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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR NOVEMBER-DECEMBER, 1967
(ANNUAL SUMMARY)

By

Evaluations and Measurements Unit Staff
Environmental Studies Section
ENVIRONMENTAL HEALTH DEPARTMENT

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR NOVEMBER-DECEMBER, 1967

By

Evaluations and Measurements Unit Staff
Environmental Studies Section
ENVIRONMENTAL HEALTH DEPARTMENT

edited by C. B. Wooldridge

April, 1968

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BNWL-CC-1197-6

ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR NOVEMBER-DECEMBER 1967 (ANNUAL SUMMARY)

I. Introduction

This report summarizes data collected in 1967 from sampling locations within the Hanford plant boundaries for the routine environmental surveillance program by the Evaluations and Measurements Unit, Environmental Studies Section, Environmental Health Department, Battelle-Northwest. These environmental measurements are reported here for the information of the Richland Operations Office of the Atomic Energy Commission and its contractors.

Data from off-site sampling locations will be presented in the annual report, "Evaluation of Radiological Conditions in the Vicinity of Hanford for 1967", scheduled for issuance in June, 1968.

Since this summary contains data for the on-site environmental surveillance program, the reader may wish to retain it for reference while discarding all previous reports in the BNWL-CC-1197 series. The next issue of this report will start a new year and will contain a new set of graphs. However, these graphs will contain 13 months of data - for the current month and the 12 months preceeding - in order to facilitate comparisons.

The term "analytical limit", as used herein, is defined as the concentration at which the laboratory can measure a radionuclide with a precision of $\pm$ 100 per cent at the 90 per cent 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 fluctuation detection limits.

The majority of the data presented in this report was supplied by the U. S. Testing Co., Inc., which performed all routine radioassays of environmental samples.

II. Surveillance Summary - 1967

A summary of 1967 surveillance highlights is given below with references to the page number(s) where more detail on the subject appears. The topics to be summarized are, in order of discussion, as follows:

1. Liquid Waste Disposal
2. Gaseous Waste Disposal
3. Surface Contamination
4. Fallout from Nuclear Weapons Testing

Liquid Waste Disposal

In June, 1967, D reactor was retired.

Fuel-element cladding failures during September and October caused increased ^{131}I concentrations in raw river water (p. 6) and in Richland drinking water.[1,2]

Fuel oil that had leaked to the ground at 100-N was detected in samples of Columbia River water (p. 6) near the reactor area.

Disposal of low-level radioactive wastes to open swamps, ponds, and trenches resulted in several unusual events. Total beta concentrations exceeded the limit for open waters - Ref. AECM 0510, 50,000 pCi/ℓ, in T Swamp Inlet and in T Swamp during October; the principal gamma emitters present were ^{137}Cs, ^{134}Cs, ^{106}Ru, and ^{144}Ce-Pr. (See p. 19). Releases through the Purex Chemical Sewer resulted in several instances of high ^{131}I concentrations in B Swamp with a maximum of 370,000 pCi $^{131}I/\ell$ occurring in February (p. 20). ^{131}I was also observed in game birds collected from B Swamp in November (p. 21). Total alpha concentrations temporarily exceeded 50,000 pCi/ℓ at the 234-5 Ditch outlet in November (p. 19). In addition, total alpha concentrations in samples from the 231 Z Waste Pit exceeded 50,000 pCi/ℓ in February, March, April, October, November, and December. The maximum alpha activity was 2,000,000 pCi/ℓ in a sample collected October 20. A gamma scan detected ^{241}Am (p. 20).

Gaseous Waste Disposal

Gaseous waste handling in the 200 Areas resulted in increases in total beta activity and ^{131}I concentrations at the end of January, in early April, May, October, and November (p. 28). A sample of atmospheric alpha activity indicated 1.6 pCi/m^3 at 200-W East Center in early March. Although the radionuclide was found to be ^{239}Pu, the source of this contamination could not be identified. (See p. 41)

---

[1] Radiological Status of the Hanford Environs for September, 1967, BNWL-420 9, edited by C.B. Wooldridge. Pacific Northwest Laboratory, Richland, Washington, December, 1967.

[2] Radiological Status of the Hanford Environs for October, 1967, BNWL-420 10, edited by C.B. Wooldridge. Pacific Northwest Laboratory, Richland, Washington, January, 1968.

Gaseous Waste Disposal (cont.)

In the 300 Area, high atmospheric beta activities indicated by air filters removed in early July and in early August were attributed to the release of radioactive particles from a 300 Area stack. Localized ground contamination resulted from a release of relatively large particles from a different 300 Area stack (p. 30).

Surface Contamination

During 1967, routine road surveys found seven widely separated radioactive particles that were attributed to the transportation of radioactive wastes (p. 46). For comparison, road contamination resulting from the transportation of radioactive materials was detected twice in 1966.

The results of re-surveys of the contamination spread around the 216 B-C Crib area indicated that some particle shifting had taken place. Approximately four square miles remained contaminated (at levels up to 400 mrads/hr) with rabbit feces containing ^{90}Sr and ^{137}Cs. (See p. 49).

Contamination detected in January near 100-N Area consisted of fresh fission products and ^{60}Co that had apparently been spread by a high wind from the 100-N trench to an area east and southeast. (See p. 50).

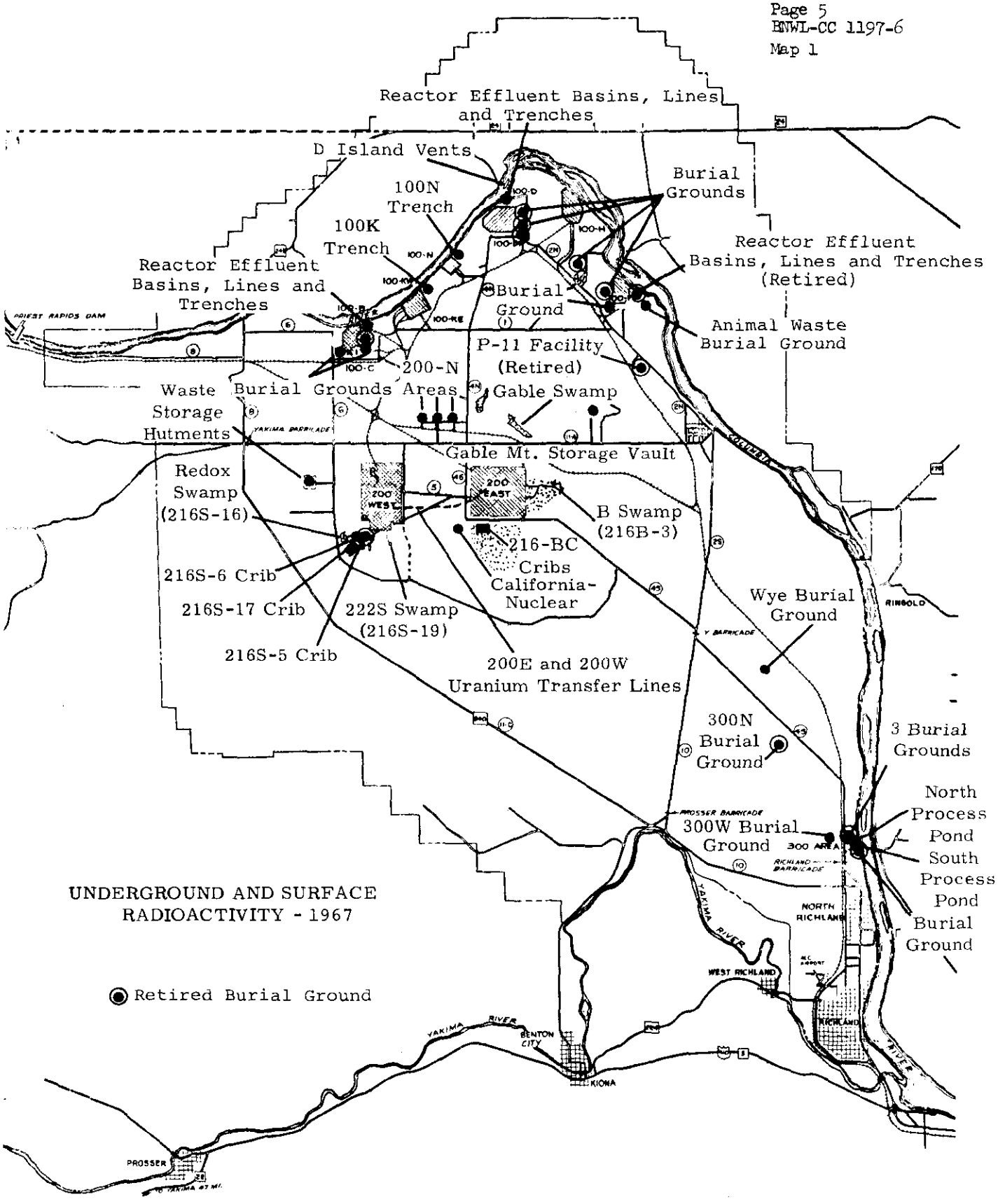
Routine surveys of control plots detected eleven radioactive particles (p. 49). Several particles (to 8,000 c/m) were found on the Wahluke Slope for the first time since 1964.

Fallout

Fallout attributed to reported nuclear weapons tests was detected three times in 1967 (pp. 29-31). A nuclear weapons test on December 27, 1966, resulted in an increase in total beta activity that was noted in early January at most sampling locations. The highest total beta concentration due to fallout was 9.7 pCi/m^3 at the 700 Area during January. In mid-year, slight increases in atmospheric beta activity were observed following a nuclear weapons test on June 17. Fallout from a nuclear weapons test on December 24, 1967, was observed at some sampling locations during the last week of December.

III. Summary of Underground and Surface Radioactivity

There are several locations within the Hanford project outside of area perimeter fences which contain underground or surface radioactivity and, therefore, require controlled access. These sites include swamps, ponds, burial grounds, etc., and are shown in Map 1 which follows.


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 Hutments
Burial Grounds Areas
Gable Swamp
Gable Mt. Storage Vault
Redox Swamp (216S-16)
200 WEST
200 EAST
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
Burial Ground
300W Burial Ground
300 AREA
UNDERGROUND AND SURFACE RADIOACTIVITY - 1967
Retired Burial Ground
PRIEST RAPIDS DAM
YAKIMA BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
Y BARRICADE
RINGOLD
NORTH RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER

IV. Columbia River Water

The locations from which raw water and drinking water samples were obtained during 1967 are shown in Map 2.

A. Raw Water

Weekly cumulative samples of raw Columbia River water were routinely taken at Priest Rapids Dam (Table 1) and 100-F (Figures 1-2). "Grab" samples were taken at Ringold (Figures 3-7) and Hanford (Figure 7). The monthly average results of tritium, strontium-90, total alpha, and total beta analyses of water collected above the reactors are shown below. The numbers in parentheses are the analytical limits for each analysis.

TABLE 1

Average Radionuclide Concentrations in Columbia River Water
(Weekly Cumulative Samples from Priest Rapids Dam)

Month	^{3}H pCi/ℓ	^{90}Sr pCi/ℓ	Total β pCi/ℓ	Total α c/m/ml
Jan.	<1100 (1000)	0.78 (0.5)	<1 (1.0)	<0.005 (0.005)
Feb.	1700	0.72	<1	<0.005
March	1800	0.56	<1	<0.005
April	1700	0.63	<1	<0.008
May	<1200	0.68	<1	<0.005
June	1600	0.69	<1	<0.005
July	<1200	0.67	<1	<0.005
Aug.	<1200	0.52	<1	<0.005
Sept.	1700	0.79	<1.1	<0.005
Oct.	1300	<0.66	<1	<0.005
Nov.	<1000	<0.65	<1	<0.005
Dec.	<1000	<0.52	<1	<0.005

A brief summary of 1967 events is shown below.

May-June - D reactor was retired in June. Because fuel oil had leaked from 100-N, special samples of river water were obtained at 100-D and 100-F; however, no oil was detected.

July-August - The increase in ^{65}Zn concentration in the third week of August at 100-F was slightly higher than expected for this time of year.

Further sampling of river water at 100-D showed oil concentrations between 0.2 and 1.7 ppm. Samples obtained above (Priest Rapids) and below the reactor areas (100-F and Richland water plant) were not significantly different.

Weekly cumulative sampling was begun at 181-D and continued through October. Results are shown on Table 2.

TABLE 2

Radionuclide Concentrations in Columbia River Water
(Cumulative Samples from 100-D)
(pCi/ℓ)

Week Ending	^{32}P	^{51}Cr	^{65}Zn	^{131}I
Analytical Limit	6	70	20	2
7-11	14	500	41	2
7-18	6.8	290	97	2
7-25	9.6	470	150	4.0
8-1	30	990	130	4.6
8-8	24	3900	97	13
8-15	8.2	2900	92	6.4
8-22	8.2	740	76	7.2
8-29	46	2400	100	12
9-5	180	3300	340	40
9-12	86	3700	68	43
9-19	350	7500	360	820
9-26	1000	5200	1100	130
10-3	570	3600	670	26
10-10	110	2300	98	16

September-October - Sampling at 100-D was discontinued on October 11 because 181-D river pumps were no longer operated continuously.

Increased concentrations of ^{131}I in Columbia River water resulted from several fuel element cladding failures. The largest single release of ^{131}I (30-35 Ci), with associated fission products, occurred on October 27. Mid-September increases in ^{131}I concentrations at 100-D were attributed to a fuel element cladding failure on September 16 which released about 15 Ci ^{131}I.

Special river water samples from four locations (Priest Rapids, 100-D, 100-F, and Richland Pumping Plant) indicated that little or no oil entered the river during September-October.

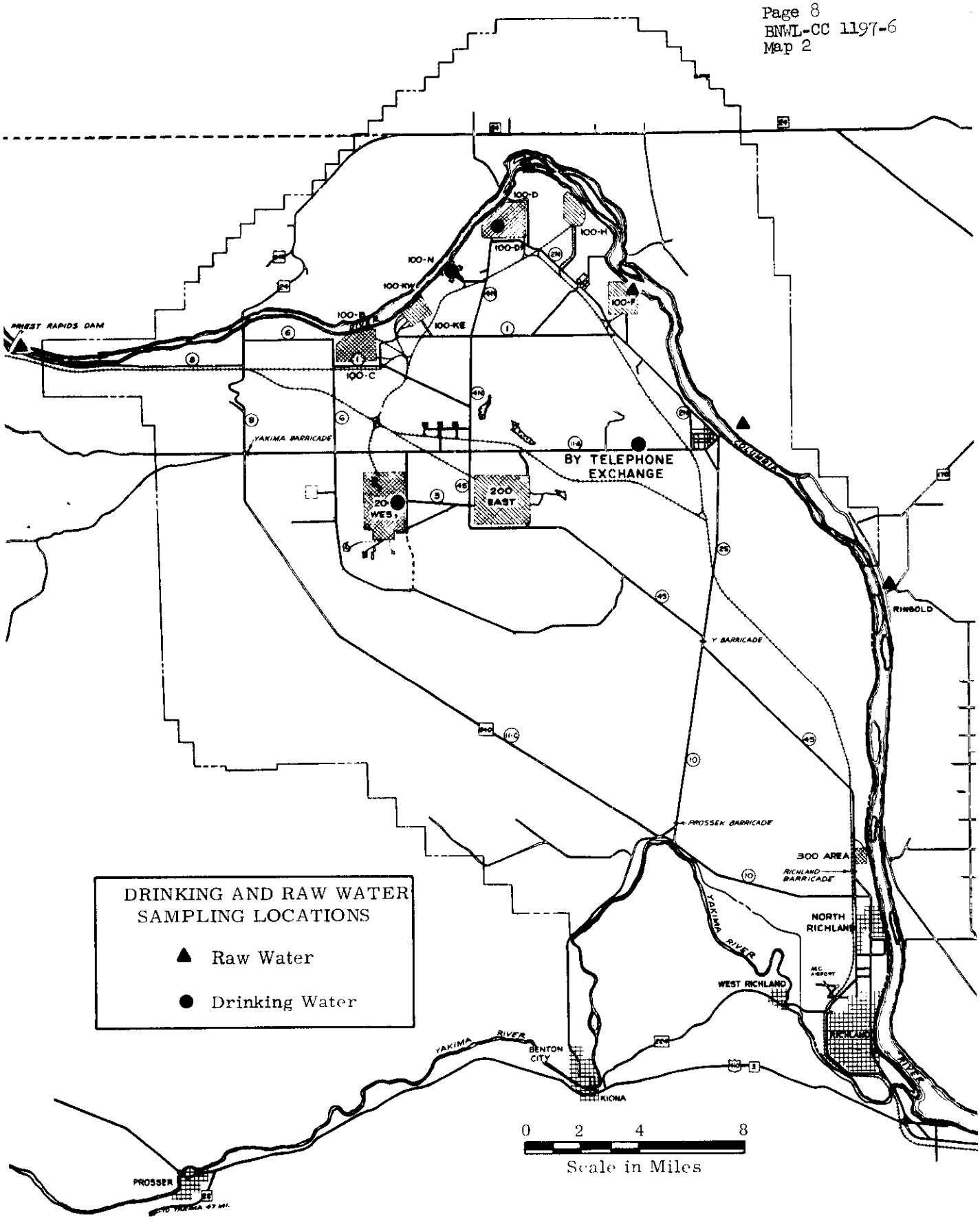

PRIEST RAPIDS DAM
100-D
100-H
100-N
100-KW
100-KE
100-F
100-B
100-C
YAKIMA BARRICADE
BY TELEPHONE EXCHANGE
200 EAST
200 WEST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
BENTON CITY
KIONA
PROSSER
DRINKING AND RAW WATER SAMPLING LOCATIONS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

