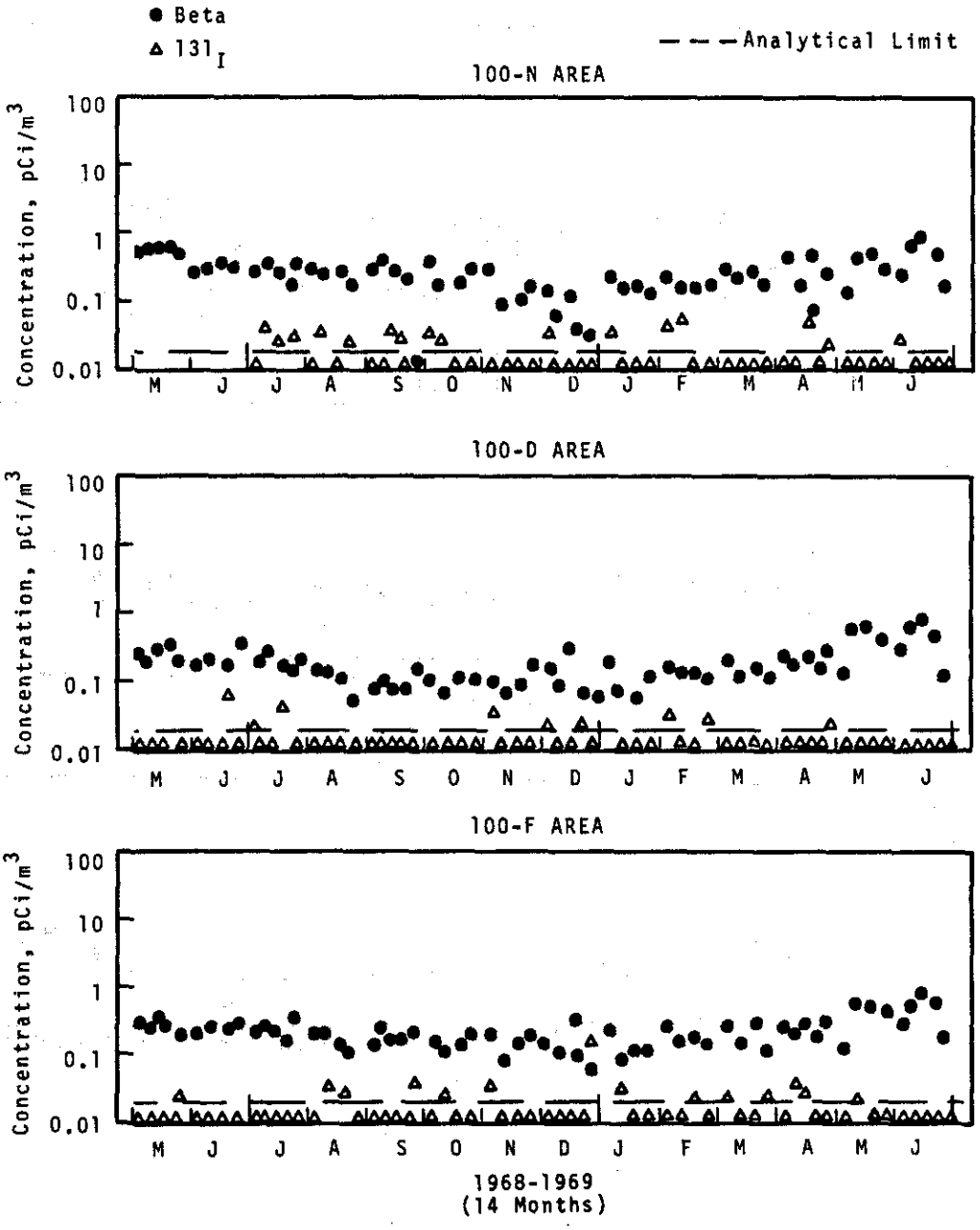
A decrease in total beta activity on samples from 200 East Area in June was attributed to a decreased work load in the waste handling areas, and increased air dispersion.

Increased total beta activity at the 300 Area (1.3 pCi/m^3 during the week 6-9 to 6-16-69) was attributed to releases of particlates from a laboratory stack as a result of faulty filter performance. The major gamma emitters present were ^{154}Eu and ^{144}Ce-Pr, based on examination of the stack sample filter.

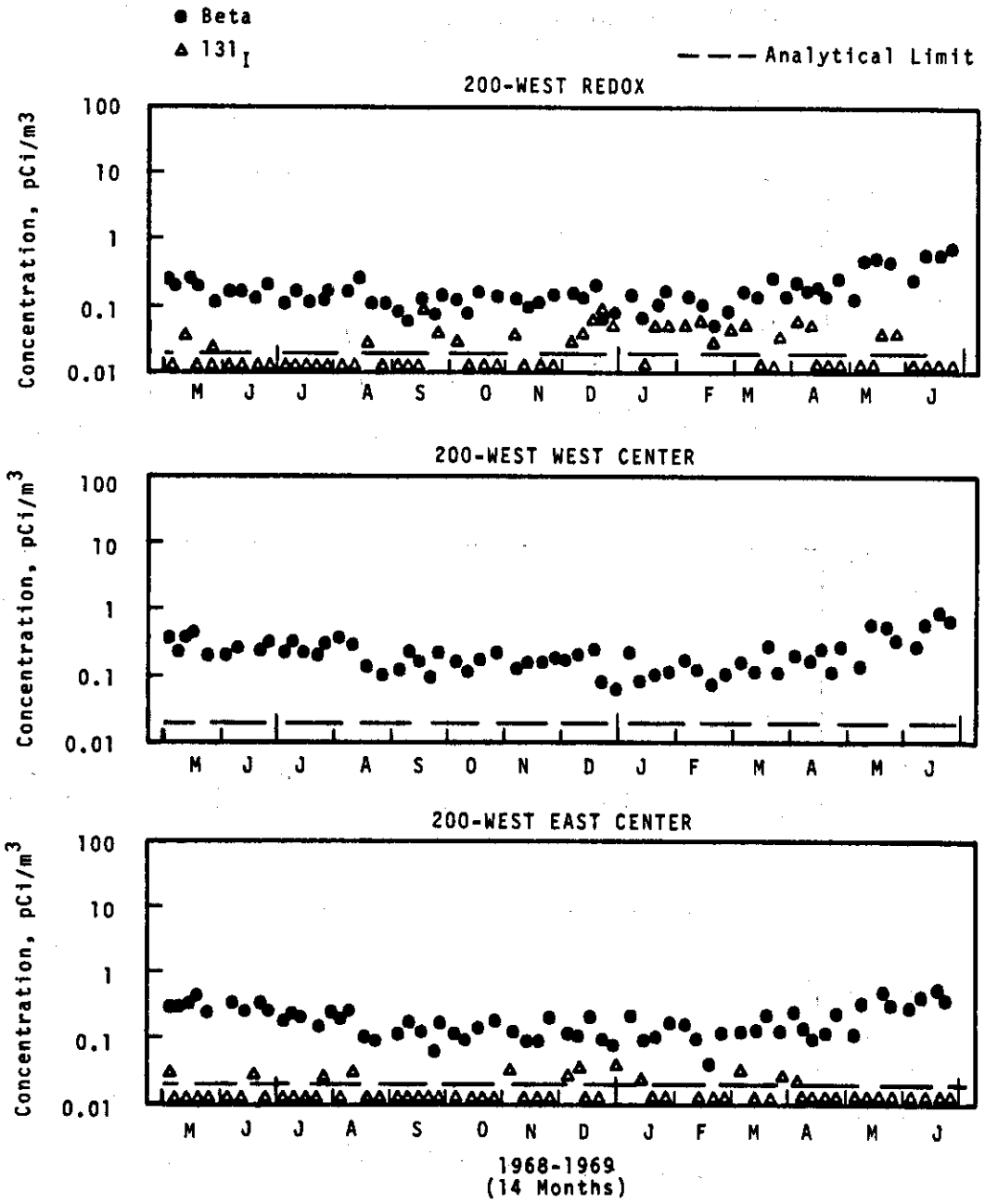
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100 AREAS AND VICINITY



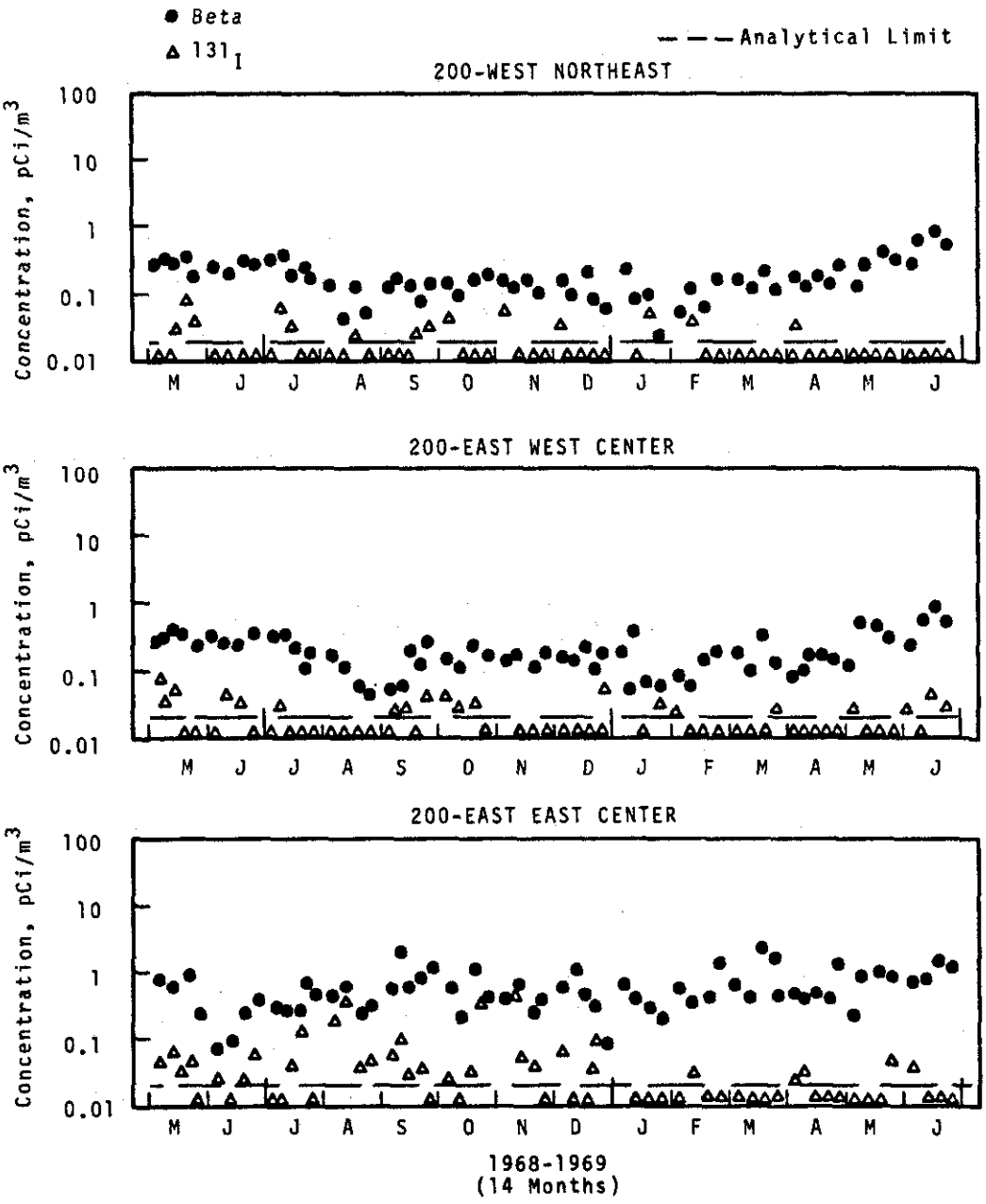
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
100-AREAS AND VICINITY



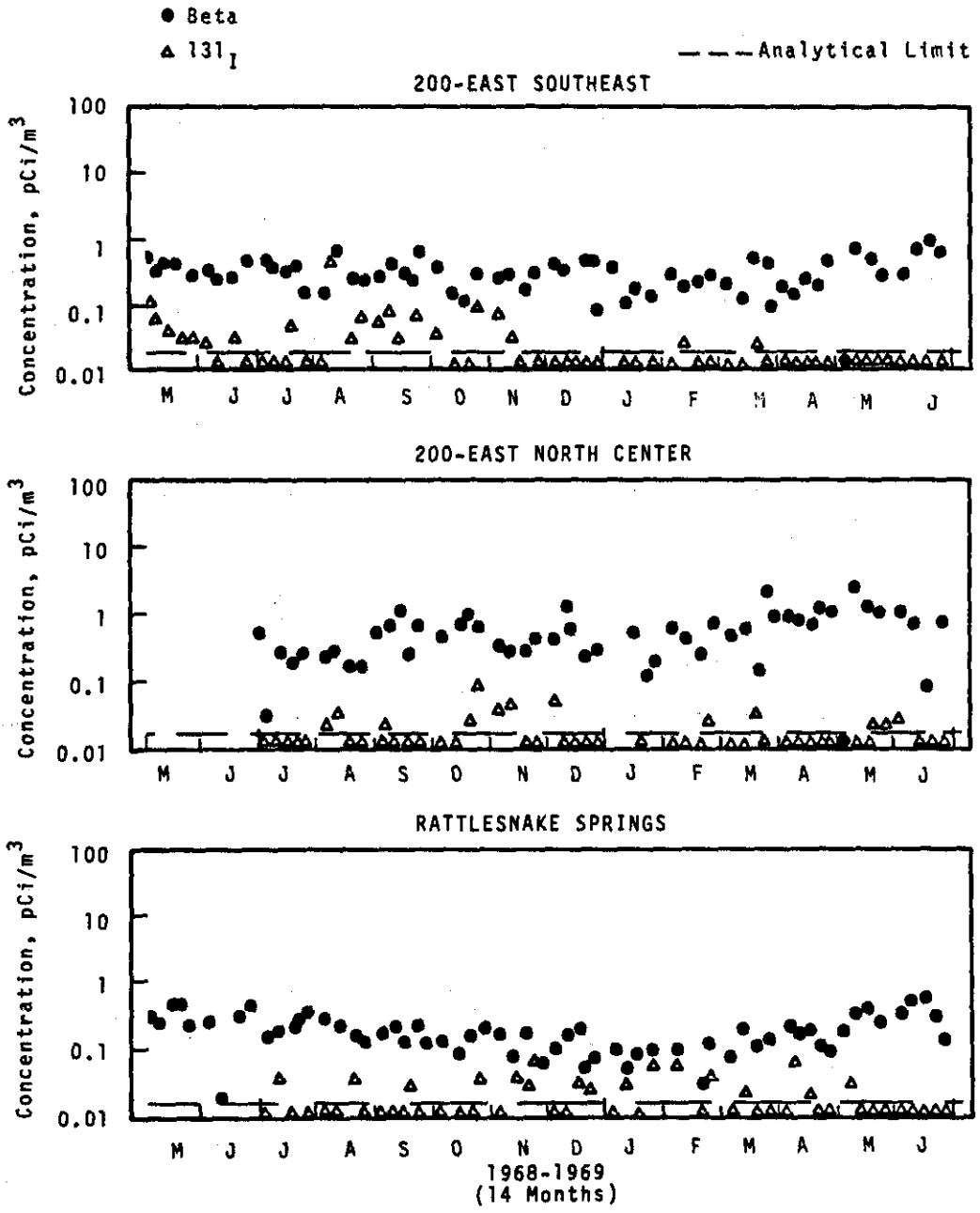
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS



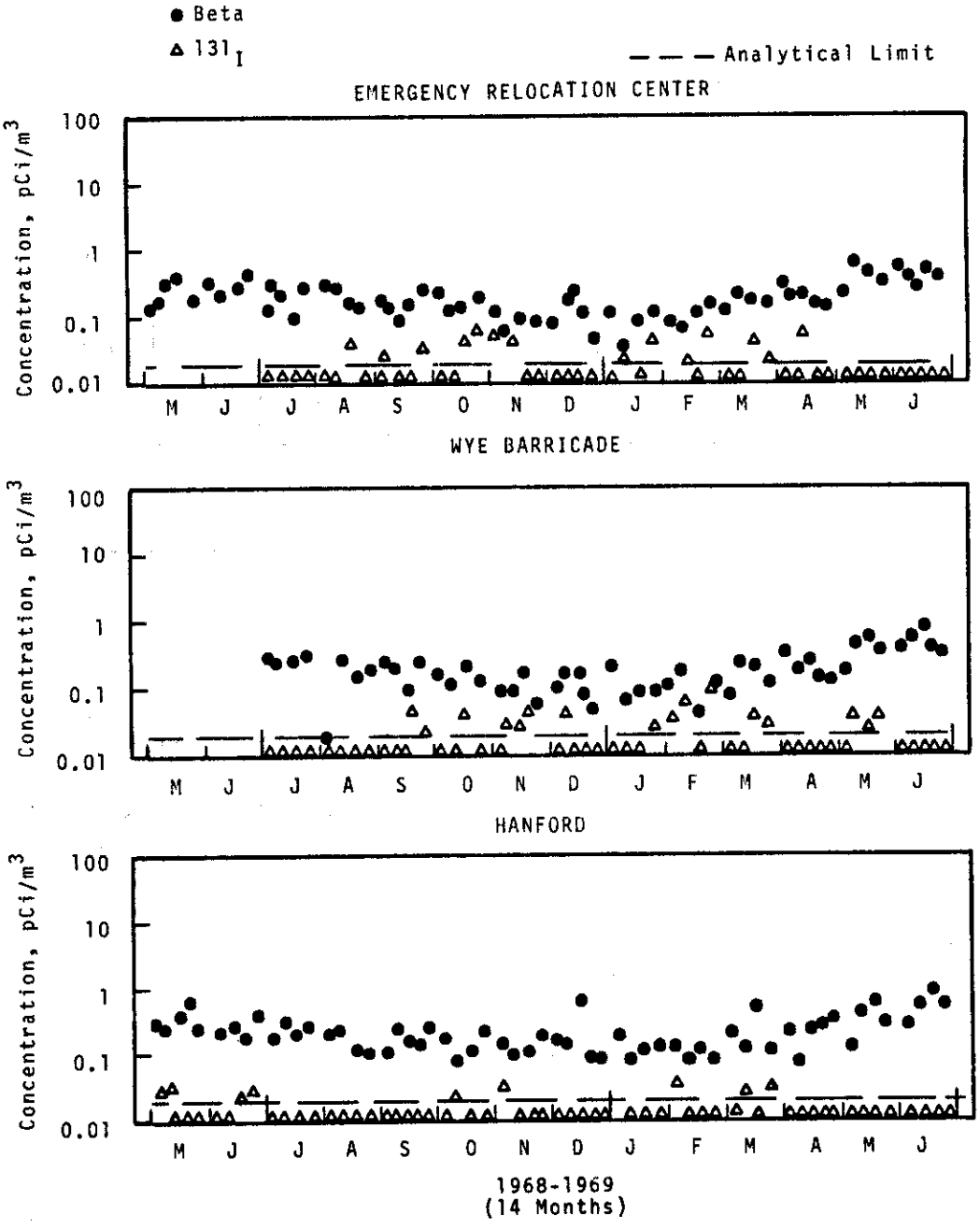
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS



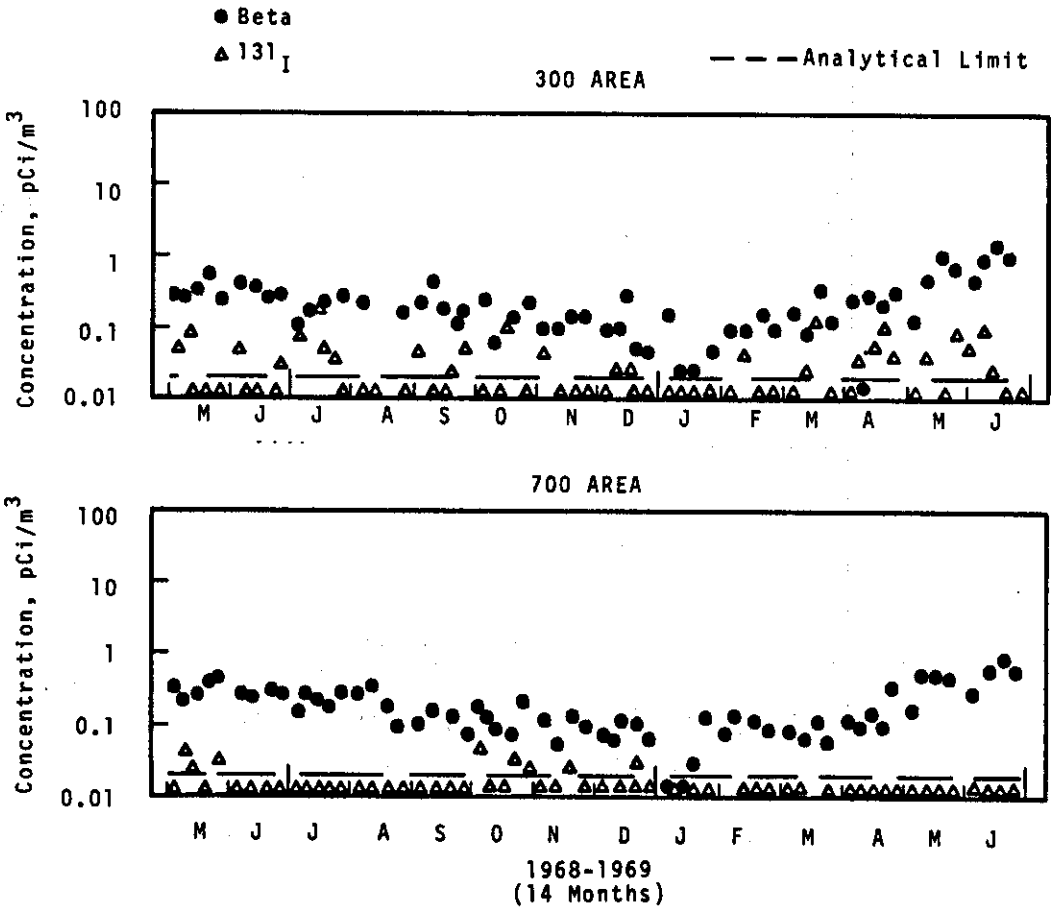
IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND INTERMEDIATE AREAS



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
INTERMEDIATE AREAS



IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
300 AND 700 AREAS



Total Alpha

Fourteen of the twenty weekly filters that are analyzed for beta-gamma emitting radionuclides are also analyzed for alpha activity, with most such sampling sites located in the 200 Areas. These data are presented in Figures 15-19. Routine analysis of the 100-K and Rattlesnake Springs filters for the presence of alpha emitters was begun in January, 1969.

Alpha counting of the filters is normally done after 48 hours to allow for the decay of short-lived activity from naturally-occurring daughters of radon-thoron.

A month-by-month summary of transient increases during the first half of 1969 is summarized below. Because the analytical limit for total alpha concentrations in air (0.01 $pCi\alpha/m^3$) is a significant fraction of the Concentration Guide for individuals in uncontrolled areas for plutonium (Table 8, 0.06 pCi/m^3), results only slightly above the analytical limit are of considerable interest.

The maximum average total alpha activity for the first six months of 1969 was 0.02 $pCi\alpha/m^3$. This maximum occurred at both the 200-East East Center and 200-East Northeast sampling locations.

The six-month average total alpha concentrations in the atmosphere for 1969 are presented in Table 11. For comparison, averages for the previous three years are also shown.

TABLE 11. Average Total Alpha Concentrations in the Atmosphere

Location	1965	1966	1967	1968	Jan-June 1969
100 Areas	<0.02	0.01	0.01	0.006	0.007
200 Areas	<0.03	0.01	0.02	0.006	0.010
300 Area	0.08	0.02	0.01	0.011	0.009
700 Area	<0.02	0.02	0.01	0.006	0.005

NOTE: During the first half of 1969 sampling locations included in the average were: 100 Areas--B, K, and F; 200 Areas--200-West (Northeast, West Center, Redox and East Center) and 200-East (West Center, Southeast East Center and North Center). The Analytical Limit is 0.010 pCi/m^3.

January:

Total alpha concentrations at 100-K during the period 12-30-68 to 1-6-69 were 0.02 pCi/m^3 but decreased to 0.004 pCi/m^3 in the following week.

February:

Total alpha concentrations during the week ending 2-24-69 at 200-East East Center and 200-East North Center were both 0.02 pCi/m^3, following the cleaning of a diversion box at the A waste tank farm.

March:

During the following week, total alpha concentrations near 0.02 pCi/m^3 were noted at 100-F and 100-K.

A week later, the filter from 200-East East Center for the period 3-6-69 to 3-10-69 indicated 0.03 pCiα/m^3. Higher than usual alpha radioactivity in airborne particulates was observed on most samples from around the 200 Areas for the week ending 3-25-69 when the highest total alpha concentration measured during the first six months of 1969 (0.25 pCiα/m^3) occurred on the filter from the east side of 200 East Area. Analysis indicated a mixture of ^{239}Pu and either ^{241}Am or ^{238}Pu. Assuming a mixture of ^{238}Pu and ^{239}Pu in a soluble form, the indicated concentrations were greater than the AECM Chapter 0524 Concentration Guides for non-occupationally exposed individuals (Table 8). ARHCO personnel were notified. Work in duckwork at the Purex facility PR vault might have caused the observed concentrations.

Concentrations during the same period were near to or exceeded 0.02 pCiα/m^3 at 200-West East Center, 200-West Northeast, 200-East North Center and 200-East Redox (0.09, 0.04, 0.03, and 0.02 pCiα/m^3, respectively).

April:

Concentrations of total alpha activity approached or exceeded 0.02 pCi/m^3 at several locations in early April. A re-count of the highest result (200-East North Center filter) indicated that the high initial alpha concentration had decayed from 0.04 to 0.03 pCi/m^3 indicating that some of the activity was not due to long-lived alpha emitters. Alpha concentrations at 200-East North Center remained near or above 0.02 pCi/m^3 through most of June.

Total alpha concentrations of about 0.02 pCi/m^3 during April were observed at 200-East East Center 4-14 to 4-28.

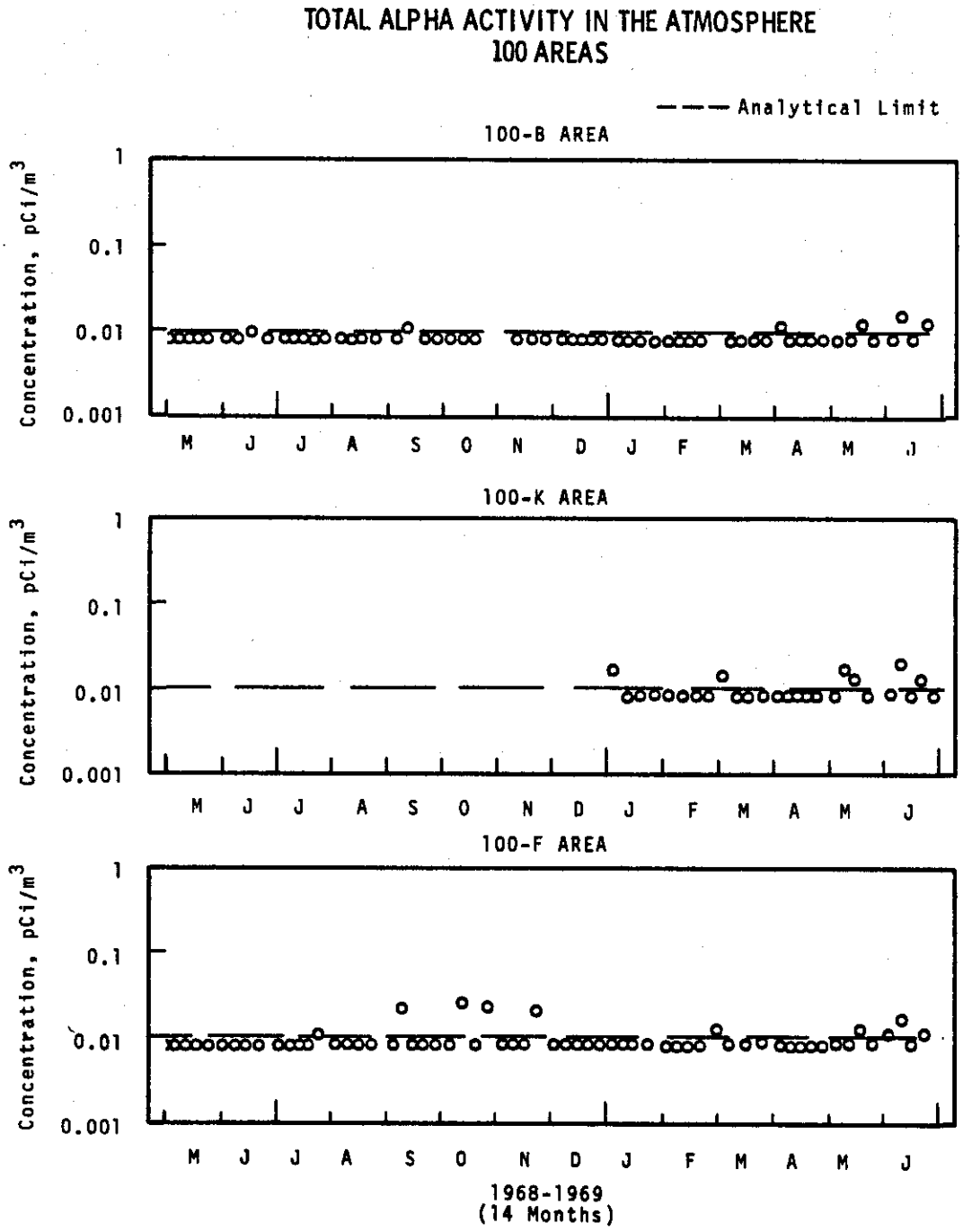
May:

Concentrations on air filters from every location increased in May. Total alpha activity exceeded 0.02 pCi/m^3 during the week 5-5 to 5-12 at 200-East North Center, 200 East Southeast, 200-West West Center, Benton City, 100-K, 200-West Northeast, and 200-East West Center Redox, 200-West East Center (0.09, 0.03, 0.02, 0.02, 0.02, and 0.02, respectively). The increased total alpha concentrations in the 200 East Area were attributed to tank farm operations in that area. During the remainder of the month, only filters from 200-East North Center had alpha activity exceeding 0.02 pCi/m^3.

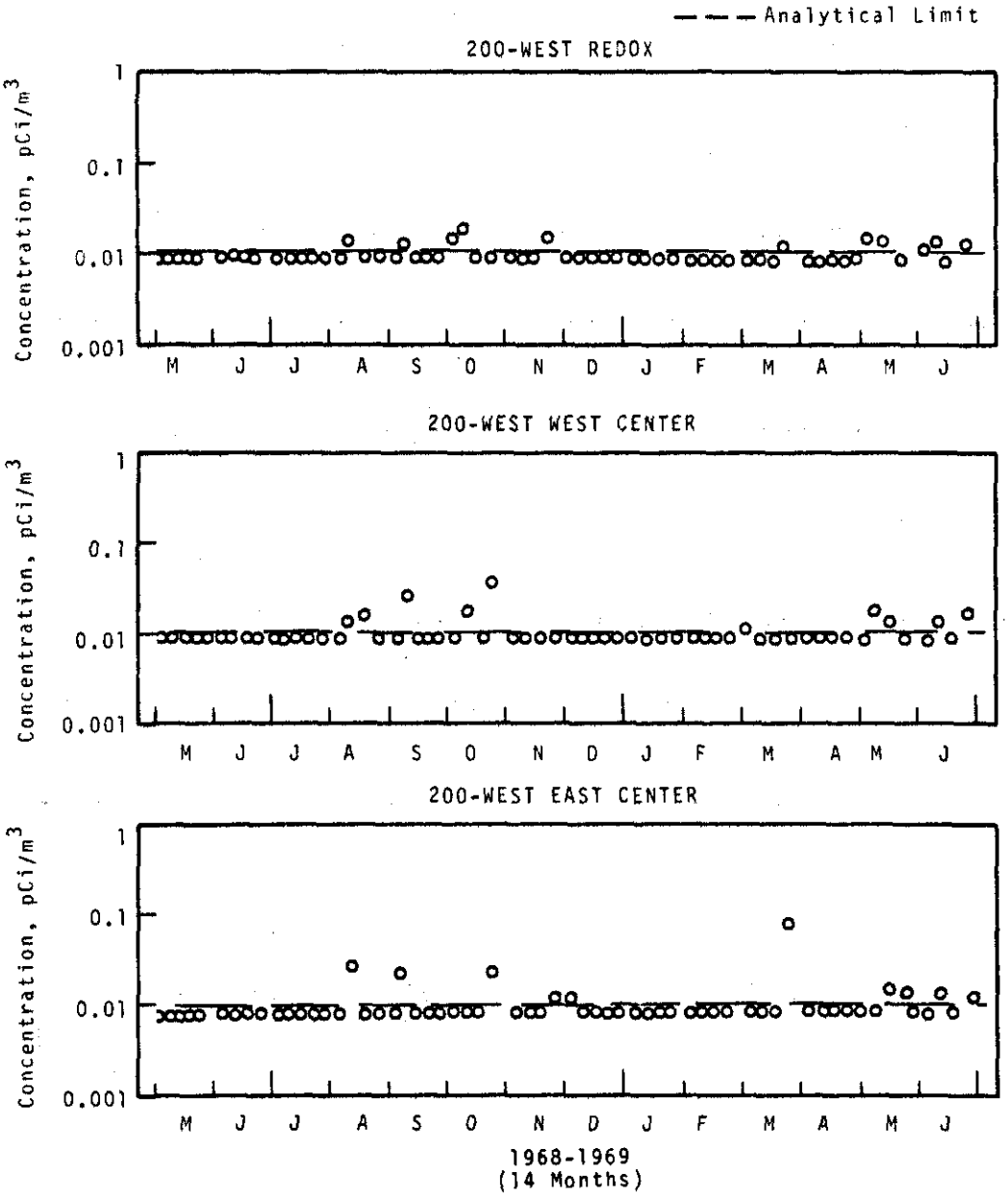
June:

In early June, the alpha activity at 200-East North Center increased to 0.03 pCi/m^3 but in the following week decreased to 0.02 pCi/m^3. In the week of 6-2 to 6-9 increases were noted at 100-K, 700 Area, and the 300 Area. During the week of 6-16 the highest alpha concentration during the month was measured on a filter from the 300 Area (0.06 pCi/m^3). Higher than usual alpha activity was noted at 200-East East Center, Ringold, and Benton City.

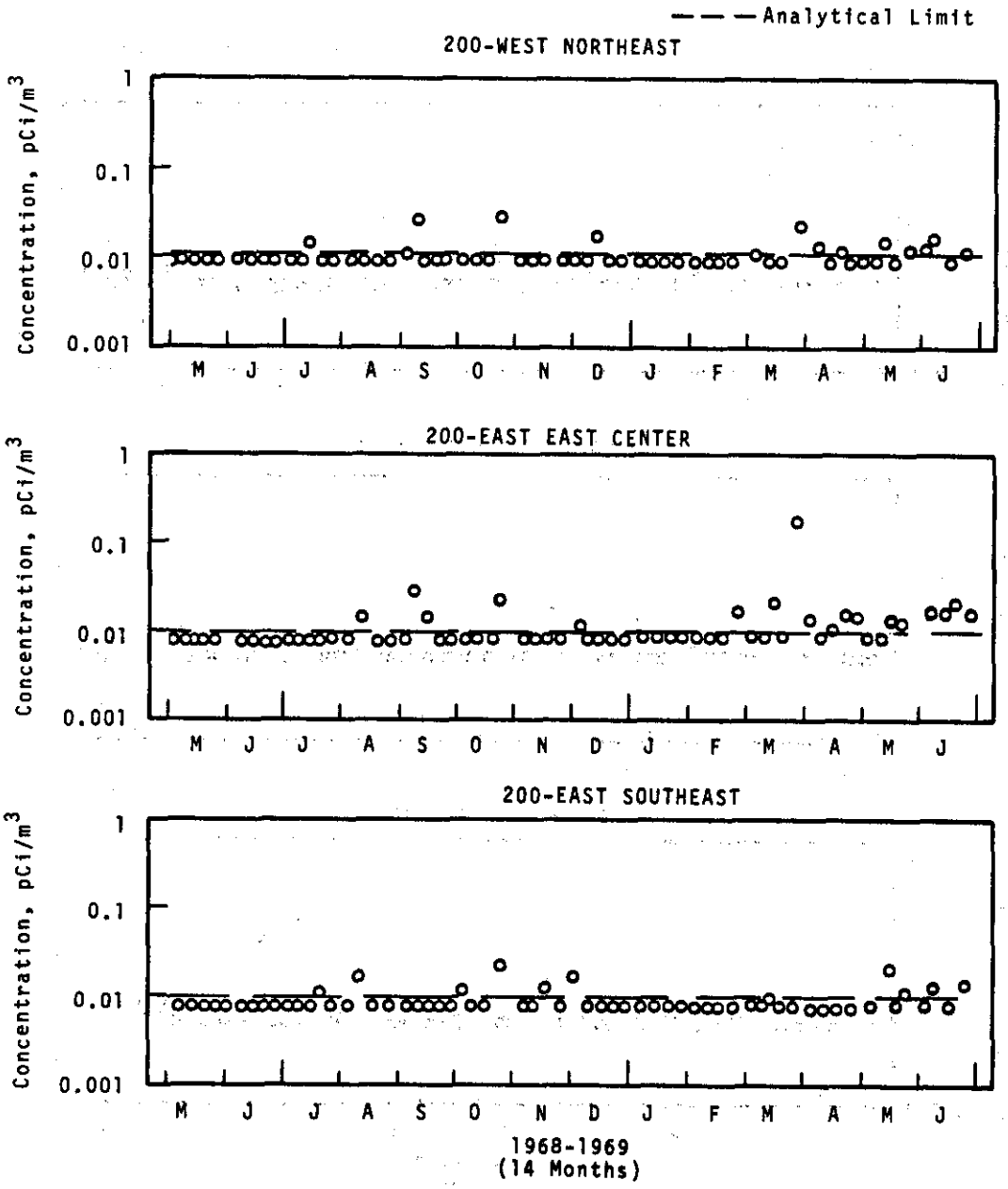
No explanation was found for the increased total alpha concentrations that occurred at several locations in June.


TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
100 AREAS
Analytical Limit
100-B AREA
100-K AREA
100-F AREA
Concentration, pCi/m3
1
0.1
0.01
0.001
M J J A S O N D J F M A M J
1968-1969
(14 Months)

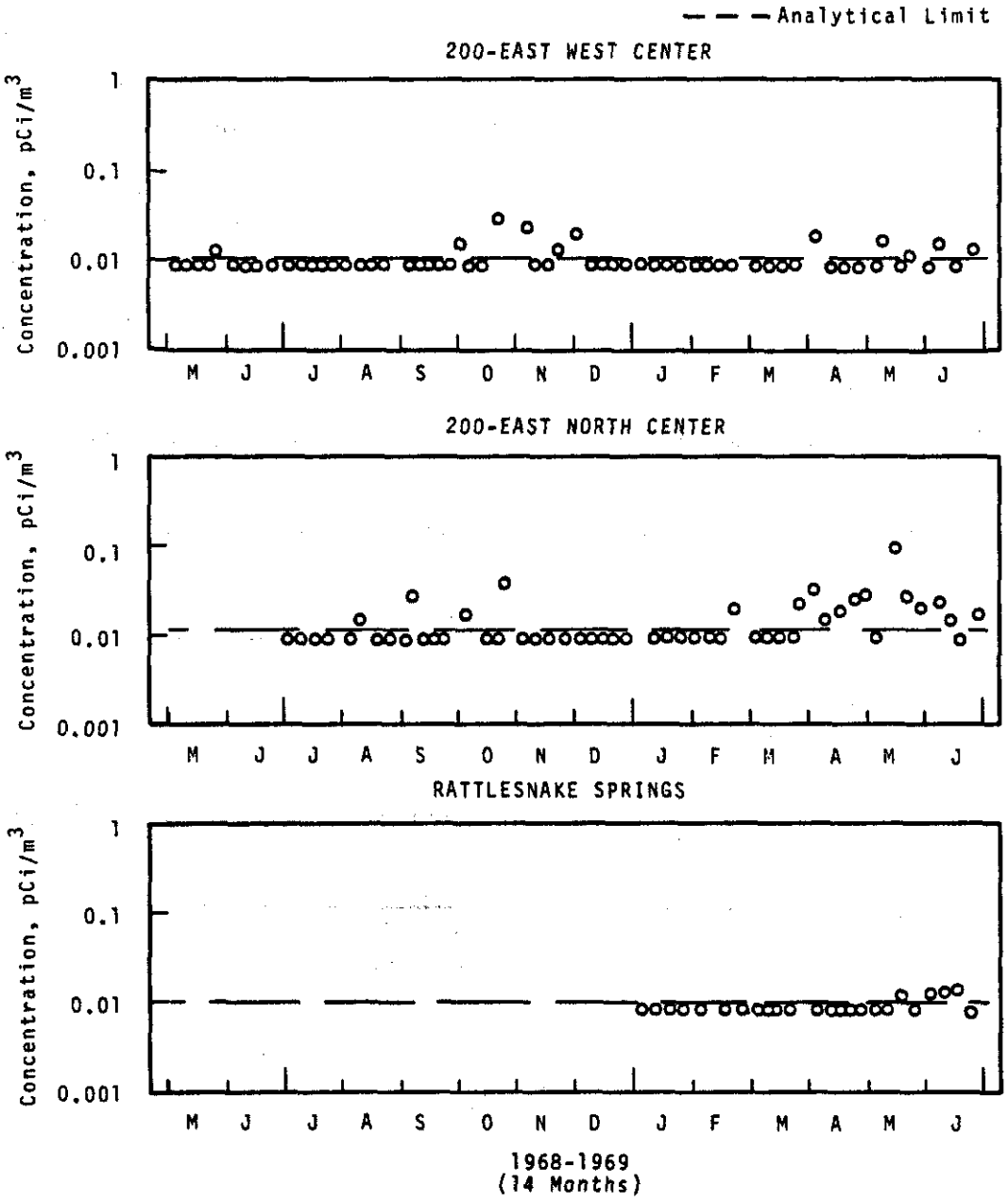
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS



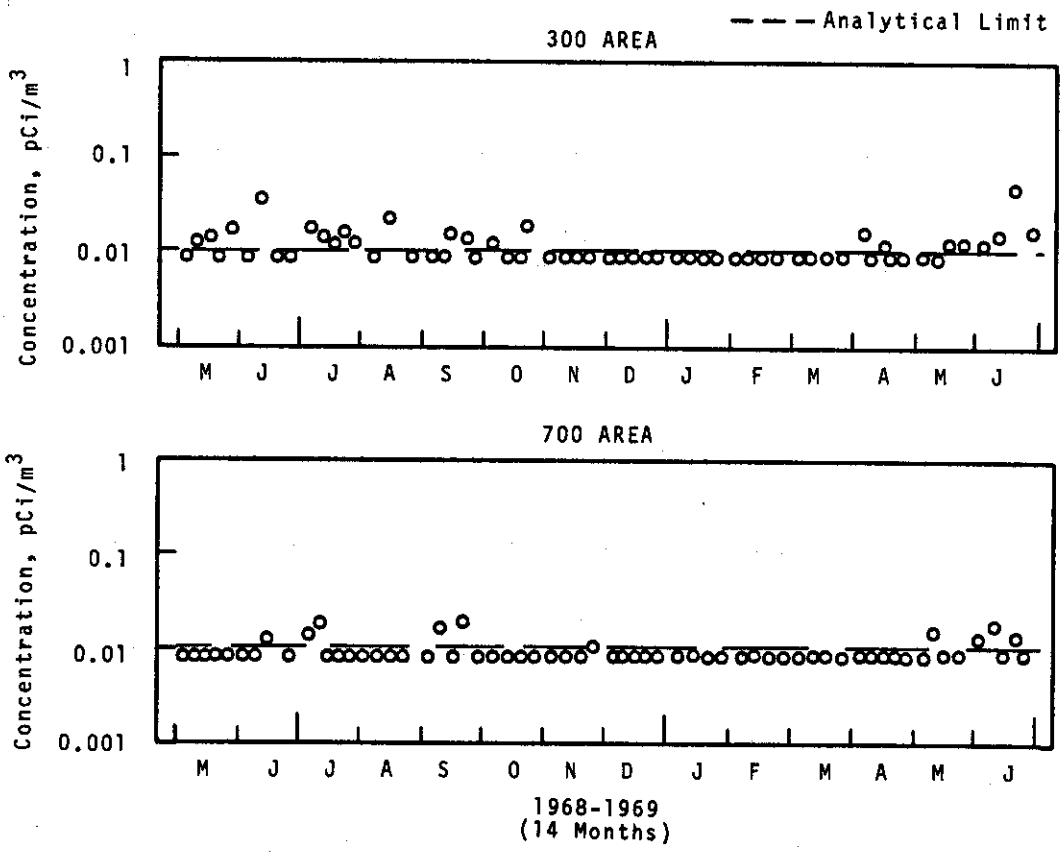
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS



TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND RATTLESNAKE SPRINGS



TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
300 AREA AND 700 AREA



VI. RADIATION SURVEYS

Surface Contamination

1. Hanford Roads

Hanford roads are routinely surveyed (see Map 4) with a bioplastic scintillation detector attached to the front end of a truck and positioned about two feet above the road surface. This road monitor has been described in BNWL-62. The routes between the 300 Area and the 200 Areas were surveyed bi-weekly during the report period; the remainder of the Hanford roads were surveyed monthly. In May, road monitor trip No. 12 (300 Area environs) was replaced by No. 15, thus eliminating areas which were difficult to evaluate due to proximity of radiation sources.

The only instance of radioactivive particulate contamination found on road surveys during the first half of 1969 was along Route 4S. The radioactive particle detected on June 4, 1969, was associated with the soil and had a surface reading of 20,000 c/m (GM). The major gamma emitter was ^{60}Co. Unusual responses noted on surveys are summarized below:

February:

On February 12, 1969, a sustained response that was noted along Route 8 from the Yakima Barricade to the junction of Route 6 was attributed to fog from the reactor basins.

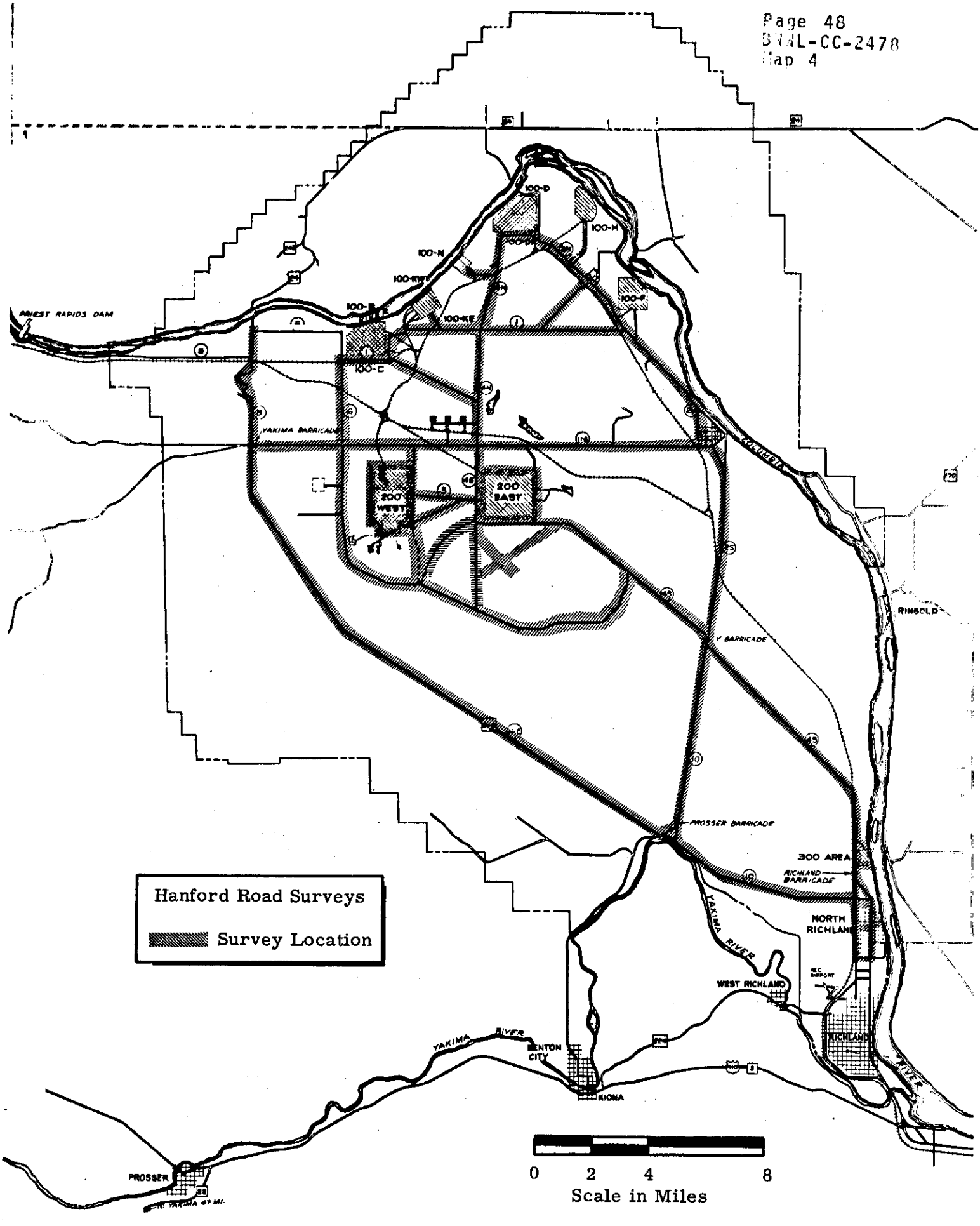
On February 27, 1969 an unusual response was noted on the road monitor along Route 4S near the southeast corner of 200 East Area. However, a GM survey indicated less than 200 c/m.

March:

Following a reported high air concentration on March 5, 1969, a special survey around 200 East Area detected no unusual activity.

June:

South of the Wye Barricade on Route 4S, a routine survey detected a radioactive particle [20,000 c/m surface (GM)] in the gravel at the east side of the road on June 4, 1969. The major gamma emitter was ^{60}Co. Appropriate personnel were notified.


100-D
100-H
100-N
100-KW
100-B
100-KE
100-F
100-C
PRIEST RAPIDS DAM
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
Hanford Road Surveys
Survey Location
0 2 4 8
Scale in Miles

North of the Wye Barricade on Route 4S, an unusual response was noted on June 26, 1969, on a routine survey. Survey of the area indicated a general increase of 100-150 c/m above background. No discrete particles were detected.

2. Control Plots

Thirty-nine small areas, called control plots, are located within the Hanford boundaries (see Map 5). These plots, measuring 10' by 10', are periodically surveyed with a GM survey meter for deposited radioactive material. In addition, thirty-two special control plots located near test wells are usually surveyed on a semi-annual basis; however, no such survey was conducted during the first half of 1969.

On three occasions during the first six months of 1969, surveys of control plots detected radioactive deposition on Control Plot 10 on the east perimeter of 200 East. No radioactive particles were detected on other control plots during this period. For comparison, two instances of radioactive deposition were detected on control plots on the perimeter of 200 East Area during the last six months of 1968.

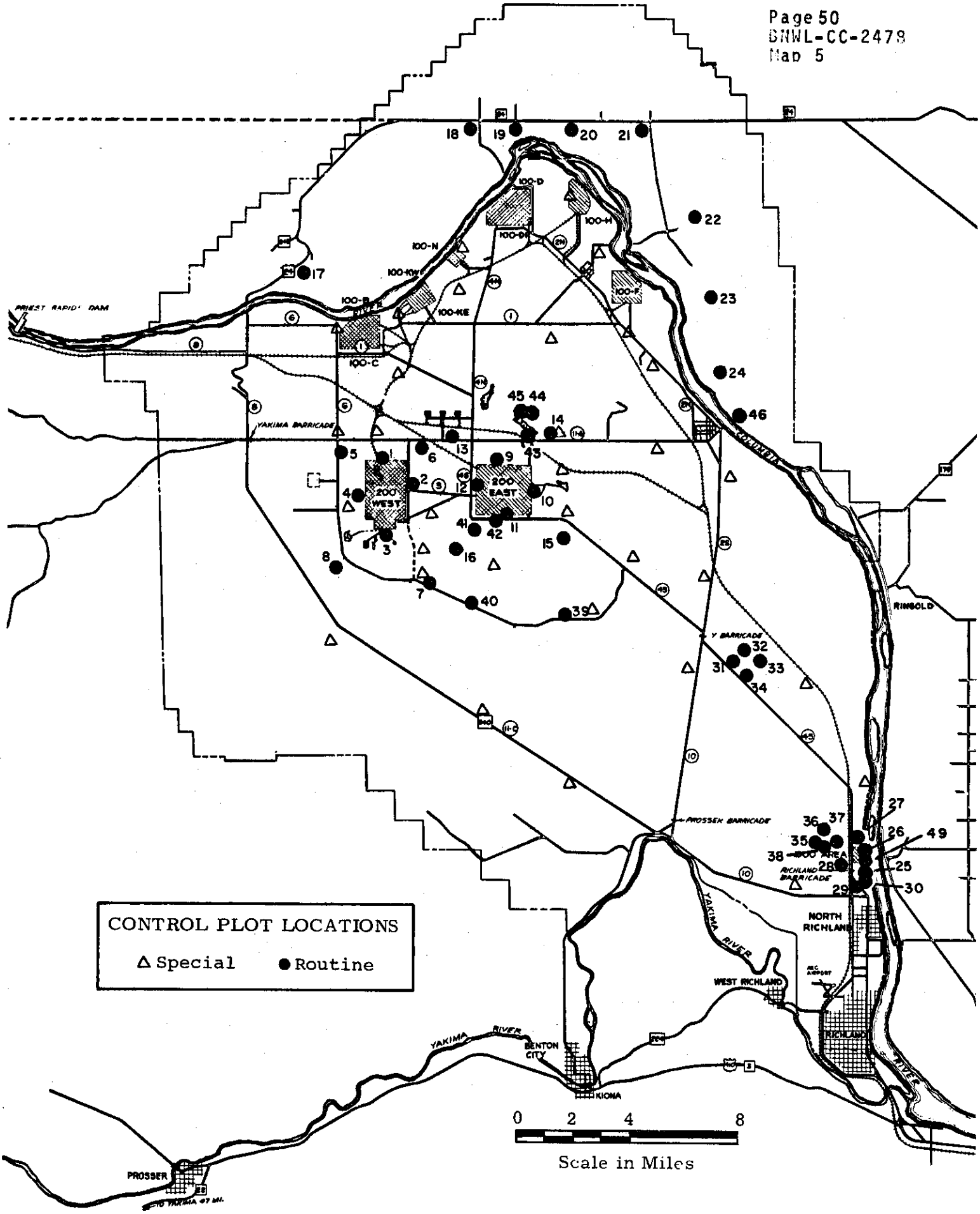
Low-level activity (250-300 c/m GM-Surface) was detected on Control Plot 10 at the east perimeter of 200 East Area on March 6, 1969, following a particulate release from Purex. Surveys of other 200 East Area Control Plots found no activity above background.

On May 20, 1969, a general activity level of 300 c/m and a maximum surface reading of 6,000 c/m (GM) was detected on Control Plot 10. Analysis of a sand sample indicated that the principal gamma emitter was ^{106}Ru-Rh with some ^{144}Ce-Pr also present. Appropriate personnel were notified.

Unusual activity was detected again on Control Plot 10 on June 3, 1969, with a maximum surface reading of 4,500 c/m (GM). The major gamma emitter was ^{106}Ru-Rh. A re-survey on June 17, 1969, detected no radioactive particles.

3. Special Surveys

A series of vegetation samples were collected around the 200 East Area following the increased alpha and beta concentrations noted on air filters during March. Beta activity was highest on vegetation from the east and north of 200 East Area. The maximum beta concentration was 13 pCi/g (wet weight) on a sample obtained near well 699-42-42.


CONTROL PLOT LOCATIONS
△ Special
● Routine
0 2 4 8
Scale in Miles
100-D
100-H
100-N
100-KW
100-KE
100-B
100-C
100-F
200 WEST
200 EAST
YAKIMA BARRICADE
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
300 AREA
RINGOLD
NORTH RICHLAND
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
YAKIMA RIVER
COLUMBIA RIVER

The principal gamma emitters were ^{137}Cs-^{137m}Ba (8.8 pCi/g) and ^{144}Ce-Pr. Alpha activity on vegetation collected during this same survey was about 0.04 pCi/g. The highest alpha concentration (0.09 pCi/g) was on a sample collected near the 200-West gate.

4. Waste Disposal Sites

Retired waste burial grounds and areas where surface contamination is known to exist are inspected periodically for general physical condition and evidence of disturbance. The locations of such sites outside plant areas are shown in Map 6. During the first half of 1969, inspections were made of all the indicated areas.

No unusual radiation levels were observed, however, the following conditions were noted and appropriate personnel were notified.

