E. Jackson / *[Signature]* *DF*
CJ / KCJ
RR BNWL-432

AEC
RESEARCH
and
DEVELOPMENT
REPORT

EARTH SCIENCES
WASTE DISPOSAL INVESTIGATIONS
JULY-DECEMBER, 1966

J. R. Eliason

June, 1967

BATTELLE-NORTHWEST

BATTELLE MEMORIAL INSTITUTE / PACIFIC NORTHWEST LABORATORY

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PACIFIC NORTHWEST LABORATORY

RICHLAND, WASHINGTON

operated by

BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

3 3679 00060 5727

BNWL-432

EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS -- JULY - DECEMBER, 1966

by

J. R. Eliason

Geochemical and Geophysical Research
Earth Sciences Section

June 14, 1967

TABLE OF CONTENTS

INTRODUCTION	1
EVALUATION OF GROUND WATER MONITORING DATA	2
200-East Area	2
200-West Area	2
Separations Disposal Sites	3
600-Area Beta Contamination	3
600-Area Tritium Contamination	8
CONTAMINATION IN CONFINED AQUIFERS	8
GROUND WATER QUALITY	9
WELL DRILLING	9
REFERENCES	10
TABLE A. Gross Beta Activity in Unconfined Ground Water	11
TABLE B. Gross Beta Activity in Confined Ground Water	15
DISTRIBUTION	16

EARTH SCIENCES WASTE DISPOSAL INVESTIGATIONS

JULY - DECEMBER, 1966

INTRODUCTION

The Hanford Project has over 500 Wells which are used for the surveillance of radionuclides in the ground resulting from waste disposal. Wells are located at disposal sites to monitor the migration of radionuclides in the soil and to determine when a disposal facility is to be abandoned. Outside of the immediate disposal areas, wells are sampled to determine the movement of contaminants in the ground water zone. The spread of wastes in unconfined ground water aquifers is followed by routine sampling, and the confined aquifers in the area are sampled frequently where possible.

This report is prepared semi-annually to give an evaluation of ground water contamination resulting from disposal of plant effluents. All ground water samples were collected by the Environmental Studies Section and analyzed by the Radiological Analysis Unit. The data presented in this report were collected during the last six months of 1966; the preceding report in this series is BNWL-CC-887.(1)

Analytical results are presented for gross beta activity in the unconfined ground water aquifer and gross beta activity at depths in the ground water (Tables A and B respectively). Results are given where concentrations of radionuclides are above the routine detection limit, 0.08 pCi/cc, for gross beta. The average concentrations detected during the previous report period are listed for comparison. The locations of wells referred to in this report may be found by referring to the well-location maps published in the latest Hanford Wells document.(2)

EVALUATION OF GROUND WATER MONITORING DATA

Ground water samples are analyzed routinely for gross beta; this is generally calculated as $Ru^{106} - Rh^{106}$ because isotopic analyses have shown that $Ru^{106} - Rh^{106}$ is the primary beta emitter in the ground water. Other analyses are made at specific sites for gross alpha, H^3 , Sr^{90} , Cs^{137} , and other isotopes of special interest. The gross beta and tritium results are plotted on water table contour maps and iso-concentration lines are drawn to show the two-dimensional extent and direction of contamination spread. Figure 1 shows the extent of ground water gross beta contamination, and Figure 2 shows the extent of ground water tritium contamination as of December 31, 1966.

200 East Area

Gross beta concentrations in the ground water beneath 200 East Area have shown no significant change during this report period (see Table A). Analyses were made for specific isotopes beneath some inactive and all of the active disposal sites (Table I). No detectable concentrations of Sr^{90} , Cs^{137} , or total α were reported for 200 East Area during the last half of 1966. The maximum average gross beta concentration was detected at the 216-A-10 crib site (91 pCi/cc).

Tritium concentrations >100 pCi/cc were detected in samples from wells near the 216-B-50 disposal site. The In Tank Solidification condensate which has tritium concentrations of approximately 30,000 pCi/cc is the probable source in this area.