Figure 1 BNWL-CC 1197-6

RADIOACTIVITY OF COLUMBIA RIVER WATER (CUMULATED) SAMPLES

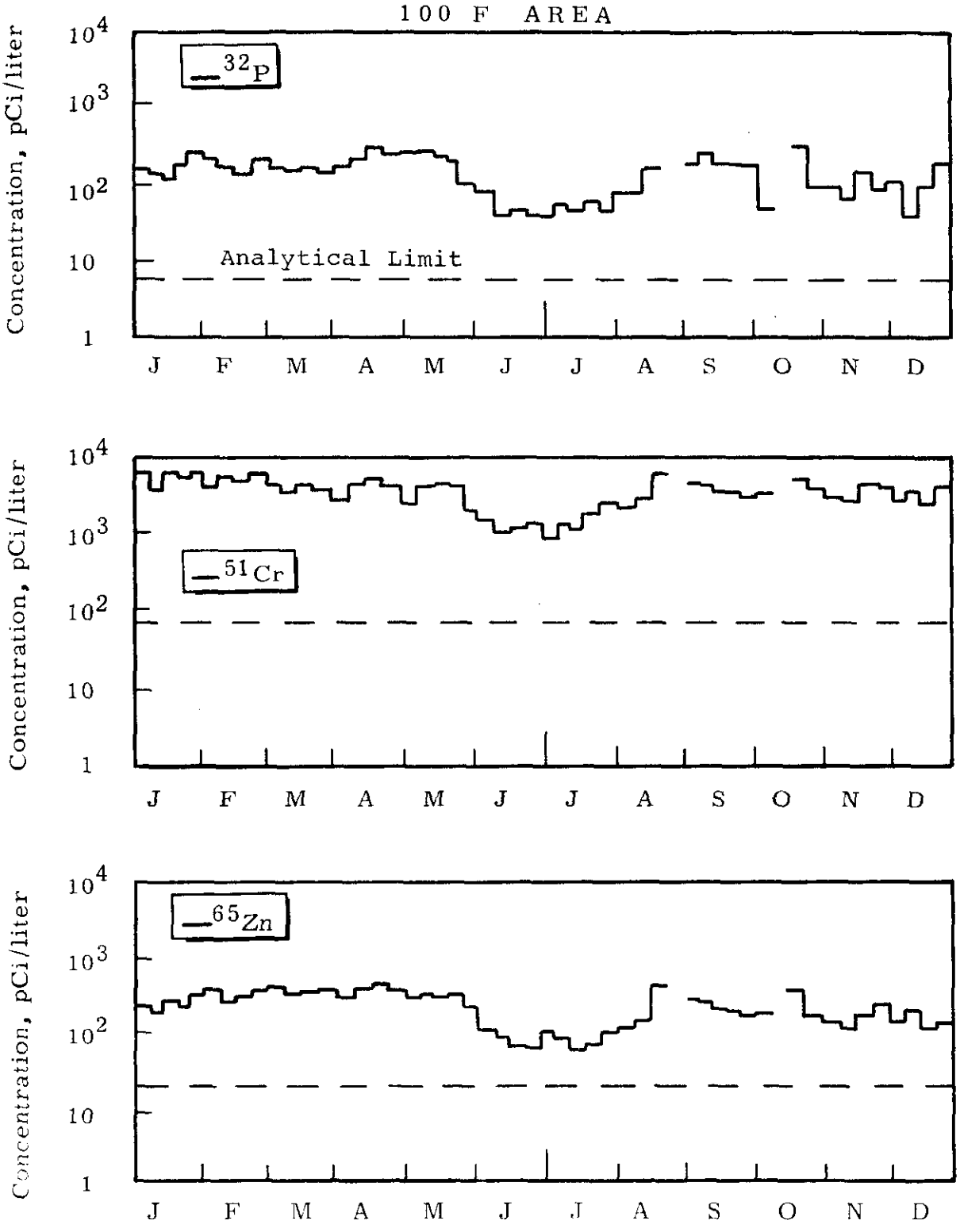


Figure 2 BNWL-CC 1197-6

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (CUMULATIVE) SAMPLES

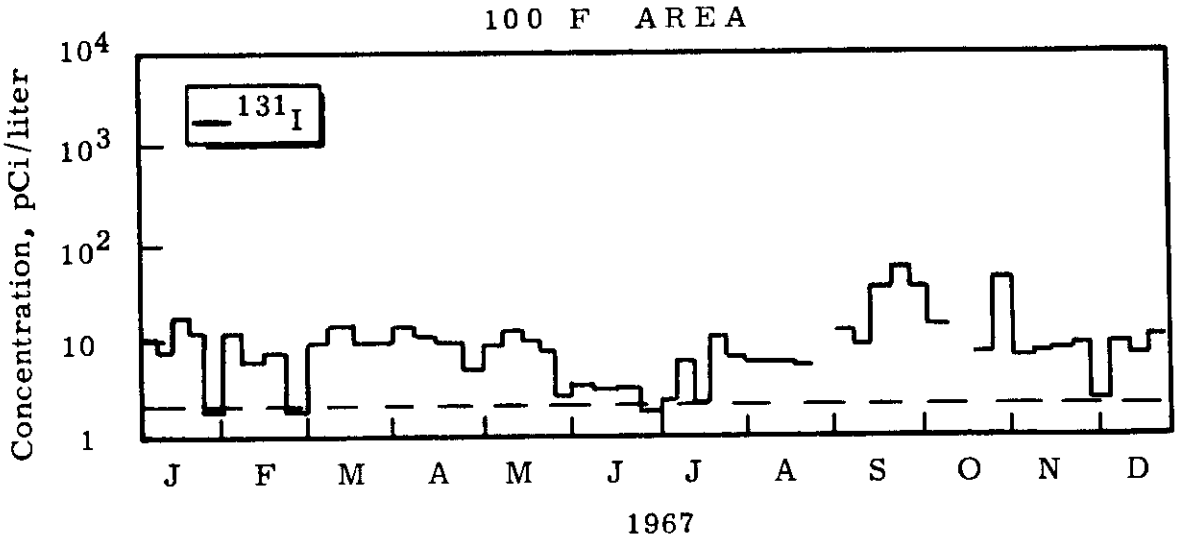


Figure 3

BNWL-CC 1197-6

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES

RINGOLD

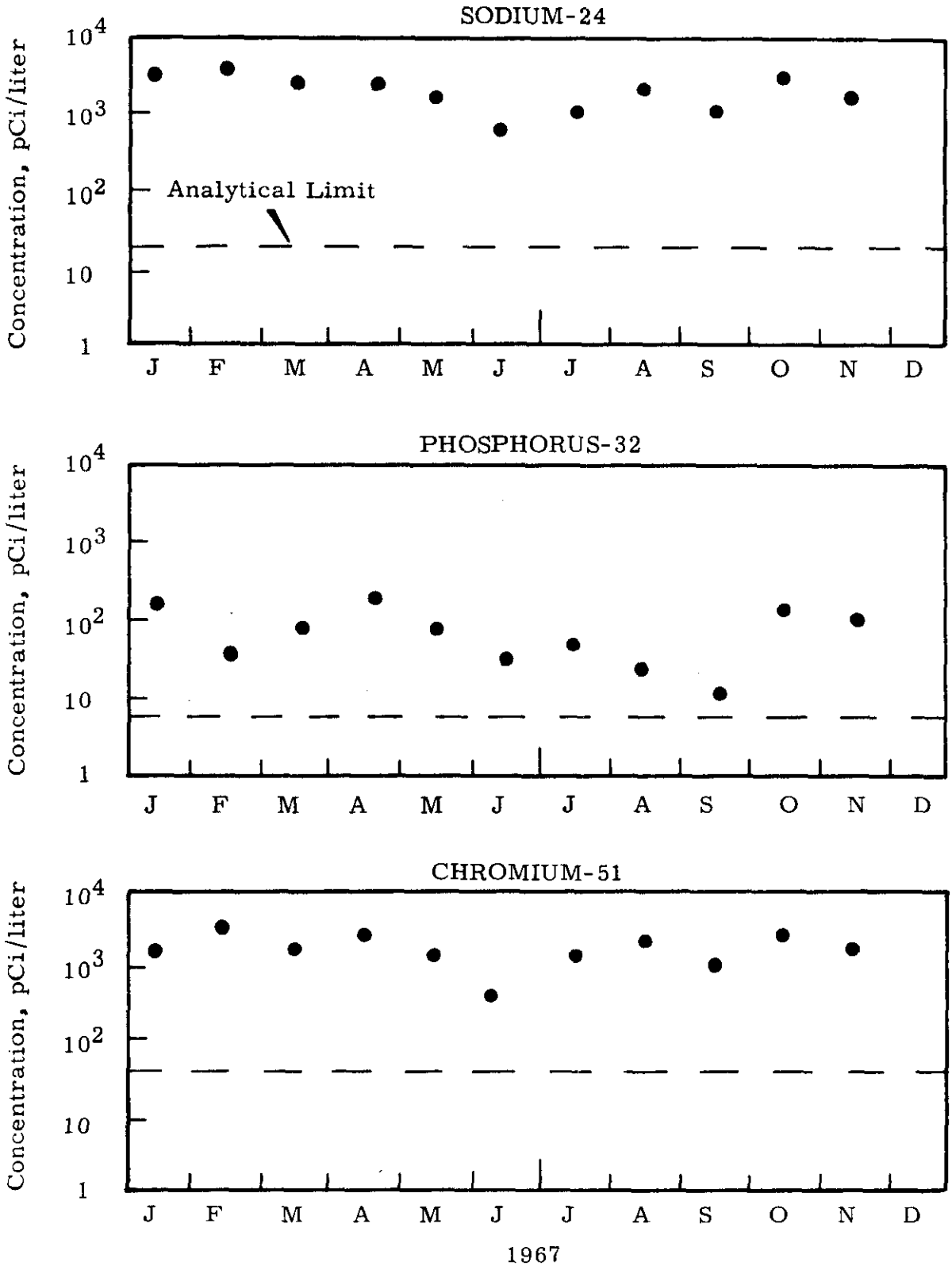


Figure 4

BNWL-CC 1197-6

RADIOACTIVITY OF COLUMBIA RIVER
RAW WATER (GRAB) SAMPLES
RINGOLD

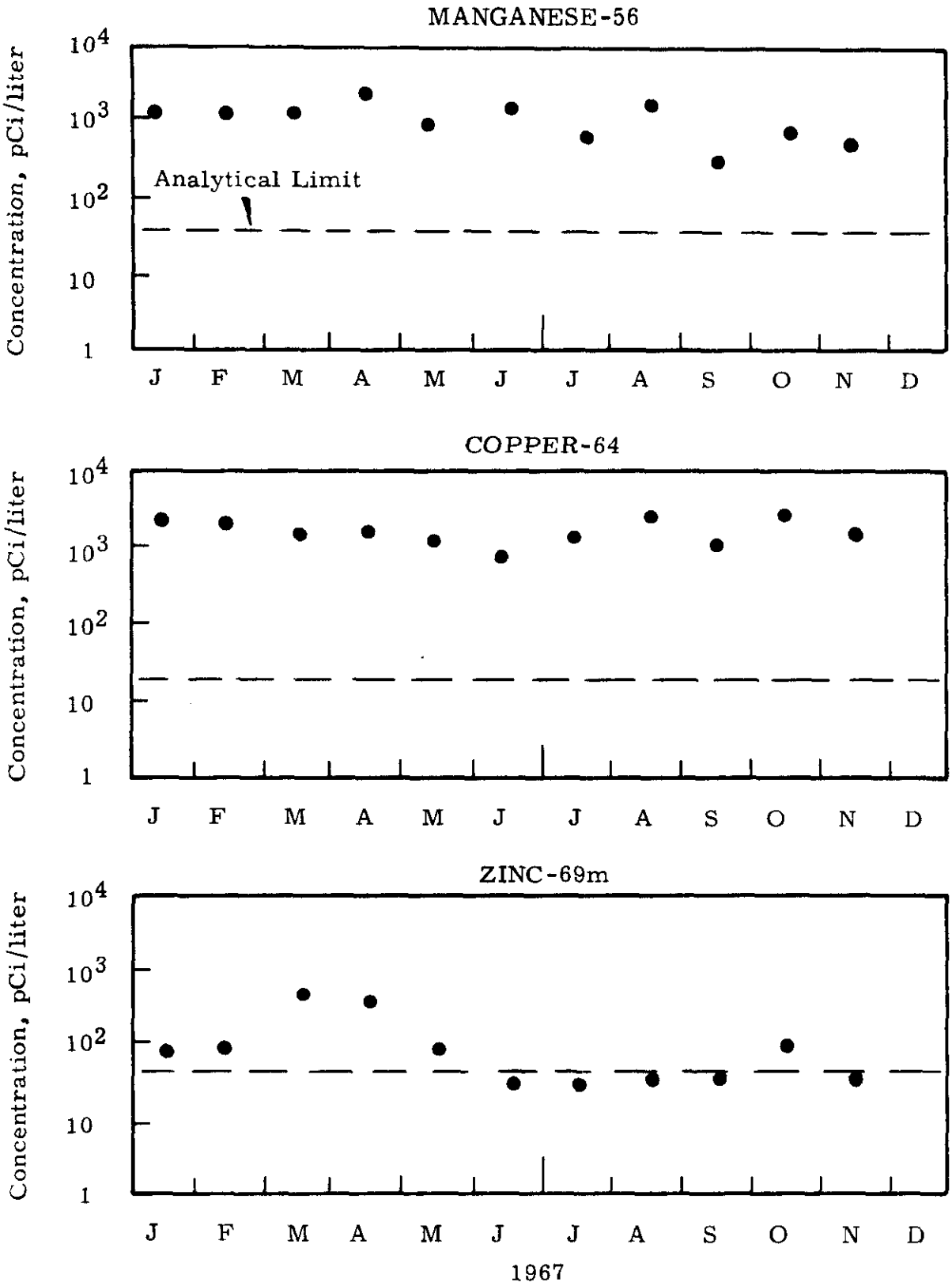


Figure 5

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES RINGOLD

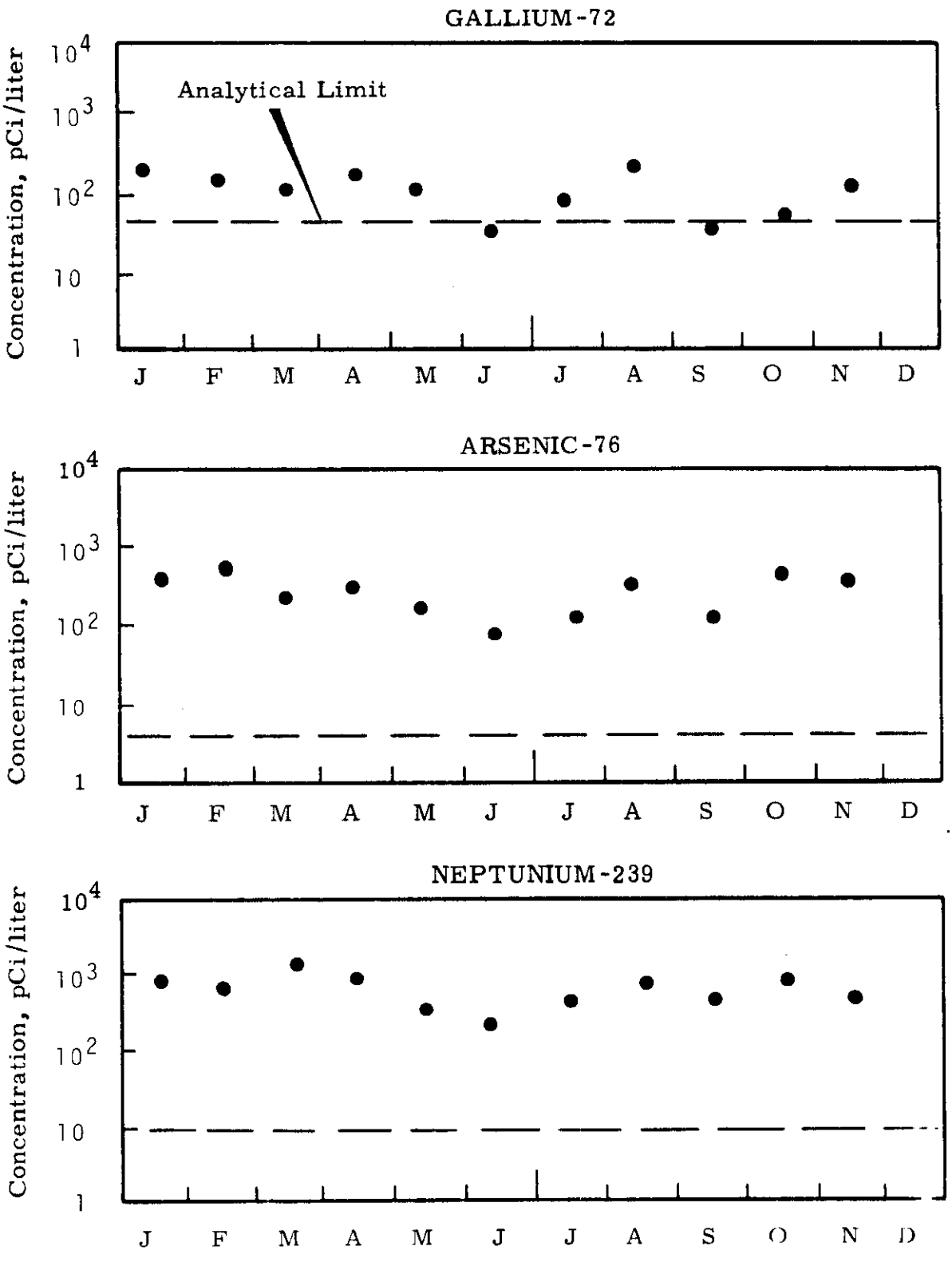
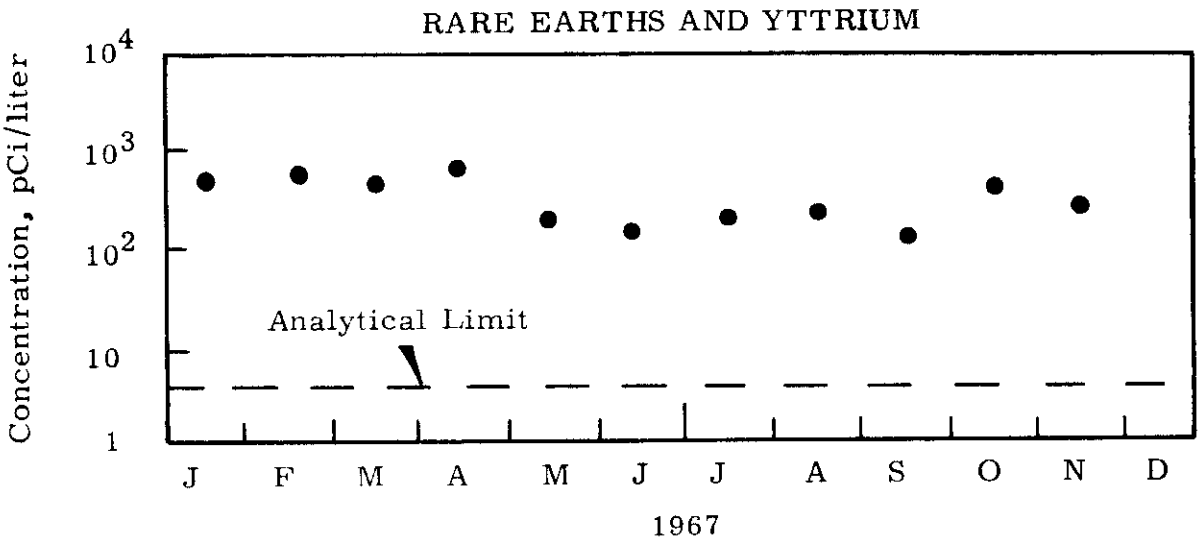
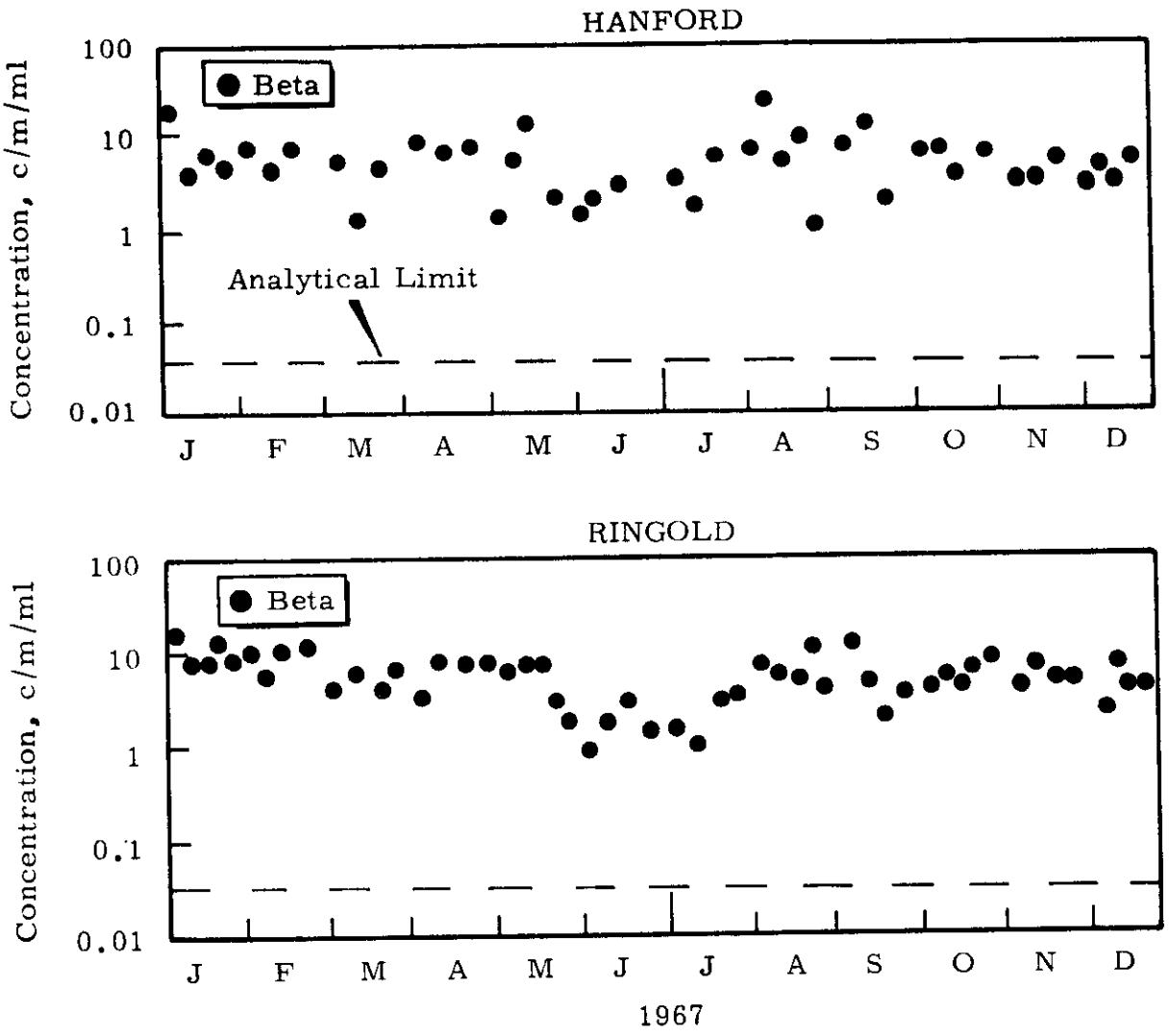


Figure 6 BNWL-CC 1197-6

RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES



RADIOACTIVITY OF COLUMBIA RIVER RAW WATER (GRAB) SAMPLES



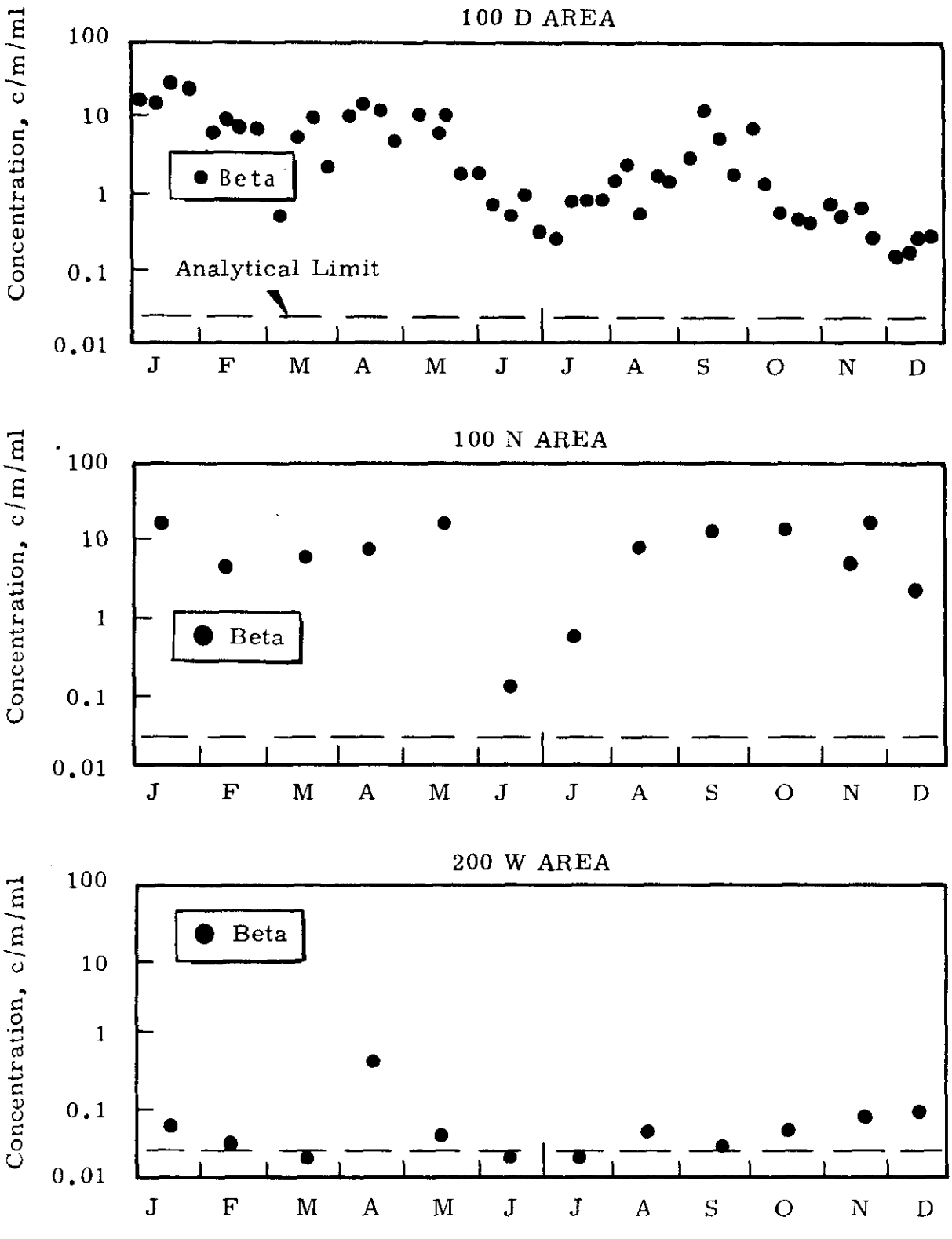
B. Drinking Water

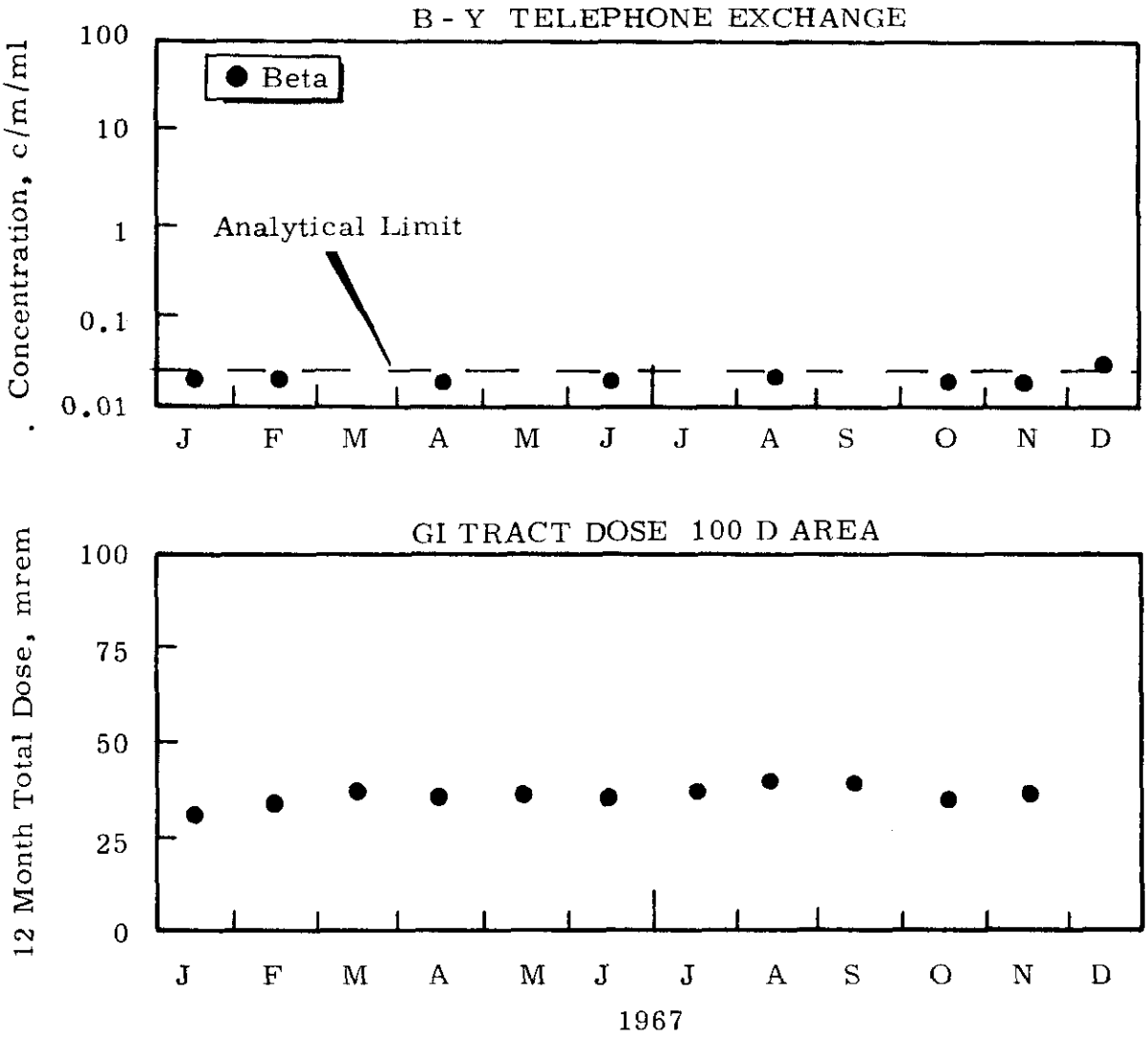
Total beta analyses of drinking water samples taken from 100-D, 100-N, 200-W, and B-Y Telephone Exchange are shown in Figures 8 and 9. The doses to the GI tracts of plant employees were estimated from isotopic analyses of drinking water samples collected at 100-D. This estimate was based on an assumed intake of 1.2 liters per day, 5 days per week. The GI tract dose integrated over the 12-month period ending November 30, 1967, (date of last sample) was 37 mrem. This was only slightly higher than the 12-month dose for 1966 (35 mrem), which included the effect of an extended period of reactor shutdown.

Routine sampling of drinking water at 100-N replaced sampling at 100-D in December, 1967.

Figure 8

RADIOACTIVITY OF DRINKING WATER (GRAB) SAMPLES




B - Y TELEPHONE EXCHANGE
Concentration, c/m/ml
100
10
1
0.1
0.01
Beta
Analytical Limit
J F M A M J J A S O N D
GI TRACT DOSE 100 D AREA
12 Month Total Dose, mrem
100
75
50
25
0
J F M A M J J A S O N D
1967

V. Swamps, Ditches, and Ponds

A. Waste Water

Open waters which may be used by migratory waterfowl are routinely sampled in the locations shown in Map 3. Results of analyses are shown in Figures 10-15. For the convenience of the reader, the maximum values appearing on some of the graphs are listed below with their corresponding dates. Transient increases in radioactivity which occurred at several locations in 1967 are also summarized below.

Swamps, Ditches, and Ponds - 1967
(Results are in units of pCi/ℓ)

200-West Area

T Swamp Inlet

Date	Alpha	Beta
9-8	770 (max.)	23,000
10-6	18	350,000* (max.)
10-13	12	93,000
10-20	33	4,000
10-27	7	84,000

* A gamma scan showed ^{137}Cs-55,000 pCi/ℓ; ^{134}Cs-18,000 pCi/ℓ; ^{106}Ru-7,700 pCi/ℓ; and ^{144}Ce-Pr-15,000 pCi/ℓ. A sample from T Swamp on Oct. 13 also showed ^{137}Cs and ^{134}Cs. (Refer below.)

234-5 Ditch Outlet

Date	Alpha
11-3	90
11-10	100,000* (max.)
11-17	720

* All subsequent samples were within the range of concentrations observed the previous three months.

U Swamp North

Date	Alpha	Beta
5-19	100	3,400
5-26	200	4,800* (max.)

* A gamma scan showed ^{137}Cs (2,400 pCi/ℓ) and ^{51}Cr (970 pCi/ℓ).

T Swamp North

Date	Alpha	Beta
10-13	4.5	120,000* (max.)
12-1	760 (max.)	2,100

* A gamma scan confirmed the presence of ^{137}Cs-2,100 pCi/ℓ; and ^{134}Cs-260 pCi/ℓ.

200-West Area (cont.)

Redox Swamp (NE)

Date	Alpha	Beta
1-13	140	1,400* (max.)
3-17	210 (max.)	77

* A gamma scan showed ^{51}Cr-1,300 pCi/ℓ; ^{95}Zr-Nb-450 pCi/ℓ; ^{65}Zn-300 pCi/ℓ; and ^{137}Cs-270 pCi/ℓ.

200-East Area

231 Z Waste Pit

Date	Alpha	Beta
2-17	140,000	3,200
2-24	66,000	920
3-17	430,000	27,000
3-31	51,000	3,500
4-14	320,000	8,300
10-20	2,000,000*(max)	53,000* (max)
11-3	270,000	2,300
12-1	44,000	11,000
12-15	1,300,000	22,000

* A gamma scan showed ^{241}Am-54,000 pCi/ℓ.

Purex Chemical Sewer

Date	Alpha	Beta
1-27	36	7,900* (max)
3-17	170 (max)	150

* Increased ^{131}I concentrations in Purex Chemical Sewer resulted in high ^{131}I concentrations in B Swamp several times in 1967. Results of some of the monthly gamma scans are shown below.

Date	^{131}I	^{137}Cs
1-27	1,530,000 (max)	2,100 (max)
3-17	61,000	ND
5-19	152,000	180
9-15	92,000	51

B Swamp North

Date	Alpha	Beta
6-30	21 (max)	340
12-1	3.8	15,000* (max)

* High concentrations of ^{131}I were observed several times in 1967. Results of some of the weekly gamma scans are shown below.

Date	^{137}Cs	^{131}I	
1-20	130	98,000	
1-27	97	220,000	
2-3	ND	370,000	(max)
2-10	90	140,000	
2-17	ND	66,000	
6-2	<51	44,000	
8-11	<51	39,000	
9-29	<51	44,000	

B. Game Birds

Game birds that have utilized swamps and ponds which receive low-level radioactive wastes may contain ^{32}P, ^{65}Zn, ^{137}Cs-^{137m}Ba and other radionuclides. Results of radioassays of game birds collected at certain locations during 1967 are shown in Table 3.

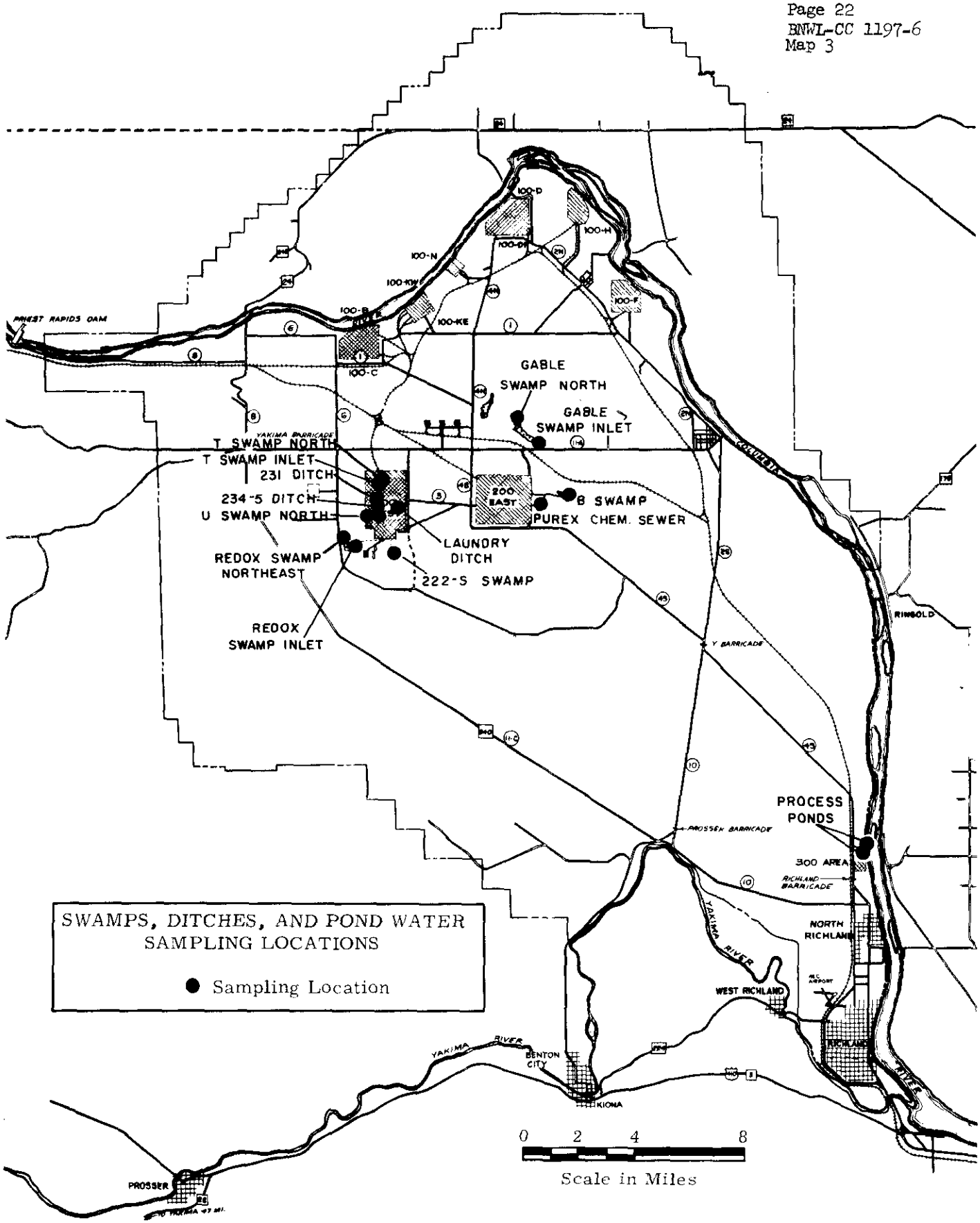
TABLE 3

GAME BIRDS - 1967

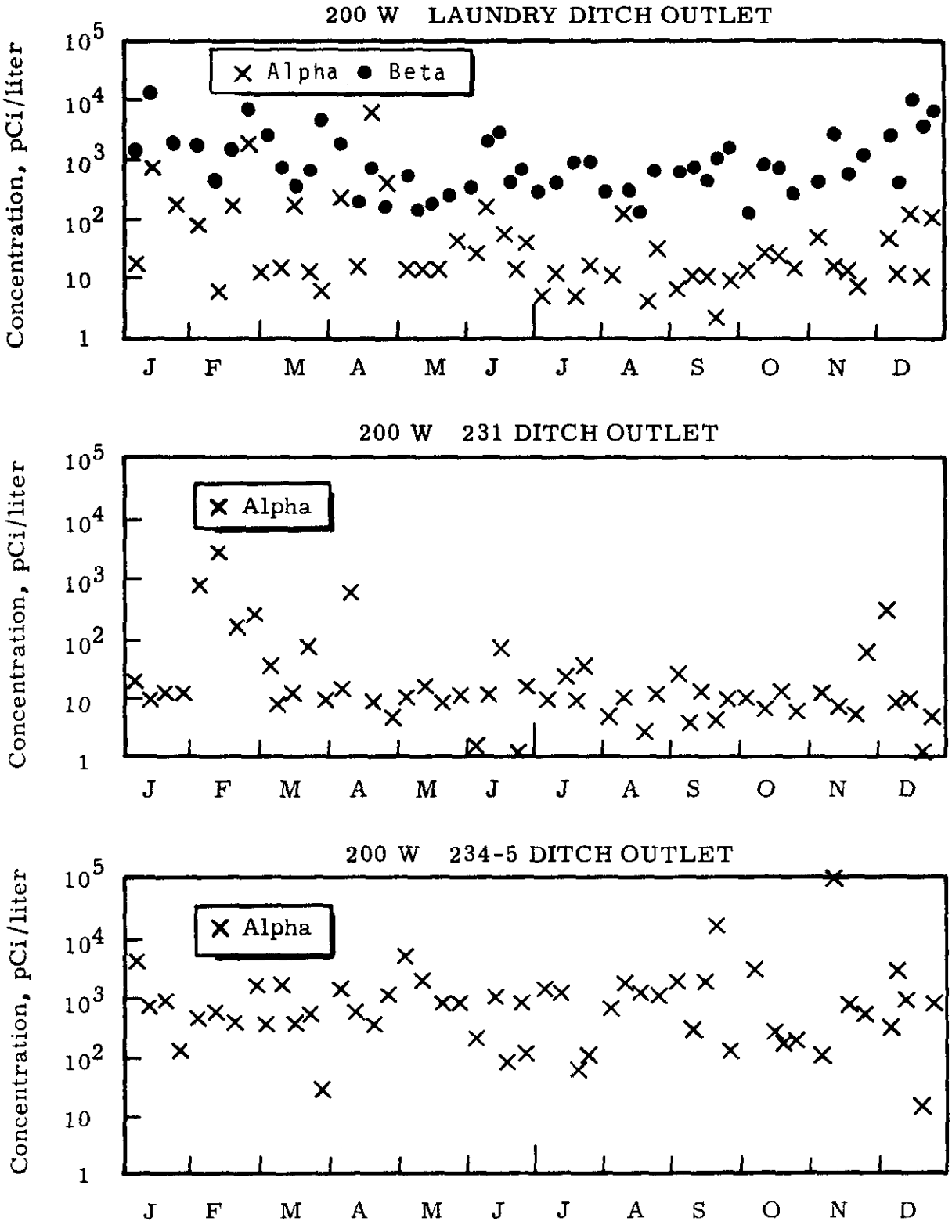
RADIONUCLIDE CONCENTRATION IN MUSCLE
(pCi/gm)

		Analytical Limit	^{32}P 1.0	^{65}Zn 0.2	^{131}I 0.15	^{137}Cs-^{137m}Ba 0.1
Location	Date	Species				
Redox Swamp	1-20	L. Scaup	7.0	.28	-	-
	1-20	Mallard	4.4	5.7	-	68
	11-10	Shoveler	52	.77		160
	11-10	Mallard	23	.23		63
U Swamp	10-20	Mallard	-	.64		20
	10-20	Coot	4.8	1.1	-	240
	10-20	Widgeon	29	.55		160
	11-10	Pheasant	1.8	.26		110
	11-10	Golden Eye	-	.44	-	43
	11-10	Widgeon	43	.38		170
B Swamp	10-20	Coot	1.9	.91	3.4	.50
	11-10	Mallard	-	-	2.3	2.8
	11-10	Coot	-	1.0	3.3	9.0
	11-10	Coot	1.7	.86	18	4.6
Gable Mt Swamp	10-20	Scaup	-	.9	.64	31
	10-20	Coot	3.4	1.1	-	160
	10-20	Coot	21	2.2	41	70
	11-10	Coot*	680	103	-	61

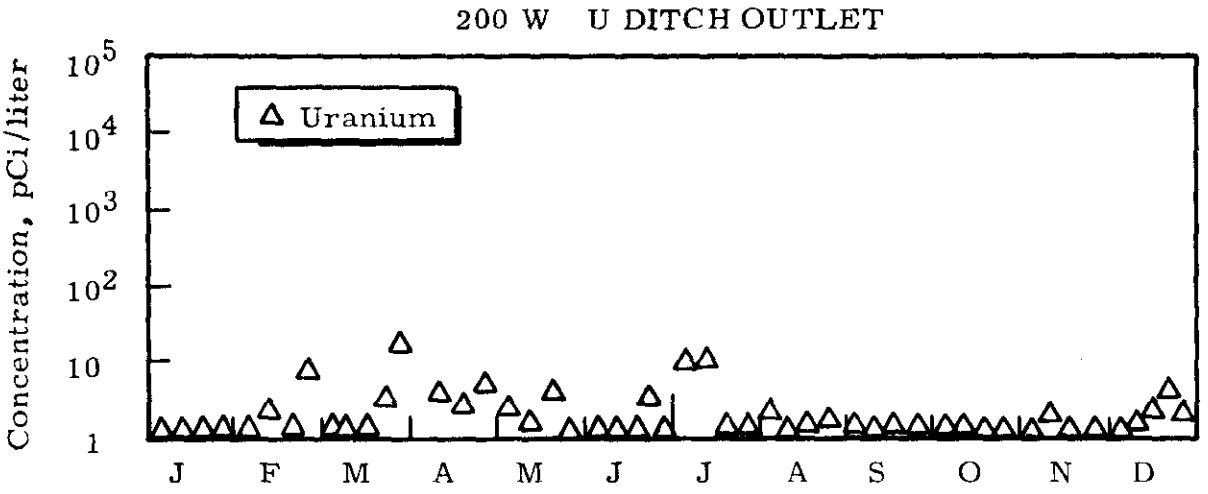
* Higher ^{32}P and ^{65}Zn concentrations are normally characteristic of ducks sampled from the areas adjacent to the Columbia River.

