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RADIOACTIVE CONTAMINATION IN THE HANFORD ENVIRONS FOR THE PERIOD OCTOBER, NOVEMBER, DECEMBER 1956

BY

B. V. ANDERSEN, M. W. McCONIGA AND J. K. SOLDAT

HANFORD LABORATORIES OPERATION

FEBRUARY 25, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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SPECIAL RE-REVIEW
FINAL DETERMINATION
DECLASSIFICATION CONFIRMED
BY J. Dr[illegible] DATE 2/12/81
BY J W Jordan DATE 2/12/81
B. Roberts 2-17-81
P. Sullivan 4-20-98

HW-48374

Health and Safety
(M-3679, 19th Ed.)

This document consists
of 68 pages. [redacted]

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Regional Monitoring
Radiation Protection Operation

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February 25, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Work performed under Contract No. W-31-109-Eng-52 between the Atomic Energy Commission and General Electric Company

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ABSTRACT

SECTION I: RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

Total average I^{131} emission from A-plant and S-plant stacks this quarter was 1.5 curies per day compared to 0.28 curie per day during the previous quarter. During one seven day period in December, 52 curies of I^{131} were discharged to the atmosphere from the S-plant stack. Ruthenium emission from the S-plant stack remained at previously noted low rates of less than 0.01 curie per day.

Average tritium oxide, C^{14}, and S^{35} measurements were generally comparable to previous measurements. Maximum emission rate of tritium oxide was 1.4 curies per day at 100-D Area in October. No significant changes were noted in the gross alpha activity density of reactor stack gases this quarter. The gross beta activity density and the concentrations of radioactive particles both decreased at 100-B reactor stack. Average values of gross beta activity density for this and the previous quarter were 9.3×10^{-5} and 5.7×10^{-3} curie per day, respectively.

SECTION II: RADIOACTIVE CONTAMINATION ON VEGETATION

The average deposition of I^{131} on vegetation was $<3 \times 10^{-6}$ $\mu c/gm$ during October and November. During December, the maximum deposition of I^{131} ranged from $<3 \times 10^{-6}$ to 1.6×10^{-4} $\mu c/gm$ with a maximum deposition outside the project of 3.5×10^{-5} $\mu c/gm$.

The I^{131} was released from the Chemical Processing Areas with only slight amounts of bomb fallout occurring throughout the quarter. The average and maximum deposition patterns for December are illustrated.

SECTION III: RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

Dose rates measured by Victoreen Integrons increased at scattered locations this quarter. Although bomb fallout contributed to some of these increases, the majority were assigned to instrument difficulties because of lack of confirming evidence from other types of monitors. No significant changes were noted in dosage rates monitored by detachable ionization chambers. The high average radioactive particle concentrations noted last quarter were repeated in October during continued fallout of bomb debris. These values returned to near normal levels during November and December.

SECTION IV: RADIOACTIVE CONTAMINATION IN HANFORD WASTES

The discharge of total beta activity in reactor cooling water to the Columbia River averaged 12,500 curies per day compared to 11,200 curies per day last quarter. A summary of liquid wastes discharged to open swamps and ditches is tabulated. A map showing frequency of particles deposited on and near the project is included at the end of the section. Ground surveys in the Tri-City Area showed one particle per 14,000 square feet.

SECTION V: RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

Increases in the activity density of beta particle emitters in the Columbia River this quarter were related to decreased river water flow rates. Activity density ranged from $<5 \times 10^{-8}$ $\mu c/ml$ above the reactor areas to 4.6×10^{-5} $\mu c/ml$ at the Hanford Ferry Landing. Average and maximum river flow was 5.0×10^{5} and 6.5×10^{5} gps this quarter compared to 1.3×10^{6} and 2.2×10^{6} gps for last quarter. Beta particle emitter activity density of samples collected from the Columbia River between McNary Dam and Portland ranged from 8×10^{-8} to 5×10^{-7} $\mu c/ml$; the maximum measurement was obtained at Arlington, Oregon. These values are not significantly different from those noted in the past. Two positive measurements of alpha particle emitters in raw water samples were obtained; one from 283-E Building on October 2, 1956, was 1.4×10^{-8} $\mu c/ml$, and the other from 283-W retention pond on November 7, 1956, was 8.1×10^{-9} $\mu c/ml$. Monthly average values remained below the detection limit of 5×10^{-9} μc of alpha emitters per ml of water in both cases.

SECTION VI: RADIOACTIVE CONTAMINATION IN TEST WELLS

Several wells lying in a general east - west line through the Purex tank farm showed sharp increases in beta emitter activity density in December. This suggests that a new source of activity may be supplementing the remnants of BY crib wastes in the ground water at Purex.

Co^{60} concentration remains constant in the ground water at the BY crib sites, suggesting that wastes formerly thought to be moving westward from the site are actually in balance between the 200 East and 200 West ground water mounds. Co^{60}, which moves essentially without holdup in the soil, should show dilution in the wells if movement of wastes exists.

Low level wastes have moved at least 10,000 feet eastward from the 200 West Area. No wastes, other than these, are known to have left their areas of disposal and only the behavior of the Purex wastes appears to be of concern at present.

SECTION VII: RADIOACTIVE CONTAMINATION IN DRINKING WATER

The Columbia River flow during the fourth quarter was the lowest of any period in the past several years. Water samples derived from the river have consequently shown higher activity levels caused by less dilution of the reactor wastes. Decay studies of samples taken from the Pasco Filter Plant in November reveal half-lives for the major components of approximately one, three, and twenty days.