February:

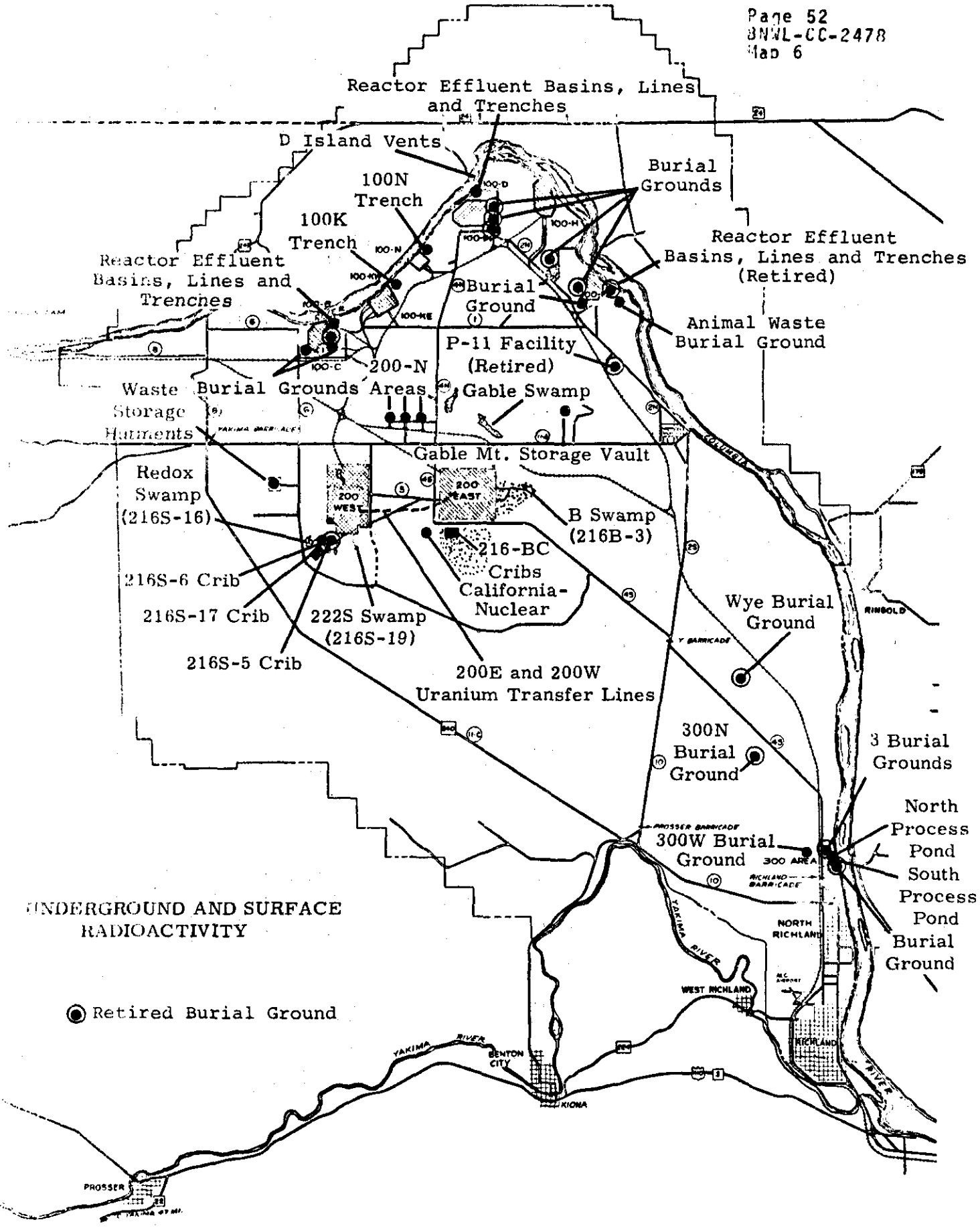
On February 20, steam leaks were noted along the 100-C effluent line. At 100-F Area, the southwest burial ground had an open chain fence and open old slag disposal holes. The biology burial ground was open and uncovered. At Gable Mountain storage vault, the southwest corner was washed out. Signs were faded along the uranium transfer lines. Trash was blowing outside the chain at the 300 West Burial Ground.

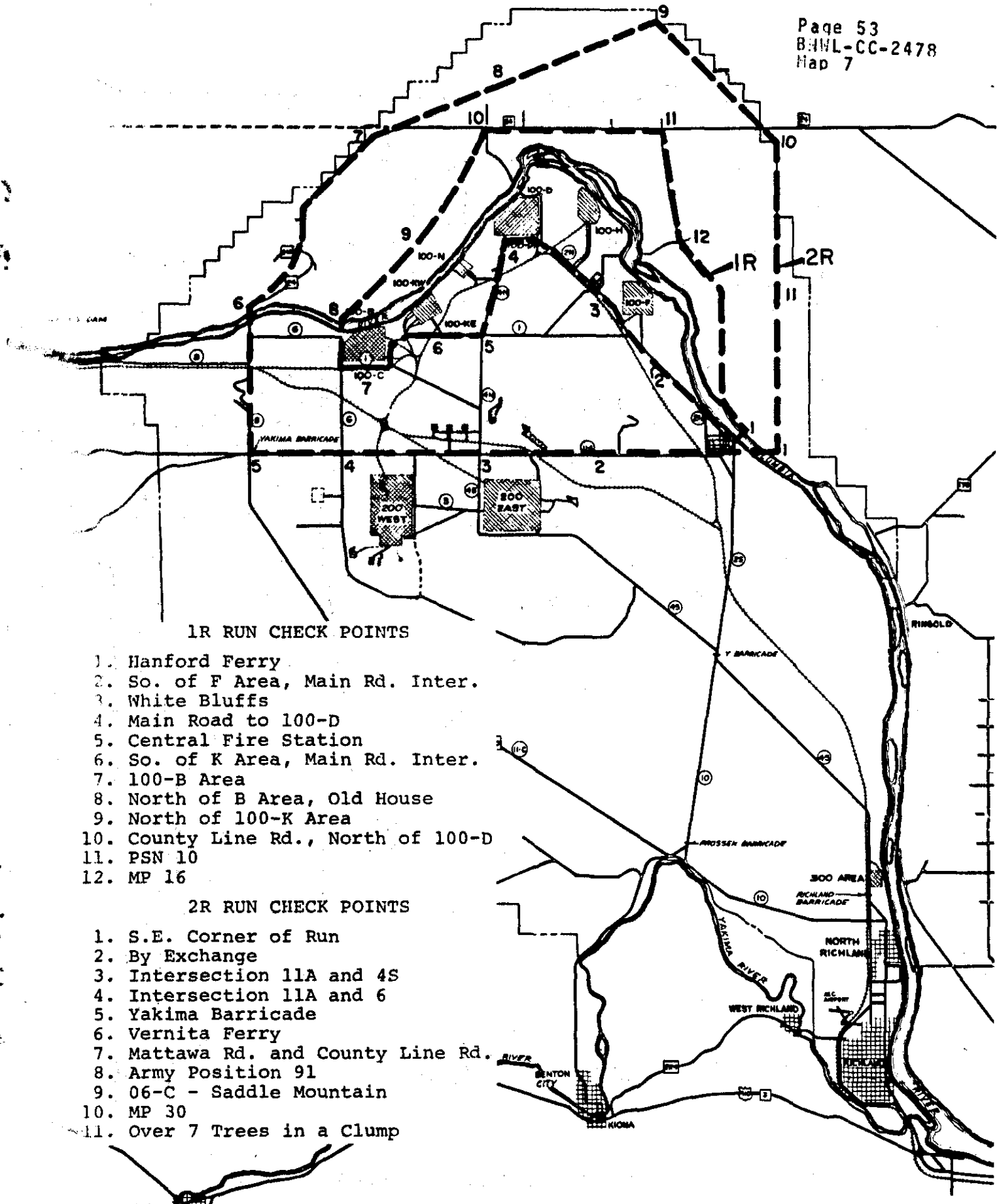
April:

On April 15, a leak was noted along the 100-B-C effluent lines. Sign appeared to be in need of repair. At 100-F Area, the Lewis Canal was not well-marked (chain and signs were down).

5. Aerial Surveys

Aerial surveys can be used to detect contamination which is spread over a large land area. Like road and control plot surveys, aerial surveys are only qualitative in nature, but through routine use of this technique, a capability for rapid assessment of an emergency situation is maintained. All surveys are conducted at an altitude of 150 meters (500 feet) using a three inch by five inch NaI (Tl) scintillation crystal detector. Aerial survey flights made during the period January-June, 1969, are shown on Maps 7-14. Two flight patterns cover the Columbia River from Priest Rapids Dam to the Pacific Ocean, and two other flight patterns cover the Richland-Pendleton-Spokane "triangle" and the Richland-


Reactor Effluent Basins, Lines and Trenches
D Island Vents
100N Trench
100K Trench
Burial Grounds
Reactor Effluent Basins, Lines and Trenches
Reactor Effluent Basins, Lines and Trenches (Retired)
Burial Ground
Animal Waste Burial Ground
P-11 Facility (Retired)
200-N Waste Storage Tanks
Burial Grounds Areas
Gable Swamp
Gable Mt. Storage Vault
Redox Swamp (216S-16)
B Swamp (216B-3)
216-BC Cribs California-Nuclear
216S-6 Crib
216S-17 Crib
222S Swamp (216S-19)
216S-5 Crib
200E and 200W Uranium Transfer Lines
Wye Burial Ground
300N Burial Ground
3 Burial Grounds
North Process Pond
South Process Pond
300W Burial Ground
Burial Ground
UNDERGROUND AND SURFACE RADIOACTIVITY
Retired Burial Ground
200 WEST
200 EAST
300 AREA
RICHLAND
NORTH RICHLAND
WEST RICHLAND
BENTON CITY
KIONA
PROSSER
YAKIMA RIVER
COLUMBIA RIVER
RINGOLD
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE



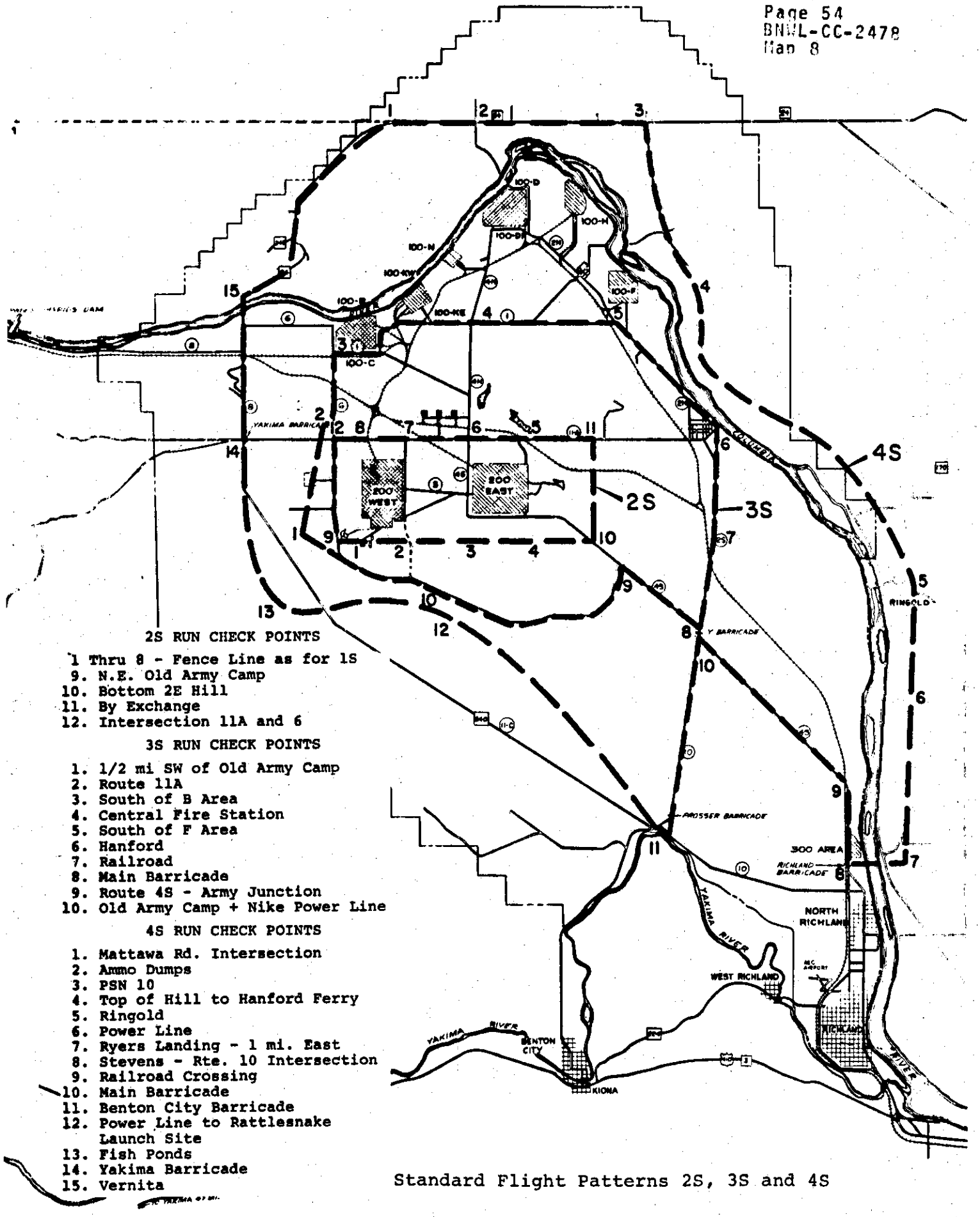
1R RUN CHECK POINTS

1. Hanford Ferry
2. So. of F Area, Main Rd. Inter.
3. White Bluffs
4. Main Road to 100-D
5. Central Fire Station
6. So. of K Area, Main Rd. Inter.
7. 100-B Area
8. North of B Area, Old House
9. North of 100-K Area
10. County Line Rd., North of 100-D
11. PSN 10
12. MP 16

2R RUN CHECK POINTS

1. S.E. Corner of Run
2. By Exchange
3. Intersection 11A and 4S
4. Intersection 11A and 6
5. Yakima Barricade
6. Vernita Ferry
7. Mattawa Rd. and County Line Rd.
8. Army Position 91
9. 06-C - Saddle Mountain
10. MP 30
11. Over 7 Trees in a Clump

Standard Flight Pattern 1R and 2R



2S RUN CHECK POINTS

1 Thru 8 - Fence Line as for 1S
9. N.E. Old Army Camp
10. Bottom 2E Hill
11. By Exchange
12. Intersection 11A and 6

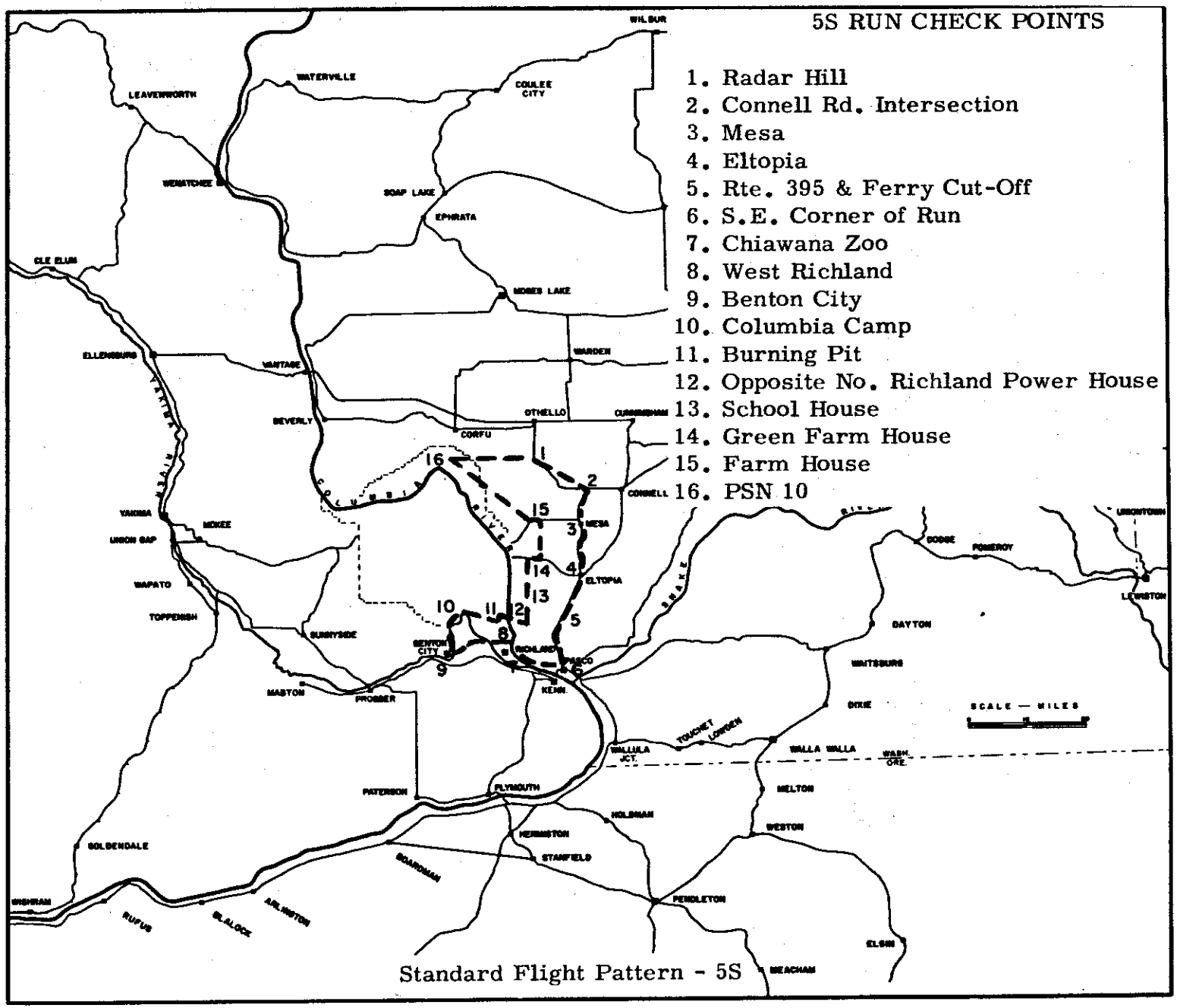
3S RUN CHECK POINTS

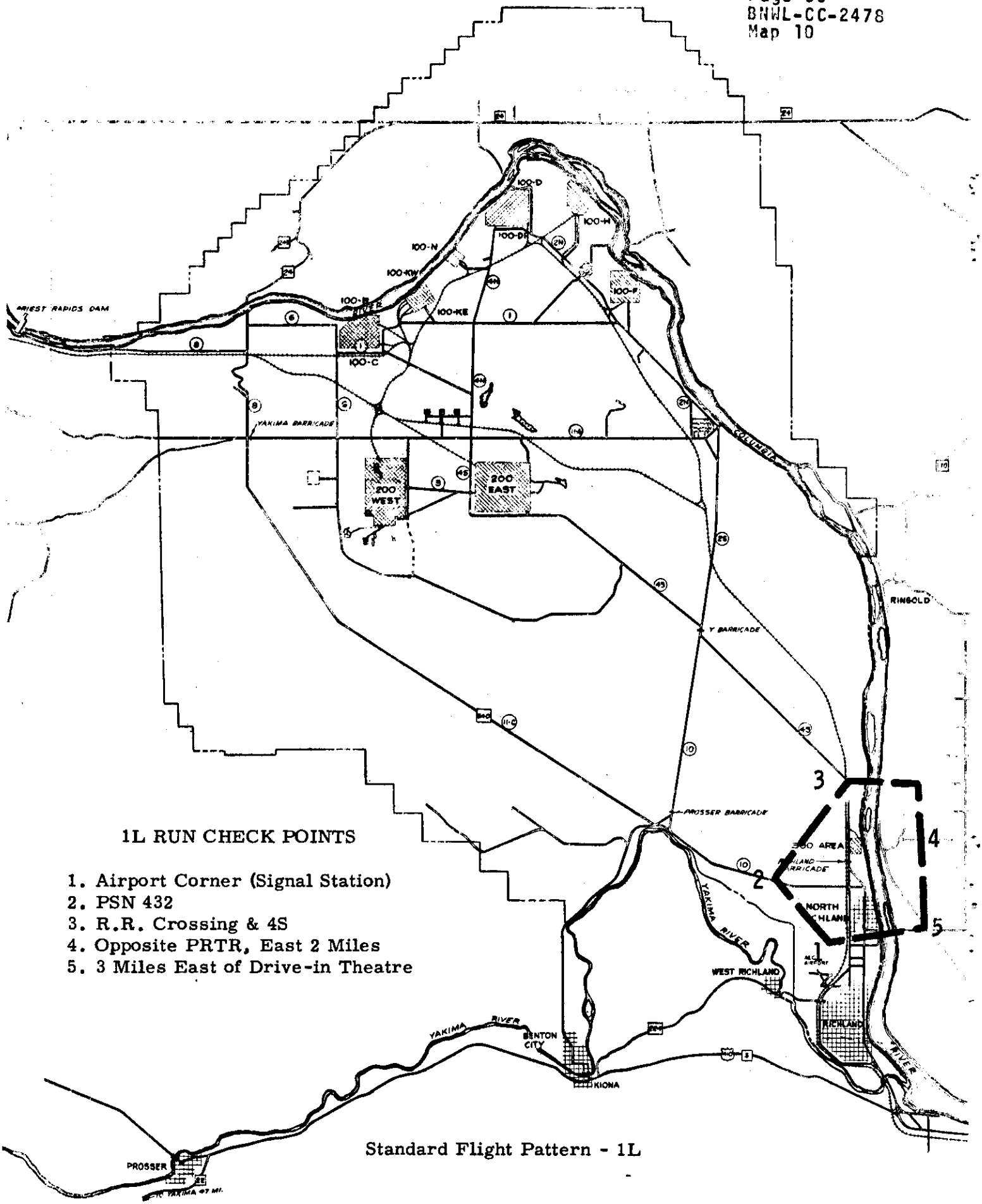
1. 1/2 mi SW of Old Army Camp
2. Route 11A
3. South of B Area
4. Central Fire Station
5. South of F Area
6. Hanford
7. Railroad
8. Main Barricade
9. Route 4S - Army Junction
10. Old Army Camp + Nike Power Line