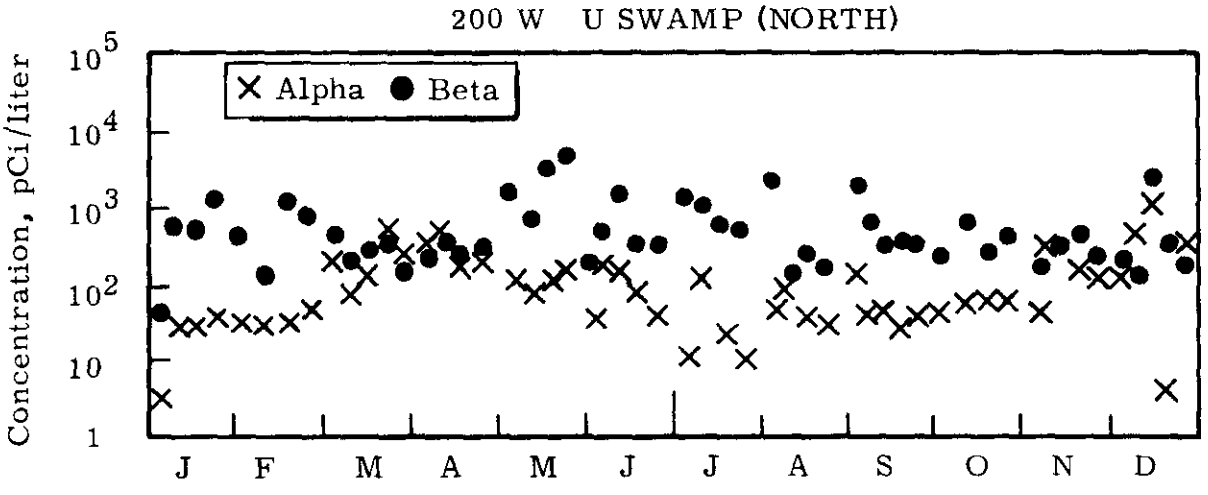

PRIEST RAPIDS DAM
100-B
100-C
100-D
100-DR
100-H
100-N
100-KW
100-KE
100-F
GABLE
SWAMP NORTH
GABLE
SWAMP INLET
YAKIMA BARRICADE
T SWAMP NORTH
T SWAMP INLET
231 DITCH
234-5 DITCH
U SWAMP NORTH
REDOX SWAMP
NORTHEAST
REDOX
SWAMP INLET
200
EAST
B SWAMP
PUREX CHEM. SEWER
LAUNDRY
DITCH
222-S SWAMP
COLUMBIA
RIVER
RICHLAND
Y BARRICADE
PROCESS
PONDS
PROSSER BARRICADE
300 AREA
RICHLAND
BARRICADE
NORTH
RICHLAND
YAKIMA
RIVER
WEST RICHLAND
AIRPORT
BENTON
CITY
KIONA
PROSSER
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
Sampling Location
0 2 4 8
Scale in Miles

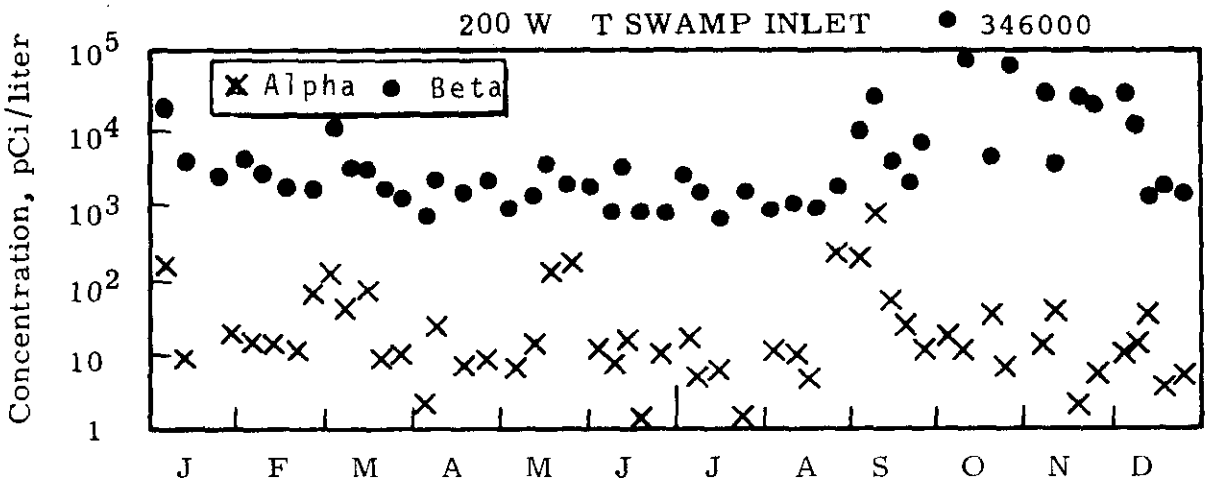
RADIOACTIVITY OF WASTE WATER SAMPLES



RADIOACTIVITY OF WASTE WATER SAMPLES



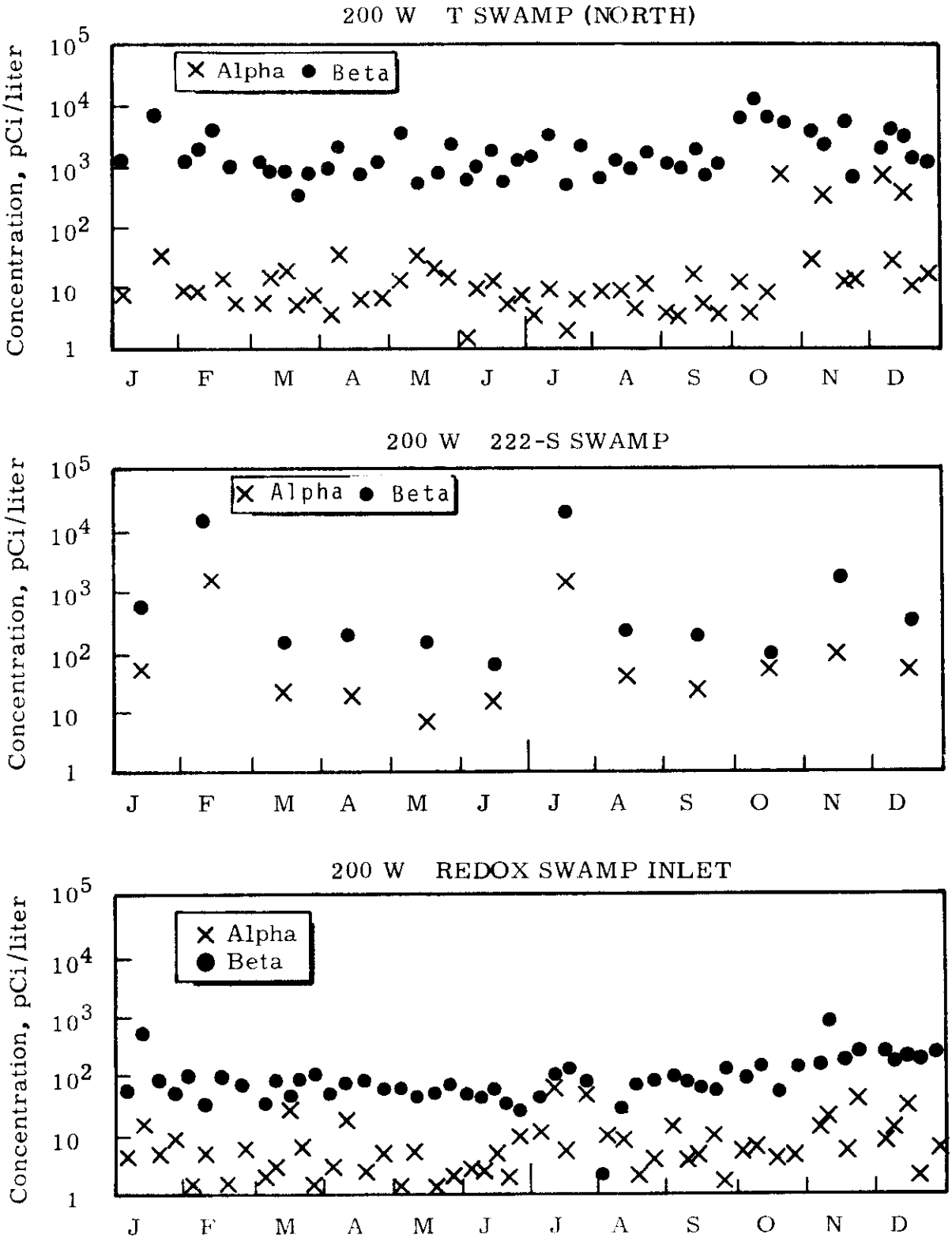




1967

Figure 12 BNWL-CC 1197-6

RADIOACTIVITY OF WASTE WATER SAMPLES



1967

RADIOACTIVITY OF WASTE WATER SAMPLES

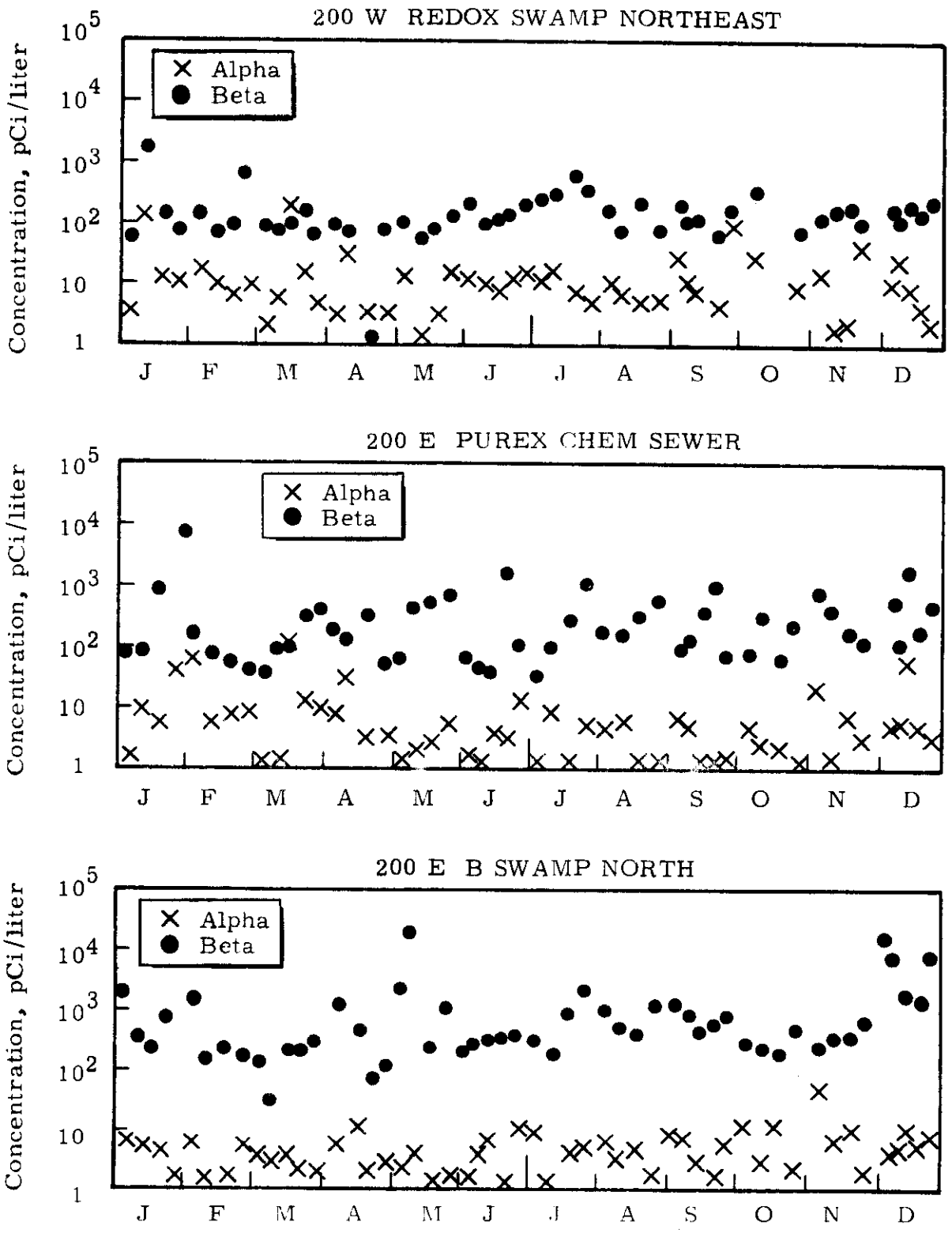


Figure 14 BNWL-CC 1197-6

RADIOACTIVITY OF WASTE WATER SAMPLES

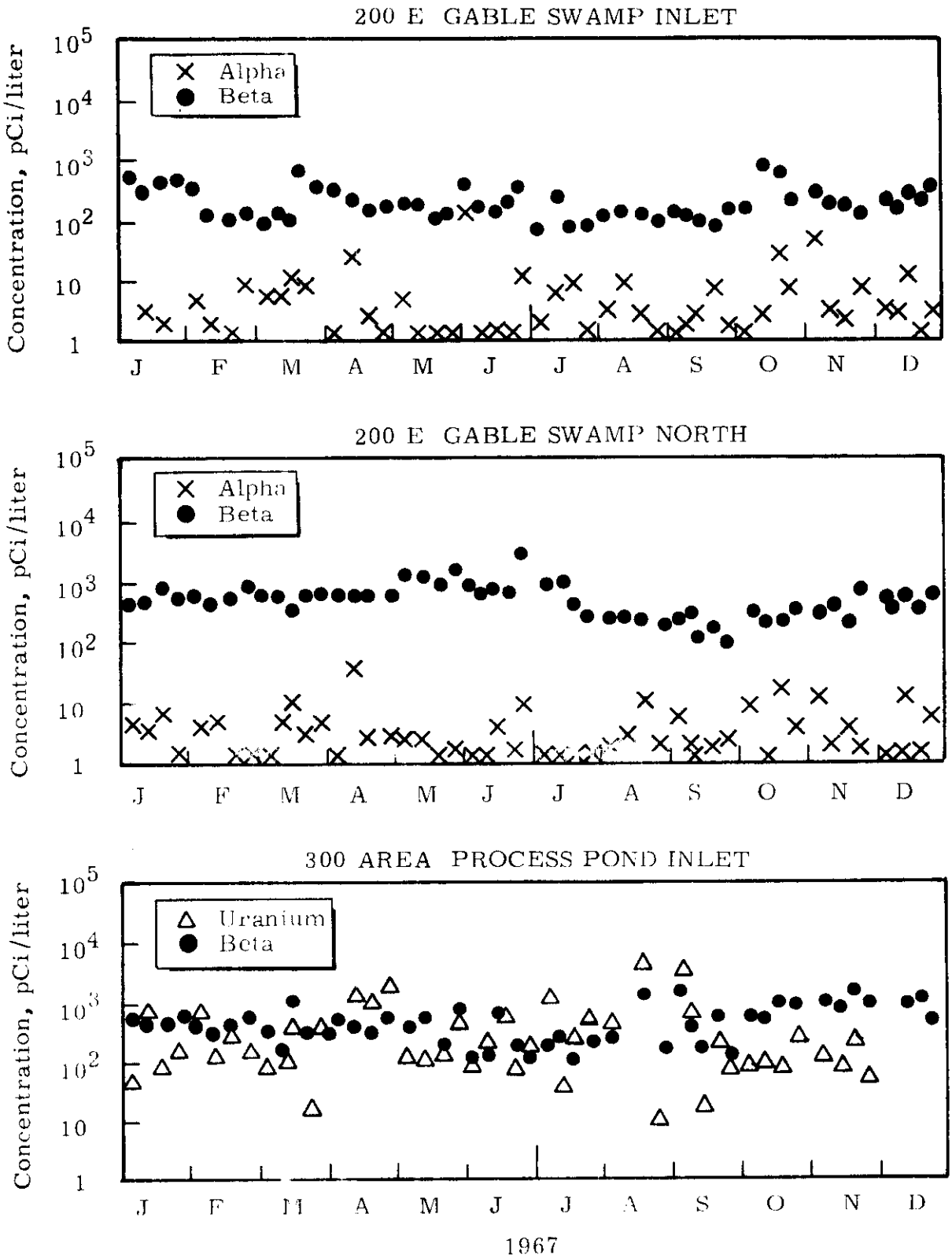
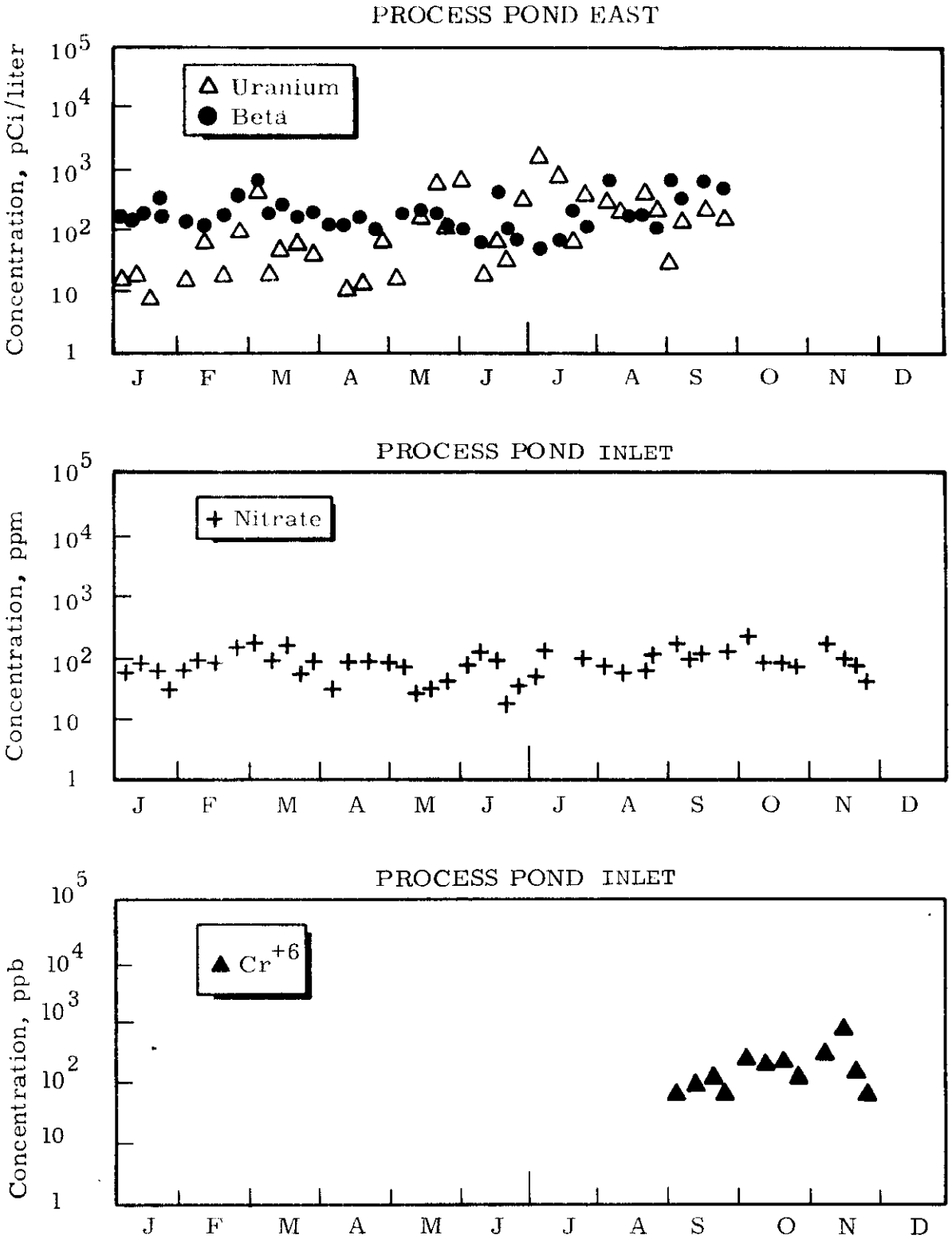


Figure 15 BNWL-CC 1197-6

WASTE WATER SAMPLE ANALYSES
300 AREA



1967

VI . The Atmosphere

A. Iodine-131 and Total Beta Activity

Results of routine sampling of the atmosphere at 23 locations within the Hanford Reservation (Map 4) are shown in Figures 16-23. At most locations, the sampling equipment was contained within a small building designated "614". "Total Beta" represents the activity of particulates collected on H-70 filter paper during a one-week sampling period. The air then passed through a solution of NaOH for ^{131}I collection. During 1967, several transient increases in total beta and/or ^{131}I concentrations were observed. A month-by-month summary of each change in concentration follows.

January-February - Fallout attributed to a reported nuclear weapons test of December 27, 1966 reached the Hanford environs in early January and caused significant increases in total beta activity at most sampling locations. The highest total beta concentration due to fallout was 9.7 pCi β/m^3 at the 700 Area for the week ending January 3. The following short-lived radionuclides were found after a qualitative gamma scan of the 700 Area filter: 2.8-day ^{99}Mo, 3.3-day ^{132}Te, 13-day ^{140}Ba-La, and 2.4-day ^{239}Np.

Increases in total beta activity and ^{131}I concentrations at the 200 East Area during the last week of January through mid-February resulted from waste-handling operations. Gamma scans of three air filters with high total beta activities (5.2, 12, and 4.2 pCi β/m^3, respectively), are shown in Table 4.

TABLE 4

Gamma Scan Analyses of Air Filters
Radionuclide Concentrations, pCi/m^3

Location	Week Ending	^{95}Zr-Nb	^{103}Ru	^{106}Ru	^{131}I	^{137}Cs	^{141}Ce	^{144}Ce-Pr
Semi works	1-30	0.20	ND	ND	0.31	0.05	ND	11
200 EEC	1-30	0.16	ND	ND	0.91	0.10	ND	22
200 EEC	2-14	0.11	0.10	0.58	0.73	0.07	0.58	ND

ND - Not Detected

March-April - ^{131}I concentrations at the end of March increased at 200 EEC, 200 ESE, Semi works, and the Emergency Relocation Center sampling locations following a small temporary increase in the emission rate of ^{131}I from a chemical separations facility. In April, increases were also noted in ^{131}I concentrations at the 300 Area following above normal ^{131}I emissions from laboratory buildings.

May-June - Increases in ^{131}I concentrations at the 200 EEC, 200 ESE, 200 EWC, Semi works, Redox, and EBC during May were the result of a small increase in emission rate of ^{131}I from a chemical separations facility. Increases were also noted in ^{131}I concentrations at the 300 and 700 Areas, following above normal ^{131}I emissions from laboratory buildings.

Slight increases in atmospheric beta activity were observed following a reported nuclear weapons test on June 17.

July-August - In early July, total beta activity reached 17 pCi/m^3 at the 300 Area following a filter change in a laboratory building. A gamma spectrometer analysis of the 300 Area air particle removed July 3 indicated ^{144}Ce-Pr - 11.4 pCi/m^3, ^{106}Ru-Rh - 2.65 pCi/m^3, ^{137}Cs-Ba - 2.47 pCi/m^3, ^{95}Zr-Nb - 0.3 pCi/m^3 and ^{134}Cs - 3.42 pCi/m^3. Later, radioactive particles were released from another 300 Area stack and resulted in localized ground contamination. (See p. 46).

Increases in total beta activity were observed in the latter part of August at sampling locations within the Hanford boundaries and at perimeter communities but could not be explained on the basis of known plant releases.[3]

September-October - Increases in total beta activity in the last week of October could not be explained on the basis of known Hanford releases.

Air sampling was discontinued at the White Bluffs townsite in early October.

November-December - At some locations, slightly increased beta activity was observed in November. A gamma scan was requested on the Emergency Relocation Center air filter that was removed November 24, 1967, which had a total beta of 1.49 pCi/m^3. The gamma emitters present were ^{95}Zr-Nb (0.21 pCi/m^3), and ^{106}Ru (0.13 pCi/m^3). A gamma scan on an air filter from an off-plant location, Moses Lake, that was removed on November 21, showed only ^{95}Zr-Nb (0.07 pCi/m^3).

During December the beta activity collected on a filter at 200 East East Center indicated a concentration of 2.35 pCi β/m^3. A gamma scan showed ^{137}Cs-^{137m}Ba (1.6 pCi/m^3), ^{95}Zr-Nb (0.45 pCi/m^3), and ^{106}Ru (0.3 pCi/m^3).

^{131}I concentrations increased slightly at 200 East Southeast in the third week of November, and at the 200 East East Center, 200 East Semiworks and Emergency Relocation Center sampling location during early December following a slight increase in the emission rate of ^{131}I from a chemical separations facility.

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[3] Radiological Status of the Hanford Environs for August, 1967, BNWL-420 8, edited by J.E. Keely and C.F. Washington. Pacific Northwest Laboratory, Richland, Washington, November, 1967.

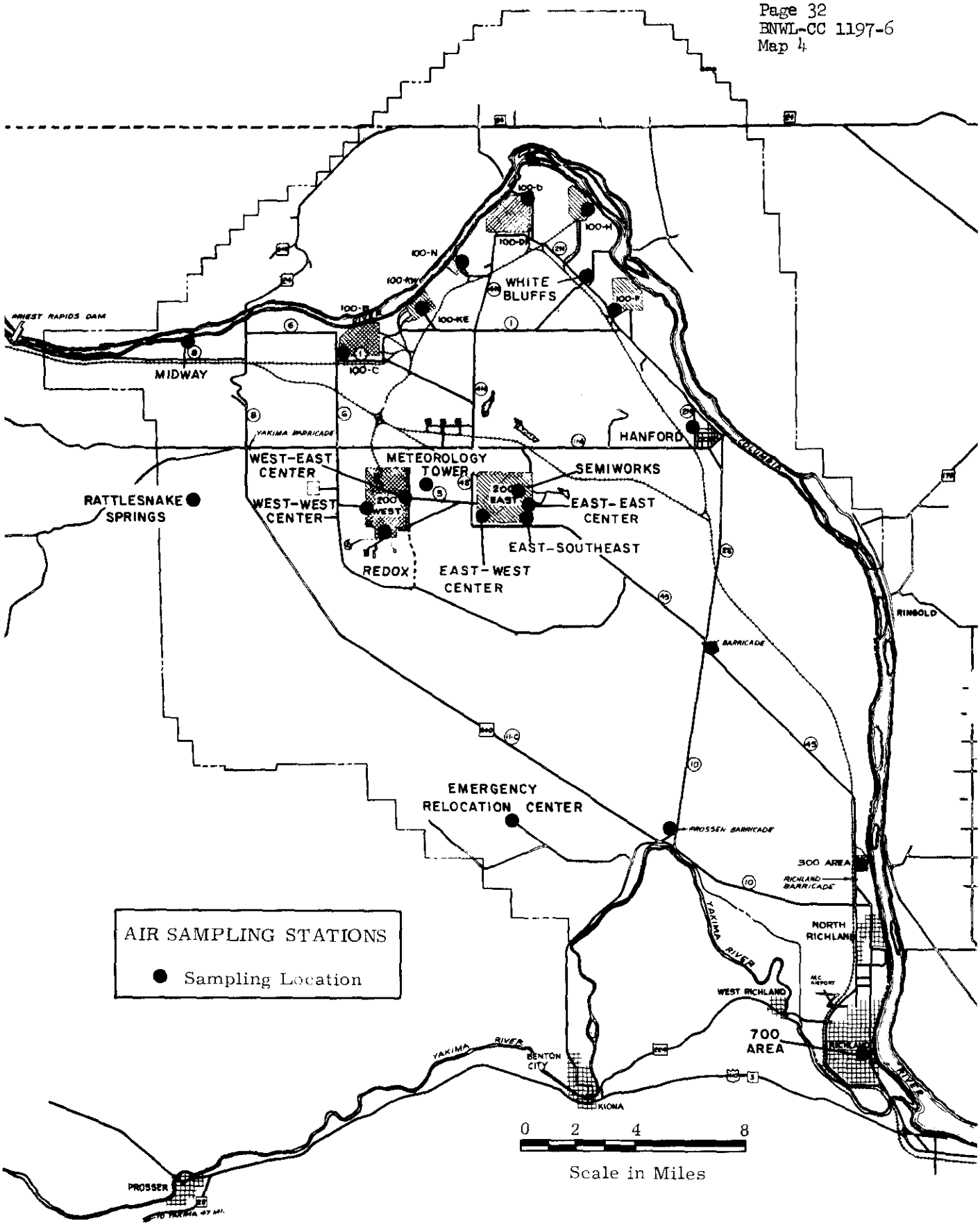
Fallout was observed at some sampling locations during the last week of December following an announced nuclear weapons test on December 24.

The average ^{131}I and total beta concentrations for 1967 are shown below in Table 5, and for comparison the averages for 1966 and 1965 are also shown.

TABLE 5

Atmospheric ^{131}I and Total Beta Concentrations - Yearly Averages
(Results in pCi/m^3)

Location	Total Beta			^{131}I		
	1967	1966	1965	1967	1966	1965
100 Areas	0.34	0.29	0.44	0.02	0.20	< 0.03
200 Areas	0.41	0.58	0.80	0.09	0.10	0.14
Other N-Plant locations	0.26	0.24	0.34	0.04	0.20	0.05


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

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

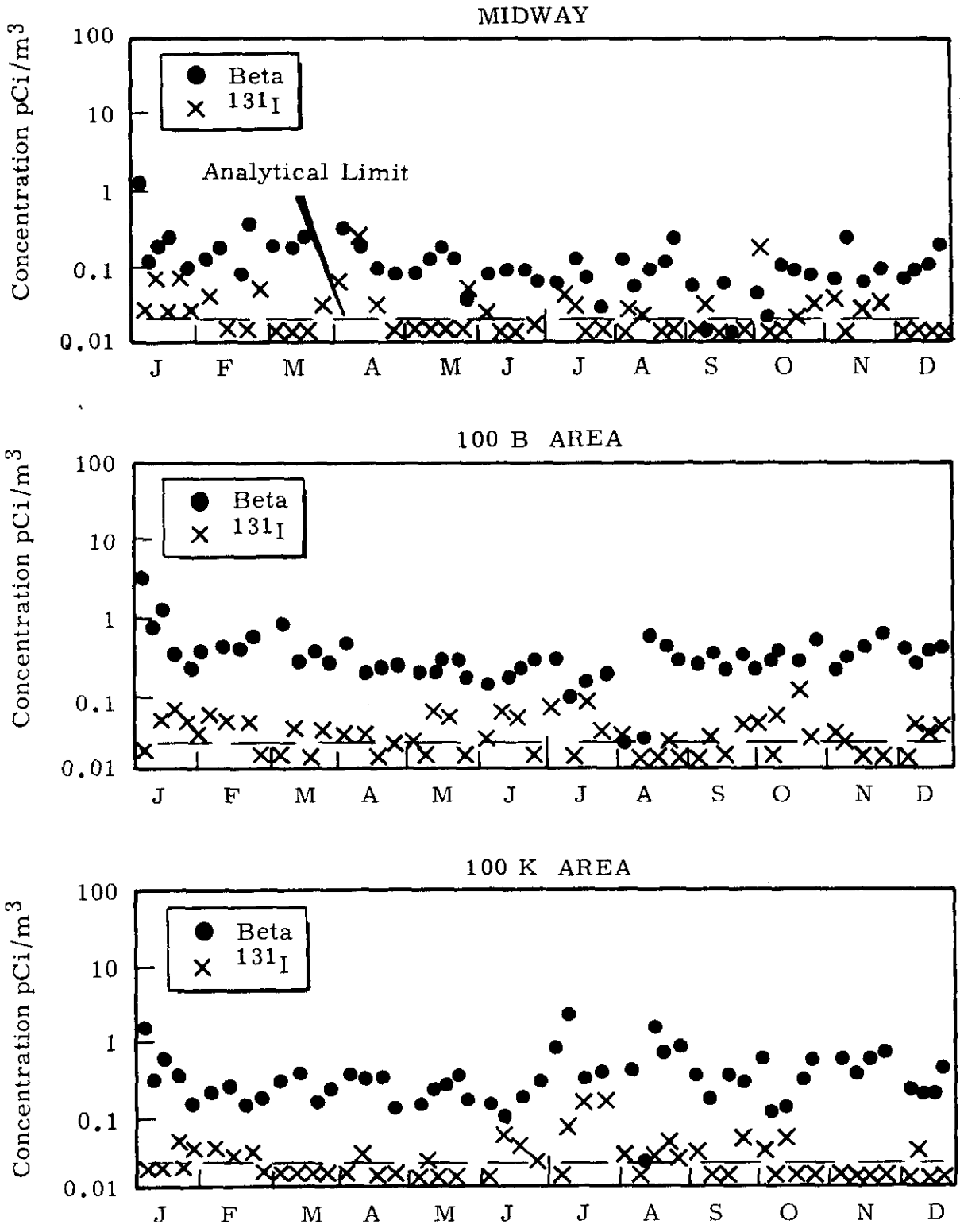
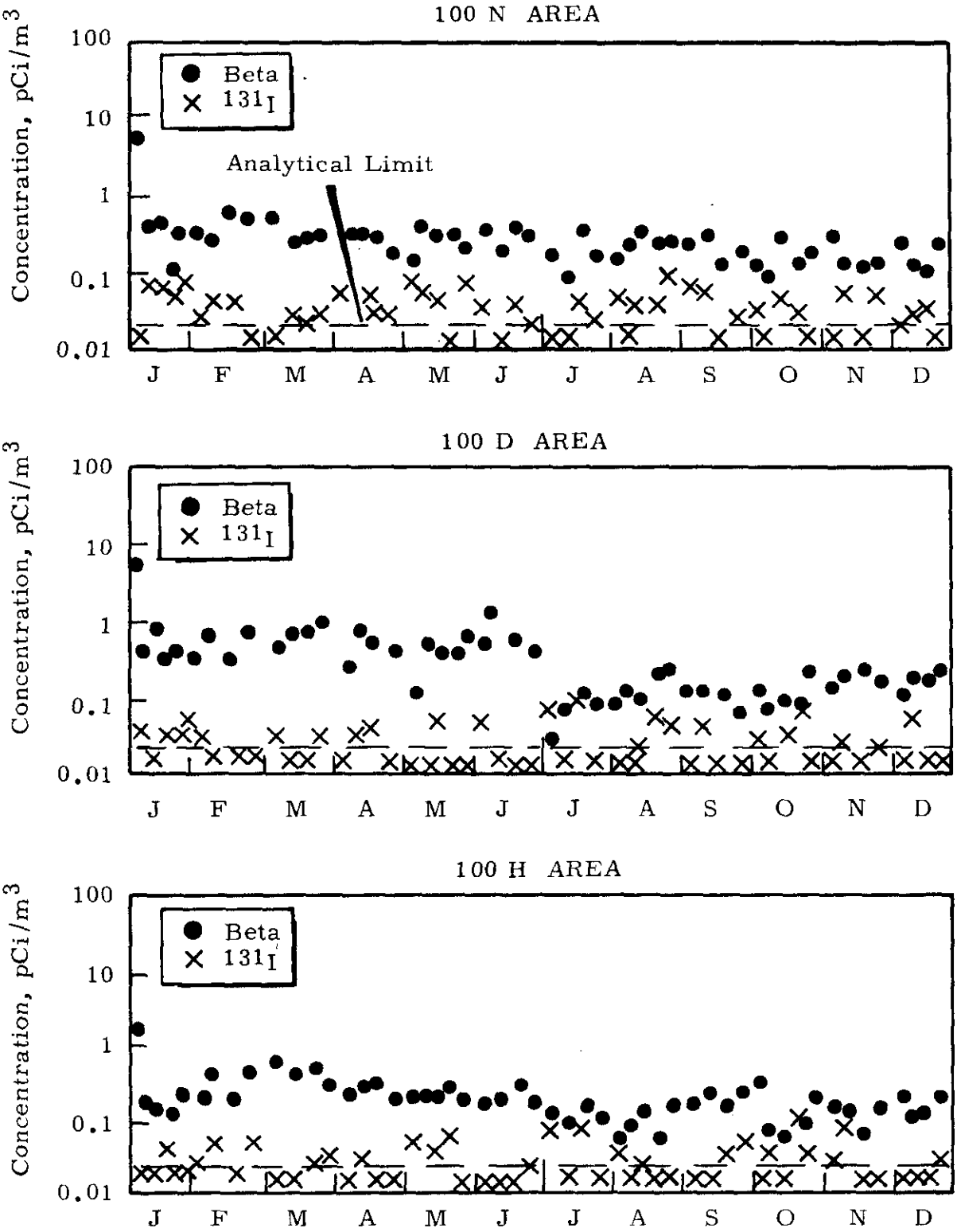


Figure 17 BNWL-CC 1197-6

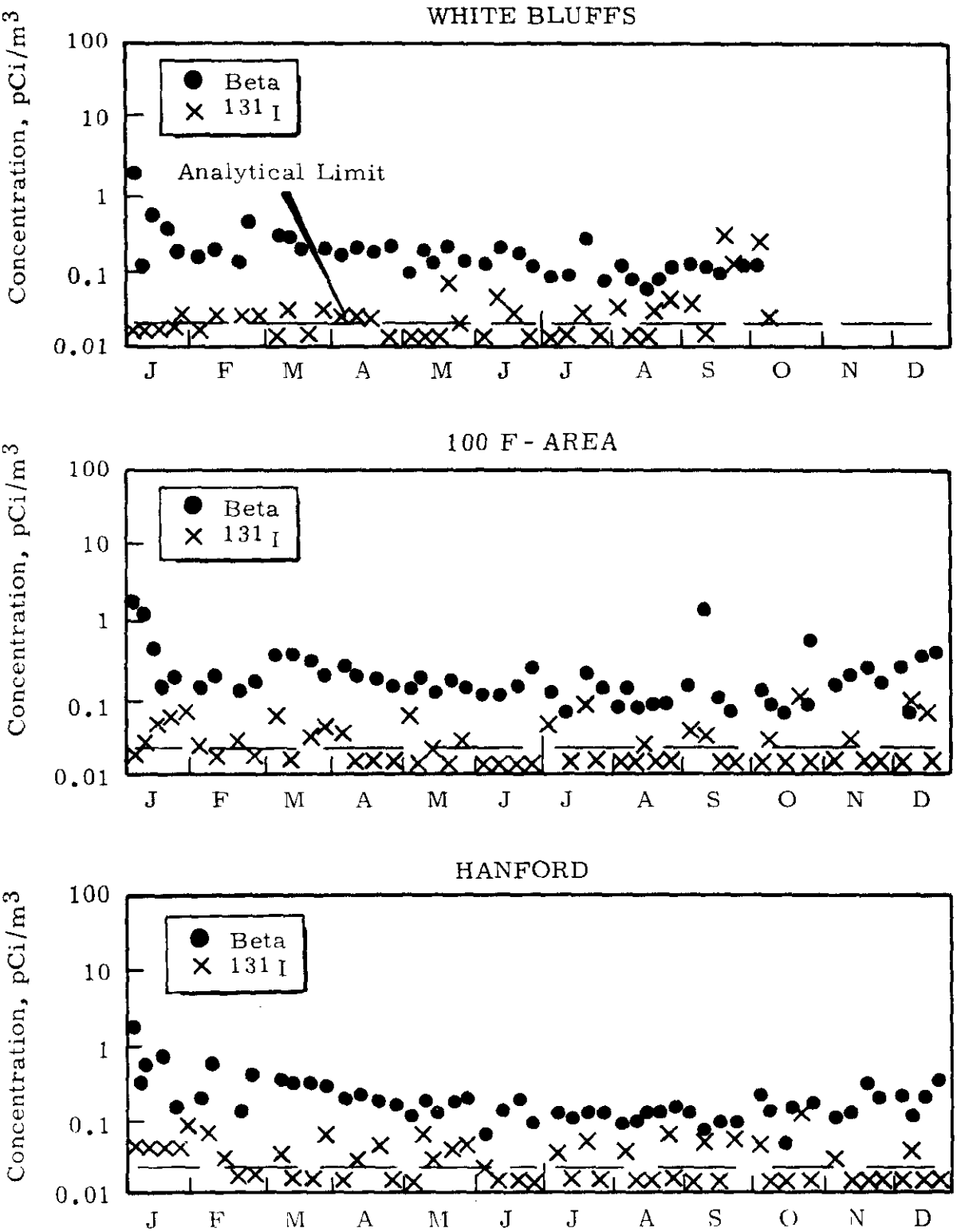
IODINE - 131 AND TOTAL BETA ACTIVITY
IN THE ATMOSPHERE



1967

Figure 18 BNWL-CC 1197-6

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



1967

Figure 19

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

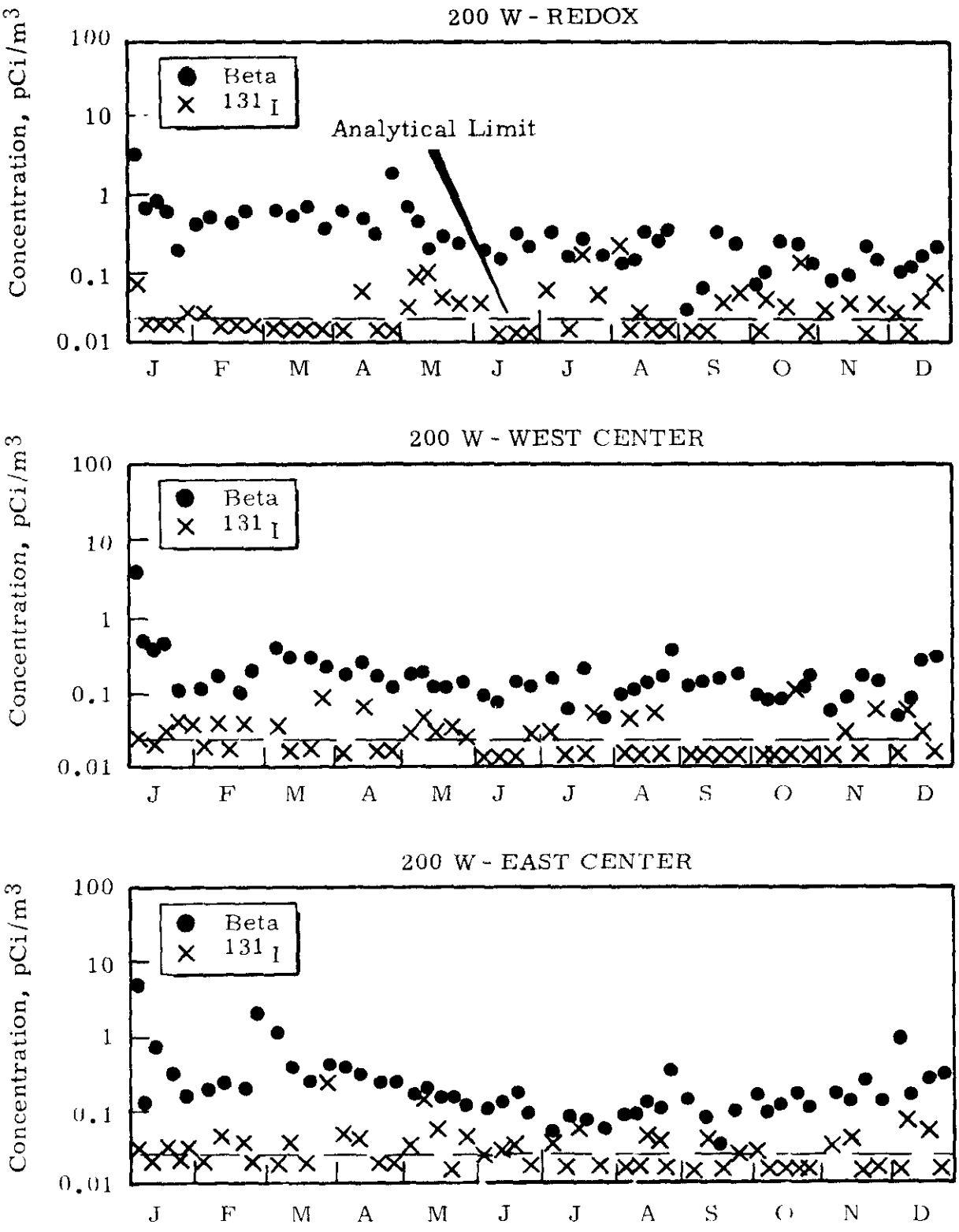
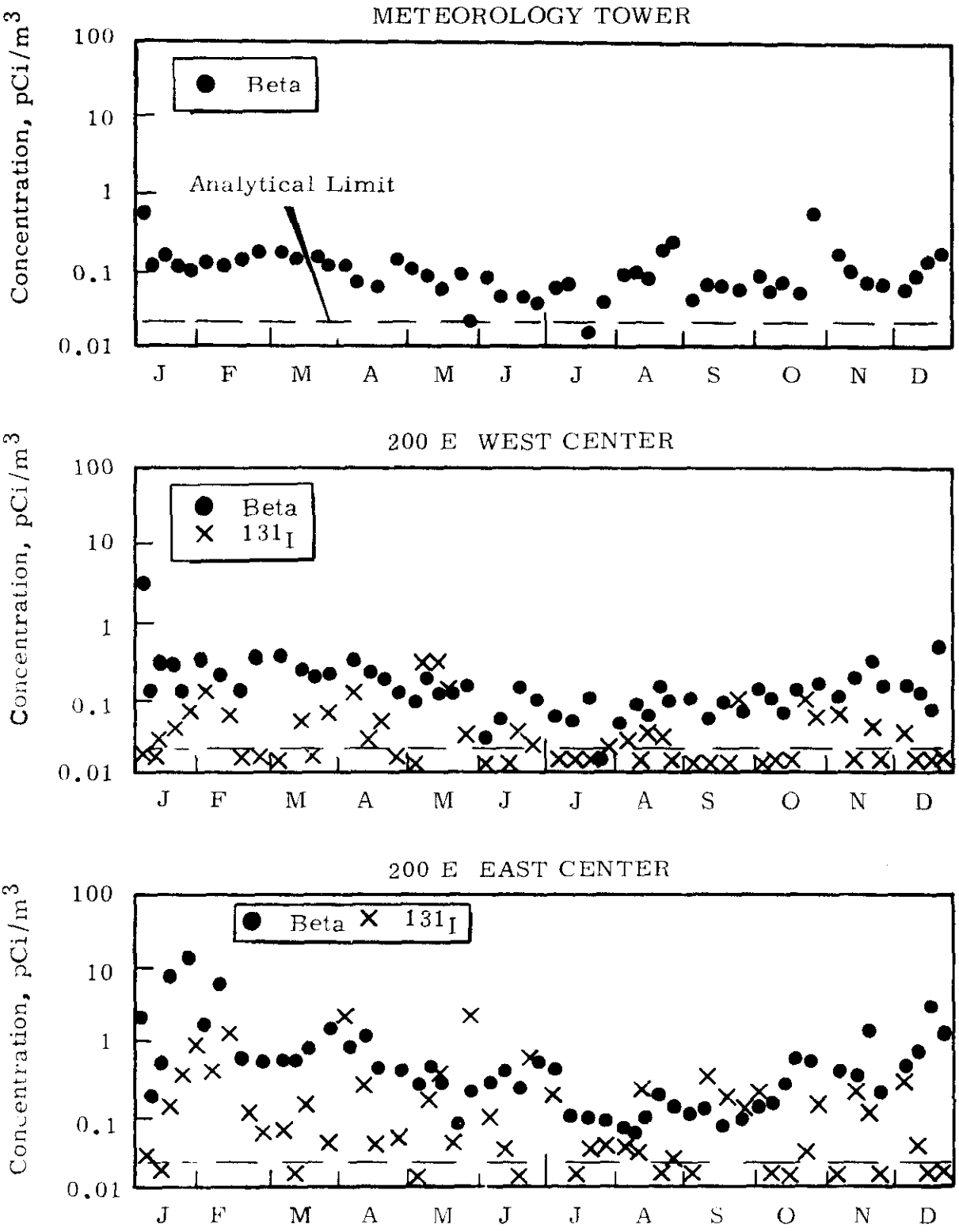


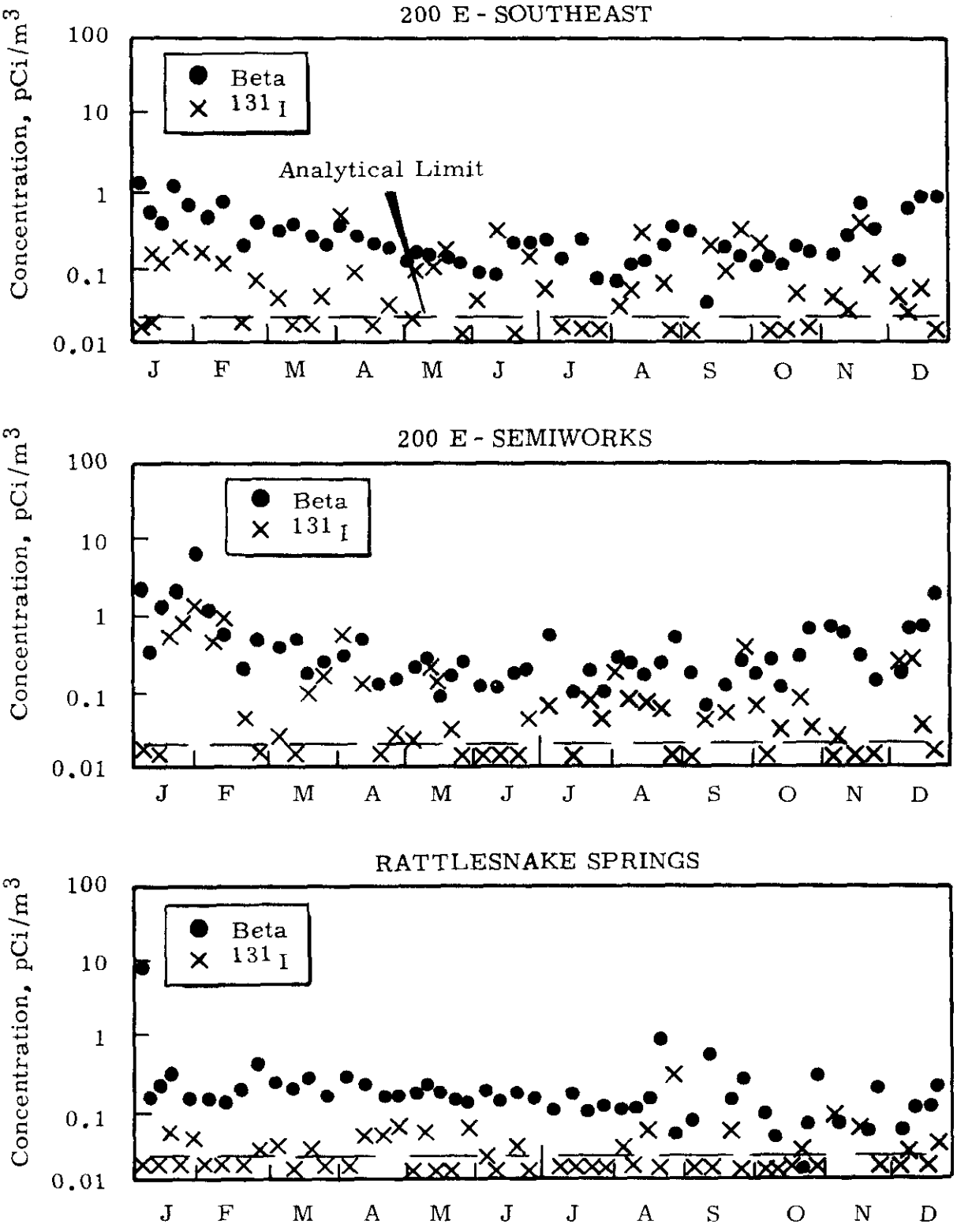
Figure 20 BNWL-CC 1197-6

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

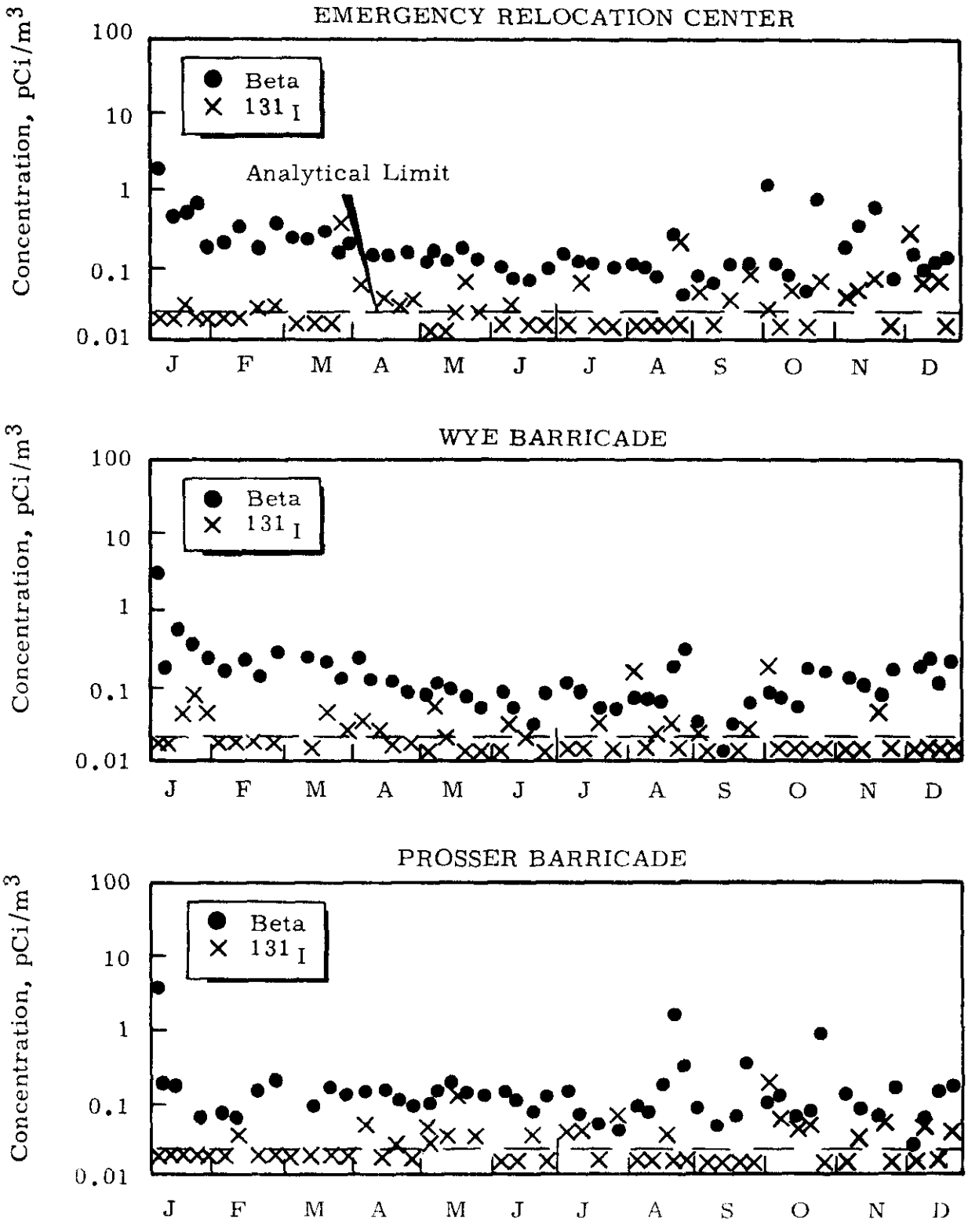


1967

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE

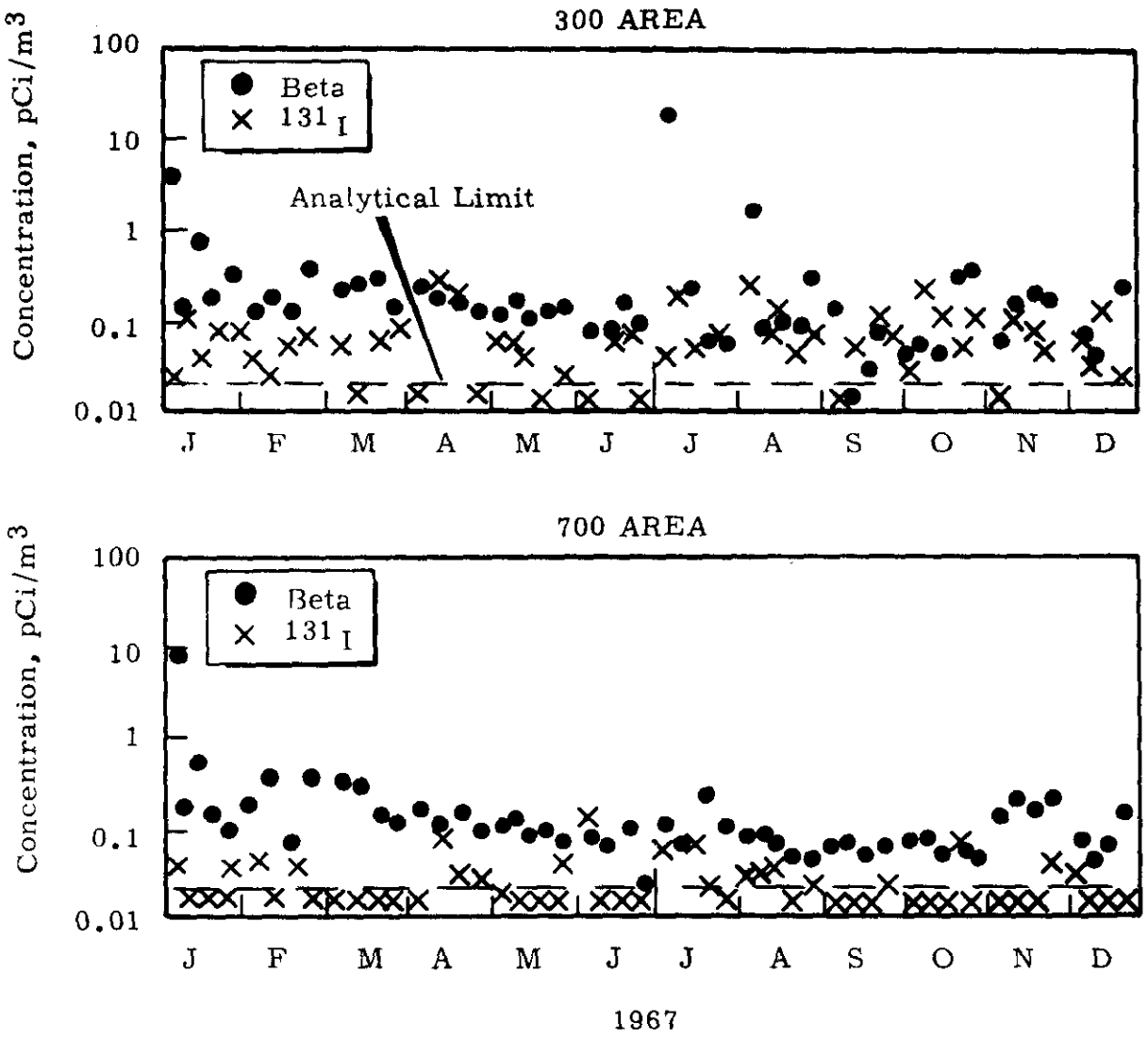


IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



1967

IODINE - 131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE



B. Total Alpha Activity

Eleven of the 23 weekly filters which collect beta-gamma emitting radionuclides are also analyzed for alpha activity, with most of the sampling sites located in the 200 Areas. These data are presented in Figures 24-27.

For most sampling locations, results were generally at or below tha analytical limit of 0.01 pCi α/m^3 throughout 1967. However, in early March, the total alpha concentration temporarily reached 1.6 pCi/m^3 at 200 West East Center. The contaminant was identified as ^{239}Pu by alpha energy analysis. The filter was autoradiographed and was found to have a particle distribution similar to those normally found in air filters. No explanation has been found for the temporarily increased alpha activity.

An isolated temporary increase in total alpha concentration at 100-F occurred during the third week of November.

The annual average total alpha concentrations in the atmosphere for 1967 are presented in Table 6. For comparison, averages for 1965 and 1966 are also shown.

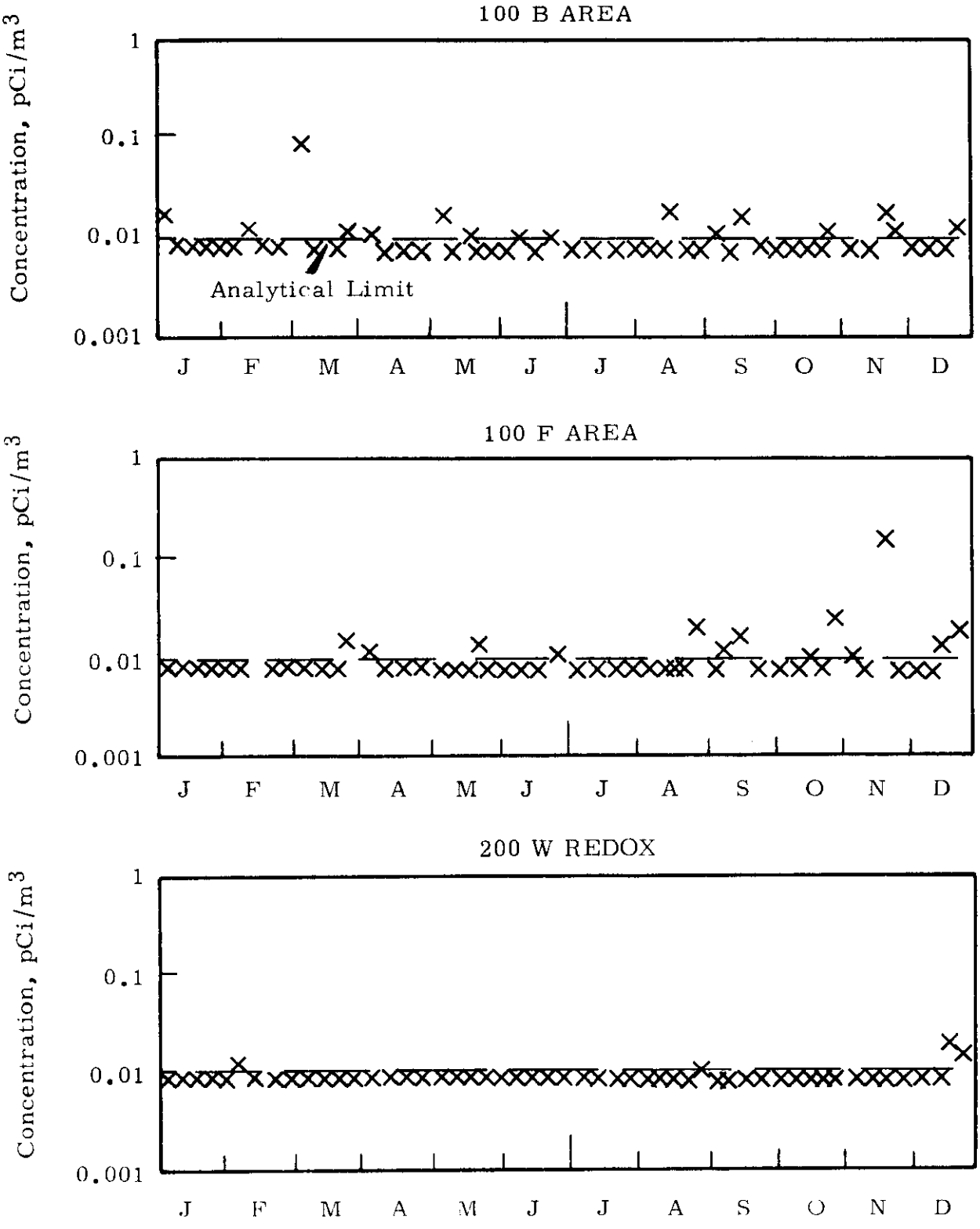
TABLE 6

Atmospheric Total Alpha Concentrations - Yearly Averages
(Results in pCi/m^3)

Location	1967	1966	1965
100 Areas	.01	.01	<0.02
200 Areas	.02	.01	<0.03
300 Area	.01	.02	0.08
700 Area	.01	.02	<0.02

Figure 24 BNWL-CC 1197-6

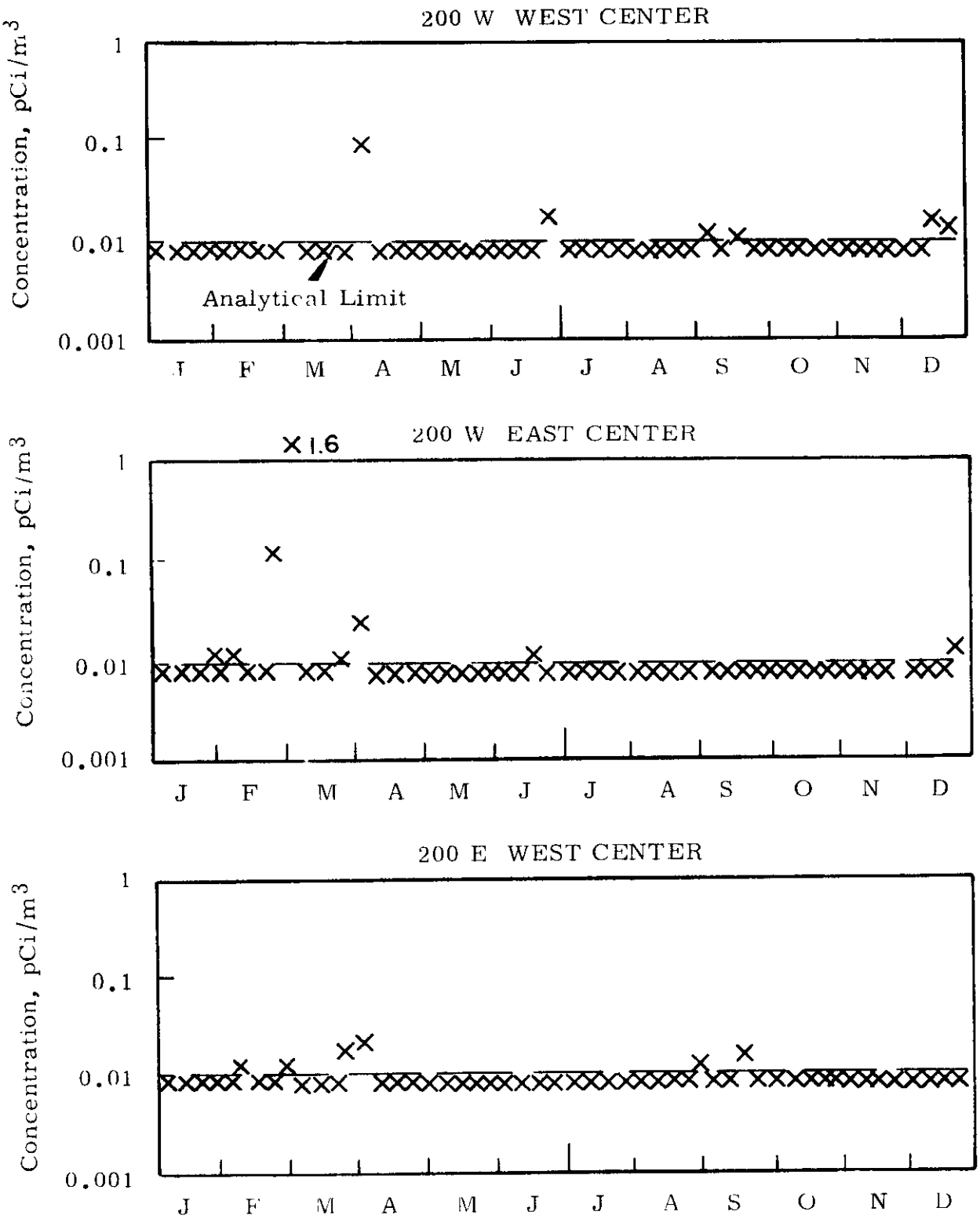
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



1967

Figure 25 BNWL-CC 1197-6

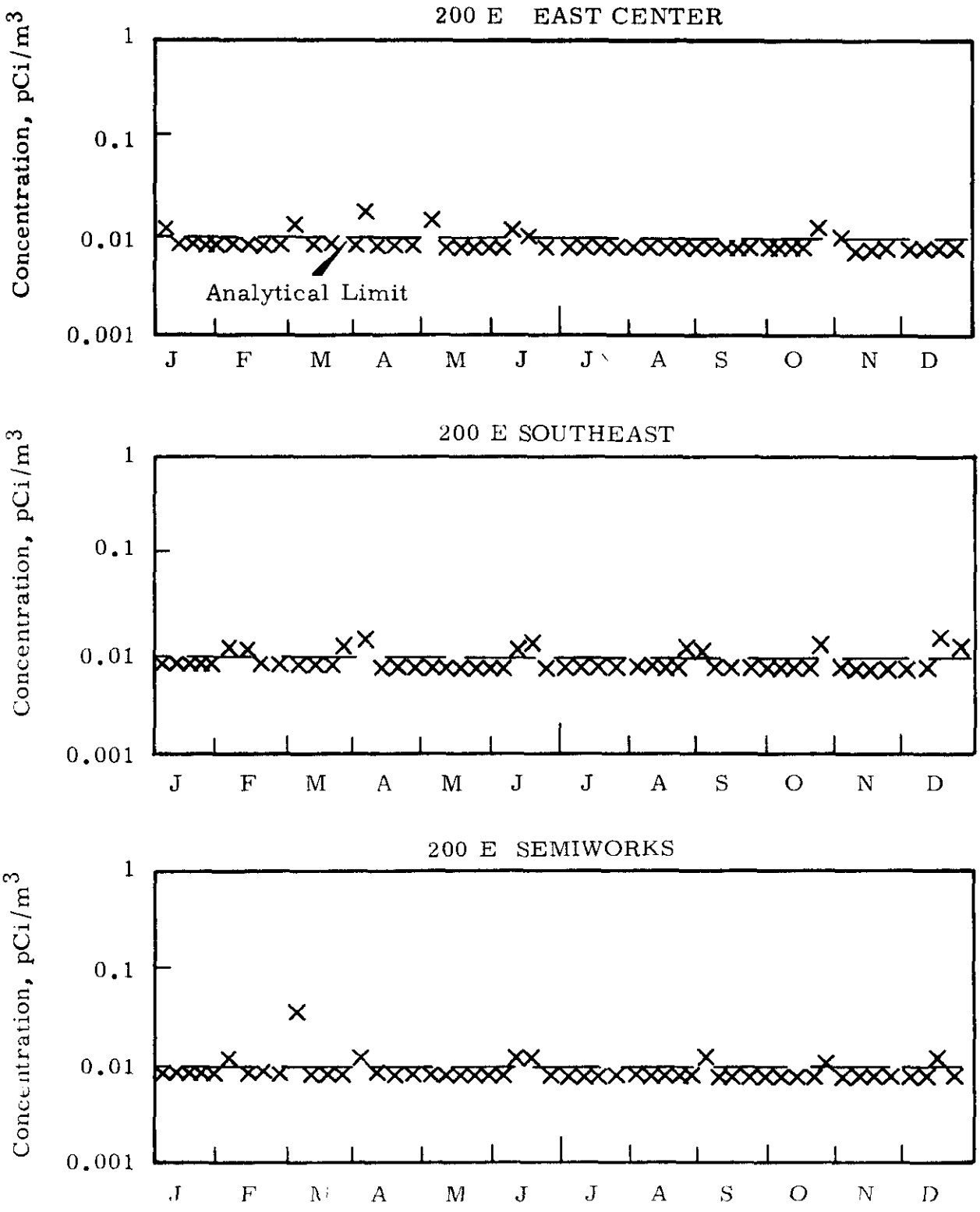
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



1967

Figure 26 BNWL-CC 1197-6

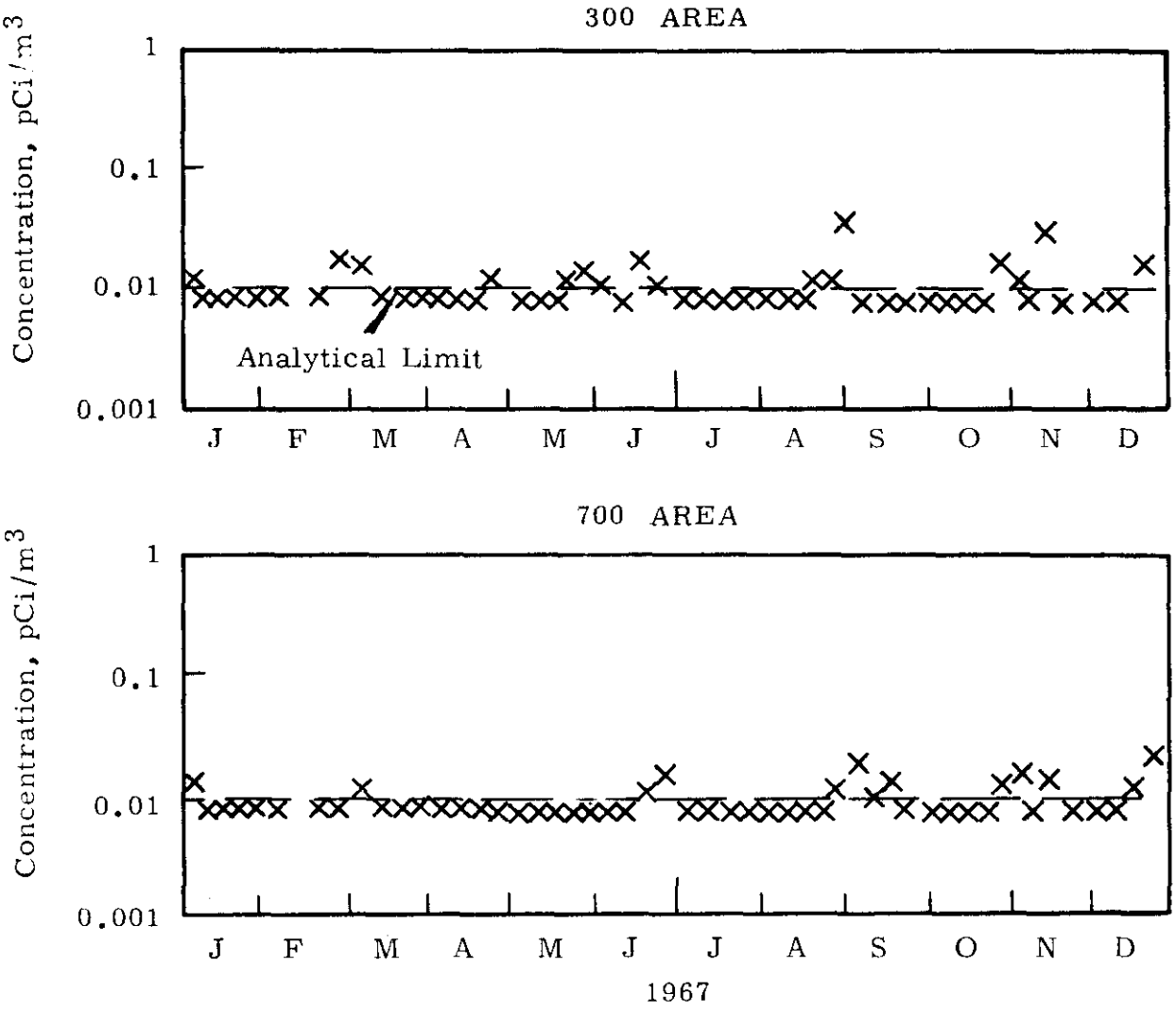
TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



1967

Figure 27 BNWL-CC 1197-6

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE



VII. Radiation Surveys

A. Surface Contamination

1. Hanford Roads

Hanford roads are routinely surveyed (see Map 5) with a bioplastic scintillation detector which is attached to the front end of a truck and is positioned about two feet above the surface of the road. The minimum level of contamination that can be detected by the road monitor corresponds to a portable GM meter response of approximately 1000 c/m per probe area.

A month-by-month summary of significant findings during 1967 follows.

May-June - On May 11, an isolated radioactive particle (^{60}Co) was found on the side of the road leading to 100-K Area. A comprehensive survey revealed no additional particles.

On May 31, an isolated radioactive particle was found on the road between 200 East and West Areas.

Tumbleweeds contaminated with ^{144}Ce-Pr were found against the 200 East Area fence near Control Plot No. 10 a week after a particle had been found on that control plot. (See p. 48).

July-August - On July 12, two isolated radioactive particles were found during routine road monitoring. One particle (100,000 c/m-GM) was on the east shoulder of Route 4S just south of the Wye Burial Ground road. The other particle (50,000 c/m-GM) was located off the side of route 4N southwest of 200-W. A supplemental survey of the two locations revealed no other radioactive particles.

On August 3, an isolated radioactive particle (100,000 c/m-GM) was found embedded in the road surface on the southeast side of the railroad crossing on the road leading to 100-N.

On August 24, a radioactive particle (10,000 c/m-GM) was removed from the White Bluffs cut-off road near its junction with Route 1. The major gamma emitter was ^{60}Co.

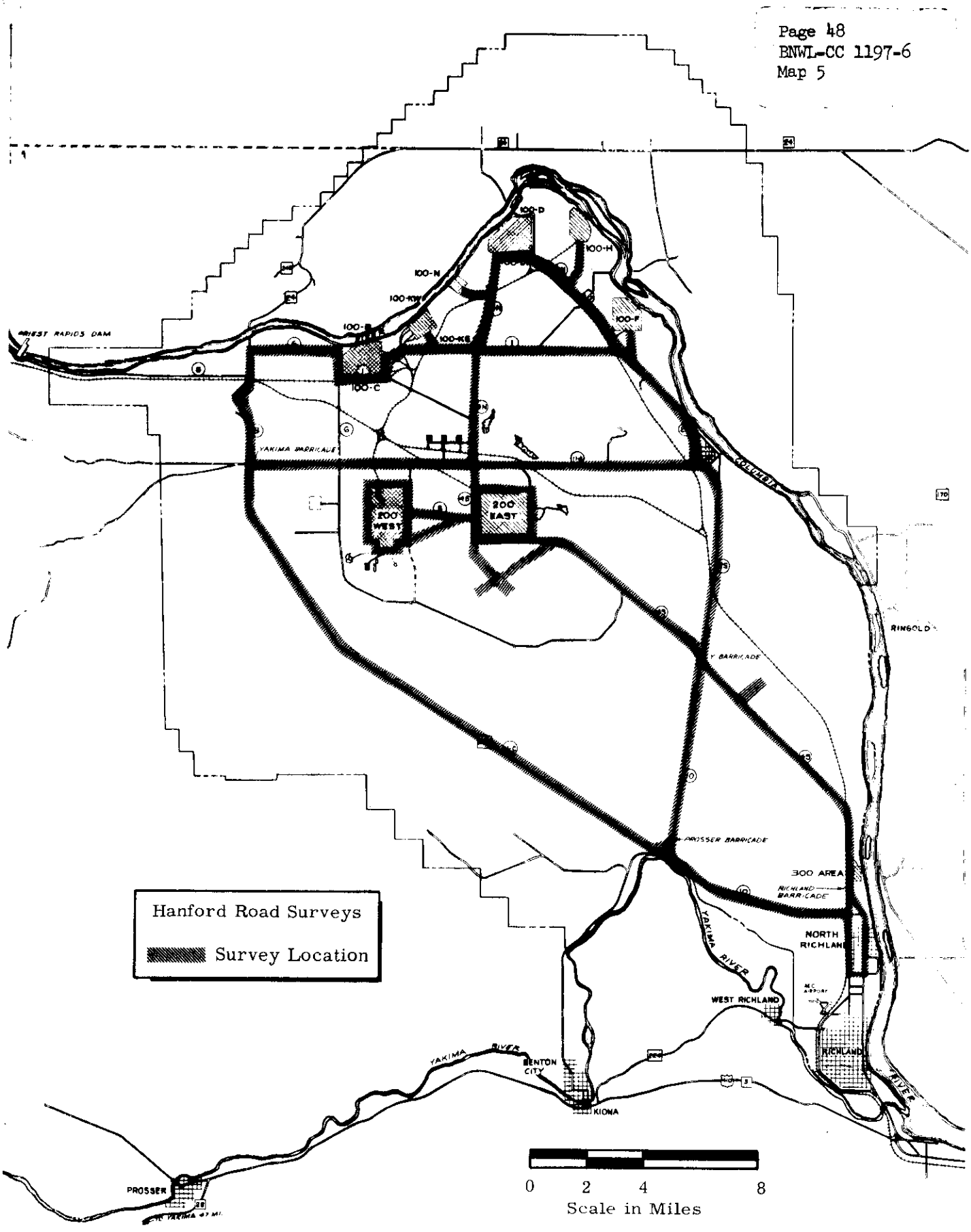
On August 31, vegetation was sampled from the back-fill area over the old B-ditch. A gamma scan on a dry weed showed ^{90}Sr and posibly ^{106}Ru or ^{103}Ru, ^{137}Cs, and ^{95}Zr-Nb. A green weed contained ^{90}Sr and ^{137}Cs.

September-October - Special supplementary surveys were made around the 300 Area following the August emmission of radioactive particles (500-70,000 c/m-GM) from the 325 building stack. Because of relatively large particle sizes, deposition was confined to the immediate vicinity of the release with some contamination extending as far south as the south edge of the 300 Area main parking lot. Analyses of several typical particles indicated that the principal radionuclides were ^{144}Ce-Pr and ^{147}Pm. Particles located during the survey were either fixed in place or removed.

November-December - Routine surveys of several retired and active radiation facilities outside of operating areas (300 West and North burial grounds, P-11 facility, White Bluffs burial ground, 100-N and 100-K trenches, 212-N, -P and -R facilities and B Swamp) revealed no measureable exposure rates or contamination except at the radiation zone boundary of the 100-N trench where exposure rates from 5-15 mR/hr were measured.

In early December, ammonium nitrate crystals contaminated with radio-ruthenium were reported to have been released from the Purex stack. However, the contamination was apparently localized as no radioactive particles were encountered in perimeter surveys of the 200 East Area.

On December 21, an isolated radioactive particle was found on the Wye Burial Ground approach road about 100 yards from the burial ground. The level of radioactivity was 100,000 c/m-GM with a corresponding CP reading of 120 mrad/hr including 13 mR/hr (uncorrected for source size). The major gamma emitters present were ^{134}Cs and ^{137}Cs, with ^{144}Ce-Pr, ^{155}Eu and ^{154}Eu also present.


100-D
100-H
100-N
100-F
100-C
100-K
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

2. Control Plots

Forty-six land areas, called control plots, are located within the Hanford boundaries (see Map 6). These plots measuring 10' by 10' are periodically surveyed with a GM counter in order to detect any deposition of particles. A summary of findings during 1967 is shown below.

200 B-C Crib Area

Re-surveys of the 200 B-C Area contamination spread were made in co-operation with Isochem and ARHCO personnel. Results indicated that conditions in the vicinity of the 200 B-C Crib Area have not changed appreciably over the past 1-2 years, although some particle shifting has taken place. On February 23, five particles (rabbit feces with radiation levels from 40,000 c/m-GM to 250 mrads/hr) were collected during a routine survey of the 216 B-C Crib access road (south of the 200 East Area). The radioactivity of these particles was due to ^{90}Sr and ^{137}Cs. On February 28, a similar particle was isolated which contained ^{90}Sr (9 μCi) and ^{137}Cs (1.1 μCi). Altogether some 250 discrete particles with radiation levels from 1000 c/m to 400 mrads/hr were found in about square miles. Particle densities were from 1 to 14 per 100 sq. ft. Surveys conducted in March and December showed no significant changes in the extent or level of old radiocontamination.

January-February - During January, four radioactive particles (6,000 - 80,000 c/m-GM) were found on Control Plot No. 11 (east of 200-E Area). The radionuclides present were ^{106}Ru and ^{144}Ce-Pr.

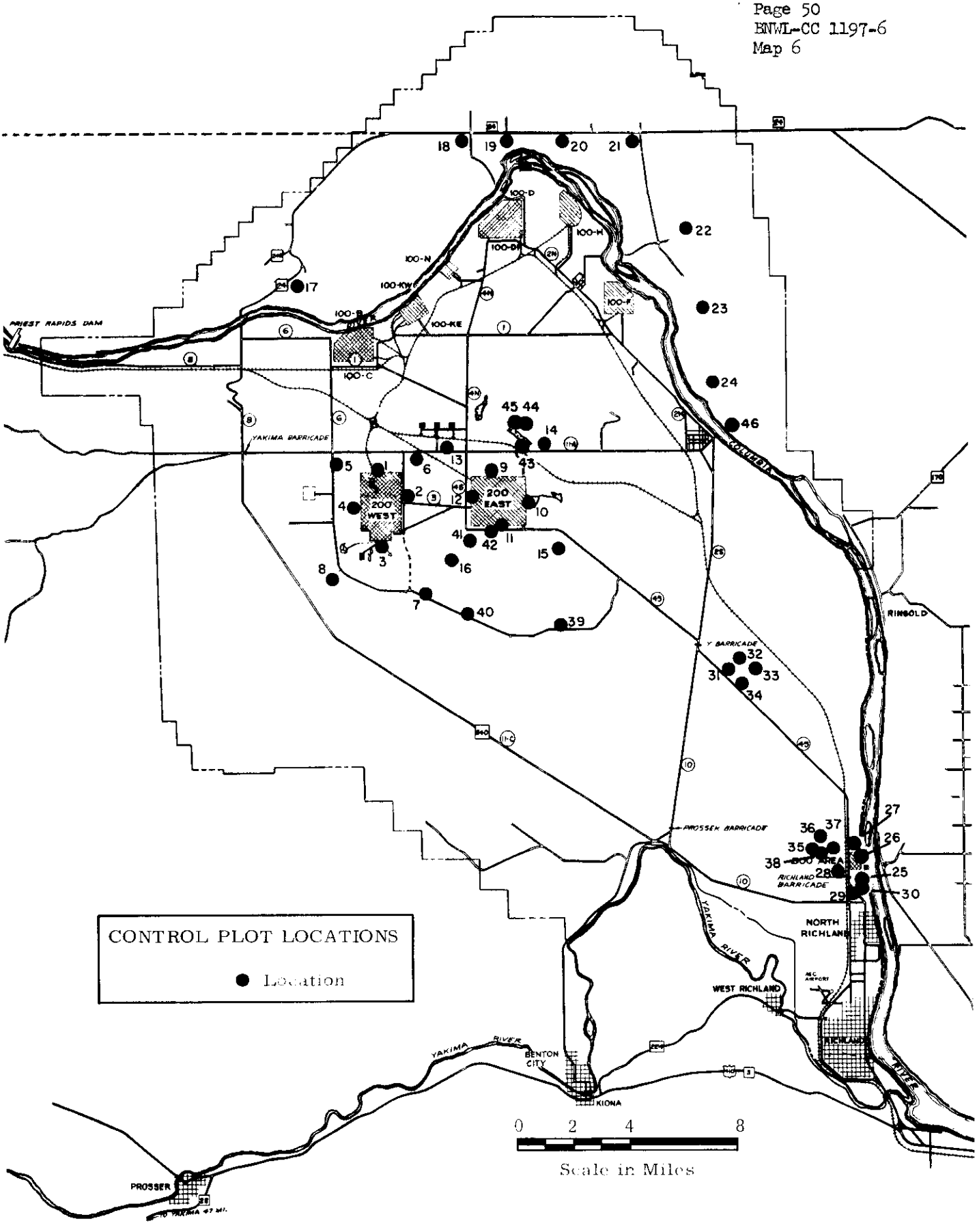
On February 25, radioactive particles (8,000 c/m-GM) were found on the Wahluke Slope (Control Plots 20 and 22) for the first time since the spring of 1964. The particles could not be isolated for analysis and could not be detected during subsequent surveys.

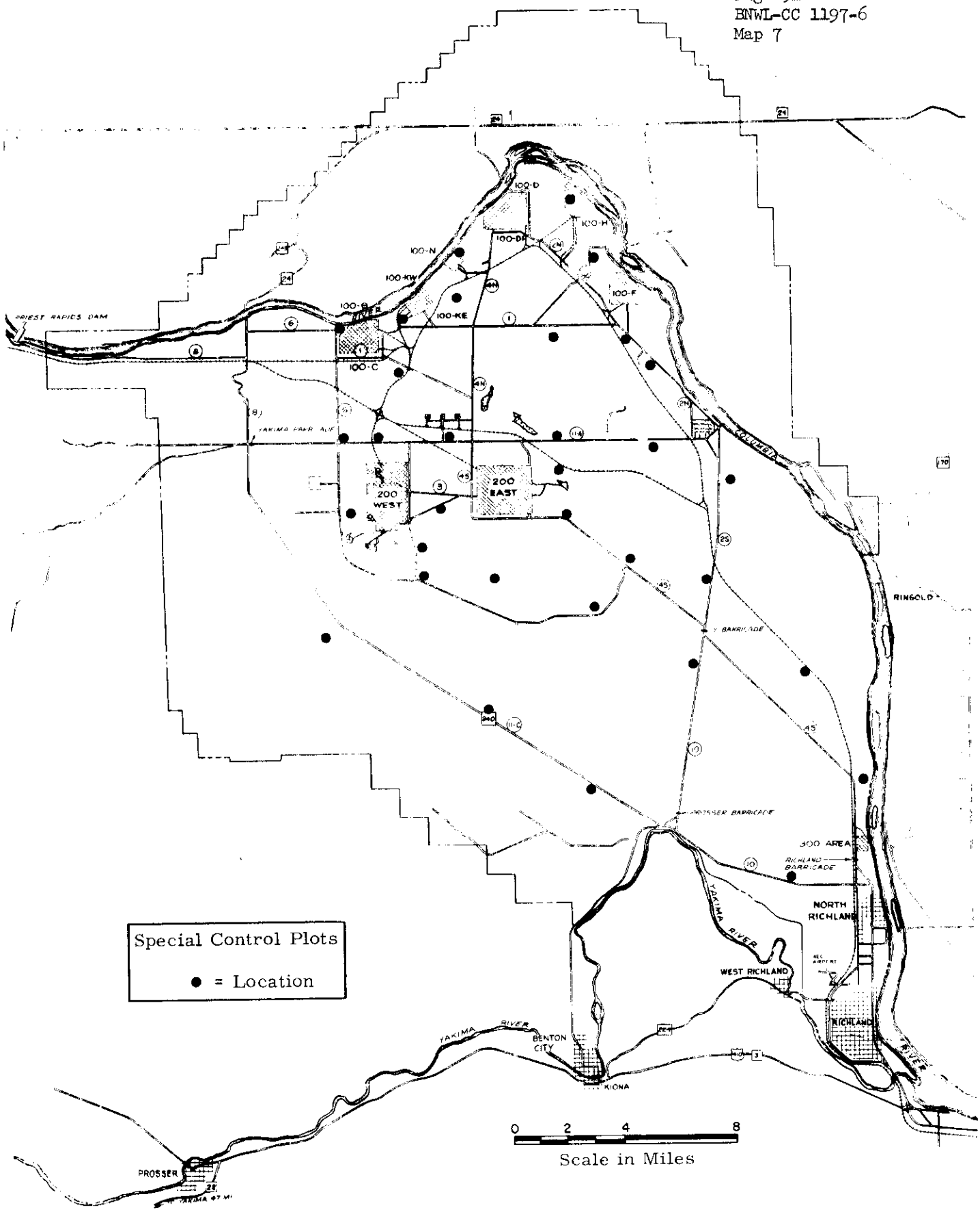
Special control plots near Hanford Test Wells (see Map 7) are surveyed on a semi-annual basis. In January, a particle (15,000 c/m-GM - 1 μCi ^{60}Co), was found on the special control plot northeast of the 100-N Area. A follow-up survey revealed particulate contamination in an area extending about 1,000 yards South to 2,000 yards Southeast of the 100-N trench. The contamination had apparently been spread by a high wind. Radiation levels were 4,000 to 90,000 c/m with particle densities of 1-4 per 100 square feet at several locations.

March-April - On March 14, a radioactive tumbleweed fragment (3,000 c/m-GM) was found on Control Plot No. 10 (east of 200-E Area). The contaminant was identified as ^{144}Ce-Pr.

May-June - On May 23, radioactive contamination that was found on Control Plot No. 10 was identified as ^{144}Ce-Pr.

September-October - In October, the routine semi-annual survey of 32 special test well control plots revealed no deposition of radioactive particles.

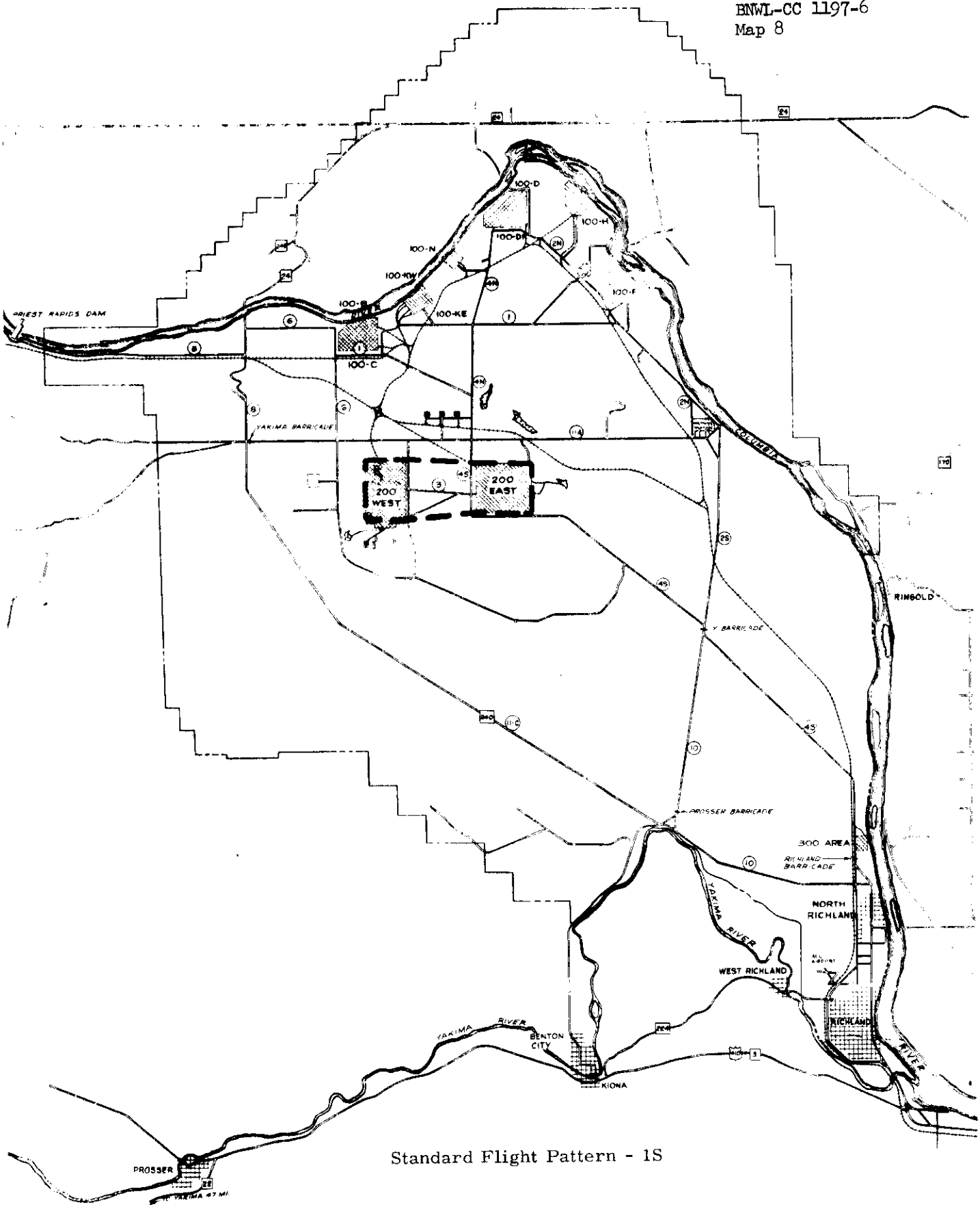

CONTROL PLOT LOCATIONS
Location
0 2 4 8
Scale in Miles
PRIEST RAPIDS DAM
YAKIMA BARRICADE
100-B
100-C
100-D
100-DR
100-H
100-N
100-KW
100-KE
100-F
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER


100-D
100-H
100-DR
100-N
100-KW
100-KE
100-F
100-B
100-C
PRIEST RAPIDS DAM
YAKIMA FAIR AVE
200 WEST
200 EAST
COLUMBIA
RINGOLD
BARRICADE
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
RICHLAND
BENTON CITY
KIONA
PROSSER
Special Control Plots
● = Location
0 2 4 8
Scale in Miles

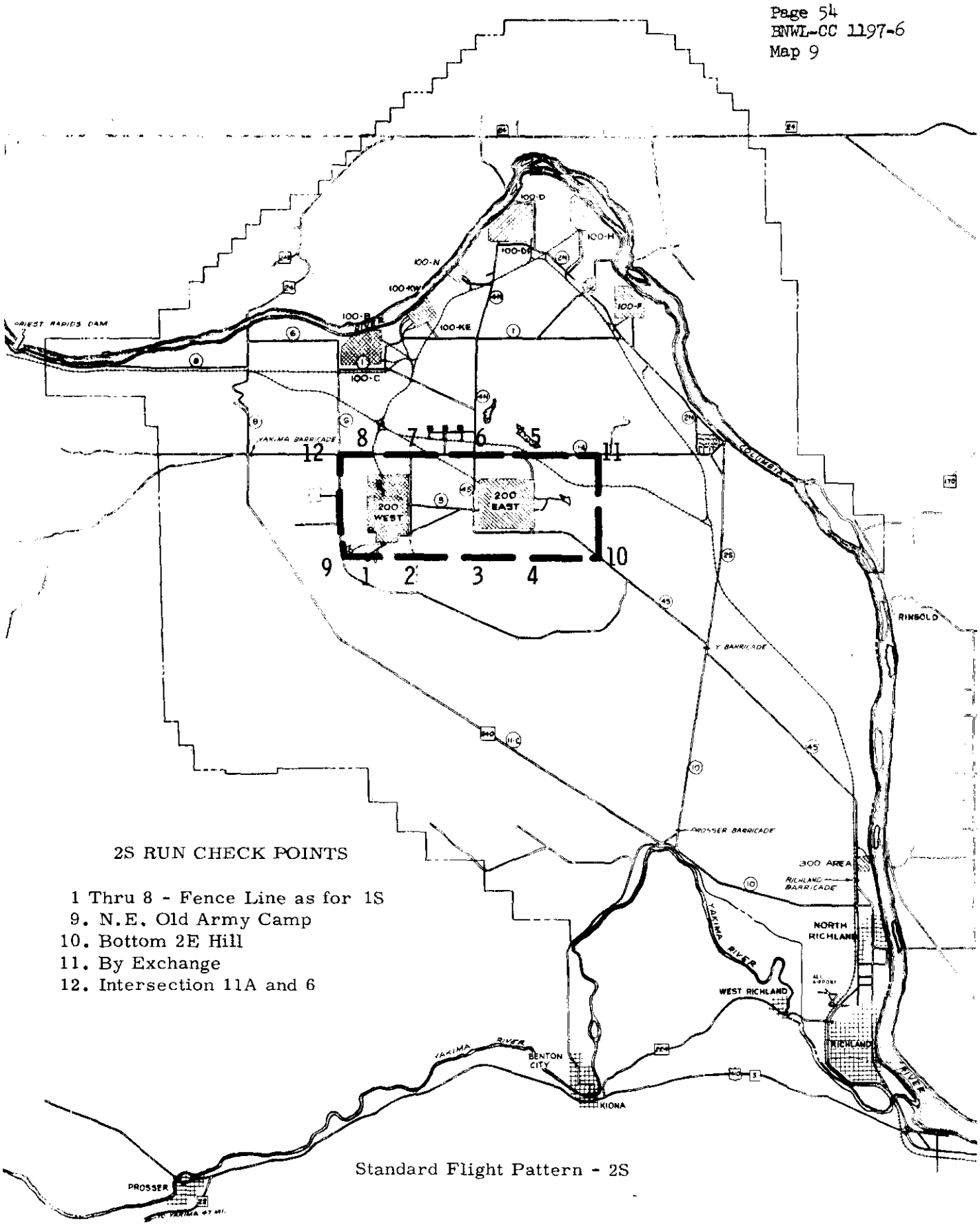
3. Aerial Surveys

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 qualitative in nature, and though 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). The detector is a three inch by five inch NaI (Tl) scintillation crystal. Nine flight patterns are located within and near the Hanford project perimeter. In addition, 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-Ellensburg-Ritzville "triangle". (See Maps 8-19).

The forty-one aerial surveys made during 1967 showed no significant changes from previous radiation levels.



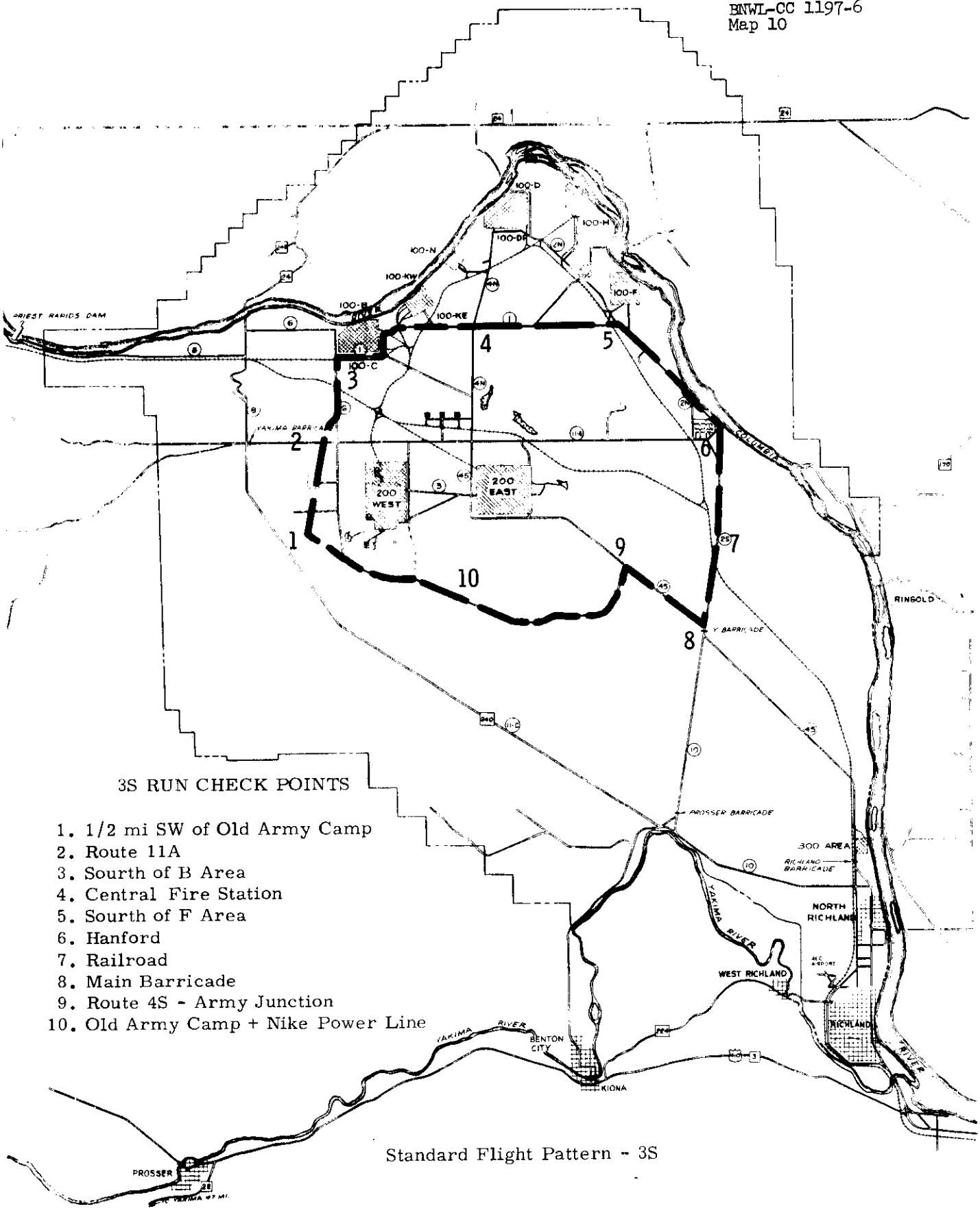
Standard Flight Pattern - 1S



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

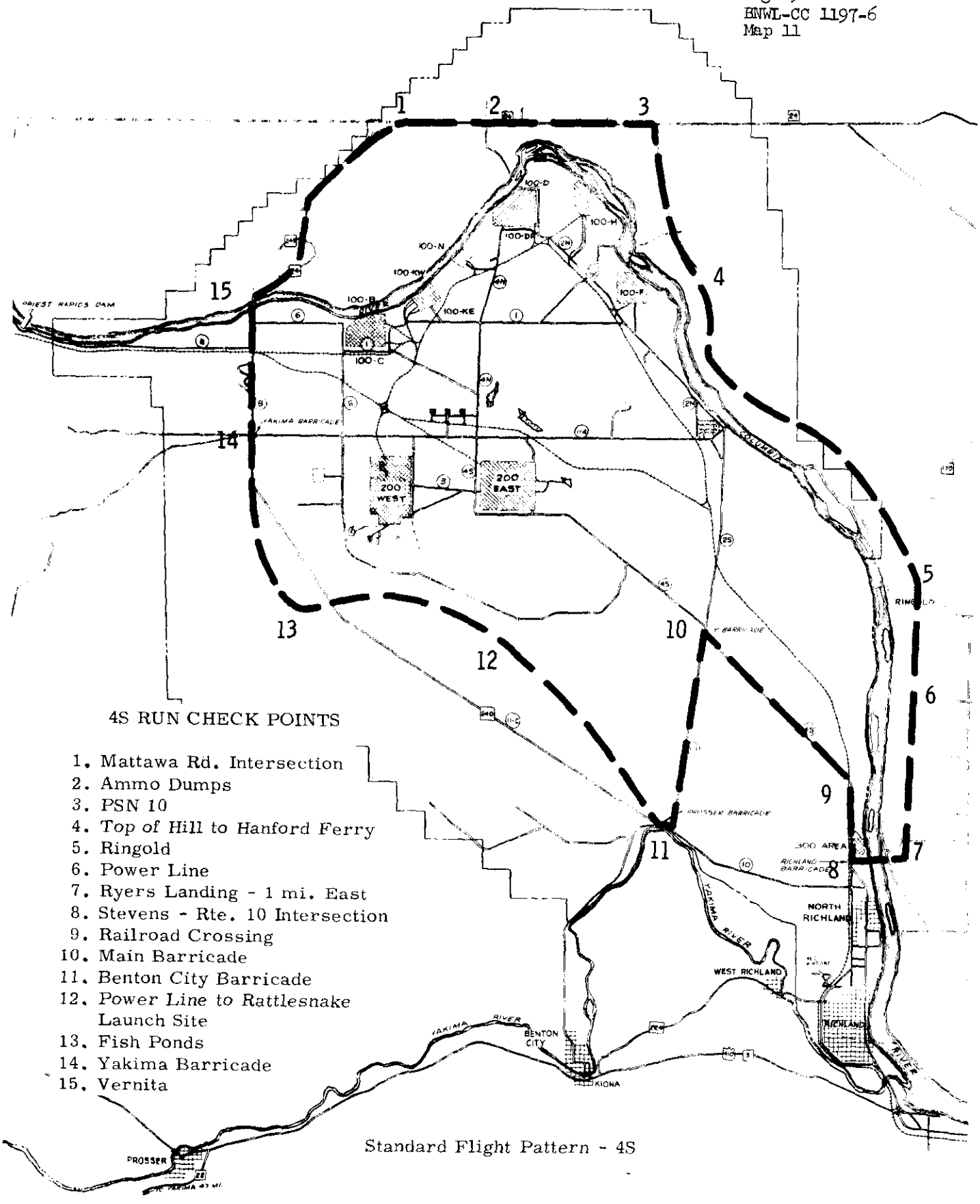
Standard Flight Pattern - 2S



3S RUN CHECK POINTS

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

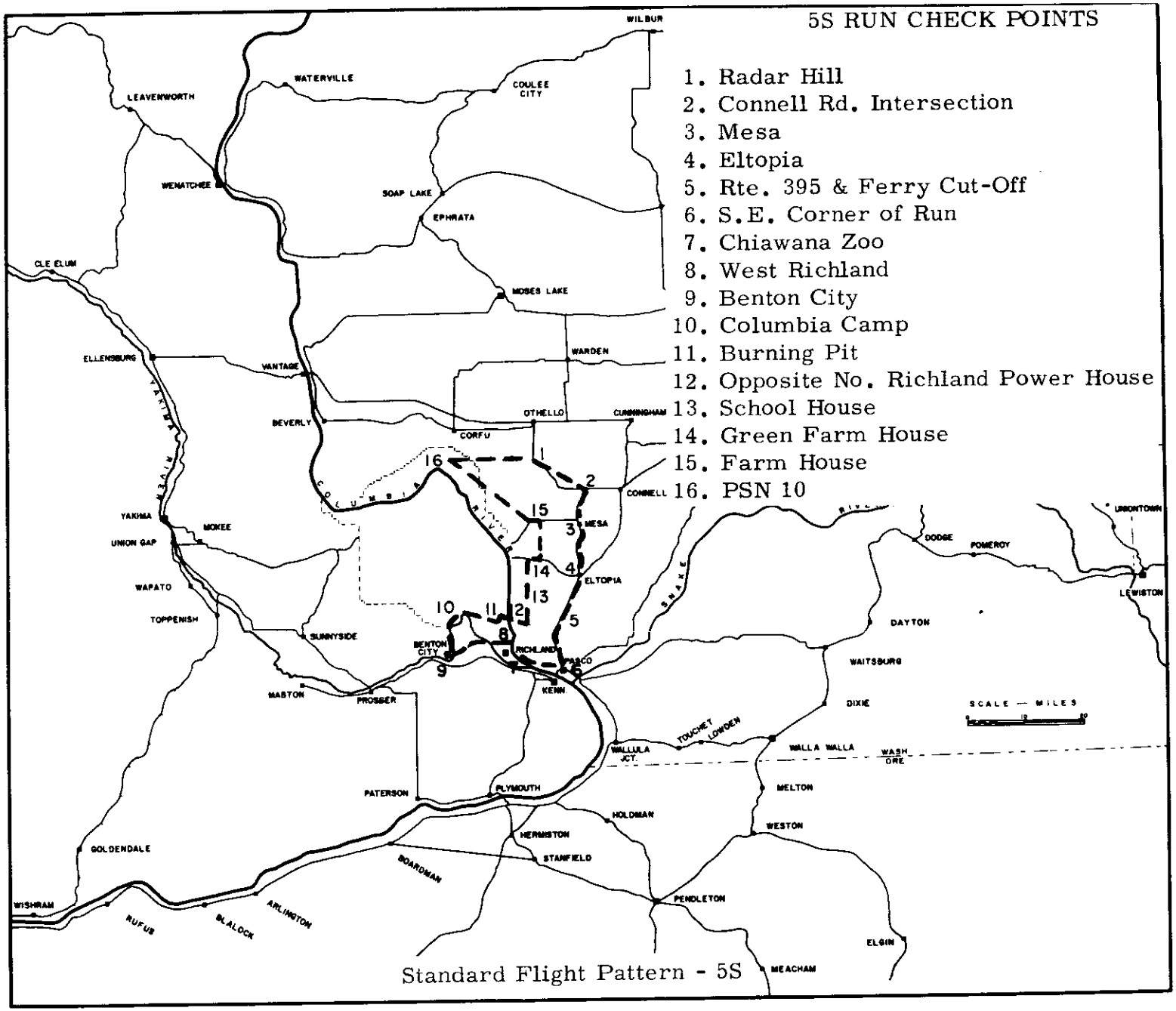
Standard Flight Pattern - 3S

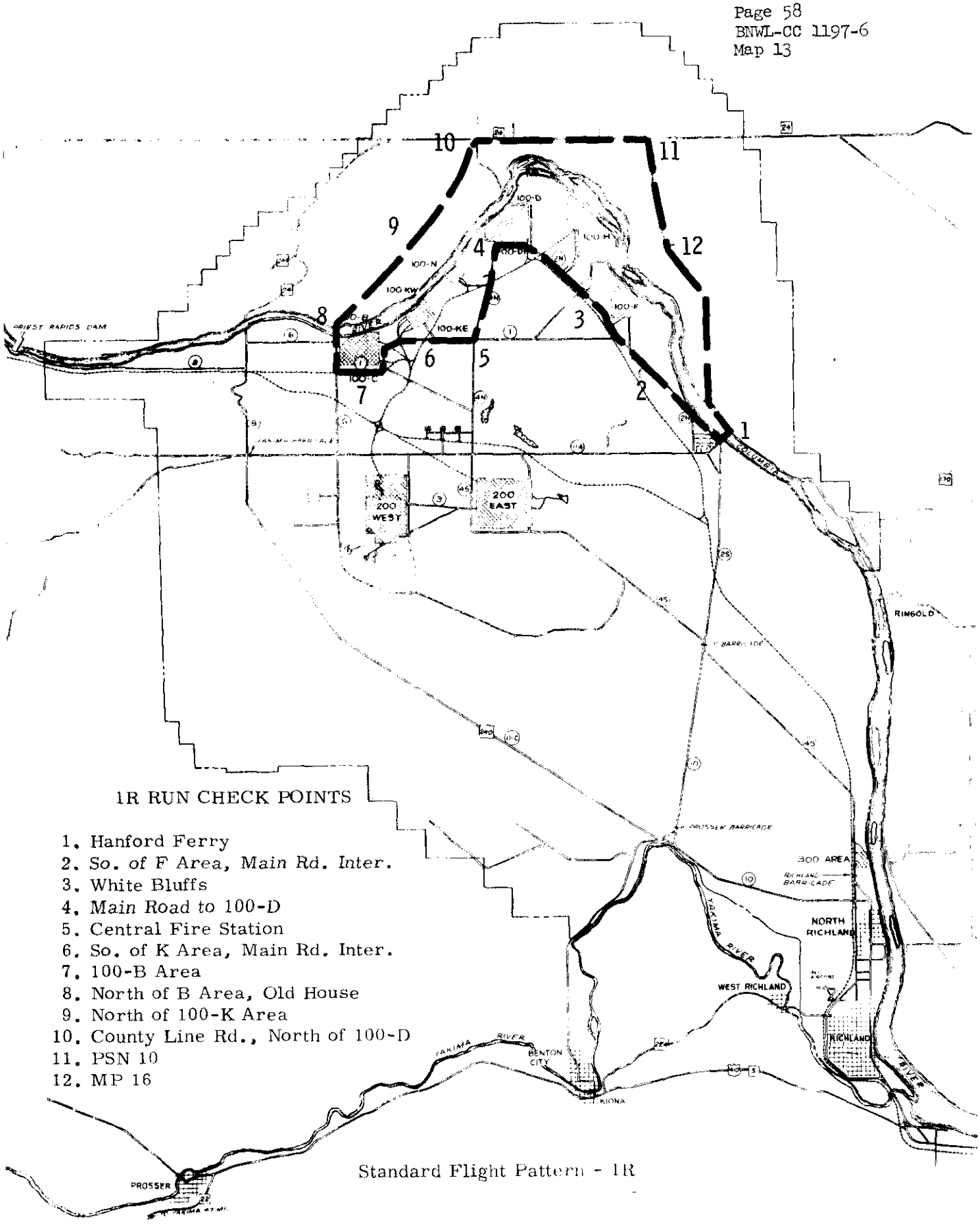


4S RUN CHECK POINTS

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 Pattern - 4S

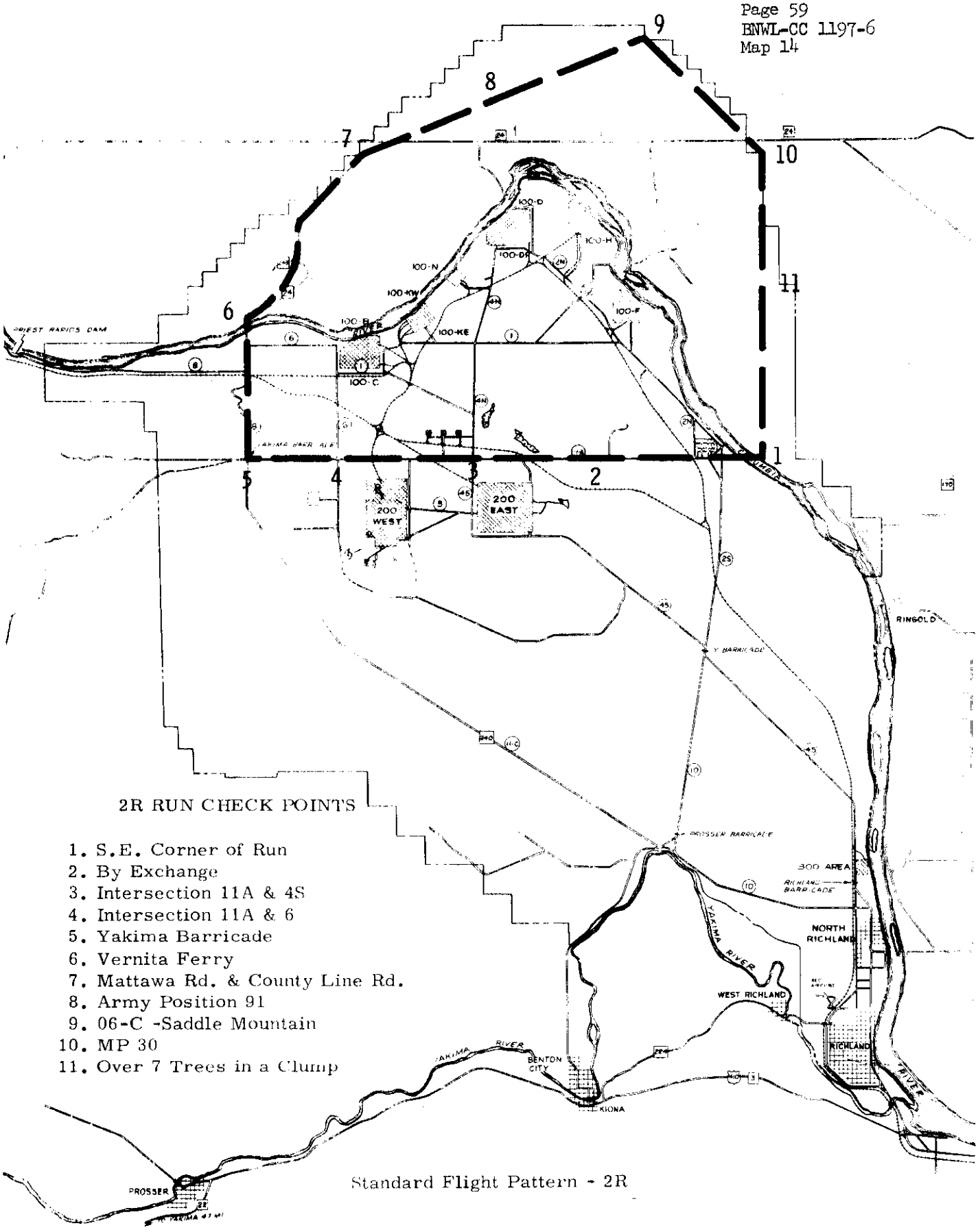

5S RUN CHECK POINTS
1. Radar Hill
2. Connell Rd. Intersection
3. Mesa
4. Eltopia
5. Rte. 395 & Ferry Cut-Off
6. S.E. Corner of Run
7. Chiawana Zoo
8. West Richland
9. Benton City
10. Columbia Camp
11. Burning Pit
12. Opposite No. Richland Power House
13. School House
14. Green Farm House
15. Farm House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



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

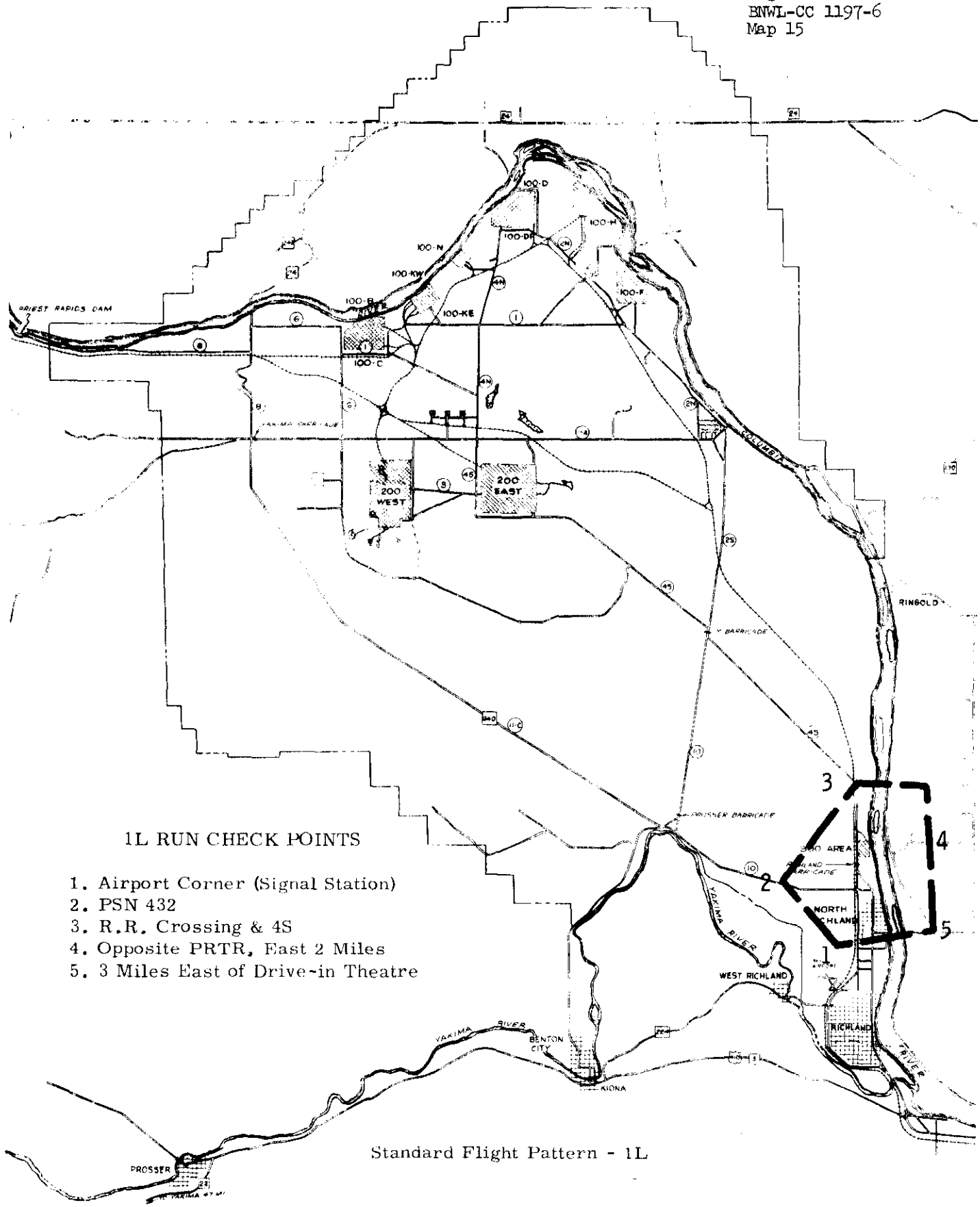
Standard Flight Pattern - 1R



2R RUN CHECK POINTS

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

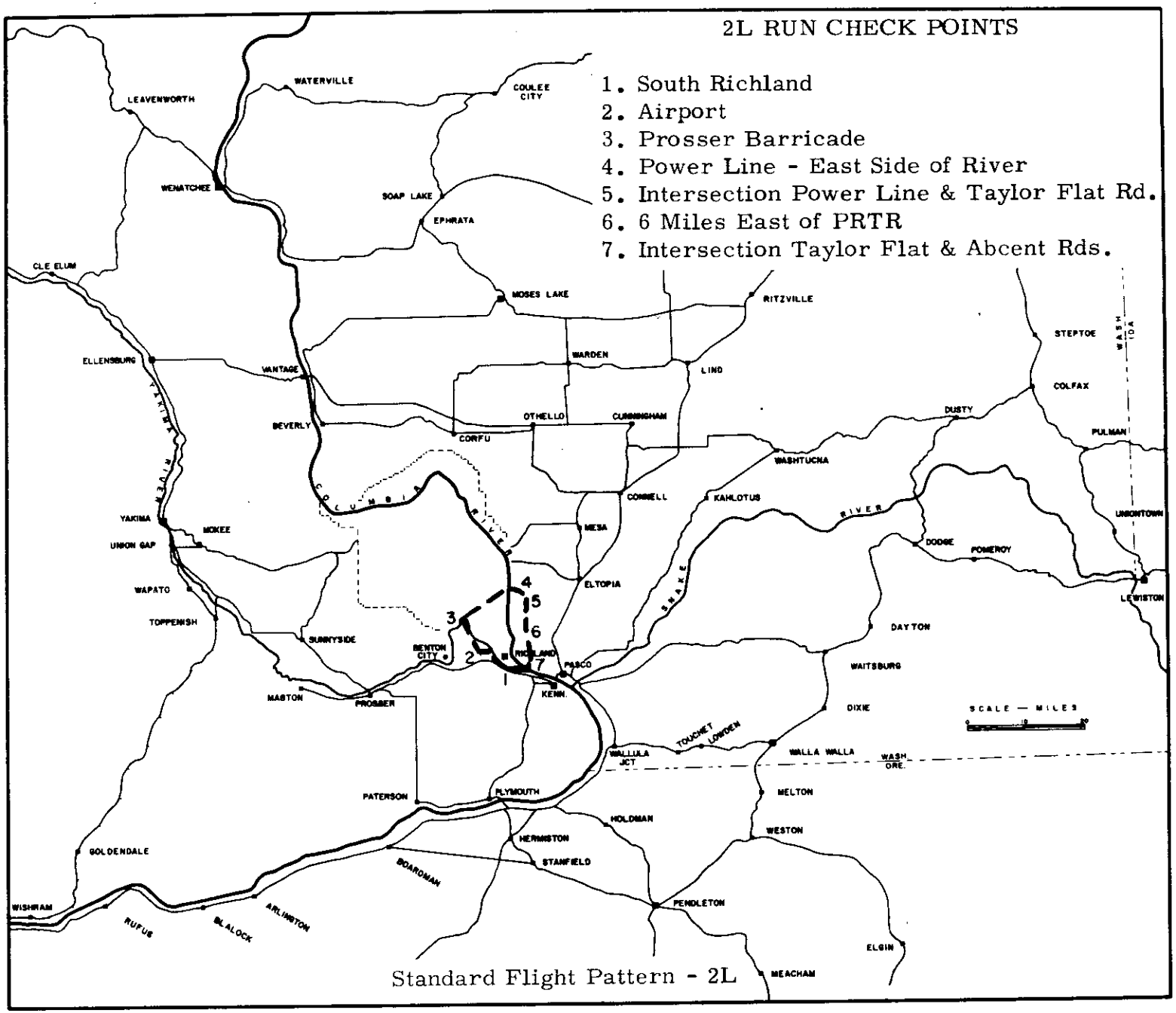
Standard Flight Pattern - 2R

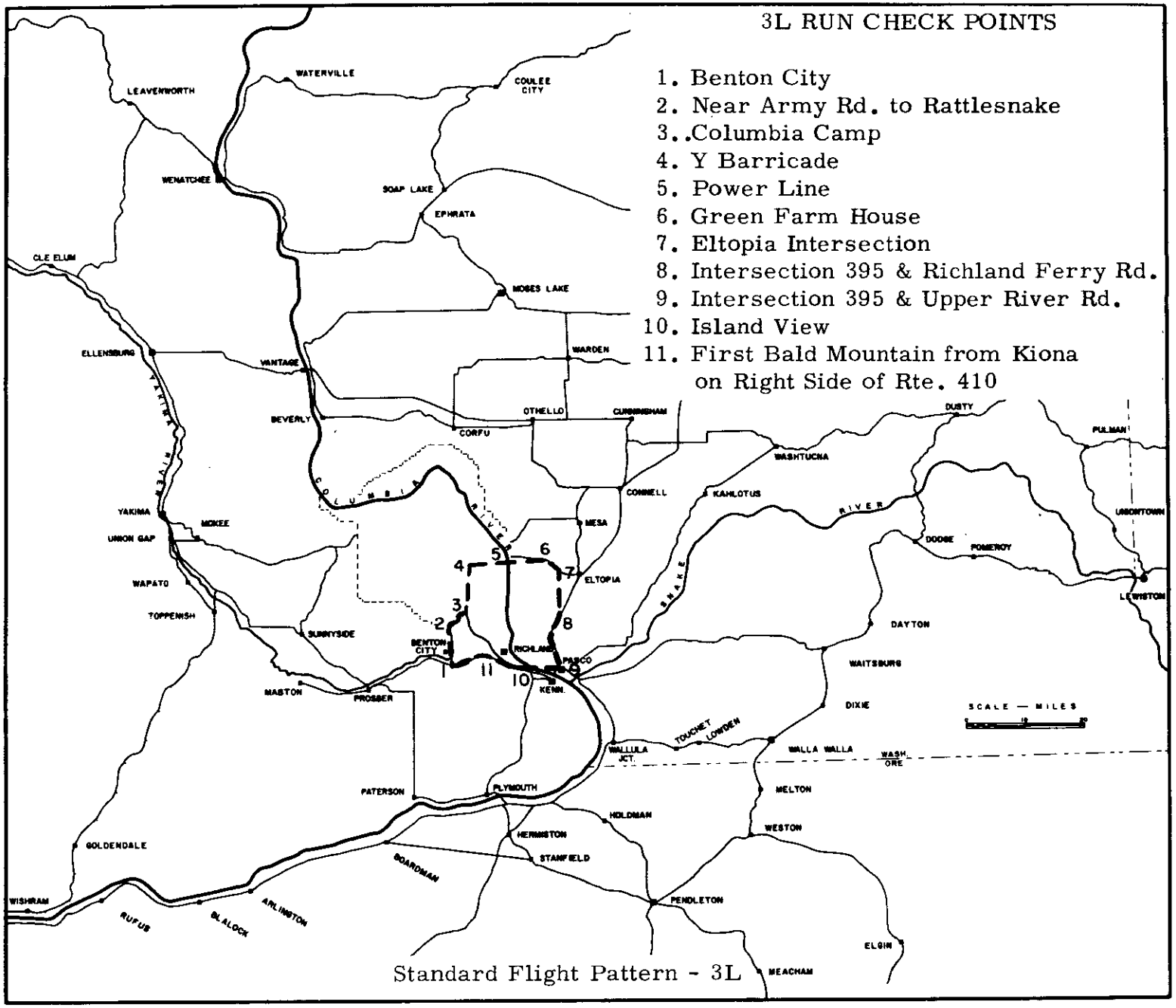


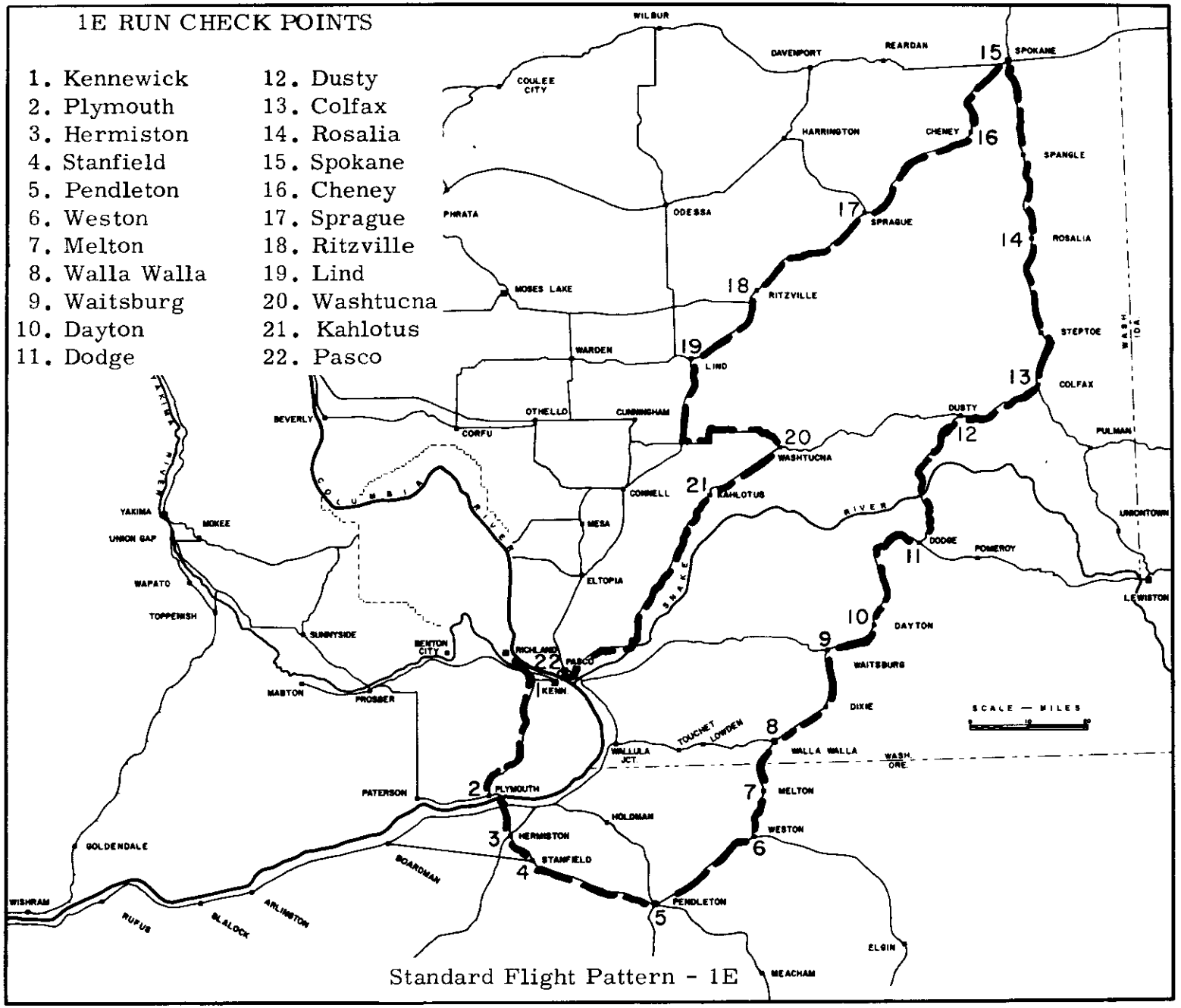
1L RUN CHECK POINTS

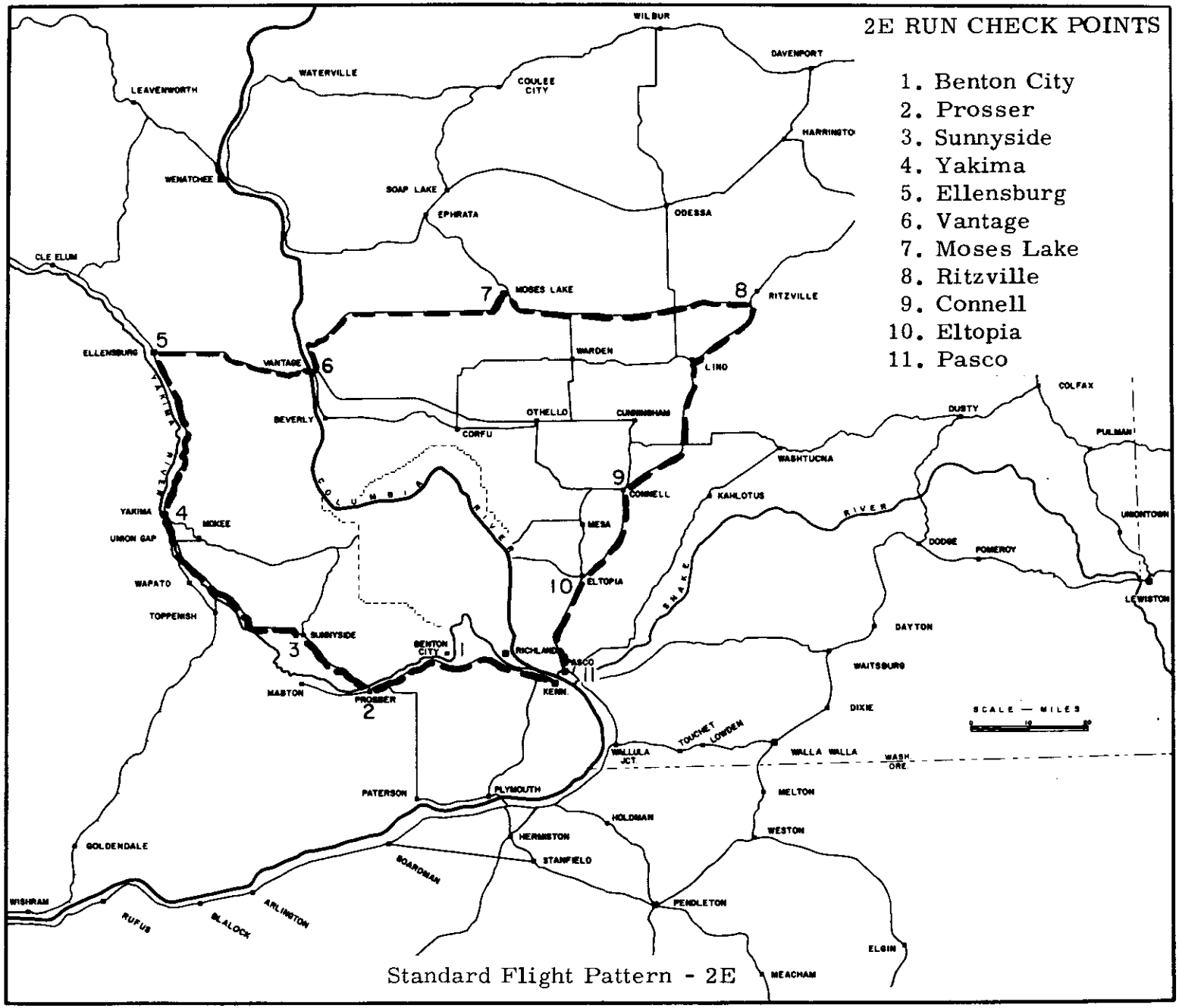
1. Airport Corner (Signal Station)
2. PSN 432
3. R.R. Crossing & 4S
4. Opposite PRTR, East 2 Miles
5. 3 Miles East of Drive-in Theatre

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.
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
RITZVILLE
STEPTOE
WASH.
IDA.
ELLENSBURG
YAKIMA VALLEY
VANTAGE
WARDEN
LIND
COLFAX
BEVERLY
OTHELLO
CUNNINGHAM
DUSTY
PULLMAN
CORFU
WASHTUCNA
COLUMBIA RIVER
CONNELL
KAHLOTUS
SNAKE RIVER
UNIONTOWN
YAKIMA
MOXEE
MESA
UNION GAP
DODGE
POMEROY
WAPATO
ELTOPIA
LEWISTON
TOPPENISH
SUNNYSIDE
DAYTON
BENTON CITY
RICHLAND
PASCO
WAITSBURG
KENN.
MABTON
PROSSER
DIXIE
SCALE — MILES
TOUCHET
LOWDEN
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
GOLDENDALE
STANFIELD
BOARDMAN
WISHRAM
PENDLETON
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
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
WATERVILLE
COULEE CITY
LEAVENWORTH
WENATCHEE
SOAP LAKE
EPHRATA
CLE ELUM
MOSES LAKE
ELLENSBURG
WARDEN
VANTAGE
BEVERLY
OTHELLO
CUNNINGHAM
CORFU
DUSTY
PULMAN
WASHTUCNA
CONNELL
KAHLOTUS
YAKIMA
MOXEE
MESA
UNION GAP
WAPATO
TOPPENISH
SUNNYSIDE
ELTOPIA
DOODE
POMEROY
LEWISTON
DAYTON
BENTON CITY
RICHLAND
PASCO
KENN.
WAITSBURG
MABTON
PROSSER
DIXIE
SCALE — MILES
TOUCHET
LOWDEN
WALLULA JCT.
WALLA WALLA
WASH.
ORE
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
GOLDENDALE
STANFIELD
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
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
BEVERLY
OTHELLO
CUNNINGHAM
DUSTY
PULMAN
CORFU
WASHTUCNA
CONNELL
KAHLOTUS
YAKIMA
MOXEE
UNION GAP
MESA
DODGE
POMEROY
LEWISTON
WAPATO
TOPPENISH
ELTOPIA
DAYTON
SUNNYSIDE
BENTON CITY
RICHLAND
PASCO
WAITSBURG
MABTON
PROSSER
KENN.
DIXIE
SCALE — MILES
WALLULA JCT.
WALLA WALLA
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
GOLDENDALE
HERMISTON
STANFIELD
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
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
DUSTY
PULLMAN
WASHTUCNA
CONNELL
KAHLOTUS
YAKIMA
MOXEE
MESA
UNIONTOWN
UNION GAP
DODGE
POMEROY
WAPATO
ELTOPIA
LEWISTON
TOPPENISH
SUNNYSIDE
DAYTON
BENTON CITY
RICHLAND
PASCO
WAITSBURG
MABTON
PROSSER
KENNEWICK
DIXIE
SCALE — MILES
TOUCHET
LOWDEN
WALLULA JCT.
WALLA WALLA
WASH.
ORE.
PATERSON
PLYMOUTH
MELTON
HOLDMAN
WESTON
HERMISTON
GOLDENDALE
STANFIELD
BOARDMAN
PENDLETON
WISHRAM
RUFUS
BLALOCK
ARLINGTON
ELGIN
MEACHAM
Standard Flight Pattern - 2E

B. External Radiation Exposure Rates

1. Exposure Rates on Plant

External pencil-type gamma radiation exposure rates (in units of mR/day) were determined from pencil-type gamma dosimeters located within buildings designated "614" (Map 20). At most locations, the peak exposure rate during 1967 was observed in the third week of January (Figures 28-35) and was primarily due to fall-out, although agumented by plant releases. The average results for the year for each location are presented in Table 7 below. Where available, 1966 averages are also presented for comparison.

TABLE 7

YEARLY AVERAGE EXPOSURE RATES
(Results in mR/day)

	Location	1967	1966*
100 Areas	Midway	0.58	-
	100-B	0.72	0.64
	100-K	1.5	1.3
	100-N	0.83	0.67
	100-D	0.56	0.58
	100-H	0.64	0.47
	White Bluffs	0.44**	0.51
	100-F	0.39	0.53
	Hanford	0.59	0.53
200-W Areas	Redox	0.59	0.95
	West Center	0.43	0.48
	East Center	0.44	0.58
200-E Areas	West Center	0.37	0.45
	East Center	0.55	0.55
	Southeast	0.39	0.59
	Semiworks	2.02	1.6
Other	Rattlesnake Springs	0.45	-
	Emergency Relocation Center	0.38	-
	Wye Barricade	0.58	-
	Rt. 10 Mile 1.6	0.35	0.35
	Prosser Barricade	0.51	-
	300 Area	0.48	0.47
	700 Area	0.59	0.50

* The 1966 averages include an extended period during July-August when the reactors were shut down due to a strike.

**Measurements in White Bluffs were discontinued 10-2-67.

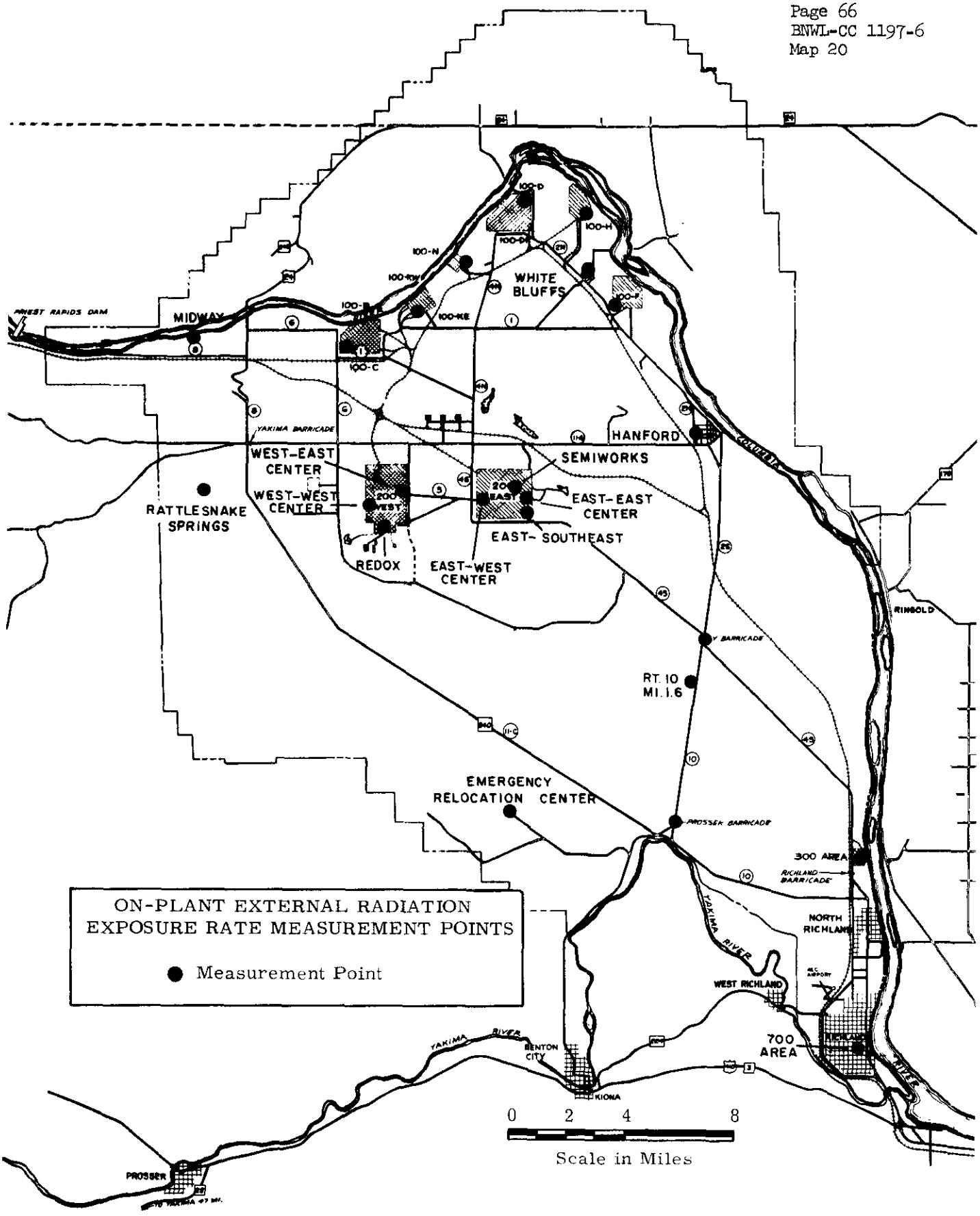
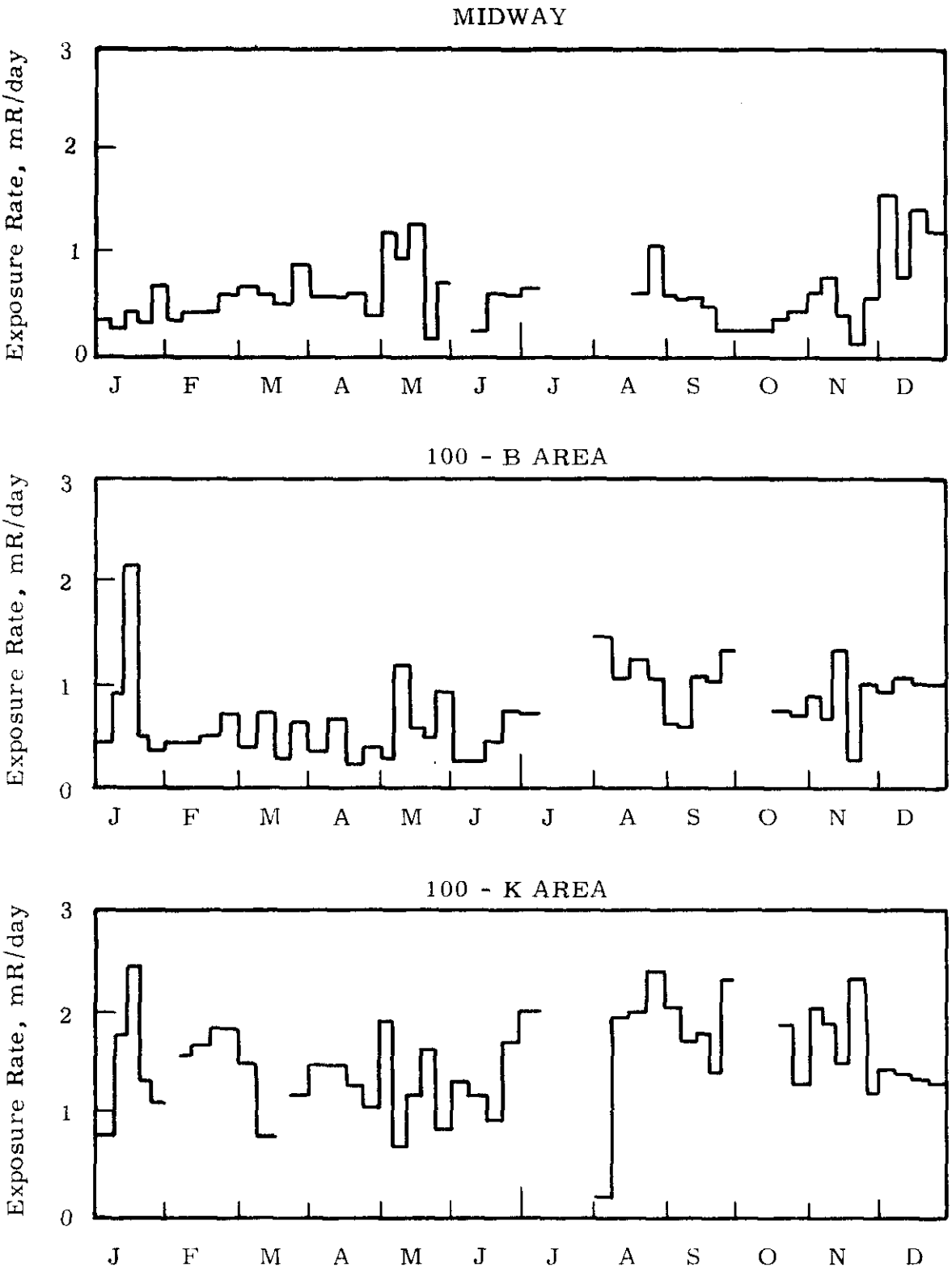

WHITE BLUFFS
100-D
100-H
100-N
100-KW
100-KE
100-F
100-B
100-C
MIDWAY
PRIEST RAPIDS DAM
YAKIMA BARRICADE
HANFORD
WEST-EAST CENTER
WEST-WEST CENTER
200 WEST
200 EAST
SEMIWORKS
EAST-EAST CENTER
EAST-SOUTHEAST
EAST-WEST CENTER
REDOX
RATTLESNAKE SPRINGS
COLUMBIA R.
RINGOLD
Y BARRICADE
RT. 10 MI. 1.6
EMERGENCY RELOCATION CENTER
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
700 AREA
BENTON CITY
KIONA
PROSSER
ON-PLANT EXTERNAL RADIATION
EXPOSURE RATE MEASUREMENT POINTS
Measurement Point
0 2 4 8
Scale in Miles

Figure 28 BNWL-CC 1197-6

EXTERNAL RADIATION ON PLANT



1967

Figure 29 BNWL-CC 1197-6

EXTERNAL RADIATION ON PLANT

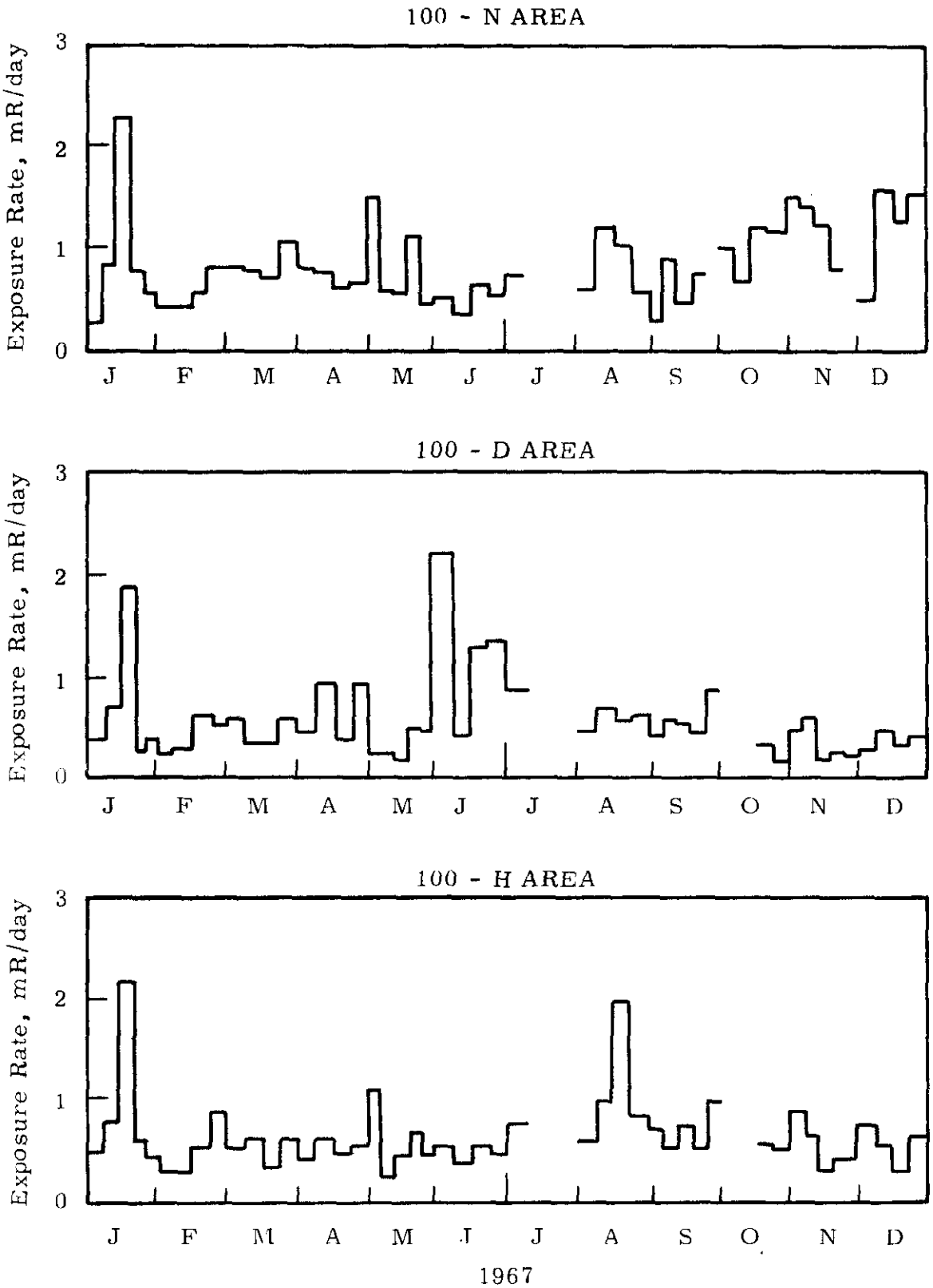


Figure 30

EXTERNAL RADIATION ON PLANT

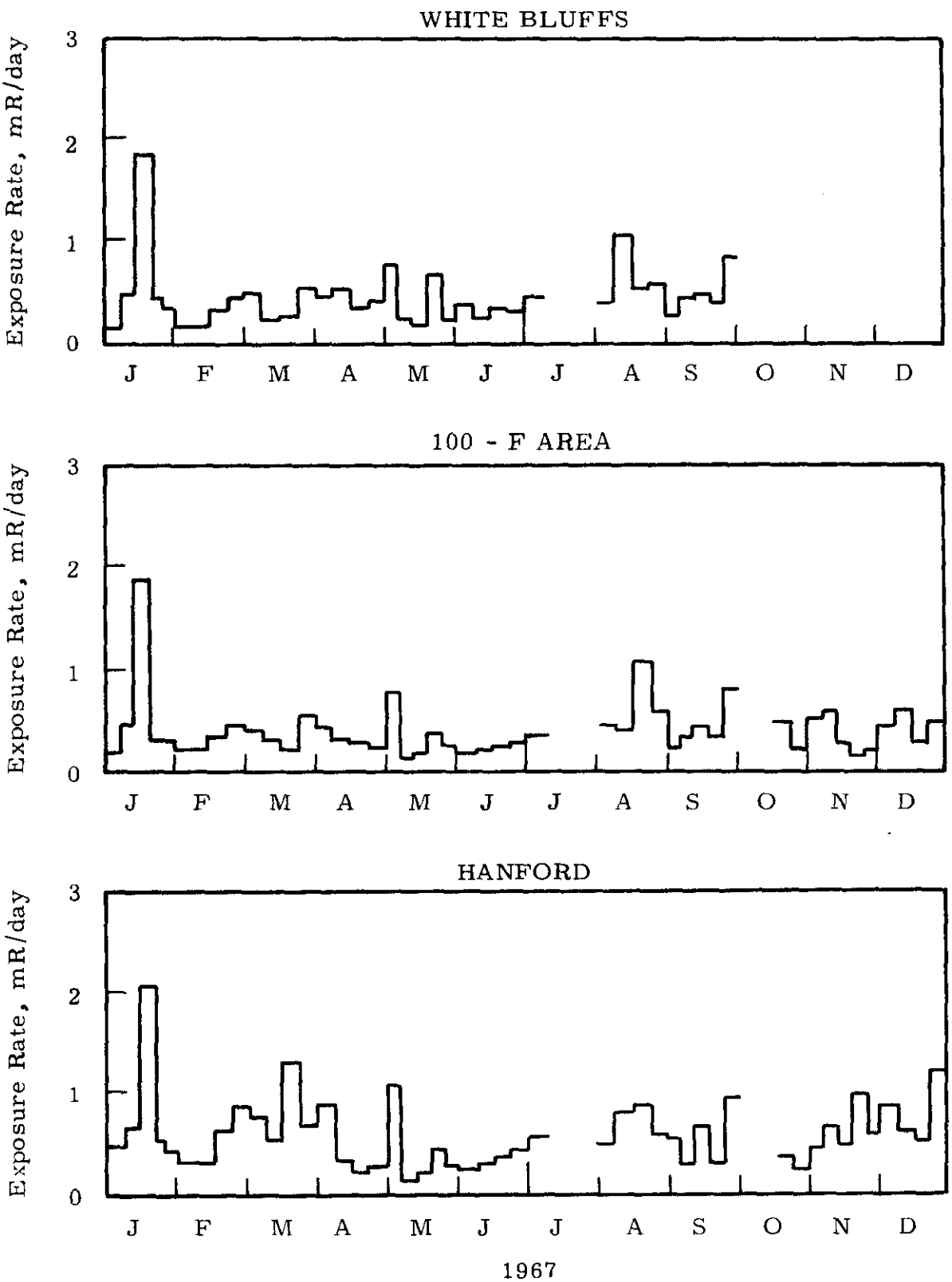


Figure 31 BNWL-CC 1197-6

EXTERNAL RADIATION ON PLANT

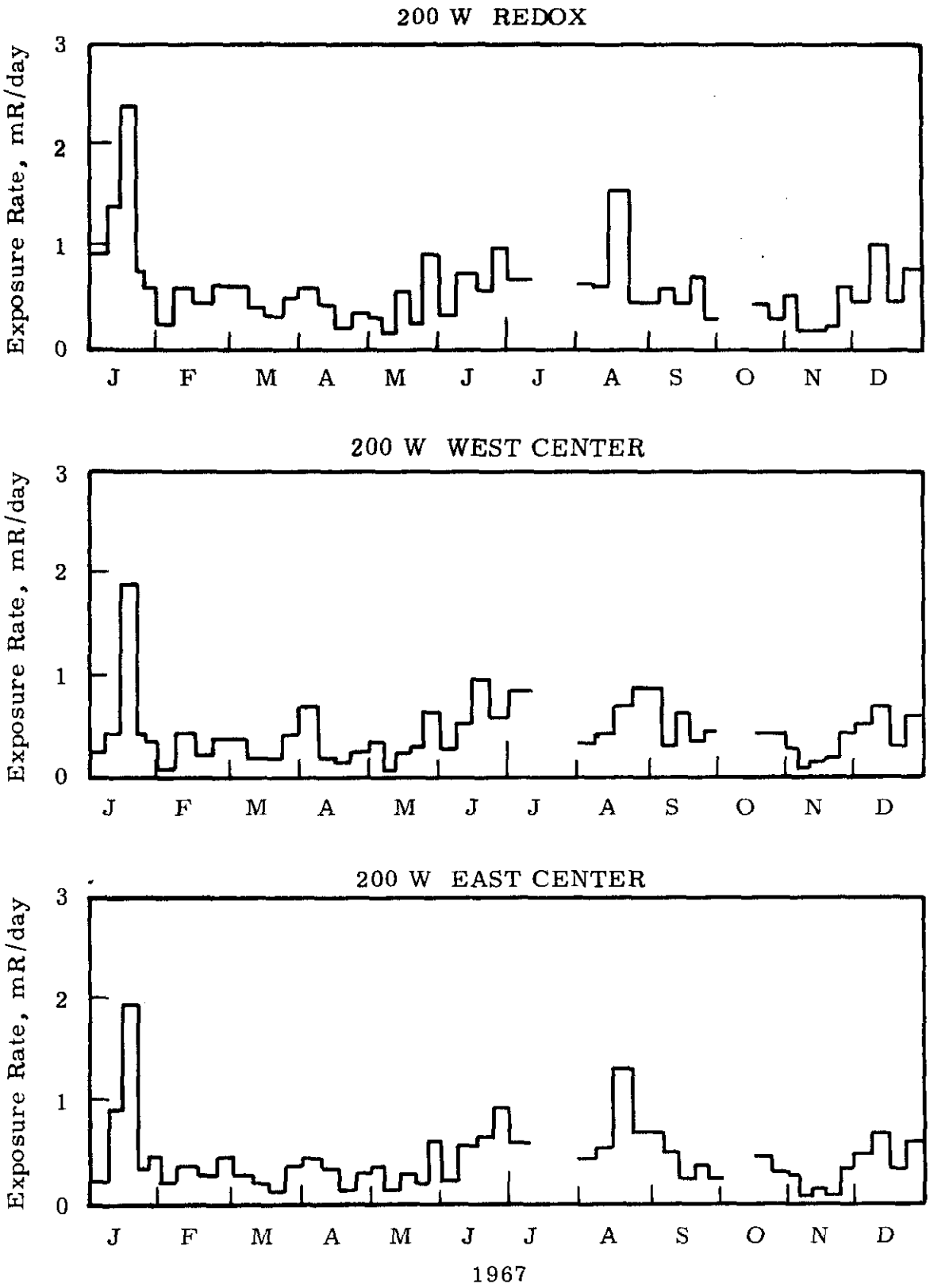
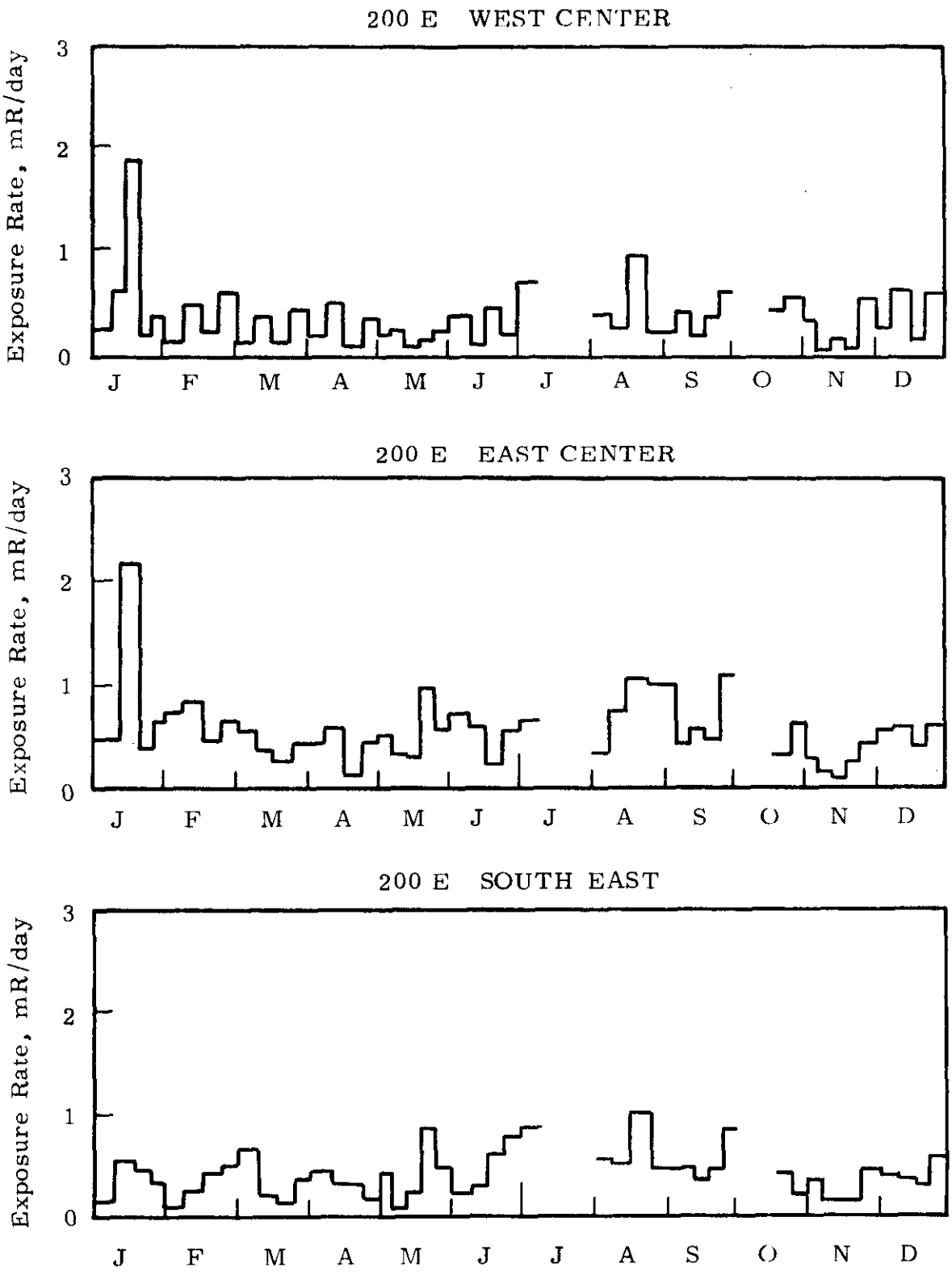
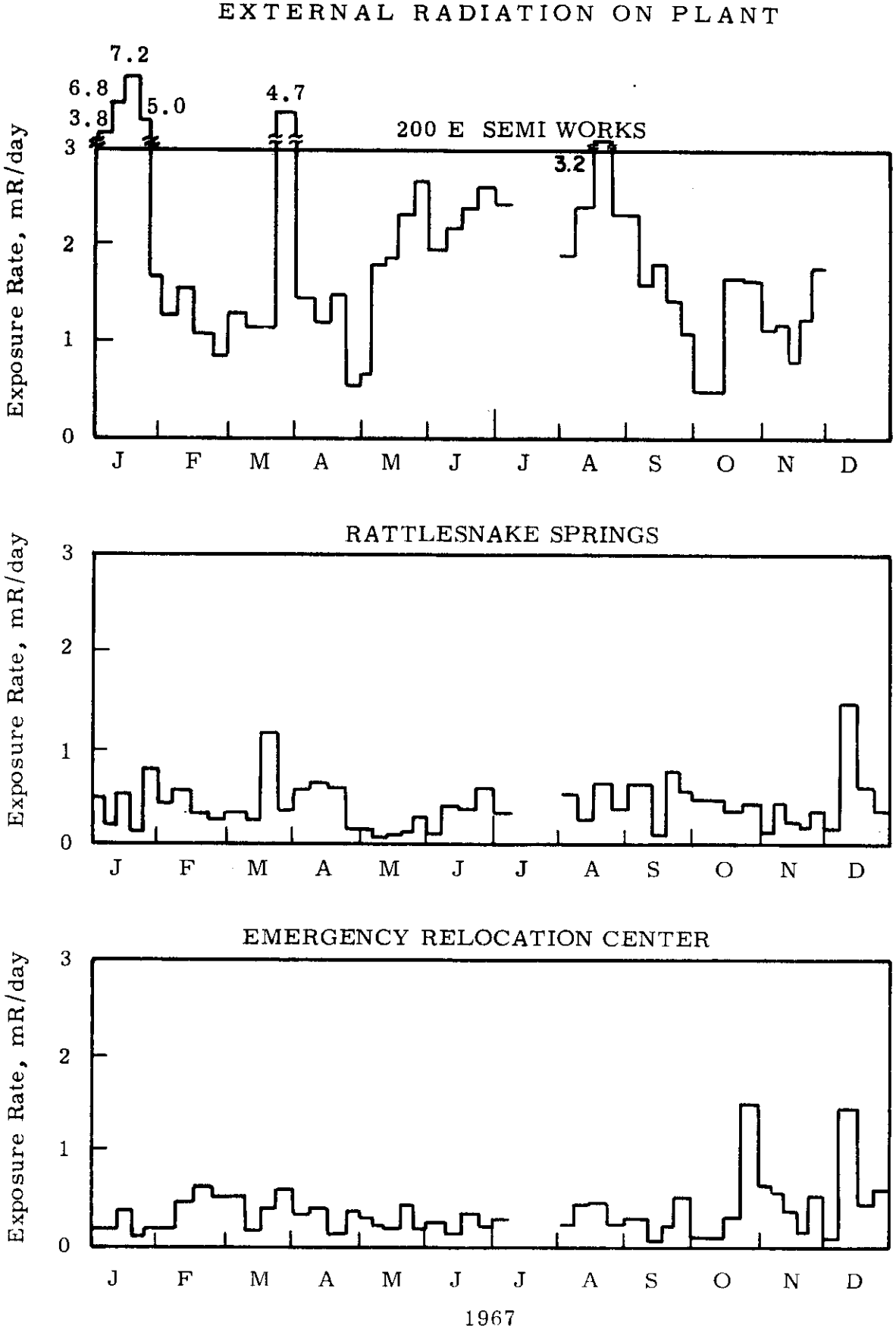


