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Environmental Status of the Hanford Site for CY-1976

May 1977

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Battelle
Pacific Northwest Laboratories

BNWL-2246

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ENVIRONMENTAL STATUS OF THE HANFORD SITE FOR CY-1976

by

Jack J. Fix, Peggy J. Blumer, Phil E. Bramson
Occupational and Environmental Safety Department

May 1977

BATTELLE
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INTRODUCTION

The environmental surveillance and evaluations program conducted by Battelle, Pacific Northwest Laboratory (also referred to as Battelle-Northwest or BNW) under contract to the U.S. Energy Research and Development Administration (ERDA) provides measurement and interpretation of Hanford operations radiological impact upon its environs, both onsite and offsite. In compliance with appropriate regulations, radiation exposures to population groups due to Hanford operations are evaluated. Also, contributions to environmental radioactivity due to fallout from nuclear detonations in the atmosphere and naturally-occurring radioactivity are evaluated and used to determine the relative significance of the radiological impact attributable to Hanford operations.

The program is designed so that all significant potential pathways are evaluated, including particularly, those resulting in direct exposure to the public and those wherein environmental reconcentration is likely to occur. Summaries of the data and interpretations are published in a series of annual reports. Ground-water data and evaluations are reported in the series, "Radiological status of the Ground Water Beneath Hanford Project for...," the latest issue being BNWL-2199 for 1976.[1] Environmental data from offsite locations are presented in the annual "Environmental Surveillance at Hanford..." series of reports, the latest being BNWL-2142 for 1976.[2] Environmental data from locations within the plant boundaries are presented in the annual "Environmental Status of the Hanford Reservation for..." report series, the previous report being BNWL-B-477 for 1975.[3] The present report describes each major monitoring program and evaluates data collected during 1976.

SUMMARY

Environmental data were collected on the Hanford Site during 1976 for several environmental media including air, Columbia River water, wildlife, ambient radiation levels, soil and vegetation, as well as ditches, ponds and trenches near operating facilities. In addition, all roadways, railways, and active, as well as retired burial grounds were surveyed on a varying frequency to detect any abnormal levels of radioactivity. Highlights of the monitoring data collected during 1976 follow:

- Radionuclide concentrations observed at perimeter and distant sampling locations were similar implying no distinguishable impact from Hanford operations. However, elevated levels of ^{137}Cs and ^{90}Sr were observed for the 200 East and 200 West filter composites relative to the levels observed elsewhere. The maximum levels observed were less-than 1% of the most restrictive ERDA Manual Chapter 0524 guidelines for unrestricted areas. (See pages 1-13.)
- Elevated levels of several radionuclides, generally short-lived, were observed in the Columbia River following spill cooler failures at N-Reactor during March and November. Downstream concentrations of ^{60}Co were elevated compared to upstream concentrations throughout the year and are attributed to routine low level releases at N-Reactor. The maximum levels of all radionuclides were less-than 1% of the most restrictive ERDAM 0524 guidelines for unrestricted areas. (See pages 14-16.)
- All onsite ponds, including naturally-occurring West Lake, had similar levels of gross alpha, gross beta, and ^{90}Sr activity. Radioactivity in West Lake is apparently elevated due to the concentrating effect of evaporation of water from the pond. The other ponds receive low-level waste from Hanford facilities. (See pages 17-21.)
- Wildlife consisting of game birds, deer, rabbits, mice, and coyotes were sampled on the Hanford Site. All wildlife, with the exception of ducks and geese from along the Columbia River and pheasant and quail from the 100 Areas, showed elevated levels of activity directly related to Hanford operations. Dose estimates to an individual assumed to

ingest 500 grams of duck meat or about 23 kilograms (50 pounds) of deer meat containing the maximum amounts of radionuclides observed would be 7.3 mrem and 6.8 mrem, respectively. (See pages 22-28.)

- There was no conclusive impact from Hanford operations on soil and vegetation samples collected during 1976. (See pages 28-33.)
- Ambient levels of radiation dose measured at perimeter and distant locations were indistinguishable implying no detectible Hanford impact. However, several onsite locations, primarily in the 200 Areas and 100-N Area, showed elevated levels of dose attributable to Hanford operations. (See pages 34-40.)
- Ambient levels of radiation measured at several locations along the Columbia River islands and shoreline were elevated compared to other locations. Residual quantities of ^{60}Co associated with sediment from past once-through production reactor operations cause the elevated levels. The maximum dose observed is 0.014 mrem/hr in addition to the approximate 0.008 mrem/hr due to background radiation. (See pages 40-43.)
- Portable instrument surveys of Hanford Site roadways, railways and waste disposal sites did not show any conditions which warranted immediate corrective action. Any unusual conditions noted were reported to the responsible contractor representative for corrective action.

ATMOSPHERIC MONITORING

Air samplers were maintained at onsite, perimeter, and distant locations during 1976 as shown in Figures 1 and 2. Specific locations of samplers around operating areas are shown in Appendix A. Each air sampler maintains a flow of 2.5 m^3/hr through a particle filter (Hollingsworth and Vose Company HV-70) and a 15-cm long, 5-cm diameter charcoal cartridge. The filters were collected biweekly and analyzed for gross beta and alpha activity after waiting a minimum of 7 days to allow the short-lived radon and thoron daughters to decay. The filters were composited into groups according to geographical location and analyzed monthly by gamma spectroscopy and quarterly for ^{90}Sr and plutonium. At a few selected locations,

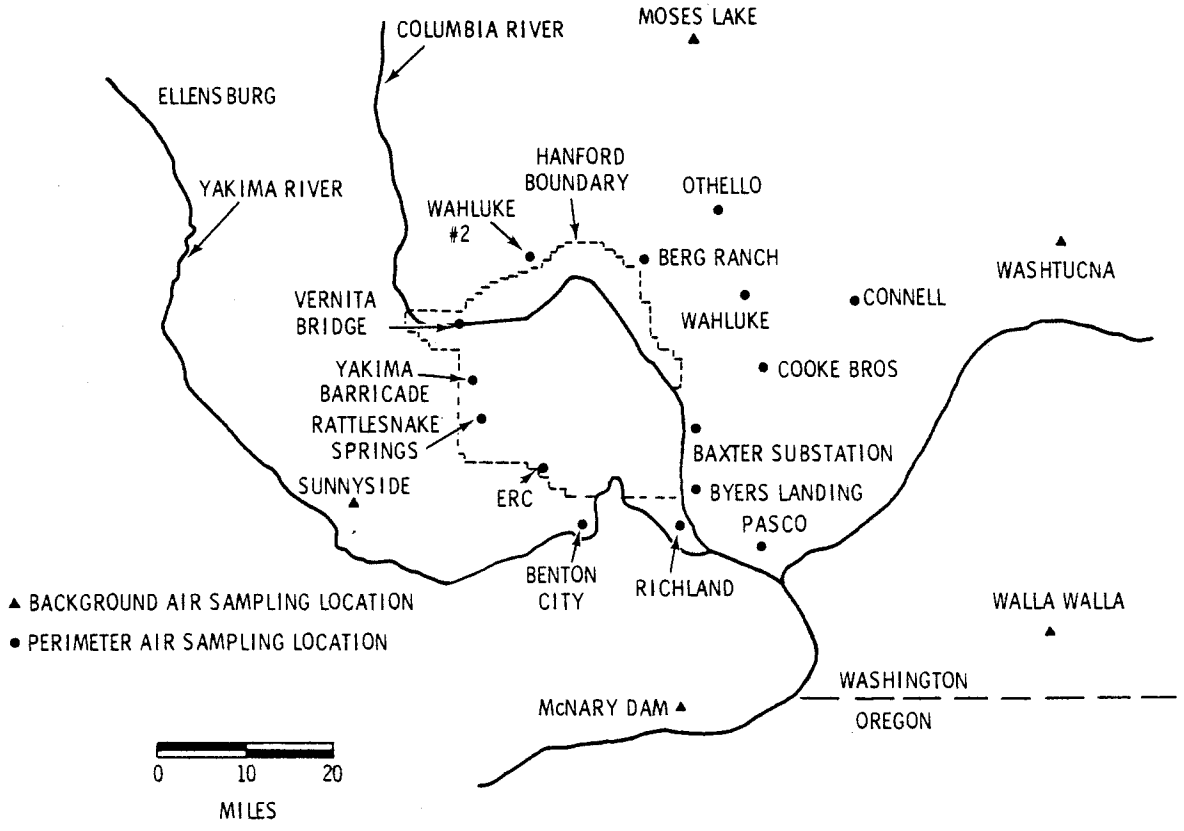

FIGURE 1. Hanford Environmental Air Sampling Locations During 1976

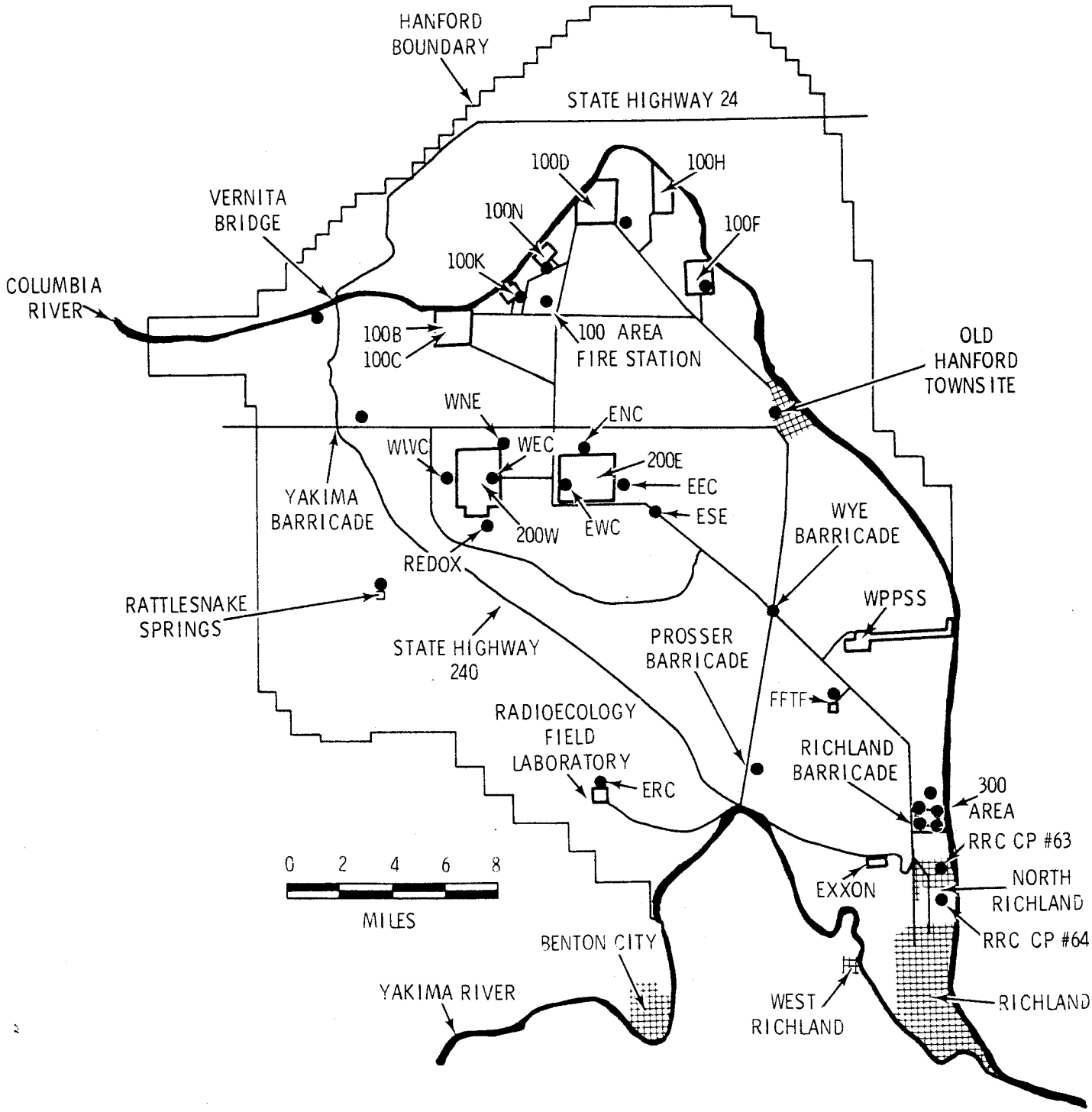

FIGURE 2. Onsite and North Richland Air Sampling Locations During 1976

transparent cartridges 25 cm long and 5 cm in diameter containing indicating silica gel were used to collect water vapor in air during biweekly sampling periods for analysis for tritium. An air flow of 70 cm^3/min passes through the cartridge after the air has passed through the particle filter. Table 1 lists all the air sampling stations, the filter used, status of charcoal or silica gel cartridges, and composite group for each filter.

Figure 3 illustrates the average monthly beta concentrations observed at eastern quadrant stations, which are located in the predominately downwind direction from Hanford operations, compared with the concentrations observed at onsite and distant stations (for the years 1972 through 1976).

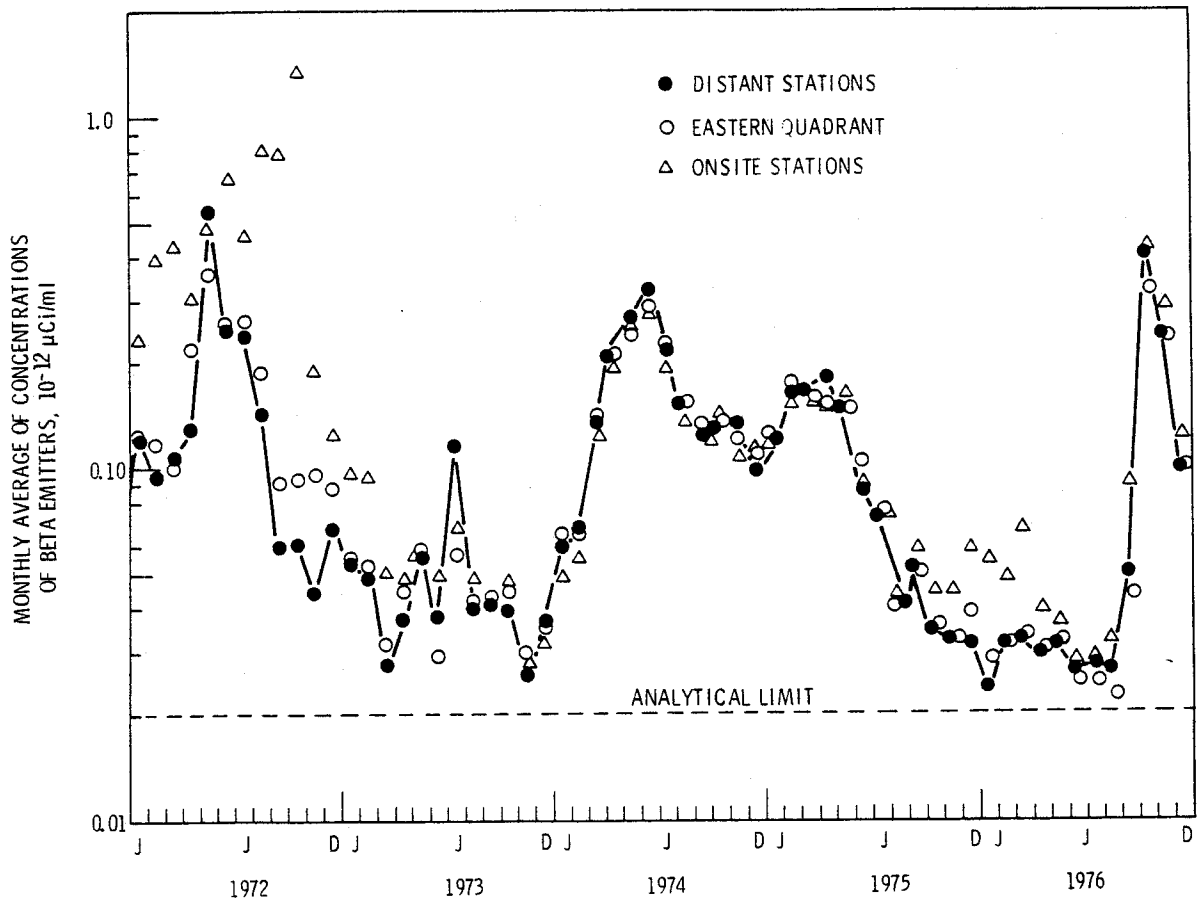

FIGURE 3. Monthly Average Gross Beta Activity in the Atmosphere

TABLE 1. Hanford Air Sampling Network During 1976 Including Location, Filter Used, Frequency of Sample Collection, and Composite Group

Location	Frequency[a]				Composite Group										
	Filter Type	Filter	Charcoal	Silica Gel	Onsite Area Comp				Inner Quadrant					Outer Quadrant		
					1	2E	2W	3	NE	E	SE	SW	NW	NE	SE	W
Onsite																
200 ENC	HV-70	BW	M (NRA)	BW		*										
200 ESE	HV-70	BW	BW			*										
200 EWC	HV-70	BW	M (NRA)			*										
200 EEC	HV-70	BW	M (NRA)			*										
200 WEC	HV-70	BW	M (NRA)				*									
Redox	HV-70	BW	M (NRA)				*									
200 WWC	HV-70	BW	M (NRA)				*									
200 WNE	HV-70	BW	M (NRA)				*									
3705 Bldg.	HV-70	BW	M (NRA)					*								
ACRMS	HV-70	BW	M (NRA)					*								
300 Pond	HV-70	BW	M (NRA)					*								
300 SW Gate	HV-70	BW	BW					*								
300 South Gate	HV-70	BW	M (NRA)					*								
Prosser Barr.	HV-70	BW	M (NRA)									*				
100K	HV-70	BW	M (NRA)		*											
100N	HV-70	BW	BW	BW	*											
100D	HV-70	BW	M (NRA)		*											
100F	HV-70	BW	M (NRA)		*											
100 Fire Stn.	HV-70	BW	M (NRA)		*											
Hanford	HV-70	BW	M (NRA)							*						
FFTF	HV-70	BW	M (NRA)							*						
Wye Barr.	HV-70	BW	M (NRA)							*						
Rattlesnake Springs	HV-70	BW	M (NRA)									*				
ERC	HV-70	BW	M (NRA)									*				
Yakima Barr.	HV-70	BW	M (NRA)										*			
Wahluke #2	HV-70	BW	M (NRA)										*			
Perimeter																
Pasco	HV-70	BW	M (NRA)								*					
Richland	HV-70	BW	BW	BW							*					
Benton City	HV-70	BW	BW									*				
Vernita	HV-70	BW	M (NRA)										*			
Berg Ranch	HV-70	BW	M (NRA)						*							
Wahluke Wm.	HV-70	BW	M (NRA)						*							
Cooke Bros.	HV-70	BW	M (NRA)						*							
Baxter Sub.	HV-70	BW	BW	BW							*					
Byers Landing	HV-70	BW	BW								*					
Othello	HV-70	BW	M (NRA)						*							
Connell	HV-70	BW	M (NRA)						*							
C.P. #63	HV-70	BW	M (NRA)													
C.P. #64	HV-70	BW	M (NRA)													
Distant																
Walla Walla	HV-70	BW	M (NRA)											*		
McNary	HV-70	BW	M (NRA)											*		
Sunnyside	HV-70	BW	M (NRA)													*
Moses Lake	HV-70	BW	M (NRA)											*		
Washtucna	HV-70	BW	M (NRA)											*		

[a] Frequency of sample collection: BW-biweekly, M-monthly. All analyses by U.S. Testing except NRA (not routinely analyzed).

The distant stations are sufficiently remote from Hanford operations that observed levels of radiation were assumed due to natural causes or fallout. The gross beta activity in the atmosphere increased sharply, as shown in Figure 3, following a nuclear detonation in the atmosphere on September 26, 1976, by the Peoples Republic of China. Average gross beta concentrations shown in Figure 3 at onsite locations, primarily around the 200 Areas, were elevated compared to average concentrations at perimeter and distant locations. This increase is attributed to ^{137}Cs released in the 200 Areas.

The results of gross beta, gross alpha, and ^{131}I analyses for the different sampling locations are shown in Table 2. The average beta concentration during 1976 observed at perimeter and distant stations was 0.9×10^{-13} µCi/cc. The average beta concentrations for onsite locations was 1.1×10^{-13} µCi/cc or slightly higher than the averages for perimeter and distant locations. This is due to the elevated levels observed at the 200 ENC, 200 WEC, 200 WWC and Redox sampling locations.

Analysis for gross alpha concentrations in the atmosphere during 1976 was done on filters obtained from 9 of the 26 onsite and 4 of the 13 perimeter sampling stations. The results were similar at all locations and the activity observed was attributed to naturally-occurring radioactivity in air.

Analysis for ^{131}I concentrations in the atmosphere was performed on a biweekly interval for three of the onsite and four of the perimeter sampling stations during 1976. Although charcoal cartridges were located at all onsite, perimeter and distant sampling stations (Table 1), the majority were not analyzed but provided available samples for analysis if there had been any indication that iodine was present in the atmosphere. The charcoal for all stations was changed monthly. Only three locations, one onsite and two perimeter, showed positive measurement of ^{131}I during 1976. However, the measurements were very near the detection limit of the analysis and are attributed to the statistical variability associated with low level counting; 6 out of 180 measurements during 1976 were greater than the 2-sigma counting uncertainty. A small percentage of the analyses are expected to yield positive results even if the radionuclide is not present.