INTRODUCTION

This document summarizes the results obtained from monitoring the Hanford environs for radioactive contamination during the period October, November, and December, 1956. Samples were collected by Regional Monitoring forces according to procedures previously outlined in documents of this series.[1, 2] These samples were analyzed by Radiological Chemical Analysis forces according to procedures and techniques described in a previously published laboratory manual.[3]

Counting rates obtained from these analyses were corrected for geometry, backscatter, air-window absorption, source size, self-absorption, chemical yield, and collection efficiency by Radiological Chemical Analysis forces using factors described in previous reports.[4, 5] Additional corrections for decay were applied to those samples in which significant amounts of short half-life beta particle emitters were found. The findings obtained from analyzing the direct samples were supplemented with readings obtained from portable and fixed instrumentation.

The results obtained from the described efforts are presented in Sections I through VII. These sections discuss the amounts of active material discharged from plant facilities and their effect on the contamination of vegetation, air, soil, and water.

SECTION I

RADIOACTIVE CONTAMINATION IN EFFLUENT GASES

Radioactive contaminants in the separations and reactor area effluent gases released to the Hanford environs were sampled at the stacks and the stack breechings. Daily filter and scrubber samples from the separations areas were analyzed for I^{131} and $Ru^{103-106}$ activity density. Monthly tritium oxide and C^{14}-S^{35} samples were taken at the reactor areas and analyzed radiochemically. Summaries of the results obtained from measurements in each manufacturing facility are presented below.

SEPARATIONS AREAS

200 EAST AREA - SEMI-WORKS

Filter samples taken from the fifty foot level of the Semi-Works stack were analyzed for total beta particle emitters. The results of these analyses calculated as curies per day emitted from the stack are summarized in Table I.

TABLE I

BETA PARTICLE EMITTERS DISCHARGED FROM THE SEMI-WORKS STACK OCTOBER, NOVEMBER, DECEMBER 1956

Units of Curie Per Day

Month	Maximum	Average
October	<0.001	<0.001
November	<0.001	<0.001
December	<0.001	<0.001
Quarter	<0.001	<0.001
Last Quarter	0.003	<0.001

The extended shutdown of the Semi-Works facility resulted in a continued low emission of gross beta particle emitters from this facility.

All results obtained from this facility were below the detection limit throughout the quarter.

200 EAST AREA - A-PLANT

A summary of the results of I^{131} measurements at the two-hundred foot level of the A-plant stack is presented in Table II.

[redacted]

TABLE II

IODINE-131 DISCHARGED FROM THE A-PLANT STACK OCTOBER, NOVEMBER, DECEMBER 1956

Units of Curies Per Day

Month	Maximum	Average
October	0.66	0.16
November	4.4	1.3
December	3.4	0.55
Quarter	4.4	0.68
Last Quarter	1.6	0.23

The average I^{131} emission rate from the A-plant stack was higher by a factor of 3 this quarter than last quarter.[(8)] Fewer shutdown periods and occasional emission rates of greater than 3 curies per day were responsible for the increased average emission. During one seven day period in November, 19.5 curies of I^{131} were emitted from the A-plant stack.

Measurement of filterable gross beta particle emitters in the A-plant effluent gases was discontinued, during November, while a moving strip filter monitor was installed and calibrated. Monthly average values for October and December were 5.4×10^{-2} and $< 5.0 \times 10^{-3}$ curie per day of beta emitters. Quarterly average and maximum values, based on two months results, were less than 3×10^{-2} and 0.20 curie per day, respectively.

200 WEST AREA - S-PLANT

Table III presents a summary of the results of I^{131} monitoring at the twenty foot level of the S-plant stack.

[redacted]

TABLE III

IODINE-131 DISCHARGED FROM THE S-PLANT STACK
OCTOBER, NOVEMBER, DECEMBER
1956

Units of Curies Per Day

Month	Maximum	Average
October	0.12	0.04
November	0.42	0.12
December	23	2.5
Quarter	23	0.86
Last Quarter	0.28	0.05

I^{131} emission from S-plant increased this quarter to an average of 0.28 curie per day, compared to an average of 0.05 curie per day obtained last quarter. The majority of this I^{131} was emitted during December when 52 curies were discharged to the atmosphere in one seven day period. Maximum emission of 23 curies of I^{131} occurred on December 21.

The results obtained from ruthenium monitoring at the S-plant stack are summarized in Table IV.

[redacted]

TABLE IV

RADIOACTIVE RUTHENIUM DISCHARGED FROM THE S-PLANT STACK OCTOBER, NOVEMBER, DECEMBER 1956

Units of Curie Per Day

Month	Maximum	Average
October	<0.01	<0.01
November	<0.01	<0.01
December	<0.01	<0.01
Quarter	<0.01	<0.01
Last Quarter	0.04	<0.01

No significant change was noted when the ruthenium emission rates for this quarter were compared with those of previous quarters.(6,7,8) No positive measurements were obtained this quarter.

Installation of the new S-plant stack monitor discussed in the previous quarterly report was completed during the present quarter. Operation of the I^{131} scrubber portion of the monitor has been satisfactory. Recent changes in the strip filter portion should permit successful operation of the entire unit during the first quarter of 1957.

200 WEST AREA - U-PLANT

Table V summarizes the results from filter monitoring at the ten foot level of the U-plant stack.