Figure 32 BNWL-CC 1197-6

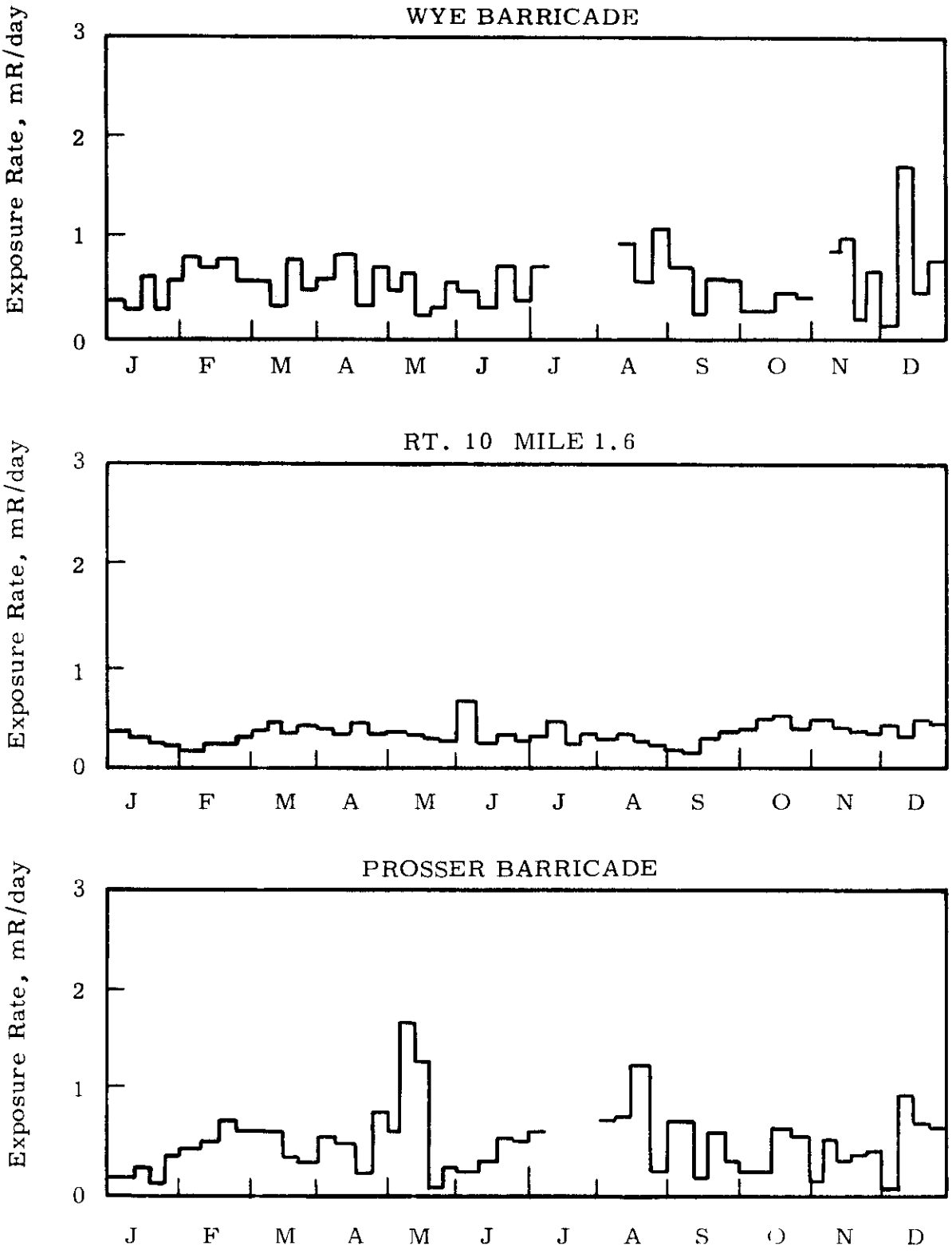
EXTERNAL RADIATION ON PLANT



1967


EXTERNAL RADIATION ON PLANT
7.2
6.8
3.8
5.0
4.7
200 E SEMI WORKS
3.2
Exposure Rate, mR/day
0
1
2
3
J F M A M J J A S O N D
RATTLESNAKE SPRINGS
Exposure Rate, mR/day
0
1
2
3
J F M A M J J A S O N D
EMERGENCY RELOCATION CENTER
Exposure Rate, mR/day
0
1
2
3
J F M A M J J A S O N D
1967

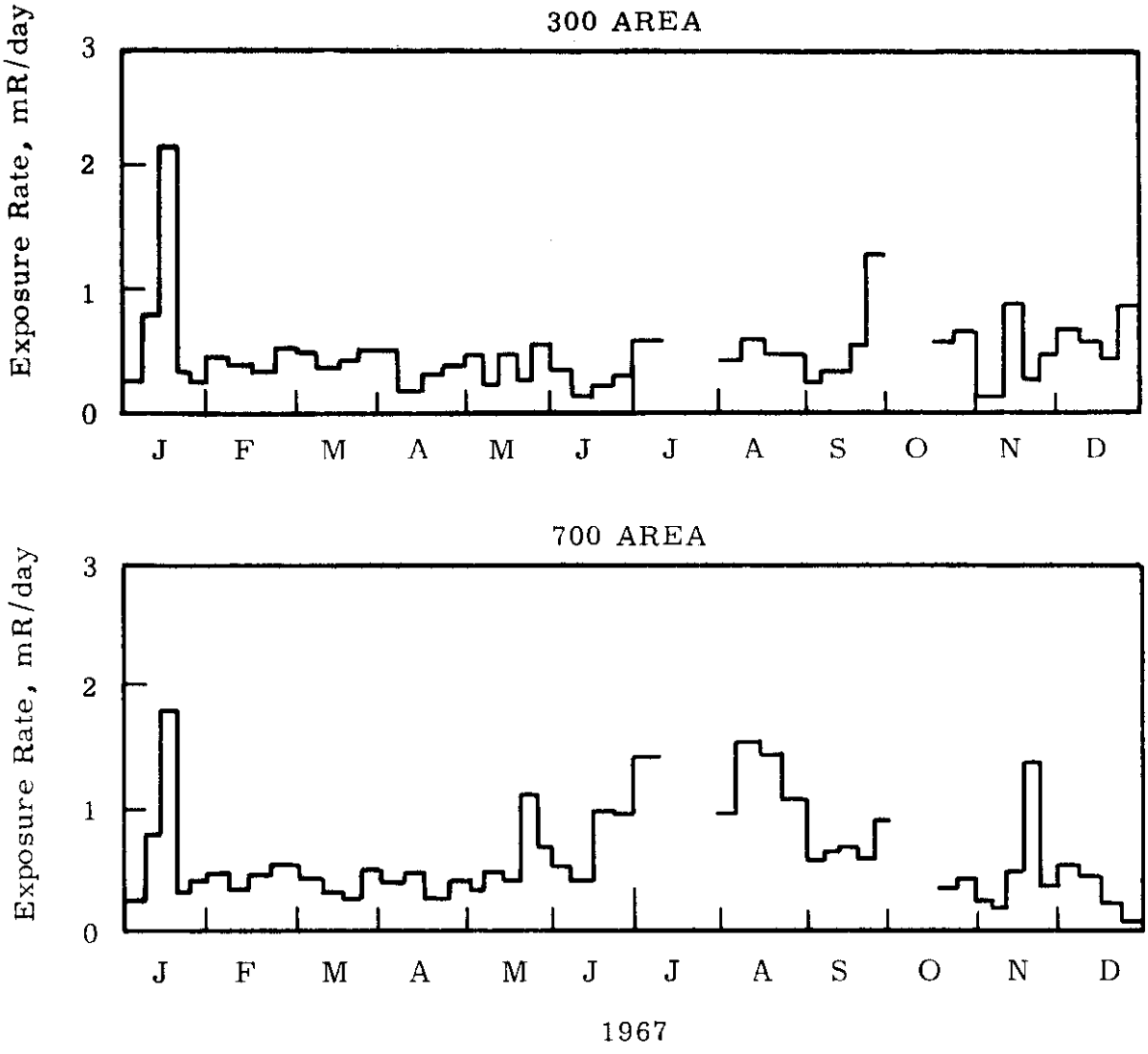
EXTERNAL RADIATION ON PLANT



1967

Figure 35

EXTERNAL RADIATION ON PLANT



2. Exposure Rates at the Columbia River Shoreline

Shoreline exposure rates (Figures 36 and 37) are measured at 3 feet above the ground with a 40-liter ionization chamber whose response is interpreted in terms of μR/hr (radium gamma calibration). This approximates the exposure rate to the gonads of a person standing on the riverbank. In addition to the locations shown in Map 21, measurements are made at Sacajawea Park and McNary Dam.

Seasonal increases in shoreline exposure rates are normally expected in March and April when increased concentrations in the Columbia River of stable ^{55}Mn due to spring run-off result in increased concentrations of ^{56}Mn.

As usual, the exposure rates decreased to the yearly minimum in June when the river flow rate was high. By August, declining river flow had begun to expose more shoreline, and exposure rates started to increase. However, the increased exposure rates measured temporarily at Ringold in mid-October were much higher (420 and 320 μR/hr) than any made at that location in recent years.

Although the data were not presented in this series of reports, additional monthly shoreline surveys in 1967 covered the reach of the river from the reactor outfalls to Richland. Shoreline exposure rates at several locations in the latter part of 1967 were somewhat higher than might normally be expected. These increases were attributed in part to increased concentrations of ^{46}Sc in the Columbia River, and, at certain upstream locations, to incomplete mixing of leaking reactor effluent with Columbia River water.

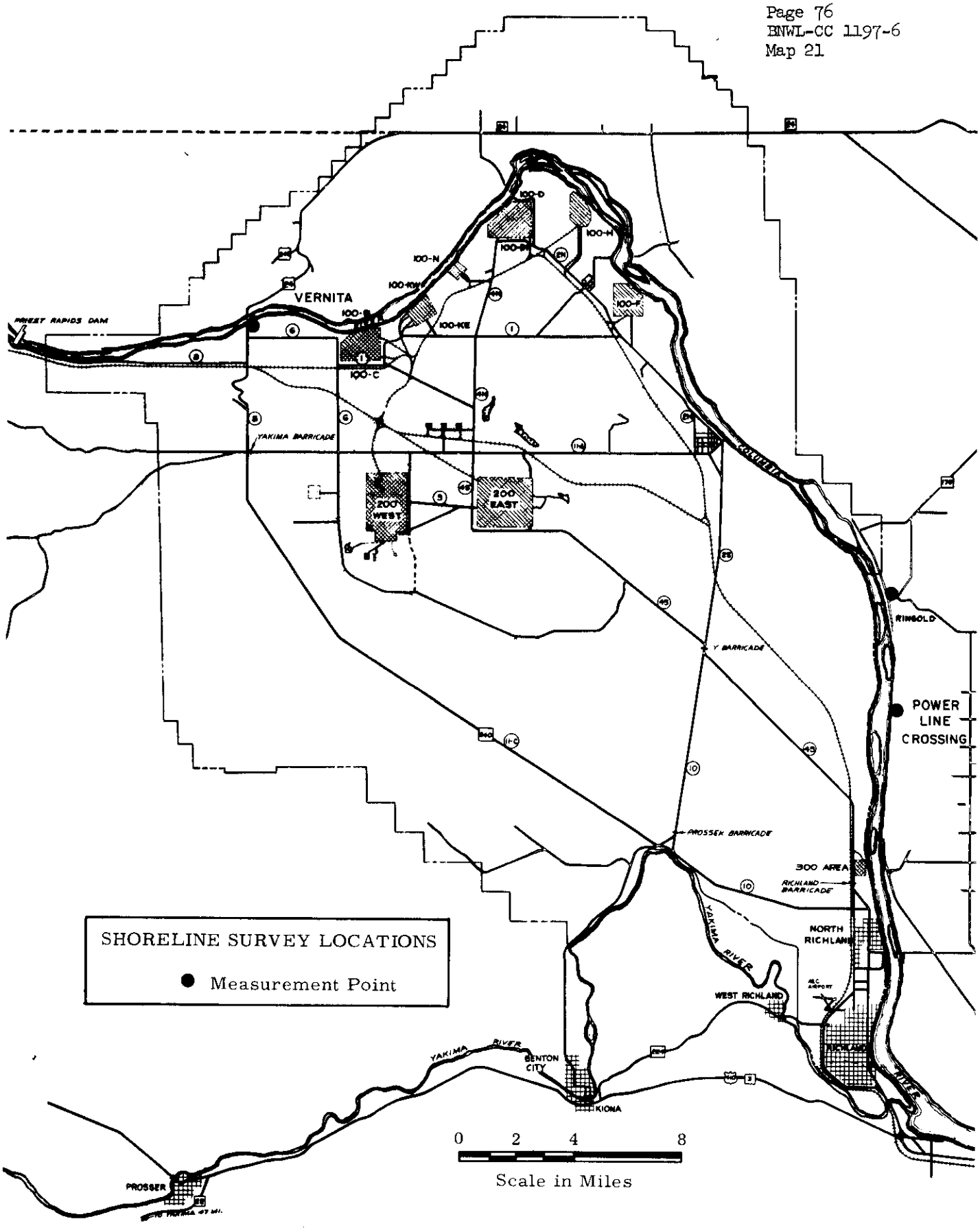
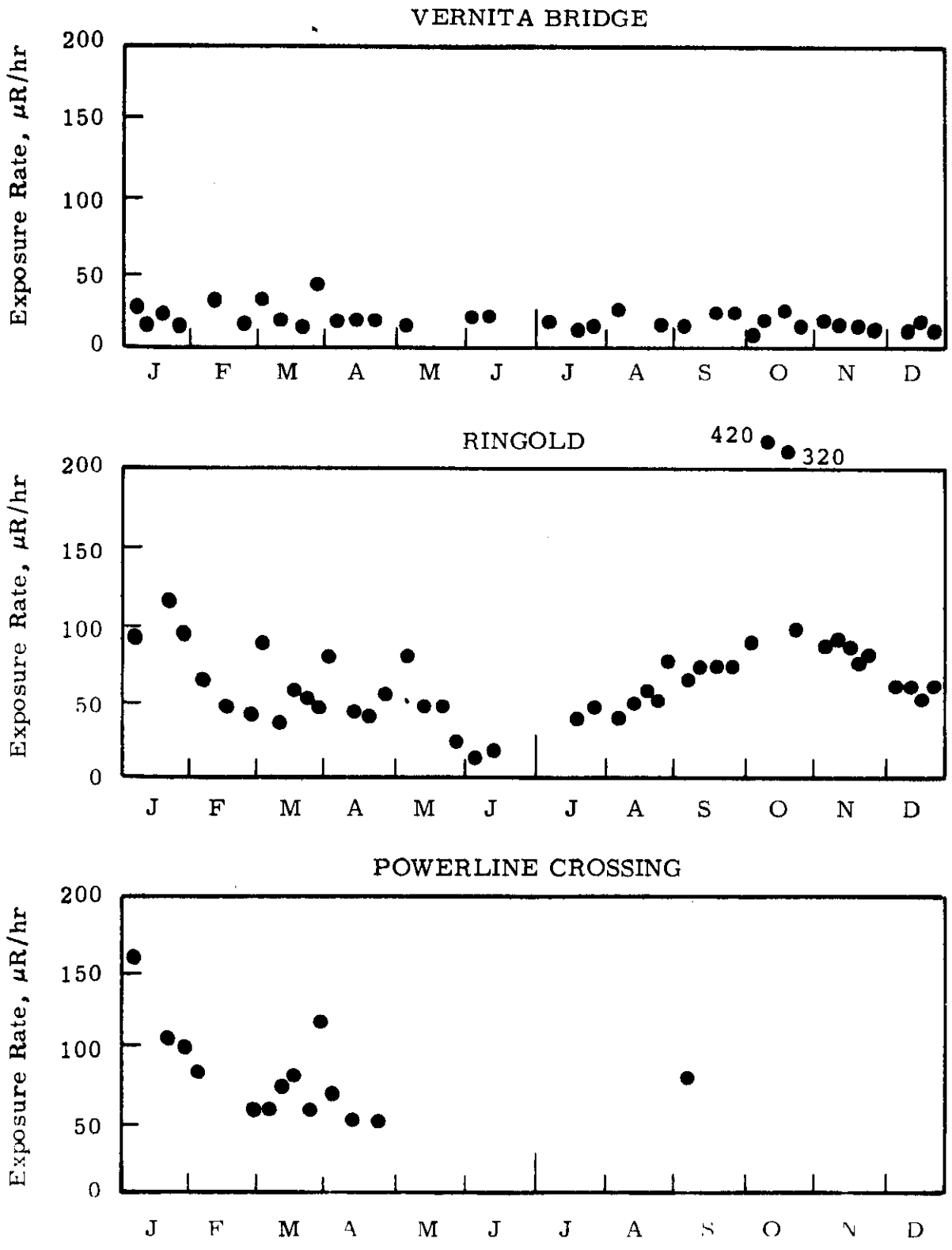

VERNITA
PRIEST RAPIDS DAM
100-D
100-H
100-N
100-KW
100-KE
100-F
100-C
YAKIMA BARRICADE
200 WEST
200 EAST
COLUMBIA
RINGOLD
Y BARRICADE
POWER LINE CROSSING
PROSSER BARRICADE
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
YAKIMA RIVER
WEST RICHLAND
BENTON CITY
KIONA
PROSSER
SHORELINE SURVEY LOCATIONS
Measurement Point
0 2 4 8
Scale in Miles

Figure 36

BNWL-CC 1197-6

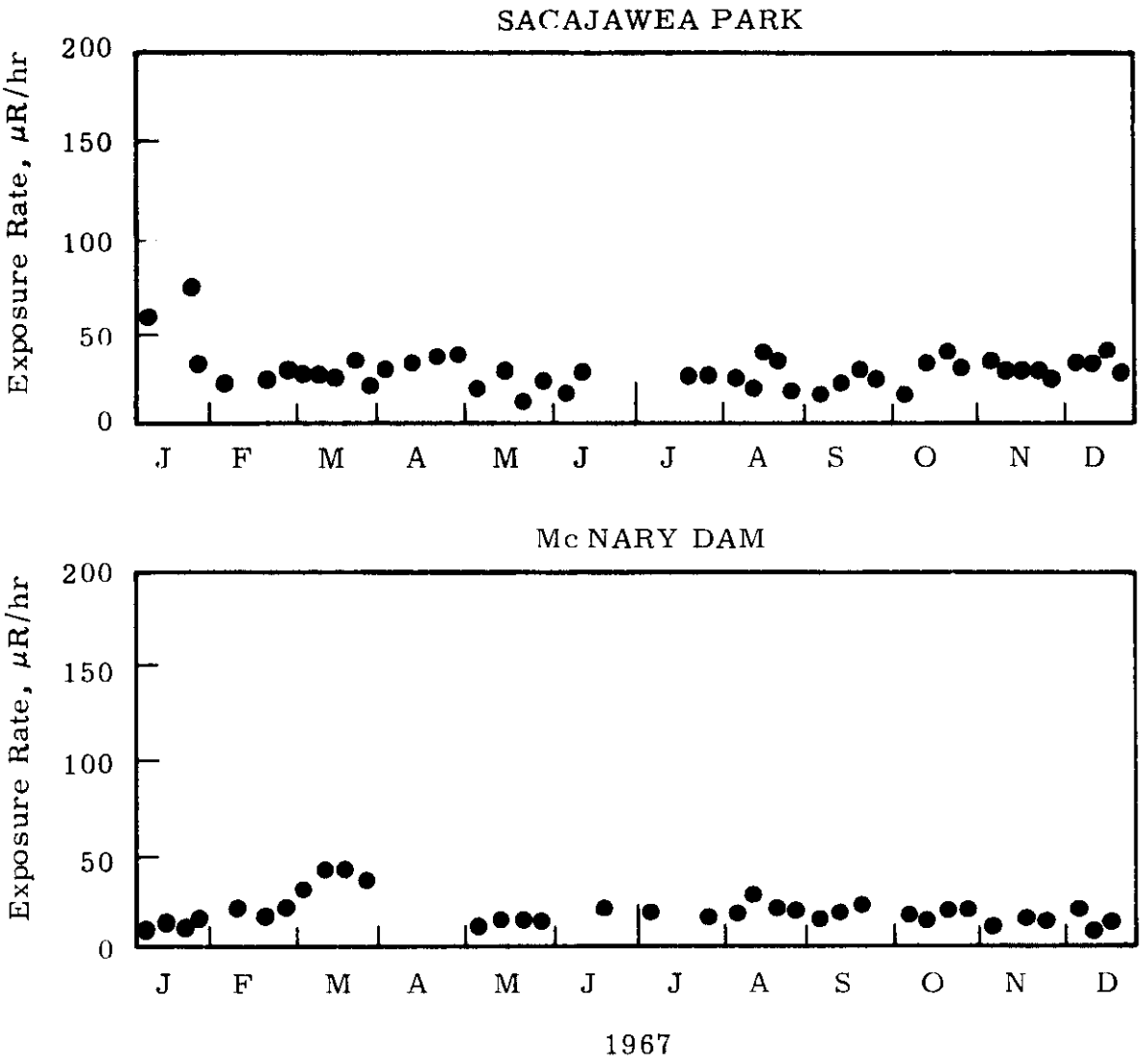
EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE



1967

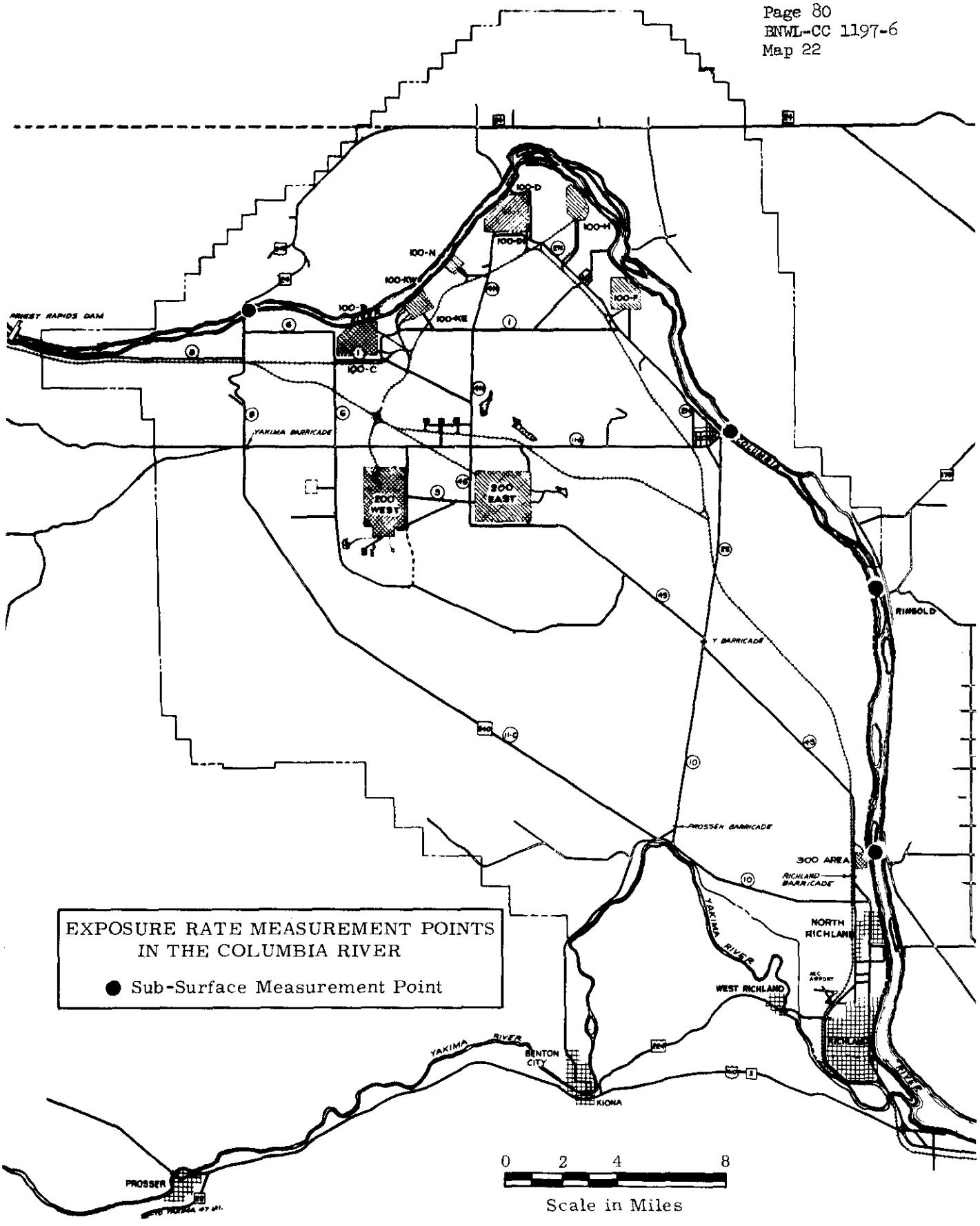
Figure 37 BNWL-CC 1197-6

EXTERNAL RADIATION
AT THE COLUMBIA RIVER SHORELINE

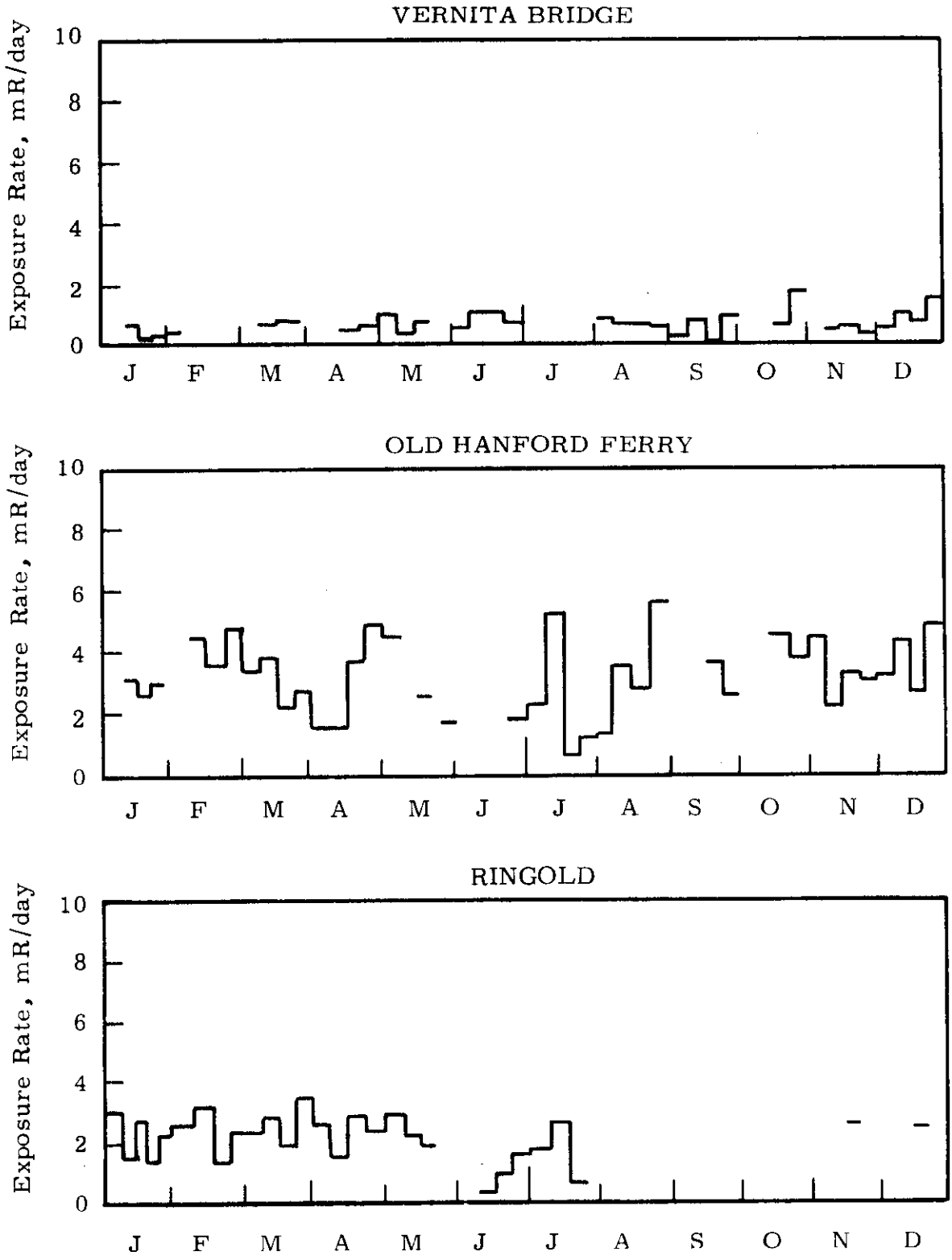


3. Exposure Rates Below the Surface of the Columbia River

Exposure rates in the river were determined from pocket dosimeters contained within submerged bottles at the location shown in Map 22. Missing data were the result of lost containers or equipment malfunctions. A slight increase in the sub-surface exposure rates was measured during the latter half of the year at McNary Dam. (See Figures 38 and 39).


EXPOSURE RATE MEASUREMENT POINTS
IN THE COLUMBIA RIVER
● Sub-Surface Measurement Point
0 2 4 8
Scale in Miles
100-D
100-H
100-N
100-KW
100-KE
100-F
100-B
100-C
200 WEST
200 EAST
YAKIMA BARRICADE
Y BARRICADE
PROSSER BARRICADE
RICHLAND BARRICADE
300 AREA
RINGOLD
NORTH RICHLAND
WEST RICHLAND
BENTON CITY
KIONA
PROSSER
YAKIMA RIVER

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER



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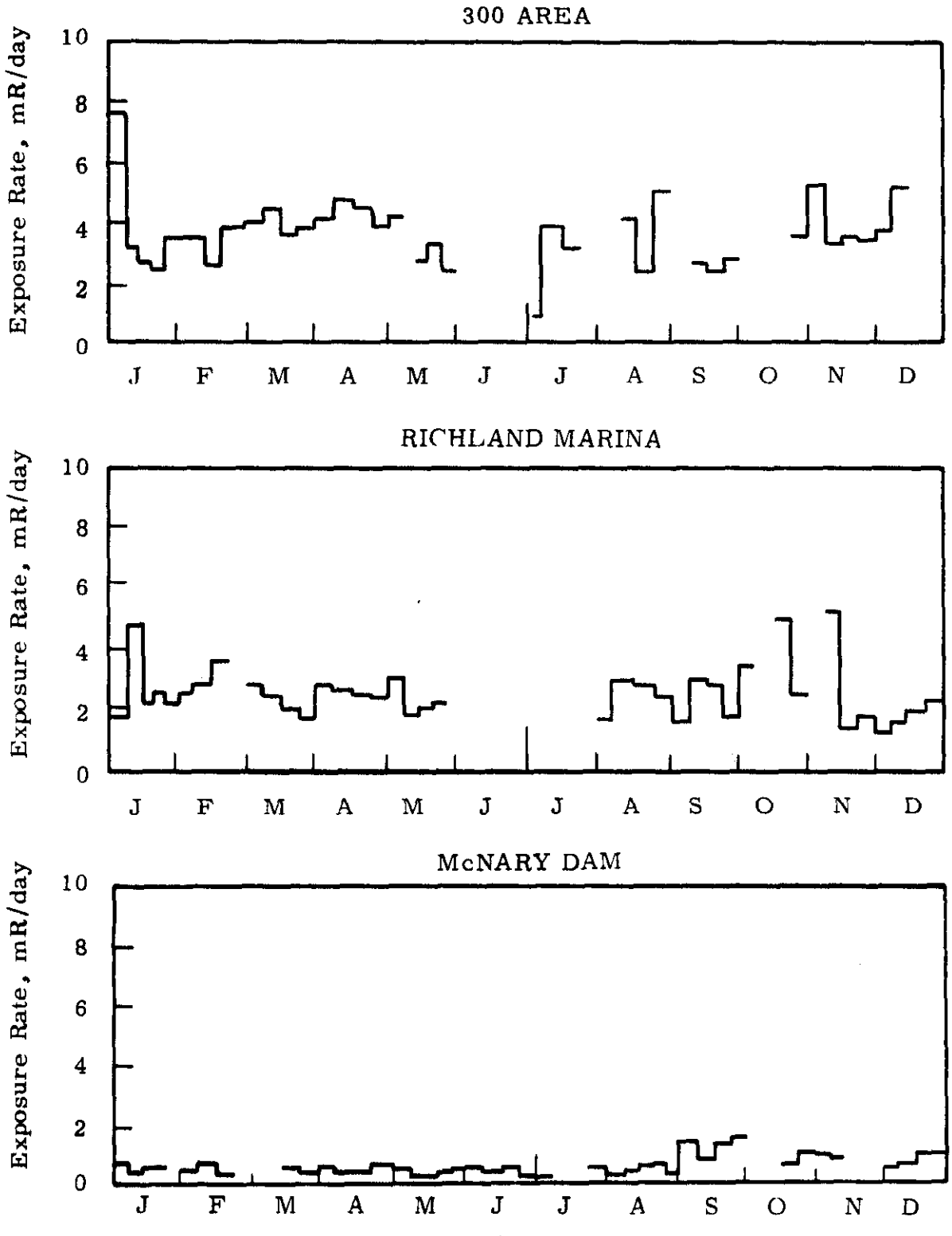
EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER



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