TABLE 2. Radioactivity in Air - 1976

Concentration (10^{-12} µCi/ml)[a]

Location	Gross Beta				Gross Alpha[b]				^{131}I			
Analytical Limit		0.01				0.0003				0.02		
Concentration Guide[c]		100				0.02				100		
	No. of Samples	Max.	Min.	Average	No. of Samples	Max.	Min.	Average	No. of Samples	Max.	Min.	Average
Onsite Stations												
100K	26	0.51	0.02	0.09 ± 0.24								
100N - WPPSS	27	0.57	0.01	0.10 ± 0.24					26	0.05	*	<0.02
100D	26	0.53	0.02	0.10 ± 0.28								
100F	25	0.68	0.02	0.10 ± 0.31								
100 Area Fire Station	26	0.49	0.02	0.09 ± 0.26								
Hanford	25	0.59	0.02	0.10 ± 0.30								
200 ENC	25	0.88	0.02	0.14 ± 0.39	26	0.004	0.0004	0.002				
200 ESE	27	0.42	0.02	0.10 ± 0.23	27	0.004	*	<0.002	25	*	*	*
200 EEC	24	0.49	0.03	0.11 ± 0.24	23	0.003	0.0007	0.002				
200 EWC	27	0.72	0.02	0.10 ± 0.30								
200 WNE	26	0.62	0.02	0.11 ± 0.29								
200 WEC	25	0.54	0.01	0.13 ± 0.29	25	0.003	0.0006	0.002				
200 WWC	26	0.82	0.01	0.16 ± 0.41								
Redox	25	0.91	0.02	0.18 ± 0.42	25	0.004	*	<0.002				
FFTF	21	0.36	0.02	0.07 ± 0.18	21	0.004	0.0007	0.002				
Wye Barricade	25	0.76	0.02	0.10 ± 0.32	25	0.004	0.0006	0.002				
300 Pond	26	0.46	0.02	0.09 ± 0.21								
300 SW Gate	25	0.44	0.02	0.09 ± 0.24					26	*	*	*
300 South Gate	26	0.66	0.02	0.10 ± 0.29	26	0.003	0.0006	0.002				
3705 Bldg.	25	0.44	0.01	0.09 ± 0.24								
ACRMS	26	0.38	0.02	0.08 ± 0.19								
Prosser Barricade	26	0.62	0.01	0.09 ± 0.28	26	0.004	*	<0.002				
				0.11 ± 0.05[d]								
Perimeter Stations												
Benton City	25	0.66	0.02	0.10 ± 0.31	26	0.005	*	<0.002	26	*	*	*
ERC	26	0.63	0.02	0.09 ± 0.28								
Rattlesnake Spring	24	0.78	0.01	0.11 ± 0.36								
Yakima Barricade	23	0.75	0.02	0.10 ± 0.34								
Vernita Bridge	26	0.70	0.01	0.09 ± 0.29								
Wahluke #2	26	0.38	0.02	0.08 ± 0.20								
Othello	25	0.39	0.02	0.08 ± 0.21								
Connell	25	0.73	0.02	0.10 ± 0.33								
Berg Ranch	23	0.50	0.02	0.10 ± 0.29	25	0.004	*	<0.002				
Wahluke Wm.	24	0.53	0.02	0.09 ± 0.25								
Cooke Bros.	24	0.24	0.02	0.05 ± 0.11								
Baxter Substation	24	0.30	0.01	0.06 ± 0.16					25	0.03	*	<0.02
Byers Landing	26	0.52	0.01	0.08 ± 0.23	25	0.003	0.0003	0.002	26	*	*	*
RRC CP #63	26	0.70	0.02	0.11 ± 0.32	25	0.004	*	<0.002				
RRC CP #64	25	0.32	0.02	0.08 ± 0.19								
Richland	24	0.44	0.01	0.08 ± 0.22	24	0.003	0.0007	0.002	26	0.03	*	<0.02
Pasco	25	0.42	0.02	0.07 ± 0.18								
				0.09 ± 0.03[d]								
Distant Stations												
Walla Walla	26	0.90	0.02	0.11 ± 0.37								
McNary	26	0.65	0.02	0.10 ± 0.32								
Sunnyside	24	0.34	0.02	0.08 ± 0.19								
Moses Lake	22	0.46	0.02	0.09 ± 0.23								
Washtucna	26	0.51	0.02	0.09 ± 0.25								
				0.09 ± 0.02[d]								

No entry indicates no analysis.

*Less than detectable.

(a) 1 pCi/m^3 = 10^{-12} µCi/ml. Average ±2 standard deviations shown if all analyses had positive results. Otherwise, a less-than number is calculated from all results, including less-than values.

(b) Gross alpha activity does not include any significant contribution due to naturally-occurring radon and short-lived daughters in the air. The filters are held 7 days before analysis to allow radioactive decay of these radionuclides.

(c) ERDAM-0524 standards only apply to concentrations of radioactivity in excess of that due to naturally-occurring or fallout radioactivity.

(d) Average ±2 Standard Deviations.

During 1976, tritiated water vapor (HTO) was measured at two onsite and two perimeter sampling stations. An air flow of approximately 1 ft^3/hr was maintained through a transparent 25-cm long, 5-cm diameter cartridge containing indicating silica gel. The biweekly results expressed in terms of specific activitiy (pCi/l) are shown in Figure 4. There are no apparent geographical patterns and the observed concentrations are attributed to fallout. The approximate average air concentration during a two-week sampling period in which 30 ml of water are collected containing 1000 pCi/l of tritium would be 3.2×10^{-12} µCi/cc. The most restrictive ERDA Manual Chapter 0524 guideline for HTO in air is 2×10^{-7} mCi/cc, or a factor of about 10^5 greater.

Results of specific radionuclide analyses are shown in Figure 5 for each monthly or quarterly analysis for each of the 12 filter composite groups (see Table 1). A comparison of the concentrations observed during the year onsite at stations with the concentrations observed at perimeter or distant

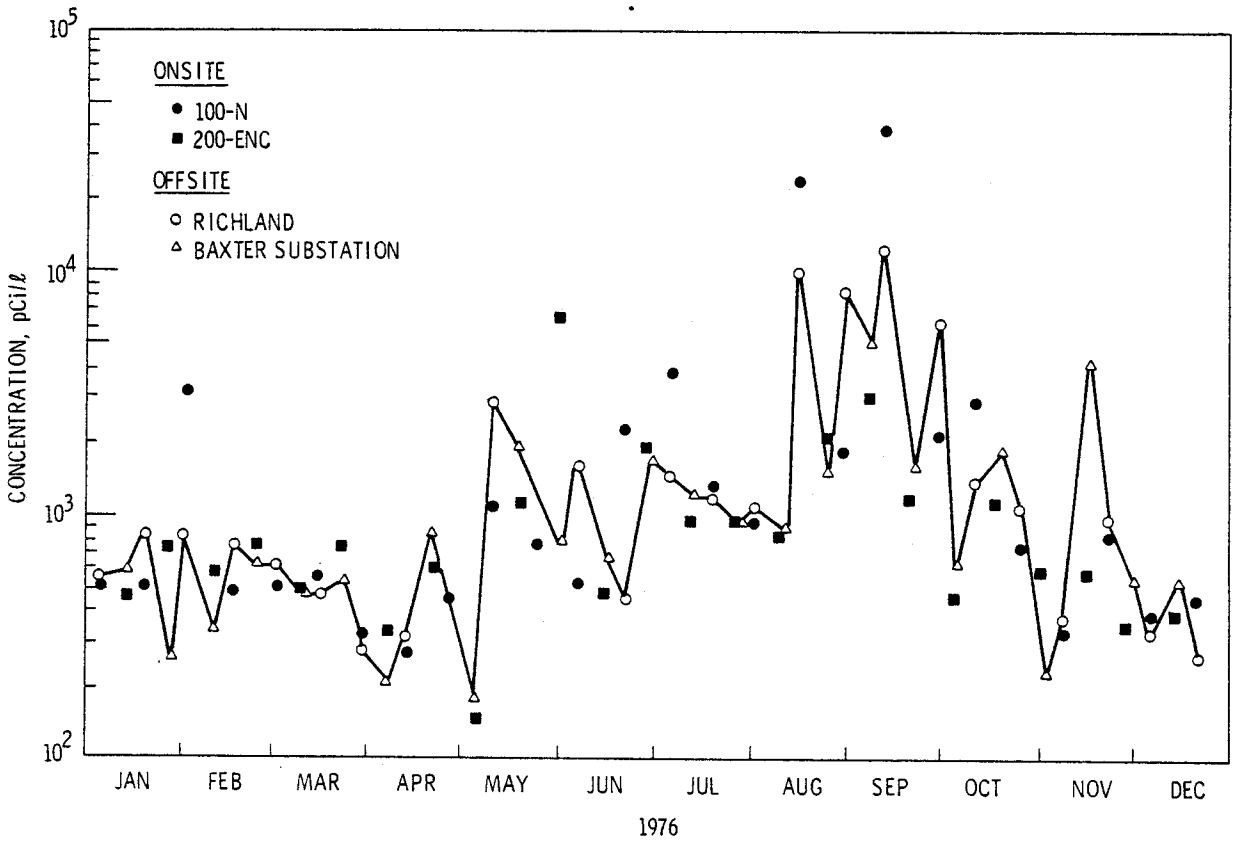

FIGURE 4. Specific Activity of Tritiated Water Vapor During 1976

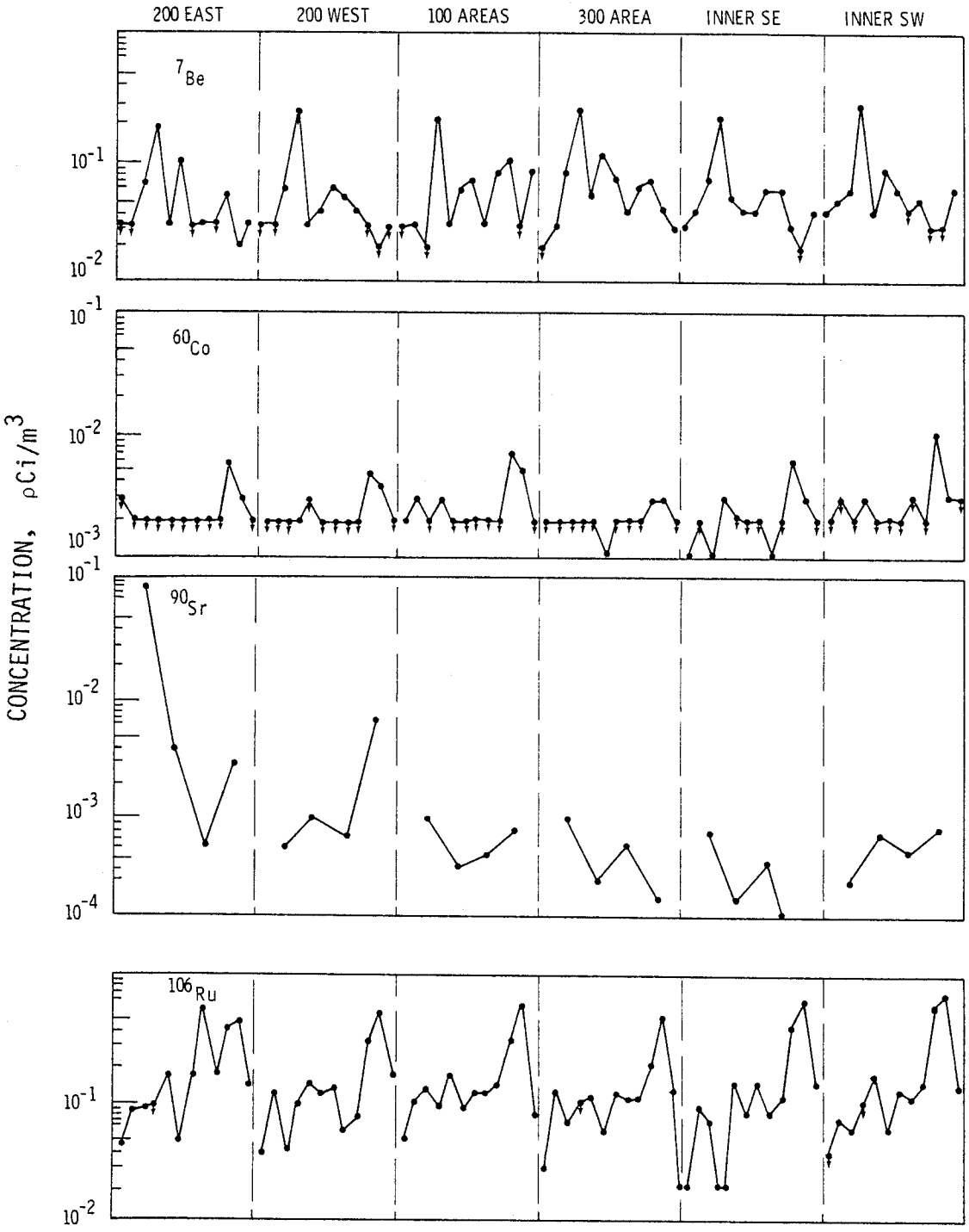

FIGURE 5. Concentrations of Radionuclides in Air for Each of the 12 Filter Composite Groups

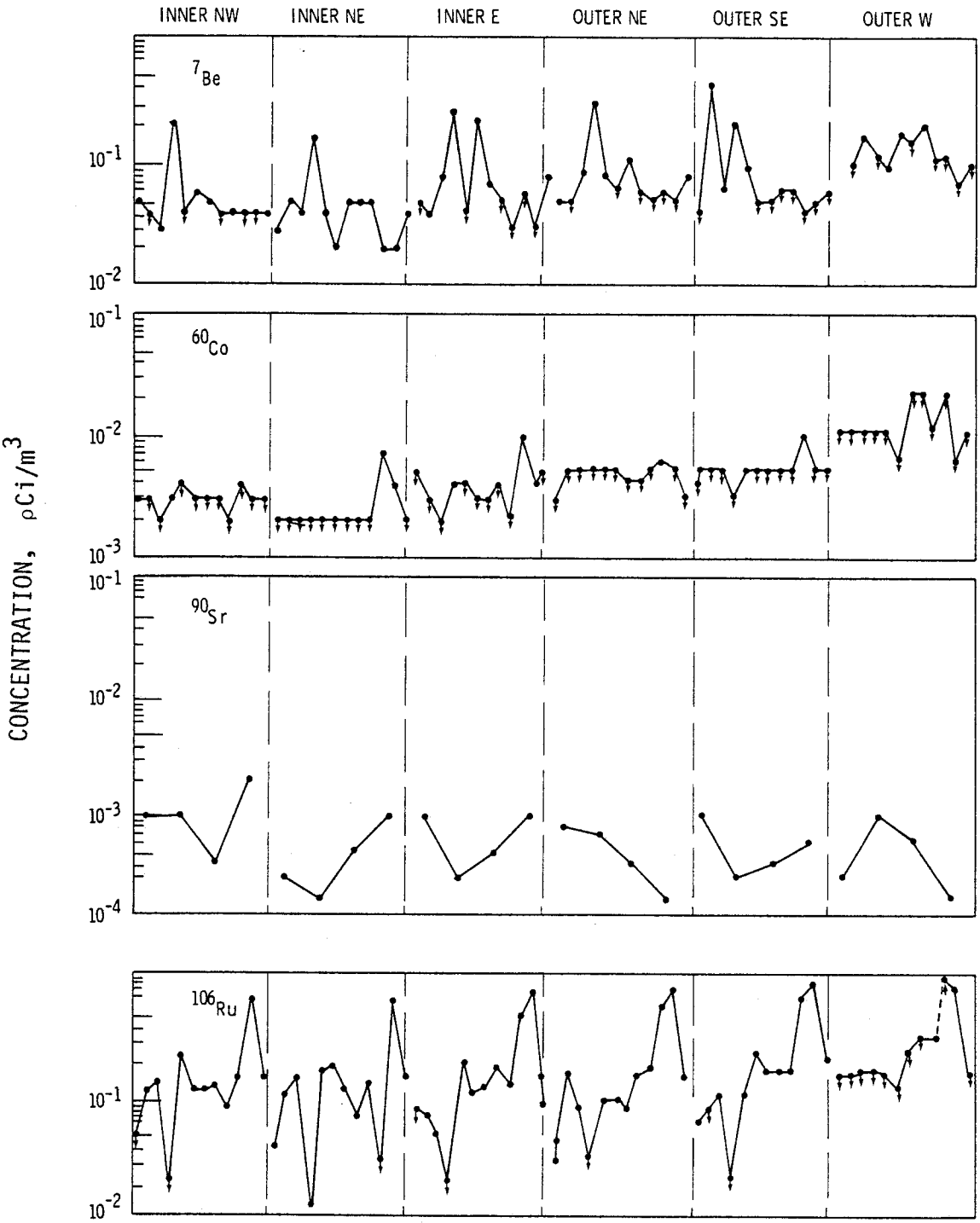

FIGURE 5. (Continued)

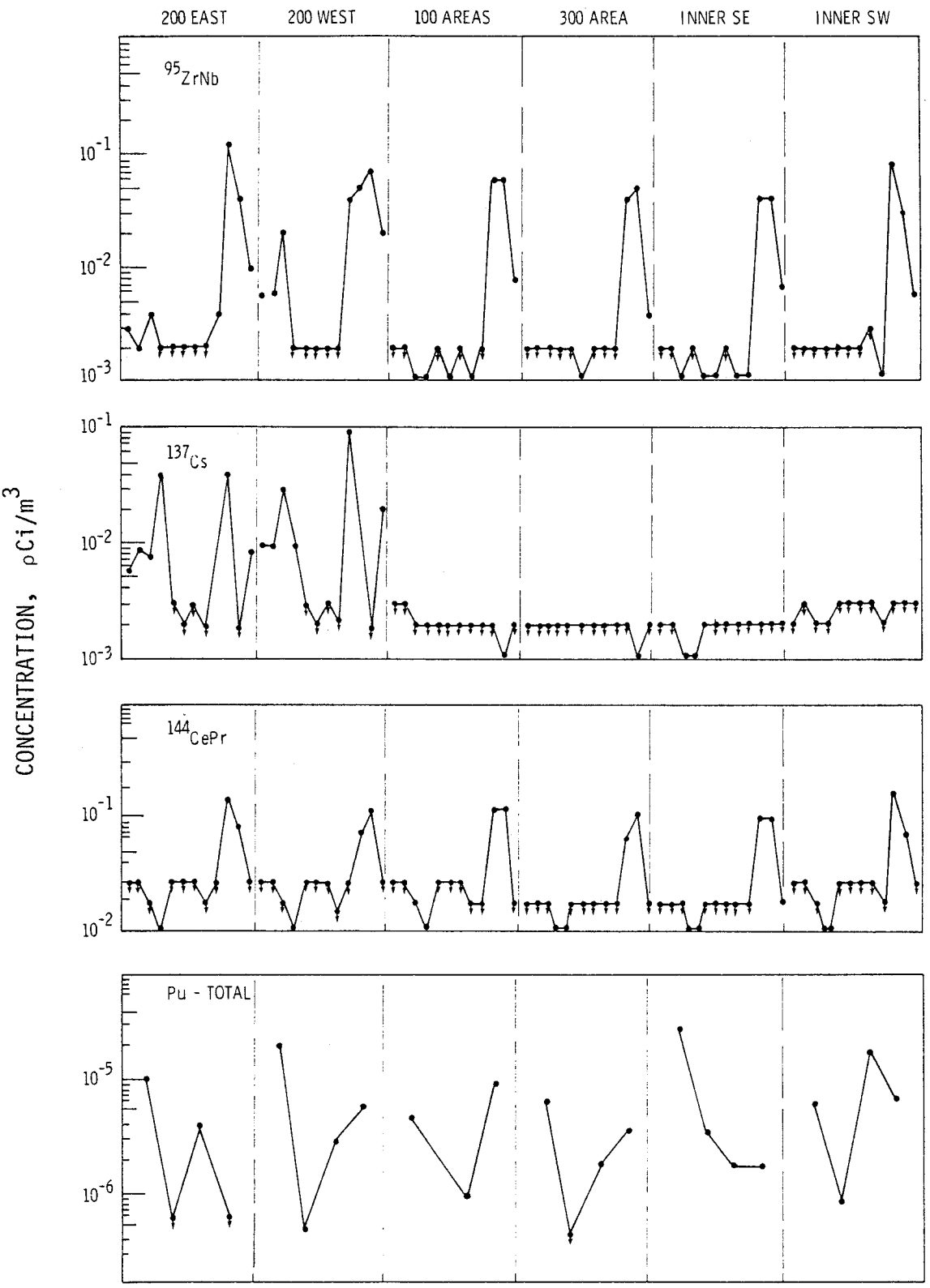

FIGURE 5. (Continued)

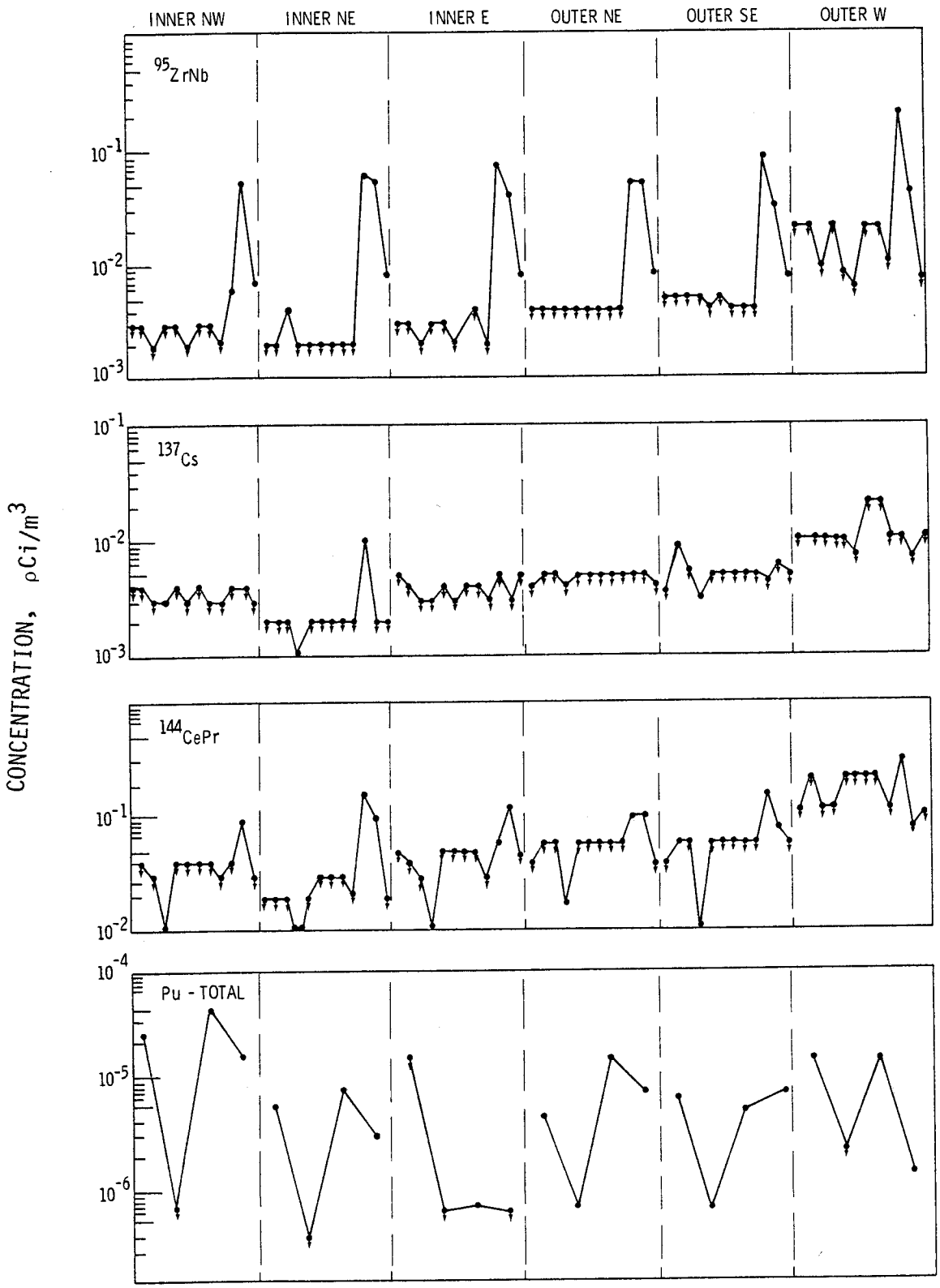

FIGURE 5. (Continued)

stations will shown any Hanford contributions to the observed concentrations. Beryllium-7 is a naturally-occurring radionuclide formed by the interaction of cosmic rays with oxygen and nitrogen radionuclides in Figure 5, except Pu, are fission or activation products resulting from worldwide fallout and, potentially, Hanford operations.

The yearly pattern of concnetrations for the different radionuclides was generally similar for each composite group. Cobalt-60, ^{95}ArNb, ^{106}Ru, and ^{144}CePr concentrations all increased sharply in the fall following the Chinese test. Cesium-137 concentrations observed in the 200 East and 200 West filter composites and are attributed to Hanford operations in the 200 Areas. Also, the maximum ^{90}Sr concentrations observed were for the 200 Area operaions. All other radionuclide concentrations were similar for each of the filter composites implying that any Hanford contribution is indistinguishable from the levels attributed to worldwide fallout.