4S RUN CHECK POINTS

1. Mattawa Rd. Intersection
2. Ammo Dumps
3. PSN 10
4. Top of Hill to Hanford Ferry
5. Ringold
6. Power Line
7. Ryers Landing - 1 mi. East
8. Stevens - Rte. 10 Intersection
9. Railroad Crossing
10. Main Barricade
11. Benton City Barricade
12. Power Line to Rattlesnake Launch Site
13. Fish Ponds
14. Yakima Barricade
15. Vernita

Standard Flight Patterns 2S, 3S and 4S

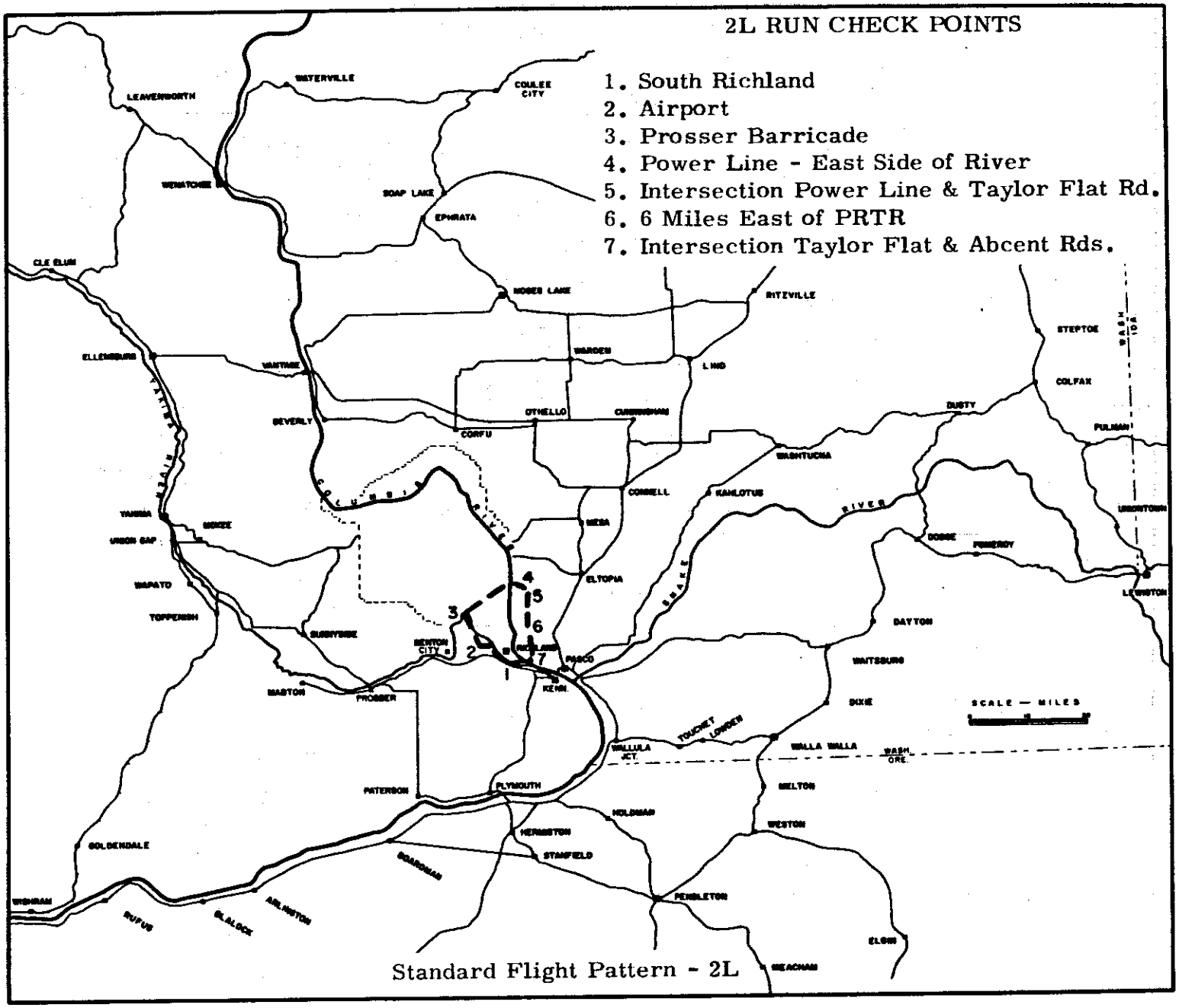

5S RUN CHECK POINTS
1. Radar Hill
2. Connell Rd. Intersection
3. Mesa
4. Eltopia
5. Rte. 395 & Ferry Cut-Off
6. S.E. Corner of Run
7. Chiawana Zoo
8. West Richland
9. Benton City
10. Columbia Camp
11. Burning Pit
12. Opposite No. Richland Power House
13. School House
14. Green Farm House
15. Farm House
16. PSN 10
WILBUR
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
ELLENSBURG
WARDEN
VANTAGE
OTHELLO
CUNNINGHAM
BEVERLY
CORFU
CONNELL
YAKIMA
MOXEE
MESA
UNION GAP
ELTOPIA
WAPATO
TOPPENISH
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
KENN.
MABTON
PROSSER
DAYTON
WAITSBURG
DIXIE
WALLULA JCT.
WALLA WALLA
WASH. ORE.
PATERSON
PLYMOUTH
MELTON
HOLEMAN
WESTON
HERMISTON
SOLDENDALE
STANFIELD
BOARDMAN
PENDLETON
ARLINGTON
RUFUS
BLALOCK
ELSIN
MEACHAM
SCALE — MILES
Standard Flight Pattern - 5S

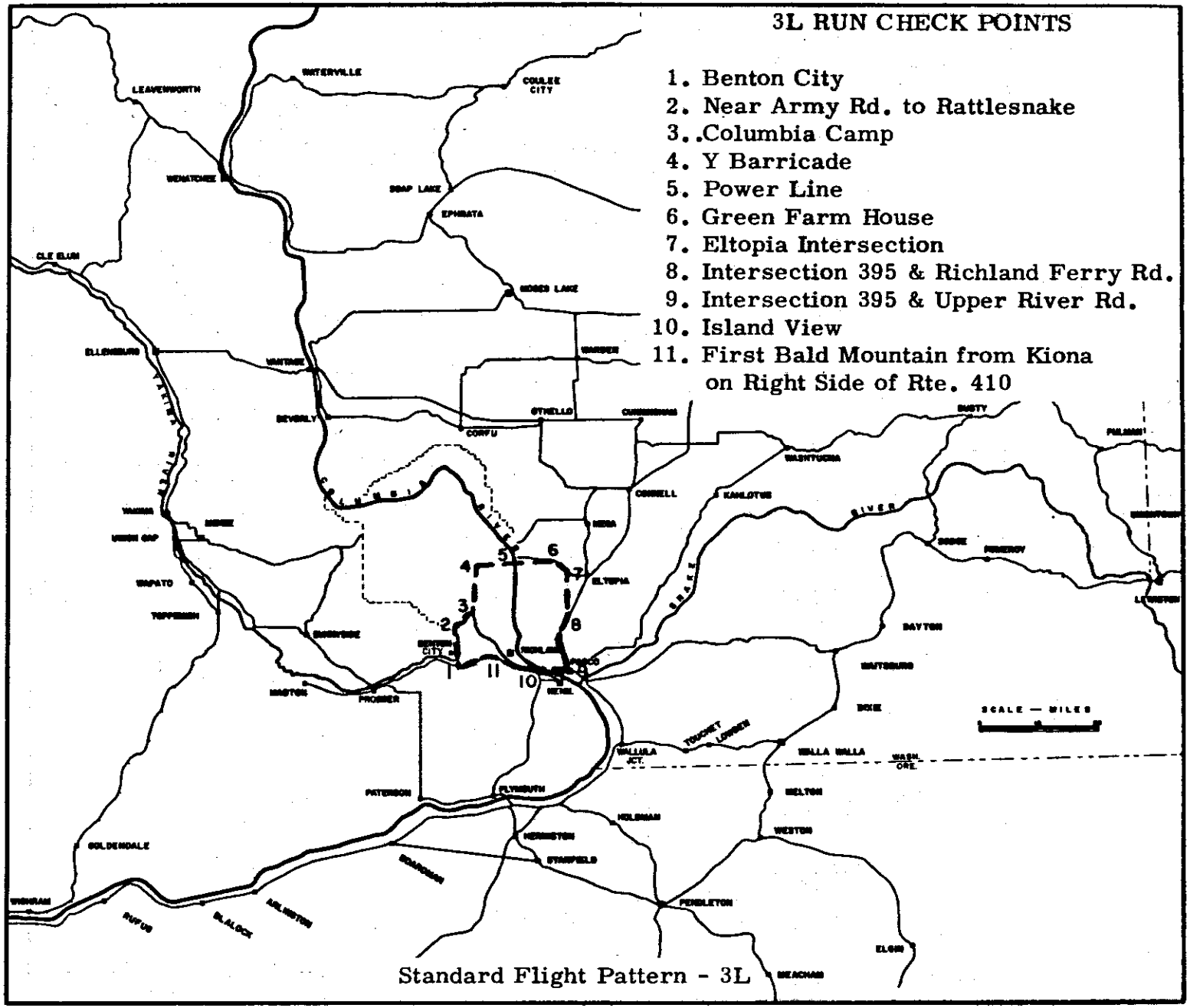


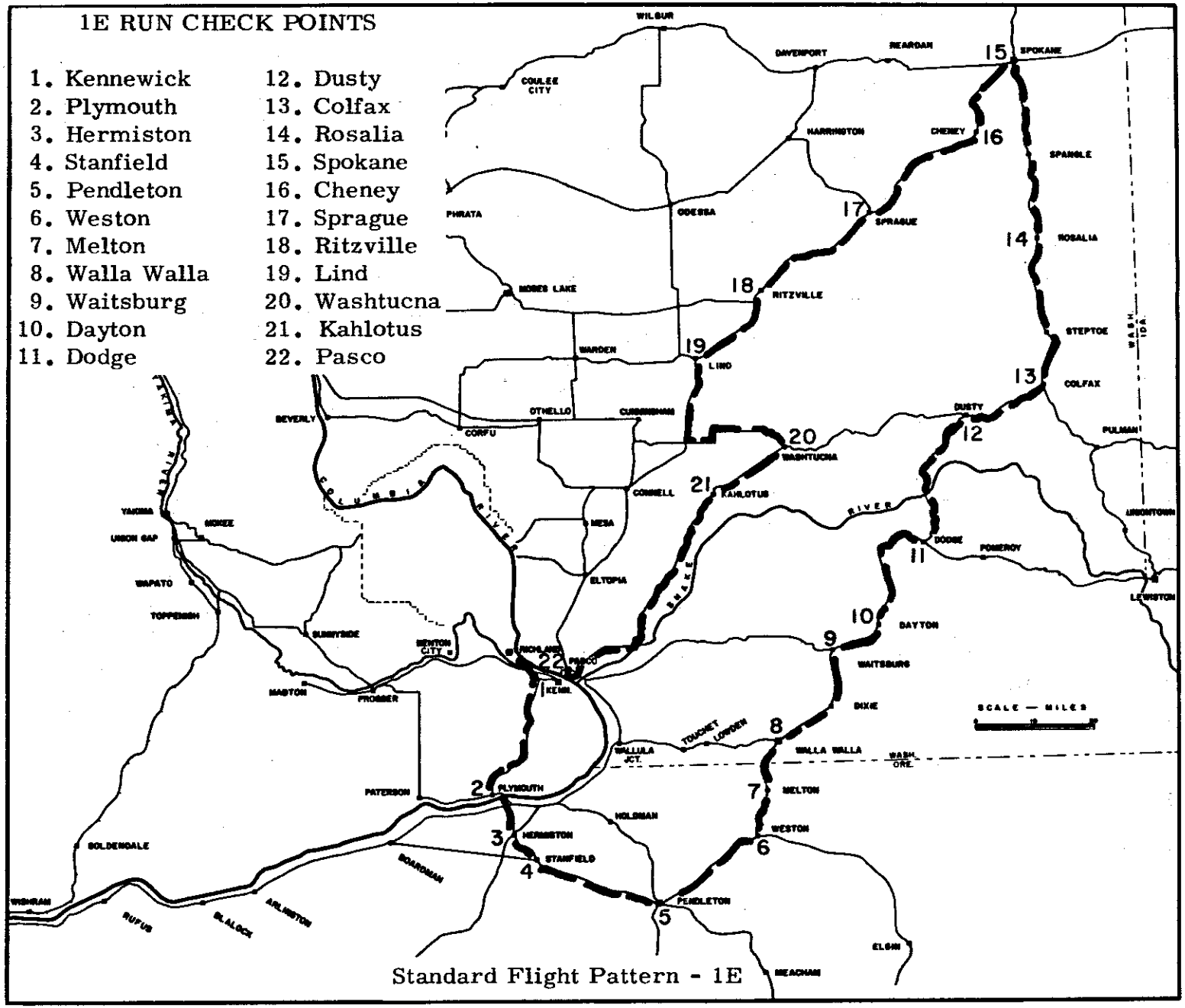
1L RUN CHECK POINTS

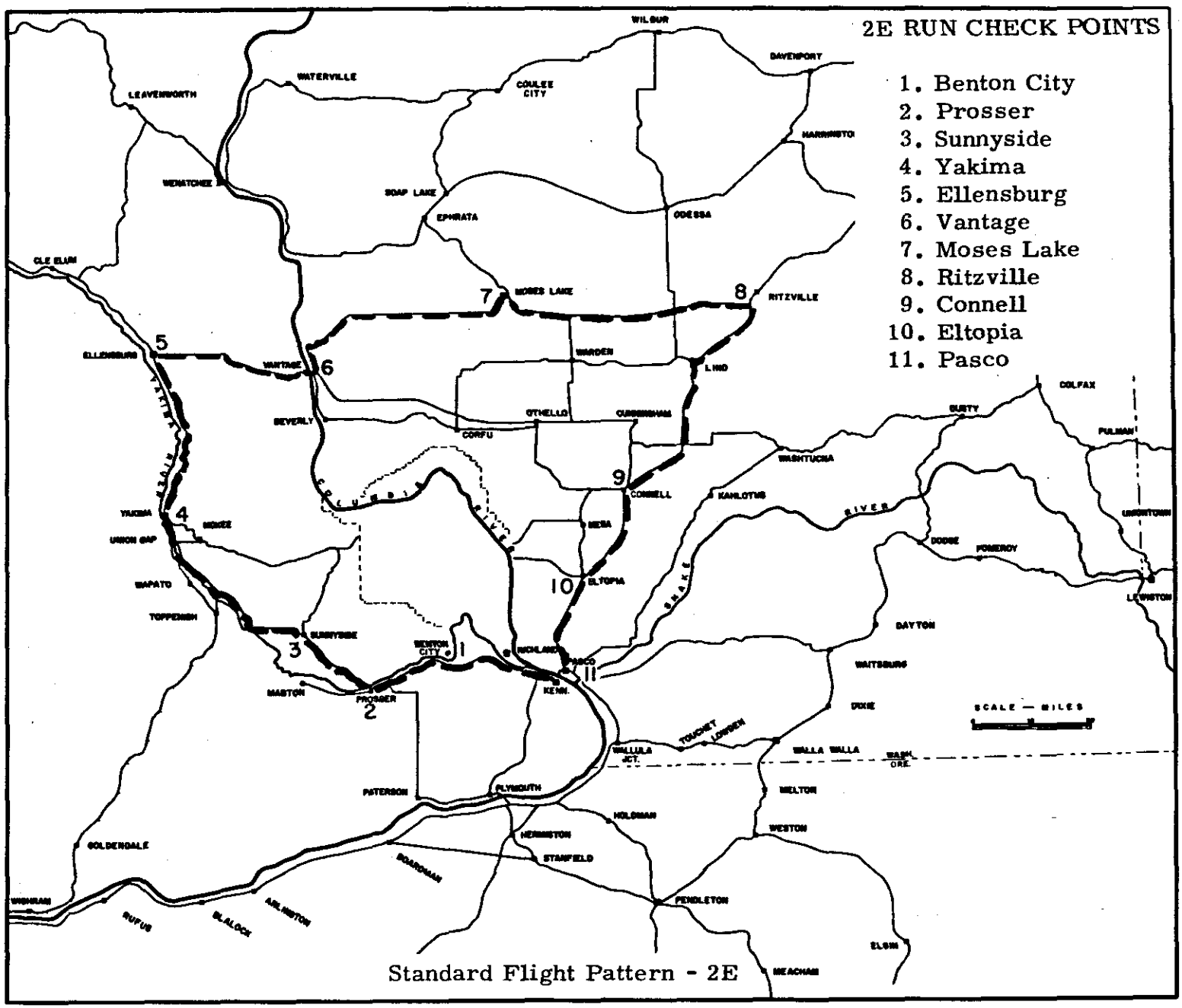
1. Airport Corner (Signal Station)
2. PSN 432
3. R.R. Crossing & 4S
4. Opposite PRTR, East 2 Miles
5. 3 Miles East of Drive-in Theatre

Standard Flight Pattern - 1L


2L RUN CHECK POINTS
1. South Richland
2. Airport
3. Prosser Barricade
4. Power Line - East Side of River
5. Intersection Power Line & Taylor Flat Rd.
6. 6 Miles East of PRTR
7. Intersection Taylor Flat & Abcent Rds.
LEAVENWORTH
WATERVILLE
COULEE CITY
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
RITZVILLE
ELLENSBURG
YAKIMA
WARDEN
LIND
STEPTOE
COLFAX
PULLMAN
OTHELLO
CUNNINGHAM
BEVERLY
CORFU
DUSTY
WASHTUCNA
CONNELL
KAHLOTUS
MESA
ELTOPIA
SNAKE RIVER
UNION GAP
MOXEE
WAPATO
TOPPENISH
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
KENN.
DAYTON
WATSBURG
DIXIE
MABTON
PROSSER
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
KENNEWICK
STANFIELD
GOLDENDALE
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
SCALE — MILES
Standard Flight Pattern - 2L


3L RUN CHECK POINTS
1. Benton City
2. Near Army Rd. to Rattlesnake
3. Columbia Camp
4. Y Barricade
5. Power Line
6. Green Farm House
7. Eltopia Intersection
8. Intersection 395 & Richland Ferry Rd.
9. Intersection 395 & Upper River Rd.
10. Island View
11. First Bald Mountain from Kiona on Right Side of Rte. 410
Standard Flight Pattern - 3L


1E RUN CHECK POINTS
1. Kennewick
2. Plymouth
3. Hermiston
4. Stanfield
5. Pendleton
6. Weston
7. Melton
8. Walla Walla
9. Waitsburg
10. Dayton
11. Dodge
12. Dusty
13. Colfax
14. Rosalia
15. Spokane
16. Cheney
17. Sprague
18. Ritzville
19. Lind
20. Washtucna
21. Kahlotus
22. Pasco
WILBUR
DAVENPORT
REARDAN
SPOKANE
COULEE CITY
HARRINGTON
CHENEY
SPANGLE
PHRATA
ODESSA
SPRAGUE
ROSALIA
MOSES LAKE
RITZVILLE
STEPTOE
WARDEN
LIND
COLFAX
OTHELLO
CUNNINGHAM
DUSTY
PULLMAN
BEVERLY
CORFU
WASHTUCNA
COMBELL
KAHLOTUS
ARMSTRONG
YAKIMA
MOXEE
MESA
DODGE
POMEROY
UNION GAP
ELTOPIA
WAPATO
LEWISTON
TOPPENISH
DAYTON
SUNNYSIDE
WAITSBURG
MABTON
PROSSER
KENNEWICK
PASCO
DIXIE
SCALE — MILES
WALLULA JCT.
WALLA WALLA
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
BOARDMAN
HERMISTON
STANFIELD
PENDLETON
ELGIN
MEACHAM
Standard Flight Pattern - 1E


2E RUN CHECK POINTS
1. Benton City
2. Prosser
3. Sunnyside
4. Yakima
5. Ellensburg
6. Vantage
7. Moses Lake
8. Ritzville
9. Connell
10. Eltopia
11. Pasco
WILBUR
DAVENPORT
WATERVILLE
COULEE CITY
LEAVENWORTH
HARRINGTON
WENATCHEE
SOAP LAKE
EPHRATA
ODESSA
CLE ELUM
MOSES LAKE
RITZVILLE
ELLENSBURG
VANTAGE
WARDEN
LIND
BEVERLY
OTHELLO
CUNNINGHAM
CORFU
COLFAX
GARTY
PULLMAN
WASHTUCNA
CONNELL
KAHLOTUS
YAKIMA
MOXEE
UNION GAP
MESA
UNIONTOWN
DODGE
POMEROY
WAPATO
TOPPENISH
ELTOPIA
LEWISTON
DAYTON
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
WAITSBURG
MABTON
PROSSER
KENN.
DIXIE
SCALE — MILES
TOUCHET
LOWDEN
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
GOLDENDALE
HERMISTON
WESTON
STANFIELD
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELSIE
MEACHAM
Standard Flight Pattern - 2E

Ellensburg-Ritzville "triangle". Nine flight patterns are located within and near the Hanford project perimeter.