[redacted]

TABLE V

RADIOACTIVE PARTICULATE MATERIALS DISCHARGED FROM THE U-PLANT STACK OCTOBER, NOVEMBER, DECEMBER 1956

	Alpha Particle Emitters Units of 10^{-8} curie/day		Beta Particle Emitters Units of 10^{-5} curie/day		Radioactive Particle Concentrations Units of 10^{5} Particles/day	
Month	Max.	Avg.	Max.	Avg.	Max.	Avg.
October	31	10	3.1	1.6	40	4.7
November	1.5	0.5	0.15	0.05	3.3	1.4
December	8.5	0.5	0.08	0.03	8.0	2.0
Quarter	31	3.7	3.1	0.57	40	2.5
Last Quarter	73	5.7	95	5.7	18	7.8

Activity densities of gross alpha and beta emitters and concentrations of radioactive particles in the U-plant stack gases compared favorably with past data. Last quarter's values were weighted by one unusally high measurement obtained on September 21, 1956. Therefore, no significance can be attached to the apparent decreases this quarter.

REACTOR AREAS

Results of measurements at the reactor area stacks for tritium oxide, C^{14}, S^{35}, and particulate materials are summarized in Tables VI through IX.

[redacted]

 [redacted]

TABLE VI

QUARTERLY SUMMARY OF
TRITIUM OXIDE, CARBON-14, SULFUR-35
DISCHARGED FROM REACTOR STACKS
OCTOBER, NOVEMBER, DECEMBER
1956

Stack	Tritium Oxide Units of curie/day		Carbon-14 Units of 10^{-3} curie/day		Sulfur-35 Units of 10^{-4} curie/day	
	Maximum	Average	Maximum	Average	Maximum	Average
100-B	0.16	<0.10	<4.5	<4.5	7.9	4.6
100-C	<0.10	<0.10	<4.5	<4.5	<4.5	<4.5
100-KW	0.32	<0.10	10	6.1	7.9	7.9
100-KE	0.42	<0.10	<4.5	<4.5	<4.5	<4.5
100-D	1.4	0.67	11	6.8	19	14
100-DR	0.32	0.20	<4.5	<4.5	5.5	<4.5
100-H	0.09	<0.10	<4.5	<4.5	6.1	<4.5
100-F	0.21	<0.10	<4.5	<4.5	57	35

TABLE VII

ALPHA PARTICLE EMITTERS DISCHARGED AS
PARTICULATES FROM REACTOR STACKS
OCTOBER, NOVEMBER, DECEMBER
1956

Units of 10^{-7} Curie Per Day

Stack	October		November		December		Quarterly	
	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
100-B	0.61	0.26	0.68	0.16	0.78	0.17	0.78	0.20
100-C	0.47	0.20	0.30	0.08	9.2	2.6	9.2	0.97
100-KW	0.65	0.18	0.74	0.40	5.2	0.46	5.2	0.35
100-KE	1.2	0.40	0.73	0.36	0.45	0.16	1.2	0.31
100-D	0.58	0.17	0.47	0.19	3.1	0.46	3.1	0.27
100-DR	0.49	0.17	0.68	0.26	0.56	0.15	0.68	0.19
100-H	0.88	0.34	1.1	0.44	0.57	0.17	1.1	0.32
100-F	0.82	0.35	0.88	0.39	0.65	0.18	0.88	0.31

[redacted]

TABLE VIII

BETA PARTICLE EMITTERS DISCHARGED AS PARTICULATES FROM REACTOR STACKS OCTOBER, NOVEMBER, DECEMBER 1956

Units of 10^{-5} Curie Per Day

Stack	October		November		December		Quarterly	
	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
100-B	270	27	0.55	0.36	2.7	0.67	270	9.3
100-C	44	15	13	4.3	240	100	240	41
100-KW	6.7	2.0	3.4	1.4	4.4	1.3	6.7	1.6
100-KE	6.4	3.5	13	8.0	15	6.8	15	6.1
100-D	200	160	220	130	670	190	670	160
100-DR	7.8	1.7	26	3.2	3.7	0.65	26	1.8
100-H	17	8.0	11	7.2	4.9	3.6	17	6.3
100-F	120	66	170	110	190	110	190	95

TABLE IX

RADIOACTIVE PARTICLES DISCHARGED FROM REACTOR STACKS OCTOBER, NOVEMBER, DECEMBER 1956

Units of 10^{5} Particles Per Day

Stack	October		November		December		Quarterly	
	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
100-B	12	4.1	12	4.4	14	1.7	14	3.2
100-C	110	54	40	42	210	75	210	59
100-KW	18	4.3	5.1	3.6	43	6.3	43	4.9
100-KE	6.4	2.3	3.1	1.6	36	5.4	36	3.4
100-D	<0.9	<0.9	0.24	0.13	51	32	51	9.3
100-DR	74	15	5.6	2.5	3.6	0.7	74	5.6
100-H	6.0	2.1	38	8.0	11	2.2	38	4.0
100-F	48	8.6	6.9	4.9	62	22	62	11

[redacted]

Total average tritium oxide emission from the eight reactor area stacks was less than 1.5 curies per day this quarter compared to 1.2 curies per day for the previous quarter. Decreased sensitivity this quarter resulted from adoption of a less expensive method of tritium oxide analysis procedure. The new detection limit is 0.10 curie per day. The only notable change in tritium oxide emission occurred at 105-DR Area where this quarter's average was 0.20 curie per day compared to an average of 0.03 curie per day during last quarter. The emission rates of C^{14} and S^{35} from the reactor area stacks this quarter were comparable to those noted previously. Continued high S^{35} emission rates at 100-F Area confirmed measurements made last quarter.