In summary, radionuclide concentrations at perimeter and distant sampling stations were similar, implying no distinguishable impact from Hanford operations. However, eleveated levels of ^{137}Cs and ^{90}Sr were observed for the 200 East and 200 West filter composites relative to the concentrations observed in other filter composites. In Table 3, the maximum observed concentration for any composite group are compared with ERDA Manual Chapter 0524 concentrations for uncontrolled areas. In all cases, the observed values are a small fraction of the concentration guides.

TABLE 3. Maximum Concentrations of Selected Radionuclides in Air During 1976

Radionuclides	Concentration (10^{-12} µCi/ml) Maximum Observed	ERDA 0524[a] Guideline	Composite Group
^{7}Be	0.45	40,000	Outer SE
^{60}Co	0.02	300	Outer W
^{90}Sr	0.09	30	200-E
$^{95}ZrNb$	0.18	3,000	Outer W
^{106}Ru	1.6	200	Outer W
^{137}Cs	0.1	500	200-W
$^{144}CePr$	0.3	200	Outer W
Pu-Total	5×10^{-5}	0.06[b]	Inner NW

[a] Most restrictive ERDA 0524 guideline for uncontrolled areas.

[b] Concentration Guide for ^{239}Pu.

COLUMBIA RIVER MONITORING

Columbia River water was obtained upstream (at Priest Rapids Dam, Vernita Bridge and 100-B) and downstream (at Hanford Powerline, 300 Forebay, and Richland pumping dock) for radiological, chemical, physical, and/or biological analyses. The majority of the information has been evaluated and presented in the 1976 Environmental Surveillance Report.[2] More specific information regarding the sample collection and analysis procedures are discussed herein.

Analysis for ^{3}H, U, and ^{90}Sr in Columbia River water is done for cumulative water samples (30 ml every 30 minutes) obtained at 100-B and Richland. A monthly analysis is done on the composite of weekly samples. Gamma-emitting radionuclides are measured every two weeks for both the filters and the resin column from the filter-resin samplers at Priest Rapids Dam and the 300 Area Forebay.[4] Iodine-129 is measured every four weeks on an aliquot of the monthly composite of the resin using neutron activation analysis.[5] Quarterly, a specific analysis for total plutonium is done on a composite of the biweekly filter and resin samples. Summaries of all of the data resulting from these analyses were presented in the Environmental Surveillance Report.[2] A few additional comparisons of radionuclide concentrations between upstream and downstream measurements will be presented in this document.

Figure 6 compares ^{40}K, ^{106}Ru, ^{129}I, and $^{239-240}Pu$ concentrations at Priest Rapids Dam with those at the 300 Area Forebay. The ^{40}K is a naturally-occurring radionuclide, whereas ^{106}Ru, ^{129}I, and $^{239-240}Pu$ result from past nuclear detonations in the atmosphere. Given the variability observed in upstream measurements, there isn't any obvious contribution from Hanford operations. However, the downstream ^{129}I concentrations appear to be slightly elevated. Additional data being collected during 1977 will allow a more definite conclusion.

Figure 7 compares the soluble forms (collected on resin) of ^{60}Co, ^{65}Zn, ^{131}I, and $^{140}BaLa$ measured upstream and downstream. At the upstream sampling station, all of the results were less-than detectible. However,

all of the radionuclides were detected downstream corresponding to the March and November spill cooler release at N-Reactor. The ^{60}Co concentrations observed during the rest of the year are due to routine releases from N-Reactor.

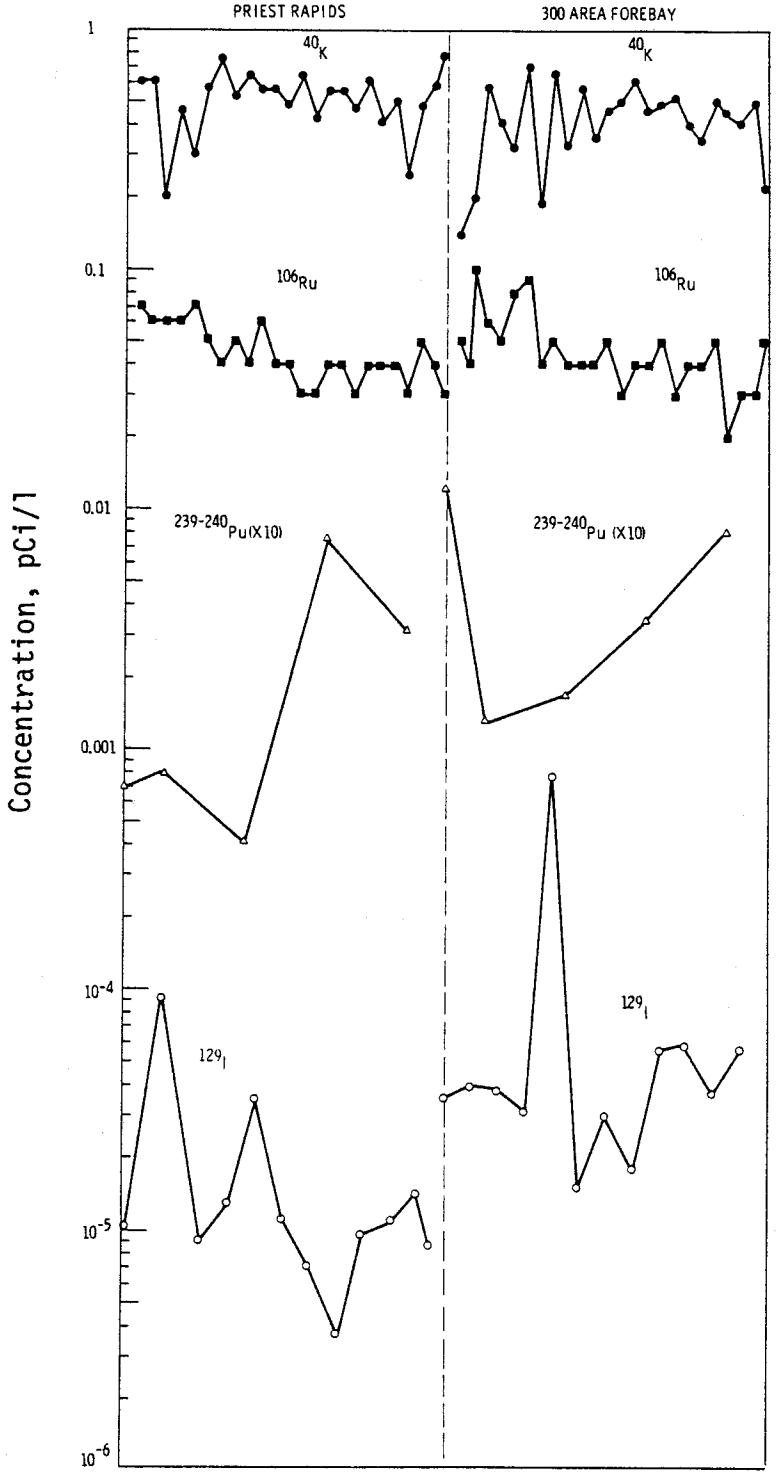

FIGURE 6. Upstream and Downstream Measurements of ^{40}K, ^{106}Ru, ^{129}I, and $^{239-240}Pu$

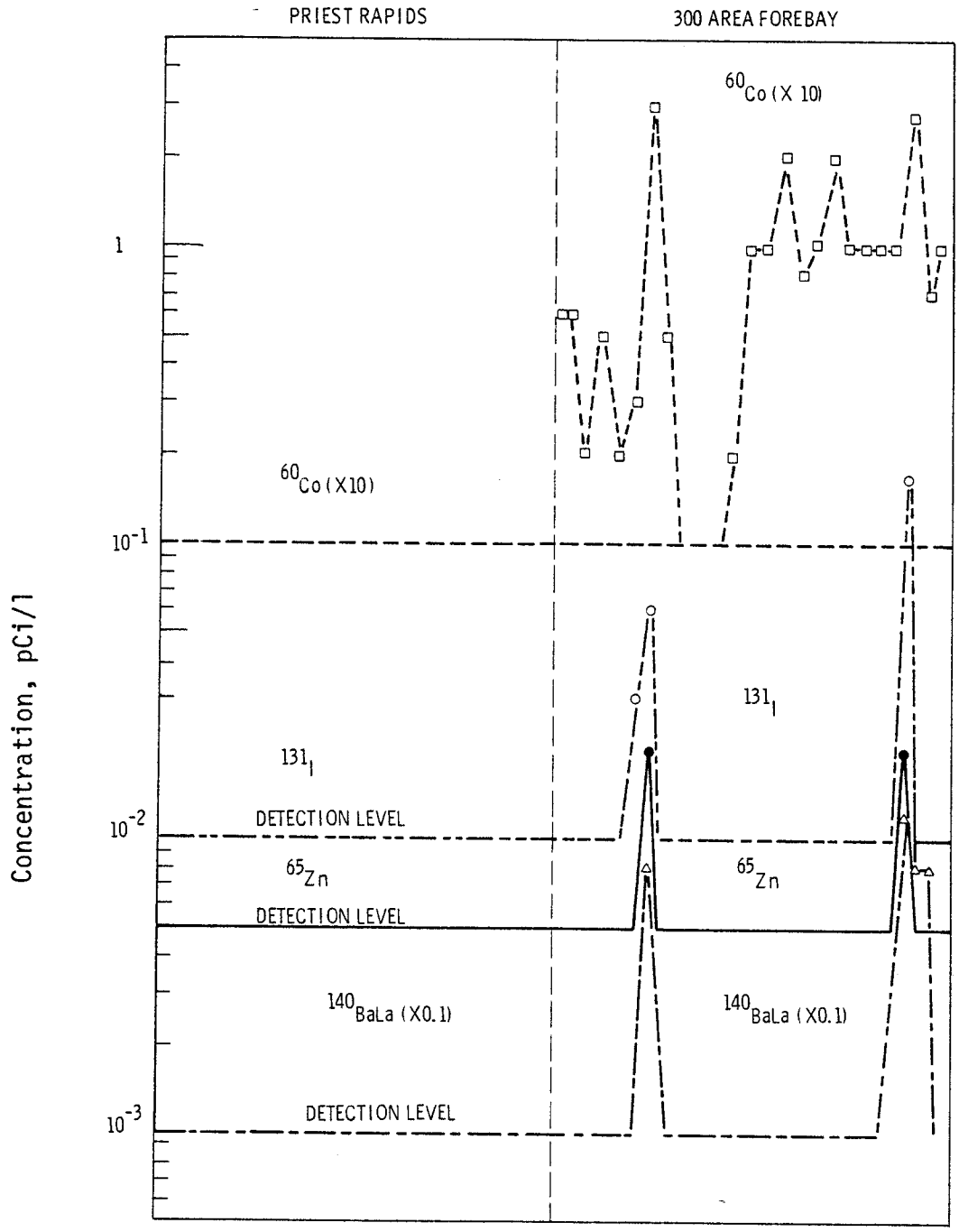

FIGURE 7. Soluble Forms of ^{60}Co, ^{65}Zn, ^{131}I and ^{140}BaLa Measured Upstream and Downstream

DITCHES, PONDS, AND TRENCHES

Surface water areas on the Hanford Site resulting from the disposal of process water were sampled routinely during 1976. Grab samples were collected and analyzed for gross beta, gross alpha, and gamma-emitting radionuclides. In some cases, specific analyses for ^{90}Sr, uranium and plutonium were done. Figure 8 shows the location of the major ditches, ponds, and trenches on the Hanford Site sampled during 1976.

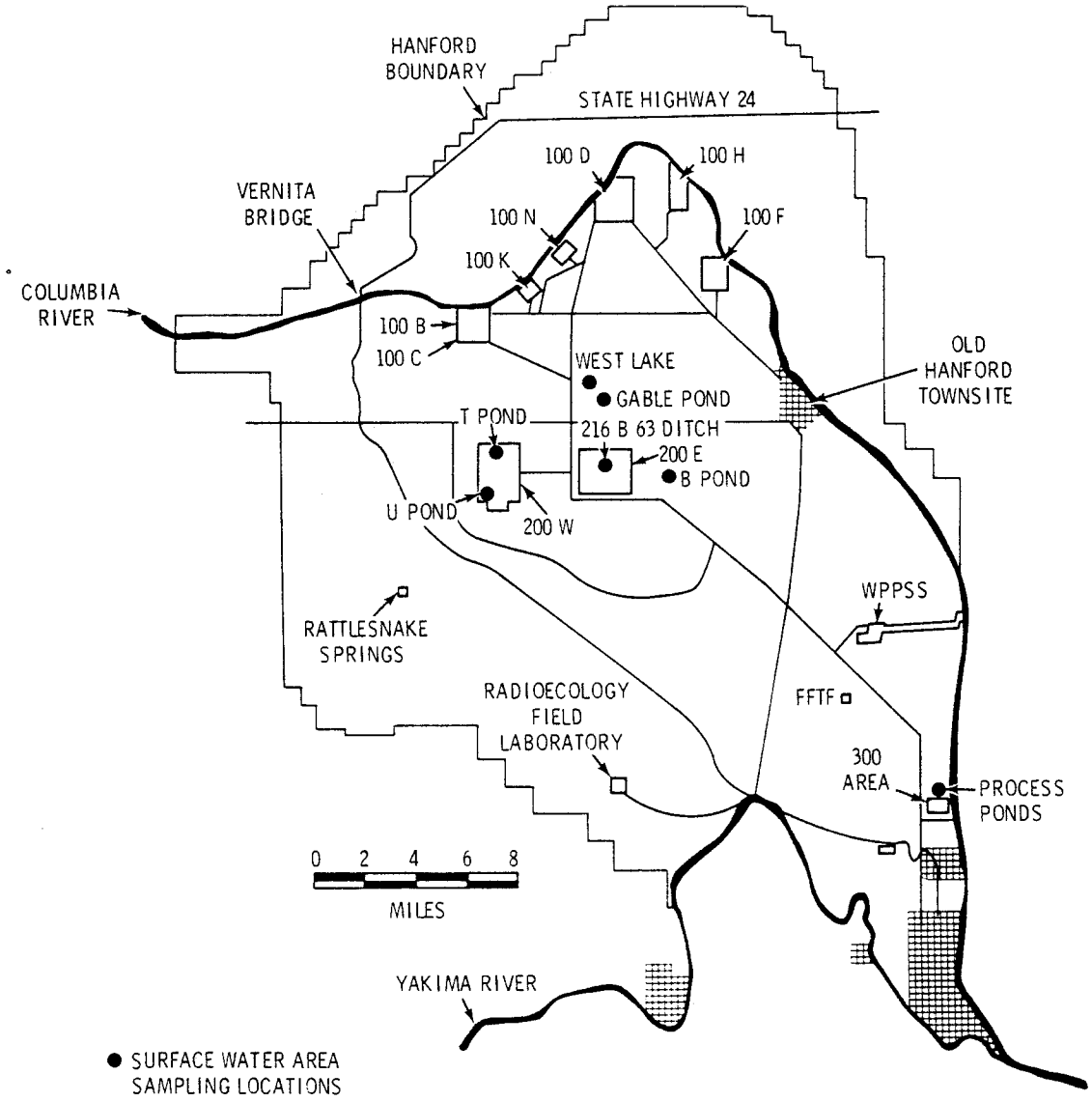

FIGURE 8. Surface Water Areas Sampled During 1976

The results for gross beta, gross alpha and ^{90}Sr analyses are shown in Figures 9 through 11 for all 200 Area and vicinity surface water areas. West Lake, a naturally-occurring pond in direct contact with the ground water, generally had the highest observed levels of gross beta and gross alpha activity. All ponds had similar levels of ^{90}Sr.

No waste is discharged to West Lake and a likely cause of the elevated concentrations is the concentrating effect of continual evaporation of water from the pond. West Lake serves as a basin for a relatively large watershed area. Uranium (accounting for gross alpha activity), eroded from the soil during the entire history of West Lake's existence, and ^{90}Sr, due to fallout in rainwater, are assumed to have accumulated in the pond. In contrast, the waste discharged to the other ponds has been diluted with river water containing relatively low concentrations of ^{90}Sr and uranium.

Table 4 is a summary of replicate sampling from Gable Mountain Pond during January 1976. The table indicates an average concentration of about 5 pCi/l of uranium and <0.03 pCi/l of plutonium. The concentrations observed in Columbia River water are approximately 0.5 pCi/l and 5×10^{-5} pCi/l, respectively.(2)

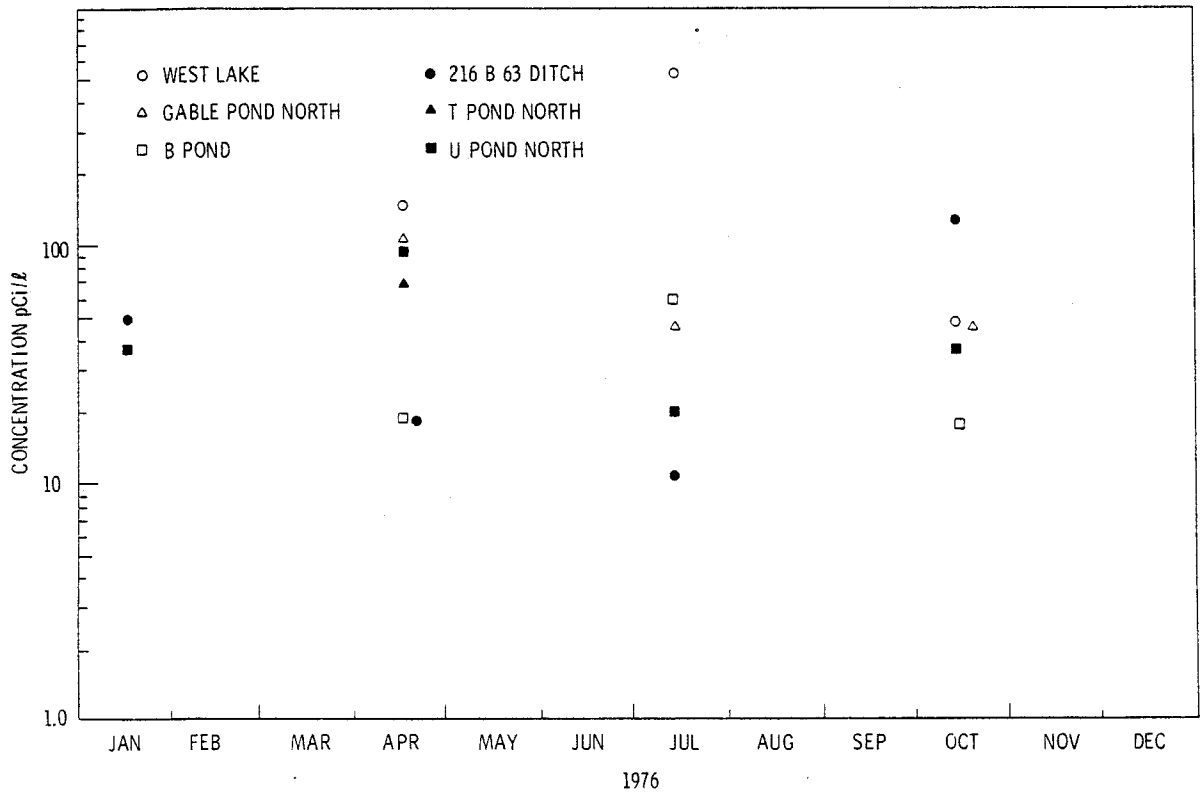

FIGURE 9. Gross Beta Activities Observed in 200 Area Ponds

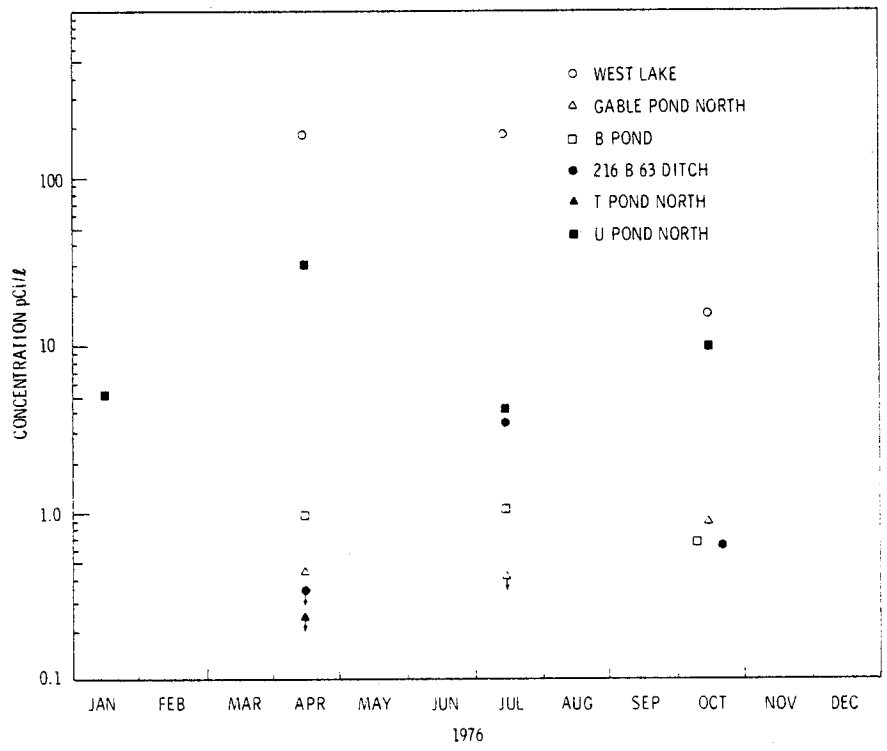

FIGURE 10. Gross Alpha Activity Observed in 200 Area Ponds

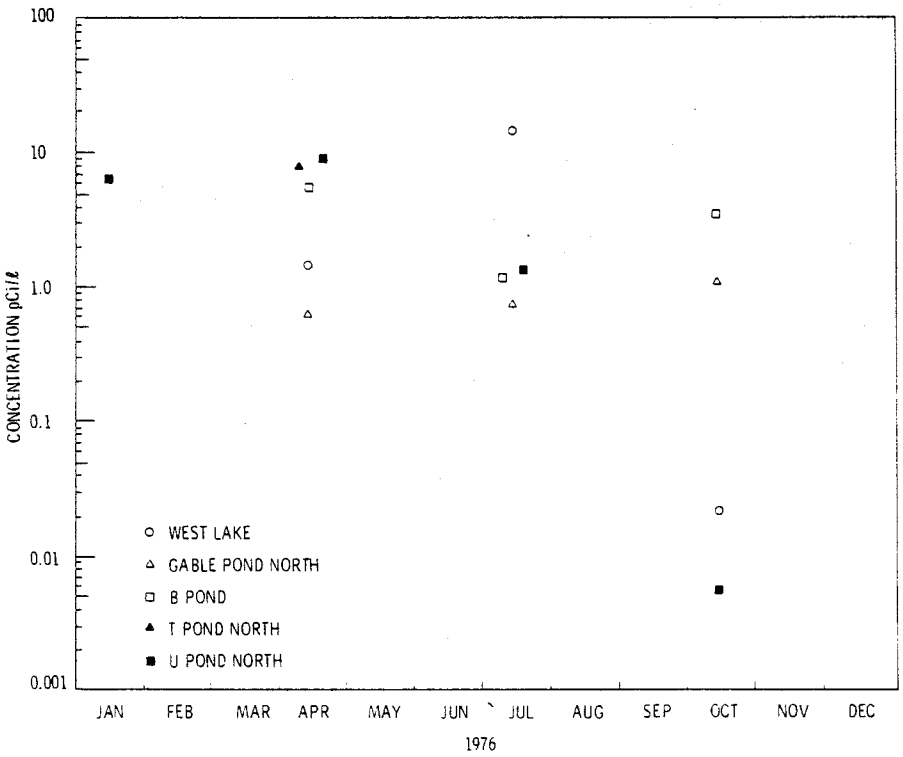

FIGURE 11. Strontium-90 Observed in 200 Area Ponds

TABLE 4. Gable Mountain Pond Replicate Sampling*

(Units of 10^{-9} μCi/ml of Water)

Sample Number	Gross Alpha	Gross Beta	^{90}Sr	Uranium	Plutonium
1	0.46 ± 0.18	5.7 ± 2.0	0.41 ± 0.07	5.7 ± 2.0	0.07 ± 0.01
2	0.52 ± 0.19	6.2 ± 2.0	0.18 ± 0.07	4.9 ± 2.0	0.03 ± 1.3
3	0.44 ± 0.19	4.9 ± 2.2	0.28 ± 0.07	4.4 ± 2.0	0.01 ± 0.01
4	0.22 ± 0.14	4.1 ± 2.0	0.47 ± 0.07	4.4 ± 2.0	0.03 ± 0.01
5	0.43 ± 0.17	4.3 ± 2.5	0.43 ± 0.07	5.5 ± 2.0	0.03 ± 0.02
Average[(a)]	0.41 ± 0.23	5.0 ± 1.8	0.36 ± 0.24	5.0 ± 1.2	<0.03

[(a)] Average ±2 standard deviation shown if all data is positive, otherwise a less-than average is shown.