A single anomalous reading over the 100 Areas Central Fire Station was attributed to reactor effluent vapors. All other flight patterns flown in May and June detected no unusual conditions.

6. Other

All railroad tracks outside the area fences were surveyed with the gamma scintillator normally used for road monitoring. No particulate contamination was found in spite of increased liquid waste transport by rail, between the 300 and 200 Areas.

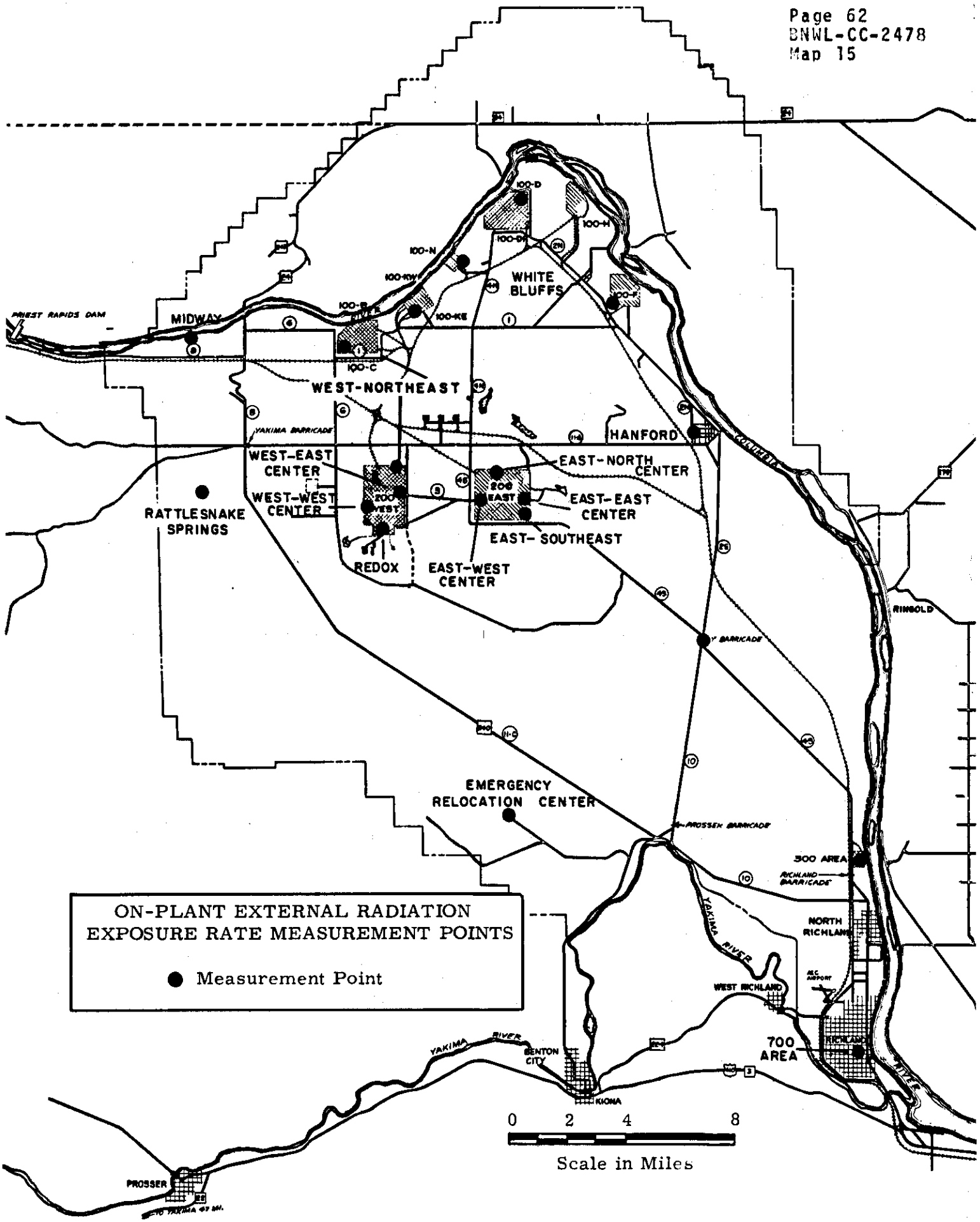
A special radiological survey of a small land area in the southwest portion of the reservation was performed in March to determine its suitability for release for public use. As expected, no unusual radioactivity was noted. Samples of the desert vegetation were analyzed for gamma emitters. The maximum concentration of the major gamma emitter, ^{137}Cs-^{137m}Ba was 2.0 pCi/g on vegetation collected near the intersection of the Emergency Relocation Center road and the boundary fence. Other radionuclides present were ^{7}Be, ^{40}K, ^{46}Sc, ^{54}Mn, ^{95}Zr-Nb, ^{103}Ru, ^{106}Ru-Rh, ^{125}Sb, ^{140}Ba-La, ^{141}Ce, ^{144}Ce-Pr, ^{154}Eu, ^{155}Eu, ^{208}Tl, ^{212}Bi, and ^{212}Pb. Concentrations of ^{137}Cs-^{137m}Ba in samples collected from Sections 8, 10, and 18 (T10N, R27E) ranged from 0.3 to 1.7 pCi/g and in samples collected along Highway 240 ranged from 0.1 to 1.1 pCi/g.

For comparison, vegetation samples collected from Finley, Benton City, Big Pasco, Island View, and Plymouth had similar radionuclides but somewhat less activity. ^{137}Cs-^{137m}Ba concentrations in samples from these locations ranged from <0.05 to 0.7 pCi/g. A fresh influx of weapons testing fallout in January and February probably contributed to the observed levels of activity at all locations.

External Exposure Rates

1. Exposure Rates On-Plant

Trends in external radiation exposure rates were determined from pencil-type ionization chambers located (in clusters of three) within buildings designated "614" (Map 15) where air samples were also collected. At three locations (100-N WPPSS, Rt. 10 Mile 1.6, and 700 Area), Victoreen stray radiation chambers were also used. The average results for the first half of 1969 are presented in Table 12 below with data from offsite locations and from previous years for



ON-PLANT EXTERNAL RADIATION
EXPOSURE RATE MEASUREMENT POINTS

● Measurement Point

TABLE 12

AVERAGE EXTERNAL GAMMA EXPOSURE RATES (January-June, 1969)
(mR/day)

Location	1969 Jan-June	1968 July-Dec	1968 Jan-June	1967 July-Dec	1967 Jan-June
100 Areas					
Midway	--(1)	0.60	0.57	0.67	0.53
100-B	1.03	0.69	0.72	0.89	0.56
100-K	1.35	1.65	1.94	1.69	1.35
100-N	1.05(2)	0.91	1.20	0.92	0.73
*100-N (WPPSS)	0.54(3)	--	--	--	--
100-D	0.95	0.41	0.48	0.51	0.65
100-F	1.06	0.43	0.42	0.42	0.35
Hanford	1.12	0.56	0.71	0.60	0.56
200 West Area					
Redox	0.53	0.61	0.56	0.56	0.62
West Center	0.60	0.43	0.41	0.51	0.40
East Center	0.56	0.41	0.41	0.49	0.42
West-Northeast	0.84	0.48	--	--	--
200 East Area					
North Center	0.94	0.58	--	--	--
West Center	0.44	0.42	0.52	0.45	0.34
Southeast	0.56	0.46	0.50	0.50	0.35
East Center	1.92	0.53	0.46	0.58	0.56
Other					
Rattlesnake Springs	0.56	0.42	0.40	0.46	0.40
Emergency Relocation Center	0.65	0.41	0.40	0.43	0.33
Wye Barricade	0.51	0.62	0.62	0.65	0.55
*Rt. 10, Mile 1.6	0.31*	0.34*	0.38*	0.34*	0.36*
300 Area	0.92(4)	0.63	0.55	0.54	0.44
700 Area	0.53	0.62	0.31	0.75	0.52
*700 Area	0.26*	0.29*	0.28*	0.27*	0.26*

TABLE 12 (Continued)

Location	1969 Jan-June	1968 July-Dec	1968 Jan-June	1967 July-Dec	1967 Jan-June
Off-Plant					
Berg Ranch	0.59	0.74	--	--	--
Wahluke	0.82	0.48	0.46	--	--
New Moon	0.75	0.64	0.40	--	--
Eltopia	0.91	0.62	0.54	--	--
Ringold Fish Station	0.70	0.55	0.42	--	--
Byers Landing	0.49	0.33	0.27	--	--
Pasco	0.89	0.46	0.38	--	--
Benton City	0.62	0.57	0.38	--	--
Finley	0.94	0.55	--	--	--
McNary	0.62	0.61	0.47	--	--

* Average measurements with stray radiation chambers.

1. Data from Midway were invalid.

2. This represents only data for January-March because the 100-N location was moved at the end of March and stray radiation chambers substituted for the pocket dosimeters.

3. Measurements with stray radiation chambers at the WPPSS location within 100-N include April-June only.

4. The 300 Area sampling location was moved from the south-central location to a west-central location in late March.

comparison (note correction of previously published numerical averages of 100 Areas data for January-June, 1968). However, data early this year may not be wholly comparable to past data due to dosimeter reader problems and consequent changes in equipment, procedures, and calibrations during the first half of 1969. In addition, the pencils are subject to error due to mechanical shock, heat, humidity and other types of leakage. The results are presented primarily as trend indicators and are only semi-quantitative measurements of exposure rates.

Increased exposure rates were generally attributed to increased fallout. Increased releases of radionuclides to the environs at 200 East Area were partially responsible for increases in pencil readings at that location.

The maximum exposure rate averaged over the first six months of 1969 was 1.9 mR/day at 200-East East Center, a location where higher than normal concentrations of airborne radioactive particulates were observed and exposure to radiation sources is also known to occur.

An unusual average exposure rate 6.2 mR/day was noted at 200-East East Center during 6-2 to 6-9. Transient exposure rates during that week could have been significantly higher than 6.2 mR/day. ARHCO personnel were notified.

Other locations where the average exposure rate during the first half of 1969 was about 1 mR/day or greater were 100-B, 100-D, 100-K, 100-N, 100-F, and Hanford, possibly as a result of reactor effluent vapors. Locations where the average exposure rate during the first half of 1969 was in the range 0.8 to 0.9 mR/day were the following: 200-East North Center, 300 Area*, 200-West Northeast (on-plant); and Finley, Pasco, Wahluke, Eltopia, and New Moon. For comparison, exposure rates at all off-plant locations with the exceptions of Kennewick and Eltopia averaged less than 0.5 mR/day during the first half of 1968. Partial cause for the increased readings during 1969 was attributed to faulty dosimeter reader performance during the early part of 1969.

2. 100-N Area

Victoreen stray radiation chambers were substituted for the pocket-type dosimeters at 100-N Area at the end of March and the sampling location was moved in order to obtain data

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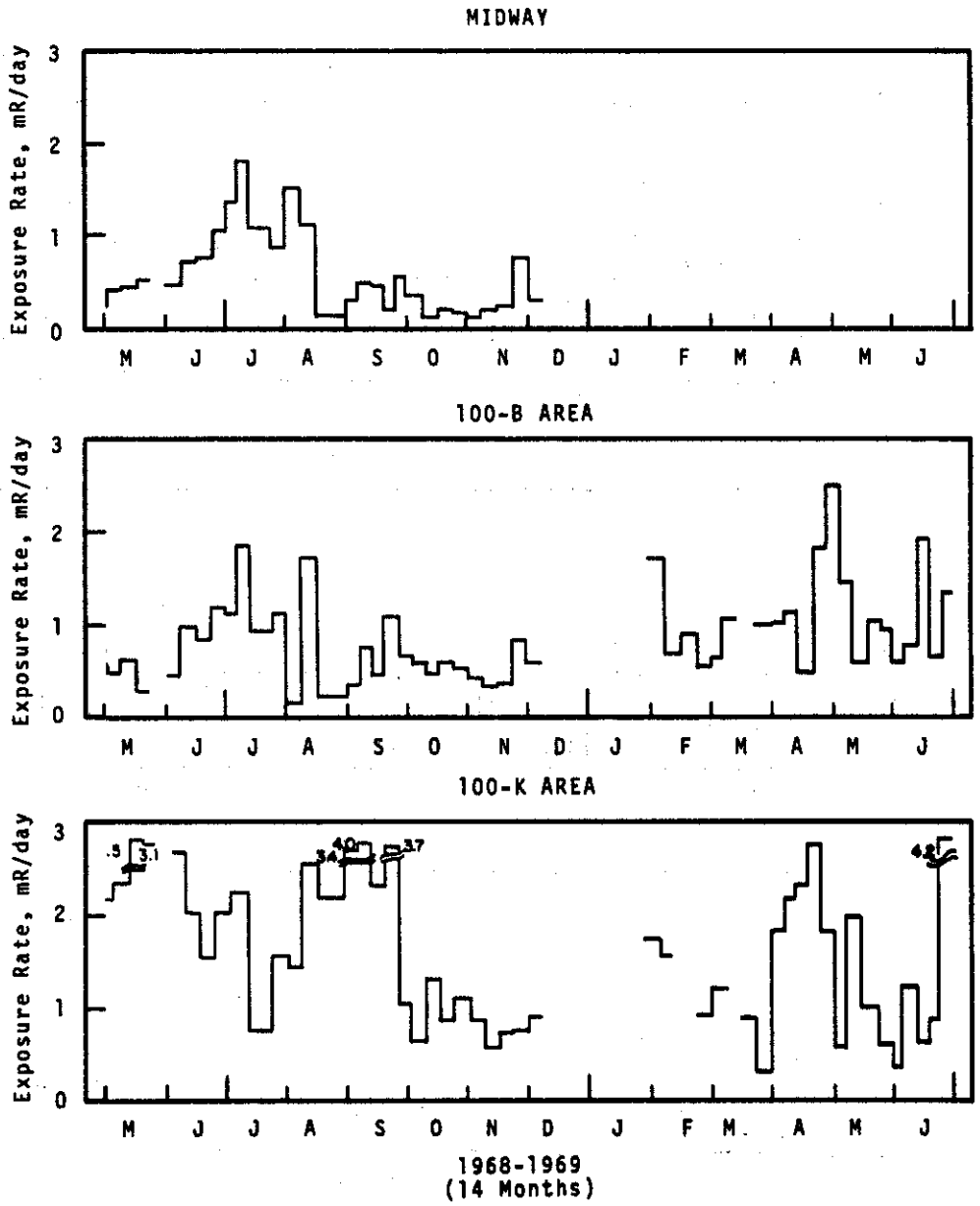
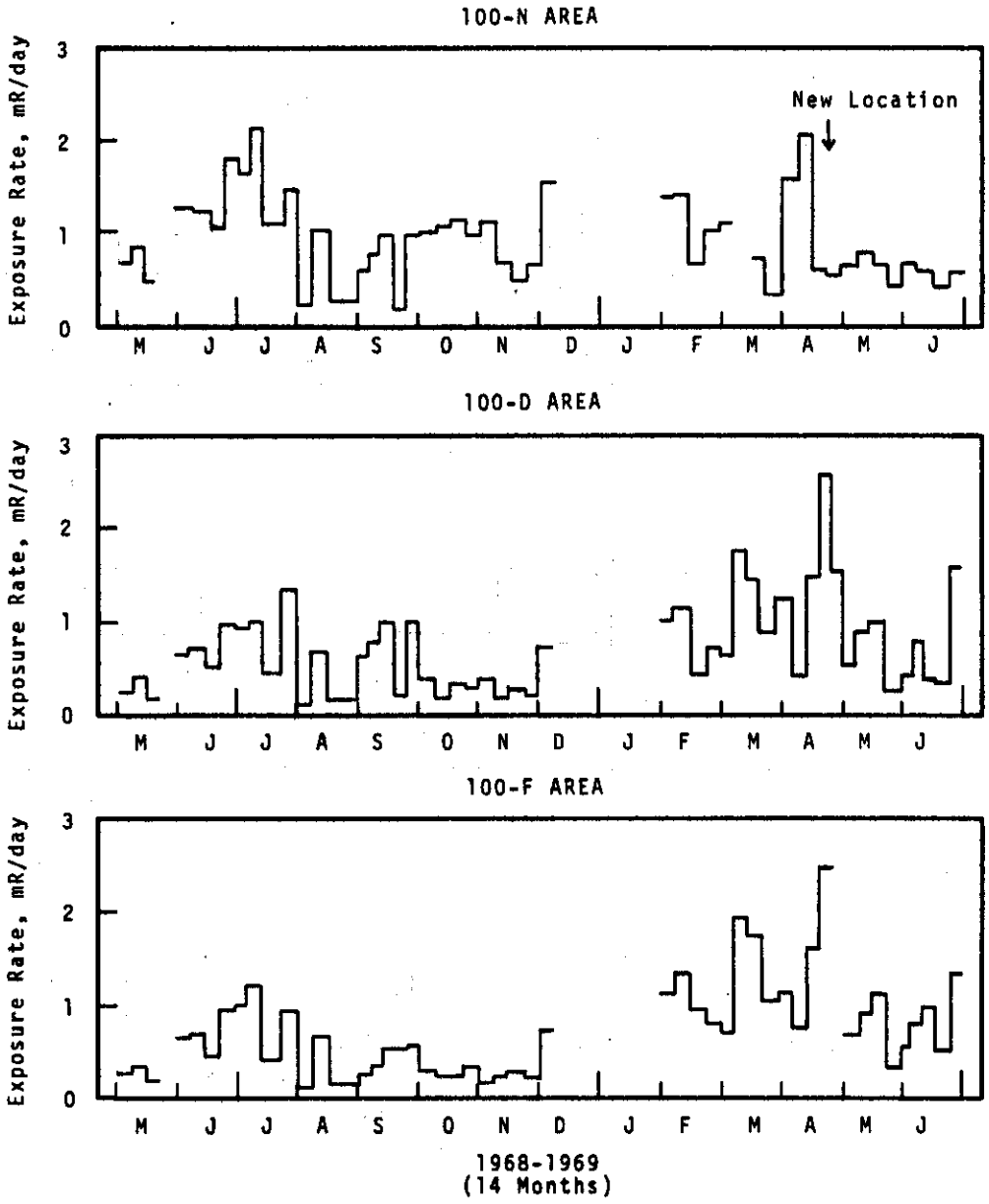
* 300 Area location is exposed to accelerator "sky shine".

suitable for estimating the potential exposure of WPPSS personnel. The appropriate radiation dose limits for this group are those for members of the general public. Based on measurements with stray radiation chambers at 100-N and Richland during March, April, and May, the exposure rate at 100-N was approximately twice that observed at Richland (0.54 compared to 0.26 mR/day). Based on the net exposure rate (0.28 mR/day) and assuming exposure for 40 hours per week (50 weeks/yr), the potential annual whole body dose to WPPSS personnel from Hanford sources of external radiation at 100-N would be 23 mrem/yr (about 5 percent of the limit for individuals non-occupationally exposed).