200 West Area

Minor changes in beta concentrations beneath 200-West Area were observed in the last six months. Gross beta activity at the 216-S-9 crib increased

from 5901 to 41,000 pCi/cc in well 299-W22-26, and gross beta concentrations averaging 117 pCi/cc have been detected at the 216-T-34 crib (300 Area Lab. Wastes). Gross beta activities in 200 West Area wells are tabulated in Table A.

Low but detectable concentrations of long-lived isotopes were reported at several 200 West Area disposal sites. Total alpha was reported at or above the 0.02 pCi/cc detection limit at the 216-S-9, 216-S-13, 216-S-21, 216-T-27, 216-U-1 & 2, and 216-Z-7 crib sites (Table I). Strontium-90 was detected in the ground water above the 0.03 pCi/cc detection limit at the 216-T-34 (0.038 pCi/cc) and 216-Z-7 (0.04 pCi/cc) crib sites, which have been used for disposal of 300 Area Lab. Wastes. No detectable Cs¹³⁷ was reported in the ground water beneath 200 West Area during this report period. The maximum total beta (40,000 pCi/cc) concentration in the ground water beneath 200 West Area were detected near the 216-S-9 crib. Increases in tritium concentrations in several wells near the 216-Z-7 and 216-T-34 cribs were observed.

Separations Disposal Sites

The concentrations of radioisotopes in the ground water at major disposal sites are listed in Table I. Analyses are made for critical isotopes at the major disposal sites. Minor cribs and french drains are not included in the table. The concentrations listed for each site are those noted in samples from the well(s) that showed the highest concentration.

600 Area (Hanford Project Outside of Exclusion Areas) Beta Contamination

Beta concentrations detected in the 600 Area wells are tabulated in Table A, and the distribution of gross beta activity in the ground water is shown in Figure 1.

TABLE I

Activity in the Ground Water at Major Crib Sites¹

Crib	Waste	Average Concentrations, July-December, 1966			
		pCi _g /cc	pCi _α /cc	pCiSr ⁹⁰ /cc	pCiCs ¹³⁷ /cc
<u>Purex</u>					
216-A-8	Tank Farm Condensate	0.2	<0.02	<0.03	<0.6
216-A-9	Acid Fractionator & 100-N	1.6	<0.02	<0.03	<0.6
216-A-10	Process Condensate	91.0	<0.02	<0.03	<0.6
216-A-27	Laboratory & Floor Drains	14.0	<0.02	<0.03	<0.6
216-A-31	Organic Waste	40.2	<0.02	----	---
216-A-36B	Scrubber Waste	78.5	<0.02	<0.03	<0.6
<u>B-Plant</u>					
216-B-7	Decontamination	2.4	<0.02	<0.03	<0.6
216-B-50	ITS and Tank Farm Cond.	21.0	----	----	---
<u>C-Plant</u>					
216-C-10	Process Condensate	1.0	<0.02	<0.03	<0.6
<u>Redox</u>					
216-S-6	Steam Condensate	3.2*	<0.02*	<0.03*	---
216-S-9	Process Wastes	41,000.	0.02	<0.03	<0.6
216-S-13	Wastes Containing Hexone	0.2	0.02	----	---
216-S-20	Laboratory Wastes	3.6	<0.02	<0.03	<0.6
216-S-21	Tank Farm Condensate	79.0	0.2	<0.03	<0.6
<u>T-Plant</u>					
216-T-19	Process Condensate	16.5	----	<0.03	<0.6
216-T-27	Decontamination	832.0	0.03	<0.03	<0.6
216-T-34	300 Area Lab.	117.0	<0.02	0.04	<0.6
<u>U-Plant</u>					
216-U-1&2	Decontamination & Cell Drain	0.2	0.1	<0.03	<0.6
216-U-12	Process Condensate	1.0	<0.02	----	---
<u>Z-Plant</u>					
216-Z-1A	Recovery Process Waste	10.3	<0.02	----	---
216-Z-7	Floor Drains	9000.	0.07	0.04	<0.6
216-Z-12	Neutralized Process Wastes	2.2	<0.02	<0.03	<0.6

¹A blank in the table indicates that the particular analysis was not made on samples from the site.

* Sampled before 7/1/66

FIGURE 1

Extent of Ground Water Gross Beta Contamination, July-December, 1966

FIGURE 2

Extent of Ground Water Tritium Contamination, July-December, 1966

TABLE II

Ground Water Quality

Well No.	Miles From Processing Facility	Total β pCi/cc	Total α pCi/cc	pH	SO_4^{--} ppm	NO_3^- ppm	Na^+ ppm	Ca^{++} ppm	Organic ppm
<u>200 East</u>									
299-E17-1	<1	49.1	<0.02	8.2	60	140	45	53	0.6
299-E17-2	<1	13.9	<0.02	8.1	68	130	35	57	0.9
299-E17-5	<1	78.9	<0.02	8.0	89	410	44	119	<0.2
299-E24-2	<1	90.8	<0.02	8.1	67	410	41	132	0.2
299-E24-9	<1	40.2	<0.02	8.1	81	290	37	95	<0.2
<u>600 Area</u>									
699-36-46R	<1	0.35	<0.02	8.2	64	<1	28	21	<0.2
699-34-39A	2.0	7.0	<0.02	7.9	68	160	34	44	1.2
699-28-40	2.6	0.47	<0.02	7.9	54	2	22	21	0.9
699-40-33	3.0	0.44	<0.02	8.1	65	130	29	41	<0.2
699-30-31	3.8	4.47	<0.02	7.9	63	20	33	25	<0.2
699-24-33	4.0	1.2	<0.02	8.0	62	90	24	26	0.6
699-41-23	4.9	0.47	<0.02	---	---	---	---	---	---
699-15-26	6.1	1.34	<0.02	7.8	64	130	23	48	<0.2
699-20-20	6.4	0.17	<0.02	7.9	63	130	15	52	<0.2
699-26-15	6.9	2.23	<0.02	7.8	69	50	27	50	<0.2
Average Concentrations in Columbia River at Hanford, July - October, 1966					9.75	0.12		21	
Average Concentrations in Ground Water Prior to Significant Plant Disposal ⁽³⁾				7.9	21.5	2.2	19.4	28.6	

Minor changes in the beta contamination pattern have been detected in the past six months. Several areas previously shown as isolated zones of 0.08-1 pCi/cc beta contamination have been included in the general 0.08-1 pCi/cc beta contamination zone. Increased release of beta activity in 200 West area accounts for the larger 1-100 pCi/cc beta contamination zone in that area. The 1-100 pCi/cc zone moving from 200 East Area was extended further toward the river because of activity >1 pCi/cc detected in wells 699-26-15 and 699-16-26. The maximum average beta activity detected in the 600 Area wells was 7.0 pCi/cc in 699-34-39A.

600 Area (Hanford Project Outside of Exclusion Areas) Tritium Contamination

The distribution of tritium in the ground water is shown in Figure 2. The general tritium concentration patterns have not changed significantly.

Several wells in 200 East Area have shown increases in tritium activity and the 100-1000 pCi/cc concentration level now covers a larger area. This increase in tritium activity is due to the disposal of the In Tank Solidification condensate waste to the 216-B-50 disposal site. Wells in 200 West Area near the 216-Z-7 and 216-T-34 cribs have shown increases in tritium concentrations and account for the small zone of 100-1000 pCi/cc zone in 200 West Area.

CONTAMINATION IN CONFINED AQUIFERS

Beta emitter concentrations detected in samples taken at various depths, and in some instances from confined aquifers, below the water table are listed in Table B.

Depth sampling in wells and samples taken from specific aquifers over the past years have shown that some activity is being carried into the confined aquifers beneath the project. The extent of waste spread in confined aquifers

is difficult to evaluate because of the limited points at which they can be sampled. The maximum average beta activity reported in a confined zone was 1.82 pCi/cc in well 699-28-40P in a zone 313 feet below the water table. The maximum average tritium activity detected in a confined zone was 2050 pCi/cc in well 699-30-31R at 333 feet below the water table.

GROUND WATER QUALITY

The disposal of wastes to the ground has caused measurable changes in ground water quality near disposal sites. The changes in water quality are due directly to the concentrations of salts in the wastes and indirectly to the degradation of minerals in the soil by the wastes. Table II shows concentrations of radioactive and non-radioactive materials in the ground water near disposal sites and down-gradient from the sites. Concentrations of the non-radioactive materials in the ground water are below the Public Health Service recommended drinking water limits except for nitrate which is above the recommended 45 ppm limit in several wells.

WELL DRILLING

Wells are being drilled around several disposal sites in 200 West Area to obtain data needed for the inventory of activity above the ground water table in connection with Ben Franklin Dam Studies. Many of these wells will be available later for ground water monitoring purposes. Two wells, 299-W11-17 and 299-W11-18, have been drilled near a new 300 Area Lab. waste disposal crib in 200 West Area.

REFERENCES

1. J. R. Eliason. Earth Sciences Waste Disposal Investigations, January - June, 1965, BNWL-CC-887. November, 1966.
2. D. J. Brown and V. L. McGhan. Hanford Wells, HW-44355 Rev. 2, January, 1963.
3. R. C. Newcomb and J. R. Strand. Geology and Ground Water Characteristics of the Hanford Reservation of the Atomic Energy Commission, Washington, USGS-W-P-8, December, 1953.

TABLE AGross Beta Activity in Unconfined Ground Water

Well Designation	<u>July - December, 1966</u>			<u>Jan-June, 1966</u>
	Avg. Conc. pCiB/cc	Max. Conc. pCiB/cc	Conc. In Latest Sample pCiB/cc	Avg. Conc. pCiB/cc

200 East Area

Wells Monitoring 216-A

Disposal Facilities

299-E16-2	1.3	2.7	1.1	.22
299-E17-1	49.1	49.1	49.1	42.2
299-E17-2	13.9	13.9	13.9	22.8
299-E17-3	29.5	32.1	30.8	28.1
299-E17-4	5.0	5.0	5.0	19.7
299-E17-5	78.9	107.0	41.5	62.8
299-E17-6	73.7	89.4	89.4	1.3
299-E24-2	90.8	120.0	120.0	168.0
299-E24-3	1.6	1.6	1.6	----
299-E24-4	.8	.8	.8	----
299-E24-9	40.2	48.5	47.6	69.7
299-E25-2	1.5	5.4	1.6	.23
299-E25-3	2.3	6.2	.74	.57
299-E25-4	.21	.21	.21	.72
299-E25-5	1.1	1.4	.99	.89
299-E25-6	1.3	1.7	1.0	.48
299-E25-7	1.8	2.8	1.4	1.4
299-E25-11	.91	.95	.95	.62
299-E25-12	1.8	3.7	2.6	.43
299-E26-4	9.7	1.7	.6	1.6

Wells Monitoring 216-B

Disposal Facilities

299-E24-8	2.1	2.1	2.1	2.4
299-E27-5	.9	1.2	.7	.84
299-E33-3	20.9	25.5	25.5	10.7
299-E33-18	2.4	2.5	2.1	2.0

TABLE A. (Continued)

Well Designation	Avg. Conc. pCi/g/cc	Max. Conc. pCi/g/cc	Conc. In Latest Sample pCi/g/cc	Avg. Conc. pCi/g/cc
<u>Wells Monitoring 216-BC Disposal Facilities</u>				
299-E13-20	22.8	45.5	.2	.14
<u>Wells Monitoring 200 East Area Outside Specific Disposal Sites</u>				
299-E19-1	1.8	8.2	.2	.23
299-E23-1	.27	.27	.27	<.08
299-E23-2	.52	.52	.52	.13
299-E24-7	.8	2.2	2.2	.21
299-E27-1	1.5	1.5	1.5	1.7
299-E28-4	.4	.19	.19	<.08
299-E28-5	1.3	1.3	1.3	.14
<u>200 West Area</u>				
<u>Wells Monitoring 216-S Disposal Facilities</u>				
299-W22-1	350.0	429.0	429.0	161.0
299-W22-14	123.0	473.0	49.6	295.0
299-W22-19	3.2	3.2	3.2	--
299-W22-20	3.6	7.0	7.0	.37
299-W22-21	.19	.21	.18	.22
299-W22-25	26000.0	4700.0	3800.0	2920.0
299-W22-26	41000.0	51000.0	1890.0	5900.0
299-W22-27	340.0	623.0	623.0	21.8
299-W23-2	.35	.48	.48	.74
299-W23-3	.23	.26	.26	.14
299-W23-4	79.0	237.0	.5	1.1
<u>Wells Monitoring 216-U Disposal Facilities</u>				
299-W19-2	.35	.35	.35	.09
299-W19-3	.22	.23	.19	.55
299-W21-1	2.4	7.6	2.9	<.08
299-W22-22	1.0	1.6	.52	2.4

TABLE A. (continued)

Well Designation	Avg. Conc. pCi8/cc	Max. Conc. pCi8/cc	Conc. In Latest Sample pCi8/cc	Avg. Conc. pCi8/cc
<u>Wells Monitoring 216-T Disposal Facilities</u>				
299-W6-1	.68	2.3	2.3	<.08
299-W11-15	4.5	1.6	3.5	--
299-W11-16	31.6	2.1	<.08	--
299-W12-1	1.1	2.8	2.3	.11
299-W14-1	510.0	510.0	510.0	---
299-W14-2	11,000.0	11,000.	11,000.0	--
299-W14-3	832.0	861.0	775.0	4380.0
299-W15-4	16.5	22.2	17.5	1.7
<u>Wells Monitoring 216-Z Disposal Facilities</u>				
299-W15-7	9000.0	9000.0	9000.0	1330.0
299-W18-1	27.3	83.1	7.0	.36
299-W18-5	2.2	2.2	2.2	.55
299-W18-6	10.3	17.1	17.1	1.5
<u>600 Area Wells</u>				
699-S12-29	.12	.38	.03	.11
699-S8-19	5.8	22.8	.09	.14
699-S6-E14	.47	1.4	1.1	.12
699-S3-E12	2.1	7.3	.7	<.08
699-8-7	.05	.07	.06	.09
699-10-E12	.26	.71	.15	.23
699-14-E6T	0.5	1.7	1.7	--
699-16-26	1.3	1.4	1.4	.42
699-19-58	1.6	5.5	.09	.14
699-20-E5T	1.3	5.6	5.6	--
699-20-20	.18	.40	.09	.22
699-24-1T	0.58	1.26	0.40	--
699-24-33	1.20	2.07	.64	5.5
699-26-15	2.2	3.1	2.8	.59
699-27-8	.14	.35	.06	.08
699-28-40	.47	1.2	.40	.18
699-29-78	.18	.32	.11	.09
699-30-31	4.5	9.1	2.3	5.6
699-31-53B	.83	3.8	.09	.08
699-31-65	.08	.17	.03	.09
699-32-62	.13	.46	.09	.09
699-33-56	.07	.14	.03	.09

TABLE A. (continued)

Well Designation	Avg. Conc. pCi _β /cc	Max. Conc. pCi _β /cc	Conc. In	
			Latest Sample pCi _β /cc	Avg. Conc. pCi _β /cc
699-34-39A	7.03	12.0	5.4	4.6
699-34-88	.19	.41	.07	.10
699-35-70	1.3	6.8	.17	.08
699-36-46S	0.3	0.4	0.4	--
699-38-65	.13	.21	.06	<.08
699-38-70	<.08	.21	<.08	<.08
699-40-1	<.08	.09	.09	<.08
699-41-23	.47	.64	.56	.16
699-42-42	.45	.99	.91	.12
699-44-64	.35	.73	.09	.12
699-45-69	.12	.37	.09	.09
699-47-35	.11	.16	<.08	.12
699-47-46	.12	.39	<.08	<.08
699-47-60	1.8	5.6	<.08	.09
699-50-53	5.7	11.8	1.3	3.6
699-50-85	1.0	4.9	.13	.08
699-53-55	2.7	10.0	10.0	<.08
699-54-57	.20	.60	.60	<.08
699-55-50A	.37	.70	.70	.31
699-55-76	.09	.16	.14	.26
699-55-89	.29	.97	<.08	.09