* Samples obtained from the same location on the same day.

The results of gamma spectroscopy and ^{90}Sr analysis of pond water samples are shown in Table 5. Cesium-137 was detected in Gable Mountain and U pond. Strontium-90 was detected in all pond samples analyzed. The concentration of ^{90}Sr in Columbia River water is about 0.5 pCi/l.[(2)] All other results were less than detectable.

TABLE 5. Specific Radionuclides in Waste Water Samples - 1976

(Units of 10^{-9} μCi/ml)

	Date	^{51}Cr	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs
Detection Limit		450	30	55	0.005	3.0
Location						
West Lake	1/9	--------	Pond Frozen	--------		
	4/2	*	*	*	1.5 ± 0.38	*
	7/23	*	*	*	10 ± 0.78	*
	10/25	*	*	*	0.02 ± 0.0007	*
Gable Pond	1/9	--------	Pond Frozen	--------		
	4/2	*	*	*	0.58 ± 0.09	34 ± 2
	7/23	*	*	*	0.70 ± 0.14	*
	10/25	*	*	*	1.0 ± 0.17	28 ± 3
B Pond	1/9	--------	Pond Frozen	--------		
	4/2	*	*	*	5.2 ± 0.10	*
	7/23	*	*	*	1.1 ± 0.14	*
	10/25	*	*	*	3.2 ± 0.17	*
T Pond	1/9	--------	Pond Dry	----------		
	4/2	*	*	*	7.6 ± 1.4	*
	7/23	--------	Pond Dry	----------		
	10/25	--------	Pond Dry	----------		
U Pond	1/9	*	*	*	6.0 ± 1.4	*
	4/2	*	*	*	8.4 ± 1.4	*
	7/23	*	*	*	1.2 ± 1.4	4 ± 3
	10/25	*	*	*	0.005 ± 0.0001	12 ± 3
216-B-63 Ditch	1/9	*	*	*		*
	4/2	*	*	*		*
	7/23	*	*	*		*
	10/25	*	*	*		*

*Less than detection limit.

No entry indicates no analysis was made.

WILDLIFE

Selected wildlife were collected throughout the Hanford environs as an indicator of radionuclide availability and potential transfer through the food chain. Although the Hanford Site south of the Columbia River is not open to hunting, several of the wildlife species collected are game animals and, as such, are potentially subject to hunting during time spent offsite. Table 13 shows the results of gamma spectroscopy and ^{90}Sr analyses of about 500 gram samples of muscle tissue taken from gamebirds collected during 1976. Ducks were collected from each of the larger trenches or ponds on the Hanford Site and along the Columbia River. Cesium-137 was present in the highest concentration and is primarily attributable to Hanford operations.

Table 7 shows the concentration of uranium and ^{239}Pu observed in liver tissue from ducks collected at the 300 Area pond, U, B and Gable Pond, as well as West Lake. Although the data are limited, apparently there are elevated concentrations of uranium and Pu in U Pond duck livers.

Analytical Limit			2.0 ^{40}K			0.2 ^{60}Co			0.3 ^{65}Zn		
Location	Species	No. of Samples	Maximum Observed	Minimum Observed	Average	Maximum Observed	Minimum Observed	Average	Maximum Observed	Minimum Observed	Average
300 Pond	Duck	1			2.2			*			*
U Pond	Ducks	9	2.8	*	<2.3	*	*	*	0.56	*	<0.33
Gable Pond	Ducks	5	2.1	*	<2.0	*	*	*	*	*	*
West Lake	Ducks	3	*	*	*	*	*	*	*	*	*
B Pond	Ducks	3	2.3	*	<2.1	*	*	*	*	*	*
Columbia River	Ducks	33	3.2	*	<2.5	0.22	*	<0.20	*	*	*
Columbia River	Geese	14	3.4	*	<2.6	*	*	*	*	*	*
100 Areas	Pheasants	8	2.4	*	<2.1	*	*	*	*	*	*
100 Areas	Quail	3	3.1	*	<2.4	*	*	*	*	*	*

Analytical Limit			0.005 ^{90}Sr			0.1 ^{137}Cs		
Location	Species	No. of Samples	Maximum Observed	Minimum Observed	Average	Maximum Observed	Minimum Observed	Average
300 Pond	Duck	1			0.005			*
U Pond	Ducks	9	0.02	*	<0.01	77	3.2	32
Gable Pond	Ducks	5	0.02	*	<0.01	155	12	73
West Lake	Ducks	3	0.01	*	<0.01	103	0.87	67
B Pond	Ducks	3	0.02	0.007	0.01	258	3.1	123
Columbia River	Ducks	33	0.28	*	<0.03	*	*	*
Columbia River	Geese	14				3.7	*	<0.55
100 Areas	Pheasant	8	0.03	*	<0.01	*	*	*
100 Areas	Quail	3	0.02	*	<0.02	*	*	*

*Less than the analytical limit

No entry indicates no analysis was made.

TABLE 6. Average Radionuclide Concentrations in Muscle of Gamebirds - 1976

TABLE 7. Average Concentrations of Selected Radionuclides in the Livers of Waterfowl Samples in the Hanford Environs - 1976

Units of 10^{-6} μCi/gm (wet weight)

Location	U Analytical Limit 0.03				Total Pu Analytical Limit 0.0008			
	No. of Samples	Maximum Observed	Minimum Observed	Average	No. of Samples	Maximum Observed	Minimum Observed	Average
300 Pond					1			0.002
U Pond	5	0.14	*	0.06	4	1.2	*	<0.31
Gable Pond	1			*	1			0.01
West Lake	1			*	1			0.12
B Pond	1			*	1			0.007

Location	^{238}Pu Analytical Limit 0.3				$^{239-240}Pu$ Analytical Limit 0.3			
	No. of Samples	Maximum Observed	Minimum Observed	Average	No. of Samples	Maximum Observed	Minimum Observed	Average
U Pond	4	2.3	*	<0.8	4	1.2	*	<0.65

*Less than the analytical limit

No entry indicates no analysis was made.

In Table 8, the observed levels of selected radionuclides in ducks are classified according to the variety of duck. Apparently, coots are inclined to nest on the ponds whereas the mallards migrate from location to location. During 1976, coots had the highest observed maximum concentration of ^{137}Cs. However, other duck varieties had elevated levels of ^{137}Cs comparable to the ^{137}Cs concentrations observed in coots.

Assuming that an individual consumed 500 grams of meat from the duck containing the highest levels (260 pCi/g) of ^{137}Cs observed during 1976, a 50-year internal dose commitment of 7.3 mrem to the whole body and 8.2 mrem to the bone would be incurred. The majority of the dose would be received during the first year after ingestion (^{137}Cs biological half-times; body, 70 days; bone, 140 days).

Samples of muscle liver and bone tissue from "road-kill" deer on the Hanford Site were analyzed for radioactivity. The results are shown in Table 9. Naturally-occurring ^{40}K was observed in muscle tissue from each of the deer. Cesium-137 was observed in deer samples collected along Route 4 north and south of the 200 Areas. Strontium-90 was also observed in muscle tissue. Plutonium-239 was detected in liver samples and ^{90}Sr was measured in bone samples. The observed concentrations of ^{137}Cs, ^{90}Sr and ^{239}Pu are due to either Hanford operations or fallout. However, the lack of similar data for deer samples collected distant from the Hanford Site makes the determination of any Hanford contribution tenuous. However, the highest concentration of ^{137}Cs observed is assumed due to Hanford operations because of the availability of ^{137}Cs on the Hanford Site (Gable Mountain Pond). Assuming a person ingested 50 pounds (22.7 Kg) of deer meat containing the 4.9 pCi/g of ^{137}Cs observed, a 50-year dose commitment of about 6.8 mrem total body and 8.5 mrem bone would be incurred.

Mice and rabbits are collected around sources of drinking water or potential sources of salt on the Hanford Site. The results are shown in Tables 10 and 11. The highest levels observed were in mice collected from around the 1301-N trench. The mesh of the screening over the trench is sufficiently large that mice can pass through easily. The highest observed ^{90}Sr concentrations occurred in samples of bone from rabbits collected in the B-C crib area.

TABLE 8. Selected Radionuclides from Muscle of Waterfowl Samples Taken from Ponds in the Hanford Environs - 1976

Units of 10^{-6} μCi/gm (wet weight)

Duck Variety	No. of Samples	^{40}K Maximum Observed	^{40}K Minimum Observed	^{40}K Average	^{60}Co Maximum Observed	^{60}Co Minimum Observed	^{60}Co Average
Mallard	9	2.8	*	<2.4	*	*	*
Blue Winged Teal	2	*	*	*	*	*	*
Shoveler	1			*			*
American Golden Eye	2	*	*	*	*	*	*
Barrow's Golden Eye	2	*	*	*	*	*	*
Widgeon	1			*			*
Coot	3	*	*	*	*	*	*
Green Winged Teal	1			*			*

Duck Variety	No. of Samples	^{65}Zn Maximum Observed	^{65}Zn Minimum Observed	^{65}Zn Average	^{90}Sr Maximum Observed	^{90}Sr Minimum Observed	^{90}Sr Average
Mallard	9	0.56	*	<0.33	0.02	*	<0.01
Blue Winged Teal	2	*	*	*	0.02	0.006	0.01
Shoveler	1			*			*
American Golden Eye	2	*		*	0.02	*	<0.01
Barrow's Golden Eye	2	*	*	*	0.02	0.01	0.02
Widgeon	1			*			*
Coot	3	*	*	*	0.01	*	<0.007
Green Winged Teal	1			*			*

Duck Variety	No. of Samples	^{137}Cs Maximum Observed	^{137}Cs Minimum Observed	^{137}Cs Average
Mallard	9	100	*	33
Blue Winged Teal	2	3.6	3.2	3.4
Shoveler	1			3.9
American Golden Eye	2	94	55	75
Barrow's Golden Eye	2	110	103	106
Widgeon	1			49
Coot	3	258	98	170
Green Winged Teal	1			0.87

TABLE 9. Concentration of Selected Radionuclides in Deer - 1976

Location	Date	Tissue	^{40}K	^{60}Co	^{90}Sr	^{137}Cs	^{239}Pu
Wye Barricade	1/27	Muscle	*	*	0.10	*	<0.0002
		Liver					
		Bone			0.55		
Rt 4 N-Mile 2	9/17	Muscle	3.4	*	0.003	4.9	0.0005
		Liver					
		Bone			0.29		
Rt 4 S-Mile 5	10/26	Muscle	2.2	*	*	0.26	0.0009
		Liver					
		Bone			0.09		

*Less than the analytical limit

No entry indicates no analysis was made

TABLE 10. Concentration of Selected Radionuclides in Rabbits - 1976

Location	Date	Tissue	^{40}K	^{60}Co	^{90}Sr	^{137}Cs	^{239}Pu
200 B-C	5/25	Muscle	2.0	*		*	0.002
		Liver					
		Bone			76		
200 B-C	6/8	Muscle	*	*		*	0.002
		Liver					
		Bone			19		
200 B-C	11/18	Muscle	3.0	*		*	<0.0004
		Liver					
		Bone			76		

TABLE 11. Concentration of Selected Radionuclides in Mice - 1976

Location	Species[a]	Date	^{40}K	^{54}Mn	^{58}Co	^{59}Fe	^{60}Co	^{65}Zn	^{90}Sr	^{95}ZrNb	^{103}Ru	^{106}Ru	^{134}Cs	^{137}Cs	^{141}Ce	^{144}Ce	U	Total Pu
100-N	PM	3/2		14,000	1,300	20,000	20,000	710	180	6,100	6,400	3,000	200	400	450	9,200		
Gable Pond	PM	3/2	*	*	*	*	*	*	0.53	*	*	*	*	*	*	*		
B Pond	PM	3/16	*	*	*	*	*	*	1.4	*	*	*	*	*	*	*		
100-N	PM	4/6	*	*	*	*	4.1	*	2.7	*	*	*	*	*	*	*		
B Pond	PM	4/6	*	*	*	*	*	*	3.6	*	*	*	*	*	*	*		0.05
Redox	PM	4/6	*	*	*	*	*	*	0.46	*	*	*	*	*	*	*		0.05
222-S	PM	4/6	*	*	*	*	*	*	0.10	3.2	*	*	*	1.5	*	*		
100-N	PM	4/20	*	5.1	*	*	4.6	*	2.7	4.1	*	*	*	1.7	*	*		
100-N	PM	5/18	*	960	*	*	300	*	50	23	*	*	80	810	*	*		
Gable Pond	MUS M	5/18	*	*	*	*	*	*	0.50	1.9	*	*	*	1.7	*	*		
U Pond	PM	5/25	*	*	*	*	*	*	3.3	2.3	*	*	*	2.0	*	*	*	0.11
222-S	PP	6/1	*	*	*	*	*	*	0.24	3.9	*	*	*	4.2	*	*	*	0.008
West Lake	PM	6/2	*	*	*	*	1.3	*	0.28	*	*	*	*	*	*	*		
300 Area	PM	6/2	*	*	*	*	*	*	0.17	*	*	*	*	*	*	*		
Redox	PM	6/2	*	*	*	*	*	*	5.8	*	*	*	*	5.8	*	*		1.4
Redox	MUS M	6/2	*	*	*	*	*	*	4.7	*	*	*	*	*	*	*		0.02
B Pond	MUS M	6/8	*	*	*	*	*	*	0.82	*	*	*	*	*	*	*		
Redox Pond	PM	7/13	*	*	*	*	*	*	2.9	*	*	*	*	46	*	*		
222-S	PM	7/13	*	*	*	*	*	*	0.42	*	*	*	*	41	*	*		
U Plant	PM	7/13	*	*	*	*	*	*	14	*	*	*	*	4.1	*	*	0.05	0.003
100-N Trench	PM	7/27	*	11,000	*	*	20,000	640	430	*	*	*	*	5,600	*	8,900		
Gable Pond	MUS M	7/27	*	*	*	*	*	*	1.1	*	*	*	*	*	*	*		
B Pond	MUS M	8/17	*	3.3	*	*	2.5	0.71	8.4	*	*	*	*	*	*	*	5.6	
300 Area		9/3	*	*	*	*	*	4.6	0.19	*	*	10	*	4.9	*	*	0.06	1.6
U Pond	PM	9/10	*	4.7	*	*	*	*	11	*	*	*	*	35	*	*		
Gable Pond	PM	9/24	*	*	*	*	*	*	2.3	*	*	*	*	1.1	*	*		
B Pond	PM	10/15	4.3	*	*	*	*	*	4.5	*	*	*	*	2.4	*	*		
Redox Pond	PM	10/22	*	*	*	*	*	*	2.0	*	*	*	*	0.56	*	*		
100-N Trench	MUS M	10/22	*	1,100	*	*	2,300	73	93	*	*	*	*	1,000	*	510		

[a] PM = Peromyscus Maniculatus (Deer Mouse)
PP = Perognothus (Great Basin Pocket Mouse)
MUS M = Mus Musculus (House Mouse)
* No entry indicates no analysis was made.

During October, 1976, four coyotes were collected from the 200 Areas for analysis. The results are shown in Table 12. Two of the coyotes (sample 3 and 4) analyzed showed elevated levels of ^{90}Sr in bone and ^{137}Cs in muscle tissue. Considering that rabbits from the same area generally show elevated levels of ^{90}Sr, the coyote levels would be expected.

TABLE 12. Radiochemical Analyses of Coyotes Collected During October, 1976

Coyote Sample	Tissue Analyzed	Concentration (pCi/g-wet weight)[a] ^{40}K	^{60}Co	^{65}Zn	^{90}Sr	^{137}Cs	Pu
#1	Muscle	2.4 ± 1.4	<0.1	<0.2	0.003 ± 0.003	<0.1	
	Bone				0.29 ± 0.02		
	Liver						0.0001 ± 0.0002
#2	Muscle	2.2 ± 0.9	<0.1	<0.1	0.003 ± 0.002	<0.1	
	Bone				0.18 ± 0.02		
	Liver						0.0004 ± 0.0002
#3	Muscle	2.4 ± 0.7	<0.1	<0.1	0.04 ± 0.003	2.4 ± 0.1	
	Bone				7.8 ± 0.1		
	Liver						0.0006 ± 0.0002
#4	Muscle	1.9 ± 0.7	<0.1	<0.1	0.002 ± 0.001	0.29 ± 0.04	
	Bone				9.1 ± 0.1		
	Liver						0.0004 ± 0.0002

[a] Concentration ± 2 sigma counting uncertainty or, if not detected, < 2 sigma counting uncertainty.

SOIL AND VEGETATION

Surface soil and perennial vegetation samples were collected from 20 different locations during August of 1976 for the purpose of measuring the levels of radioactivity due to fallout and natural causes, as well as to assess any potential buildup of radioactivity from Hanford operations. These locations are shown in Figure 12 and the results listed in Tables 13 and 14. Each soil sample represents the composite of five "plugs" of soil from an approximate 10 m^2 area. Each plug was approximately 2.5 centimeters (1 inch) in depth and 10 centimeters (4 inches) in diameter. The vegetation samples were collected in the immediate vicinity of each soil sampling location and consisted of perennial vegetation, primarily the new growth from rabbitbrush plants. Both sets of samples were analyzed for gamma-emitting radionuclides using a lithium drifted germanium detector, for plutonium nuclides using alpha spectroscopy, and for ^{90}Sr and uranium by specific analysis.

From the information in Tables 13 and 14, there aren't any obvious Hanford contributions to the observed radionuclide concentrations. The location of the maximum concentration in soil and vegetation is quite variable. In Figure 13, the data for naturally-occurring ^{40}K, ^{224}Ra, ^{226}Ra and U-Nat are plotted on log-normal probability paper. It is apparent that ^{40}K is present in the largest concentrations. All of the data for each radionuclide are very consistent with the exception of a single U result. This result represents the analysis of a soil sample from map location number 4 which is near the 100-F Area. All other radionuclide concentrations for this location were similar to the concentrations observed at the other locations.

Statistically positive results for ^{90}Sr, ^{137}Cs and $^{239-240}Pu$ in soil and vegetation are plotted on log-normal probability paper in Figures 14 through 16. The data are quite variable as indicated by the slope of the graphs. Only two locations are suspected of receiving activity from Hanford operations. These locations are 1) east of the 200 West Area (map location #9) which showed the highest ^{137}Cs in vegetation in Figure 15 and

the highest Pu in soil in Figure 16, and 2) east of the California Nuclear burial ground (map location #11) which showed the second highest Pu in soil in Figure 16. However, more data would be necessary to determine if the increased levels are attributable to Hanford operations.

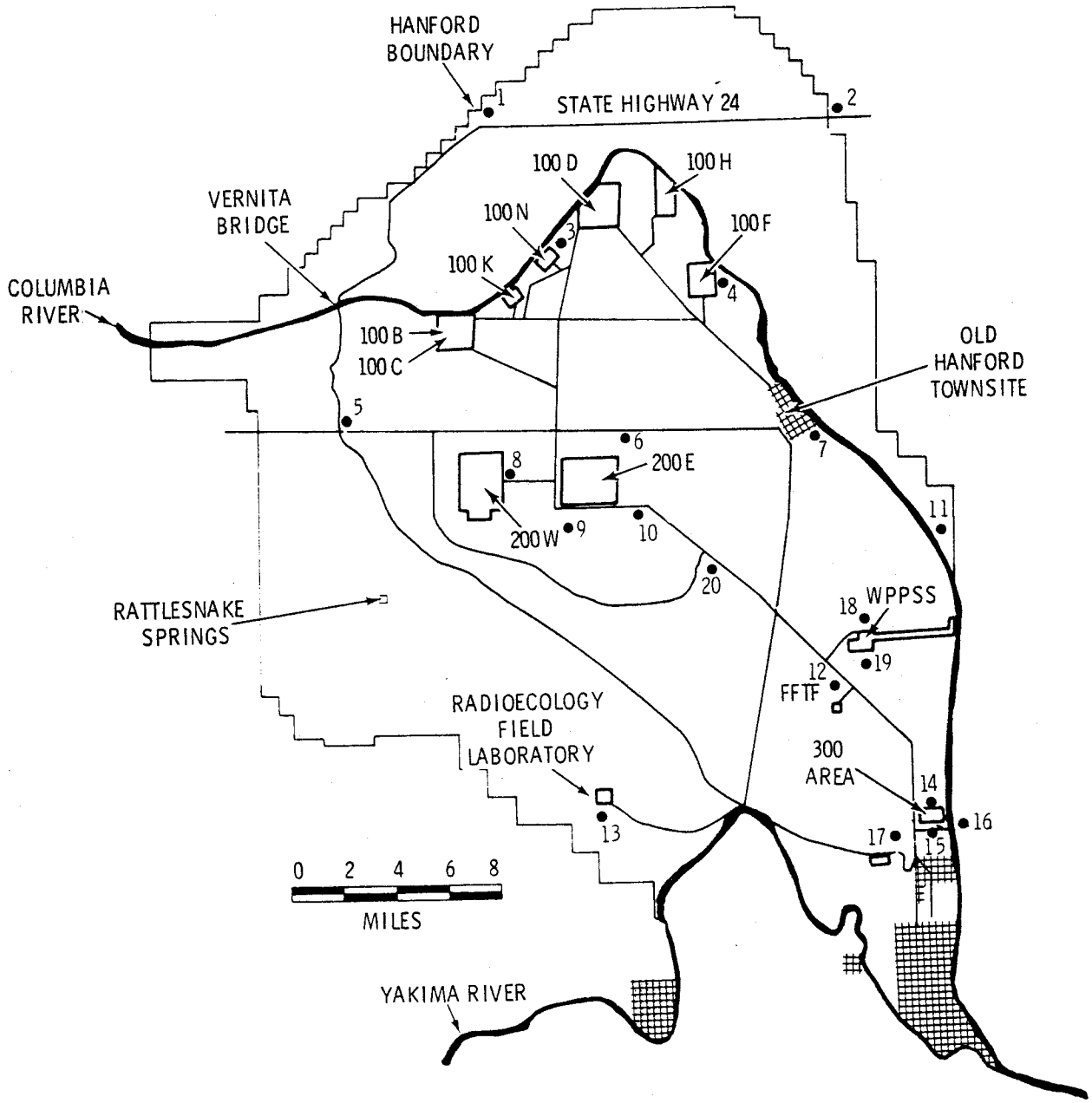

Figure 12. Soil and Vegetation Sampling Locations During 1976

TABLE 13. Radionuclides Observed in Soil During 1976

Radionuclide	Detection Level	Maximum Observed	Minimum Observed	Average	Location of Maximum Concentration[a]	Map Location
			Naturally Occurring			
^{40}K	0.04	17	10	13	4S-Army Loop Inter.	20
					1 Mi N WPPSS #2 Fence	18
^{224}Ra	0.09	1.5	0.70	1.0	E of ALE Field Lab	13
^{226}Ra	0.09	0.82	0.30	0.62	E of ALE Field Lab	13
U	0.03	0.89	0.13	0.27	100-F Area C.P. #58	4
			Man-Made			
^{54}Mn	0.03	0.06	*	<0.03	Ringold	11
^{58}Co	0.03	0.08	*	<0.03	E of 200-W C.P. #2	8
^{60}Co	0.04	0.07	*	<0.04	1 Mi N of 300 Area	14
^{65}Zn	0.07	0.08	*	<0.07	E of Cal. Nuclear B G	9
^{90}Sr	0.005	0.32	0.007	0.12	1/2 NE of FFTF	12
$^{95}ZrNb$	0.04	0.06	*	<0.04	E of 200-W C.P. #2	8
^{106}Ru	0.18	0.20	*	<0.18	Gable Pond C.P. #43	6
					Berg Ranch	2
^{134}Cs	0.03	0.07	*	<0.05	4S-Army Loop Inter.	20
					E of ALE Field Lab	13
^{137}Cs	0.02	0.92	*	<0.50	NE Corner Exxon Site	17
^{141}Ce	0.04	0.16	*	<0.08	1 Mi S of 300 Area	15
^{144}Ce	0.12	0.49	*	<0.27	1 Mi S of WPPSS #2 Fence	19
^{154}Eu	0.18	*	*	*		
^{155}Eu	0.09	0.17	*	<0.10	1 Mi SE of 100-N Trench	3

[a] In some cases the maximum concentration was observed in more than one location.

TABLE 14. Radionuclides Observed in Vegetation During 1976

Radionuclide	Detection Level	Maximum Observed	Minimum Observed	Average	Location of Maximum Concentration[a]	Map Location
			Naturally Occurring			
^{40}K	2	65	8.9	18	1 Mi SE of 100-N Trench	3
U	0.03	0.04	*	<0.03	NE Corner of Exxon Site	17
			Man-Made			
^{60}Co	0.1	0.90	*	<0.15	Gable Pond C.P. #43	6
^{90}Sr	0.004	0.13	0.01	0.04	Wahluke Slope #2 200 E Hill C.P. #61	1 10
$^{95}ZrNb$	0.1	0.14	*	<0.10	Gable Pond C.P. #43	6
^{106}Ru	0.5	*	*	*		
^{131}I	0.2	*	*	*		
^{137}Cs	0.1	0.56	*	<0.13	E of 200-W C.P. #2	8
$^{140}BaLa$	0.3	*	*	*		
^{141}Ce	0.1	0.16	*	<0.10	Gable Pond C.P. #43	6
^{144}Ce	0.4	1.0	*	<0.43	1 Mi S of 300 Area	15
^{238}Pu	0.003	*	*	*		
$^{239-240}Pu$	0.001	0.006	*	<0.002	E of ALE Field Lab	13

[a] In some cases the maximum concentration was observed in more than one location.

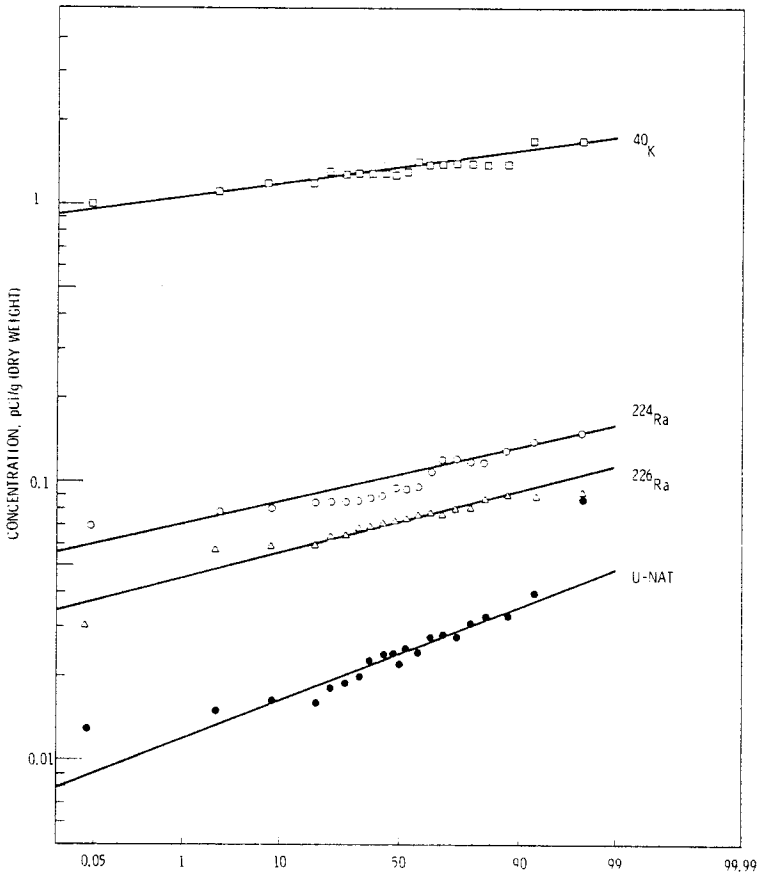

Figure 13. Log Normal Plot of Naturally-Occuring Radionuclides in Soil

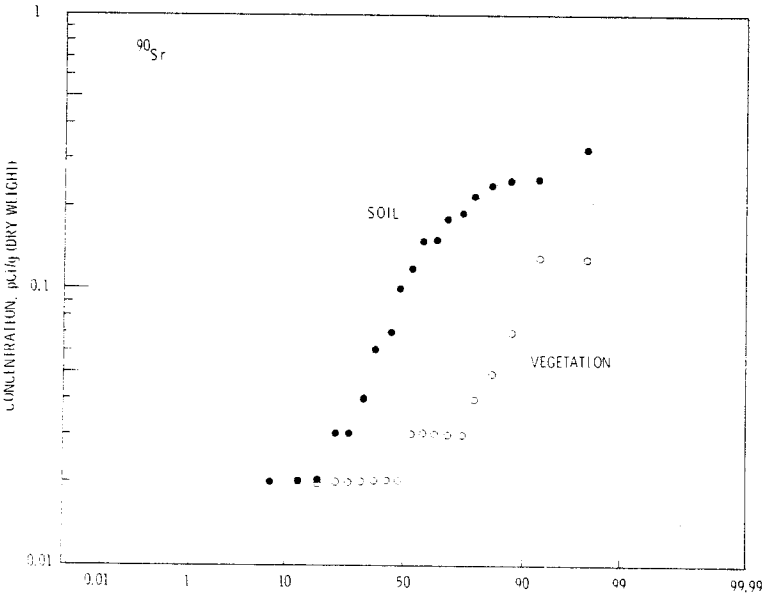

FIGURE 14. Log Normal Plot of ^{90}Sr Activity in Soil and Vegetation Samples

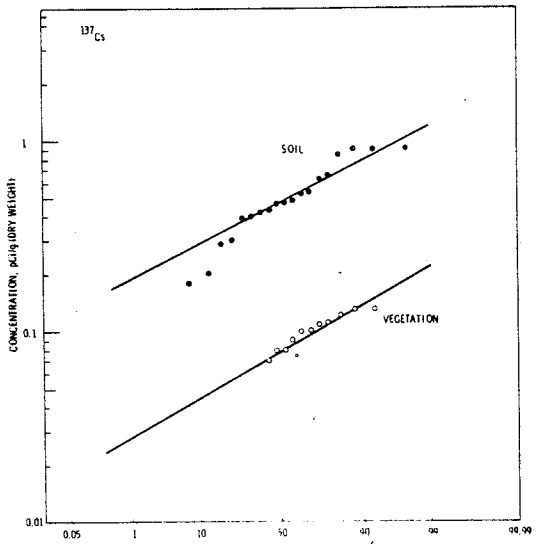

FIGURE 15. Log Normal Plot of ^{137}Cs Activity in Soil and Vegetation Samples

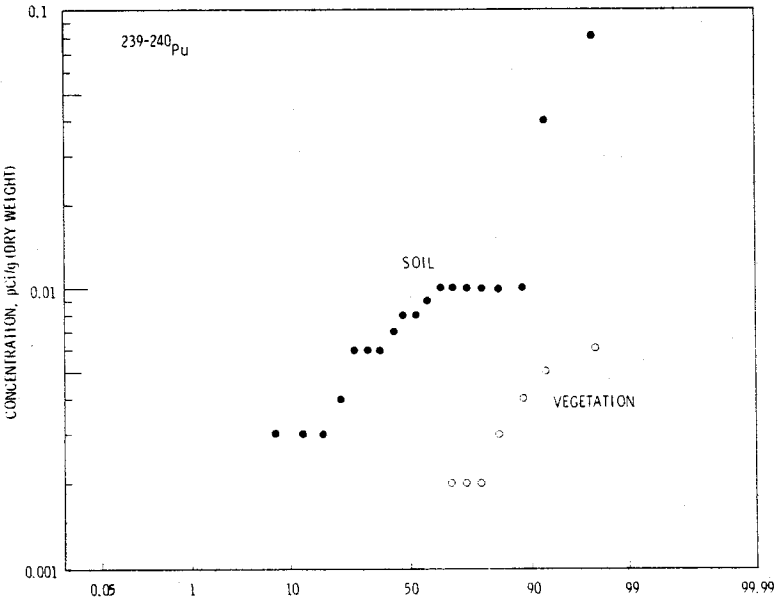

FIGURE 16. Log Normal Plot of $^{239-240}Pu$ Activity in Soil and Vegetation Samples

EXTERNAL RADIATION

HANFORD ENVIRONS

Thermoluminescent dosimeters (TLDs) were used to measure the external dose at several onsite, perimeter, and distant locations as shown in Figure 17. Specific locations of TLDs stationed around each facility area (100-N, 200-E, etc.) are shown in Appendix A. In general, all dosimeters are located on the perimeter of each area. Table 15 shows the results of these measurements. The dosimeter employed consisted of 3 chips of CaF_2:Dy (Harshaw TLD-200) encased in an opaque plastic capsule lined with 0.010" of tantalum and 0.002" of lead to flatten the lower energy response.[6] The dosimeters were mounted approximately one meter above ground level and changed monthly.

The external dose measured at any location is affected by several parameters, including the height of the dosimeter, elevation, and the amount of natural, fallout, and potentially Hanford origin radioactivity in the underlying soil. The variability in measured dose from the different locations was expected primarily because of the spatial dependence of natural radioactivity in soil. Figure 18 is a log-normal probability plot of the annual average dose for each location divided into two groups: onsite and offsite stations. Both groups represent straight line plots although elevated doses measured onsite primarily around the 200 Areas do not lie on the line, as expected. According to the straight line plot for perimeter and distant stations, contributions from Hanford operations at perimeter stations were indiscernible from the variability in background dose measured at the distant stations.

From the information in Table 15, the external background dose from natural radioactivity received by the population in the Hanford environs can be estimated. The average measured dose and 95% confidence interval were about 70 ± 15 mrem/year at parameter locations (1 mrem equals 1 mrad in this case). To this number an additional 6 mrem/year must be added to account for the neutron component of cosmic radiation.[7] Thus, an estimate of the total (external plus internal) background dose must include

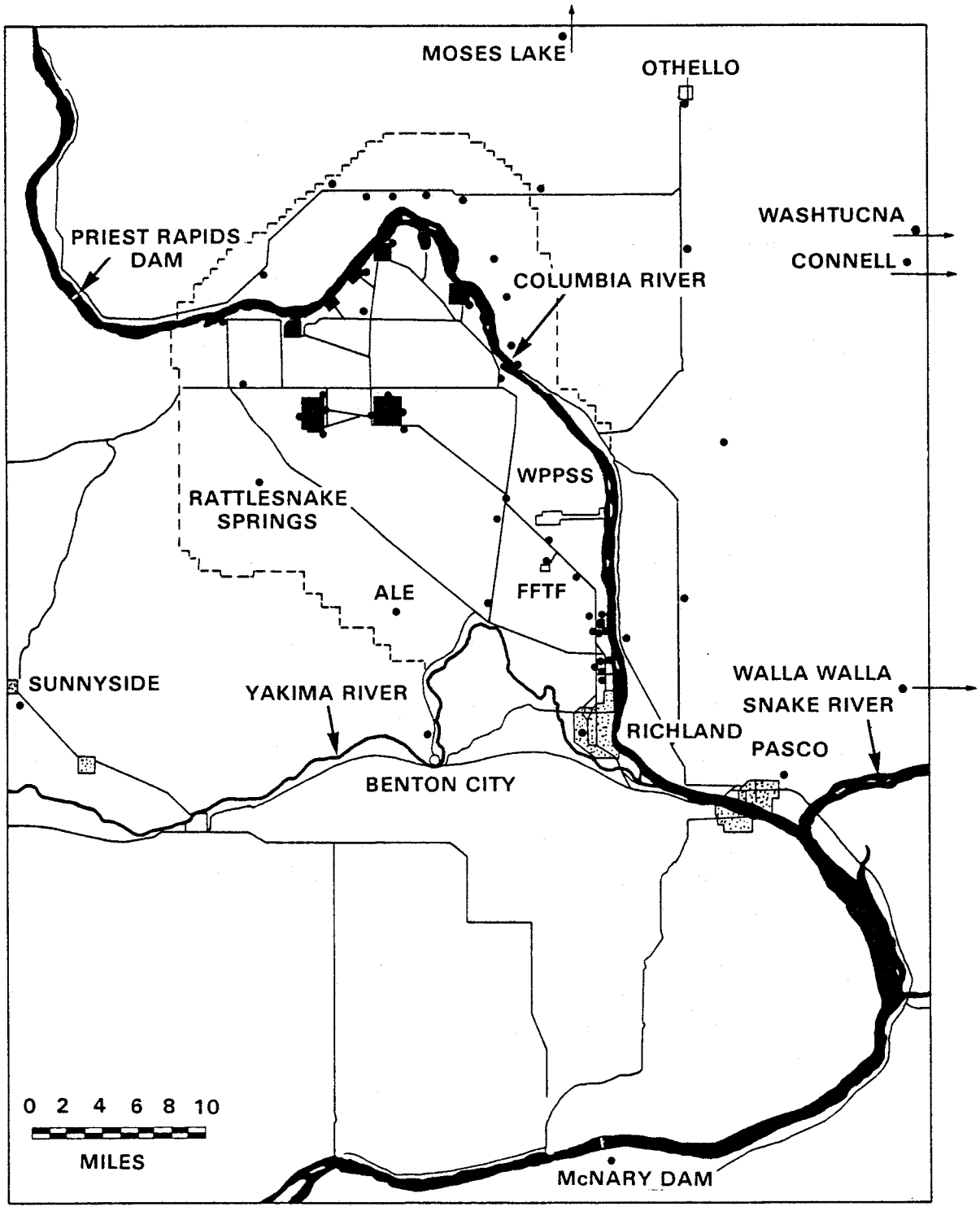

FIGURE 17. TLD Locations During 1976

TABLE 15. Results Of TLD Measurements During 1976.[a]

Location	No. of Measurements[b]	Dose (mrad/yr)[c] Max.	Min.	Average
Onsite Stations				
200 ENC	13	314	226	252 ± 44
200 EWC	13	77	58	69 ± 11
200 ESE	13	80	62	73 ± 11
200 EEC	13	91	73	80 ± 15
200 WEC	13	113	66	77 ± 26
Redox	10	95	77	84 ± 15
200 WWC	13	110	80	99 ± 18
200 WNE	13	84	62	69 ± 11
100-K	13	84	55	66 ± 15
WPPSS-100-N	13	99	69	80 ± 22
100-D	13	88	66	73 ± 15
100 Area Fire Station	13	84	58	69 ± 15
100-F	13	73	58	66 ± 11
Rt 10 Mile 1.6	13	73	58	66 ± 11
3705 Bldg.	13	73	62	69 ± 7
ACRMS	13	80	58	73 ± 11
300 Pond	13	88	69	80 ± 15
300 SW Gate	13	73	55	66 ± 11
300 South Gate	13	73	51	66 ± 15
331 Bldg.	12	73	51	62 ± 15
Hanford	13	73	55	66 ± 11
Wye Barricade	13	77	62	69 ± 7
FFTF Site	13	77	55	69 ± 15
FFTF North	13	80	55	69 ± 11
FFTF Southeast	13	73	55	66 ± 11
Prosser Barricade	13	77	66	69 ± 11
Wahluke C.P. #17	11	84	66	77 ± 18
Wahluke C.P. #18	11	80	66	73 ± 11
Wahluke C.P. #19	12	80	62	73 ± 11
Wahluke C.P. #20	12	88	69	77 ± 15
Wahluke C.P. #21	12	84	66	73 ± 11
Wahluke C.P. #22	10	80	62	73 ± 15
Wahluke C.P. #23	10	80	62	62 ± 15
Wahluke C.P. #24	11	88	55	77 ± 18
Wahluke C.P. #46	12	88	66	77 ± 18
	Average ±2 Standard Deviations[d]			77 ± 62
Perimeter Stations				
Richland	13	69	51	62 ± 11
Pasco	13	77	62	69 ± 11
Byers Landing	13	84	66	77 ± 11
Baxter Substation	13	73	55	66 ± 15
RRC C.P. #63	12	73	58	66 ± 11
RRC C.P. #64	12	69	55	62 ± 11
RRC C.P. #65	13	80	58	69 ± 11
RRC C.P. #66	13	80	62	69 ± 11
RRC C.P. #67	13	73	51	62 ± 11
Yakima Barricade	13	77	69	73 ± 7
Vernita	13	88	69	77 ± 11
Wahluke #2	13	84	66	77 ± 15
Benton City	13	62	51	58 ± 7
ERC	13	84	69	77 ± 11
Rattlesnake Springs	13	73	62	69 ± 7
Othello	13	69	51	62 ± 11
Connell	13	73	55	62 ± 15
Berg Ranch	13	88	66	77 ± 15
Wahluke Wm.	12	77	58	66 ± 11
Cooke Bros.	13	80	62	69 ± 11
	Average ±2 Standard Deviations[d]			68 ± 12
Distant Stations				
Walla Walla	13	77	62	69 ± 7
McNary	13	95	58	69 ± 18
Sunnyside	13	73	51	62 ± 11
Moses Lake	13	69	55	66 ± 11
Washtucna	12	69	58	66 ± 7
	Average ±2 Standard Deviations[d]			66 ± 6

[a] Total background dose from external irradiation would include an additional dose from the neutron component of cosmic radiation. At the Hanford elevation, this additional dose is estimated from EPA publication ORP/SID 72-1 to be 6 mrem/year.

[b] Dosimeters are generally deployed on a 4-week interval. This practice results in approximately 13 separate measurements at each location. There is some variability because of scheduling and year-to-year overlap.

[c] Monthly or biweekly measurements converted to equivalent annual dose. Average ±2 standard deviations calculated for each location.

[d] Average annual dose for each location used to calculate mean and standard deviation for the onsite, perimeter, and distant stations.

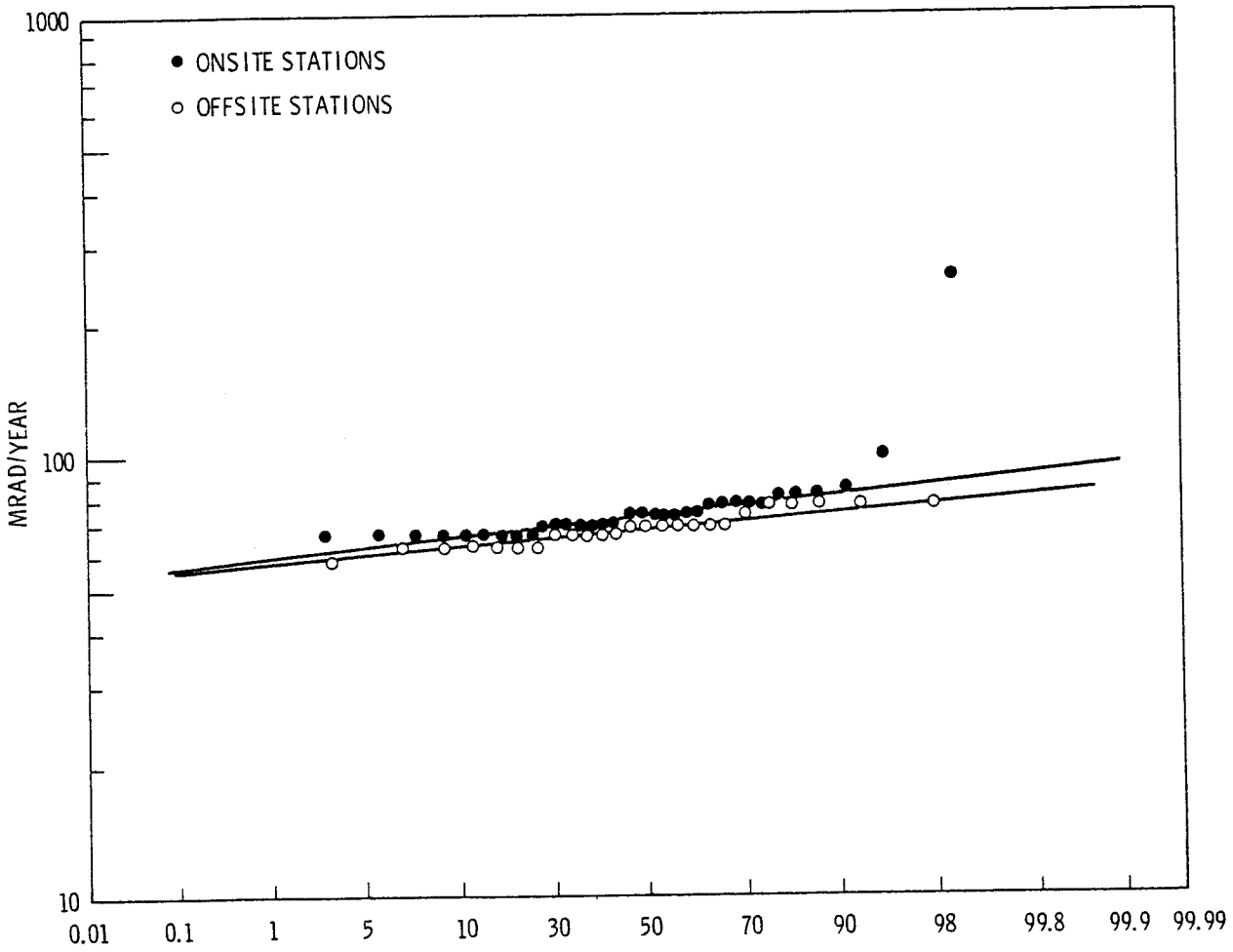

FIGURE 18. Log-Normal Probability Plot Onsite and Offsite TLD Data During 1976

the approximate 25 mrem/year received from radioactivity, primarily ^{40}K, in human bodies.[8] Therefore, the average total background dose received from natural radioactivity in the Hanford environs is approximately 100 ± 15 mrem/year. A realistic breakdown of the doses due to different sources of natural background radiation is shown in Table 16. An additional dose, approximately 4 mrem/year, must be added to account for the dose, primarily internal, due to fallout radionuclides.[8]

TABLE 16. Background Dose Received in the Hanford Environs from Natural Causes

	millirem/year	
External Irradiation:		75
Terrestrial	33	
Cosmic: ionizing component	36	
Neutron component	6	
Internal Irradiation:[a]		25
^{40}K	17	
^{14}C	1	
^{210}Po	3	
^{222}Rn	3	
Other (^{3}H, ^{87}Rb)	1	
TOTAL		100

[a] Adopted from U. S. Environmental Protection Agency Publication ORP/CSD 72-1[8]

COLUMBIA RIVER IMMERSION DOSE

Environmental dosimeters were submerged in the Columbia River at the four locations labeled in Figure 19: at Coyote Rapids (above the 100-K Area), below the 100-N Area, at the Hanford powerline, and at the Richland pumphouse. The dosimeters were collected monthly. The readings (shown in Table 17) are similar to those obtained in previous years and show that a swimmer immersed in the Columbia at Richland would receive a radiation dose of approximately 0.004 mrad/hr. By comparison, approximately 0.008 mrad/hr would be received on land (see Table 16).

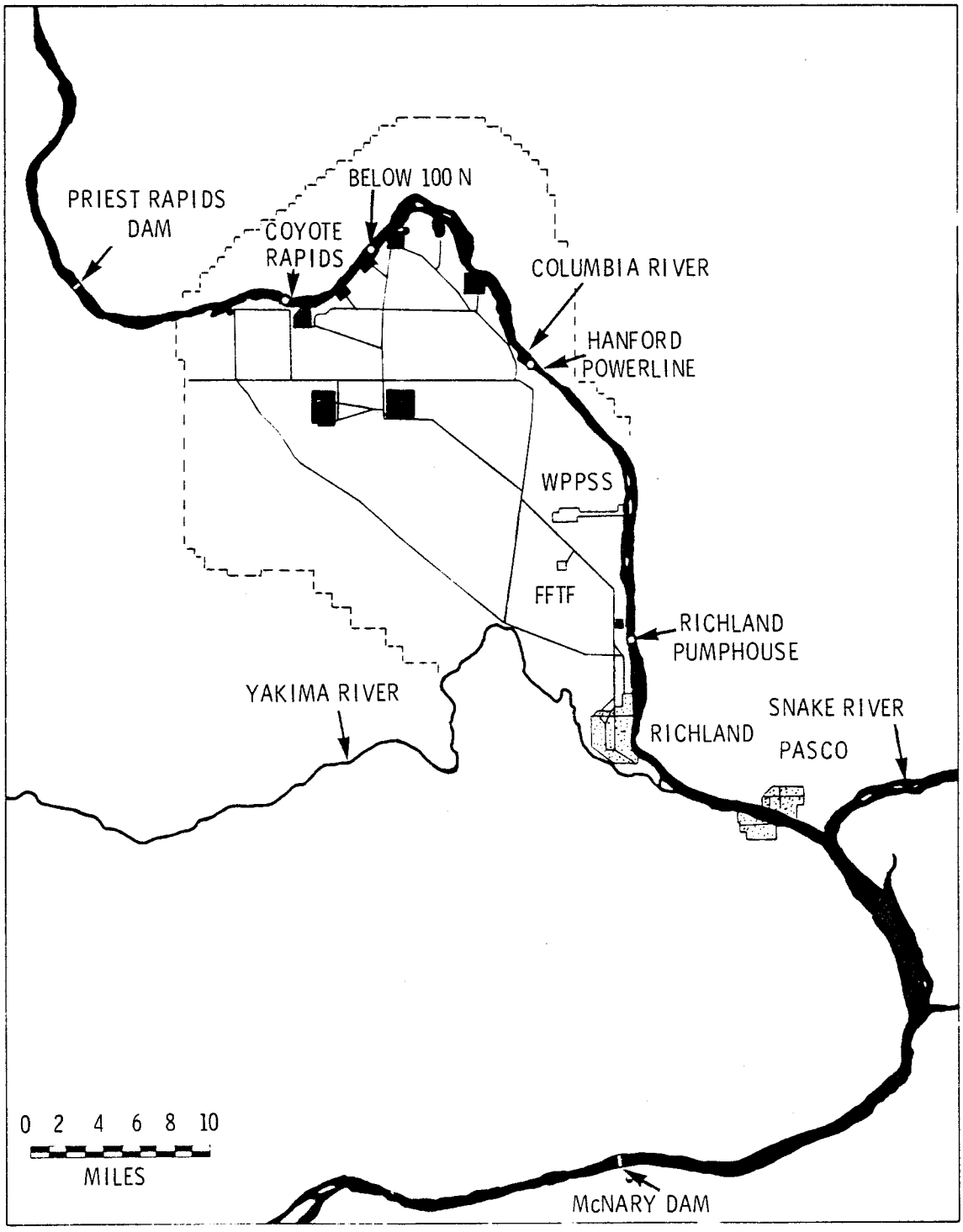

FIGURE 19. Location of Immersed TLDs in the Columbia River During 1976

TABLE 17. TLD Measurement During Immersion in the Columbia River During 1976

Location	No. of Measurements	Dose (mrad/yr)(a) Max.	Min.	Average
Immersion				
Coyote Rapids	10	47	29	40 ± 11
Below 100-N	12	80	26	51 ± 40
Hanford Powerline	8	55	18	44 ± 26
Richland Pumphouse	11	37	29	33 ± 7
	Average ±2 Standard Deviations(b)			42 ± 15

(a) Monthly measurements converted to equivalent annual dose. Average ±2 standard deviations calculated for each location.

(b) Average annual dose for each location used to calculate mean and standard deviation.

COLUMBIA RIVER SEDIMENT

Past analyses of sediment samples collected along the Columbia River have shown the presence of a few long-lived radionuclides, primarily ^{60}Co, attributable to the past operation of once-through production reactors.(9) A 1974 aerial monitoring flight by E.G. & G. of Las Vegas showed low level deposition of ^{60}Co over much of the Hanford reach of the river.(10) The activity found occurs in sediments along the river's islands, shoreline, and slough areas; it gradually decreases downstream from the historical production reactors, becoming undetectable below North Richland. The maximum exposure rate detected in 1974 was 0.014 mR/hr in addition to the exposure of approximately 0.008 mR/hr (70 mrad/yr) observed from natural background radiation.

Table 18 summarized the data from environmental dosimeters placed at 10 locations along the Columbia River shoreline and at three of the larger islands during 1976. The locations are shown in Figure 20. The wide variation in results among the different locations is attributed to the varying levels of ^{60}Co activity in the sediment. The variation between the maximum and minimum level observed at each location is attributed to changes in exposure rate as the river's flow rate changes. The maximum dose rate observed for 1976, 142 mrad/yr, is approximately equal to the maximum of 0.014 mrad/hr observed during the aerial survey in 1974. The total external dose that would result from a dose rate of 0.014 mrad/hr from the ^{60}Co plus 0.008 mrad/hr from natural background radiation would be 193 mrad/yr.

TABLE 18. TLD Measurement Along the Columbia River Islands and Shoreline During 1976

Location	No. of Measurements	Dose (mrad/yr)[a] Max.	Min.	Average
Shoreline				
100-K	12	80	58	72 ± 15
100-D	12	77	55	66 ± 15
Locke Island	12	91	66	80 ± 18
White Bluffs	12	84	62	77 ± 15
100-F	12	84	62	73 ± 15
Hanford Ferry Landing	6	91	66	77 ± 22
Hanford RR Track	12	142	66	113 ± 51
Ringold Island	10	95	69	84 ± 18
Powerline Crossing	12	102	73	88 ± 18
Wooded Island	12	99	69	84 ± 18
	Average ±2 Standard Deviations[b]			81 ± 26

[a] Monthly measurements converted to equivalent annual dose. Average ±2 standard deviations calculated for each location.

[b] Average annual dose for each location used to calculate mean and standard deviations.

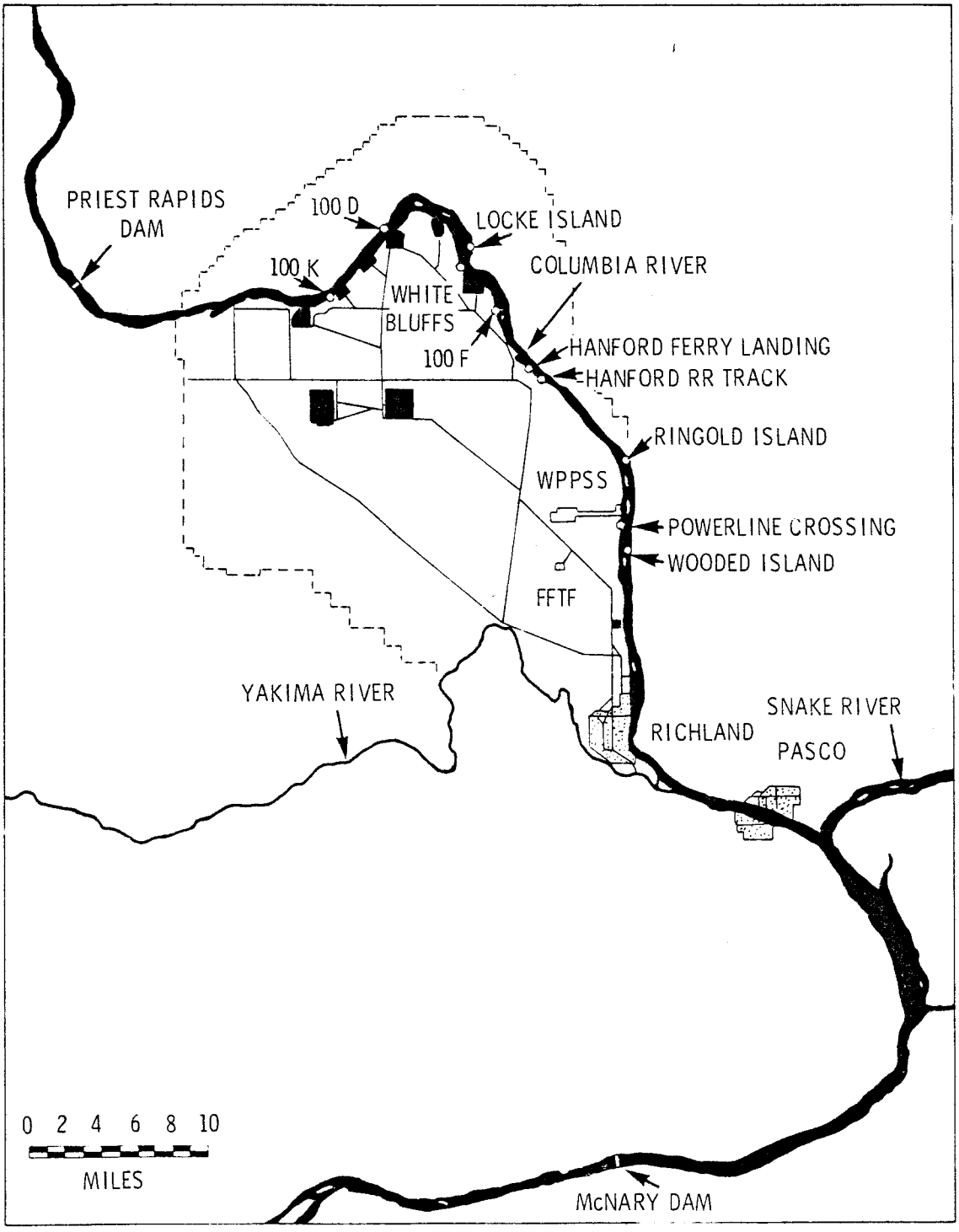

FIGURE 20. TLD Locations Along The Columbia River During 1976

RADIATION SURVEYS

HANFORD ROADS SURVEY

Hanford roads were routinely surveyed with a bioplastic scintillation detector attached to the front end of a truck and positioned about 0.6 meters (2 ft) above the road surface. This road monitor has been described in BNWL-62.[11] Most traveled roads within the Hanford Reservation were surveyed monthly. During 1976, no conditions were detected which required corrective action.

RAILROAD SURVEY

All Hanford railroad tracks outside area fences were surveyed semi-annually with the previously described road survey detector attached to a railroad maintenance car. No conditions were detected in 1976 which required corrective action.

WASTE DISPOSAL SITES

Active, inactive, and retired waste disposal sites were surveyed during 1976 and inspected for general physical condition and evidence of disturbance. The sites were generally in good order, with the most recurring problem being housekeeping--primarily vegetation growing inside the waste sites. Radiation levels were noted during each survey and, if unusual, reported to responsible contractor representatives for corrective action.

AERIAL SURVEYS

Aerial surveys can be used to detect contamination which is spread over a large land area. Although Hanford aerial surveys have been only comparative from year to year, through routine use a capability for rapid assessment of an emergency situation is maintained. Aerial surveys are conducted at an altitude of 150 meters (500 ft) using a 3-inch by 5-inch NaI (Tl) scintillation crystal detector. During September of 1976, three flight patterns were flown:

1) the perimeter of the Hanford Reservation
2) the Columbia River from Vernita Bridge to Plymouth
3) a pattern parallel to the perimeter of the Hanford Reservation but 15 to 20 air miles distant.

No significant differences from previous measurements were observed.

ACKNOWLEDGMENT

The efforts of several people are necessary to accomplish the collection, analysis, and evaluation of the extensive environmental data acquired each year. Ron Schrotke is responsible for scheduling the collection and delivery of environmental samples. The laboratory of U.S. Testing Company performed most of the analyses. The efforts of Harold Oens, U.S. Testing, are particularly appreciated. Shellie Canada typed the report.

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10. W. J. Tipton, An Aerial Radiological Survey of the U. S. Atomic Energy Commission's Hanford Reservation, EG&G, Las Vegas, NV, draft, 1975.

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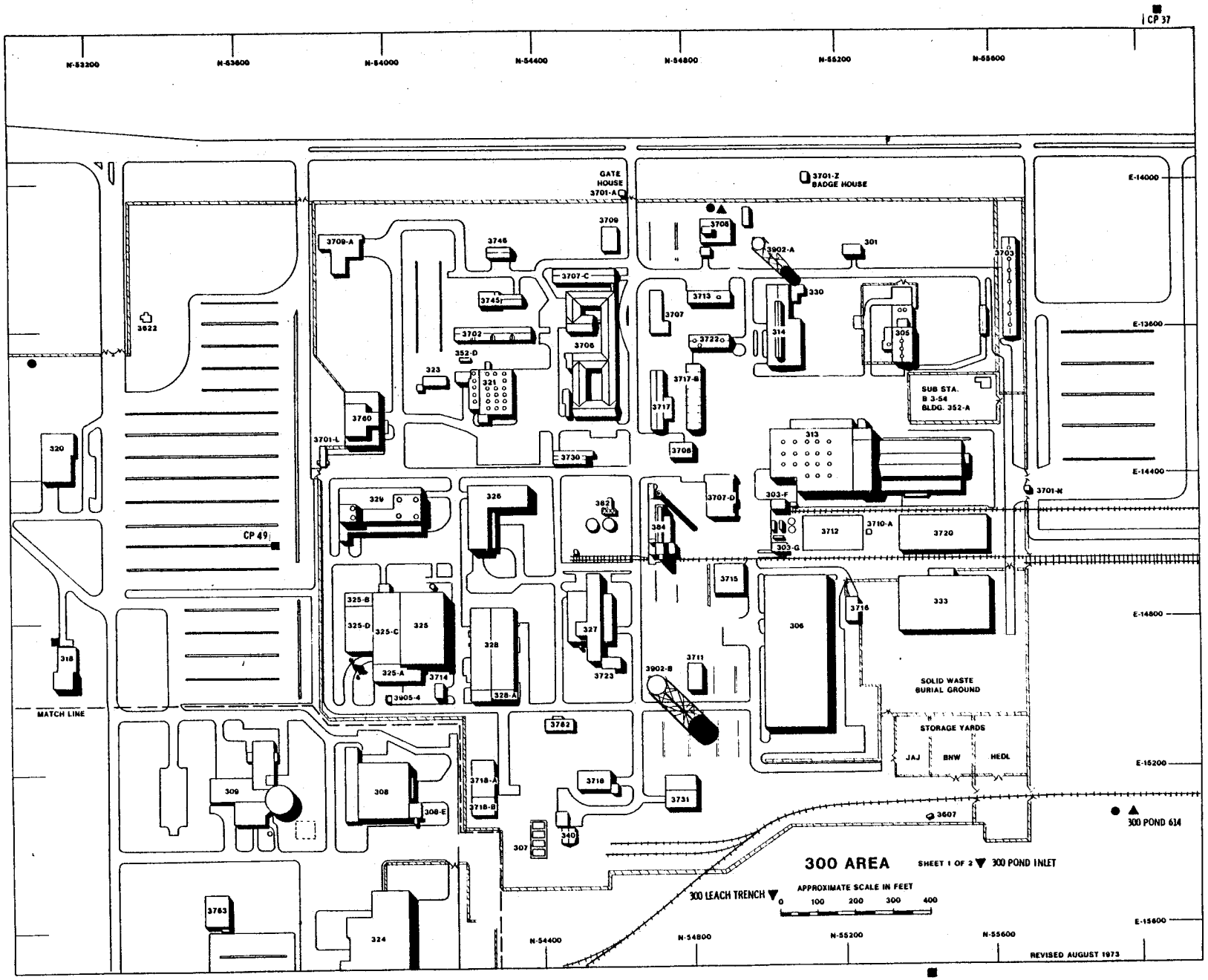
APPENDIX A

SPECIFIC SAMPLING LOCATIONS AROUND HANFORD FACILITIES

100-K
100-N
100-D
100-H
100-F
200-W
200-E
300 Area
300 Area
3000 Area



■ CONTROL PLOT

● AIR SAMPLE (FILTER AND CHARCOAL)

▼ WATER SAMPLE

▲ TLD

▼ SHORELINE SPGS #1

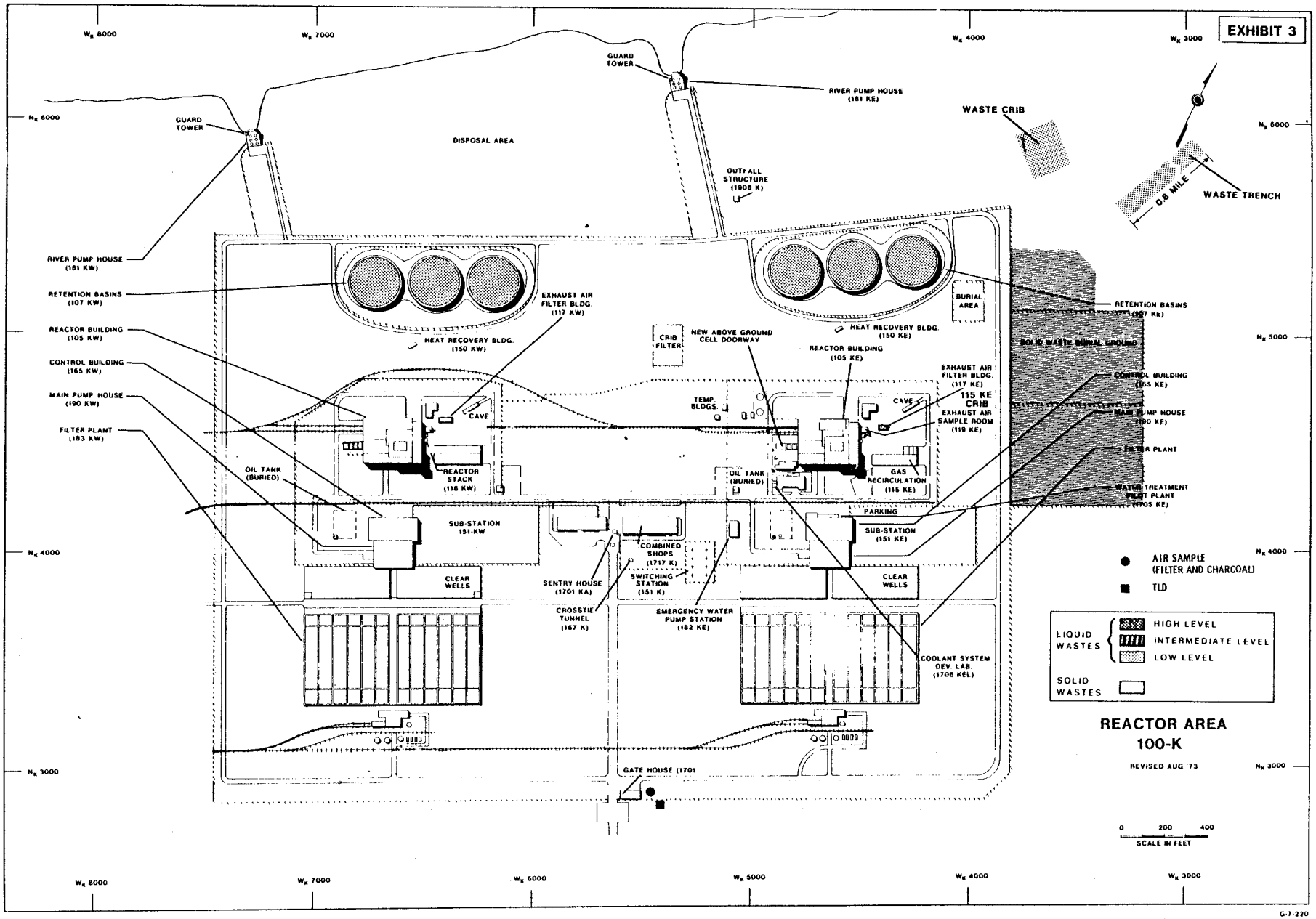
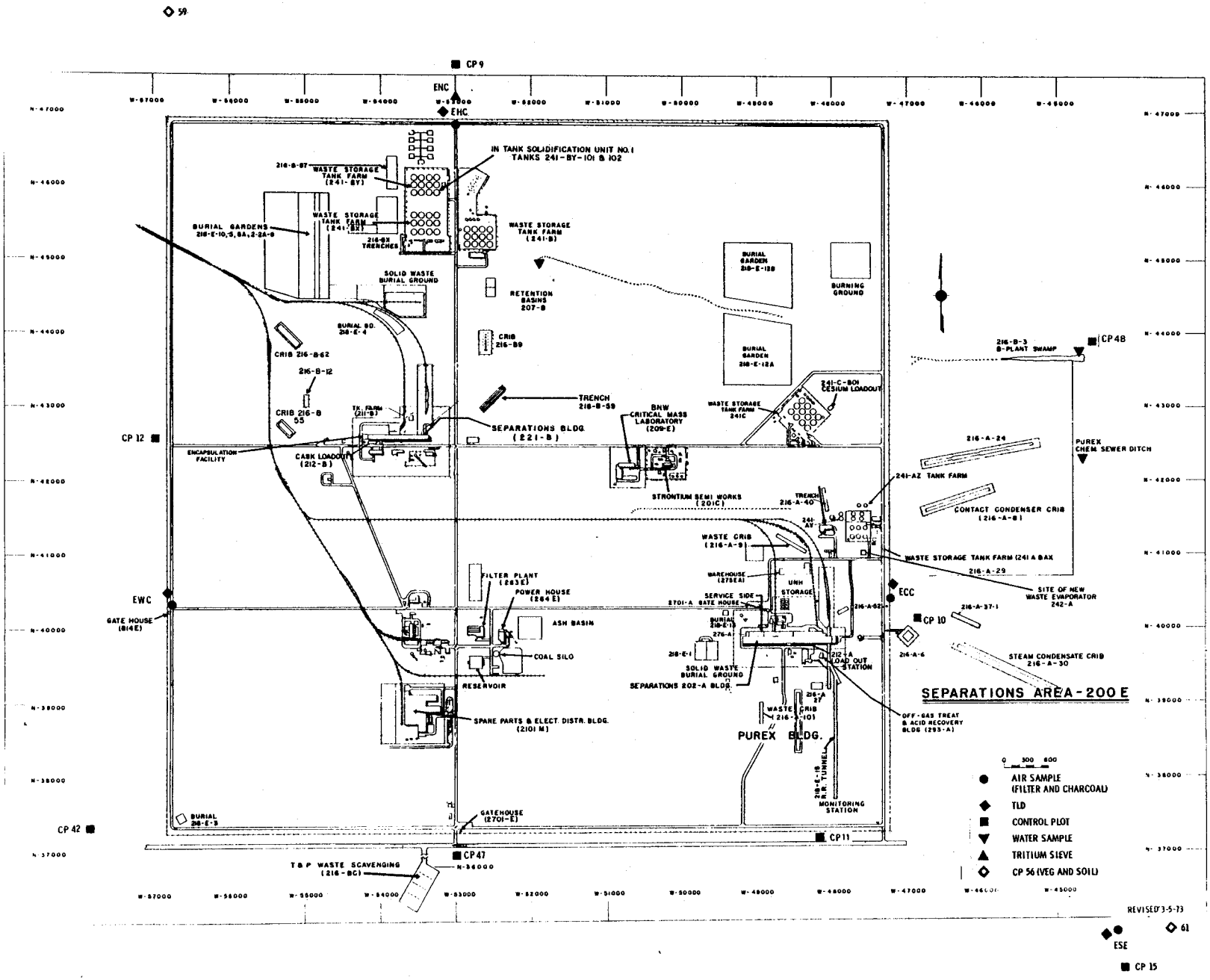
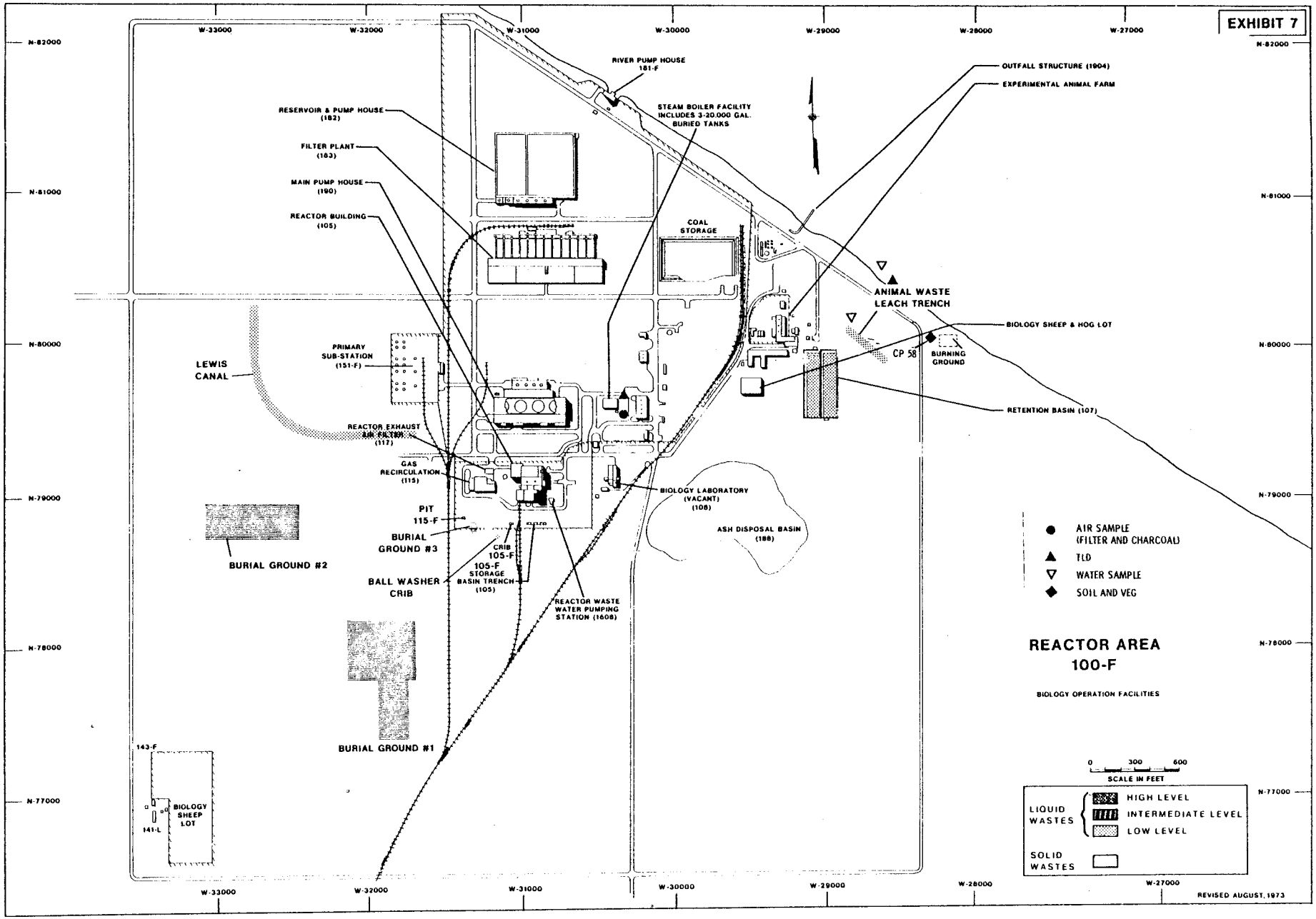


EXHIBIT 3
GUARD TOWER
RIVER PUMP HOUSE (181 KE)
WASTE CRIB
GUARD TOWER
DISPOSAL AREA
OUTFALL STRUCTURE (1908 K)
0.8 MILE
WASTE TRENCH
RIVER PUMP HOUSE (181 KW)
RETENTION BASINS (107 KW)
EXHAUST AIR FILTER BLDG. (117 KW)
BURIAL AREA
RETENTION BASINS (107 KE)
REACTOR BUILDING (105 KW)
CONTROL BUILDING (165 KW)
MAIN PUMP HOUSE (190 KW)
FILTER PLANT (183 KW)
HEAT RECOVERY BLDG. (150 KW)
CRIB FILTER
NEW ABOVE GROUND CELL DOORWAY
HEAT RECOVERY BLDG. (150 KE)
REACTOR BUILDING (105 KE)
SOLID WASTE BURIAL GROUND
EXHAUST AIR FILTER BLDG. (117 KE)
115 KE CRIB
CONTROL BUILDING (165 KE)
MAIN PUMP HOUSE (190 KE)
FILTER PLANT
WATER TREATMENT PILOT PLANT (1705 KE)
EXHAUST AIR SAMPLE ROOM (119 KE)
TEMP. BLDGS.
CAVE
CAVE
REACTOR STACK (116 KW)
OIL TANK (BURIED)
OIL TANK (BURIED)
GAS RECIRCULATION (115 KE)
PARKING
SUB-STATION 151-KW
SUB-STATION (151 KE)
COMBINED SHOPS (1717 K)
SWITCHING STATION (151 K)
CLEAR WELLS
CLEAR WELLS
SENTRY HOUSE (1701 KA)
CROSSTIE TUNNEL (167 K)
EMERGENCY WATER PUMP STATION (182 KE)
COOLANT SYSTEM DEV. LAB. (1706 KEL)
GATE HOUSE (1701)
AIR SAMPLE (FILTER AND CHARCOAL)
TLD
LIQUID WASTES
HIGH LEVEL
INTERMEDIATE LEVEL
LOW LEVEL
SOLID WASTES
REACTOR AREA
100-K
REVISED AUG 73
0 200 400
SCALE IN FEET
G-7-220


59
CP 9
ENC
EHC
IN TANK SOLIDIFICATION UNIT NO.1
TANKS 241-BY-101 & 102
WASTE STORAGE TANK FARM (241-BY)
WASTE STORAGE TANK FARM (241-BY)
BURIAL GARDENS 216-E-10,9,8A,2-2A-8
216-BX TRENCHES
WASTE STORAGE TANK FARM (241-B)
SOLID WASTE BURIAL GROUND
RETENTION BASINS 207-B
BURIAL GARDEN 216-E-12B
BURNING GROUND
BURIAL GD. 216-E-4
CRIB 216-B-62
CRIB 216-B-59
BURIAL GARDEN 216-E-12A
216-B-12
CRIB 216-B-55
TK FARM (241-B)
TRENCH 216-B-59
SEPARATIONS BLDG. (221-B)
241-C-801 CESIUM LOADOUT
BNW CRITICAL MASS LABORATORY (209-E)
WASTE STORAGE TANK FARM 241C
CP 48
216-B-3 B-PLANT SWAMP
CP 12
ENCAPSULATION FACILITY
CASK LOADOUT (212-B)
216-A-24
PUREX CHEM SEWER DITCH
241-AZ TANK FARM
STRONTIUM SEMI WORKS (201C)
TRENCH 216-A-40
241-AY
CONTACT CONDENSER CRIB (216-A-8)
WASTE CRIB (216-A-9)
WASTE STORAGE TANK FARM (241-A BAX)
216-A-29
FILTER PLANT (283E)
POWER HOUSE (284 E)
WAREHOUSE (275EA)
UNH STORAGE
SITE OF NEW WASTE EVAPORATOR 242-A
EWC
GATE HOUSE (814E)
ASH BASIN
SERVICE SIDE
2701-A GATE HOUSE
ECC
216-A-37-1
CP 10
COAL SILO
BURIAL 216-E-13
276-A
216-A-6
STEAM CONDENSATE CRIB 216-A-30
218-E-1
SOLID WASTE BURIAL GROUND
212-A LOAD OUT STATION
RESERVOIR
SEPARATIONS 202-A BLDG.
216-A 37
SEPARATIONS AREA-200 E
SPARE PARTS & ELECT. DISTR. BLDG. (2101 M)
WASTE CRIB (216-A-101)
OFF-GAS TREAT & ACID RECOVERY BLDG (293-A)
PUREX BLDG.
218-E-18 A.R. TUNNEL
MONITORING STATION
BURIAL 218-E-3
GATEHOUSE (2701-E)
CP 42
CP 11
CP 47
T & P WASTE SCAVENGING (216-BC)
0 300 600
AIR SAMPLE (FILTER AND CHARCOAL)
TLD
CONTROL PLOT
WATER SAMPLE
TRITIUM SIEVE
CP 56 (VEG AND SOIL)
REVISED 3-5-73
61
ESE
CP 15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W-33000
W-32000
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W-30000
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W-28000
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N-81000
N-80000
N-79000
N-78000
N-77000
RIVER PUMP HOUSE 181-F
OUTFALL STRUCTURE (1904)
EXPERIMENTAL ANIMAL FARM
RESERVOIR & PUMP HOUSE (182)
STEAM BOILER FACILITY INCLUDES 3-20,000 GAL. BURIED TANKS
FILTER PLANT (183)
MAIN PUMP HOUSE (190)
REACTOR BUILDING (105)
COAL STORAGE
ANIMAL WASTE LEACH TRENCH
BIOLOGY SHEEP & HOG LOT
CP 58
BURNING GROUND
PRIMARY SUB-STATION (151-F)
LEWIS CANAL
RETENTION BASIN (107)
REACTOR EXHAUST AIR FILTER (117)
GAS RECIRCULATION (115)
BIOLOGY LABORATORY (VACANT) (108)
PIT 115-F
BURIAL GROUND #3
ASH DISPOSAL BASIN (188)
CRIB 105-F
105-F STORAGE BASIN TRENCH (105)
BALL WASHER CRIB
REACTOR WASTE WATER PUMPING STATION (1608)
BURIAL GROUND #2
BURIAL GROUND #1
143-F
BIOLOGY SHEEP LOT
141-L
AIR SAMPLE (FILTER AND CHARCOAL)
TLD
WATER SAMPLE
SOIL AND VEG
REACTOR AREA
100-F
BIOLOGY OPERATION FACILITIES
0 300 600
SCALE IN FEET
LIQUID WASTES
HIGH LEVEL
INTERMEDIATE LEVEL
LOW LEVEL
SOLID WASTES
REVISED AUGUST, 1973

G-7-219

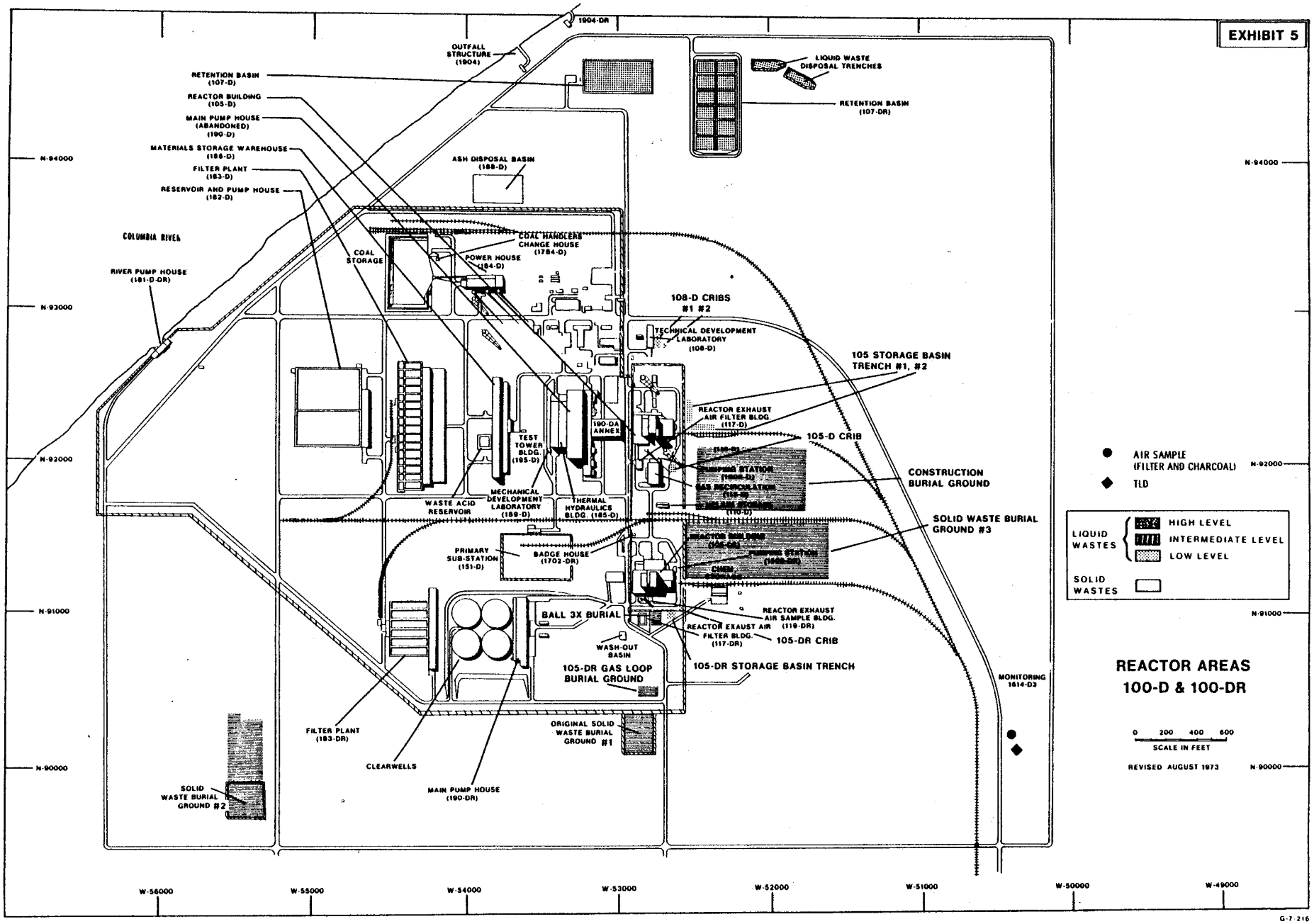


EXHIBIT 5
1904-DR
OUTFALL STRUCTURE (1904)
RETENTION BASIN (107-D)
REACTOR BUILDING (105-D)
MAIN PUMP HOUSE (ABANDONED) (190-D)
MATERIALS STORAGE WAREHOUSE (186-D)
FILTER PLANT (183-D)
RESERVOIR AND PUMP HOUSE (182-D)
COLUMBIA RIVER
RIVER PUMP HOUSE (181-D-DR)
ASH DISPOSAL BASIN (188-D)
COAL STORAGE
COAL HANDLERS CHANGE HOUSE (1704-D)
POWER HOUSE (184-D)
108-D CRIBS #1 #2
TECHNICAL DEVELOPMENT LABORATORY (108-D)
105 STORAGE BASIN TRENCH #1, #2
REACTOR EXHAUST AIR FILTER BLDG. (117-D)
105-D CRIB
190-DA ANNEX
TEST TOWER BLDG. (185-D)
CONSTRUCTION BURIAL GROUND
WASTE ACID RESERVOIR
MECHANICAL DEVELOPMENT LABORATORY (189-D)
THERMAL HYDRAULICS BLDG. (185-D)
SOLID WASTE BURIAL GROUND #3
PRIMARY SUB-STATION (151-D)
BADGE HOUSE (1702-DR)
BALL 3X BURIAL
REACTOR EXHAUST AIR SAMPLE BLDG. (119-DR)
REACTOR EXAUST AIR FILTER BLDG. (117-DR)
105-DR CRIB
WASH-OUT BASIN
105-DR GAS LOOP BURIAL GROUND
105-DR STORAGE BASIN TRENCH
MONITORING 1614-D3
ORIGINAL SOLID WASTE BURIAL GROUND #1
FILTER PLANT (183-DR)
CLEARWELLS
MAIN PUMP HOUSE (190-DR)
SOLID WASTE BURIAL GROUND #2
LIQUID WASTE DISPOSAL TRENCHES
RETENTION BASIN (107-DR)
AIR SAMPLE (FILTER AND CHARCOAL)
TLD
LIQUID WASTES
HIGH LEVEL
INTERMEDIATE LEVEL
LOW LEVEL
SOLID WASTES
REACTOR AREAS
100-D & 100-DR
0 200 400 600
SCALE IN FEET
REVISED AUGUST 1973
N-94000
N-93000
N-92000
N-91000
N-90000
W-56000
W-55000
W-54000
W-53000
W-52000
W-51000
W-50000
W-49000
G-7-216

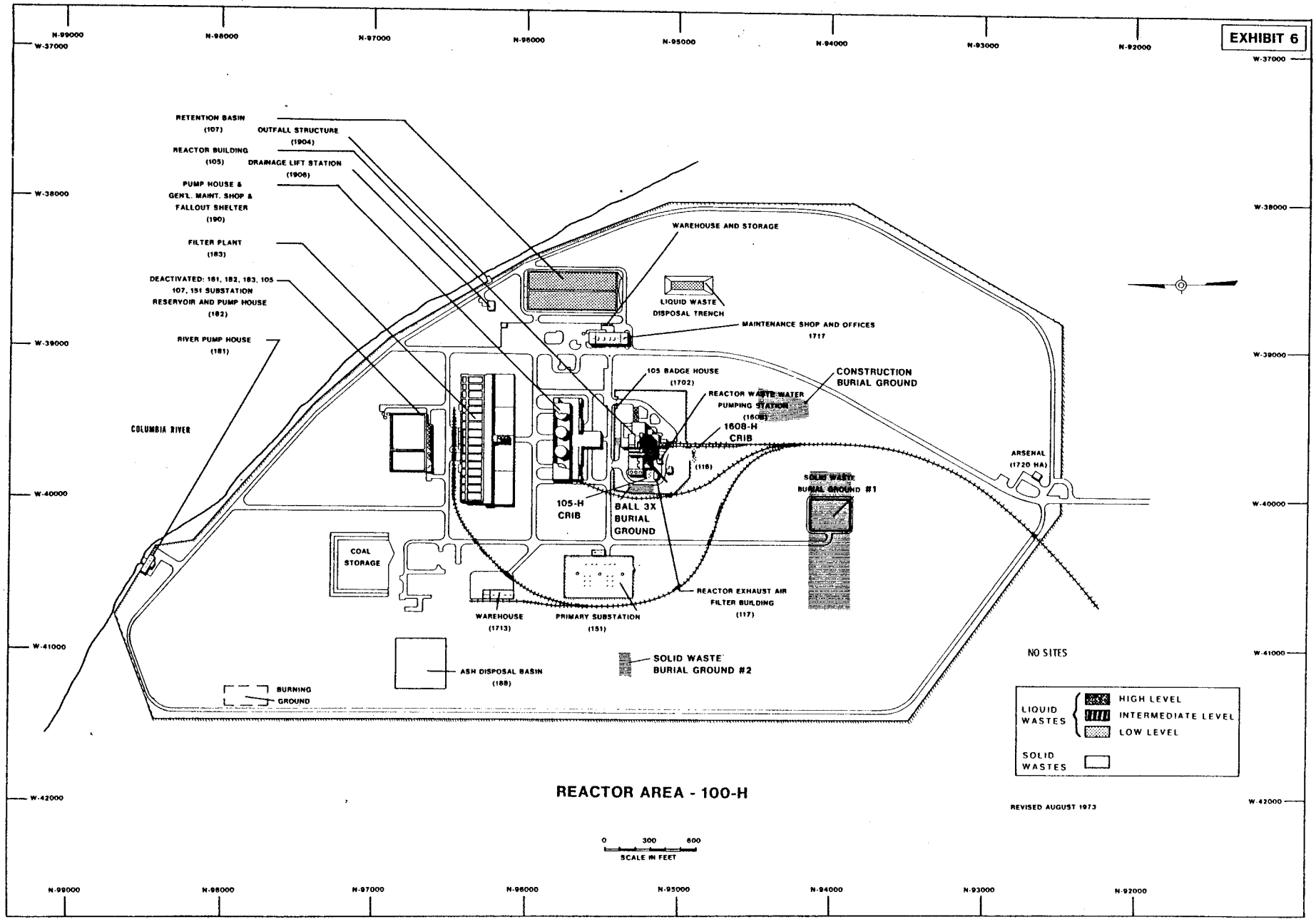


EXHIBIT 6
N-99000
N-98000
N-97000
N-96000
N-95000
N-94000
N-93000
N-92000
W-37000
W-38000
W-39000
W-40000
W-41000
W-42000
RETENTION BASIN (107)
OUTFALL STRUCTURE (1904)
REACTOR BUILDING (105)
DRAINAGE LIFT STATION (1908)
PUMP HOUSE & GEN'L. MAINT. SHOP & FALLOUT SHELTER (190)
FILTER PLANT (183)
DEACTIVATED: 181, 182, 183, 105 107, 151 SUBSTATION RESERVOIR AND PUMP HOUSE (182)
RIVER PUMP HOUSE (181)
COLUMBIA RIVER
WAREHOUSE AND STORAGE
LIQUID WASTE DISPOSAL TRENCH
MAINTENANCE SHOP AND OFFICES 1717
105 BADGE HOUSE (1702)
REACTOR WASTE WATER PUMPING STATION (1608)
1608-H CRIB
CONSTRUCTION BURIAL GROUND
(118)
ARSENAL (1720 HA)
SOLID WASTE BURIAL GROUND #1
105-H CRIB
BALL 3X BURIAL GROUND
COAL STORAGE
REACTOR EXHAUST AIR FILTER BUILDING (117)
WAREHOUSE (1713)
PRIMARY SUBSTATION (151)
ASH DISPOSAL BASIN (188)
SOLID WASTE BURIAL GROUND #2
BURNING GROUND
NO SITES
LIQUID WASTES
HIGH LEVEL
INTERMEDIATE LEVEL
LOW LEVEL
SOLID WASTES
REACTOR AREA - 100-H
REVISED AUGUST 1973
0 300 600
SCALE IN FEET