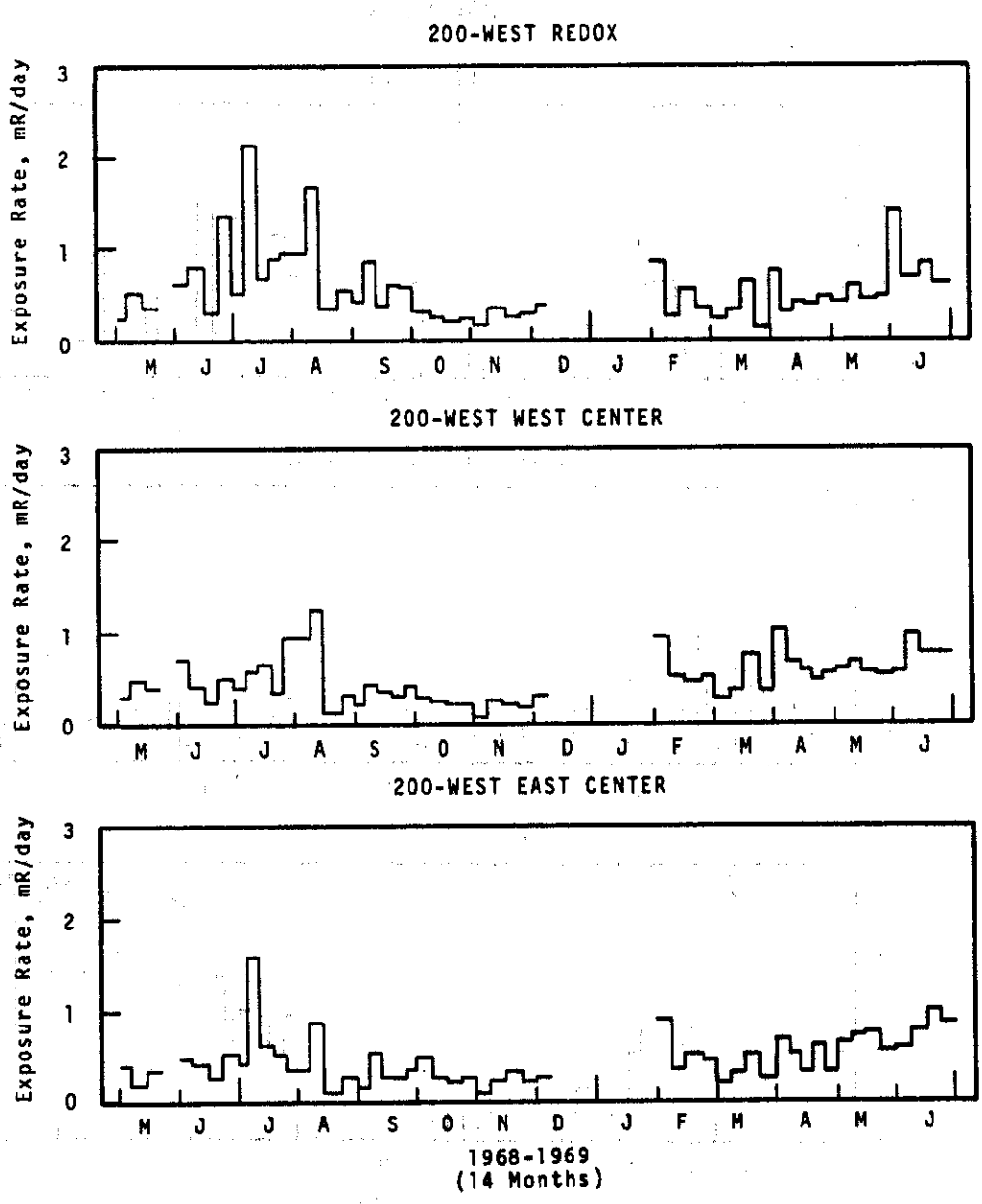
EXTERNAL RADIATION ON PLANT
100 AREAS AND VICINITY



EXTERNAL RADIATION ON PLANT
100 AREAS AND VICINITY



EXTERNAL RADIATION ON PLANT
200 AREAS



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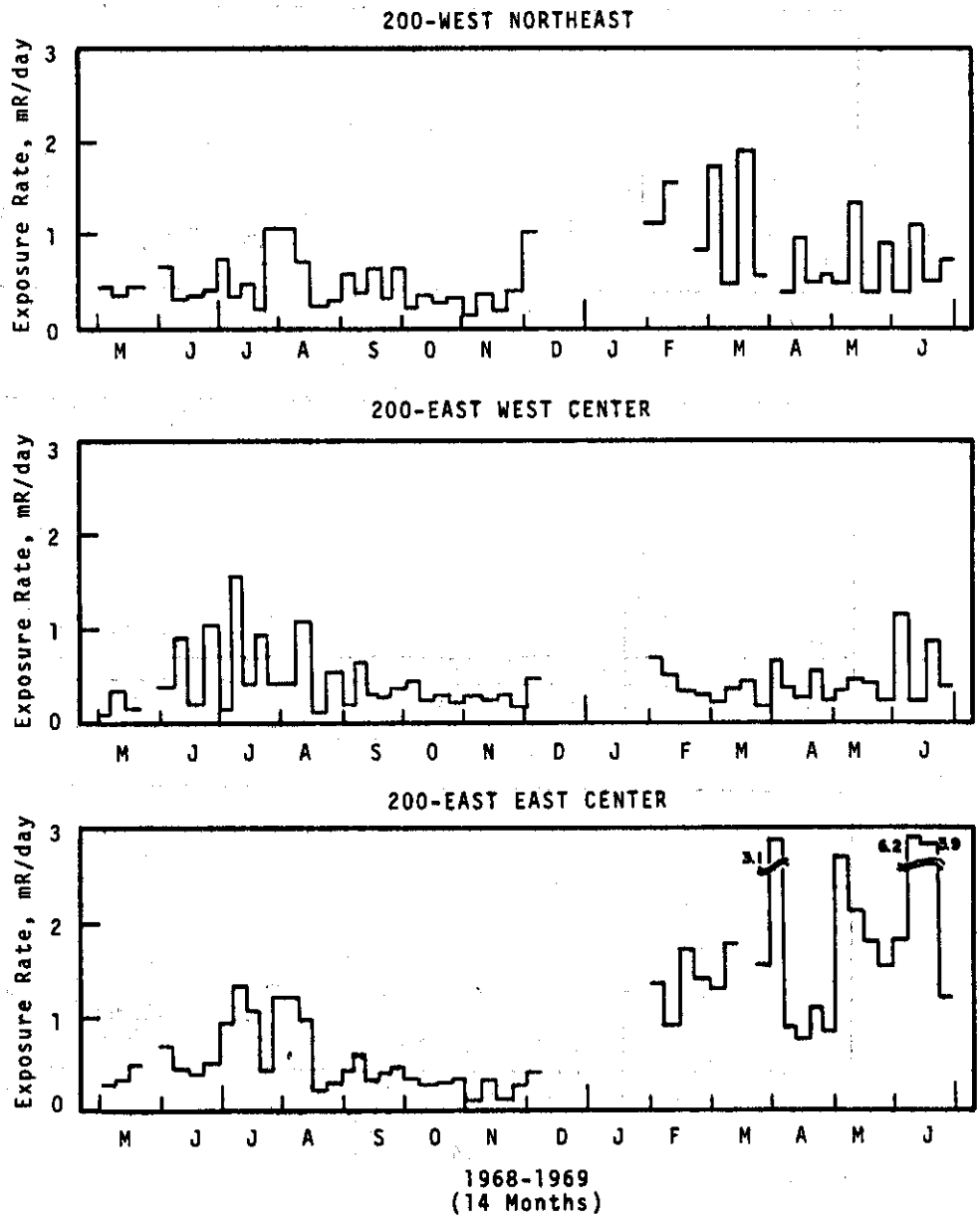
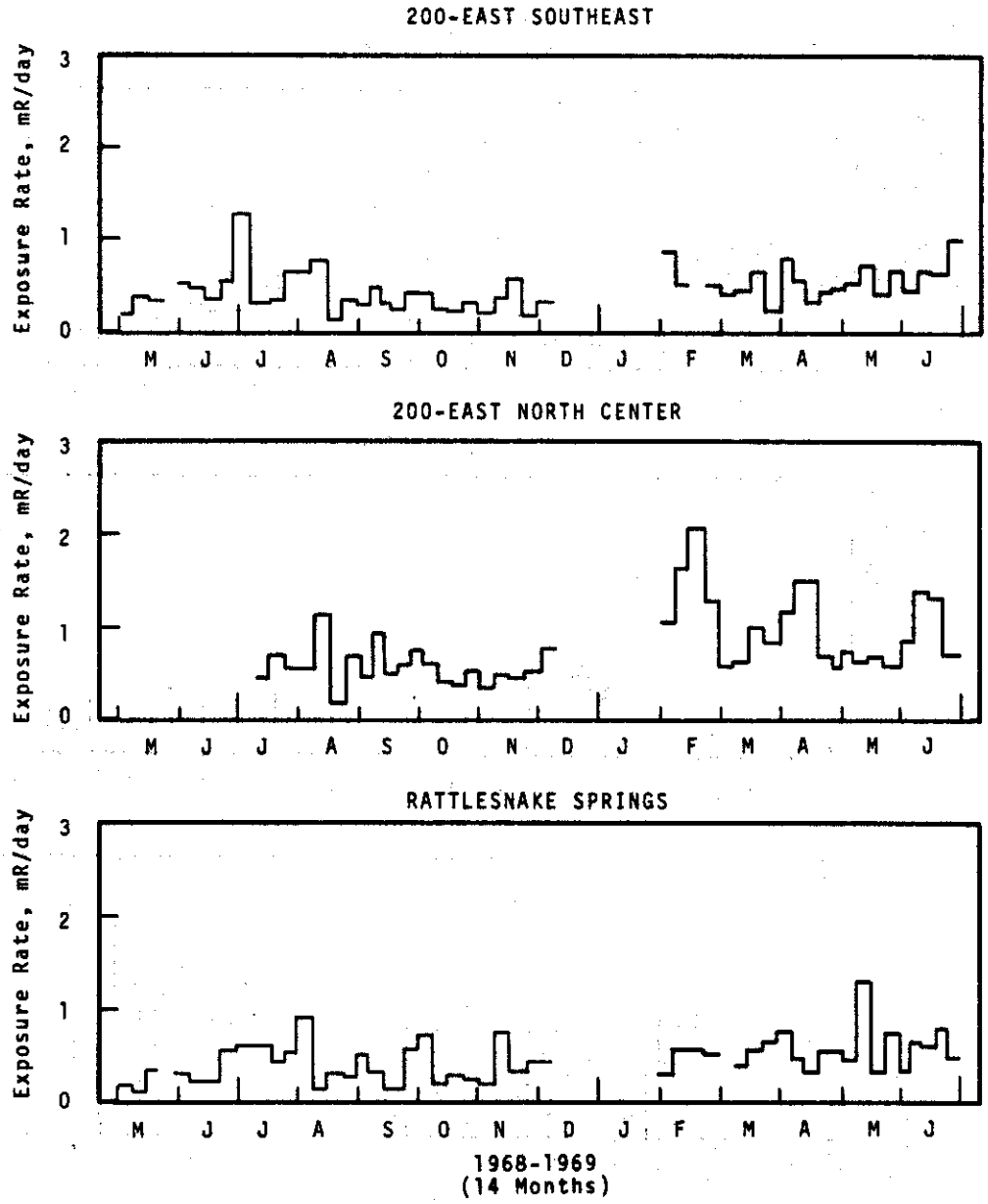
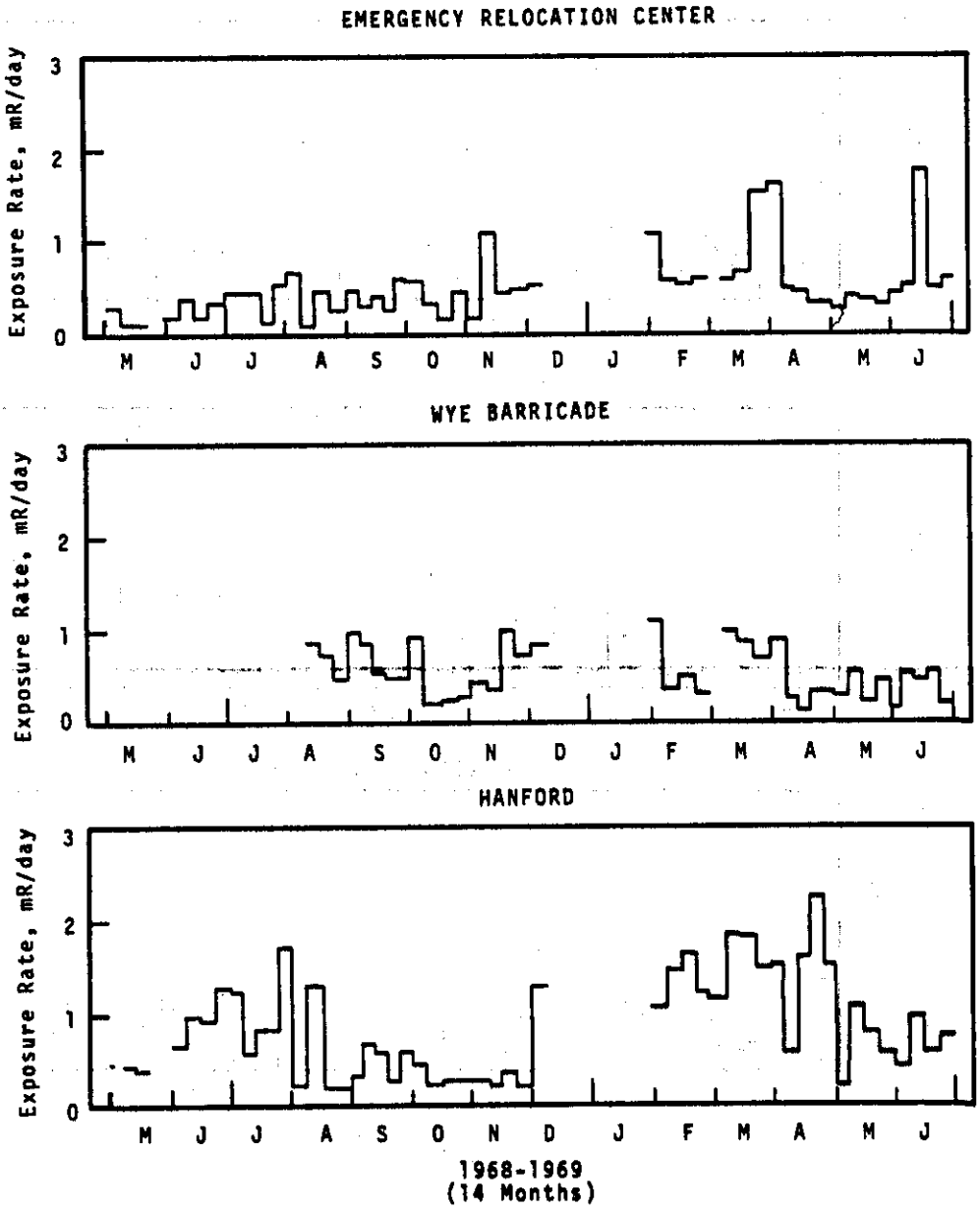
200 AREAS



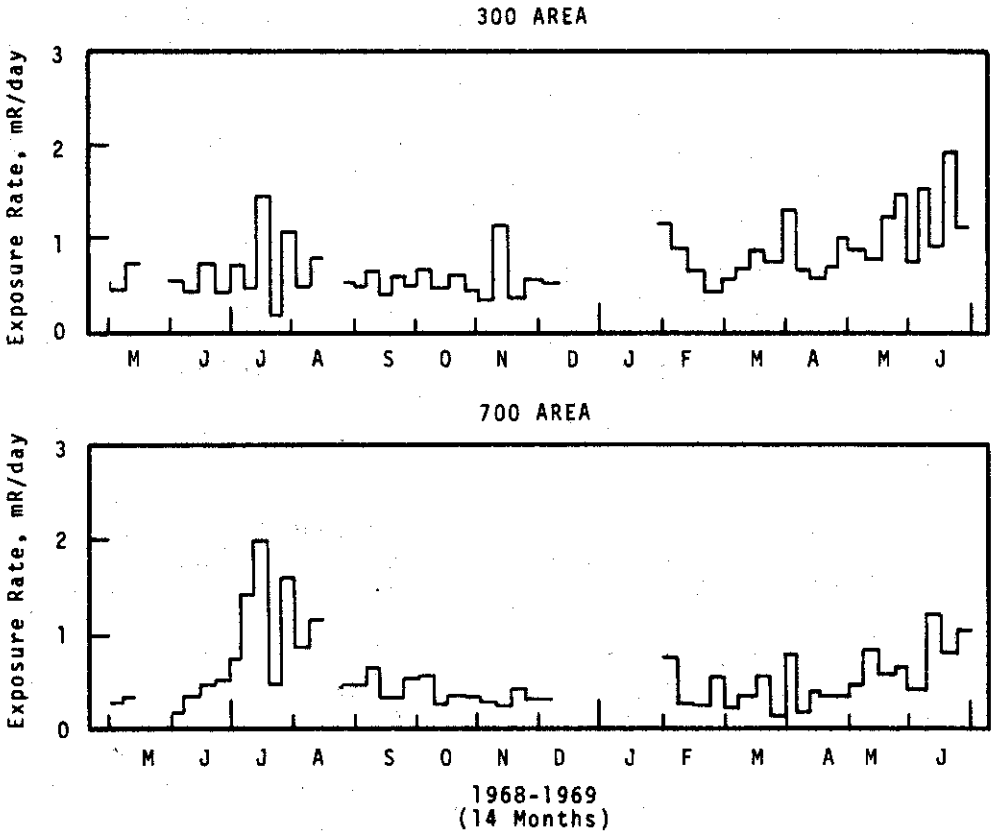
EXTERNAL RADIATION ON PLANT
200 AREAS AND INTERMEDIATE AREAS



EXTERNAL RADIATION ON PLANT INTERMEDIATE AREAS



EXTERNAL RADIATION ON PLANT
300 AREA AND 700 AREA



3. Exposure Rates at the Columbia River Shoreline

Radiation exposure rates are measured at 3 feet above the river shoreline with a 40-liter ionization chamber whose response is calibrated in μR/hr (radium gamma). Measurements at 3 feet approximate the exposure rate to the gonads of a person standing on the riverbank.