No significant changes in gross alpha activity density of reactor stack gases were noted during this and the previous two quarters. Gross beta activity density decreased significantly at 100-B Area. Average and maximum values were 9.3×10^{-5} and 2.7×10^{-3} curie per day this quarter, compared to values of 5.7×10^{-3} and 4.6×10^{-2} curie per day obtained last quarter.

Slight increases in concentrations of radioactive particles were noted at 100-D, 100-DR, and 100-H Areas this quarter, while decreased concentrations were noted at 100-KE and 100-B Areas. The decrease at 100-B Area accompanied the decreased beta emitter activity density discussed above. Concentrations at 100-KE Area were returning to normal after increases noted last quarter.

300 AREA

327 BUILDING

Weekly filter and scrubber samples collected from the plenum of the 327 Building stack were analyzed for gross beta particle emitters. Monthly average values for October, November, and December were $<5 \times 10^{-5}$, $<5 \times 10^{-5}$, and 1.3×10^{-4} curie of beta particle emitters per day. Quarterly average and maximum values were 7.1×10^{-5} and 4.3×10^{-4} curie per day. This quarter's average compares favorably with that obtained last quarter.

[redacted]

SECTION II

RADIOACTIVE CONTAMINATION ON VEGETATION

Determination of the radioactive contamination of vegetation in the environs was made by the radiochemical analysis of 2500 vegetation samples. More than 1900 of the samples were from the immediate environs and the remainder from off-area locations in eastern and southern Washington and northern Oregon. All samples were analyzed for I^{131}; 1400 were analyzed for non-volatile beta particle emitters. Fifty samples from selected locations were analyzed for alpha particle emitters.

Averages for the present and previous quarter are compared in Table I. Tables II and III show by months the average iodine and non-volatile beta particle contamination measured at each general location. The concentrations of alpha particle emitters on vegetation are summarized in Table IV.

The average deposition of I^{131} for the quarter was $< 3 \times 10^{-6}$ $\mu c/gm$ with only minor amounts of iodine deposited during October and November. During the last half of December, substantial amounts of I^{131} were released from the Chemical Processing plants (See Section I). The maximum deposition detected was 1.6×10^{-4} $\mu c/gm$ near Military Camp, PSN-50. The deposition patterns for December are illustrated in Figures 1 and 2.

The concentrations of non-volatile beta emitters on vegetation remained at low levels throughout the quarter. The majority of the non-volatile emitters are deposited from bomb fallout and there was only minor deposition from this source throughout the quarter.

The average concentration of alpha particle emitters on vegetation near the Chemical Processing Areas increased threefold while the concentration in outlying districts remained below the detection limit of 1×10^{-9} $\mu c/gm$.

[redacted]

TABLE I

RADIOACTIVE CONTAMINATION ON VEGETATION
OCTOBER, NOVEMBER, DECEMBER
1956

Units of 10^{-6} $\mu c/gm$

Location	No.	Iodine			Non-Volatile Beta Emitters		
Project	Samples	Max.	Avg.	Avg. Last Qtr.	Max.	Avg.	Avg. Last Qtr.
200-West Area	77	28	4	12	240	110	210
200-West - Redox	26	17	4	16	350	140	260
200-West - Gate	61	20	3	14	270	110	200
Route 3	13	8	< 3	7	--	--	--
Meteorology Tower	13	6	< 3	7	370	100	190
Batch Plant	13	11	3	12	230	94	150
200-East Area	51	13	3	13	350	98	180
200-East - Purex	98	89	8	12	610	91	170
Near 200 Areas	309	45	< 3	9	700	98	190
North of 200 Areas	245	18	< 3	9	490	89	180
South of 200 Areas	385	160	< 3	11	260	75	150
PSN 50-51-61	39	17	< 3	9	190	73	170
Goose Egg Hill	117	14	< 3	18	600	79	190
Wahluke Slope	144	4	< 3	8	810	110	140
Off Project							
Pasco to Ringold	100	7	< 3	14	160	72	210
Richland	124	4	< 3	13	100	52	180
Benton City-Kiona	26	35	< 3	8	130	69	160
Richland "Y"	12	< 3	< 3	13	--	--	--
Kennewick Environs	171	8	< 3	7	150	53	110
Pasco Environs	124	11	< 3	10	110	51	110
Prosser to Paterson-McNary	59	4	< 3	6	250	59	99
Eastern Washington	127	4	< 3	17	320	70	170
So. Washington and No. Oregon	138	4	< 3	4	400	54	63

[redacted]

 [redacted]

TABLE II

RADIOACTIVE CONTAMINATION FROM IODINE ON VEGETATION

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-6} $\mu c/gm$

Location	October		November		December	
Project	Max.	Avg.	Max.	Avg.	Max.	Avg.
200 West	4	< 3	5	< 3	28	8
200 West - Redox	5	< 3	3	< 3	17	8
200 West - Gate	4	< 3	4	< 3	20	6
Route 3	< 3	< 3	< 3	< 3	8	4
Meteorology Tower	4	< 3	< 3	< 3	6	3
Batch Plant	3	< 3	< 3	< 3	11	6
200 East Area	4	< 3	7	< 3	13	5
200 East - Purex	4	< 3	18	5	89	15
Near 200 Areas	7	< 3	12	< 3	45	3
North of 200 Areas	18	< 3	3	< 3	5	< 3
South of 200 Areas	4	< 3	4	< 3	160	< 3
PSN 50-51-61	3	< 3	< 3	< 3	17	5
Goose Egg Hill	4	< 3	5	< 3	14	5
Wahluke Slope	< 3	< 3	< 3	< 3	4	< 3
Off Project						
Pasco to Ringold	4	< 3	< 3	< 3	7	< 3
Richland	3	< 3	< 3	< 3	4	< 3
Benton City - Kiona	< 3	< 3	7	< 3	35	< 3
Richland "Y"	< 3	< 3	< 3	< 3	< 3	< 3
Kennewick Environs	< 3	< 3	< 3	< 3	8	< 3
Pasco Environs	11	< 3	< 3	< 3	3	< 3
Prosser to Paterson - McNary	< 3	< 3	< 3	< 3	4	< 3
Eastern Washington	3	< 3	< 3	< 3	4	< 3
So. Washington and No. Oregon	4	< 3	< 3	< 3	4	< 3

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TABLE III

RADIOACTIVE CONTAMINATION FROM NON-VOLATILE BETA PARTICLE EMITTERS ON VEGETATION OCTOBER, NOVEMBER, DECEMBER 1956

Units of 10^{-6} $\mu c/gm$

Location	October		November		December	
Project	Max.	Avg.	Max.	Avg.	Max.	Avg.
200 West Area	240	110	200	96	240	120
200 West - Redox	350	180	240	130	130	110
200 West - Gate	260	140	270	99	130	93
Meteorology Tower	370	140	180	110	70	59
Batch Plant	230	140	74	65	87	74
200 East Area	270	110	120	80	350	110
200 East - Purex	610	120	150	72	150	78
Near 200 Areas	350	120	700	93	170	79
North of 200 Areas	490	110	170	73	150	83
South of 200 Areas	260	87	150	63	190	75
PSN 50-51-61	190	100	81	61	75	58
Goose Egg Hill	600	90	110	75	140	72
Wahluke Slope	470	120	810	110	590	92
Off Project						
Pasco to Ringold	110	75	120	68	160	72
Richland	100	62	86	48	73	47
Benton City - Kiona	130	93	65	46	74	69
Kennewick Environs	70	41	140	53	150	65
Pasco Environs	90	50	76	51	110	52
Prosser to Paterson - McNary	92	51	190	60	250	64
Eastern Washington	230	79	320	73	135	59
So. Washington and No. Oregon	400	64	130	52	130	45

[redacted]

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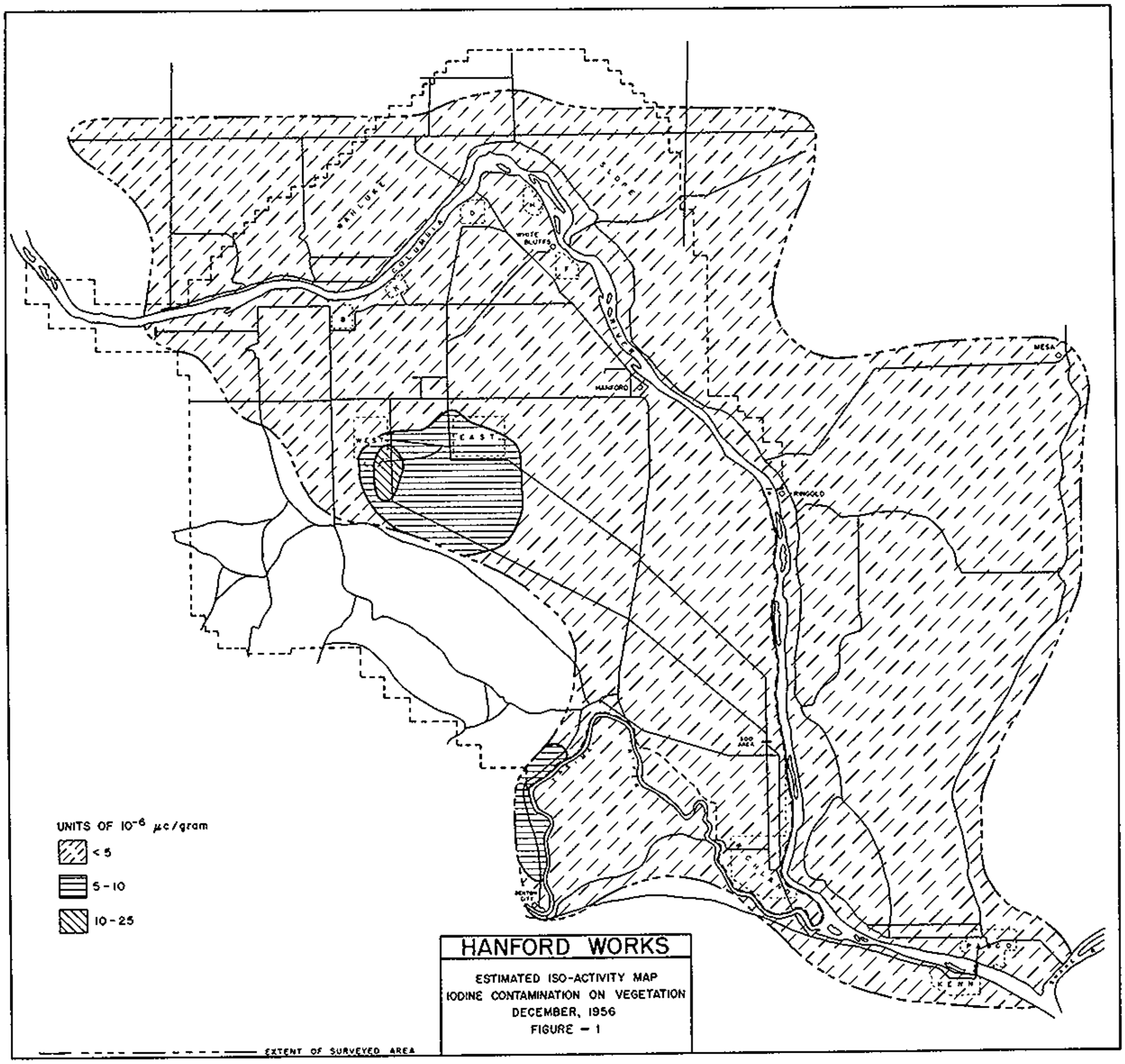
TABLE IV

RADIOACTIVE CONTAMINATION FROM ALPHA PARTICLE EMITTERS ON VEGETATION OCTOBER, NOVEMBER, DECEMBER 1956

Units of 10^{-8} $\mu c/gm$

Location	October Average	November Average	December Average	Quarter Maximum	Quarter Average
Near 200 Areas					
200 West Gate	25	66	77	120	56
Meteorology Tower	<10	30	45	58	28
Batch Plant	13	27	59	98	33
Rt. 4S, Mi. 4	12	15	19	27	15
Rt. 4S, Mi. 6	<10	<10	16	19	<10
Outlying					
Pasco	<10	<10	<10	<10	<10
Benton City	<10	<10	<10	14	<10

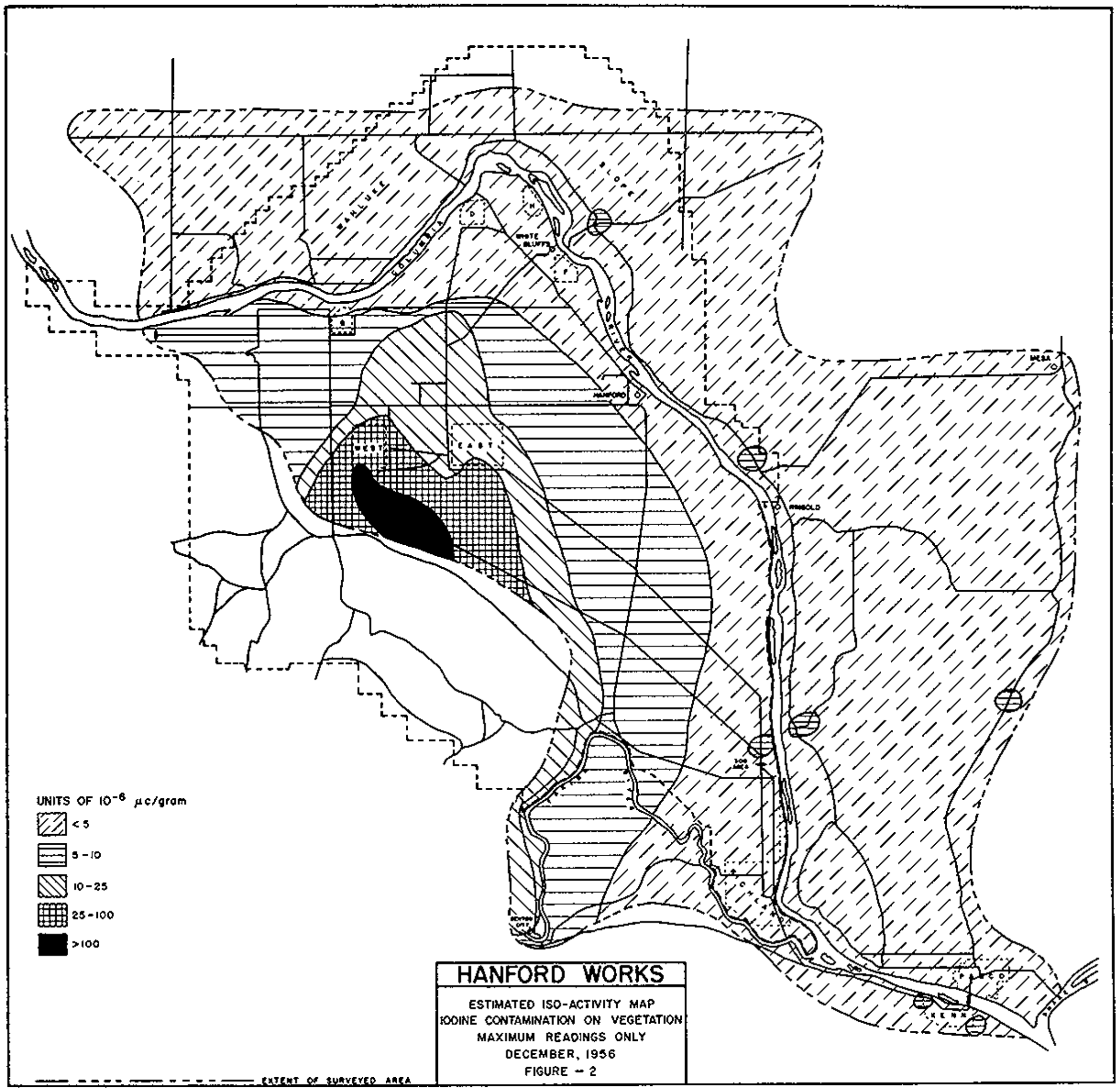
[redacted]



HANFORD WORKS

ESTIMATED ISO-ACTIVITY MAP
IODINE CONTAMINATION ON VEGETATION
DECEMBER, 1956
FIGURE - 1

[redacted]



HANFORD WORKS

ESTIMATED ISO-ACTIVITY MAP
IODINE CONTAMINATION ON VEGETATION
MAXIMUM READINGS ONLY
DECEMBER, 1956
FIGURE - 2

[redacted]

SECTION III

RADIOACTIVE CONTAMINATION IN THE ATMOSPHERE

The magnitude and extend of airborne contamination in the Hanford environs were determined from analyses of filter and scrubber samples and from data recorded in the operation of Victoreen Integrons and detachable ionization chambers. The results obtained by measurements made by each of the monitoring methods during the quarter are summarized in the accompanying tables.

Victoreen Integrons and H. M. chambers were operated continuously at stations located at the perimeter of the manufacturing areas and in residential communities neighboring the plant. Accumulated dosage readings are tabulated in units of mrad per day in Table I.

[redacted]

TABLE I

AVERAGE DOSE RATES MEASURED BY VICTOREEN INTEGRONS
OCTOBER, NOVEMBER, DECEMBER
1956

Units of mrad Per Day

Location	No. of Units	October	November	December	Quarterly Average
100 Areas and Vicinity					
100-B Area	3	5.4	20	4.9	10
100-K Area	3	2.1	0.6	1.8	1.5
100-D Area	3	3.2	2.9	2.0	2.7
100-H Area	3	0.4	0.4	0.5	0.4
White Bluffs	1	18	9.0	18	15
100-F Area	3	3.7	8.9	2.5	5.0
Hanford	1	3.2	1.6	0.8	1.9
200 Areas and Vicinity					
200 East Area	3	2.5	4.1	7.5	4.7
200 East - Semi-Works	1	0.8	6.0	7.4	4.7
200 West Area	2	0.7	2.5	4.0	2.4
200 West - Redox	1	5.7	4.3	3.6	4.5
300 Area	1	0.4	9.3	0.7	3.5
Outlying Areas					
Riverland	1	7.6	2.8	6.1	5.5
1100 Area	1	0.8	2.0	5.9	2.9
Richland	1	0.6	0.5	0.5	0.5
Benton City	1	3.2	1.2	0.3	1.6
Kennewick	1	1.2	0.7	1.1	1.0
Pasco	1	14	0.8	1.1	5.2

Occasional high dosage measurements at scattered locations were noted this quarter. The unusually high monthly averages at 100-B, 100-F, and 300 Areas for November and at Pasco for October were only partially confirmed by other types of measurements. The increases were attributed to spotty fallout of bomb debris and to instrument troubles. The high measurements at the White Bluffs station were mostly related to instrument difficulties which were not confirmed by evidence from other sources, such as film badges. Correction of these difficulties at the end of December should reduce the readings to more normal values during the next quarter.

The dosage rates present at intermediate locations on the project and in residential areas around the plant perimeter were measured with detachable M and S-type ionization chambers. Readings were obtained from these instruments at frequencies ranging from daily to weekly, and dosage rates were again reported from the chamber which showed the minimum discharge at each location. A summary of these measurements is given in Table II.

TABLE II

AVERAGE DOSE RATES MEASURED WITH "M" AND "S" TYPE DETACHABLE IONIZATION CHAMBERS OCTOBER, NOVEMBER, DECEMBER 1956

Units of mrad Per 24 Hours

Location	October	November	December	Quarterly Average	Group Average
100 Areas and Environs					
Route 1, Mile 8	0.7	0.5	1.1	0.8	
Route 2N, Mile 5	0.6	0.5	0.6	0.6	
Route 11-A, Mile 1	1.4	2.2	2.1	1.9	
Intersection, Rt. 1 & 4N	0.7	0.5	0.7	0.6	
Military Camp, PSN 3	2.9	1.1	0.8	1.6	
Military Camp, PSN 21	0.9	0.8	0.5	0.7	1.0
200 Areas and Environs					
Route 3, Mile 1	0.6	1.2	0.8	0.9	
Route 2S, Mile 4	0.9	1.1	1.0	1.0	
Route 4S, Mile 2.5	1.5	1.1	0.8	1.1	
Route 4S, Mile 6	0.8	0.8	0.7	0.8	
Route 4S, Mile 10	1.2	1.9	0.8	1.3	
Route 10, Mile 1	1.1	0.9	1.1	1.0	
Route 11-A, Mile 6	0.6	0.7	0.9	0.7	
Military Camp, PSN 42	2.0	1.6	1.4	1.7	
Military Camp, PSN 50	1.3	3.9	2.5	2.6	
Military Camp, PSN 51	1.1	1.2	1.2	1.2	
Military Camp, PSN 61	0.8	1.1	0.9	0.9	
Military Camp, PSN 70	1.2	1.0	0.5	0.9	1.2
300 Area and Environs					
Route 4S, Mile 16	0.8	1.5	1.7	1.3	
Route 4S, Mile 22	0.6	1.0	1.0	0.9	
Military Camp, PSN 60	0.8	1.1	0.6	0.8	1.0

[redacted]

The average dosage rates of about 1 mrad per day measured at the given grouped locations were not significantly different from the values reported for the previous period.

Filters were used to measure the activity density of beta and alpha particle emitters in the atmosphere. Air was passed through the filters at flow rates of 2 to 2.5 cfm for daily or weekly periods. These samples were counted several days after their removal from the sampling location to allow for the decay of the daughter products of the natural airborne particle emitters. Summaries of the results obtained from the beta and alpha measurements are given in Tables III and IV, respectively.