G-7-22

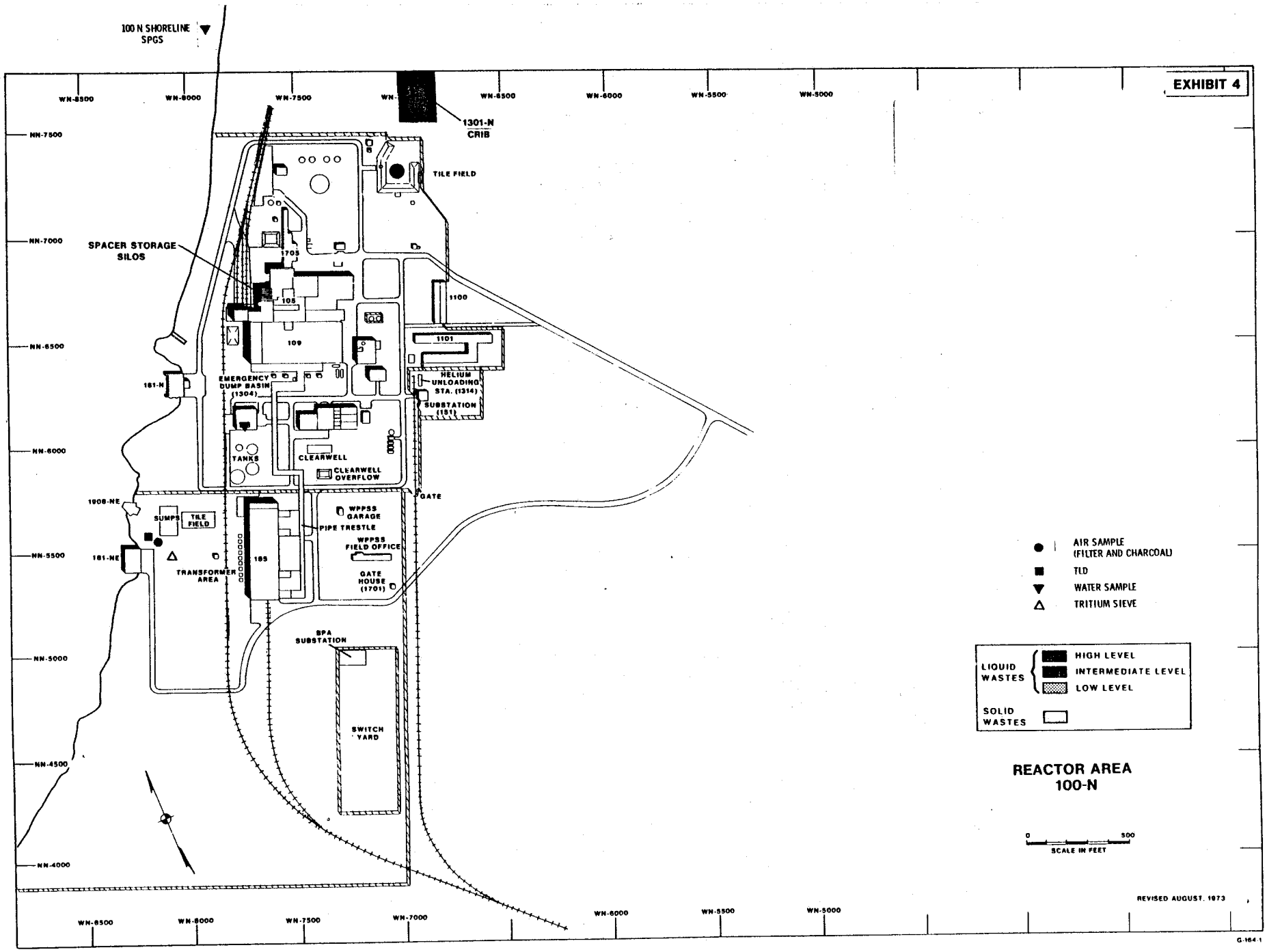
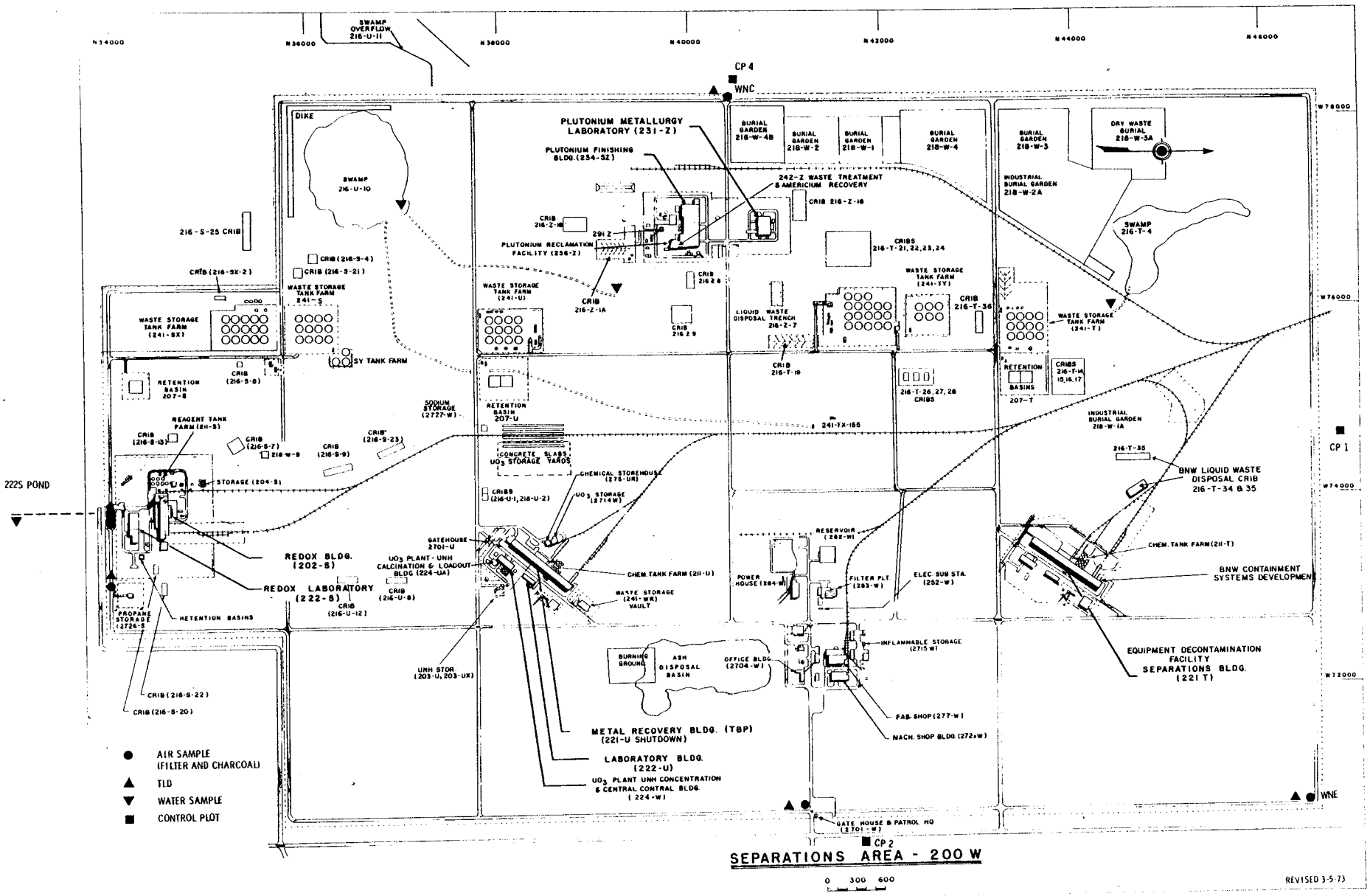
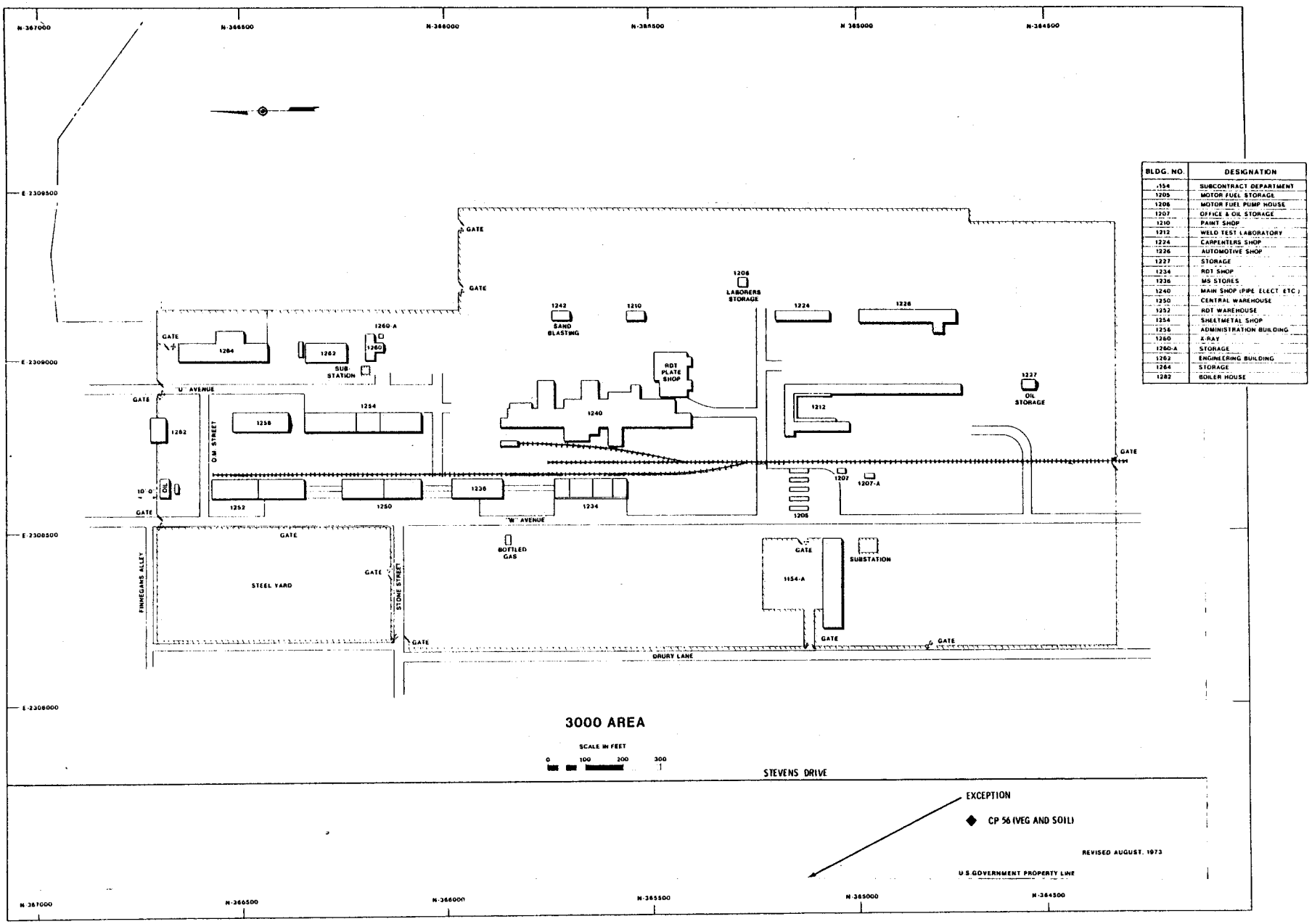


EXHIBIT 4
100 N SHORELINE
SPGS
WN-8500
WN-8000
WN-7500
WN-7000
WN-6500
WN-6000
WN-5500
WN-5000
NN-7500
NN-7000
NN-6500
NN-6000
NN-5500
NN-5000
NN-4500
NN-4000
1301-N
CRIB
TILE FIELD
SPACER STORAGE
SILOS
1705
105
109
1100
1101
181-N
EMERGENCY
DUMP BASIN
(1304)
HELIUM
UNLOADING
STA. (1314)
SUBSTATION
(1311)
TANKS
CLEARWELL
CLEARWELL
OVERFLOW
GATE
1908-NE
SUMPS
TILE
FIELD
WPPSS
GARAGE
PIPE TRESTLE
WPPSS
FIELD OFFICE
181-NE
TRANSFORMER
AREA
185
GATE
HOUSE
(1701)
BPA
SUBSTATION
SWITCH
YARD
AIR SAMPLE
(FILTER AND CHARCOAL)
TLD
WATER SAMPLE
TRITIUM SIEVE
LIQUID
WASTES
HIGH LEVEL
INTERMEDIATE LEVEL
LOW LEVEL
SOLID
WASTES
REACTOR AREA
100-N
0
500
SCALE IN FEET
REVISED AUGUST, 1973
G-164-1


N34000
N36000
N38000
N40000
N42000
N44000
N46000
W78000
W76000
W74000
W72000
SWAMP OVERFLOW 216-U-11
CP 4
WNC
DIKE
SWAMP 216-U-10
PLUTONIUM METALLURGY LABORATORY (231-Z)
PLUTONIUM FINISHING BLDG. (234-5Z)
242-Z WASTE TREATMENT & AMERICIUM RECOVERY
PLUTONIUM RECLAMATION FACILITY (236-Z)
291 Z
CRIB 216-Z-16
CRIB 216-Z-18
CRIB 216-Z-1A
CRIB 216 Z 8
CRIB 216 Z 9
CRIBS 216-T-21, 22, 23, 24
BURIAL GARDEN 218-W-4B
BURIAL GARDEN 218-W-2
BURIAL GARDEN 218-W-1
BURIAL GARDEN 218-W-4
BURIAL GARDEN 218-W-3
DRY WASTE BURIAL 218-W-3A
INDUSTRIAL BURIAL GARDEN 218-W-2A
SWAMP 216-T-4
216-S-25 CRIB
CRIB (216-SX-2)
CRIB (216-S-4)
CRIB (216-S-21)
WASTE STORAGE TANK FARM 241-S
WASTE STORAGE TANK FARM (241-SX)
WASTE STORAGE TANK FARM (241-U)
WASTE STORAGE TANK FARM (241-TY)
WASTE STORAGE TANK FARM (241-T)
SY TANK FARM
CRIB (216-S-8)
RETENTION BASIN 207-S
LIQUID WASTE DISPOSAL TRENCH 216-Z-7
CRIB 216-T-19
CRIB 216-T-36
216-T-26, 27, 28 CRIBS
RETENTION BASINS 207-T
CRIBS 216-T-14, 15, 16, 17
SODIUM STORAGE (2727-W)
RETENTION BASIN 207-U
241-TX-155
INDUSTRIAL BURIAL GARDEN 218-W-1A
REAGENT TANK FARM (2H-S)
CRIB (216-S-13)
CRIB (216-S-7)
218-W-9
CRIB (216-S-9)
CRIB (216-S-23)
CONCRETE SLABS UO3 STORAGE YARDS
CHEMICAL STOREHOUSE (276-UX)
UO3 STORAGE (2714W)
CRIBS (216-U-1, 216-U-2)
222S POND
STORAGE (204-S)
CP 1
216-T-35
BNW LIQUID WASTE DISPOSAL CRIB 216-T-34 & 35
GATEHOUSE 2701-U
UO3 PLANT-UNH CALCINATION & LOADOUT BLDG (224-UA)
CHEM. TANK FARM (2H-U)
RESERVOIR (282-W)
CHEM. TANK FARM (2H-T)
REDOX BLDG. (202-S)
REDOX LABORATORY (222-S)
CRIB (216-U-8)
CRIB (216-U-12)
WASTE STORAGE (241-WR) VAULT
POWER HOUSE (284-W)
FILTER PLT. (283-W)
ELEC SUB STA. (252-W)
BNW CONTAINMENT SYSTEMS DEVELOPMENT
RETENTION BASINS
PROPANE STORAGE (2726-S)
CRIB (216-S-22)
CRIB (216-S-20)
UNH STOR (203-U, 203-UX)
BURNING GROUND
ASH DISPOSAL BASIN
OFFICE BLDG. (2704-W)
INFLAMMABLE STORAGE (2715 W)
EQUIPMENT DECONTAMINATION FACILITY SEPARATIONS BLDG. (221 T)
FAB. SHOP (277-W)
MACH. SHOP BLDG. (272-W)
METAL RECOVERY BLDG. (TBP) (221-U SHUTDOWN)
LABORATORY BLDG. (222-U)
UO3 PLANT UNH CONCENTRATION & CENTRAL CONTROL BLDG. (224-W)
GATE HOUSE & PATROL HQ (2701-W)
CP 2
WNE
AIR SAMPLE (FILTER AND CHARCOAL)
TLD
WATER SAMPLE
CONTROL PLOT
SEPARATIONS AREA - 200 W
0 300 600
REVISED 3-5-73



BLDG. NO.	DESIGNATION
1154	SUBCONTRACT DEPARTMENT
1205	MOTOR FUEL STORAGE
1206	MOTOR FUEL PUMP HOUSE
1207	OFFICE & OIL STORAGE
1210	PAINT SHOP
1212	WELD TEST LABORATORY
1224	CARPENTERS SHOP
1226	AUTOMOTIVE SHOP
1227	STORAGE
1234	RDT SHOP
1236	MS STORES
1240	MAIN SHOP (PIPE ELECT ETC.)
1250	CENTRAL WAREHOUSE
1252	RDT WAREHOUSE
1254	SHEETMETAL SHOP
1256	ADMINISTRATION BUILDING
1260	X-RAY
1260-A	STORAGE
1262	ENGINEERING BUILDING
1264	STORAGE
1282	BOILER HOUSE

3000 AREA

SCALE IN FEET

0 100 200 300

EXCEPTION

◆ CP 56 (VEG AND SOIL)

REVISED AUGUST, 1973

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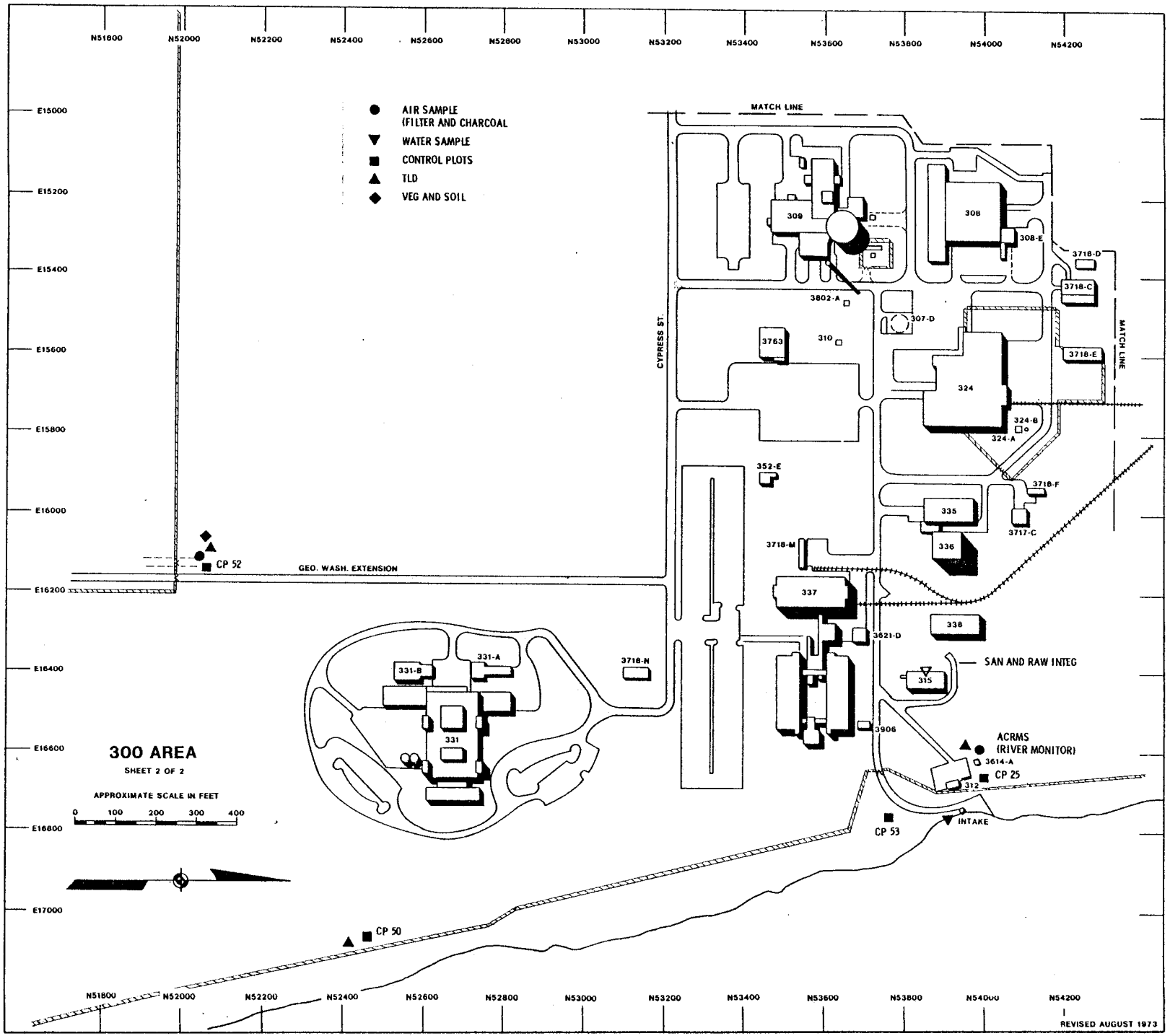
AIR SAMPLE (FILTER AND CHARCOAL
WATER SAMPLE
CONTROL PLOTS
TLD
VEG AND SOIL
MATCH LINE
CYPRESS ST.
GEO. WASH. EXTENSION
CP 52
CP 50
CP 53
CP 25
CP 26
ACRMS (RIVER MONITOR)
INTAKE
SAN AND RAW INTEG
300 AREA
SHEET 2 OF 2
APPROXIMATE SCALE IN FEET
0 100 200 300 400
N51800 N52000 N52200 N52400 N52600 N52800 N53000 N53200 N53400 N53600 N53800 N54000 N54200
E15000 E15200 E15400 E15600 E15800 E16000 E16200 E16400 E16600 E16800 E17000
309 308 308-E 3718-D 3718-C 3802-A 307-D 3763 310 3718-E 324 324-B 324-A 352-E 3718-F 335 3717-C 336 3718-M 337 338 3621-D 315 3906 3614-A 312 331-A 331-B 331 3718-N
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