The weekly measurements of exposure rates at five sampling locations shown on Map 16 and at Sacajawea Park and McNary Dam (Washington shore) appear in Figures 27-28. Additional monthly shoreline surveys covering the reach of the river from the reactors to Richland include both the exposure rate at 3 feet and the levels of surface contamination as measured with a portable GM survey meter. These data appear in Table 13.

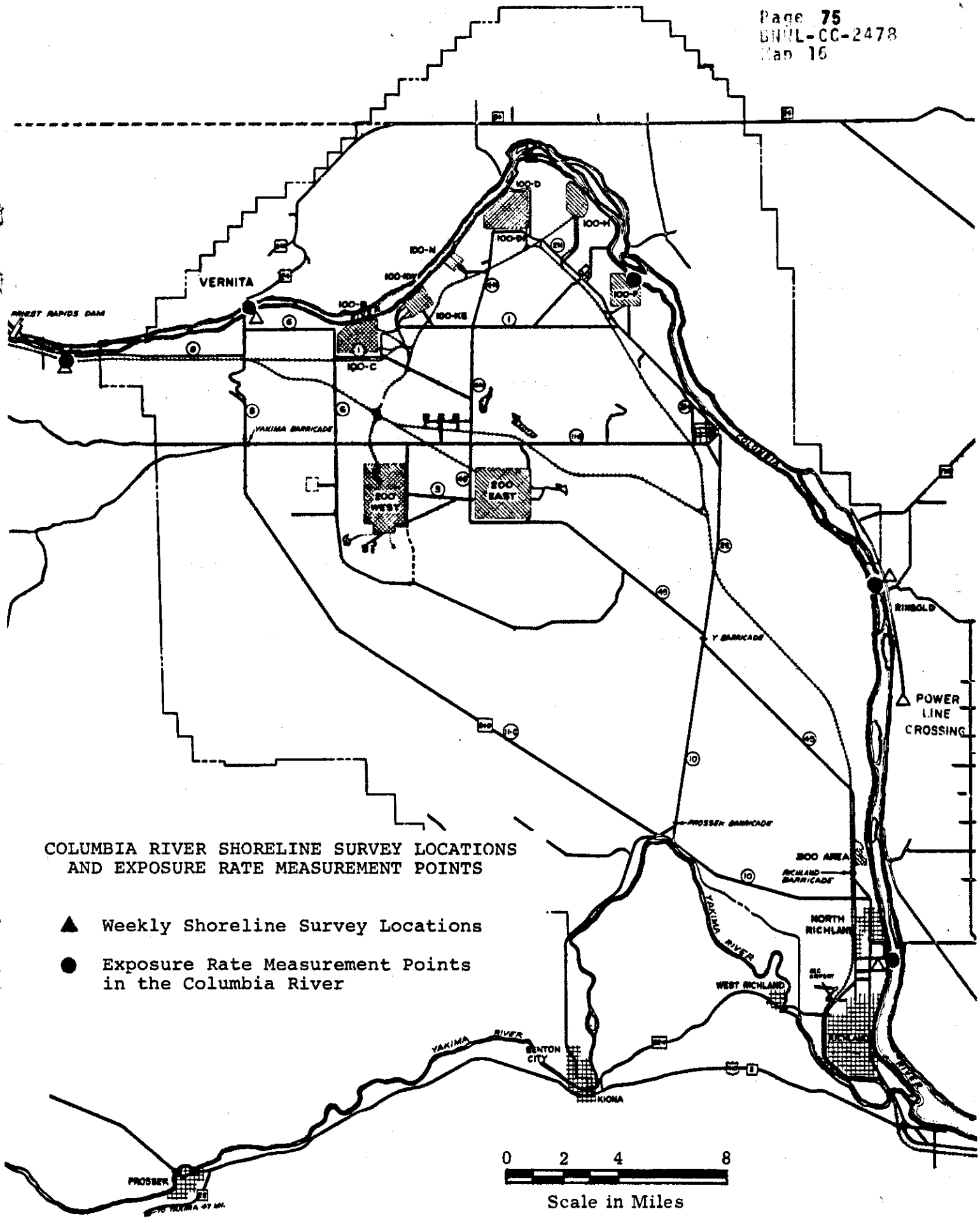
During the first six months of 1969, exposure rates on the Columbia River shoreline were generally lower than in the spring of 1968. Only one of the scheduled weekly surveys was made at Powerline Crossing due to its inaccessibility from land, however monthly surveys (by boat) indicated no unusually high exposure rates at this location during the period.

The maximum shoreline exposure rates during January-June, 1969, were measured on the far side of D Island (210 μR/hr) and on the plant shore below 181-KE (200 μR/hr) on March 13. For comparison, the maximum shoreline exposure rate measured during 1968 was 1550 μR/hr below 181-KE on February 21, 1968 and several other locations had exposure rates during the spring of 1968 that exceeded 200 μR/hr.

Levels of shoreline surface contamination at sampling locations below the plant boundary during the first six months of 1969 were generally less than 300 c/m (GM). A maximum reading of 5000 c/m (GM) was obtained on foam at the shoreline near the Richland water plant pumphouse on March 6. The general reading somewhat back from the water's edge was 500 c/m.

4. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river (Figures 29-30) were determined from a cluster of five pocket dosimeters contained within submerged plastic bottles at the locations shown in Map 16. Missing data were the result of lost containers or equipment malfunction. (Note comments on page 66 regarding data acquisition based on the dosimeter reader during the first half of 1969.)



COLUMBIA RIVER SHORELINE SURVEY LOCATIONS
AND EXPOSURE RATE MEASUREMENT POINTS

▲ Weekly Shoreline Survey Locations

● Exposure Rate Measurement Points in the Columbia River

TABLE 13

MAXIMUM READINGS(1) FROM MONTHLY SHORELINE SURVEYS 1969
(μR/hr with c/m in parentheses)

A. COLUMBIA RIVER - PLANT SHORE

Date	#4 1/2 mile Below 100-B	#6 1 mile Below 100B	#8 1 1/2 miles Below 100-B	#10 Above 181 KW	#13 Below 181 KE
Mar 13	52(200)	28(100)	24(150)	30(200)	200(1200)
Apr 25	-	-	-	50(350)	71(550)
Jun 4	-	-	-	60(200)	120(600)

Date	#17 Above 181 NE	#25 Below 181 NE	#29 Below 181 D	#39 Below 181 H	#44 White Bluffs Ferry
Mar 13	130(1000)	140(800)	130(900)	125(1000)	100(850)
Apr 25	40(450)	120(7000)	114(2500)	118(5500)	110(800)
Jun 4	26(150)	58(400)	64(1800)	60(400)	65(400)

Date	Hanford	Powerline Crossing	PRTR	Richland(2) Ferry
Mar 13	85(1500)	120(2000)	62(550)	40(400)
Apr 25	72(800)	43(650)	28(300)	28(200)
Jun 4	44(350)	33(250)	32(200)	30(200)

TABLE 13 (Continued)

B. COLUMBIA RIVER - FAR SHORE

Date	#18 Below 181 KE	#13 Above 181 D	#1 D Island	#16 Below DR. Outfall	#25 White Bluffs Ferry
Mar 13	42(200)	34(200)	210(1500)	36(200)	52(500)
Apr 25	19(100)	18(100)	-	22(300)	120(1000)
Jun 4	22(150)	15(150)	-	16(150)	46(300)

Date	Hanford(3)	Ringold(3)	Powerline(2) Crossing	Byers(2) Landing
Mar 13	115(1500)	63(600)	67(500)	68(400)
Apr 25	64(500)	25(150)	28(100)	32(400)
Jun 4	28(200)	24(200)	25(250)	38(250)

1. Measurements reported in μR/hr are taken with a 40-liter ionization chamber, the center of the chamber 3 ft above ground and 3 ft back from the water's edge. Measurements reported in () are the maximum c/m found with a GM in the immediate area of the water's edge.

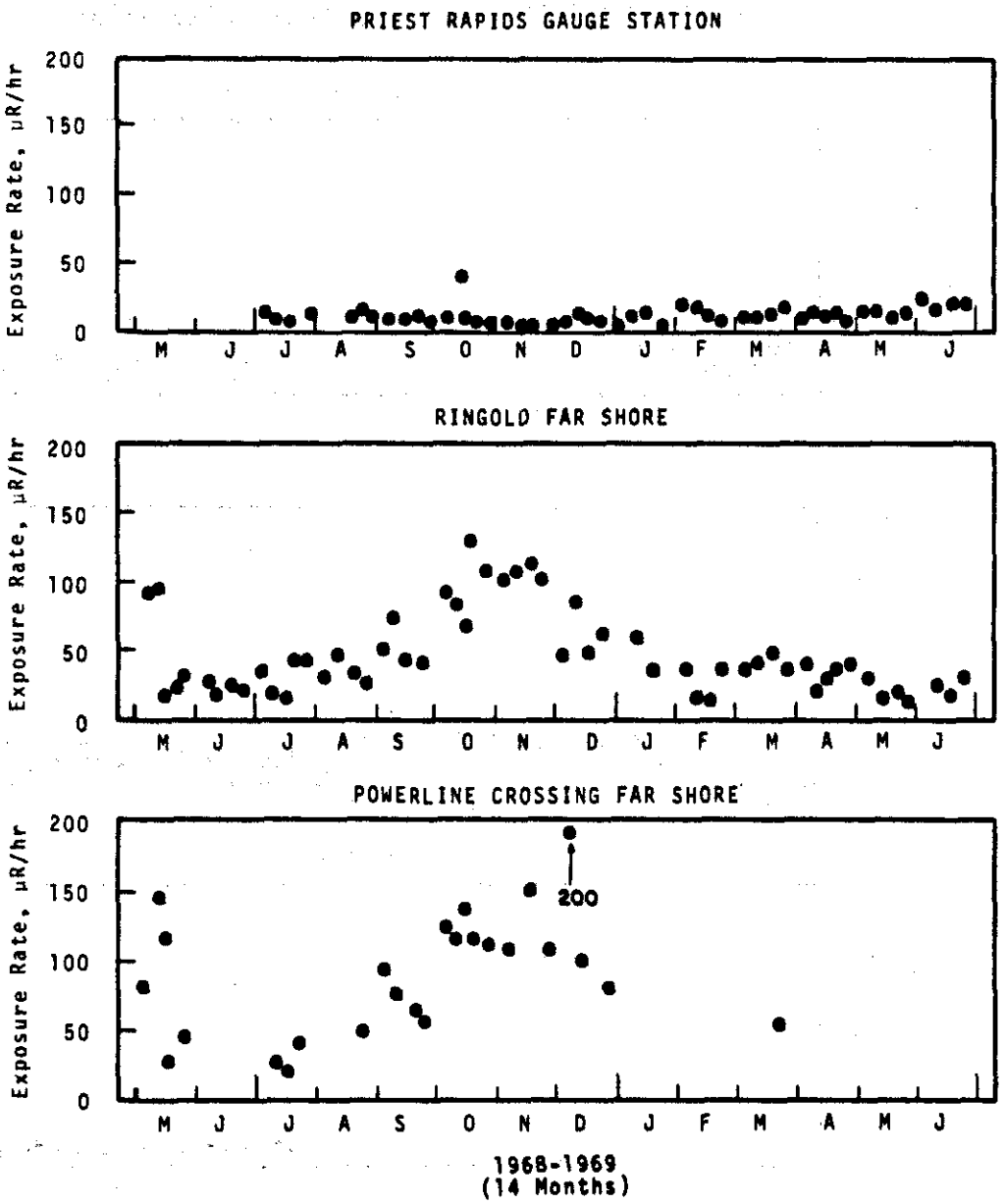
2. Point open to the general public during the entire year.

3. Point only open to the general public on Wednesdays, Saturdays, and Sundays, during the hunting season.

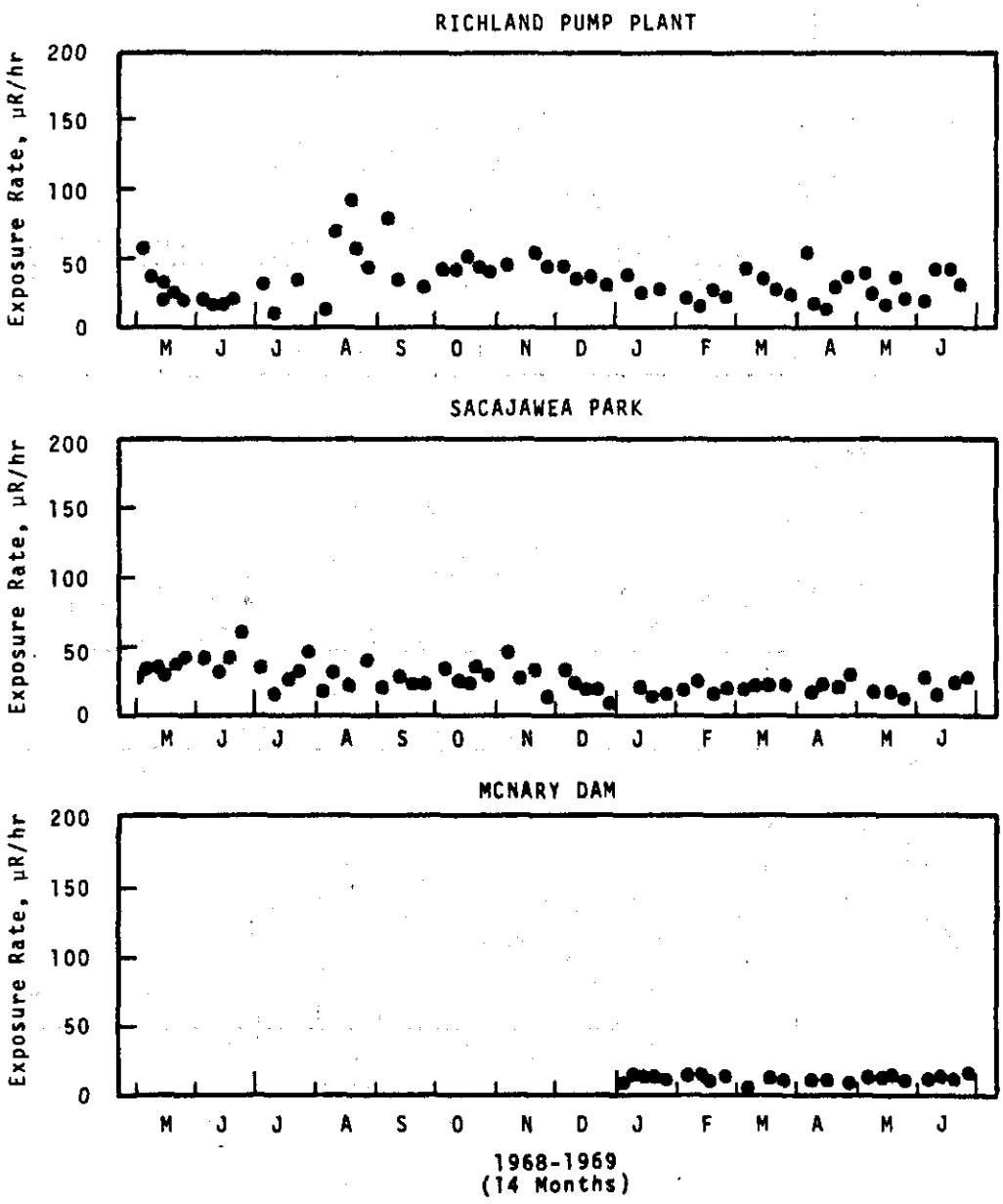
The exposure rates in the river during the spring of 1969 were generally higher than comparable data for the spring of 1968. Increases were probably due to the unusually high concentrations of the short-lived (2.58 hr) ^{56}Mn observed in the river. Other river water concentrations during the first half of 1969 were below the comparable 1968 values.

Observed exposure rates downstream from the reactor outfalls during May 1969 were generally higher than during April, possibly as a result of increased river flow and consequent scouring of river sediments.

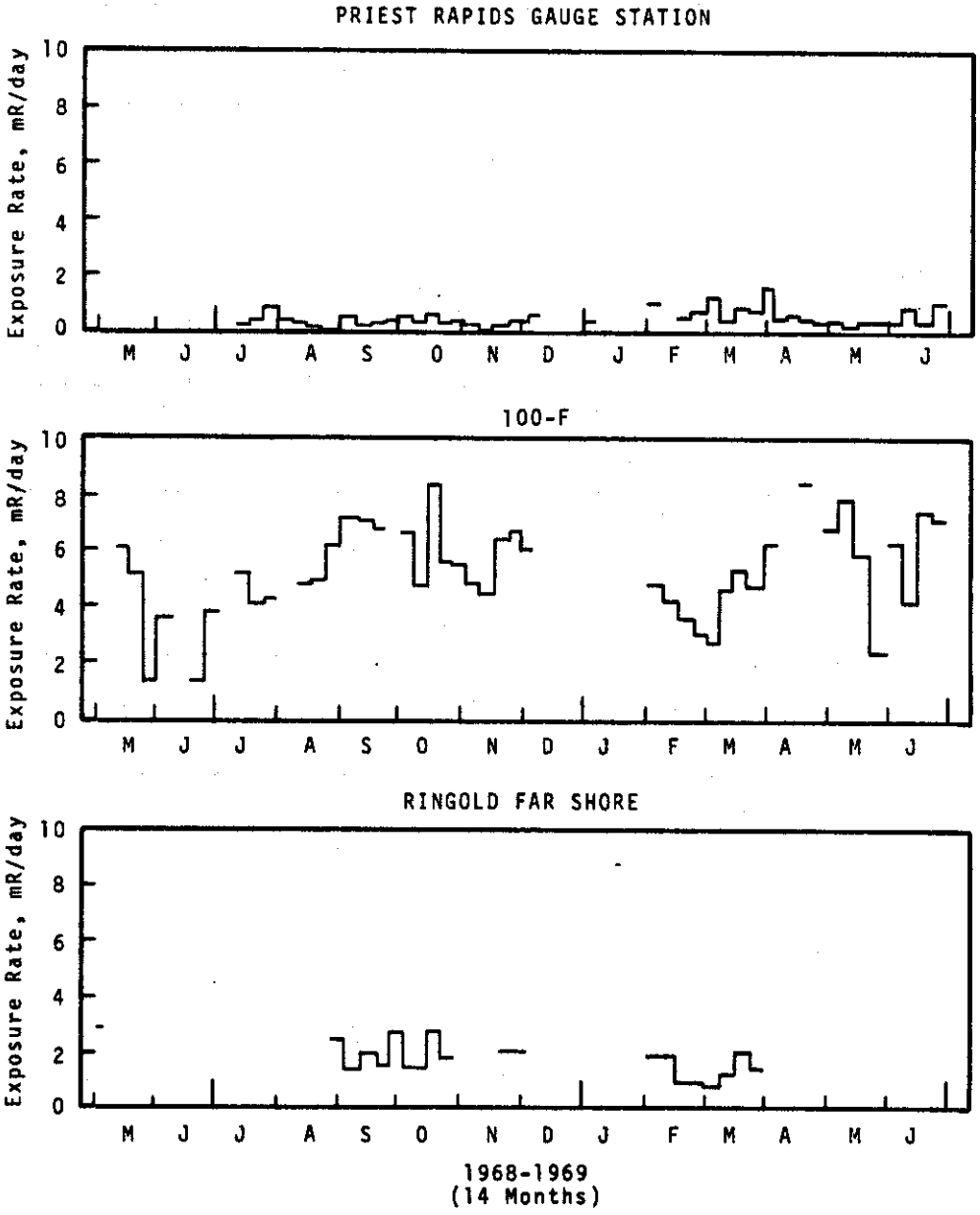
EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER



EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER