BNWL-C-96

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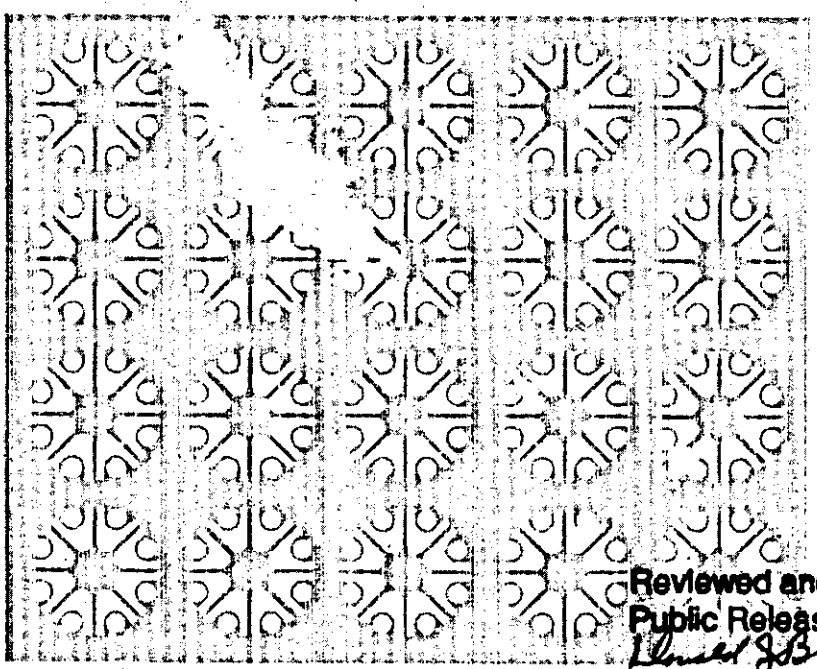
Battelle
Pacific Northwest Laboratories
Richland, Washington 99352

ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1970

JUNE 1972



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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1970

By

The Environmental Evaluations Staff
Occupational and Environmental Safety Department
Operations and Services Division

P. E. Bramson, Editor

June 1972

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ENVIRONMENTAL STATUS OF THE HANFORD RESERVATION FOR 1970

I. INTRODUCTION

This report summarizes data collected during 1970 from locations within the Hanford plant boundaries for the 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-2583, "Environmental Status of the Hanford Reservation for July-December, 1969." The graphs in this report show 14 months of data--the subject 12 months and the preceeding two. Groundwater data are not included in this report but are presented in BNWL-1613, "Radiological Status of the Groundwater Beneath the Hanford Project." Data from offsite sampling locations are summarized 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 100-KW reactor was shut down in February 1970, leaving as plutonium production reactors the 100-KE and 100-N reactors.

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 HIGHLIGHTS

Columbia River Water

During 1970, average concentrations of coliform bacteria decreased relative to the 1969 averages by factors of 2.5 and 3.0 at locations upstream and downstream respectively of the Hanford project. All other river analyses results were within their expected ranges of variation. The estimated annual GI Tract dose from drinking 100-N water was 9.5 mrem, a decrease of about a factor of 3 from 1969.

Swamps, Ditches, and Ponds

Radionuclide concentrations in samples collected from open waters on the Hanford project during 1970 were, in general, within their expected range of variation and were well below the recommended limit of 50,000 pCi/ℓ.

A notable exception occurred at B Swamp in April, 1970, following an unusual release in March, when total beta activity in B Swamp increased to 113,000 pCi/ℓ. The principal gamma emitter was ^{144}Ce-Pr (3600 pCi/ℓ), but the majority of the beta activity was due to ^{90}Sr.

Results of radiological, chemical and biological analyses of samples collected from 300 Area ponds and trenches were generally within the expected range. Coliform and enterococci concentrations in the 300 Area leach trench peaked in May and June at levels about twice any experienced during 1969.

A total of fourteen ducks and coot were collected in the vicinity of 100-K from December 29, 1969, through December 31, 1970. Two ducks collected from 100-K Trench and one duck collected from 100-N Trench contained unusually high radionuclide concentrations. ^{32}P concentrations were 110,000, 68,000 and 140,000 pCi/gram (wet weight) of muscle respectively. Most notable gamma emitters were ^{51}Cr and ^{65}Zn in the 100-K ducks and ^{54}Mn, ^{137}Cs and ^{144}Ce-Pr in the 100-N duck. These samples and consequent actions have been separately reported in correspondence with AEC-RL. No similar results were obtained after covering the trenches.

Airborne Radioactivity

Concentrations of ^{131}I in the atmosphere, as measured with caustic scrubbers, during the first 6 months of 1970 averaged about 0.01 pCi/m^3 at most locations. As measured in charcoal samples, the average concentration of ^{131}I during the last half of the year was about 0.08 pCi/m^3. The apparently increased concentrations during the last half of the year result from the greater collection efficiency of charcoal for organic-bound iodine. The maximum sample concentration measured during this reporting period was 0.52 pCi/m^3, noted in December at the 300 West East Center Area using a charcoal sampler. For comparison the maximum ^{131}I concentration measured during the last six months of 1969 was 0.7 pCi/m^3 at the 300 Area using a caustic scrubber sampler.

At most locations, both onsite and offsite, total beta activity increased by about a factor of ten during the first half of the year and then decreased by a slightly smaller factor by the end of the year. Foreign weapons testing fallout was the probable source. The maximum measured beta activity, 3.7 pCi/m^3, occurred in February at the 200 ENC location. Annual average activity ranged from 0.4 to 0.5 and 0.4 to 1.8 pCi/m^3 in the 100 and 200 Areas, respectively.

Total alpha concentrations in air during 1970 averaged about 0.01 pCi/m^3 at most locations. Monthly averages at several locations occasionally reached 0.03 pCi/m3. On several occasions, weekly average concentrations exceeded 0.1 pCi/m^3, reaching a maximum of 0.18 pCi/m^3 on two occasions in the fall. Analysis of several of the higher samples showed no plutonium.

Radiation Surveys

Several radioactive particles were found on Hanford roadways during road surveys. The most significant particle had a beta dose rate of 6 rad/hr. Major radionuclides comprising the activity were ^{144}Ce-Pr, ^{90}Sr-Y, ^{106}Ru and ^{137}Cs. Generally, the occurrences were attributed to inter-area waste hauling operations.

Contaminated particles were found on control plots around 200 East Area on five occasions. Gross activity ranged from 1000 to 15,000 counts/min on a GM survey instrument, and was attributed to wind-borne particulates from tank farm areas.

At midyear, pencil ionization chambers were replaced by thermoluminescent dosimeters (TLD) for the measurement of external exposure rates. There was a general downward trend in exposure rates at most locations. The maximum exposure rate noted was 1.5 mR/day at 100 K Area.

On the basis of exposure rate measurements at Richland and at 100-N, the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1970 was estimated to be 9 mrem.

The exposure rates and surface contamination levels at shoreline locations downstream from the operating reactors during 1970 were generally somewhat less than 1969. The maximum shoreline exposure rate during 1970, 250 μR/hr, was detected on D Island location in March. The maximum shoreline contamination level encountered during 1970 (2000 c/m - GM) was observed at the Hanford Far Shore location in May. These were discussed in a topical report, BNWL-CC-2363 (p. 61).

Radiation levels from shoreline contamination below the plant boundary were generally less than 2000 c/m (GM). The average Columbia river immersion dose rates in 1970 generally were lower than the 1969 levels. The maximum immersion dose rate, 3.1 mR/day, was observed at the 100-F Area location.

III. COLUMBIA RIVER WATER

Columbia River water sampled upstream of the Hanford project is analyzed for comparison with samples collected downstream of the project. In January 1970, the upstream sampling location was moved from the Priest Rapids Gauge Station to the Vernita bridge. Sampling locations for raw Columbia River water are shown in Map 1.

Fallout radionuclides ^{3}H and ^{90}Sr, as well as total alpha activity, were measured in monthly composites of weekly grab samples at Vernita and in monthly composites of weekly integrated samples at Richland (Figure 1).

The measured concentrations of ^{90}Sr and total alpha activity in river water averaged, respectively, 0.44 and 0.60 pCi/liter at Vernita and 0.51 and 0.58 pCi/liter at Richland during the year. Measured tritium concentrations averaged 840 pCi/liter at Vernita and 1100 pCi/liter at Richland. Averages were based on the actual sample results, which in many instances were less than the analytical limit of about 1000 pCi/liter.

Average radionuclide transport rates for other radionuclides measured at Richland during this period (Figures 2 & 3) were about half the comparable averages for 1969.

Biological measurements of Columbia River water samples collected semimonthly from Vernita, 100-F, and North Richland appear in Table 1. From the Washington-Oregon border to Grand Coulee Dam, the Columbia is considered a Class A river, according to the Washington State Water Quality Standards,* which state that for Class A rivers total coliform organisms shall not exceed median values of 240 per 100 ml with less than 20 percent of the samples exceeding 1000 per 100 ml when associated with a fecal source. In addition to coliform, enterococci is measured to indicate contaminants of fecal origin.

Concentrations of coliform bacteria increased sharply in June and September at all three locations. The enterococci count increased temporarily at the North Richland location in May, and at all three locations in September and October. Standards do not appear to have been exceeded at any time during the year.

Chemical analyses of river water grab samples collected at Vernita and 100-F (above and below the production reactors) as reported by Douglas United Nuclear are presented in Tables 2 and 3. Nitrate and hexavalent chromium analyses also were performed on the weekly samples of river water from Vernita, and nitrate analyses were performed on samples from Richland. Hexavalent chromium was monitored continuously by the Technicon analyzer at the 300 Area ACRMS. The monitor has a detection level of 1 ppb of Cr^{+6}, but trends below this concentration can be followed by comparing Cr^{+6} and ^{51}Cr concentrations. These data are presented in Figure 4.

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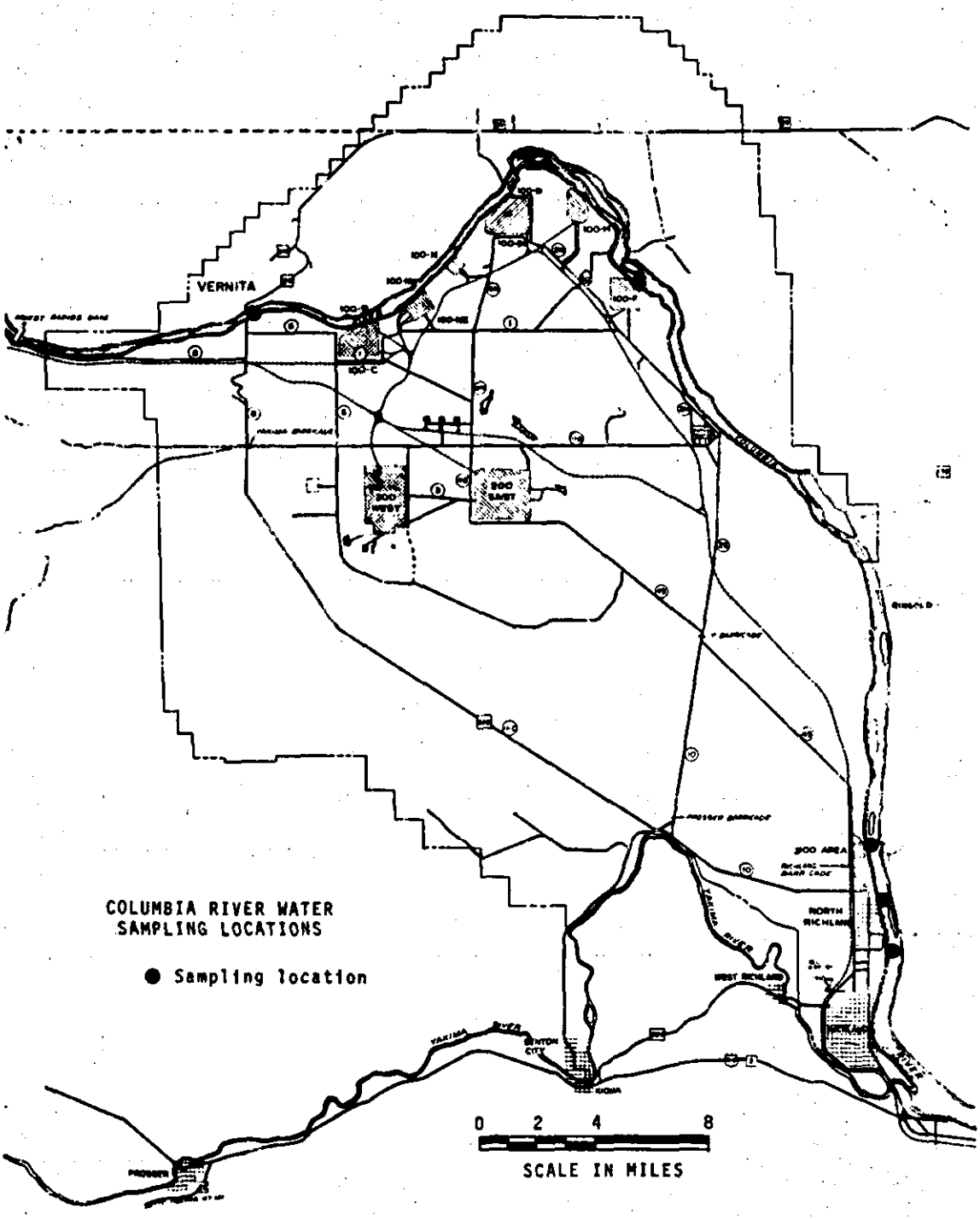
* "Implementation and Enforcement Plan for Water Quality Standards; Surface Waters" State of Washington, Department of Ecology. September 1970.


VERNITA
100-C
100-N
100-NR
100-H
100-D
100-F
200 WEST
200 EAST
200 AREA
COLUMBIA RIVER WATER
SAMPLING LOCATIONS
● Sampling location
COLUMBIA RIVER
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
PROSSER
0 2 4 8
SCALE IN MILES

MAP 1

CONCENTRATIONS OF ^{3}H AND ^{90}Sr IN COLUMBIA RIVER WATER AT THE VERNITA BRIDGE AND AT RICHLAND
(Results in pCi/liter)

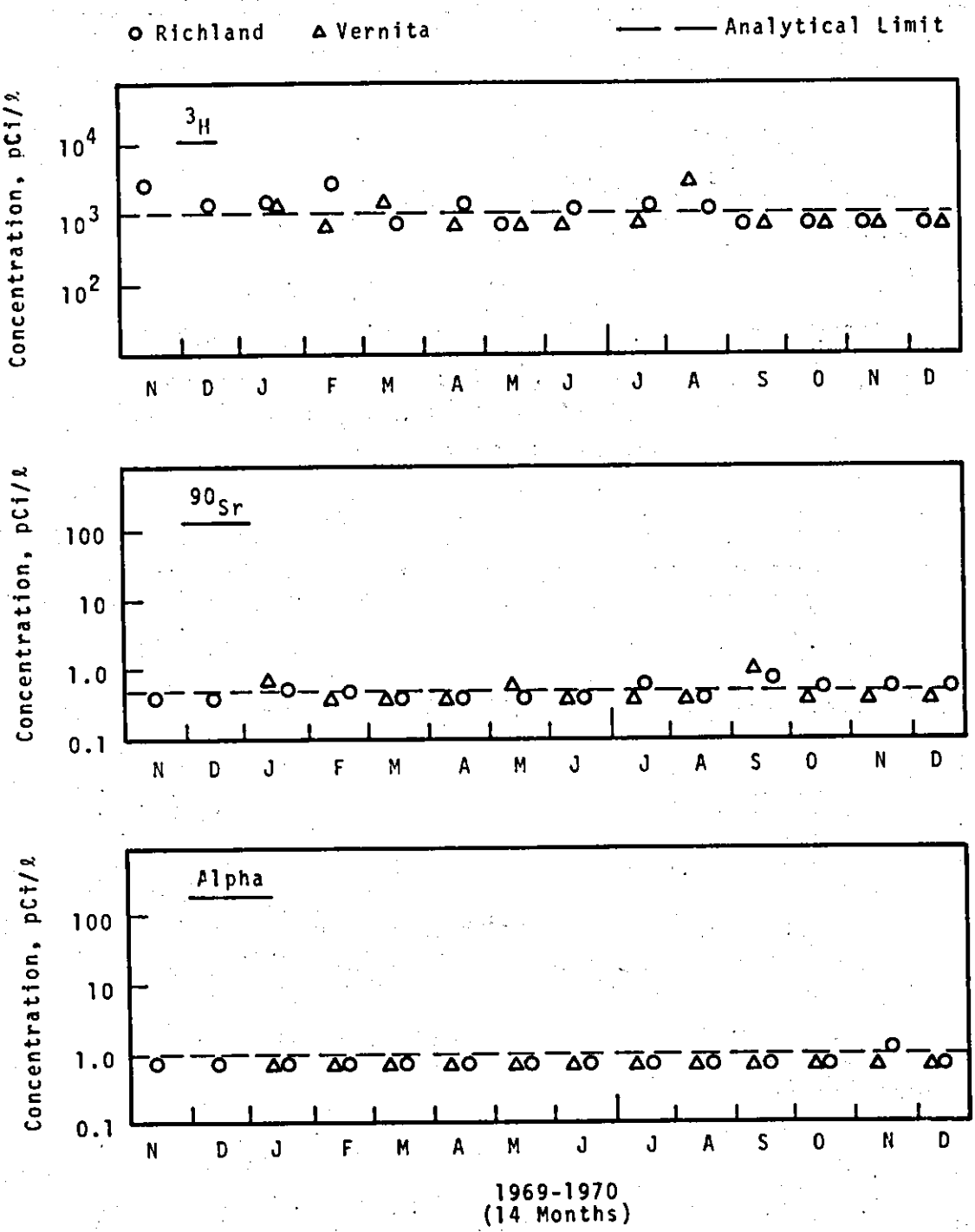


FIGURE 1

COLUMBIA RIVER RADIONUCLIDE TRANSPORT RATES AT RICHLAND

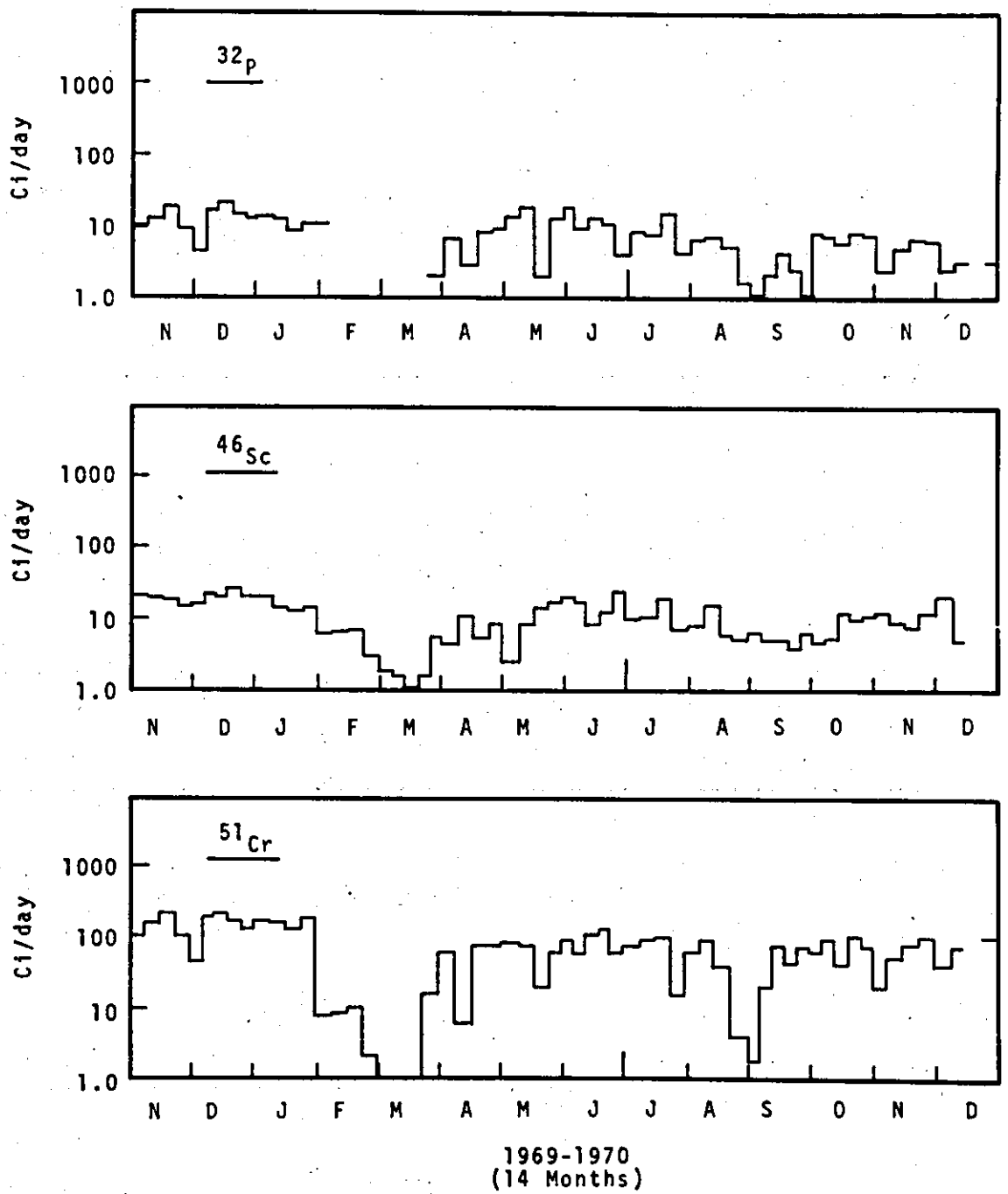


FIGURE 2

COLUMBIA RIVER RADIONUCLIDE TRANSPORT RATES AT RICHLAND

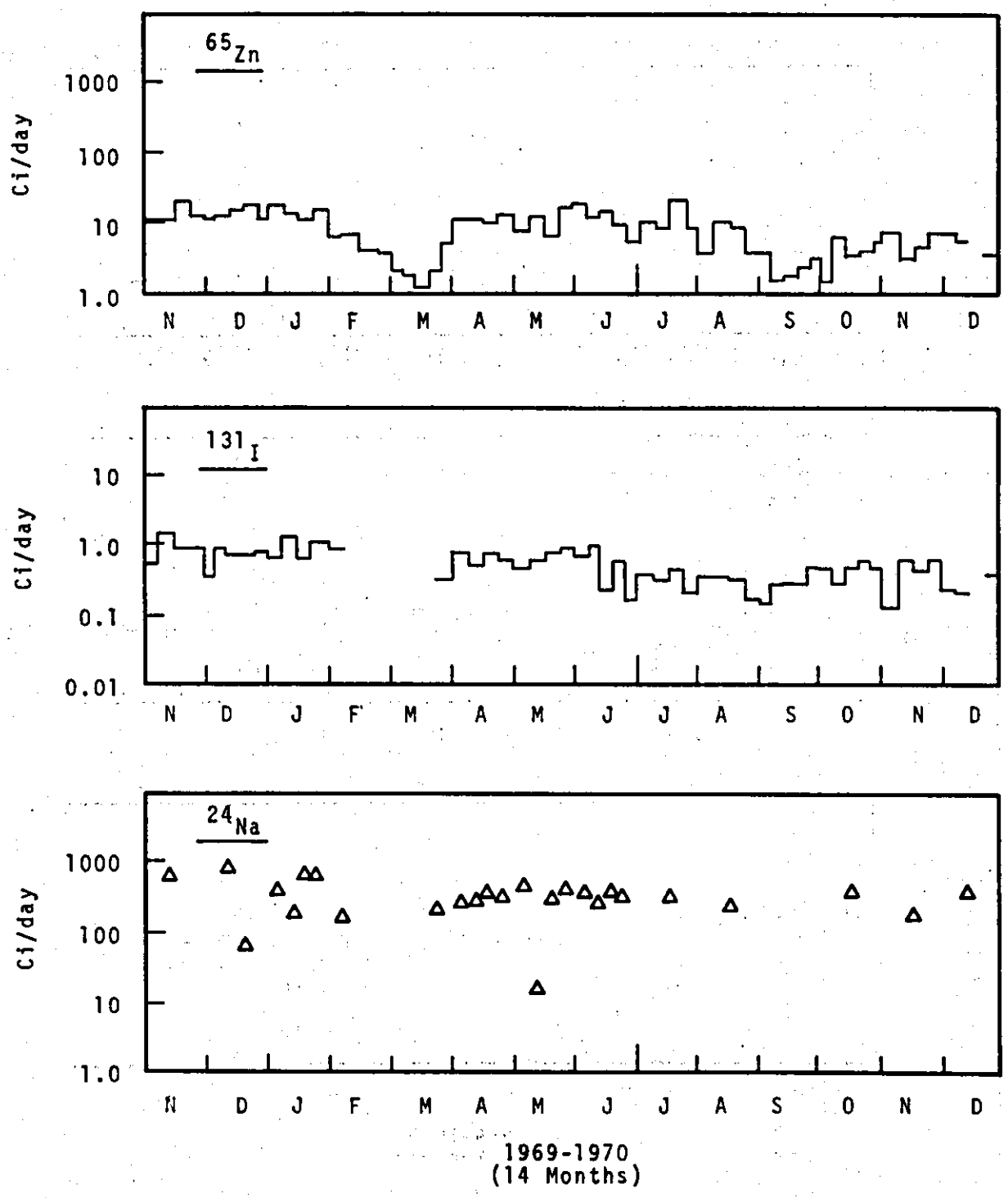


FIGURE 3

TABLE 1

BIOLOGICAL MEASUREMENTS IN THE COLUMBIA RIVER FOR 1970

	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
1/20/70	8.	3.	3.55	13.	7.	2.8	15.	16.	3.8
2/17/70	4.	<1.	3.0	2.	<1.	3.1	2.5	8.	2.05
3/24/70	1.	<1.	2.45	1.	<1.	2.75	2.	4.5	2.85
4/21/70	3.	1.	4.55	2.	<1.	3.7	2.	2.	3.75
5/19/70	19.	4.	3.8	11.	21.	4.15	24.	214	4.15
6/16/70	70.	4.5	4.45	175	6.5	3.65	122.5	23.5	3.10
7/28/70	20.	4.	3.85	10.	7.	3.45	30.	29.	2.65
8/18/70	25.	8.	0.95	30.	10.	1.25	30.	19.	1.05
9/29/70	75.	86.	1.8	155.	59.	2.5	180.	45.	1.15
10/16/70	25.	52.	2.05	100.	158.	2.05	85.	30.	1.8
11/18/70	30.	0.	NA	10.	2.	NA	20.	5.	NA
12/15/70	2.	1.	4.35	1.	0.5	4.85	12.	2.	4.55
Annual, 1970	24.	13.	3.2	42.	23.	3.1	44.	33.	2.8

NA - Not Analyzed

TABLE 2

CHEMICAL CHARACTERISTICS OF THE COLUMBIA RIVER AT VERNITA FOR 1970

(Results in parts per million)

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Diss. O_2	Phth Alk.	M.O. Alk.	Hard-ness	Solids
1/6/70	6.0	0.02	0.002	19.	15.	0.00	0.36	11.9	2.	67.	74.	93.
1/20/70	4.0	0.01	0.002	23.	15.	0.03	0.30	NA	2.	70.	74.	92.
2/3/70	4.0	0.02	0.003	21.	14.	0.04	0.52	11.8	1.	68.	72.	92.
2/17/70	4.0	0.00	0.011	23.	17.	0.01	0.50	8.2	1.	68.	73.	89.
3/3/70	5.8	0.030	0.003	21.	16.	0.018	0.43	11.78	1.	63.	76.	89.
3/17/70	5.0	0.026	0.003	21.	17.	0.022	0.50	12.32	1.	66.	74.	90.
3/31/70	5.8	0.098	0.002	20.	16.	0.025	0.39	12.00	2.	67.	74.	74.
4/14/70	5.2	0.200	0.004	21.	20.	0.038	0.60	10.88	2.	67.	75.	93.
4/28/70	6.7	0.07	0.004	22.	28.	0.024	0.53	12.26	2.	69.	83.	106
5/12/70	5.7	0.02	0.017	24.	22.	0.006	0.35	12.16	2.	70.	84.	100
6/16/70	4.3	0.010	0.004	19.	13.	0.036	0.26	11.20	2.	55.	64.	66.
7/21/70	4.4	0.048	0.013	23.	13.	0.023	0.10	10.6	1.	59.	77.	90.
8/4/70	3.9	0.01	0.007	24.	16.	0.04	0.33	9.76	2.	72.	76.	95.
8/14/70	3.8	0.02	0.004	24.	14.	0.01	0.24	8.96	2.	66.	75.	102.
9/8/70	5.0	0.03	0.01	25.	15.	0.04	0.30	9.4	3.	64.	83.	78.
9/22/70	5.2	0.02	0.005	17.	12.	0.03	0.28	8.3	2.	60.	63.	77.
10/6/70	4.0	0.03	0.005	21.	23.	0.03	0.73	8.3	2.	70.	70.	107.
10/20/70	5.2	0.02	0.003	12.	13.	0.01	0.40	9.7	0.	91.	52.	72.
11/3/70	4.4	0.01	0.004	19.	15.	0.11	0.32	18.7	3.	66.	65.	79.
11/17/70	4.9	0.02	0.002	18.	16	0.10	0.26	9.9	4.	66.	65.	89.
12/1/70	4.3	0.01	0.002	19.	15.	0.18	0.41	21.1	2.	66.	65.	91.
12/15/70	6.2	0.01	0.001	16.	14.	0.16	0.16	19.0	2.	68.	66.	91.
Average, 1970	4.8	0.03	0.006	21.	16.	0.042	0.36	11.75	1.9	66.	72.	88.

TABLE 3

CHEMICAL CHARACTERISTICS OF THE COLUMBIA RIVER AT 100-F FOR 1970

(Results in parts per million)

Date	Mg	Fe	Cu	Ca	SO_4	PO_4	Cl	Diss. O_2	Phth Alk.	M.O. Alk.	Hard-ness	Solids
1/6/70	6.	0.03	0.002	20.	15.	0.00	0.33	NA	2.	68.	74.	93.
1/20/70	4.	0.01	0.004	22.	15.	0.05	0.36	7.8	2.	71.	73.	84.
2/3/70	5.	0.01	0.002	21.	13.	0.06	0.33	12.2	2.	69.	72.	100.
2/17/70	5.	0.01	0.004	22.	19.	0.01	0.33	11.2	2.	68.	75.	105.
3/3/70	5.4	0.016	0.003	22.	17.	0.045	0.26	8.32	1.	65.	76.	96.
3/17/70	6.2	0.026	0.004	19.	17.	0.022	0.50	13.44	1.	65	73.	81.
3/31/70	6.2	0.074	0.005	20.	17.	0.019	0.39	12.22	2.	69.	76.	81.
4/14/70	4.4	0.22	0.002	24.	20.	0.050	0.60	11.81	1.	66.	77.	100.
4/28/70	6.3	0.12	0.005	22.	24.	0.020	0.56	12.29	1.	70.	82.	115.
5/12/70	5.5	0.016	0.017	25.	23.	0.005	0.40	11.84	2.	72.	85.	104.
6/16/70	4.6	0.00	0.011	22.	13.	0.039	0.29	10.72	2.	56.	68.	74.
7/21/70	4.2	0.092	0.007	23.	15.	0.022	0.16	9.6	1.	61.	76.	75.
8/4/70	3.9	0.02	0.007	25.	17.	0.02	0.46	9.63	1.	70.	78.	86.
8/18/70	4.0	0.03	0.004	24.	13.	0.018	0.26	8.86	1.	70.	77.	106.
9/8/70	4.8	0.03	0.005	23.	15.	0.08	0.43	9.0	3.	70.	77.	73.
9/22/70	5.3	0.02	0.002	17.	13.	0.03	0.26	9.4	2.	63.	65.	87.
10/6/70	4.0	0.03	0.003	21.	20.	0.02	0.66	8.2	2.	66.	70.	99.
10/20/70	5.4	0.02	0.006	16.	12.	0.01	0.32	10.6	0.	92.	66.	80.
11/3/70	5.3	0.01	0.001	19.	18.	0.11	0.49	20.0	2.	70.	68.	80.
11/16/70	4.9	0.02	0.003	20.	15.	0.11	0.58	9.8	6.	69.	70.	86.
12/1/70	3.8	0.01	0.002	20.	16.	0.01	0.46	20.8	2.	66.	65.	92.
12/15/70	6.6	0.01	0.000	18.	16.	0.11	0.53	21.7	2.	76.	73.	97.
Annual, 1970	5.0	0.038	0.006	22.	16.	0.038	0.40	11.58	1.8	68.	74.	90.

NITRATE AND HEXAVALENT CHROMIUM CONCENTRATIONS IN COLUMBIA RIVER WATER

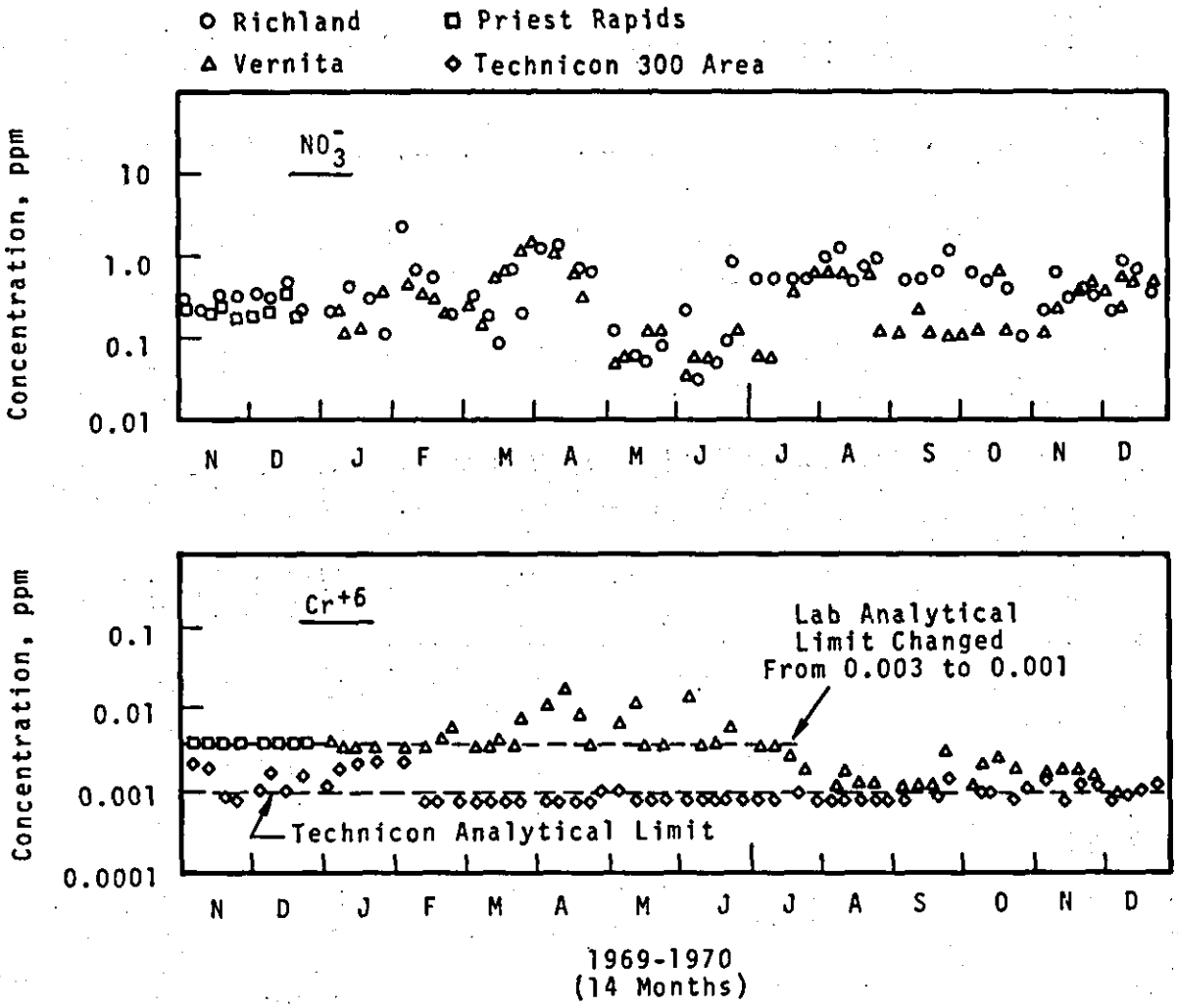


FIGURE 4

IV. DRINKING WATER

Drinking water was sampled at the locations shown in Map 2. Total beta activity is presented in Figures 5 and 6. Total beta analyses of 100-K drinking water were discontinued in mid-June 1970. Concentrations had been at or below the analytical limit of 0.02 c/m/mℓ since May 1969, except for a single sample collected on April 14, 1970 (0.17 c/m/mℓ).

In March, the 300 Area began to supplement its water supply from the Richland plant on an intermittent basis with Columbia River water processed by the 300 Area water treatment plant. By the end of May, however, continuous operation of the 300 Area facility was supplying 40 to 50 percent of the 300 Area water. The measurement of total beta activity in 300 Area drinking water was begun in late June (Figure 6).

The GI Tract dose from drinking 100-N water (Figure 6) was estimated from monthly isotopic and more frequent total beta analyses. The assumed water intake rate was 0.93 liters per day, five days per week, 50 weeks per year, as reported previously.* The GI Tract dose from drinking 100-N water was about 9.5 mrem during 1970, compared with 29 mrem during 1969 and 53 mrem during 1968. These GI Tract doses represented 0.6, 1.9, and 3.5 percent, respectively, of the 1500 mrem per year dose standard for nonoccupationally exposed individuals. The values for 1969 and 1968 are greater than previously reported,* due to an error in the ^{56}Mn dose factor previously used in calculating dose for those years.

Grab samples of drinking water collected in April and June from the B-Y Telephone Exchange (506 Building) and in February and May from the Road Crew Headquarters (615 Building - Hanford 9 well) were analyzed for gross beta activity. Concentrations at both locations were less than the analytical limit (0.1 c/m/mℓ).

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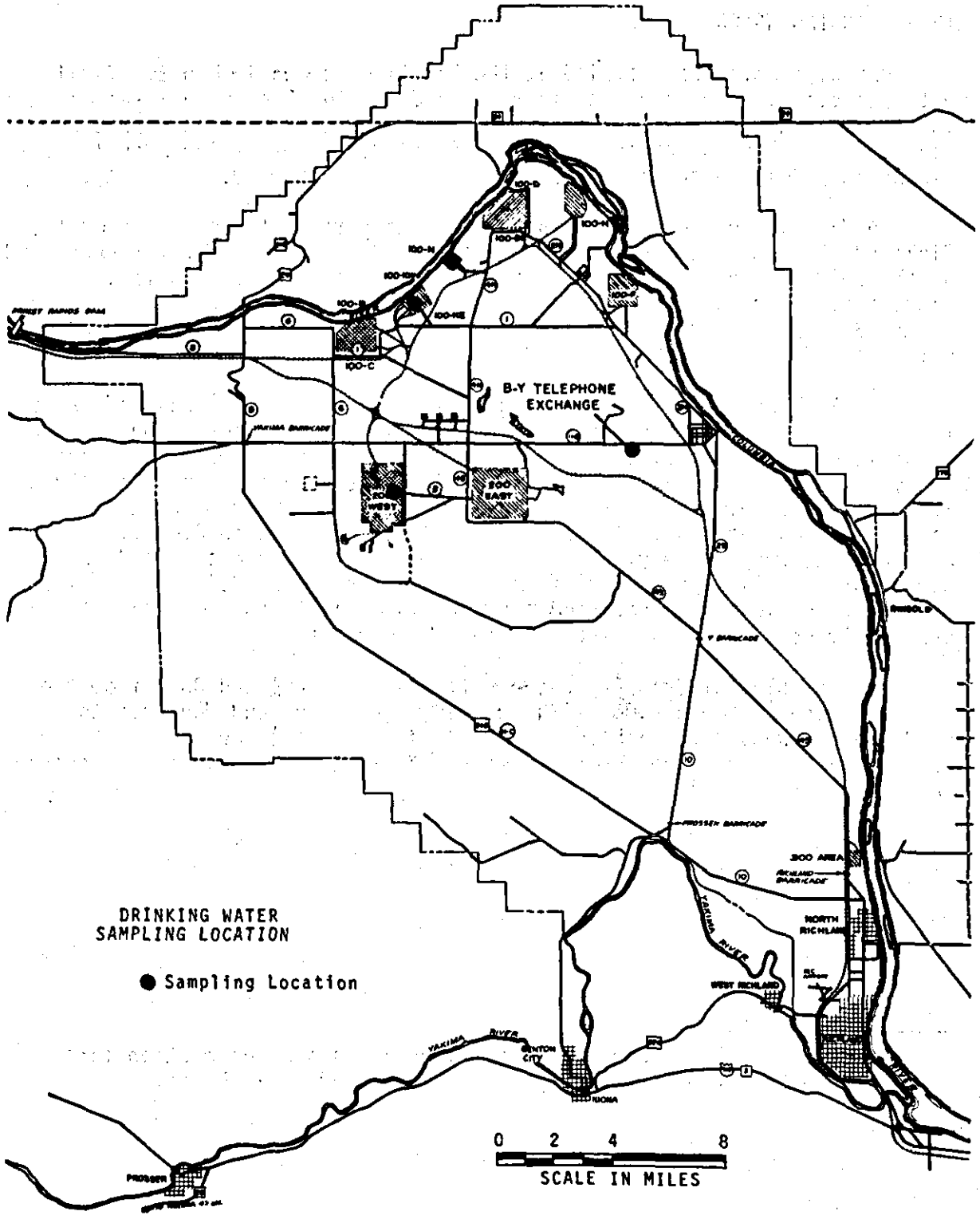
* BNWL-CC-2583, "Environmental Status of the Hanford Reservation for July-December 1969," edited by C. B. Wilson and T. H. Essig.


B-Y TELEPHONE EXCHANGE
200 EAST
200 WEST
300 AREA
RICHLAND BARRICADE
NORTH RICHLAND
WEST RICHLAND
YAKIMA RIVER
BENTON CITY
KIONA
PROSSER
DRINKING WATER SAMPLING LOCATION
● Sampling Location
0 2 4 8
SCALE IN MILES

MAP 2

TOTAL BETA ACTIVITY OF DRINKING WATER (GRAB) SAMPLES

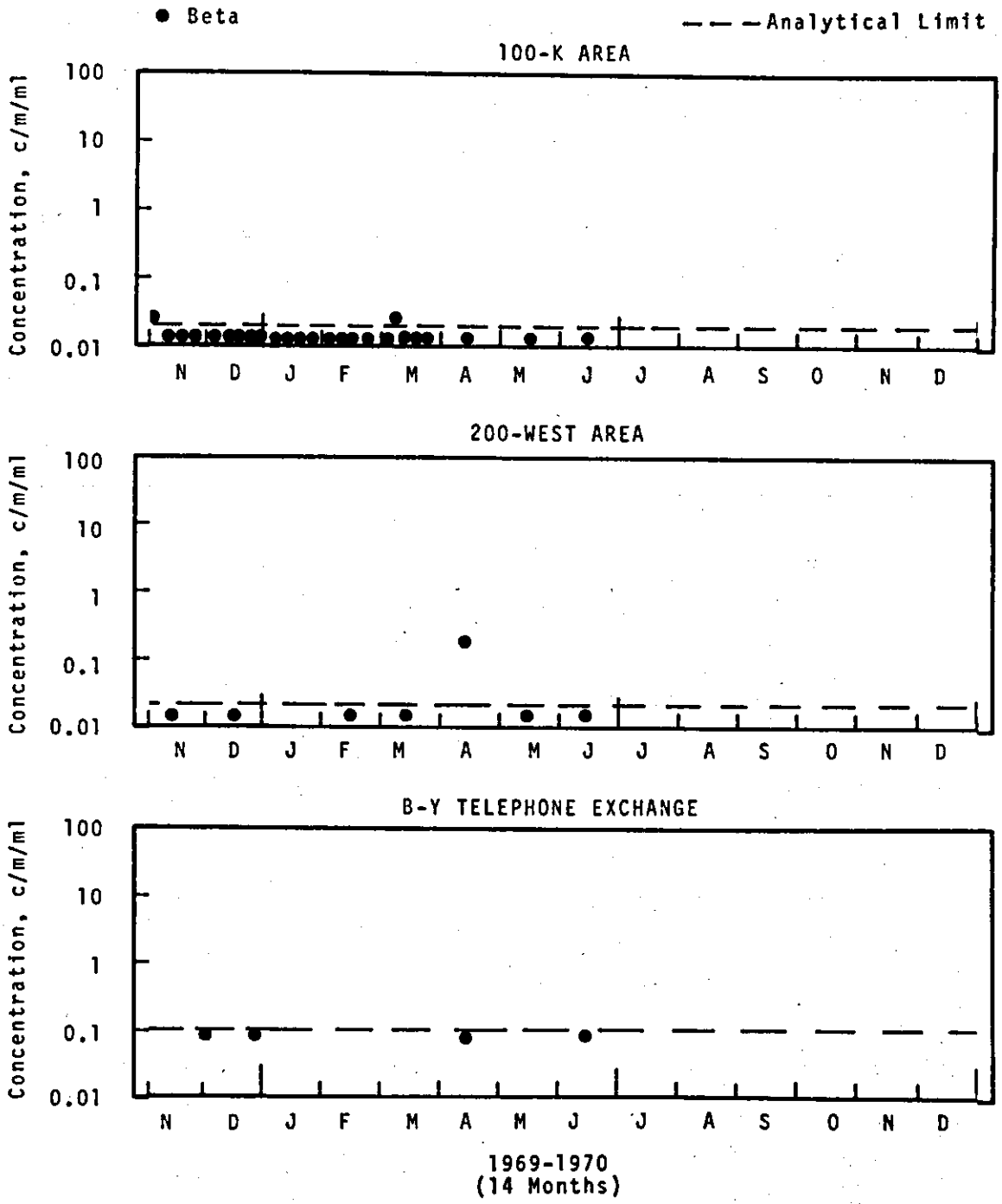


FIGURE 5

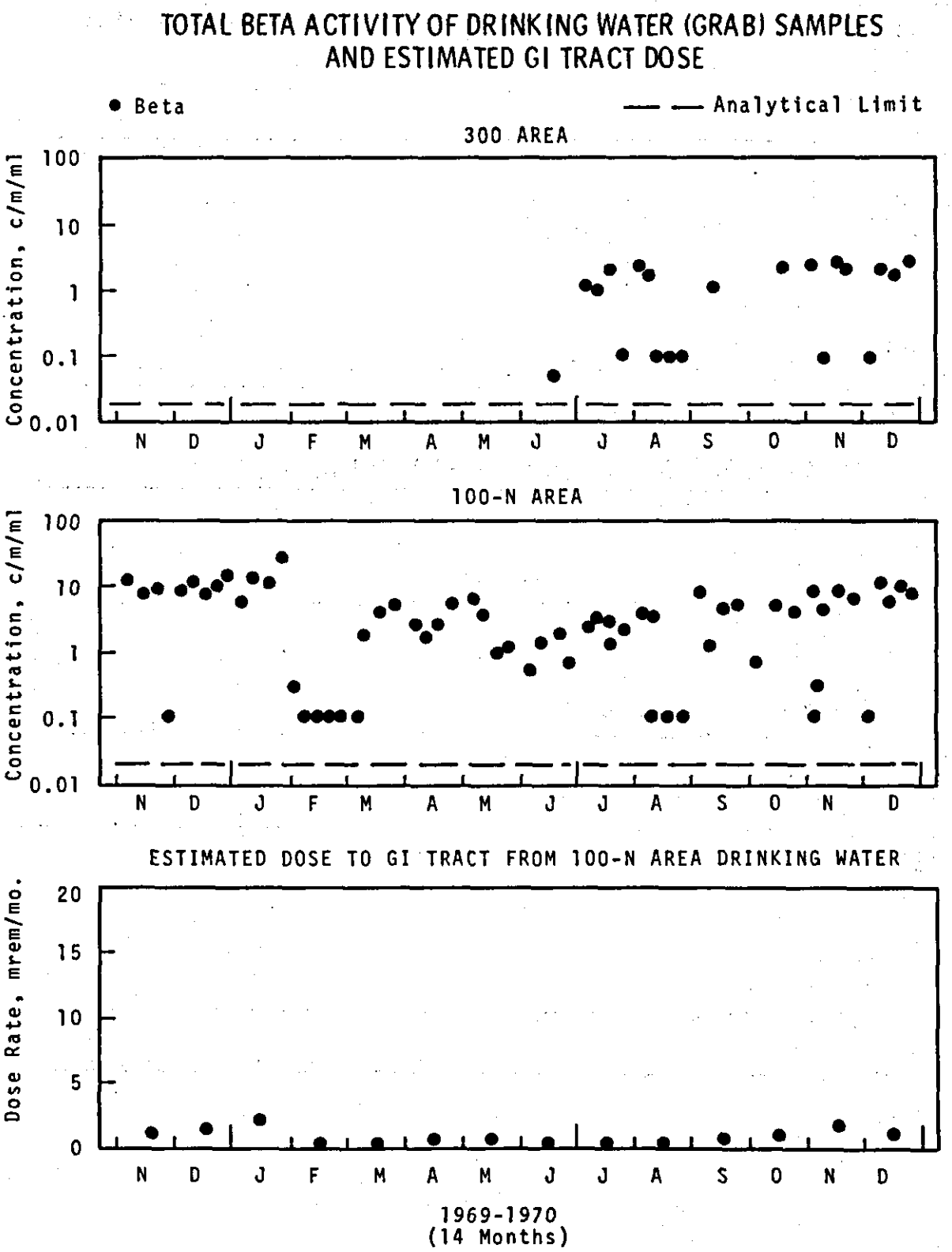

TOTAL BETA ACTIVITY OF DRINKING WATER (GRAB) SAMPLES
AND ESTIMATED GI TRACT DOSE
● Beta
— — Analytical Limit
300 AREA
Concentration, c/m/ml
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
100-N AREA
Concentration, c/m/ml
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
ESTIMATED DOSE TO GI TRACT FROM 100-N AREA DRINKING WATER
Dose Rate, mrem/mo.
20
15
10
5
0
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 6

V. SWAMPS, DITCHES, AND PONDS

Open waters, primarily sites for disposal of cooling water, used by waterfowl were sampled routinely at the locations shown in Map 3. Grab samples were collected monthly, except that a cumulative sample was collected weekly from the 300 Area Process Pond Inlet. Total alpha and total beta concentrations were below 50,000 pCi/liter, the limit for open waters (AEC Manual RL Supplement 0510), except at 216-B-3 (B Swamp) following an unusual release in late March. Waterfowl collected from this location and from other 200 Area swamps subsequent to this release were examined for unusual concentrations of ^{90}Sr, the major radionuclide released. (See Birds and Mammals.)

Open water and biota in the 100 Areas were sampled following the discovery of unusually radioactive waterfowl on the 100-K Trench. The most significant concentrations of radioactivity in wild game were found in waterfowl that had fed in the 100-N and 100-K trenches. (See Birds and Mammals.)

Estimates of the quantities of radioactivity contained in these two trenches were made following special sampling and surveys. Action was taken by the reactor operating contractor to deny waterfowl further access to the water surfaces of these trenches.

300 Area Process Pond samples received both radiochemical and chemical analyses. Biological measurements were obtained on samples from the 300 Area Leach Trench and its associated river shoreline seepage area.

A. 200 Area Waste Waters

Routine samples were collected from 222-S Swamp (216-S-19), T Swamp (216-T-4), U-Swamp (216-U-10), Redox Swamp (216-S-16), Gable Swamp (216-A-25), B Swamp (216-B-3), 231-Z Ditch (216-Z-11), and 100-F Leach Trench. Analysis results are presented in Figures 7, 8, and 9 and Table 6. Alpha activity in all swamps was within the normal range of fluctuation.

The total beta activity in all swamps, with the exception of B Swamp, was for the most part, within the normal range of variation. The total beta activity in B-Swamp increased to 113,000 pCi/liter during April. The principal gamma emitter was ^{144}Ce-Pr (3600 pCi/ℓ), but the majority of the activity was due to ^{90}Sr. A release which occurred on March 22 was the source of the unusually high radioactivity.

The frequency of gamma scan analyses on swamp samples was monthly at B Swamp and quarterly for all others (Table 6). From time to time the activation products typically found in Columbia River water were also detected in samples collected from the swamps at concentrations similar to those found in river water.

Radioactivity was detected in July in vegetation growing at the water's edge at B Swamp and B Ditch. Samples were collected for analysis, the results of which appear in Table 4.

TABLE 4

GAMMA ACTIVITY IN B SWAMP AND B DITCH VEGETATION

(pCi/gm)

Location	Alpha	^{90}Sr	^{65}Zn	$^{95}ZrNb$	^{137}Cs	^{106}Ru
B Swamp	0.17	280	--	0.9	0.6	2.7
B Ditch	0.08	52	0.2	0.5	1.4	1.8

B. 100-F Leach Trench

Commencing in September 1970, monthly grab samples were collected from 100-F Leach Trench. Alpha analysis results are presented in Figure 9.

C. 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, are presented in Figure 10. The concentration of uranium is based on a measurement of total alpha. Monthly average fluoride ion measurement results appear in Table 5.

TABLE 5

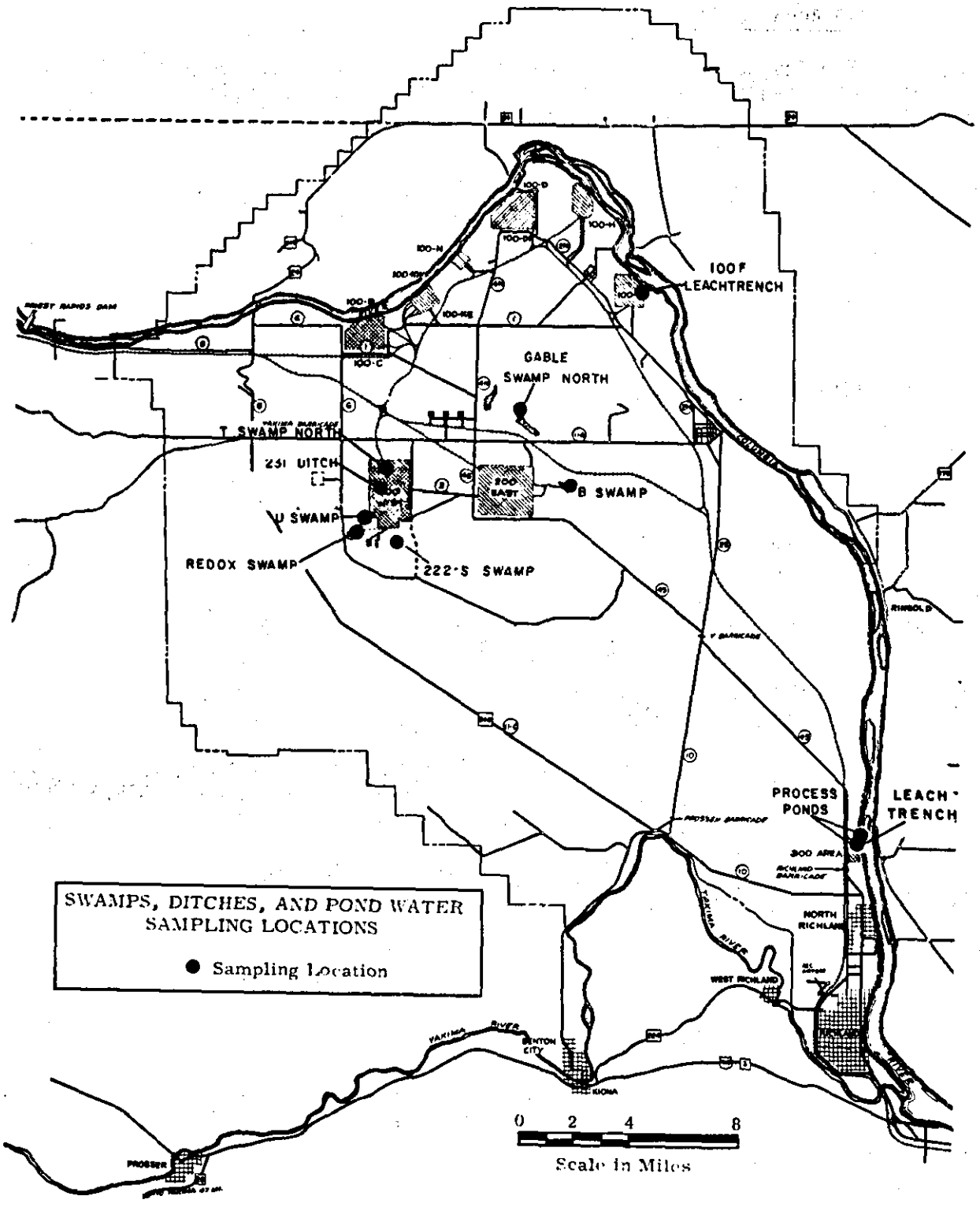
FLUORIDE ION CONCENTRATIONS IN THE 300 AREA PROCESS POND, 1970

Month	F^- ppm
January	1.0
February	1.4
March*	1.6
April*	3.7
May	2.0
June*	2.4
July*	0.7
August	2.6
September*	2.4
October*	2.3
November	1.8
December*	1.6

* No analyses were made for the periods: 3-3-70 to 4-12-70, 6-29-70 to 7-13-70, 9-28-70 to 10-5-70, and 12-15-70 to 12-22-70. Otherwise, cumulative samples were analyzed weekly.

D. 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 7.


100 F
LEACHTRENCH
GABLE
SWAMP NORTH
T SWAMP NORTH
231 DITCH
B SWAMP
U SWAMP
REDOX SWAMP
222-S SWAMP
PROCESS
PONDS
LEACH
TRENCH
300 AREA
NORTH
RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON
CITY
KIONA
PROSSER
SWAMPS, DITCHES, AND POND WATER
SAMPLING LOCATIONS
Sampling Location
0 2 4 8
Scale in Miles

MAP 3

TABLE 6

GAMMA ACTIVITY IN WASTE WATER SAMPLES

(pCi/ℓ)

Location	Date	^{46}Sc	^{65}Zn	$^{95}ZrNb$	$^{140}BaLa$	^{137}Cs	^{106}Ru	$^{144}CePr$
Gable Swamp	1/23/70		92					
	7/24/70					70		
	10/23/70					37		
B Swamp	1/23/70						310	
	2/20/70		47	180				
	4/24/70			120		29	390	3600
	10/23/70						720	
T Swamp	1/23/70	56				230		
	4/24/70	58		98		1400		
	7/24/70					270		
	10/23/70					42		
S Swamp	1/23/70					88	270	
	10/23/70					80		
U Swamp	7/24/70					55		
	10/23/70						210	
Redox Swamp	10/23/70		59		420			

TABLE 7

BIOLOGICAL MEASUREMENTS OF SAMPLES COLLECTED FROM THE 300 AREA LEACHING TRENCH AND ITS ASSOCIATED RIVER SHORELINE SEEPAGE AREA

300 Area Leaching Trench

Date	Coliform/100 mℓ	Enterococci/100 mℓ	BOD mg/ℓ
1/20/70	360,000	43,000	8.7
2/17/70	50,000	1,200	7.8
3/24/70	59,000	600	6.8
4/21/70	180,000	4,800	4.2
5/19/70	740,000	1,200	4.6
6/16/70	670,000	160,000	4.1
7/28/70	150,000	1,000	6.5
8/18/70	150,000	1,900	4.9
9/29/70	102,000	4,200	4.8
10/16/70	105,000	13,000	5.7
11/18/70	146,000	23,000	NA
12/15/70	180,000	4,000	10.4

River Shoreline Seepage Area

Date	Coliform/100 mℓ	Enterococci/100 mℓ	BOD mg/ℓ
1/20/70	50.	6.	3.8
2/17/70	14.	7.5	2.8
3/24/70	7.	11.	2.9
4/21/70	19.	3.	3.9
5/19/70	31.	21.	3.8
6/16/70	170.	28.	3.2
7/28/70	20.	7.	2.9
8/18/70	35.	11.	1.3
9/29/70	205.	72.	1.4
10/16/70	70.	22.	1.8
11/18/70	20.	3.	NA
12/15/70	5.	4.	4.5

RADIOACTIVITY OF WASTE WATER SAMPLES
200-EAST AREA

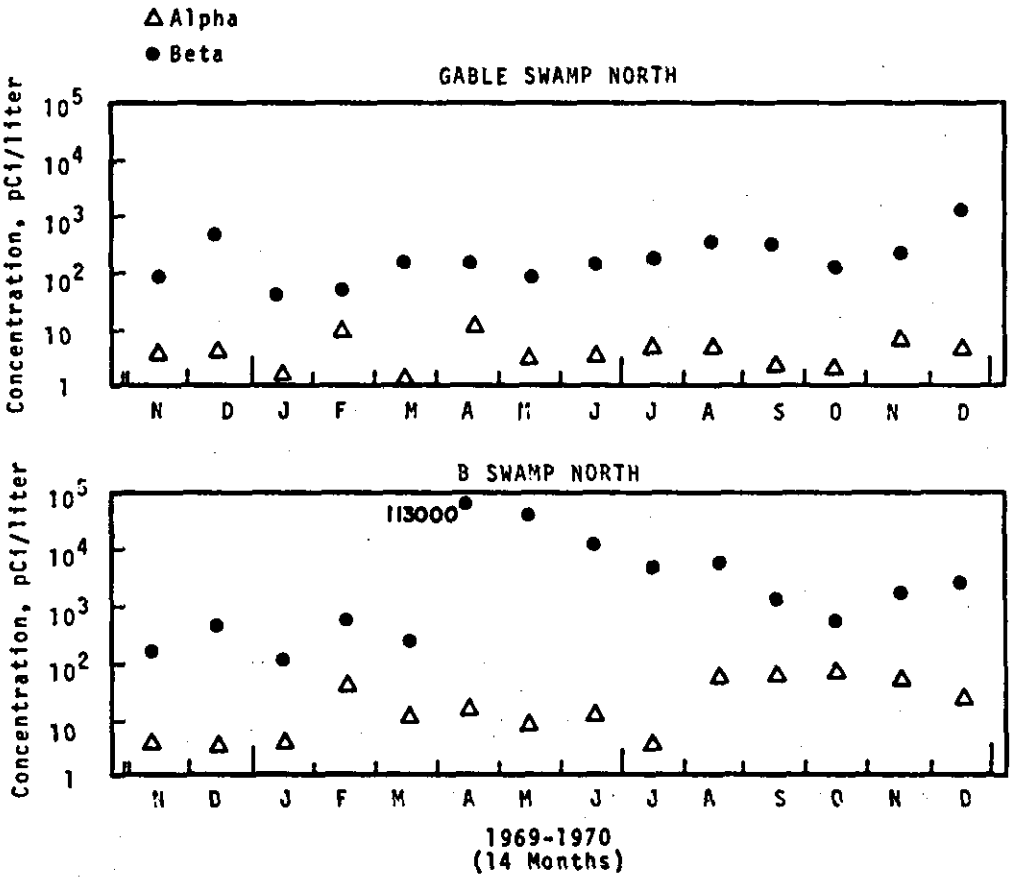
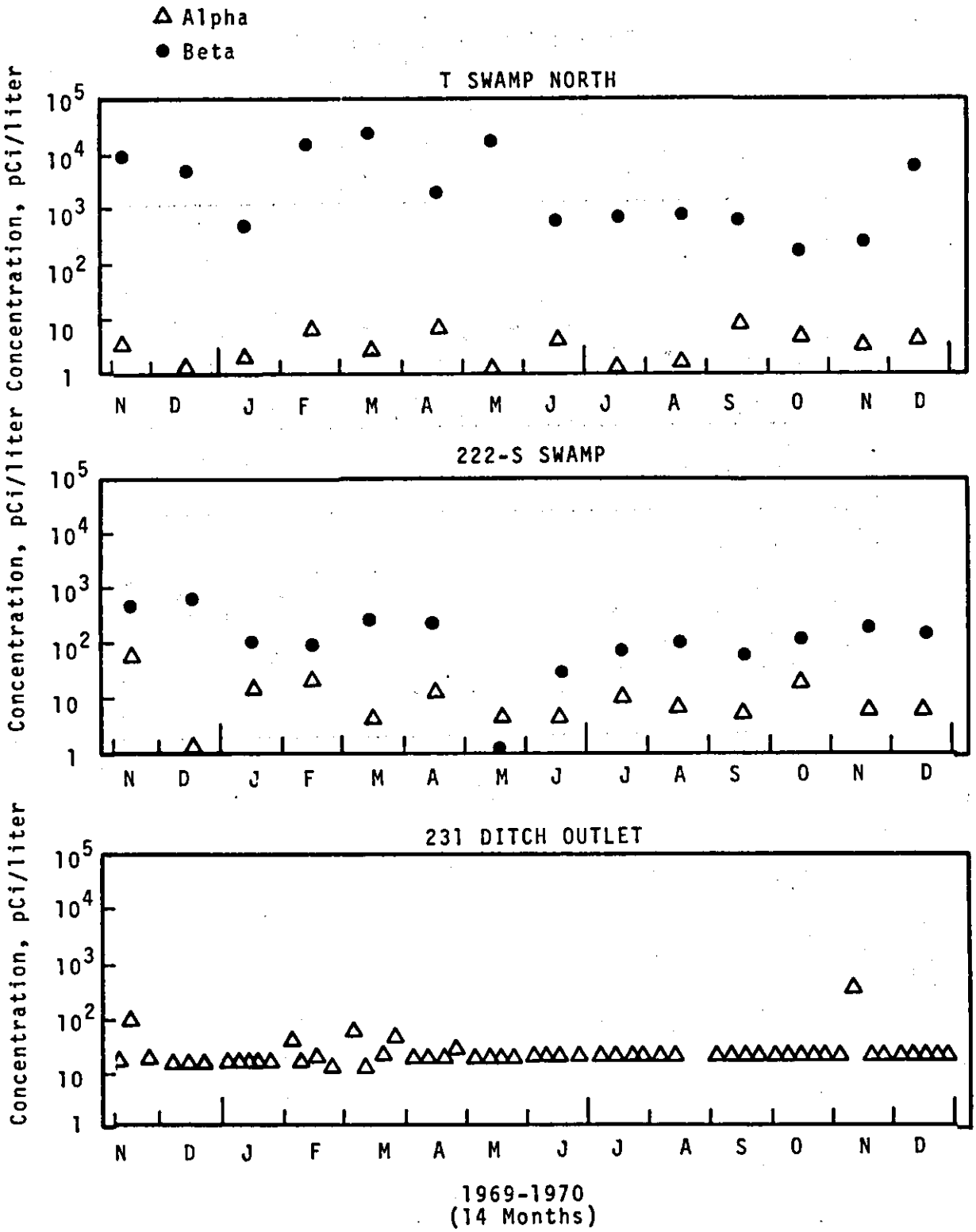


FIGURE 7

RADIOACTIVITY OF WASTE WATER SAMPLES
200-WEST AREA



RADIOACTIVITY OF WASTE WATER SAMPLES 200W, 100F AREAS

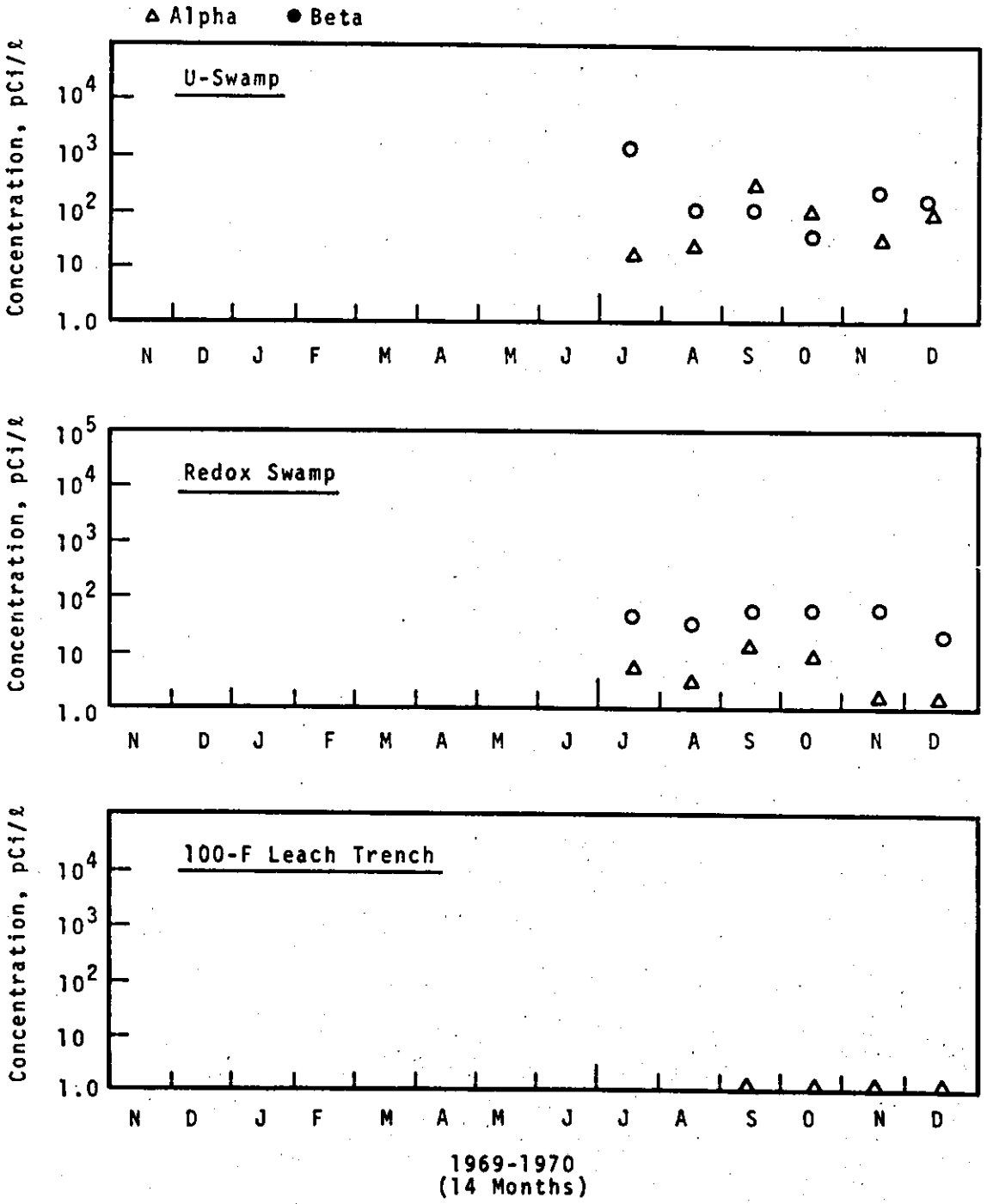


FIGURE 9

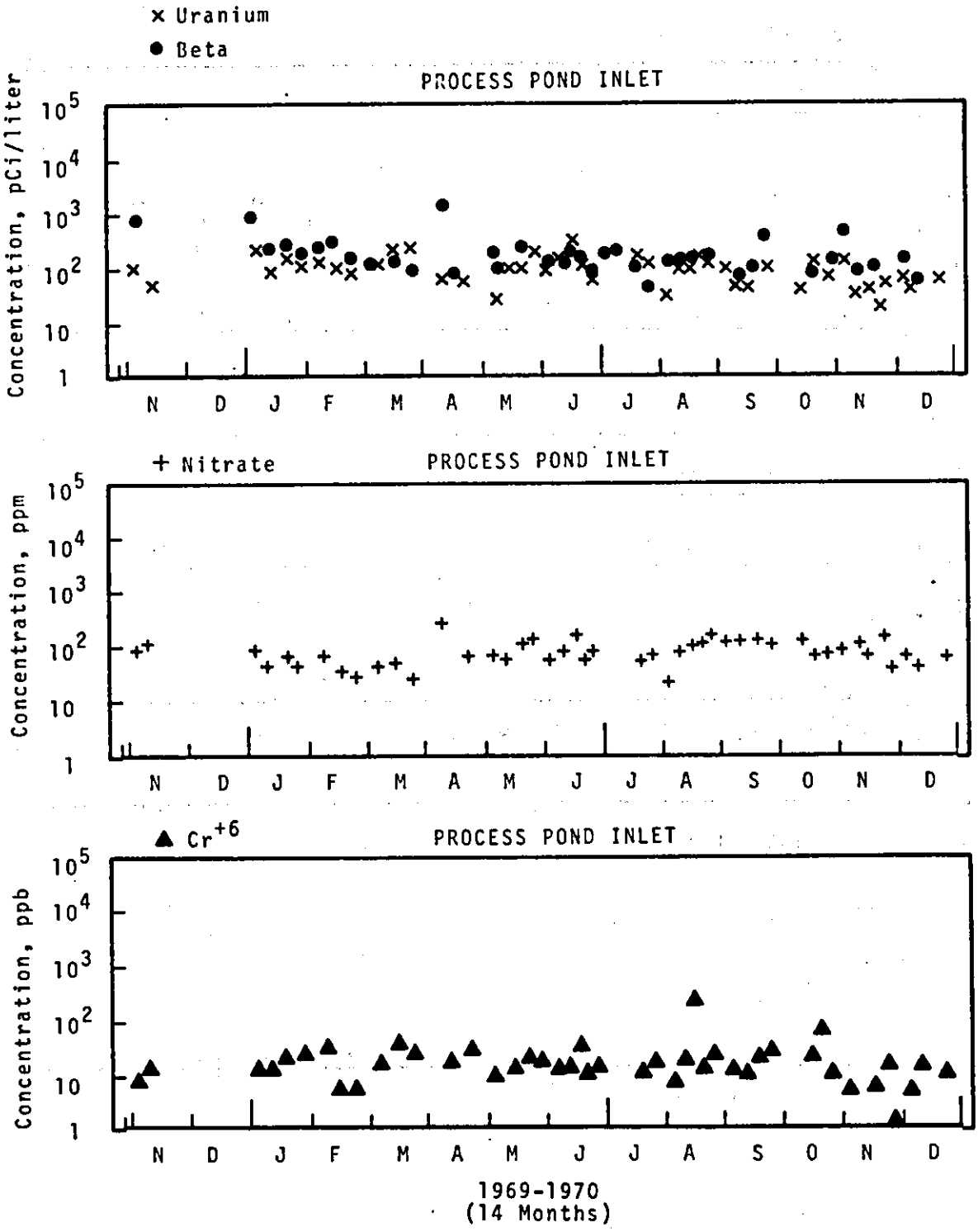

WASTE WATER ANALYSES
300 AREA
× Uranium
● Beta
PROCESS POND INLET
Concentration, pCi/liter
10^5
10^4
10^3
10^2
10
1
N D J F M A M J J A S O N D
+ Nitrate
PROCESS POND INLET
Concentration, ppm
▲ Cr^{+6}
PROCESS POND INLET
Concentration, ppb
1969-1970
(14 Months)

FIGURE 10

VI. GROUNDWATER

Results of the groundwater surveillance program for 1970 have been reported separately in BNWL-1539, "Radiological Status of the Groundwater Beneath the Hanford Project January-June 1970," and BNWL-1613, "Radiological Status of the Groundwater Beneath the Hanford Project July-December 1970."

VII. BIRDS AND MAMMALS

Upland gamebirds and waterfowl are sampled along the river in order to estimate radiation dose from this pathway. The results of this program are discussed in the report series, "Evaluation of Radiological Conditions In the Vicinity of Hanford for ...," the latest of which is BNWL-1669. Birds, primarily waterfowl, are also sampled near open waste disposal waters in order to maintain an awareness of the uptake of waste radionuclides by the predominantly resident fowl. Although mammals were not sampled routinely, several special samples were obtained during 1970, near liquid or solid radioactive waste disposal sites.

A. Waterfowl

On December 29, 1969, two ducks containing unusually high radionuclide concentrations were collected from the 100-K Trench. Filamentous algae in the gizzard of the bird containing the highest concentration of ^{32}P, the radionuclide of main concern from a population exposure standpoint, suggested trench biota to be the source of the radioactivity. Additional samples were taken to determine the prevalence of such unusually radioactive waterfowl. Analytical results are presented in Table 8.

A total of fourteen ducks and coot were collected in the vicinity of 100-K from December 29, 1969 through December 31, 1970. One duck, also unusually radioactive, was collected at the 100-N Trench. Of the fifteen waterfowl collected at these locations, seven contained ^{32}P concentrations in muscle greater than five times the maximum concentration found in any other birds collected during 1968 and 1969. It seems likely that such birds were local, not transient, and thus were unlikely to be taken by hunters. However, a discussion of the dose implications if they were to be shot and eaten is included in the above referenced annual report.

B. Deer

On March 26 a gravid doe and on April 7 a buck were shot as part of the environmental program. On May 20 and December 3 samples were obtained from road-killed does. Concentrations of several radionuclides found in muscle samples are presented in Table 9. These animals are assumed to be resident on the Hanford Plant, and therefore not available to hunters.

C. Small Animals

Prior to May 1970, small animals were not sampled as part of the routine environmental program. Since that time, routine sampling of mice, muskrats, and rabbits has been initiated in or near 100, 200, and 300 Area waste disposal sites. A few such samples were taken in 1970, the analytical results are presented in Table 10.

D. Radioactive Owl Pellets

While performing a land survey between 100-K and 100-BC, a small spot of low-level contamination was found in the abandoned Hanford Irrigation Project pumping station. The contamination is believed to have originated from pellets regurgitated by a great horned owl seen that day and subsequently in the Hanford Irrigation Project building. The major radionuclides identified in this sample were ^{60}Co, ^{65}Zn, ^{95}Zr-Nb, ^{106}Ru-Rh, and ^{144}Ce-Pr. Several days later, a great horned owl pellet measuring approximately 200 mrad/hr near the surface was found at the base of a tree in a grove upstream from 100-H. The following day, a pellet containing deer mouse bones measuring less than 1 mrad/hr was found near 100-F Area at the base of a tree in a grove known to be inhabited by a pair of great horned owls. Radionuclide concentrations measured in the 100-H and 100-F samples are listed in Table 11. Later in the year, after the deciduous trees had shed their leaves, an "owl pellet" survey was made of all areas within a mile of the river, from Hanford to Vernita. No additional radioactive pellets were found.

TABLE 8

CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN WATERFOWL

pCi/gram (wet weight)

Date	Species	^{32}P	^{46}Sc	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	^{103}Ru	^{106}Ru	^{137}Cs	^{144}Ce-Pr
Analytical Limit					0.25	0.15		0.15	0.2	0.002	1.6	1.6	0.1	
100 K TRENCH														
12-29-69	Mallard-Gadwall Cross	2,800				0.53		<0.15	42.				0.27	
12-29-69	Mallard-Gadwall Cross	110,000	450	7600		71.		12.	2900				95.	240
1-12-70	Gadwall	68,000	8.3	230		11.		4.1	1500				52.	
1-14-70	Widgeon	12							1.8				<0.1	
1-14-70	Widgeon	100				3.7		2.5	5.1				8.0	
1-15-70	Mallard	31,000				1.8		3.2	4.0				5.4	
1-15-70	Coot	80							29.				0.31	
1-16-70	Mallard	4							1.6				6.2	
1-16-70	Coot	2,900				1.0		0.35	52.				1.9	
1-21-70	Coot	130						<0.15	6.7				0.23	
1-22-70	Gadwall	7,900				3.5			320				1.5	
1-22-70	Coot	5							2.5				<0.1	
1-29-70	Mallard	2							1.5				<0.1	
4-2-70	Goldeneye	43	71.	6.2		9.5	1.6	7.6	47.				30.	7.8
100 N TRENCH														
3-6-70	Mallard	140,000			1100		68.	64.		29.			1600	1000
100 F TRENCH														
7-30-70	Mallard									4.9				
7-30-70	Mallard									30.				
7-30-70	Mallard									4.6				
7-30-70	Mallard									2.0				
8-28-70	Mallard	44							0.4	0.02			0.11	
B SWAMP														
3-14-70	Coot		85.	49		3.3	4.3	1.8	13.	<2.7			8.6	<5.4
3-17-70	Coot		0.17			1.2	<0.74		<0.2	0.10	<1.6		5.9	
3-18-70	Coot		0.31	<1.1				0.48		<0.45			0.71	<1.4

TABLE 8 (continued)

CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN WATERFOWL

pCi/gram (wet weight)

Date	Species	^{32}P	^{46}Sc	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	^{103}Ru	^{106}Ru	^{137}Cs	^{144}Ce-Pr
Analytical Limit					0.25	0.15		0.15	0.2	0.002	1.6	1.6	0.1	
B SWAMP (continued)														
3-19-70	Goldeneye								0.78	0.017			37.	
3-19-70	Goldeneye								<0.2	0.007			62.	
3-19-70	Mallard								<0.2	0.002			7.1	
3-19-70	Mallard								<0.2	0.004			6.3	
3-20-70	Bufflehead								<0.2	0.009			12.	
3-20-70	Bufflehead								<0.2	0.012			48.	
2-21-70	Bufflehead								<0.2	0.008			5.6	
3-21-70	Bufflehead								0.34	0.005			64.	
3-22-70	Coot								<0.2	<0.002			<0.1	
3-22-70	Coot								<0.2	<0.002			<0.1	
3-29-70	Coot		3.3				0.84	0.61	0.86	24.			7.8	25.
3-30-70	Coot		7.0				0.80	0.73		15.			7.1	20
4-8-70	Ruddy								<0.2	13.			0.49	<0.04
4-17-70	Coot								1.2	4.2			41.	<3.7
5-6-70	Coot								0.37	4.6			<0.1	
5-20-70	Mallard								0.25	3.4			11.	
5-20-70	Mallard Duckling								<0.76	170			<0.67	
6-10-70	Coot								1.2	5.7			6.2	
7-10-70	Coot								<0.2				3.1	
8-21-70	Coot								0.55	0.09			3.3	
8-28-70	Coot								1.3	0.79			1.9	
8-28-70	Coot								0.70	0.06			<0.1	
9-18-70	Coot								0.24	0.27			1.7	
10-22-70	Coot								1.0	0.75			1.5	
12-4-70	Coot								<0.2	0.42			0.78	
GABLE SWAMP														
3-17-70	Gr. Winged Teal		0.53		<0.25		0.39	0.88	<0.34	<1.0	<1.6		26.	<1.2
3-18-70	Bufflehead		0.58		0.33	<0.26	<0.39	0.68	<0.44	<3.2			91.	
3-18-70	Coot		0.87	<2.5	0.36		0.31	0.83	0.36	<0.65	<1.6		96.	<1.8
9-25-70	Coot								0.70	0.003			190	
11-20-70	Coot								0.58	0.019			260	

TABLE 8 (continued)

CONCENTRATIONS OF SEVERAL RADIONUCLIDES IN WATERFOWL

pCi/gram (wet weight)

Date	Species	^{32}P	^{46}Sc	^{51}Cr	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	^{103}Ru	^{106}Ru	^{137}Cs	^{144}Ce-Pr
Analytical Limit					0.25	0.15		0.15	0.2	0.002	1.6	1.6	0.1	
REDOX SWAMP														
3-13-70	Mallard		20.	7.6		0.6	1.1	0.51	2.5	0.24		2.2	0.2	
9-25-70	Widgeon								0.64	0.009			2.3	
12-4-70	Goldeneye								<0.2	0.014			23.	
T SWAMP														
3-16-70	Mallard		51.	0.88		0.9	1.2	1.0	2.7	<0.42	<1.6		26.	1.9
U SWAMP														
3-14-70	Coot		59.	31.		2.0	2.8	1.3	11.	<0.67	<1.6		48.	3.0
3-14-70	Coot		24.	12.		0.88	2.0	1.7	4.4	<0.59	<1.6		130	<4.7
3-16-70	Wood Duck		49.	21.	<0.42	1.0	2.2	0.94	7.9	<0.48	<1.6		0.3	2.2
3-18-70	Goldeneye		0.34	<1.6	<0.25		<0.40	0.67	<0.36	<2.7	<1.6		10.	<1.1
3-18-70	Mallard		0.28	<0.23	<0.25		0.32	0.39	<0.2	<0.14			0.21	
3-19-70	Mallard								<0.2	0.006			43.	
3-19-70	Mallard								<0.2	0.01			45.	
3-20-70	Mallard								<0.2	<0.002			0.63	
3-20-70	Gadwall								<0.2	0.002			5.0	
3-21-70	Mallard								<0.2	<0.002			0.19	
3-22-70	Coot								<0.2	0.01			1.4	
3-22-70	Ruddy Duck								<0.2	<0.002			14.	
9-25-70	Mallard								<0.2	0.006			100	
10-26-70	Mallard								<0.2	0.006			58.	
300 AREA POND														
3-17-70	Mallard		0.13	<0.40	0.26		0.25	0.42	2.1	<1.6	<1.6		<0.1	<0.43
3-17-70	Mallard		0.06	<0.49	0.29		0.52	0.45	2.7	<1.6			<0.1	
12-3-70	Mallard		<0.02	<0.25				<0.15	3.9				<0.1	<1.8
12-4-70	Mallard		0.03	<0.38					0.83					

TABLE 9

CONCENTRATION OF SEVERAL RADIONUCLIDES IN DEER MUSCLE
pCi/gram (wet weight)

Location	Date	Species	^{32}P	^{46}Sc	^{51}Cr	^{54}Mn	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs	^{144}Ce-P
100 N	3-26-70	Gravid Deer	<15	0.24	<0.51	0.40	0.30	1.0	9.6		0.25	<0.82
100 N	3-26-70	Fetus	<3.4	0.10		<0.13			1.4		0.11	
North of Gable Mountain	4-7-70	Buck Deer	<6.8	<0.03				<0.04	1.0	0.054	<0.05	<0.53
Route 45, Mile 4.5 (Road Kill)	5-20-70	Doe Deer							0.05	0.012	1.5	
Route 2N, Mile 1	12-3-70	Doe Deer			0.4				0.79	0.15	0.089	

TABLE 10

CONCENTRATION OF SEVERAL RADIONUCLIDES IN SMALL ANIMALS*

pCi/gram (wet weight)

Location	Date	Species	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs	U (µg/g)
South of BC Crib	5-7-70	Rabbit		0.68		2.3	
105 N	5-11-70	Muskrat		14.0		5.2	
NW of B Swamp	5-18-70	Rabbit			0.22		
100 F	5-25-70	Muskrat		0.23	0.90	<-0.039	
216-2-11 Ditch	9-2-70	Muskrat #3		<0.099		220.	
216-2-11 Ditch	9-2-70	Muskrat #4		<0.40		92.	
216-2-11 Ditch	9-2-70	Muskrat #5		1.0		200.	
300 W Burial Ground	12-15-70	Rabbit		0.24		0.26	$<5 \times 10^{-4}$
107 H	12-21-70	Mice (4)	0.67	5.9	1.3	2.7	
Army Camp SW of 200 W Area	12-23-70	Rabbit		0.72	0.021	0.53	

* Muscle analyzed except for mice, which are homogenized for analysis.

TABLE 11

RADIONUCLIDE CONCENTRATIONS IN OWL PELLETS
(μCi/g)

	Above 100-H	Near 100-F
^{32}P	Not Significant	$1.2 \times 10^{-5} \pm 9.2 \times 10^{-6}$
^{54}Mn	10.2	
^{58}Co	Trace	
^{59}Fe	1.5 ±0.31	
^{60}Co	25.5	0.11
^{90}Sr	0.64	0.026
$^{95}ZrNb$	4.5	
^{106}Ru	1.8 ±1.7	
^{124}Sb	0.45 ±0.26	
^{137}Cs	0.17 ±0.11	
^{141}Ce	0.30 ±0.29	
$^{144}Ce\text{-}Pr$	6.0 ±2.5	
^{154}Eu	Trace	
^{155}Eu	Trace	
^{233}Pa	Trace	
^{239}Pu	0.0085	$<1.1 \times 10^{-5}$

VIII. AIRBORNE RADIOACTIVITY

Results of routine sampling of the atmosphere for radioactivity at 19 locations within the Hanford Reservation (Map 4) are presented in Fugures 11 through 24. For comparison, data from 18 offsite locations (Map 5) are included in the following discussion. (Sampling for chemical pollutants in the atmosphere is conducted and reported by the Hanford Environmental Health Foundation.)

The sampling equipment, sheltered in small buildings, draws air at a flow rate of 2.5 m^3/hr (1.5 cfm) through HV-70 or, beginning in July 1970, through Acropor filter paper, and then through activated charcoal cartridges or a caustic scrubber for radioiodine collection. The normal sampling period was one week through June, but beginning in July, several of the sampling locations were changed to a biweekly schedule. "Total beta" represents the gross beta activity (^{90}Sr-Y calibration) and "total alpha" represents the gross alpha activity (^{239}Pu calibration) of particulates collected on the filter paper during the sampling period.

Table 12 shows the average ^{131}I, particulate total beta, and particulate total alpha activity in air at various locations. Results of gamma scans, gross alpha, and gross beta analyses on selected environmental air filters are presented in Table 13. Concentration Guides shown are taken from AECM 0524, Annex A, Table II, Column 1 and are applicable to individuals not occupationally exposed.

A. Iodine-131

Concentrations of ^{131}I in the atmosphere, as measured with caustic scrubbers, during the first 6 months of 1970 averaged about 0.01 pCi/m^3 at most locations. Exceptions were the 300 Area with an average of 0.03 pCi/m^3, three locations (Midway, 200-East Southeast and Ringold) with averages of about 0.02 pCi/m^3 and 200-West East Center with an unusually low average of 0.002 pCi/m^3. As measured in charcoal samples, the average concentration of ^{131}I during the last half of the year was about 0.08 pCi/m^3. Concentration averages at individual sampling locations ranged from 0.03 (Kennewick) to 0.12 (Berg Ranch) pCi/m^3. The highest monthly average, 0.35 pCi/m^3, occurred in December at 200 WEC.

The maximum individual concentrations measured during this reporting period were 0.45 and 0.52 pCi/m^3, noted in December at 200 West East Center Area. For comparison the maximum ^{131}I concentration measured during the last six months of 1969 was 0.7 pCi/m^3 at the 300 Area.

The apparently increased concentrations during the last half of the year result from the greater collection efficiency of charcoal for organic-bound iodine.

B. Total Beta

During the first half of the year, environmental air filters from 19 onsite locations and 15 offsite locations were examined weekly for total beta activity. During the last half, the numbers of onsite and offsite locations changed to 16 and 18 respectively. Table 12 shows the average ^{131}I and particulate total beta activity in air at various locations, and Table 13 presents results of gamma energy analyses of selected filters.

At most locations, both onsite and offsite, beta activity increased by about a factor of ten during the first half of the year and then decreased by a slightly smaller factor by the end of the year. Concentrations in and near the 100 Areas were quite uniform during any given period, indicating the lack of a significant source at the 100-K or 100-N Areas. This also was true of the 200 Areas, except for the 200 EEC and ENC locations, which were affected by 200 East Area waste disposal operations. The maximum measured concentration, 3.7 pCi/m^3, occurred in February at the 200 ENC location. Monthly average concentrations measured in the 100 and 200 Areas generally ranged from about 0.1 to 1.0 pCi/m^3 during the year. Annual average concentrations ranged from 0.4 to 0.5 and 0.4 to 1.8 pCi/m^3 in the 100 and 200 Areas, respectively.

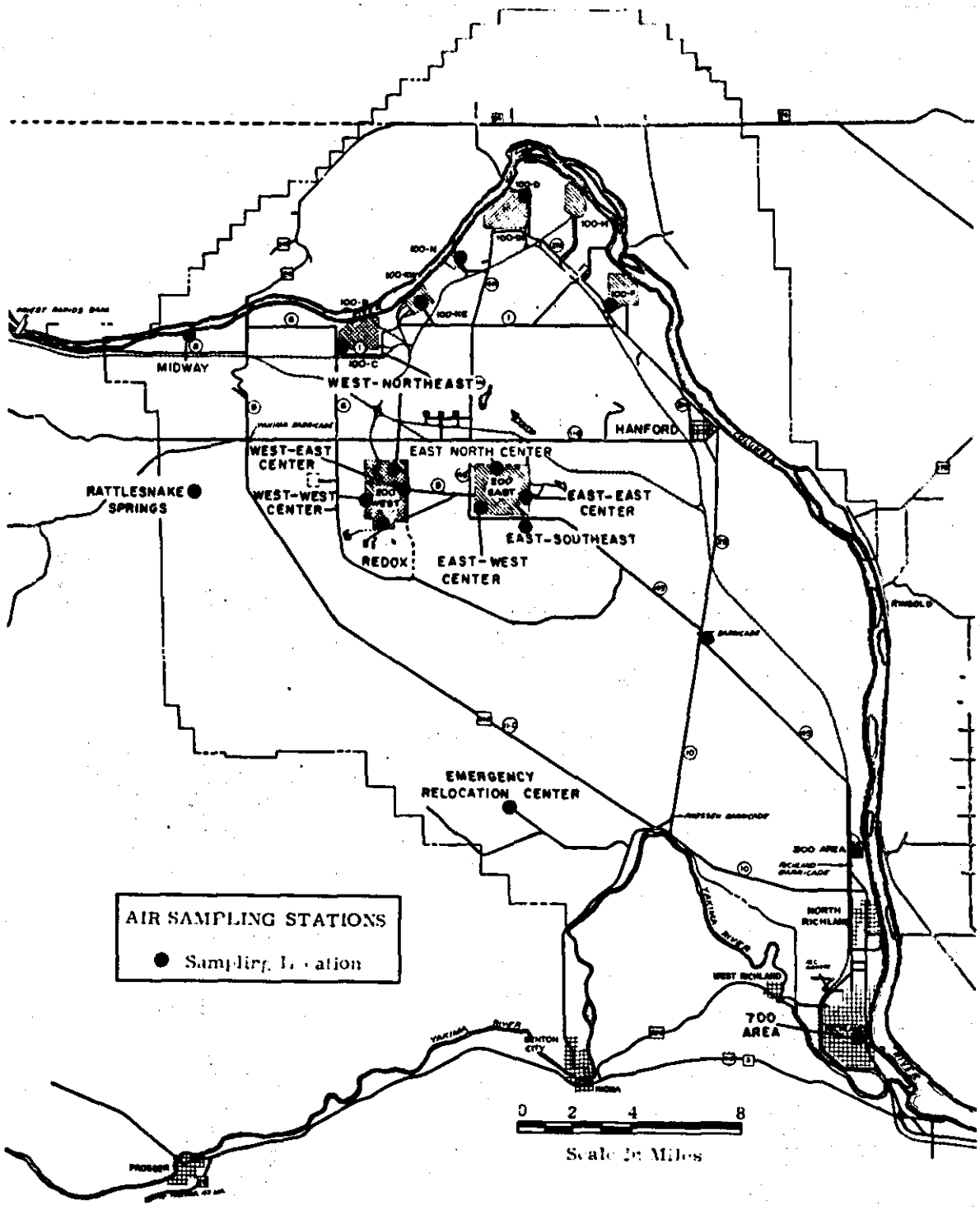
The maximum measured concentration at an offsite location, 1.2 pCi/m^3, occurred in July at Byer's Landing. Monthly average concentrations measured at offsite locations generally ranged from about 0.1 to 1.0 pCi/m^3 during the year. Annual average concentrations at offsite locations ranged from about 0.2 to 0.4 pCi/m^3.

C. Total Alpha

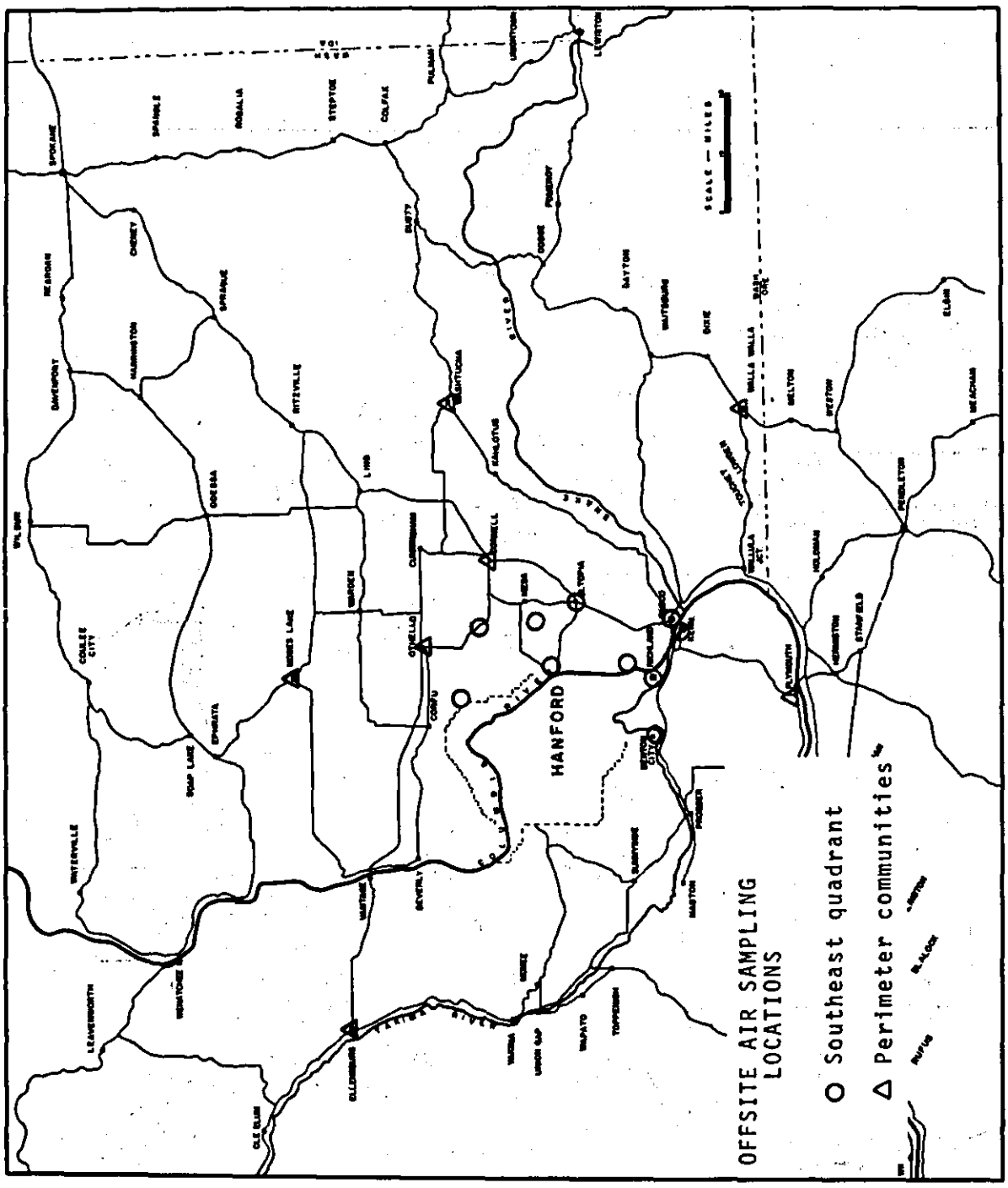
Twenty-five of the weekly filters analyzed for beta-gamma emitting radionuclides were also analyzed for alpha activity, but about half of these were analyzed for only half of the year. These data are presented in Figures 18 through 24. Measurements of atmospheric alpha activity at 100-F, Rattlesnake Springs, 200 West Northeast, 200 West West Center, 200 East West Center, and 200 East East Center were discontinued at the end of June. Measurements began in July at New Moon, Othello, Walla Walla, Yakima Barricade, 100-K, Hanford, Kennewick, and Pasco.

Alpha counting of the filters was normally performed after seven days to allow for the decay of short-lived activity from naturally occurring radon and thoron daughters. Because the analytical limit for total alpha concentrations (0.01 pCi/m^3) is a significant fraction of the Concentration Guide for ^{239}Pu in air for individuals in uncontrolled areas (0.06 pCi/m^3) results only slightly above the analytical limit are of interest.

Total alpha concentrations during 1970 averaged about 0.01 pCi/m^3 at most locations. Monthly averages at several locations occasionally reached 0.03 pCi/m^3. In general, concentrations (both onsite and offsite), which were low early and late in the year, peaked during the summer at about 0.02 to 0.03 pCi/m^3. This fluctuation is believed unrelated to Hanford operations. On several occasions, weekly average concentrations at that location exceeded 0.1 pCi/m^3, reaching a maximum of 0.18 pCi/m^3 on two occasions in the fall.


MIDWAY
WEST-NORTHEAST
HANFORD
WEST-EAST CENTER
EAST NORTH CENTER
RATTLESNAKE SPRINGS
WEST-WEST CENTER
EAST-EAST CENTER
EAST-SOUTHEAST
REDOX
EAST-WEST CENTER
EMERGENCY RELOCATION CENTER
AIR SAMPLING STATIONS
Sampling Location
700 AREA
0 2 4 8
Scale In Miles

MAP 4


OFFSITE AIR SAMPLING LOCATIONS
O Southeast quadrant
Δ Perimeter communities
HANFORD
SCALE — MILES

MAP 5

TABLE 12

AVERAGE ^{131}I, PARTICULATE TOTAL BETA, & PARTICULATE TOTAL ALPHA CONCENTRATIONS IN THE ATMOSPHERE

(pCi/m^3)

	^{131}I (100 pCi/m^3)†				
Location	1967	1968	1969	Jan-June 1970*	July-Dec 1970**
100 Areas	0.02	0.02	0.01	0.007	0.06
200 Areas	0.09	0.03	0.01	0.01	0.09
Other Onsite Locations	0.04	0.02	0.02	0.02	0.08

	Total Beta			
	1967	1968	1969	1970
100 Areas	0.34	0.30	0.33	0.43
200 Areas	0.41	0.28	0.53	0.65
Other Onsite Locations	0.26	0.20	0.28	0.35

	Total Alpha			
	1967	1968	1969	1970
100 Areas	0.01	0.006	0.007	0.01
200 Areas	0.01	0.008	0.01	0.02
Other Onsite Locations	0.009	0.01	0.008	0.01

ND - No Data

* Scrubbers
** Charcoal Cartridges
† Most restrictive control guide - 100 pCi/m^3.

TABLE 13

AVERAGE CONCENTRATION OF GAMMA EMITTERS, TOTAL ALPHA, & TOTAL BETA ACTIVITY ON SELECTED AIR FILTERS - 1970

pCi/m^3

	$^{95}ZrNb$	^{106}Ru	^{137}Cs-^{137m}Ba	$^{140}BaLa$	$^{144}CePr$	Total Alpha	Total Beta
Most Restrictive Control Guide	1000	200	500	1000	200		
Inner Ring	0.07*	0.12*	0.005*	0.014*	0.14*		
Wye Barricade							0.41
100 F						0.009+	0.46
Hanford						0.01*	0.31*
100 D							0.46
Yakima Barricade						0.01*	0.30*
Rattlesnake Spring	0.09	0.16	0.009	0.05	0.16	0.01+	0.33
ERC							0.29
Vernita Bridge							0.28*
Wahluke Slope #2							0.35*
SE Quadrant	0.06*	0.13*	0.005*	0.02*	0.13*		
Benton City						0.01	0.32
Richland	0.07*	0.15*	0.01*	0.07*	0.17*	0.01	0.37
Kennewick						0.01*	0.23*
Pasco						0.02*	0.37
Byers Landing	0.08	0.15	0.01	0.04	0.16	0.01	0.35
Eltopia							0.34
Ringold	0.05	0.15	0.009	0.02	0.10	0.01	0.31
New Moon						0.01*	0.26
Connell							0.24*
Othello						0.01*	0.26*
Berg Ranch						0.01	0.27
Wahluke Watermaster							0.31*
Midway							0.33+
Perimeter Communities	0.07*	0.12*	0.005*	0.02*	0.13*		
McNary							0.33
Walla Walla						0.02*	0.33
Washtucna							0.38
Moses Lake							0.31
Ellensburg							0.21
Sunnyside							0.33

TABLE 13 (Continued)

AVERAGE CONCENTRATION OF GAMMA EMITTERS, TOTAL ALPHA, & TOTAL BETA ACTIVITY ON SELECTED AIR FILTERS - 1970

pCi/m^3

	$^{95}ZrNb$	^{106}Ru	^{137}Cs-^{137m}Ba	$^{140}BaLa$	$^{144}CePr$	Total Alpha	Total Beta
Active Areas	0.08*	0.09*	0.08*	0.04*	0.16*		
200 ENC	0.14	-0.28	1.3	0.14	0.35	0.05	1.8
200 ESE						0.01	0.44
200 WEC						0.02	0.40
Redox						0.02	0.40
100 N						0.01	0.36
100 K	0.08	0.14	0.12	0.08	0.13	0.02*	0.44
300						0.02	0.44
100 B							0.42†
200 WNE						0.01†	0.33†
200 WWC						0.01†	0.38†
200 EWC						0.01†	0.46†
200 EEC						0.02†	0.74†

* July-December Average

† January-June Average

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

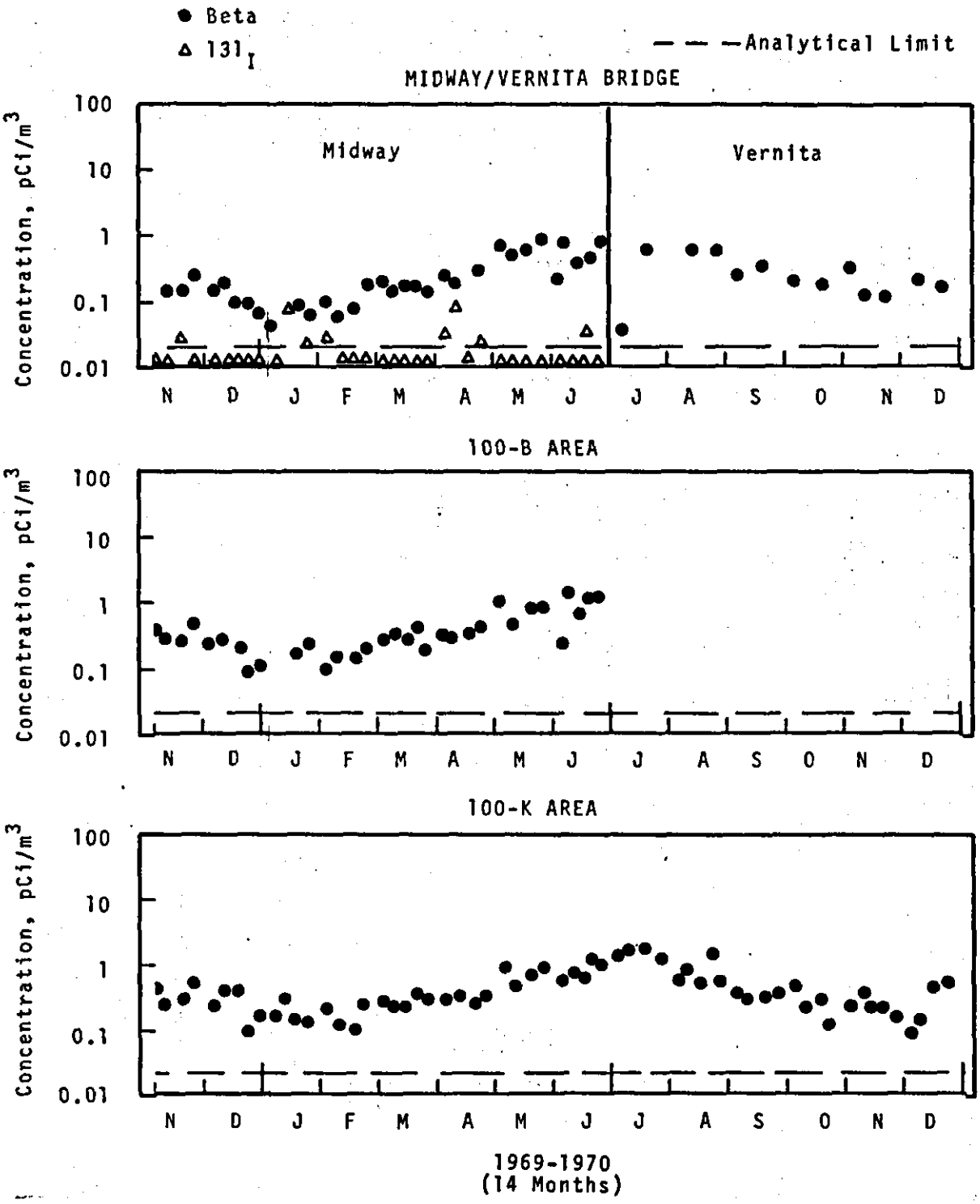


FIGURE 11

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

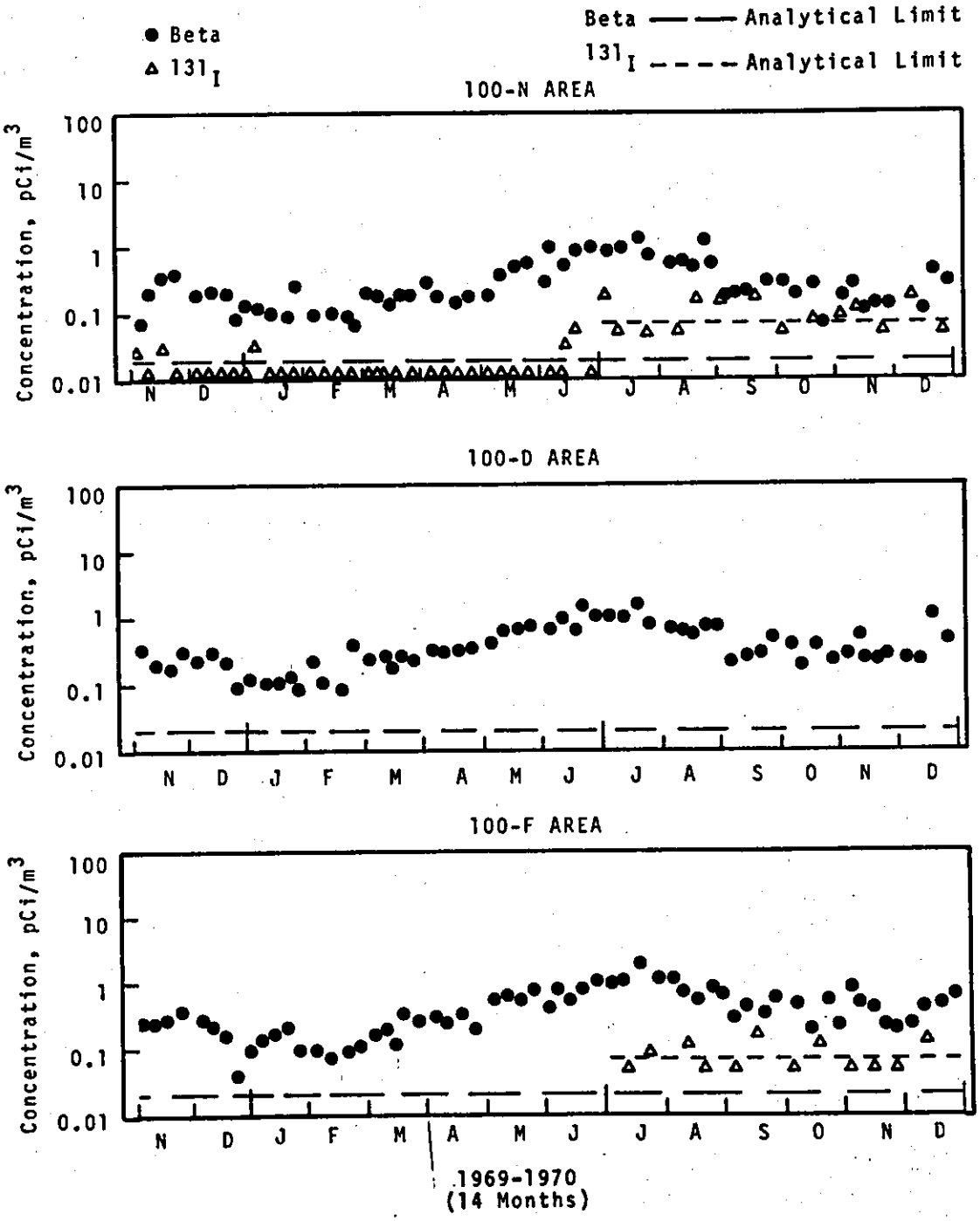


FIGURE 12

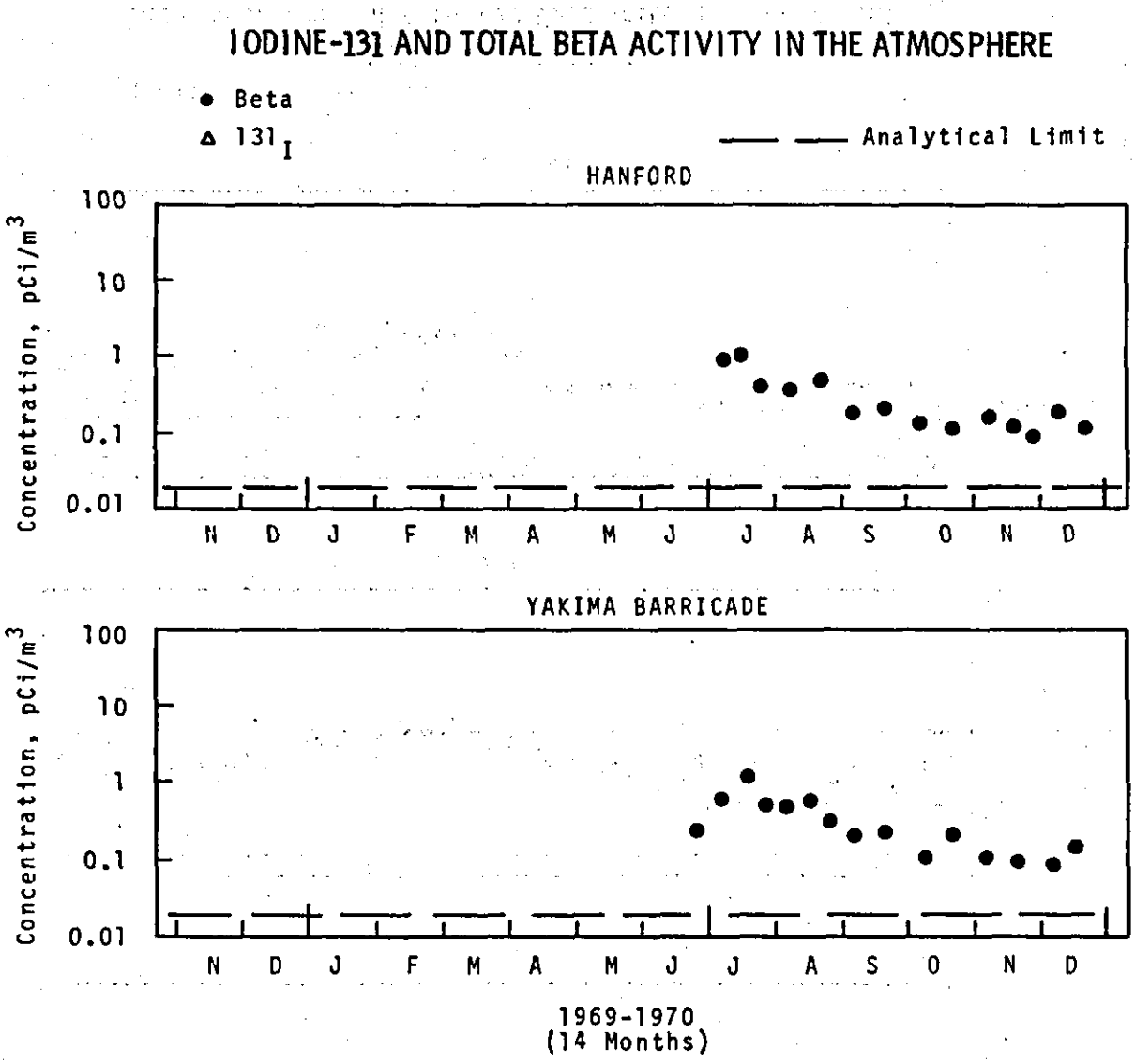

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
● Beta
△ ^{131}I
Analytical Limit
HANFORD
Concentration, pCi/m^3
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
YAKIMA BARRICADE
Concentration, pCi/m^3
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 13

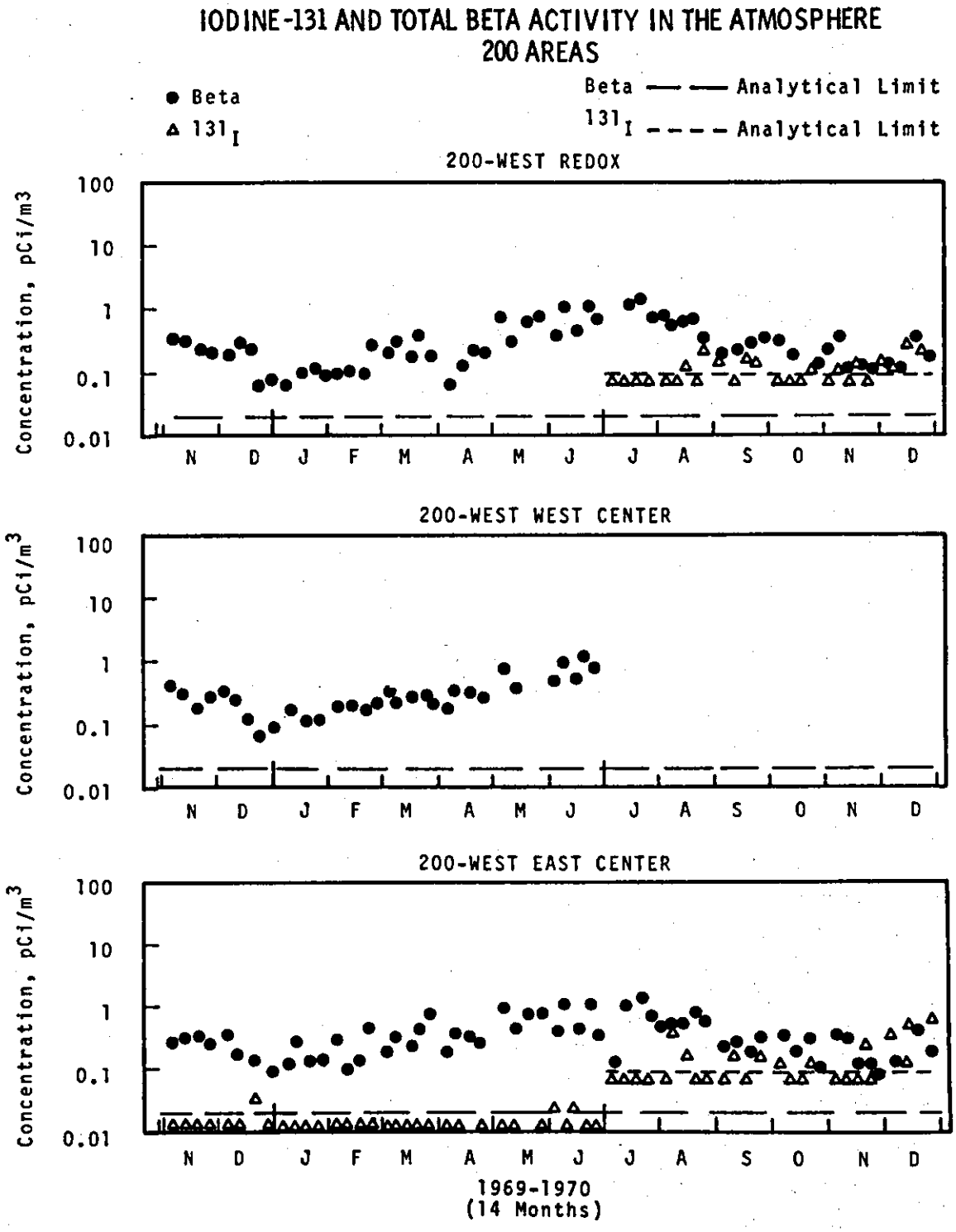

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS
● Beta
△ 131I
Beta —— —— Analytical Limit
131I - - - - Analytical Limit
200-WEST REDOX
200-WEST WEST CENTER
200-WEST EAST CENTER
Concentration, pCi/m3
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 14

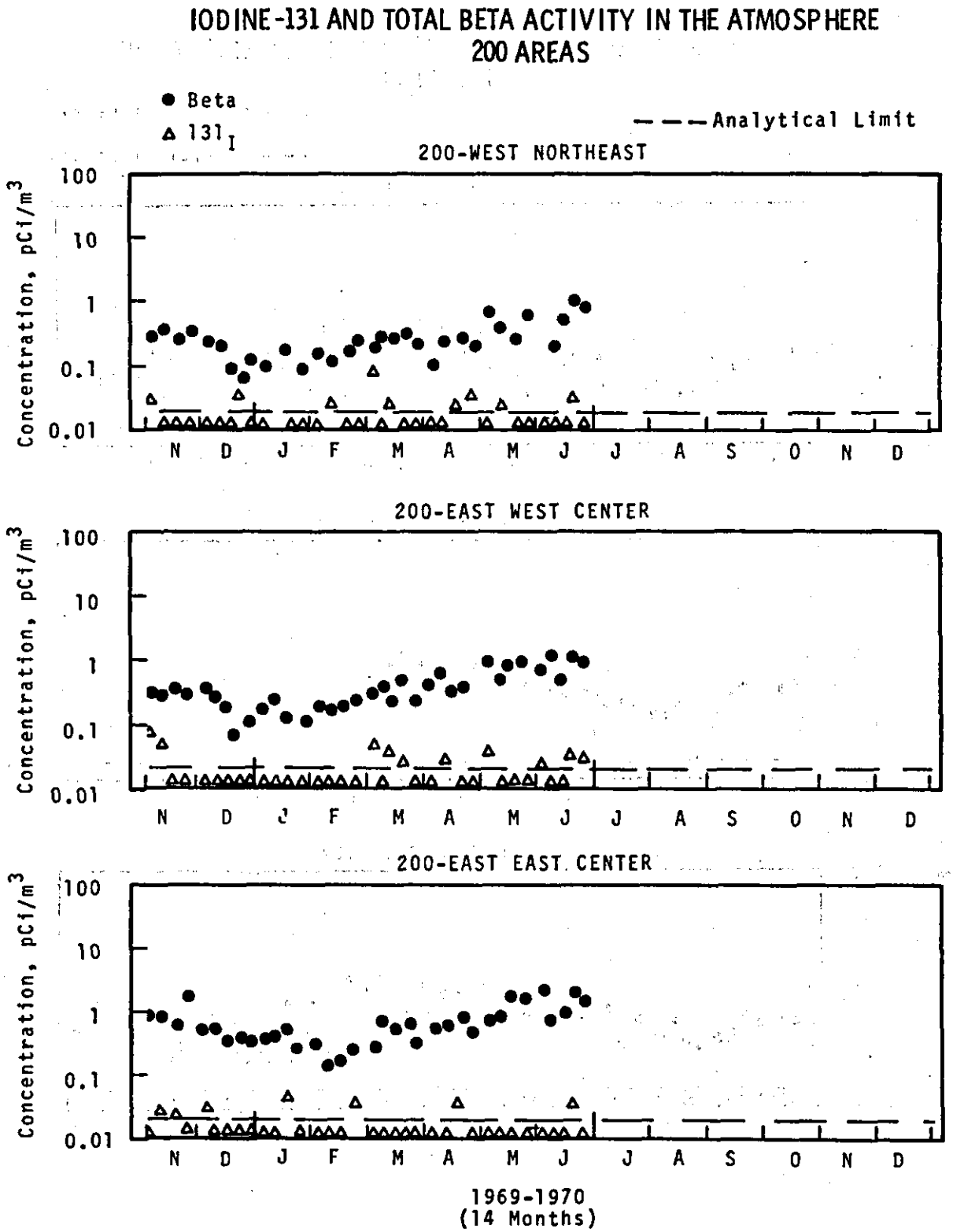

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS
● Beta
△ 131I
Analytical Limit
200-WEST NORTHEAST
200-EAST WEST CENTER
200-EAST EAST CENTER
Concentration, pCi/m3
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 15

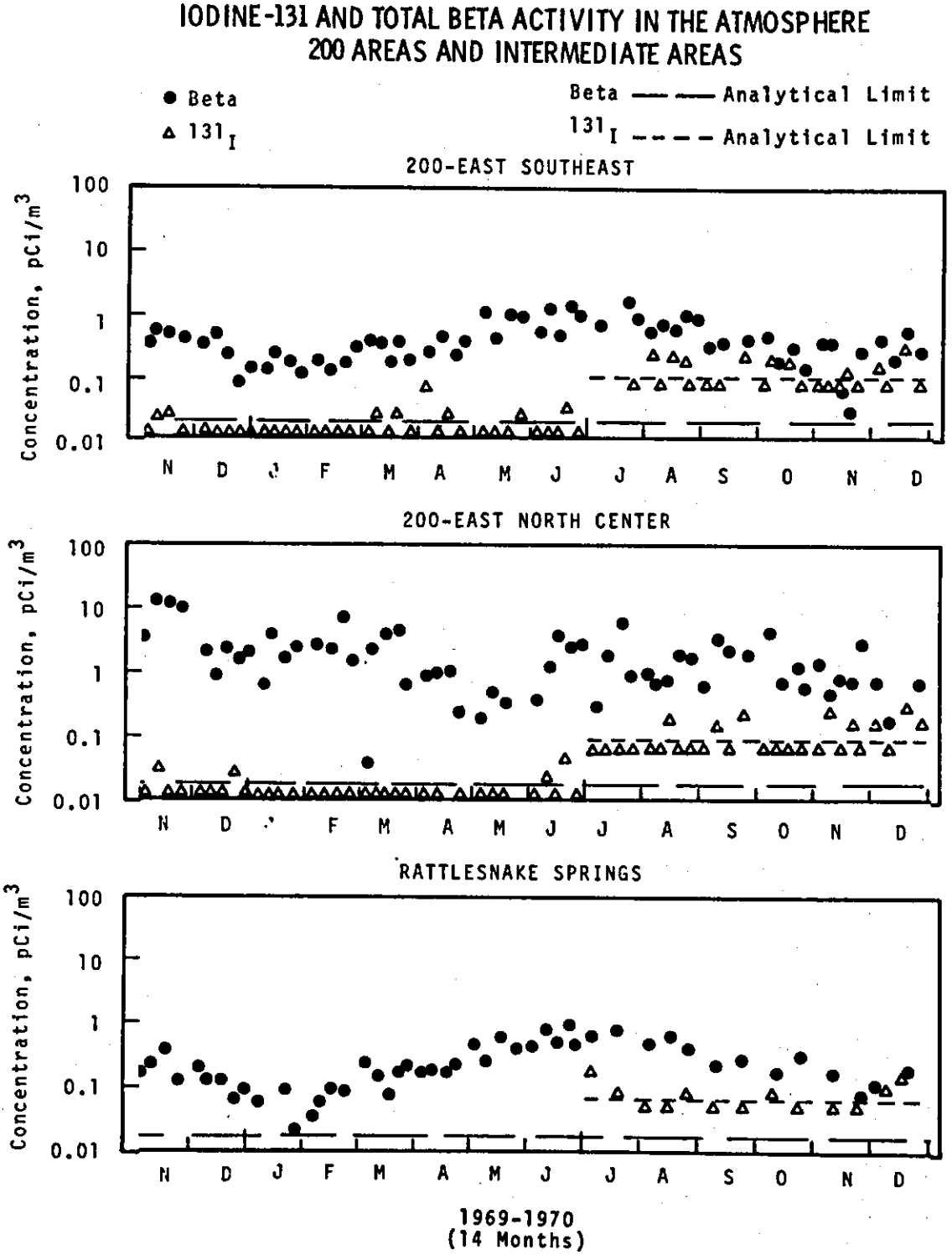

IODINE-131 AND TOTAL BETA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND INTERMEDIATE AREAS
● Beta
△ 131I
Beta —— —— Analytical Limit
131I - - - - Analytical Limit
200-EAST SOUTHEAST
200-EAST NORTH CENTER
RATTLESNAKE SPRINGS
Concentration, pCi/m3
100
10
1
0.1
0.01
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 16

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

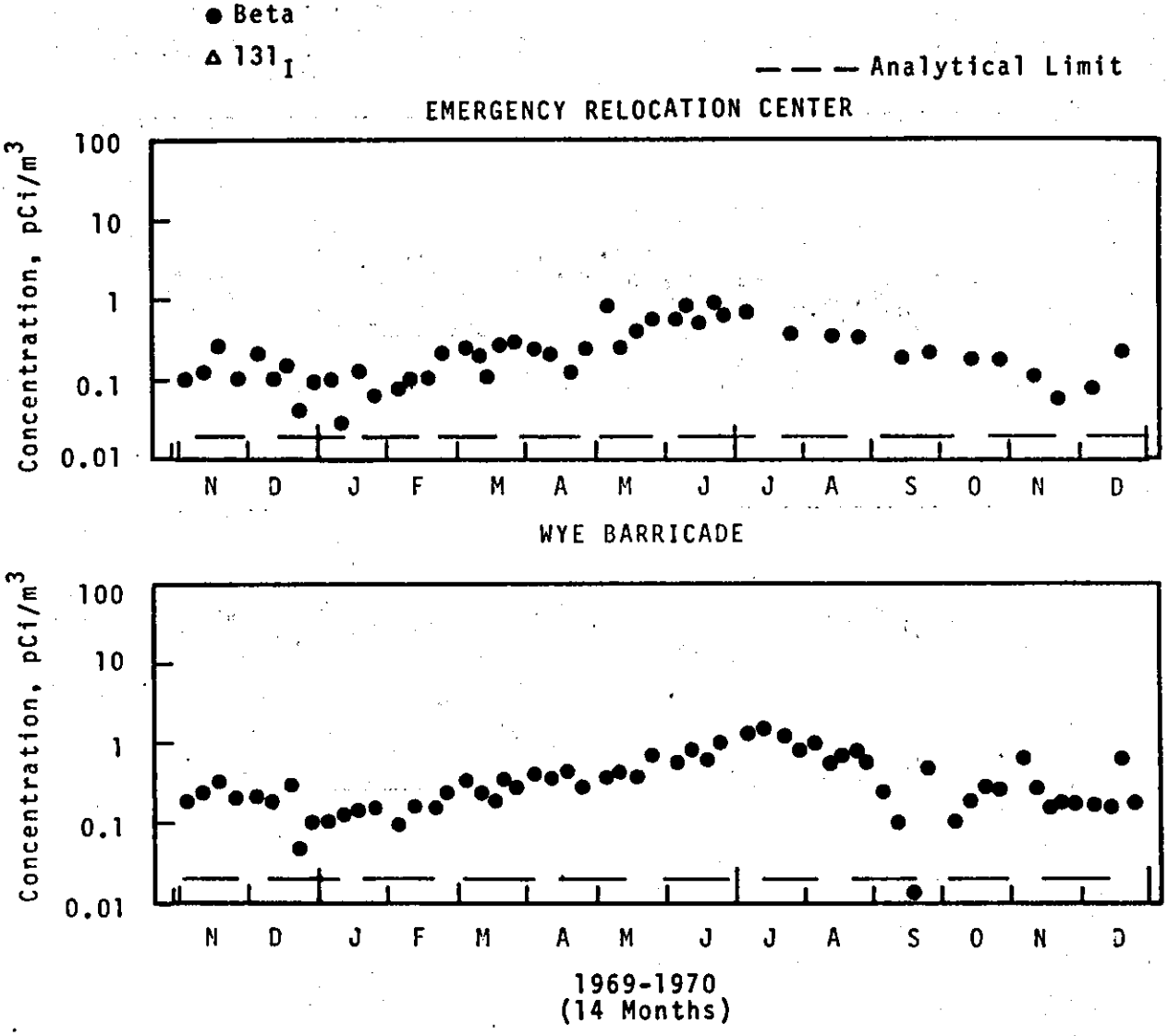


FIGURE 17

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

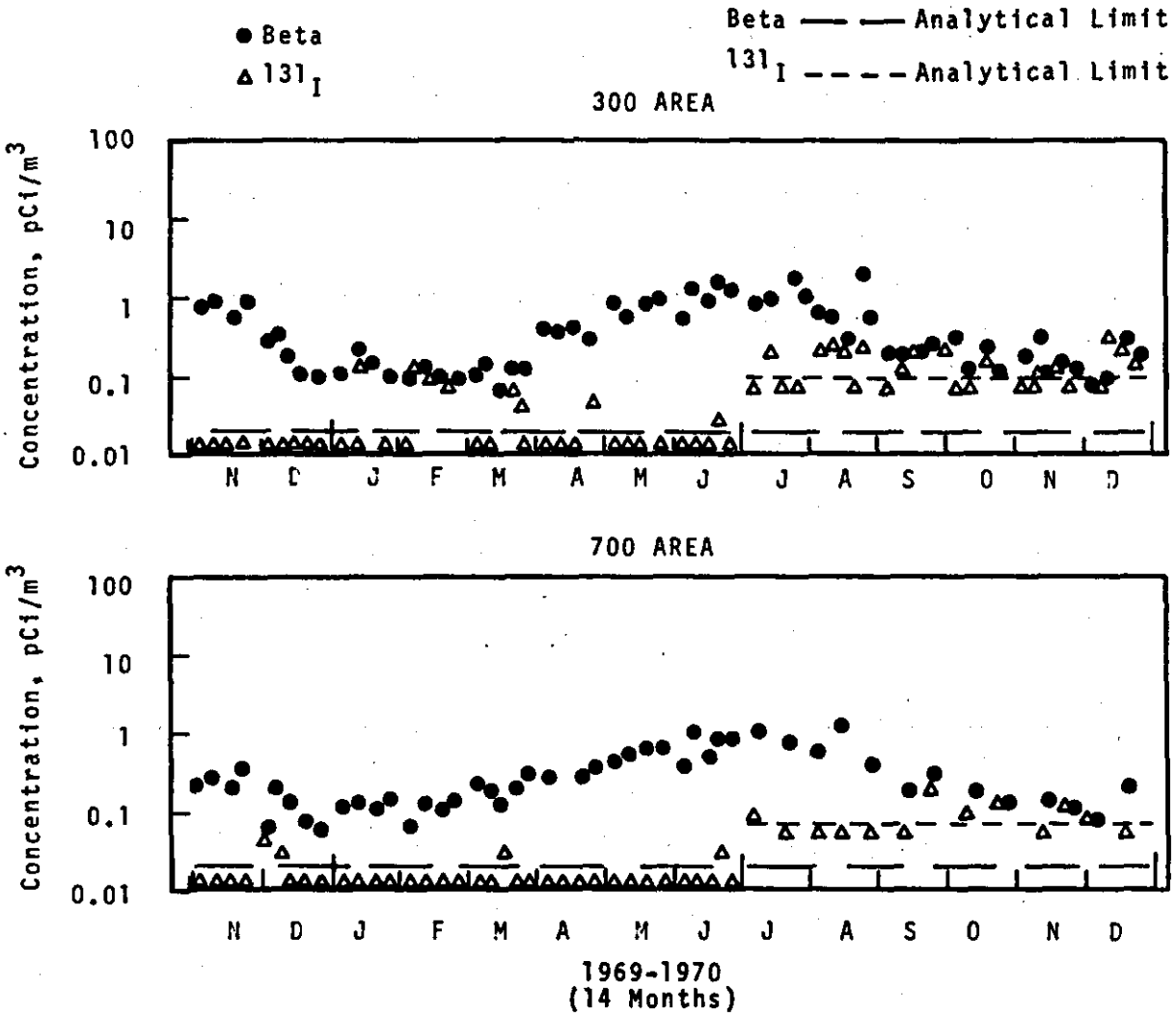


FIGURE 18

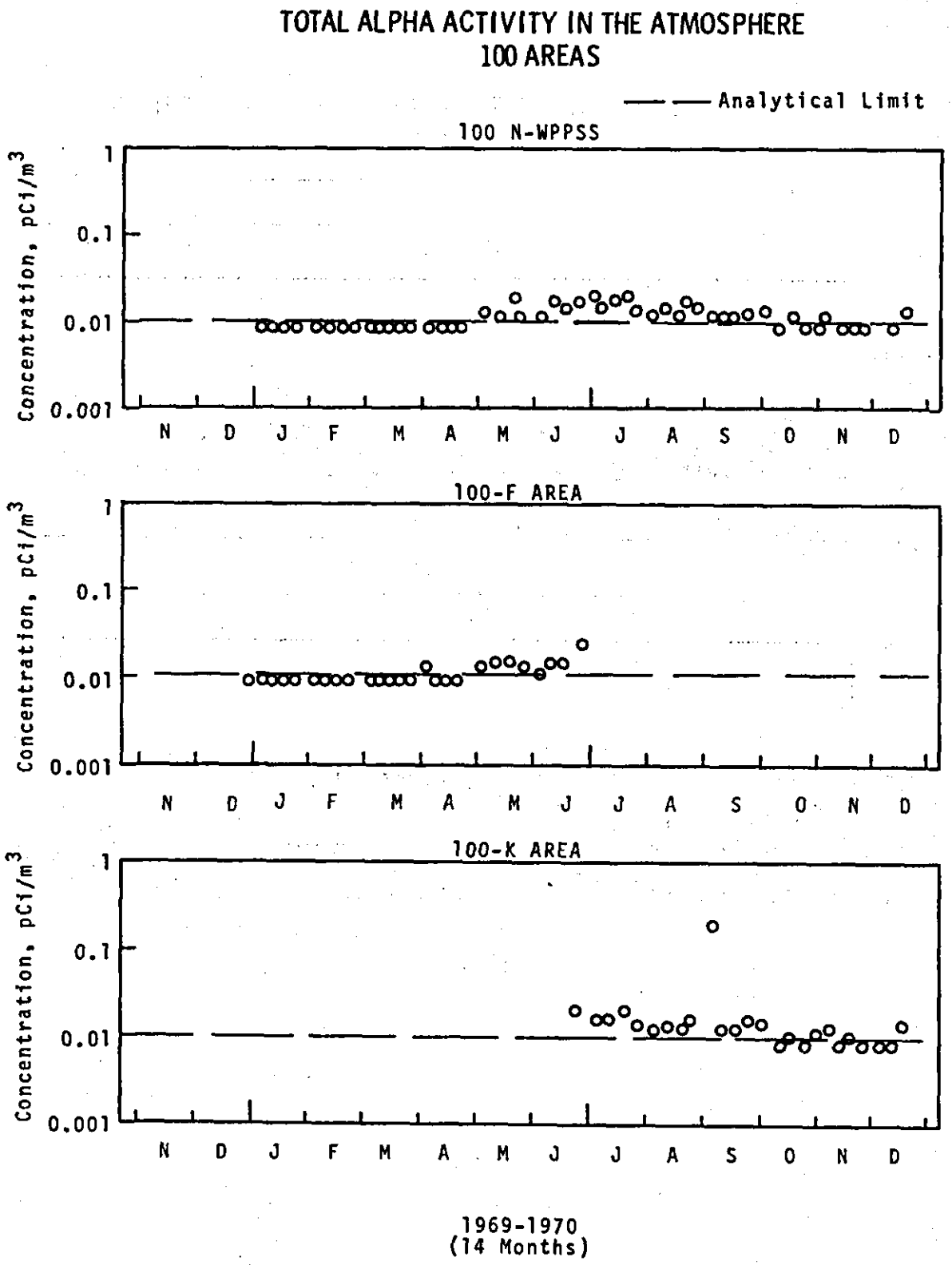

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
100 AREAS
Analytical Limit
100 N-WPPSS
100-F AREA
100-K AREA
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 19

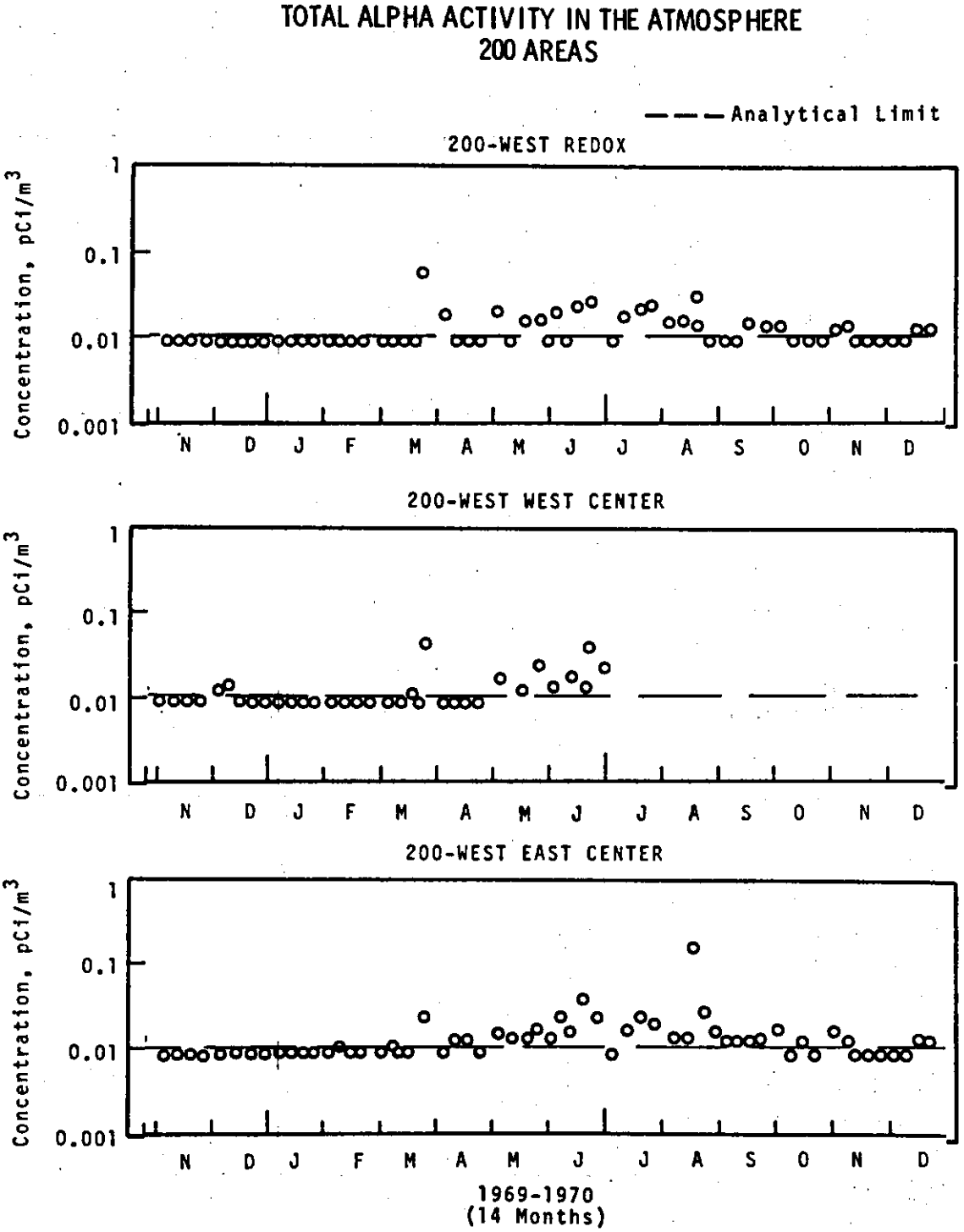

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS
Analytical Limit
200-WEST REDOX
200-WEST WEST CENTER
200-WEST EAST CENTER
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 20

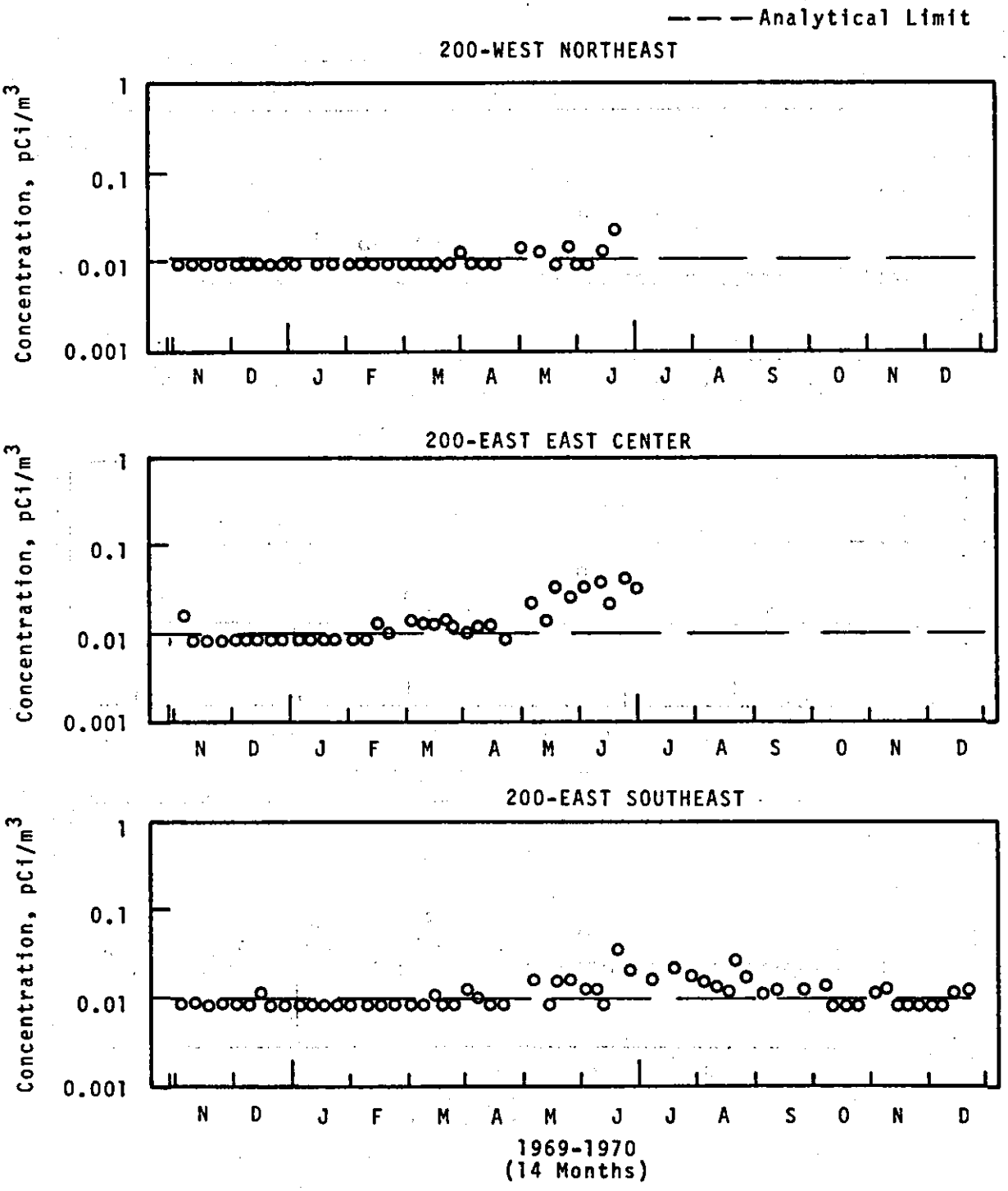

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS
Analytical Limit
200-WEST NORTHEAST
200-EAST EAST CENTER
200-EAST SOUTHEAST
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 21

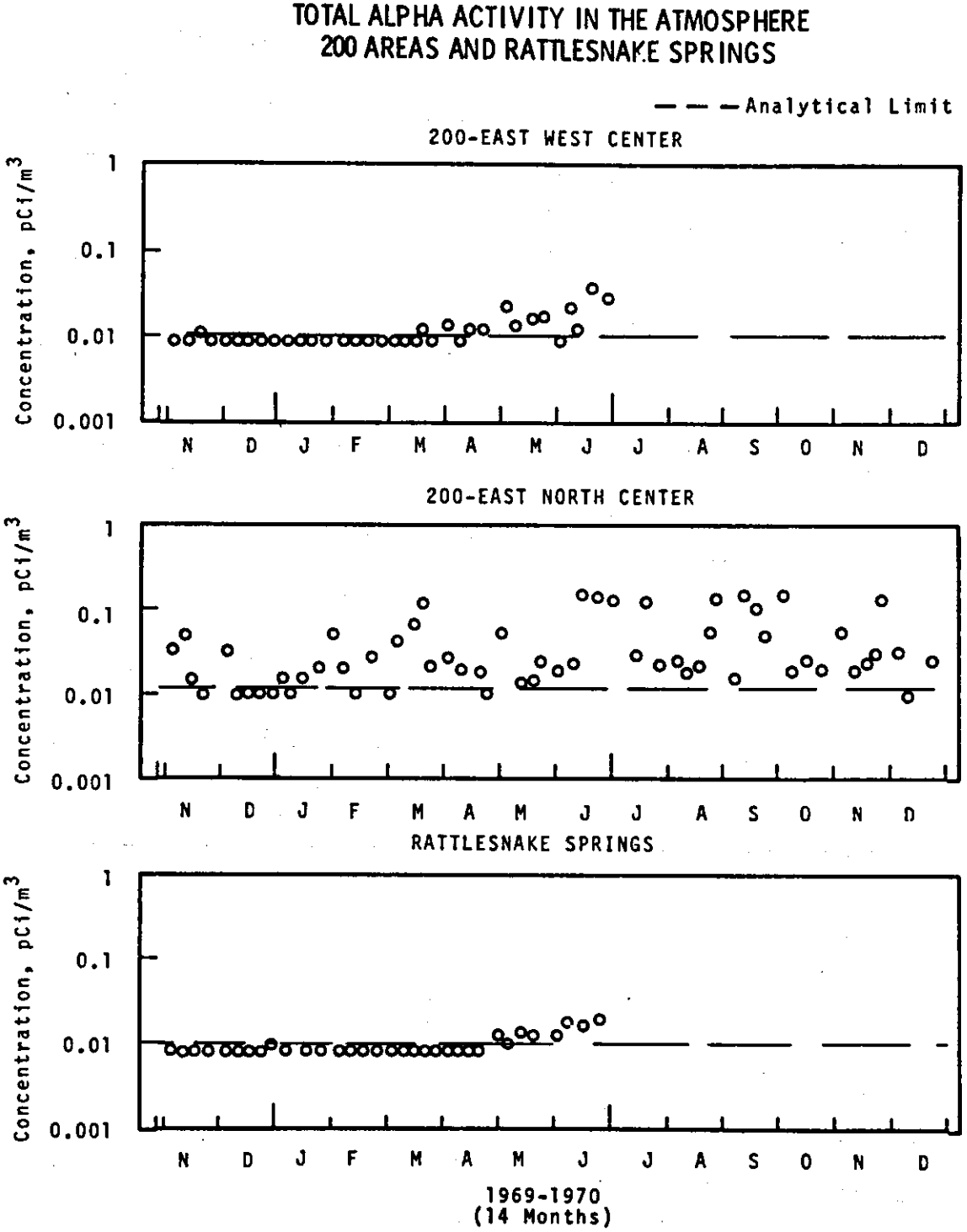

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
200 AREAS AND RATTLESNAKE SPRINGS
— — — Analytical Limit
200-EAST WEST CENTER
200-EAST NORTH CENTER
RATTLESNAKE SPRINGS
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 22

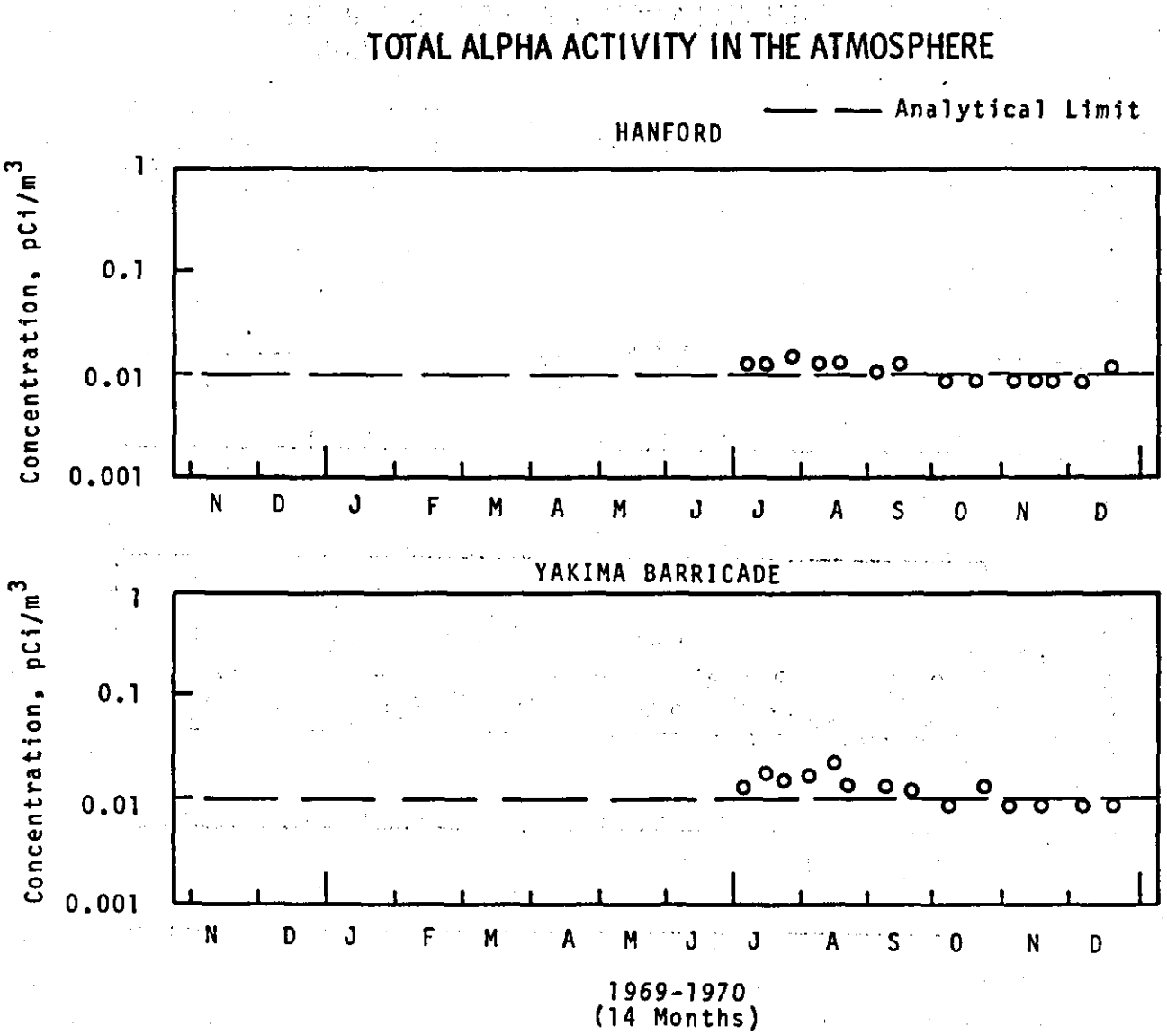

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
Analytical Limit
HANFORD
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
YAKIMA BARRICADE
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 23

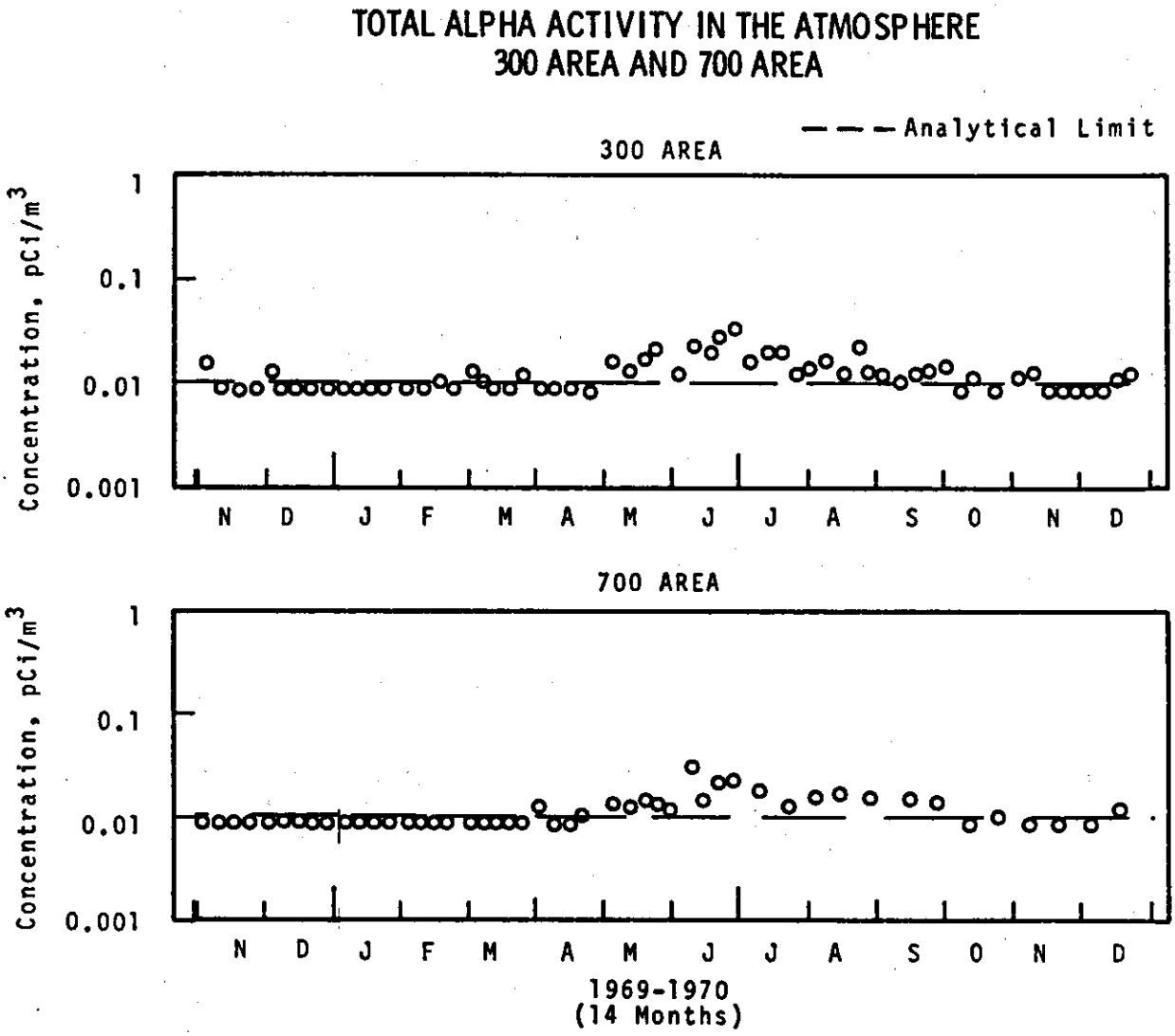

TOTAL ALPHA ACTIVITY IN THE ATMOSPHERE
300 AREA AND 700 AREA
Analytical Limit
300 AREA
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
700 AREA
Concentration, pCi/m3
1
0.1
0.01
0.001
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 24

IX. RADIATION SURVEYS

A. Surface Contamination

1. Hanford Roads

Hanford roads are routinely surveyed (Map 6) with a bioplastic scintillation detector attached to the front end of a truck and positioned about 0.6 meter (2 ft.) above the road surface. This road monitor has been described in BNWL-62. Most roads were surveyed monthly.

During the year, several radioactive particles were found on Hanford roadways. In general, these appear to have resulted from the transport (truck) of radioactive waste. The most significant of these particles was found on July 23 on the roadway 0.1 mile west of Mile 7, Route 1. An uncorrected beta dose rate of 6 rad/hr was observed at the roadway surface. The particle was removed and laboratory analysis revealed the major radionuclides and their relative activity as follows:

Nuclide	Relative Disintegration Rate
CePr-144	1.00
SrY-90	0.32
Ru-106	0.19
Cs-137	0.15
Nb-95	0.04
Zr-95	0.02
Cs-134	0.01

A number of special road surveys of 100 Area roads were conducted during June 1970. The only significant finding was three pieces of metal (maximum 500 mR/hr) on a road over a discontinued disposal site in 100-H Area.

2. Control Plots

Forty-one small areas, called control plots, are located within the Hanford boundaries (Map 7). These plots, measuring 3.05 m by 3.05 m (10' by 10'), are periodically surveyed with a GM survey meter for deposited radioactive material. In addition, 22 special control plots located near test wells are surveyed on a semiannual basis.

Contamination was found on control plots around 200 East Area on five occasions. A single particle was found on control plot #9 on March 3 which measured 3000 c/m on a GM. No isotope identification was made. Particles were found on control plot #10 in February (7000 c/m), March (6000 c/m), April (1000 c/m), September (1000 c/m) and December (15,000 c/m). Analysis of the March and April particles from plot #10 revealed ^{106}Ru to be the major gamma emitter.

3. 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 8. During 1970, inspections were made at most of the indicated areas on a quarterly schedule.

Unusual radiation levels or conditions were noted as follows. Conditions requiring correction were reported to responsible contractor representatives for action.

March:

a. 100-F - Particles on surface of retired site reading 5-18mR/hr. Contaminated sawdust covering about one-third of active animal waste burial ground (2000-6000 c/m).

b. 300 North - Open barrel outside of burial ground; 4000 c/m on the outer surfaces, not smearable.

c. 300 West - 30 mR/hr at closest approach due to stored filters.

May:

a. 100-F - Contaminated sawdust exposed in animal waste burial ground 2500-6000 c/m.

b. Gable Mountain Storage Vault - Wind erosion at southwest corner.

June:

a. 100-DR - Cave-in in burial ground south of 105 DR; 30,000 c/m at bottom of cave-in.

August:

a. 100-F - Animal waste burial ground fence down, no gate

b. 300 WYE - Fence repair and radiation zone signs needed.

September:

a. 100-DR - Condition unchanged from June.

b. 100-F - Exposed perf. at southwest burial ground (35 mR/hr).

c. 300 Burial ground #2 - 3500 c/m on end of pipe exposed by cave-in.

December:

a. 100-F - Several readings up to 4 mR/hr at southwest burial ground. Chains and signs down.

b. Gable Mountain Storage Vault - Wind erosion at southwest corner.

c. 300 North - 1500 c/m on weeds. 8 mR/hr from buried waste.

d. 300 West - Blowing papers outside fence; 400-20,000 c/m.

e. 300 Burial ground #2 - Condition unchaged from September.

4. 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. Aerial 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 flight patterns used during 1970 are shown on Maps 9 and 10. Flight patterns 1, 2, and 3 are located within and near the Hanford project perimeter. Flight pattern 4 follows the Columbia River from the Vernita bridge (upstream of the Hanford reactors) downstream to Plymouth. Flight pattern 5 lies fifteen to forty air miles beyond the project perimeter. No unusual activity conditions were noted by aerial survey in 1970.

B. External Exposure Rates

1. Exposure Rates On-Plant

During the first six months of 1970, trends in external radiation exposure rates (Figures 25 through 33) were determined from pencil-type ionization chambers located (in clusters of three) within small shelters (Map 11) where air samples were also collected. Pencil chamber measurements were also made at control plots 17 through 24 on the Wahluke Slope. At three locations (100-N WPPSS, Rt. 10, Mile 1.6, and 700 Area), Victoreen stray radiation chambers were used. The average results for the first half of 1970 using ionization chambers are presented in Table 14, with data from offsite locations and from previous years for comparison.

Beginning in July, all pencil chambers were replaced by thermoluminescent dosimeters (TLD). At the same time the Midway, 100-B, 100-N, Wahluke and McNary locations were discontinued, TLD was added to the 100-N (WPPSS) and Rt. 10 Mile 1.6 locations and twelve new locations were added.

The average dose rates measured during the second half of 1970 (Table 14) with TLD were a factor of about 2.2 lower than the pencil chamber measurements for the first half. This factor of difference probably was not due to an actual change in exposure but rather represents a more nearly correct assessment of gamma exposure. The TLD dosimeter has a different energy dependency and is less subject to errors due to mechanical shock, heat, and humidity.

As measured by pencils, there was a general downward trend in exposure rates at nearly all locations in the first half of 1970 compared with 1969. Notable exceptions include McNary and control plots 20 through 24. Stray radiation chamber measurements showed slight increases in the second half of 1970 over the first half--a trend also noted for 1968 and 1969.

The maximum exposure rate noted during the first half of 1970 was 1.5 mR/day at 100-K followed closely by 1.3 mR/day at 200 East East Center. The highest exposure rates noted using TLD during the second half of 1970 were 0.35 mR/day at 200 East North Center and 0.33 mR/day at the 300 Area process pond. Average of the onsite TLD locations in Table 14 was 0.20 mR/day compared with 0.18 mR/day for the 10 offsite listed.

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 suitable for estimating the potential exposure of WPPSS personnel. Based on measurements with stray radiation chambers during 1970, the average exposure rate was 0.45 mR/day at 100-N compared to 0.34 mR/day at Richland. Based on the net exposure rate of 0.11 mR/day and assuming exposure for 40 hours per week (50 weeks/year), the whole-body dose to WPPSS personnel from Hanford sources of external radiation at 100-N during 1969 would be 9 mrem/year (2% of the standard for individuals non-occupationally exposed or 0.2% of the standard for individuals occupationally exposed). The comparable exposure for 1969 was 20 mrem/year (4% or 0.4% of the respective standards).

TABLE 14

AVERAGE EXTERNAL GAMMA EXPOSURE RATES (mR/day)

Location	1968 Jan-June	1968 July-Dec	1969 Jan-June	1969 July-Dec	1970 Jan-June	1970 ** July-Dec
100 AREAS						
Vernita	--	--	--	--	--	0.22
Midway	0.57	0.60	--	--	0.62	(1)
100-B	0.72	0.69	1.0	0.49	0.35	(1)
100-K	1.9	1.6	1.4	1.6	1.5	0.27
100-N	1.20	0.91	1.0	(1)	--	--
*100-N (WPPSS)	--	--	0.54*	0.54*	0.43*	0.46*
100-N (WPPSS)	--	--	--	--	0.47	0.23
100-D	0.48	0.41	0.95	0.37	0.40	0.17
100-F	0.42	0.43	1.1	0.55	0.41	0.17
Hanford	--	--	--	--	--	0.16
200-WEST AREA						
Redox	0.56	0.61	0.53	0.56	0.51	0.18
West-Center	0.41	0.43	0.60	0.52	0.45	0.24
East-Center	0.41	0.41	0.56	0.59	0.45	0.17
West-Northeast	--	0.48	0.84	0.54	0.37	0.21
200-EAST AREA						
North-Center	--	0.58	0.94	1.2	0.74	0.35
West-Center	0.52	0.42	0.44	0.39	0.34	0.18
Southeast	0.50	0.46	0.56	0.53	0.50	0.23
East-Center	0.46	0.53	1.9	3.6	1.3	0.24
WAHLUKE SLOPE						
C.P. 17	--	--	0.41	0.60	0.42	0.20
C.P. 18	--	--	0.44	0.52	0.46	0.20
C.P. 19	--	--	0.45	0.36	0.42	0.19
C.P. 20	--	--	0.44	0.39	0.45(2)	0.19(4)
C.P. 21	--	--	0.38	0.38	0.43	0.19
C.P. 22	--	--	0.41	0.28	0.46	0.19
C.P. 23	--	--	0.42	0.46	0.46	0.20(4)
C.P. 24	--	--	0.41	0.34	0.52	0.20
C.P. 46	--	--	--	--	--	0.19(8)

TABLE 14 (continued)

AVERAGE EXTERNAL GAMMA EXPOSURE RATES (mR/day)

Location	1968 Jan-June	1968 July-Dec	1969 Jan-June	1969 July-Dec	1970 Jan-June	1970 ** July-Dec
OTHER ONSITE						
Yakima Barricade	--	--	--	--	--	0.18
Rattlesnake Springs	0.40	0.42	0.56	0.63	0.46	0.18
Emergency Relocation Center	0.40	0.41	0.65	0.57	0.39	0.18
FFTF Site	--	--	--	--	--	0.19(7)
Wye Barricade	0.62	0.62	0.51	0.40	0.38	0.16
*Rt. 10 Mile 1.6	0.38*	0.34*	0.31*	0.42*	0.37*	0.42*
Rt. 10 Mile 1.6	--	--	--	--	--	0.18
300 Area (3705 Bldg.)	0.55	0.63	0.92	1.0	0.54	0.20
300 Area (320 Bldg.)	--	--	--	--	--	0.20(4)
300 Pond	--	--	--	--	--	0.33(4)
ACRMS	--	--	--	--	--	0.18(4)
BNW Alfalfa Field	--	--	--	--	--	0.20
700 Area	0.31	0.62	0.53	0.55	0.45	0.13
*700 Area	0.28*	0.29*	0.26*	0.32*	0.32*	0.35*
OFFSITE						
Berg Ranch	--	0.74	0.59	0.52	0.59	0.18(4)
Wahluke	0.46	0.48	0.82	0.55	0.57(3)	--
Wahluke #2	--	--	--	--	--	0.20(4)
Wahluke Watermaster	--	--	--	--	--	0.18(5)
New Moon (Mesa)	0.40	0.64	0.75	0.50	0.48	0.17(6)
Eltopia	0.54	0.62	0.91	0.48	0.50	0.20(4)
Ringold Fish Station	0.42	0.55	0.70	0.66	0.40	0.16(4)
Byers Landing	0.27	0.33	0.49	0.60	0.48	0.17
Pasco	0.38	0.46	0.89	0.73	0.55	0.18(4)
Kennewick	--	--	--	--	--	0.15(4)
Benton City	0.38	0.57	0.62	0.81	0.54	0.18(4)
McNary	0.47	0.61	0.62	0.74	0.75	(1)

* Average measurements with stray radiation chambers
** Measurements by TLD instead of stray radiation chambers
(1) Discontinued
(2) January-February average
(3) January-February average; Discontinued March
(4) August-December average
(5) September-December average
(6) August-November average
(7) October-November average
(8) October-December average

3. Exposure Rates at the Columbia River Shoreline

Radiation exposure rates are measured at 1 meter (about 3 feet) above the river shoreline with a 40-liter ionization chamber whose response is calibrated in μR/hr (radium gamma). Measurements at 1 meter approximate the exposure rate to the gonads of a person standing on the riverbank.

The weekly measurements of exposure rates at seven sampling locations shown in Map 12 and at Sacajawea Park and McNary Dam (Washington shore) appear in Figures 34-36. Additional monthly shoreline surveys covering the reach of the river from the reactors to Richland include both the exposure rate at 1 meter and the levels of surface contamination measured with a portable GM survey meter. These data appear in Table 15.

During 1970, exposure rates on the Columbia River shoreline were generally lower than during 1969. The maximum shoreline exposure rate found during routine surveys during 1970 was 250 μR/hr, measured in March on the plant shore on D Island (Table 15). For comparison, the maximum shoreline exposure rate measured during 1968 was 250 μR/hr above 181-NE.

The maximum level of surface shoreline contamination encountered during 1970 [2000 counts/min (GM)] was detected at the routine Hanford Far Shore location in May and again in August on the plant shore at the Hanford location.

Levels of shoreline surface contamination at sampling locations below the plant boundary during 1970 were not significantly changed from 1969.

TABLE 15

MAXIMUM READINGS[1] FROM MONTHLY SHORELINE SURVEYS FOR 1970

(microRoentgens/hour with counts/minute in parentheses)

A. COLUMBIA RIVER - PLANT SHORE

	382.5 P[2] Above 181 KW		381.5 P Above 181 KE		379.0 P White Bluffs Ferry		369.7 P White Bluffs Ferry		364.4 P Between 100F & Hanford		362.0 P Hanford	
Date	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)
2/10/70	24	(<200)	53	(350)	80	(500)	67	(800)	32	(400)	67	(600)
3/13/70	16	(400)	170	(700)	39	(500)	78	(400)	63	(400)	74	(500)
7/8/70	26	(200)	62	(400)	37	(800)	37	(250)	--	--	46	(300)
8/6/70	20	(200)	72	(1500)	34	(600)	48	(500)	--	--	60	(2000)
11/13/70	18	(150)	100	(800)	82	(450)	64	(450)	--	--	84	(550)

B. COLUMBIA RIVER - FAR SHORE

	381.0 F Opposite KE Basins		380.5 F Above 181 NE		378.6F Above 181 D		377.0 F Below DR Outfall		369.8 F White Bluffs Ferry		368.4 F Below 100F		362.0 F[4] Hanford		354.7 F[3] Ringold		345.2 F[3] Above 300 Area	
Date	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)
2/10/70	13	(<200)	40	(350)	32	(<200)	13	(<200)	30	(<200)	22	(<200)	32	(400)	30	(200)	32	(300)
3/13/70	9	(300)	110	(500)	18	(250)	12	(250)	24	(200)	33	(300)	130	(2000)	46	(400)	39	(300)
7/8/70	15	(100)	--	--	13	(100)	--	--	21	(200)	--	--	46	(300)	19	(150)	23	(200)
8/6/70	14	(200)	--	--	14	(200)	--	--	28	(600)	--	--	36	(600)	--	--	58	(1000)
11/13/70	30	(150)	--	--	16	(100)	--	--	18	(200)	--	--	38	(200)	32	(250)	46	(250)

C. COLUMBIA RIVER - ISLAND LOCATIONS

	377.4 I D Island		375.8 IF E Island		373.3 IP Locke Island		373.0 IF Locke Island		372.1 F Below 1904-H		371.1 IP Locke Island		367.0 IF 100F Slough		355.7 I[4] Near Ringold	
Date	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)	40-Liter	(GM)
2/10/70	210	(800)	24	(200)	72	(500)	90	(500)	16	(200)	38	(300)	62	(400)	40	(400)
3/13/70	250	(1500)	45	(300)	48	(400)	89	(600)	39	(400)	50	(400)	230	(1000)	110	(1000)
7/8/70	34	(300)	60	(300)	--	--	--	--	--	--	34	(250)	25	(250)	28	(150)
8/6/70	64	(500)	--	--	--	--	--	--	--	--	50	(700)	--	--	50	(400)
11/13/70	52	(350)	50	(350)	--	--	--	--	--	--	34	(250)	45	(250)	74	(500)

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

(2) River miles measured from the mouth of the Columbia. Plant shore, far shore, and island are designated by P, F, and I, respectively.

(3) Point open to the general public during the entire year.

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

4. Exposure Rates Below the Surface of the Columbia River

During January through June, 1970, exposure rates in the river (Figures 37-39) were determined from a cluster of five pencil ionization chambers contained within submerged plastic bottles at the locations shown in Map 12.

Six-month averages for 1970 are shown in Table 16 with data from 1969 for comparison.

As expected, exposure rates in the river for the first half of 1970 were, for the most part, markedly reduced compared to the same period in 1969. Beginning in June at the Richland pumphouse and in July or August at other locations, the pencil chambers were replaced by TLD dosimeters. The apparently significant reduction in exposure rate for July-December 1970 as compared with January-June, 1970, was probably largely due to the change in dosimeter types as previously discussed.

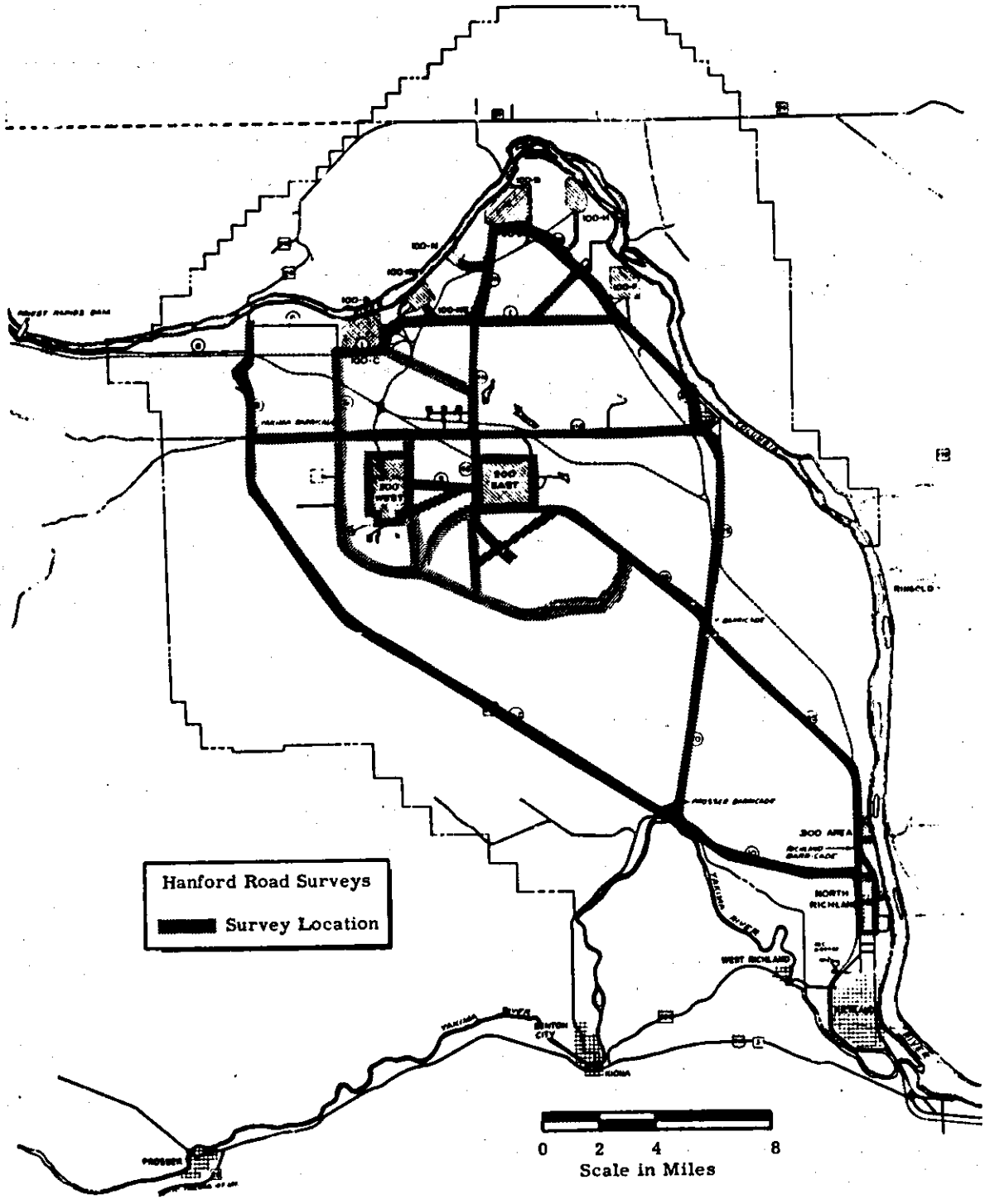
Approximately coincident with the switch to TLD dosimeters, the Priest Rapids, Ringold, Hanford, and Pasco pumphouse locations were discontinued and the Vernita, 100-D, and South Wooded Island locations started. Also, the 100-F Plant shore location was moved to a barge anchored in the Columbia River channel.

TABLE 16

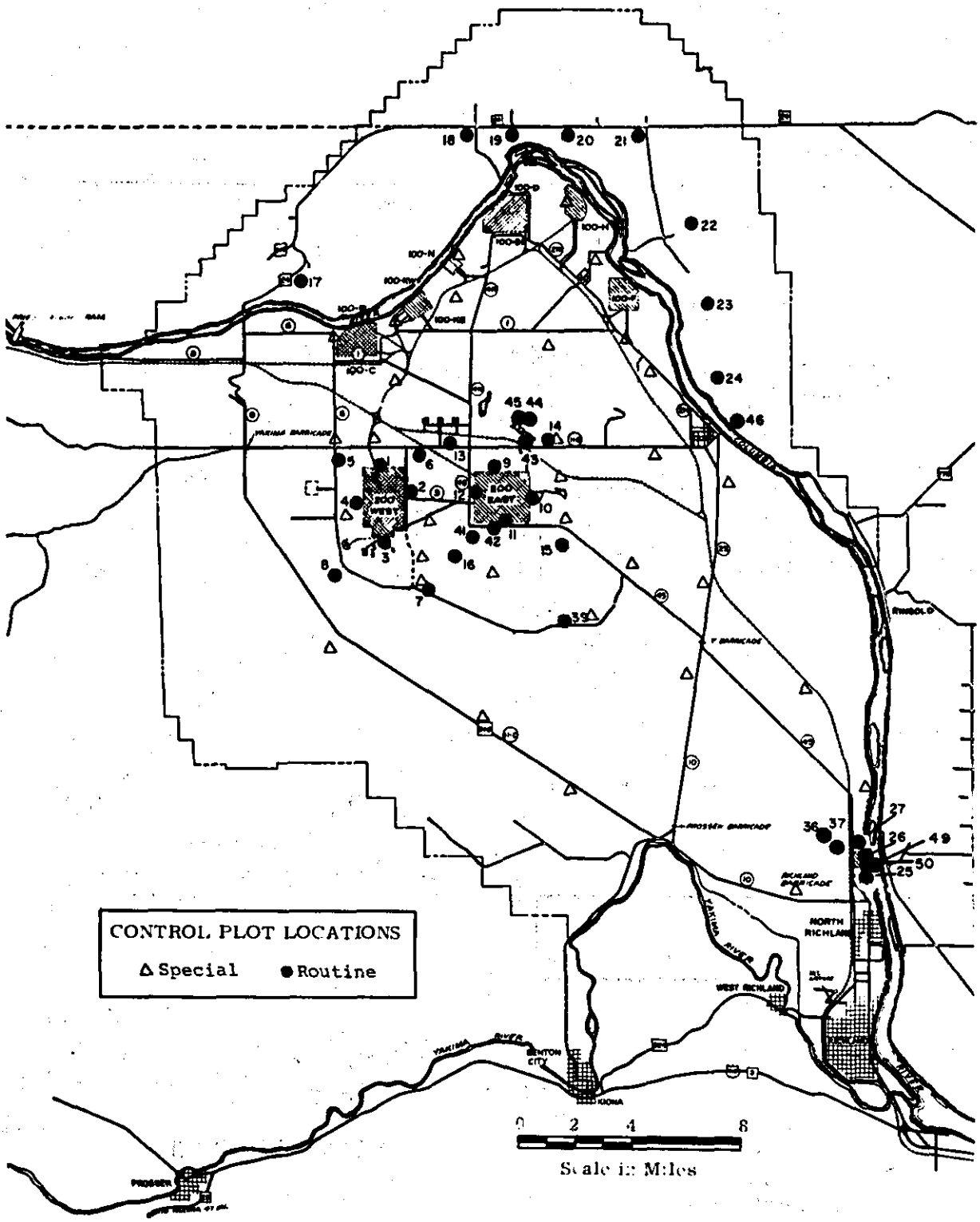
AVERAGE EXPOSURE RATES BELOW THE SURFACE OF THE COLUMBIA RIVER (1969-1970)

	(mR/day)			
	1969		1970	
	Jan-June	July-Dec	Jan-June	July-Dec
Priest Rapids/Vernita	0.6	0.6	0.4 (1)	0.1 (2)
100-F Area	5.5	7.4	3.1	0.7 (3)
Ringold/So. Wooded Island	2.7 (4)	1.8 (5)	1.1 (1)	0.6 (6)
Richland Pumphouse	2.2	3.0	2.4 (7)	0.6 (6)
Pasco Pumphouse	2.4	1.7	0.9 (7)	Discontinued

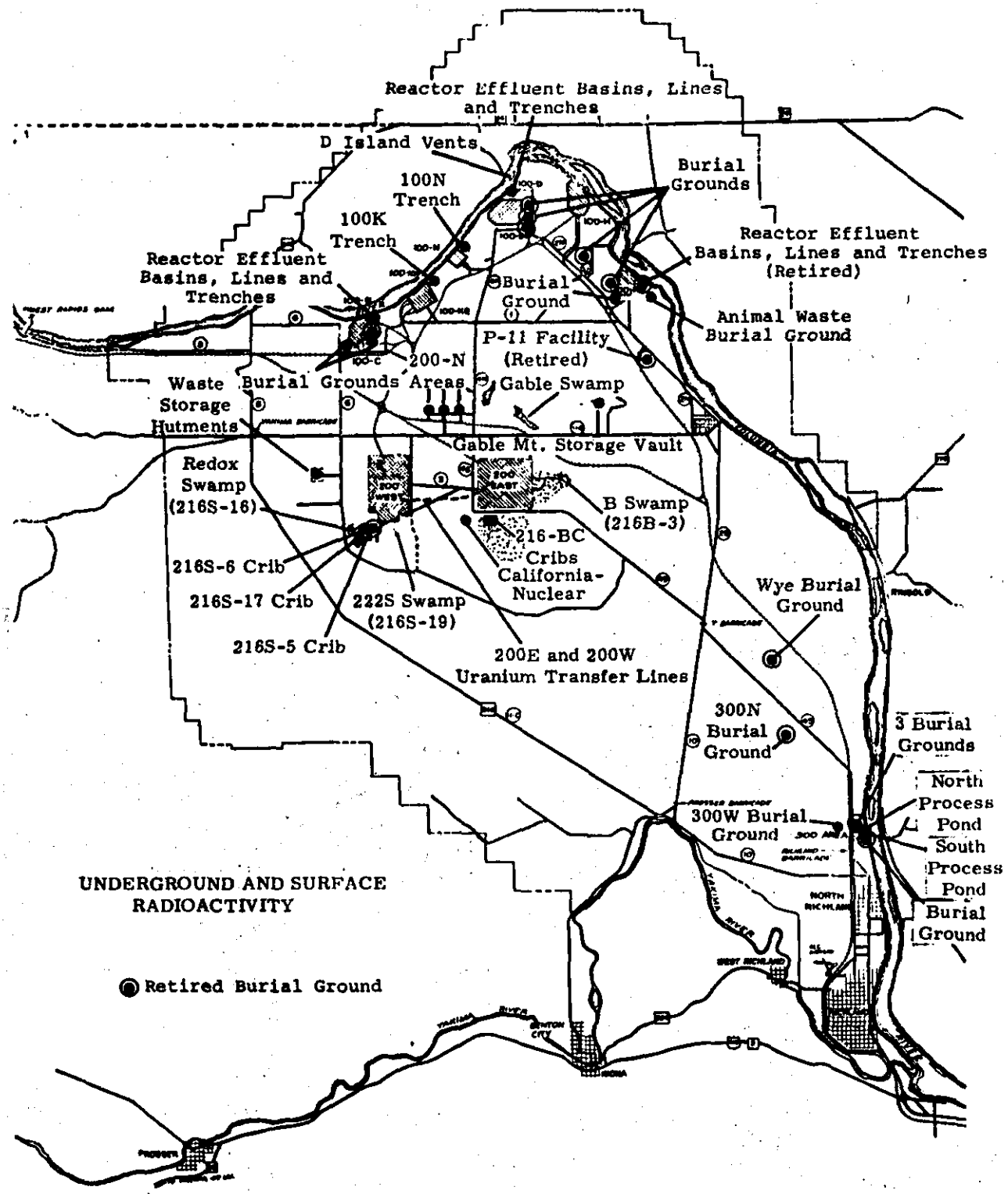
(1) Upstream location was Vernita during this period
(2) July, November, December
(3) October through December
(4) January through March
(5) September through December
(6) May through June
(7) January through May



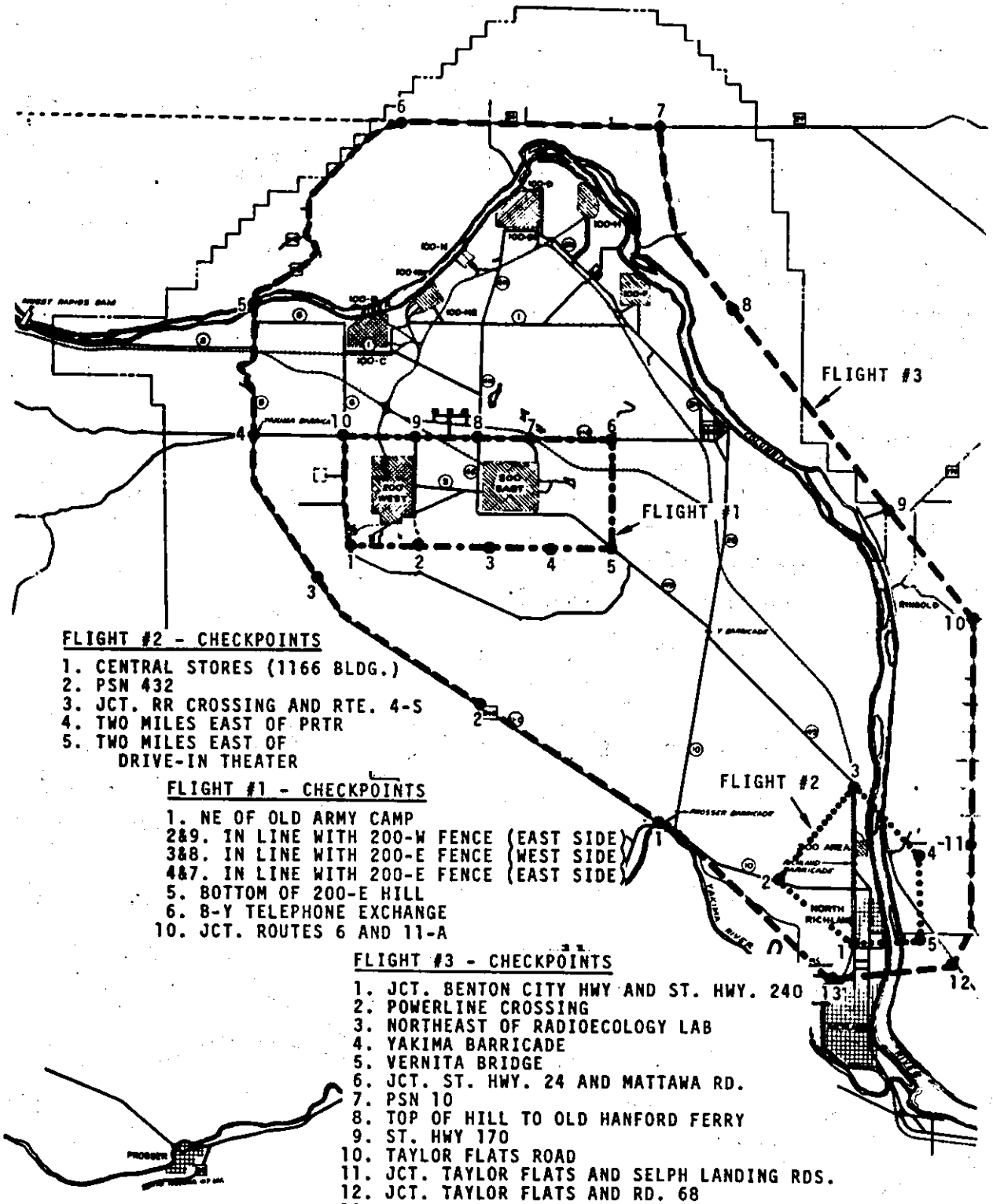
MAP 6


CONTROL PLOT LOCATIONS
Special
Routine
0 2 4 8
Scale in Miles
200 WEST
200 EAST
100-C
100-D
100-H
100-N
100-F
RICHLAND
NORTH RICHLAND
WEST RICHLAND
KENNEWICK
PASCO
YAKIMA RIVER
COLUMBIA RIVER

MAP 7


Reactor Effluent Basins, Lines and Trenches
D Island Vents
100N Trench
100K Trench
Burial Grounds
Reactor Effluent Basins, Lines and Trenches (Retired)
Reactor Effluent Basins, Lines and Trenches
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)
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
300W Burial Ground
South Process Pond
Burial Ground
UNDERGROUND AND SURFACE RADIOACTIVITY
Retired Burial Ground

MAP 8



FLIGHT #2 - CHECKPOINTS

1. CENTRAL STORES (1166 BLDG.)
2. PSN 432
3. JCT. RR CROSSING AND RTE. 4-S
4. TWO MILES EAST OF PRTR
5. TWO MILES EAST OF DRIVE-IN THEATER

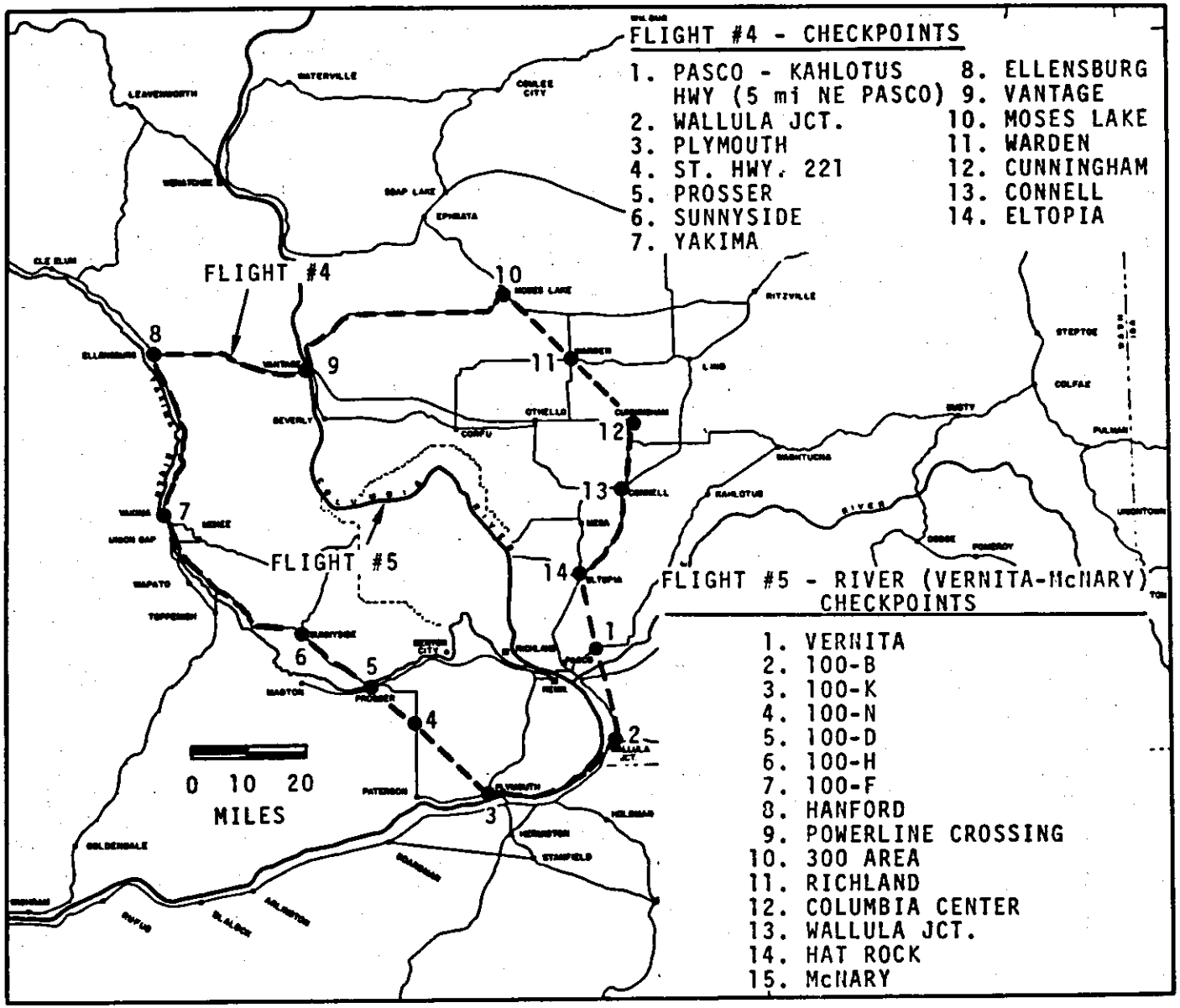
FLIGHT #1 - CHECKPOINTS

1. NE OF OLD ARMY CAMP
2&9. IN LINE WITH 200-W FENCE (EAST SIDE)
3&8. IN LINE WITH 200-E FENCE (WEST SIDE)
4&7. IN LINE WITH 200-E FENCE (EAST SIDE)
5. BOTTOM OF 200-E HILL
6. B-Y TELEPHONE EXCHANGE
10. JCT. ROUTES 6 AND 11-A

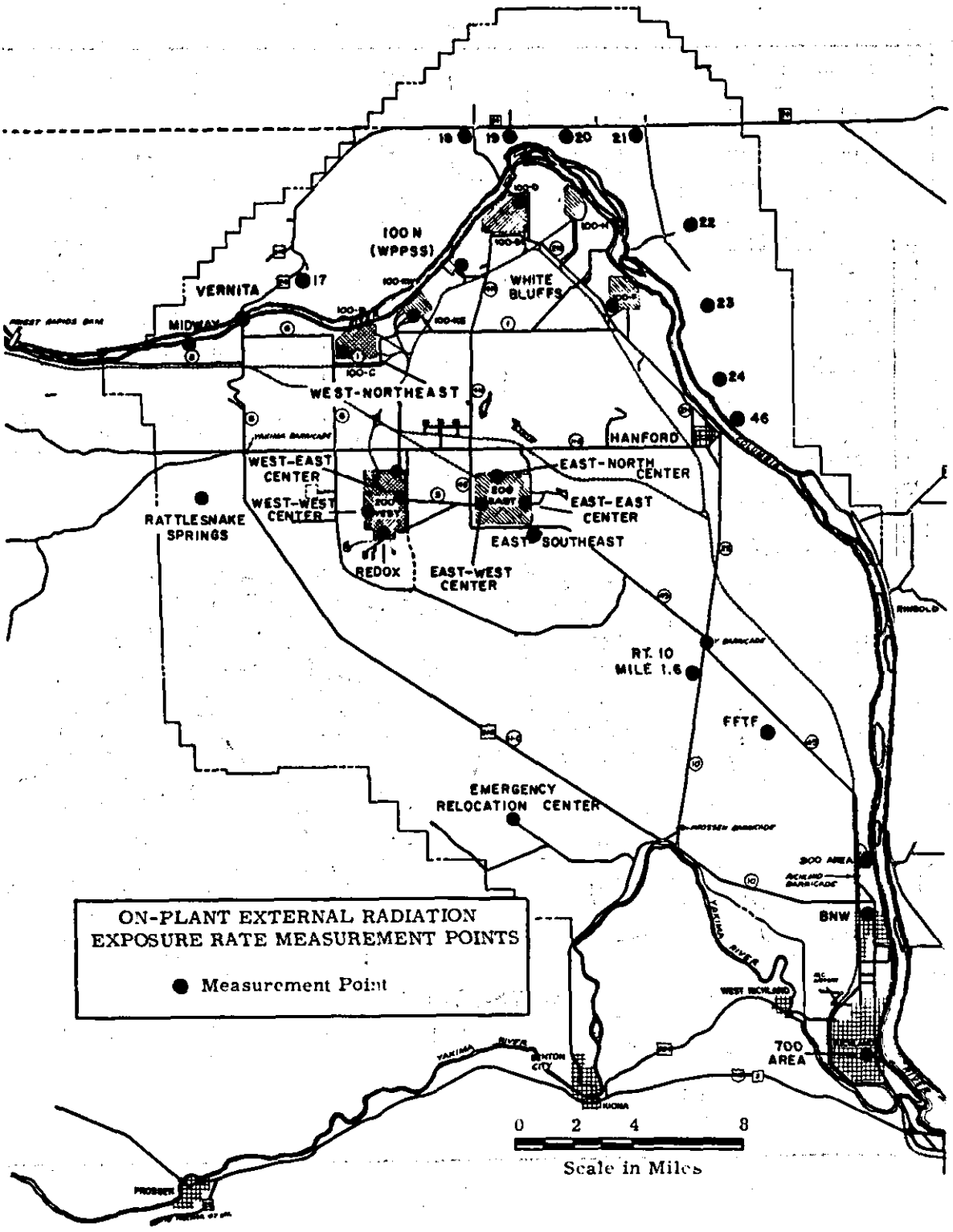
FLIGHT #3 - CHECKPOINTS

1. JCT. BENTON CITY HWY AND ST. HWY. 240
2. POWERLINE CROSSING
3. NORTHEAST OF RADIOECOLOGY LAB
4. YAKIMA BARRICADE
5. VERNITA BRIDGE
6. JCT. ST. HWY. 24 AND MATTAWA RD.
7. PSN 10
8. TOP OF HILL TO OLD HANFORD FERRY
9. ST. HWY 170
10. TAYLOR FLATS ROAD
11. JCT. TAYLOR FLATS AND SELPH LANDING RDS.
12. JCT. TAYLOR FLATS AND RD. 68
13. RICHLAND AIRPORT

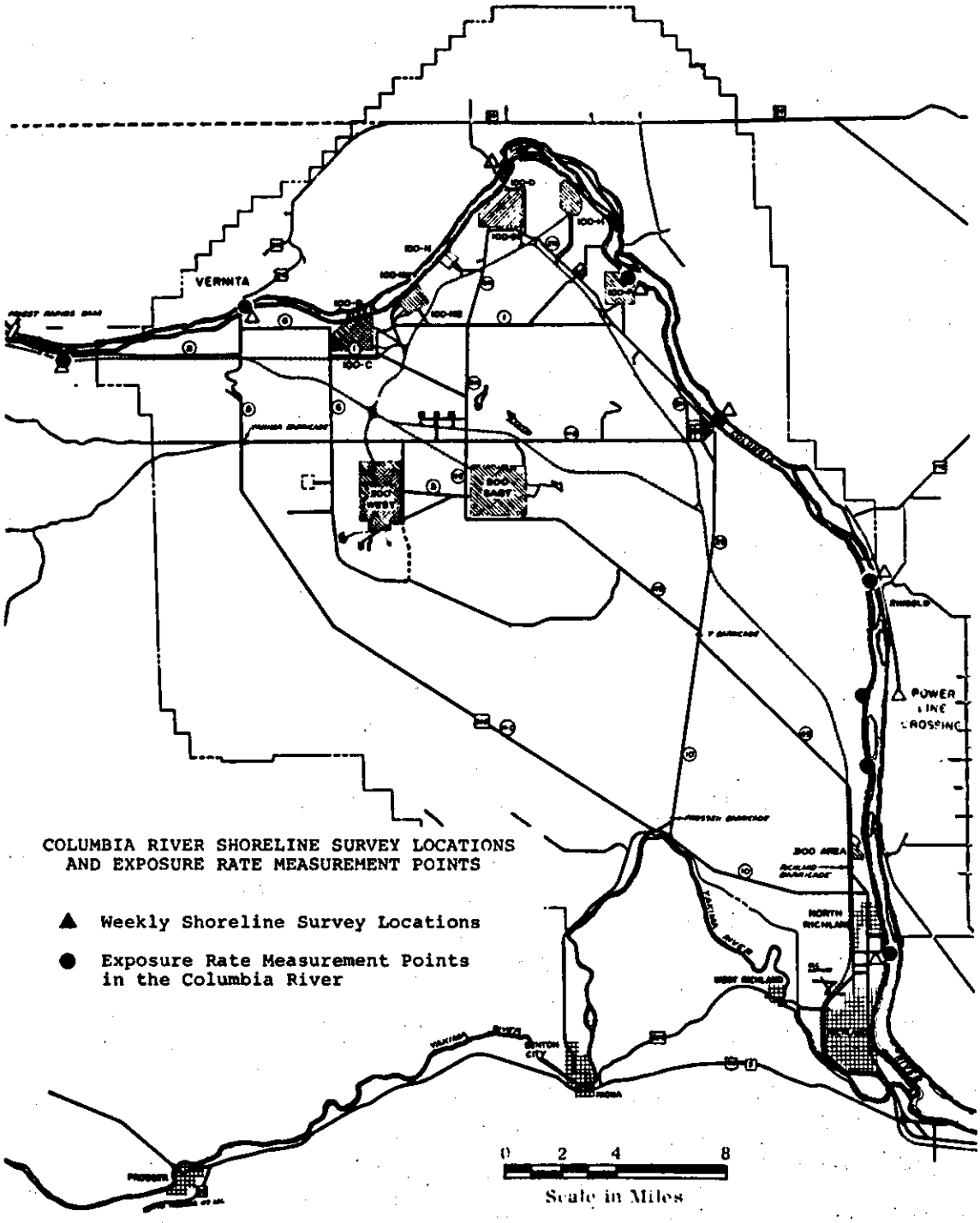
MAP 9


FLIGHT #4 - CHECKPOINTS
1. PASCO - KAHLOTUS HWY (5 mi NE PASCO)
2. WALLULA JCT.
3. PLYMOUTH
4. ST. HWY. 221
5. PROSSER
6. SUNNYSIDE
7. YAKIMA
8. ELLENSBURG
9. VANTAGE
10. MOSES LAKE
11. WARDEN
12. CUNNINGHAM
13. CONNELL
14. ELTOPIA
FLIGHT #4
FLIGHT #5
0 10 20
MILES
FLIGHT #5 - RIVER (VERNITA-McNARY) CHECKPOINTS
1. VERNITA
2. 100-B
3. 100-K
4. 100-N
5. 100-D
6. 100-H
7. 100-F
8. HANFORD
9. POWERLINE CROSSING
10. 300 AREA
11. RICHLAND
12. COLUMBIA CENTER
13. WALLULA JCT.
14. HAT ROCK
15. McNARY

MAP 10


18
19
20
21
22
23
24
46
100 N
(WPPSS)
VERNITA
17
MIDWAY
WHITE
BLUFFS
WEST-NORTHEAST
HANFORD
WEST-EAST
CENTER
EAST-NORTH
CENTER
WEST-WEST
CENTER
EAST-EAST
CENTER
RATTLESNAKE
SPRINGS
EAST SOUTHEAST
REDOX
EAST-WEST
CENTER
RT. 10
MILE 1.6
FFTF
EMERGENCY
RELOCATION CENTER
ON-PLANT EXTERNAL RADIATION
EXPOSURE RATE MEASUREMENT POINTS
Measurement Point
BNW
700
AREA
0 2 4 8
Scale in Miles

MAP 11


VERNITA
100-C
200 WEST
200 EAST
POWER LINE CROSSING
300 AREA
NORTH RICHLAND
WEST RICHLAND
RICHLAND
YAKIMA RIVER
BENTON CITY
PROSSER
COLUMBIA RIVER SHORELINE SURVEY LOCATIONS
AND EXPOSURE RATE MEASUREMENT POINTS
▲ Weekly Shoreline Survey Locations
● Exposure Rate Measurement Points in the Columbia River
0 2 4 8
Scale in Miles

MAP 12

EXTERNAL RADIATION ON PLANT 100 AREAS AND VICINITY

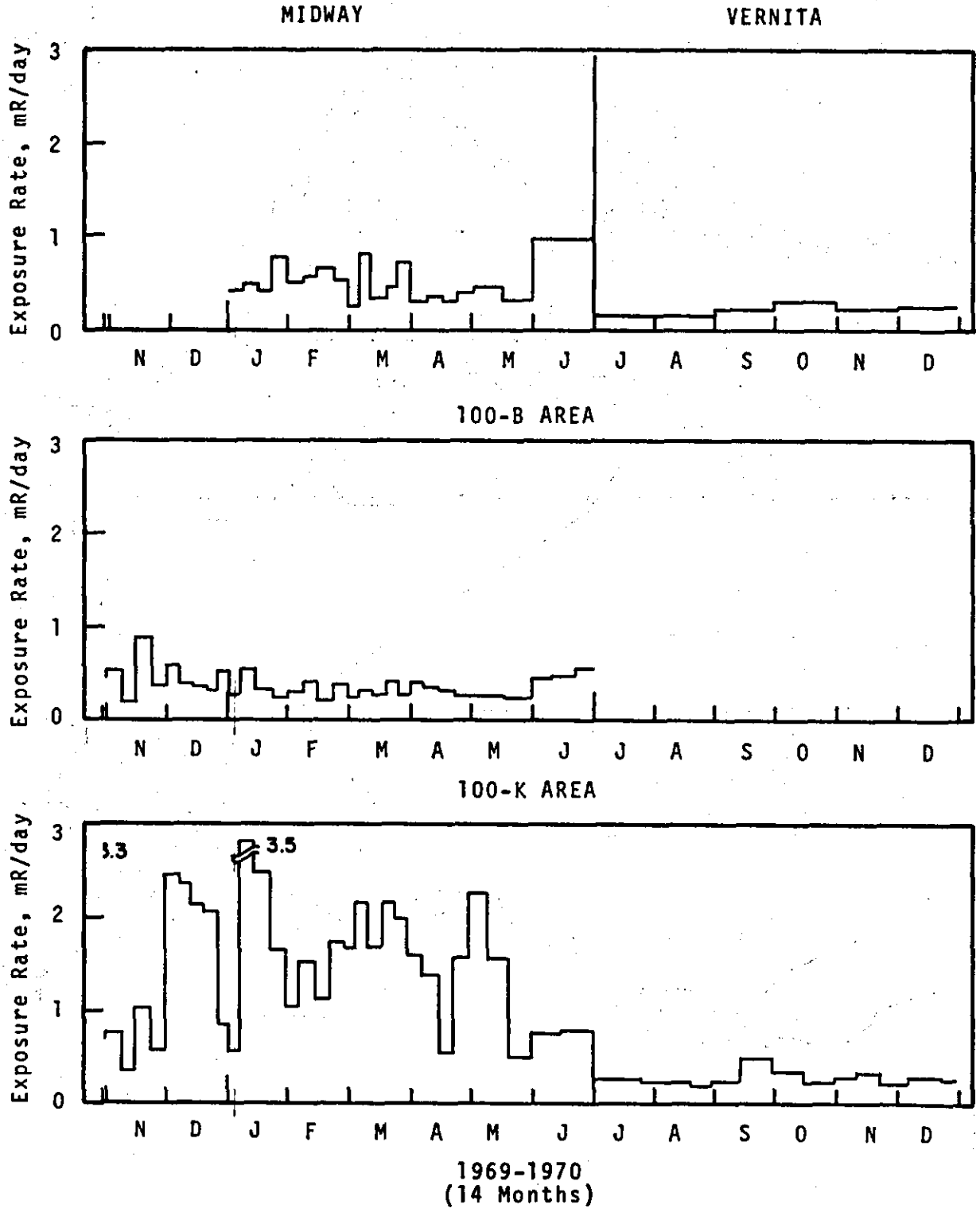


FIGURE 25

EXTERNAL RADIATION ON PLANT 100 AREAS AND VICINITY

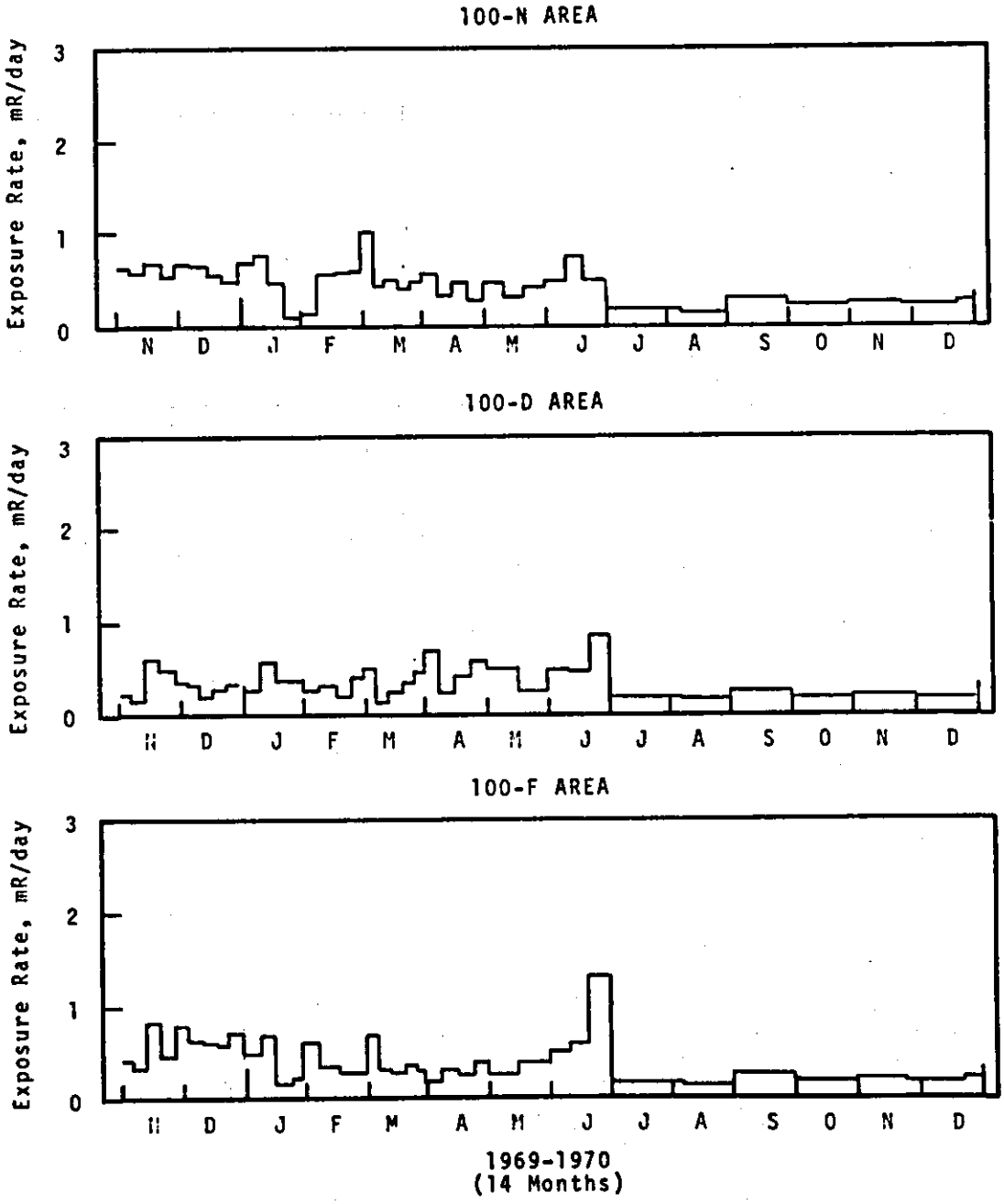


FIGURE 26

EXTERNAL RADIATION ON PLANT 100 AREAS AND VICINITY

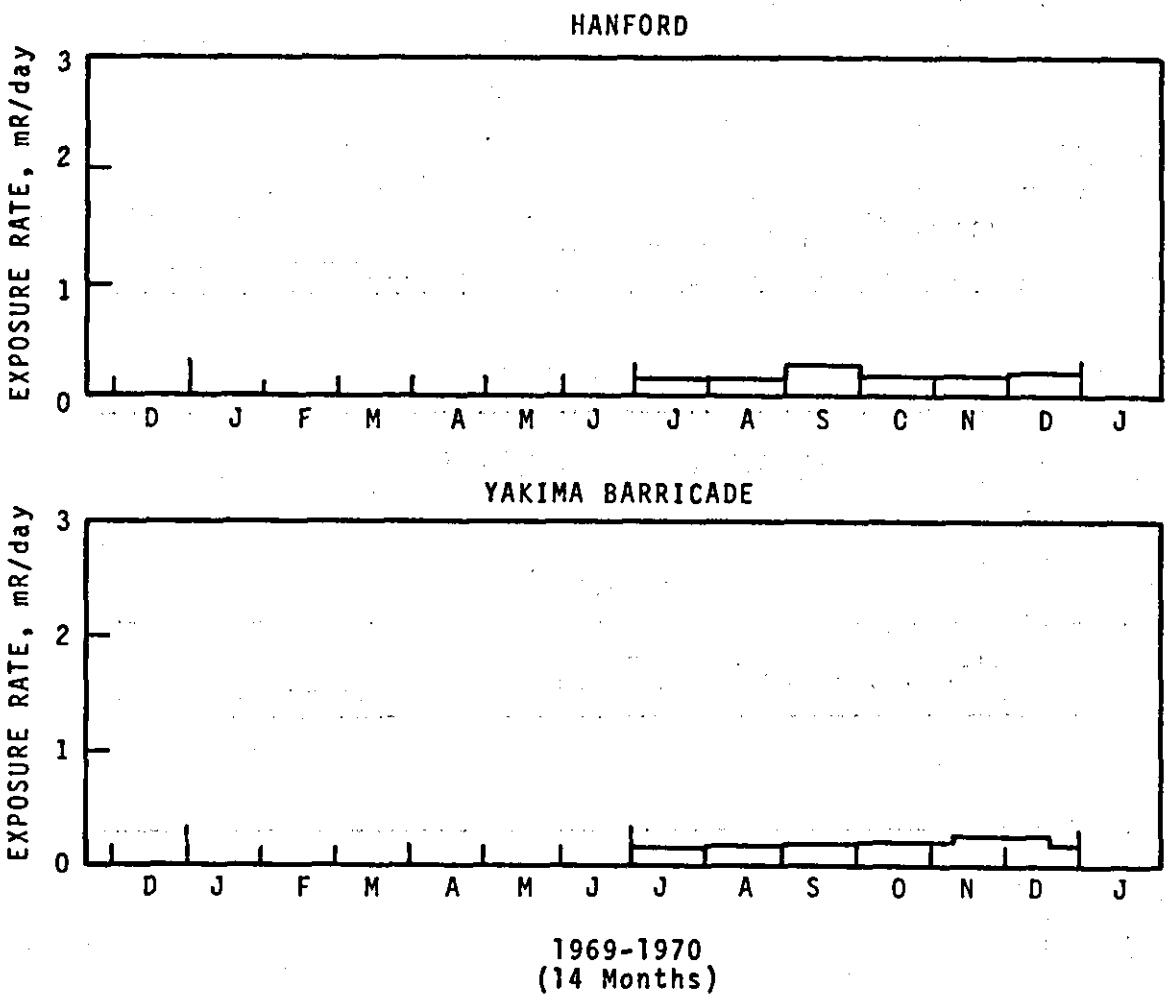


FIGURE 27

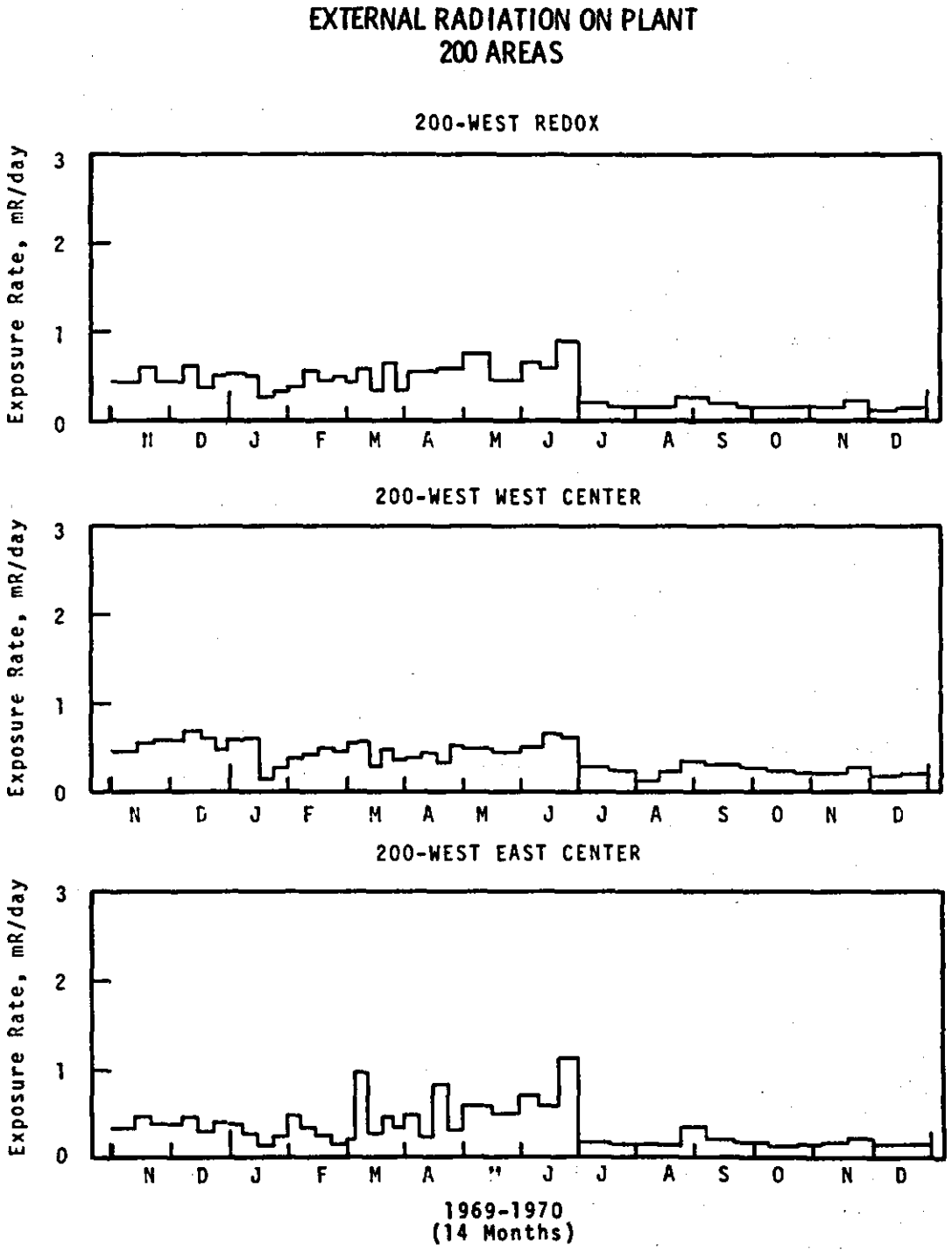

EXTERNAL RADIATION ON PLANT
200 AREAS
200-WEST REDOX
Exposure Rate, mR/day
0
1
2
3
N D J F M A M J J A S O N D
200-WEST WEST CENTER
Exposure Rate, mR/day
0
1
2
3
N D J F M A M J J A S O N D
200-WEST EAST CENTER
Exposure Rate, mR/day
0
1
2
3
N D J F M A " J J A S O N D
1969-1970
(14 Months)

FIGURE 28

EXTERNAL RADIATION ON PLANT
200 AREAS

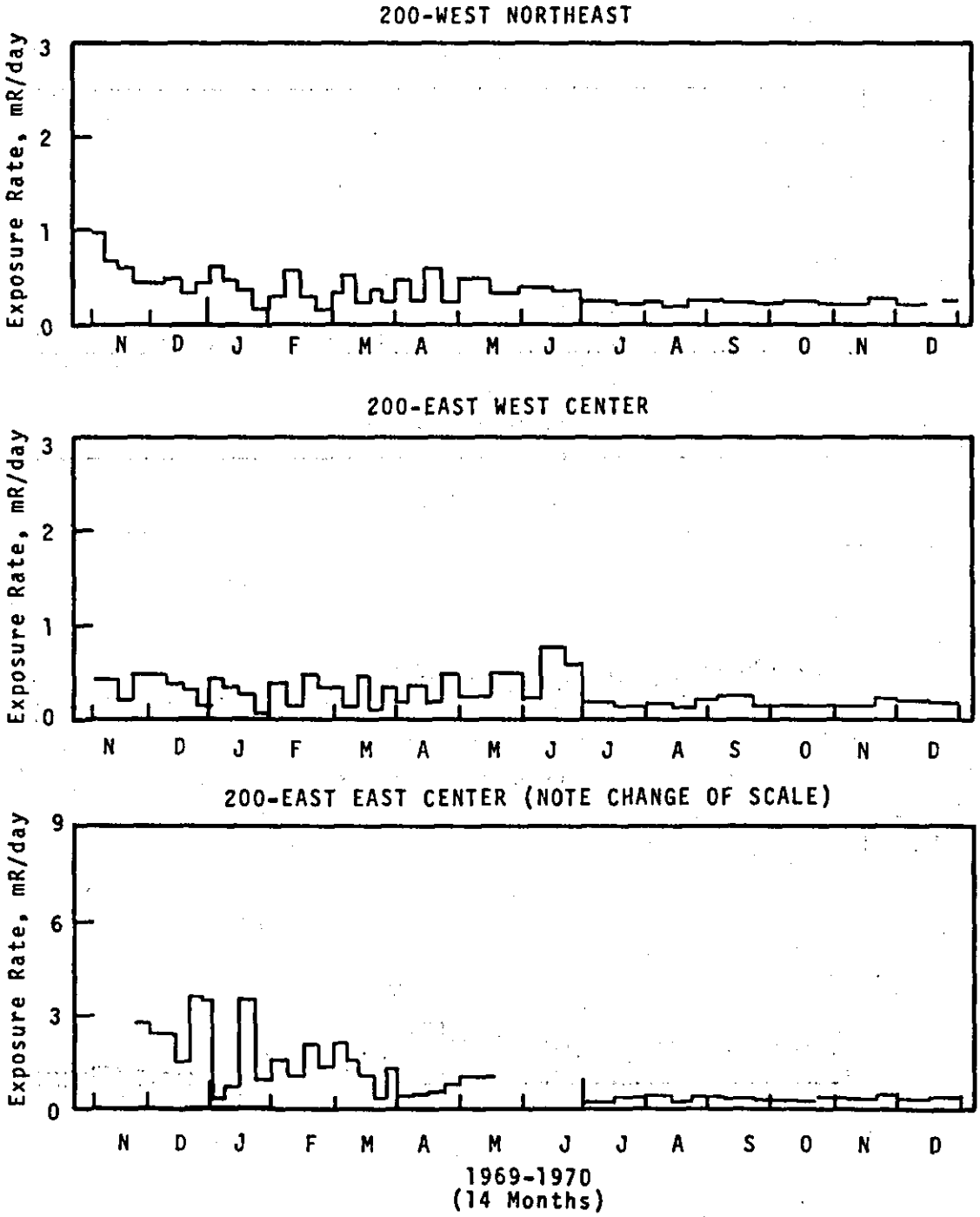


FIGURE 29

EXTERNAL RADIATION ON PLANT
200 AREAS AND INTERMEDIATE AREAS

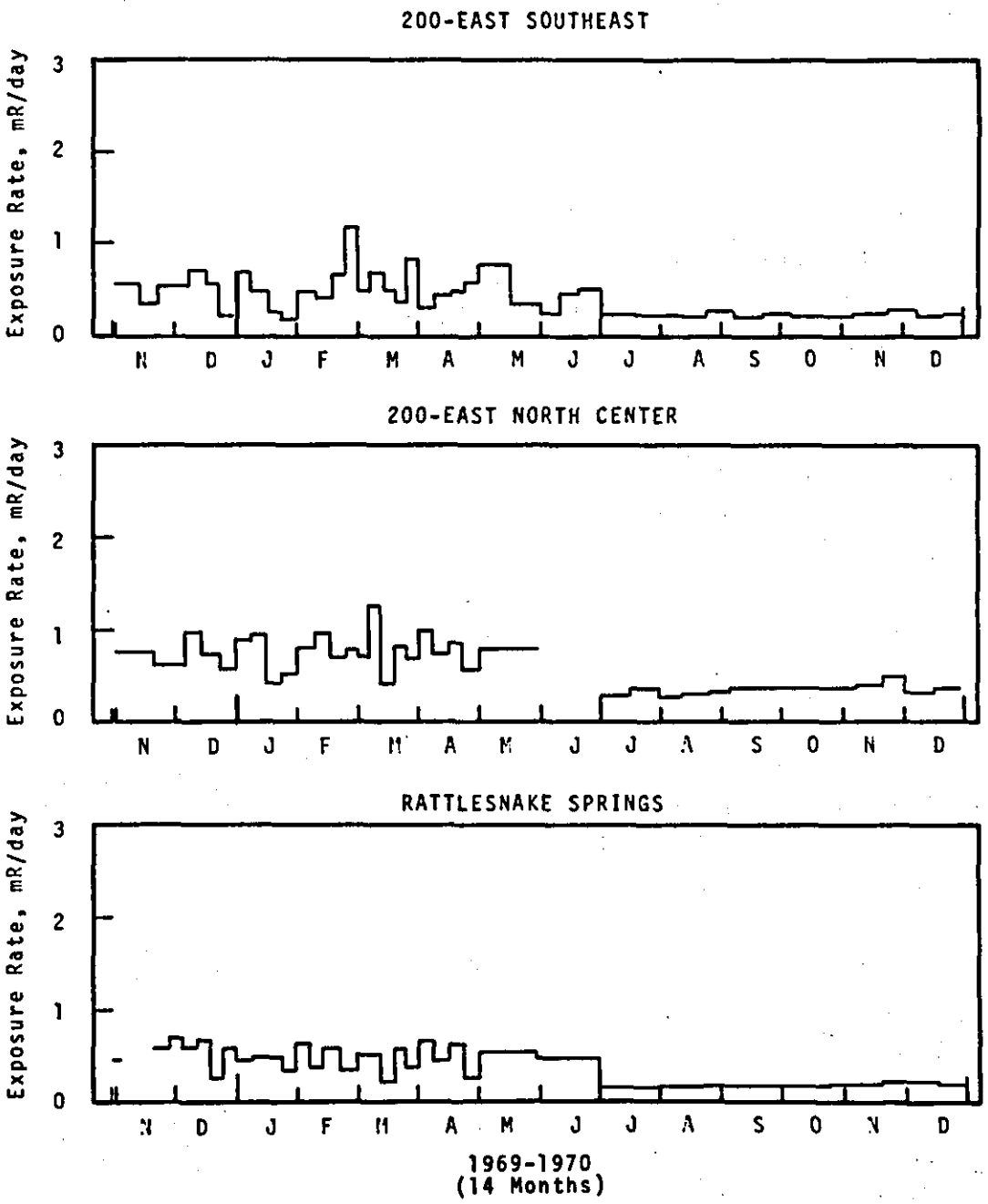


FIGURE 30

EXTERNAL RADIATION ON PLANT INTERMEDIATE AREAS

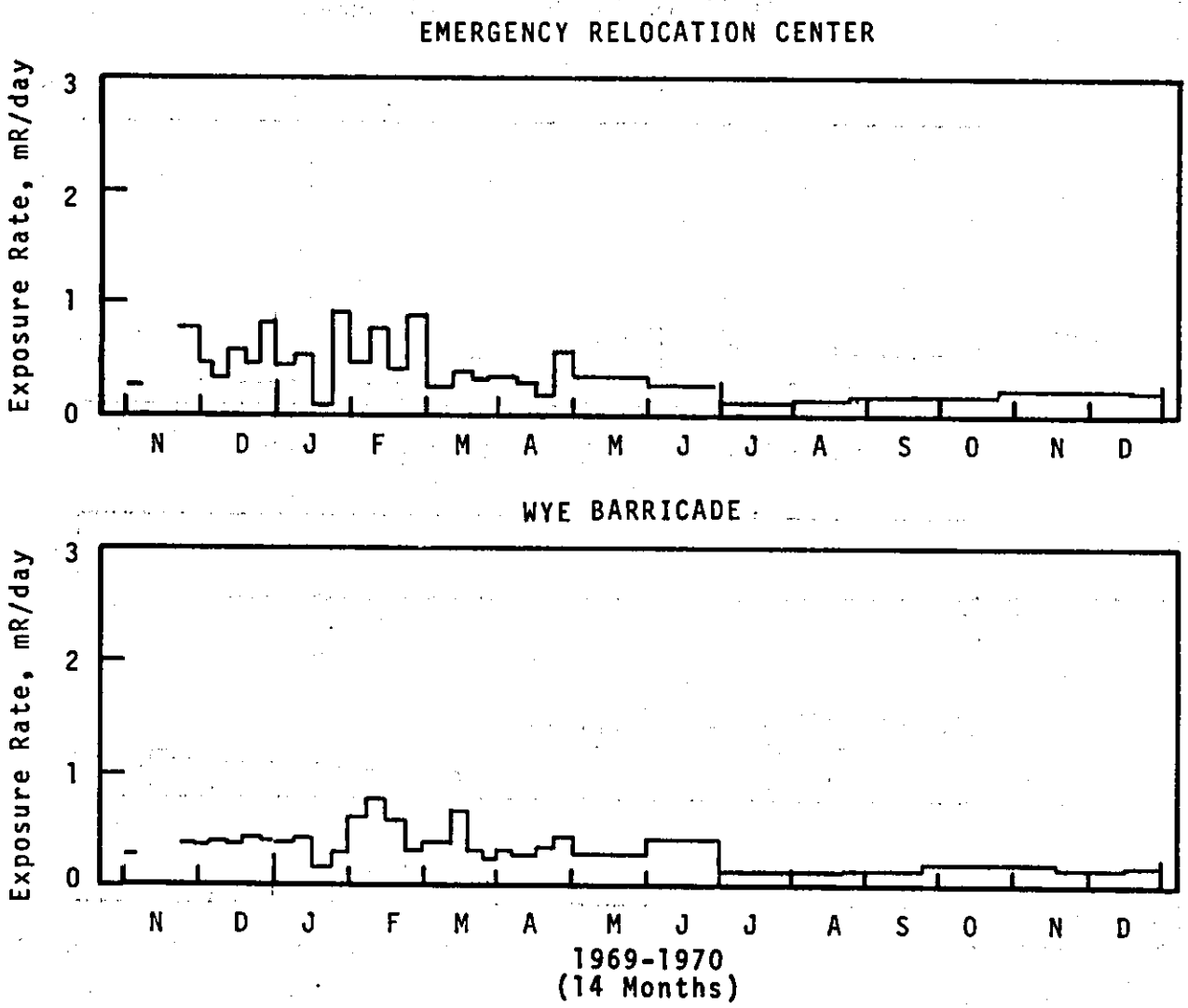


FIGURE 31

EXTERNAL RADIATION ON PLANT
300 AREA

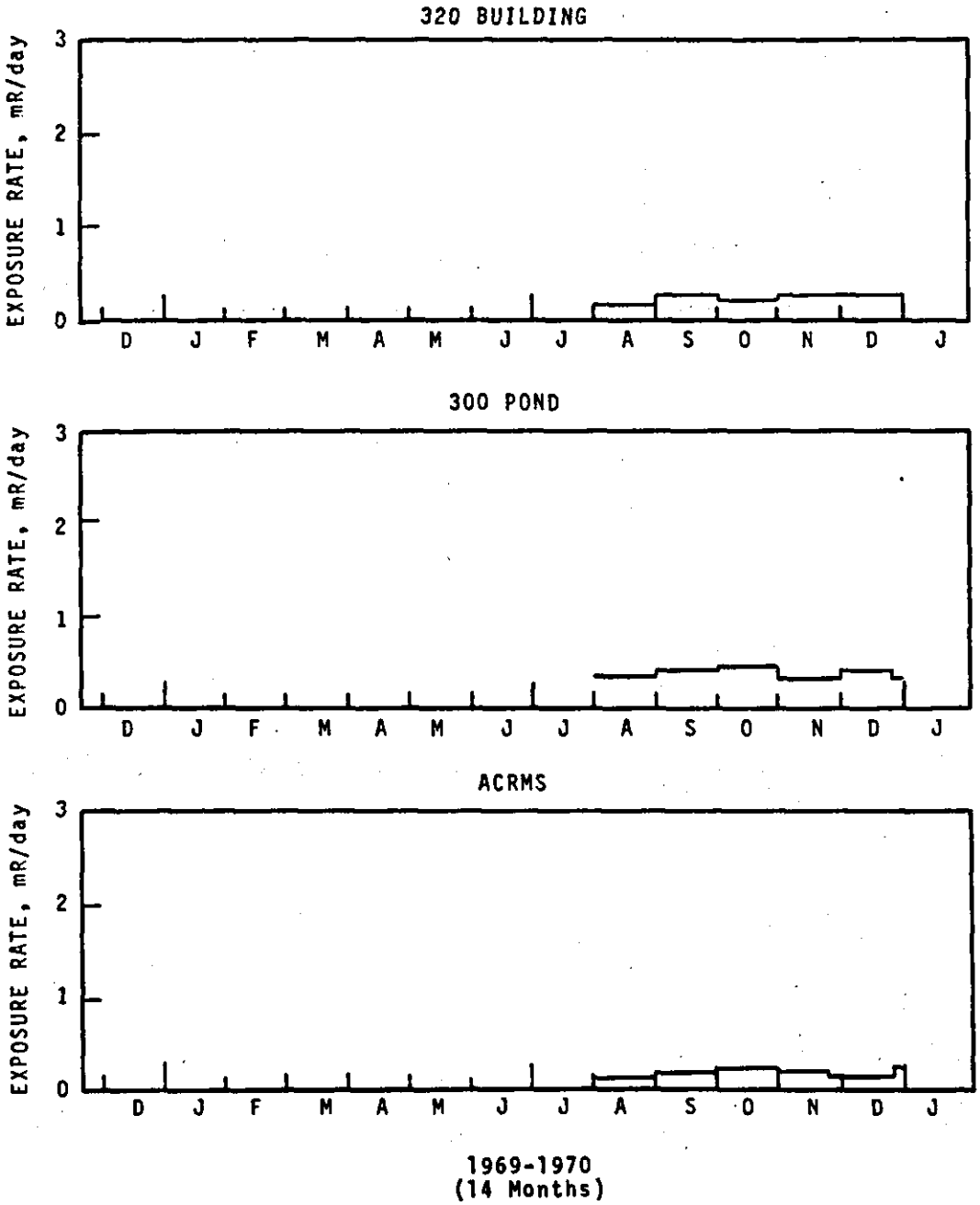


FIGURE 32

EXTERNAL RADIATION ON PLANT
300 AREA AND 700 AREA

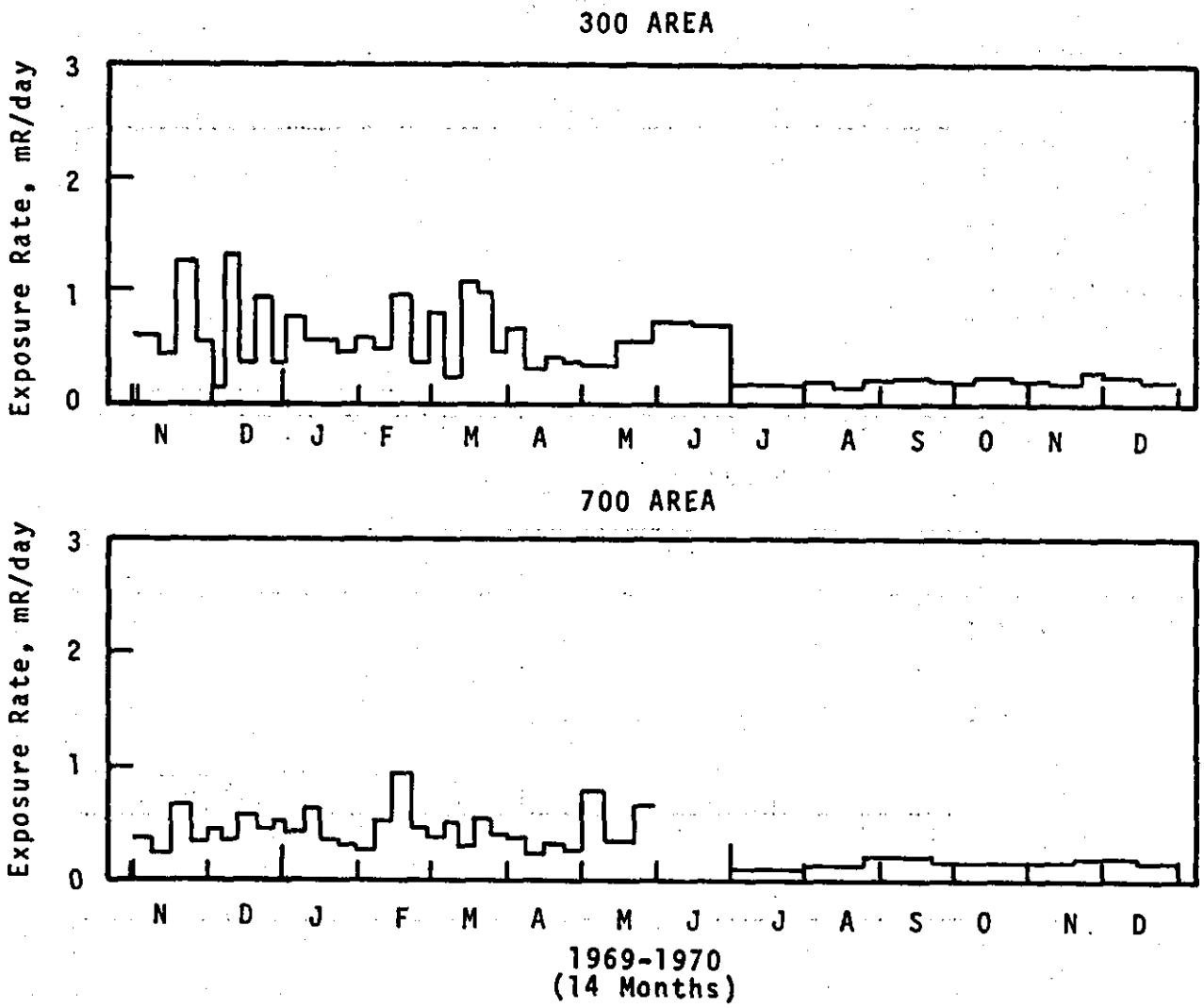


FIGURE 33

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

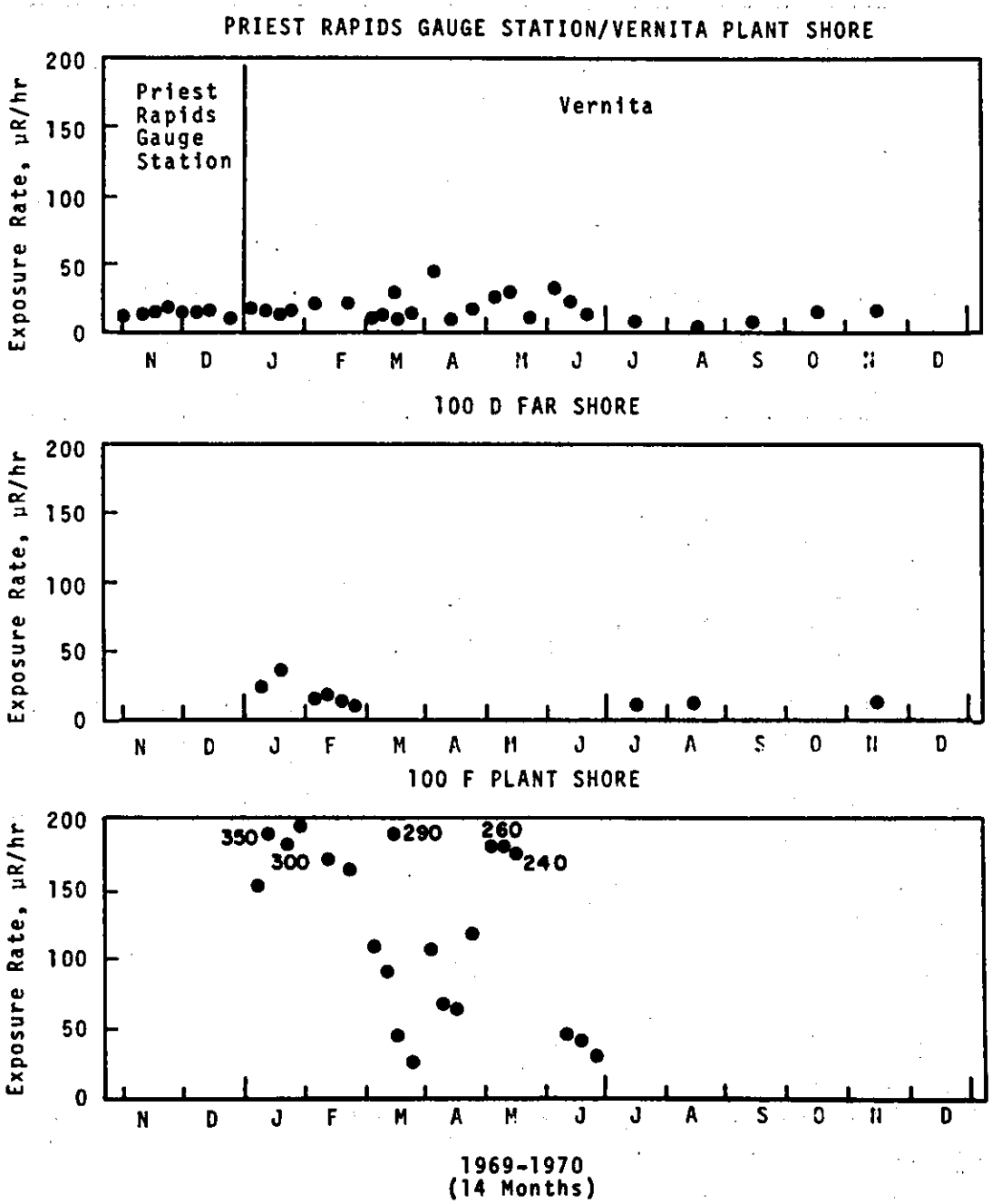


FIGURE 34

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

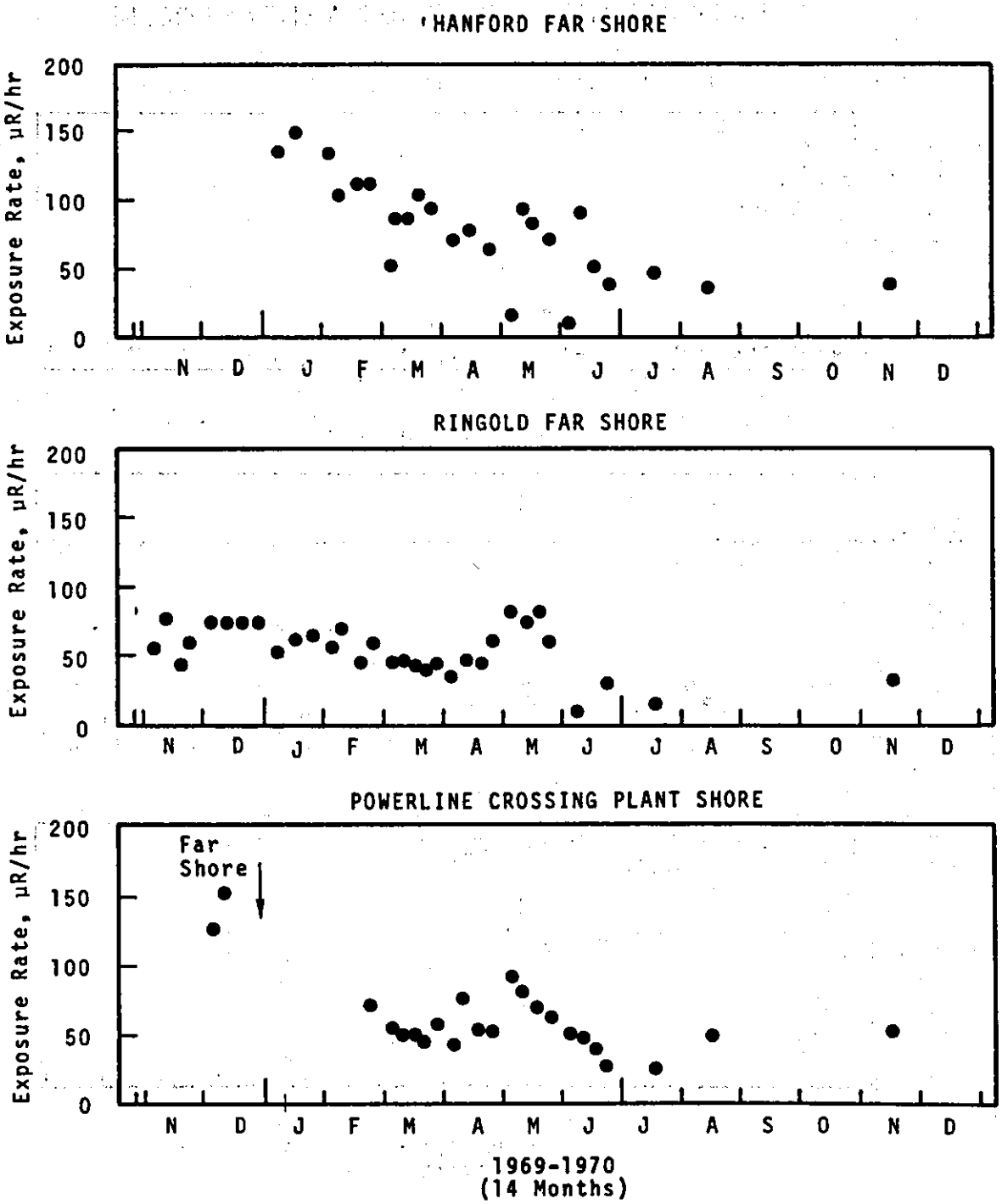


FIGURE 35

EXTERNAL RADIATION AT THE COLUMBIA RIVER SHORELINE

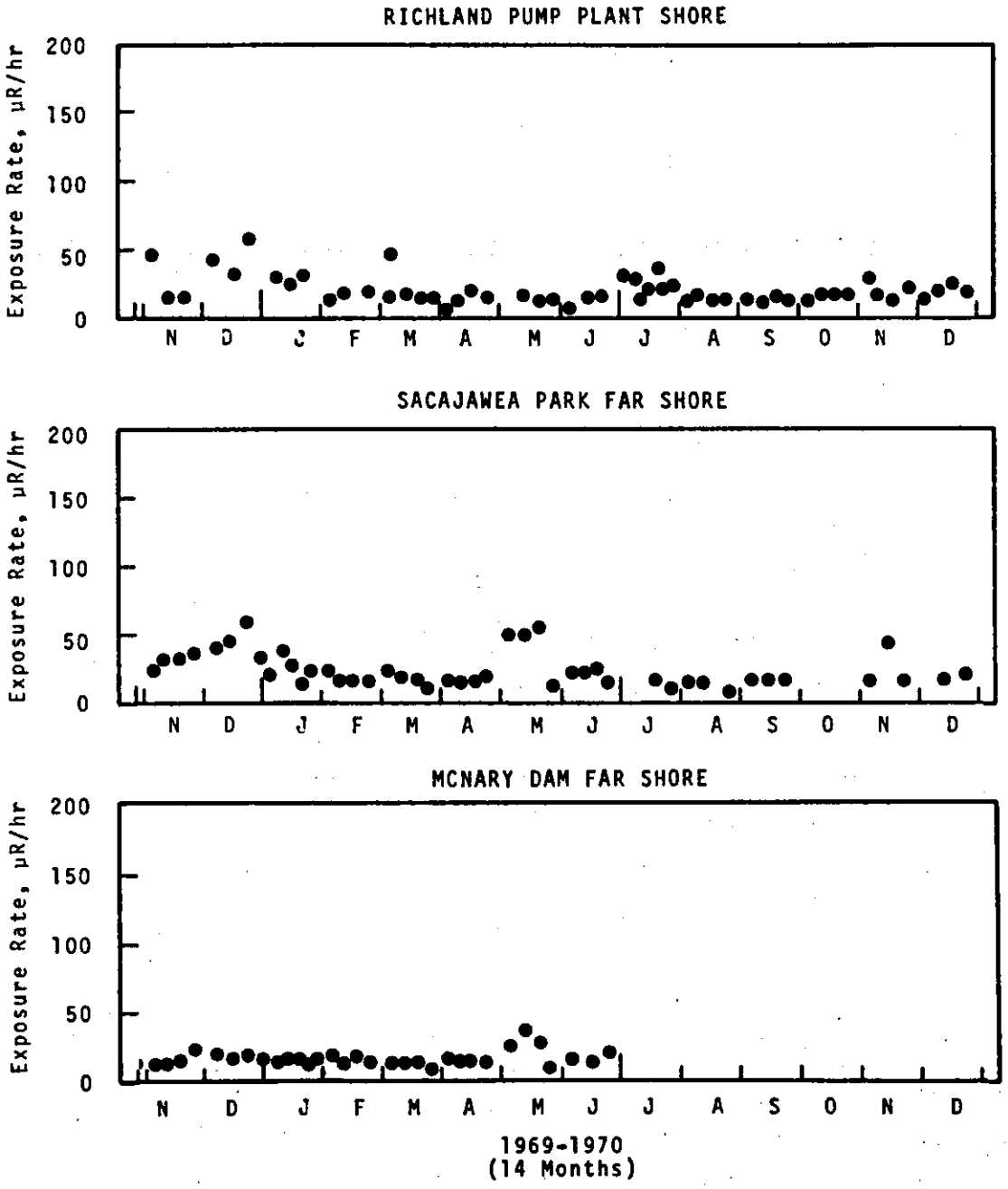


FIGURE 36

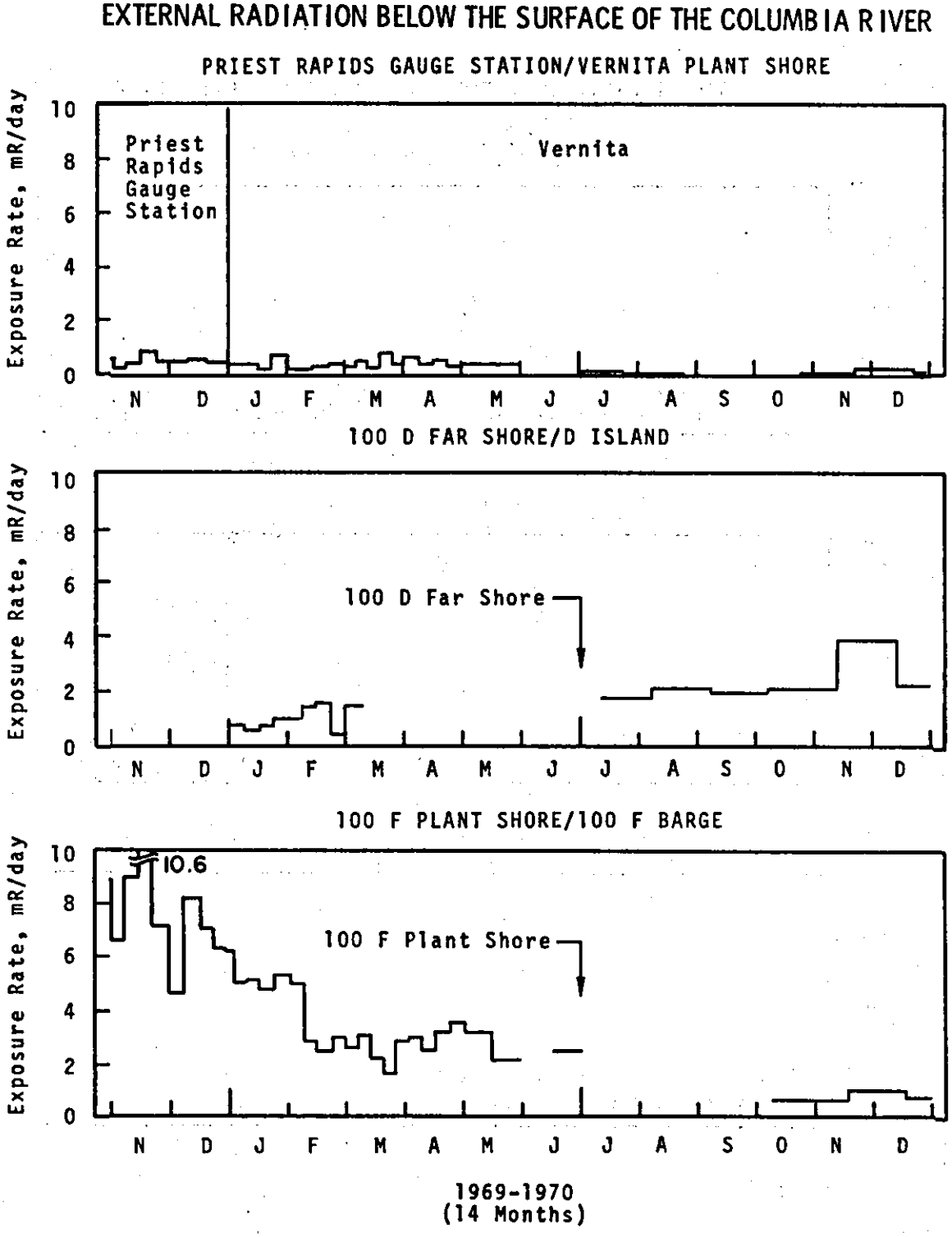

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER
PRIEST RAPIDS GAUGE STATION/VERNITA PLANT SHORE
Exposure Rate, mR/day
10
8
6
4
2
0
Priest Rapids Gauge Station
Vernita
N D J F M A M J J A S O N D
100 D FAR SHORE/D ISLAND
Exposure Rate, mR/day
100 D Far Shore
N D J F M A M J J A S O N D
100 F PLANT SHORE/100 F BARGE
Exposure Rate, mR/day
10.6
100 F Plant Shore
N D J F M A M J J A S O N D
1969-1970
(14 Months)

FIGURE 37

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER

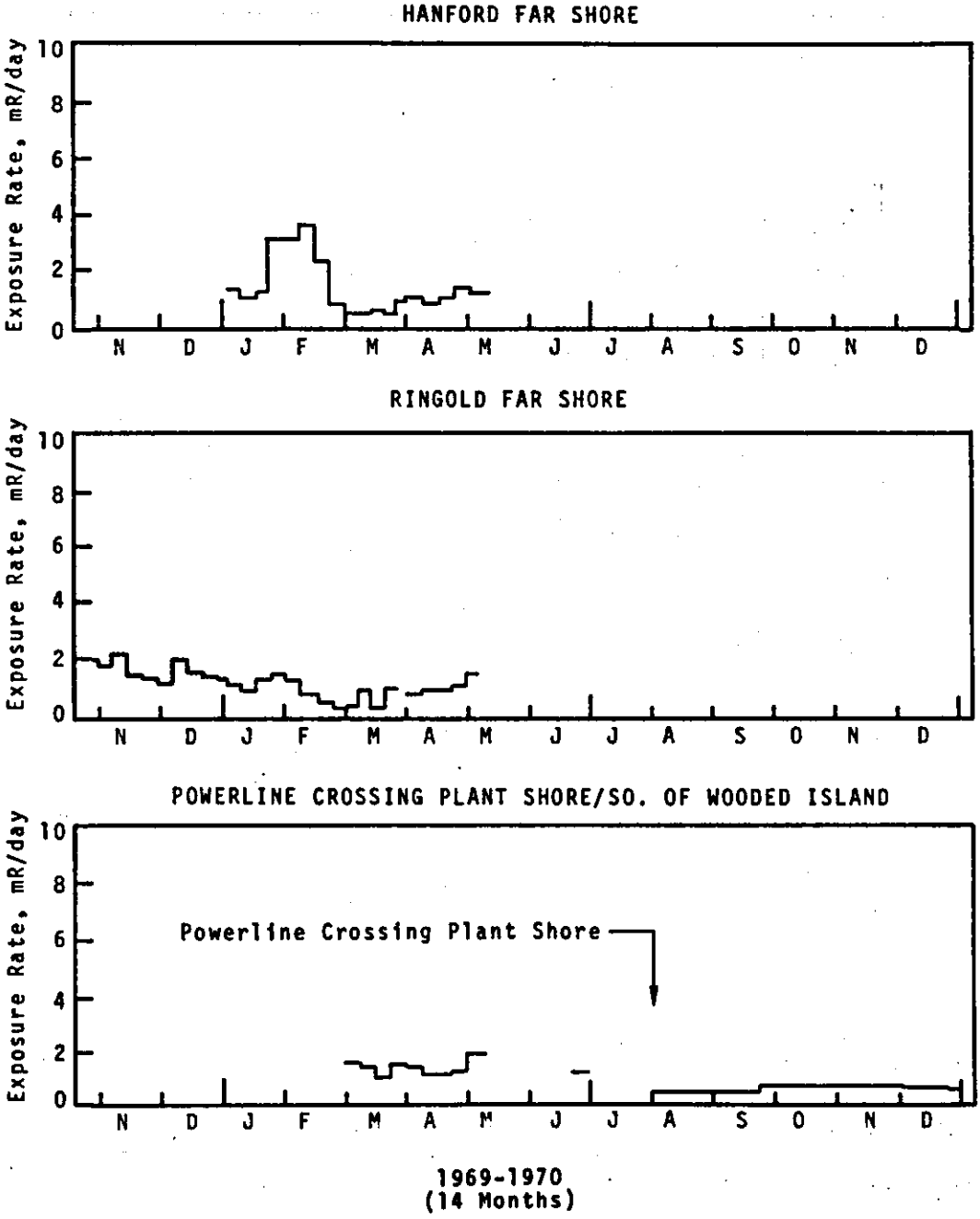


FIGURE 38

EXTERNAL RADIATION BELOW THE SURFACE OF THE COLUMBIA RIVER

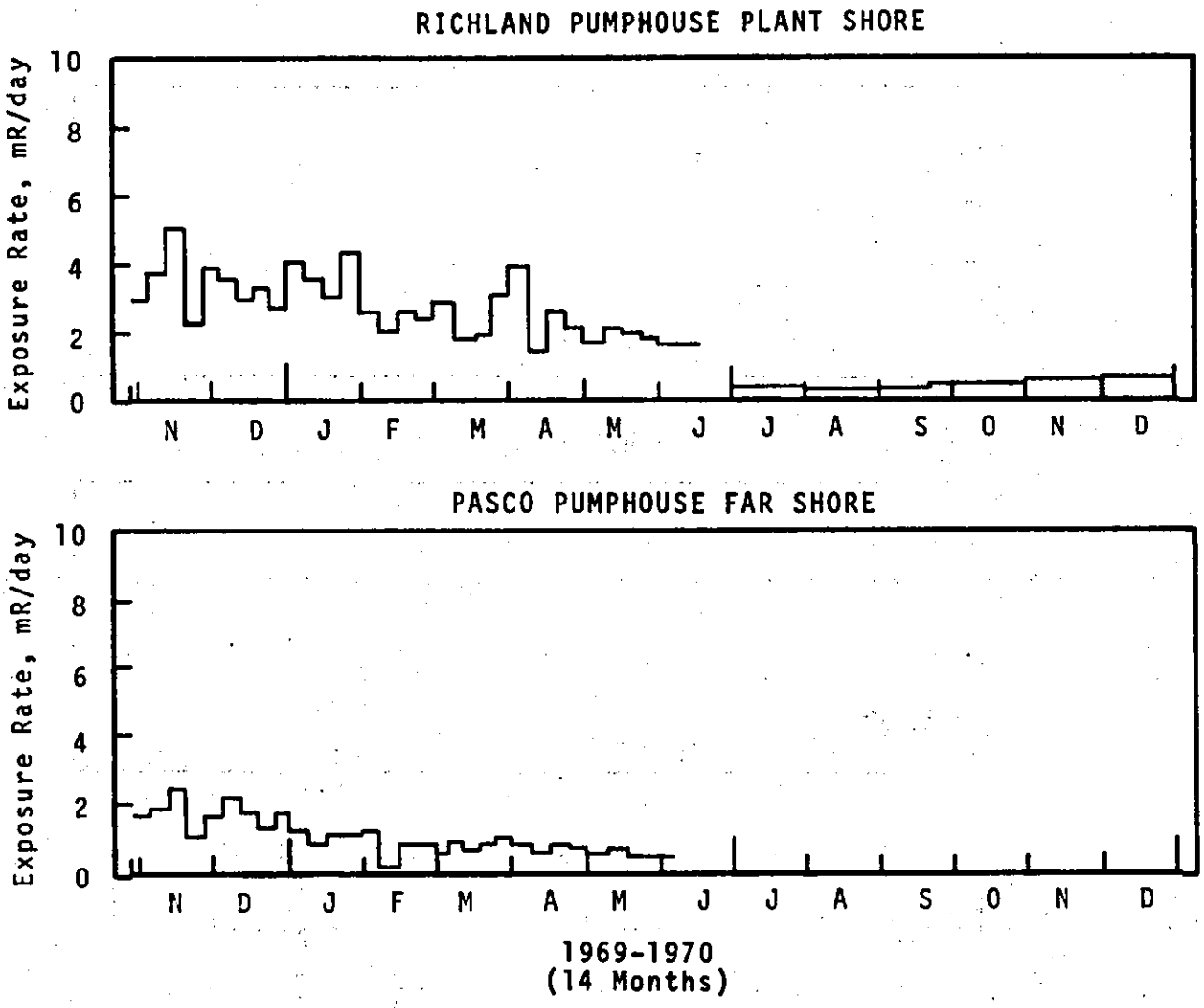


FIGURE 39

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