Other wells were sampled and found to be below the routine detection limit of 0.08 pCi_β/cc.

TABLE BGross Beta Activity in Confined Ground Water

Piezometer Tube Designation	Depth	<u>July - December, 1966</u>			<u>Jan-June, 1966</u>
	Below Water Table	Avg. Conc. pCi β /cc	Max. Conc. pCi β /cc	Conc. In Latest Sample pCi β /cc	Avg. Conc. pCi β /cc
<u>600 Area</u>					
699-S31-1P	141	.14	.32	<.08	<.08
699-S18-E2P	168	.08	.13	.13	<.08
699-S14-20P	74	.158	.29	.22	.10
699-S12-29P	84	.302	.41	.41	.09
699-S6-E4CP	377	.40	.76	.76	.34
699-10-E12P	283	.35	1.38	.18	.19
699-20-E12P	260	.48	1.61	.33	.22
699-28-40P	313	1.82	3.56	.10	.09
699-30-31P	503	.14	.31	<.08	.12
699-30-31R	333	.70	.73	.68	.51
699-42-42P	106	.18	.26	.23	.10
699-55-50AP	55	.75	1.1	.57	.38

DISTRIBUTION

<u>No. of Copies</u>		<u>Bldg.</u>	<u>Area</u>
3	<u>Douglas United Nuclear, Incorporated</u>		
	T. W. Ambrose	1704-H	100-H
	R. G. Geier	1760-D	100-D
	P. C. Jerman	1760-D	100-D
14	<u>Isochem, Incorporated</u>		
	G. E. Backman	222-T	200-W
	S. J. Beard	271-B	200-E
	D. J. Brown	271-U	200-W
	V. R. Chapman	2704-W	200-W
	R. E. Roberts	2704-W	200-W
	D. T. Crawley	234-5	200-W
	J. W. Fillmore	234-5	200-W
	G. L. Hanson	202-S	200-W
	G. R. Kiel	271-U	200-W
	W. N. Koop	222-T	200-W
	H. C. Rathvon	202-A	200-E
	R. J. Sloat	271-U	200-W
	R. E. Tomlinson	2704-E	200-E
	L. L. Zahn	202-A	200-E
4	<u>U. S. Atomic Energy Commission</u>		
	J. T. Christy	Federal	700
	N. W. Fraser	Federal	700
	J. E. Goodwin	Federal	700
	G. B. Vincent	Federal	700
1	<u>Vitro Engineering Company</u>		
	D. E. Anderson	Federal	700
1	<u>Hanford Occupational Health Foundation, Inc.</u>		
	F. E. Adley	747	1100
5	<u>AEC, DTIE</u>		

No. of
Copies

Bldg. Area

45

Battelle-Northwest

G. J. Alkire	326	300
J. R. Bovington	329	300
R. E. Brown	2707-U	200-W
J. P. Corley	329	300
J. R. Eliason	2707-U	200-W
W. L. Fisher	3706	300
R. F. Foster	326	300
J. J. Fuquay	326	300
R. B. Hall	3706	300
W. A. Haney	222-U	200-W
F. E. Holt	329	300
R. L. Junkins	Federal	700
A. R. Keene	328	300
J. M. Nielsen	329	300
H. M. Parker	3201	3000
D. W. Pearce	325	300
L. C. Schwendiman	325	300
F. W. Woodfield	3201	3000
Technical Information	3760	300
Technical Publications	Federal	700
Extras (20)		