[redacted]

TABLE III

CONCENTRATIONS OF BETA PARTICLE EMITTERS FILTERED FROM AIR

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-14} $\mu c/ml$

Location	October	November	December	Quarterly Average	Weekly Maximum
100 Areas and Vicinity					
100-K Area No. 1	340	24	23	130	1110
100-K Area No. 2	95	26	26	49	180
100-K Area No. 3	98	25	31	51	120
100-D Area	120	15	22	53	250
100-H Area	56	17	41	38	110
White Bluffs	50	13	18	27	83
Hanford	76	24	22	41	130
200 Areas and Vicinity					
200 East Southeast	57	16	19	31	110
200 East - Semi-Works	110	38	58	68	190
200 West - Redox	75	43	37	52	130
200 West East Center	70	28	28	42	110
200 West West Center	66	32	23	40	96
Gable Mountain	60	16	28	34	110
Military Camp, PSN 50	84	28	36	50	160
300 Area	73	18	21	37	120
Outlying Areas					
Riverland	93	18	26	45	140
1100 Area	120	37	36	63	190
Richland	52	10	28	30	110
Benton City	41	14	17	24	65
Pasco	100	24	37	55	140

TABLE IV

CONCENTRATIONS OF ALPHA PARTICLE EMITTERS FILTERED FROM AIR

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-15} $\mu c/ml$

Location	No. of Samples	Quarterly Average	Weekly Maximum
100 Areas and Vicinity			
100-K Area No. 1	13	7	30
100-K Area No. 2	13	6	15
100-K Area No. 3	12	4	17
100-D Area	13	< 4	8
100-H Area	13	< 4	4
White Bluffs	13	< 4	4
Hanford	13	< 4	< 4
200 Areas and Vicinity			
200 East Southeast	12	< 4	4
200 East - Semi-Works	13	< 4	4
200 West - Redox	13	< 4	< 4
200 West East Center	13	< 4	4
200 West West Center	13	< 4	4
Gable Mountain	12	< 4	5
Military Camp, PSN 50	13	< 4	< 4
300 Area	13	< 4	6
Outlying Areas			
Riverland	12	< 4	< 4
1100 Area	13	< 4	< 4
Richland	13	< 4	27
Benton City	12	< 4	8
Pasco	12	5	11

[redacted]

Beta particle emitter concentrations returned to more normal values during the last two months of the quarter. The previous quarter's measurements and those of October were significantly above normal, because of radioactive debris from nuclear detonations. The maximum values listed in the last column of Table III occurred during October in almost all instances. Concentrations of alpha particle emitters in the atmosphere (Table IV) remained at expected levels. Average values were generally below the detection limit of 4×10^{-15} $\mu c/ml$ at off-site locations. Occasional positive averages have previously been noted at project stations.

The number of radioactive particles in the atmosphere was determined by autoradiographing air filters through which air flow rates of 2.5 to 10 cfm were passed for periods ranging from daily to weekly. Monitoring stations were maintained throughout the immediate plant environs and at several remote locations in Washington, Oregon, Idaho, and Montana in order to evaluate particles originating both from Hanford and from outside sources. All filters were autoradiographed for seven days using Type K X-ray film. A summary of the results of measurements near the separations areas is given in Table V; results of similar measurements made outside the separations areas and at remote locations are given in Table VI.

[redacted]

TABLE V

SUMMARY OF PARTICLE CONCENTRATIONS NEAR THE SEPARATIONS AREAS OCTOBER, NOVEMBER, DECEMBER 1956

Units of 10^{-3} Particle/Meter^3

Location	October	November	December	Quarterly Average	Last Quarterly Average
200 East Vicinity					
2704 Outside	150	21	12	60	140
2704 Inside	200	43	42	98	80
BY - SE	250	120	140	170	160
2 EWC, 614 Building	250	48	15	110	140
2701-E Outside	300	46	36	130	110
2701-E Inside	280	64	42	130	130
2 ESE, 614 Building	---	21	37	31	---
B-Gate	280	93	*	240	---
200 West Vicinity					
2701 Outside	510	81	76	230	180
2701 Inside	200	66	45	110	120
2722	270	62	55	130	140
T-Gate	210	57	*	180	110
222-T Outside	210	84	*	190	140
231	220	56	47	110	140
Redox	330	160	39	170	170
272	210	57	37	99	96
2-WWC, 614 Building	140	46	31	65	130
U-Gate	180	120	32	110	130
222-U Lab, Inside	160	71	25	78	56
Meteorology Tower					
3'	50	7	2	21	22
50'	63	10	5	27	30
100'	73	13	3	31	37
150'	60	11	3	26	43
200'	100	8	3	39	43
250'	92	8	3	36	37
300'	80	11	1	32	38
350'	72	6	3	29	40
400'	89	12	5	37	61

* Discontinued

[redacted]

TABLE VI

SUMMARY OF PARTICLE CONCENTRATIONS
OUTSIDE THE SEPARATIONS AREAS
OCTOBER, NOVEMBER, DECEMBER
1956

Units of 10^{-3} Particle/Meter^3

Locations	October	November	December	Quarterly Average	Last Quarterly Average
Area Locations					
100-B Area	190	43	43	94	70
100-K Area No. 3	220	19	19	93	99
100-D Area	290	23	28	110	81
White Bluffs	160	55	28	81	83
100-F Area	370	55	32	140	89
300 Area	220	30	20	90	87
Off Area Locations					
Richland, Wn.	440	110	28	200	150
Benton City, Wn.	180	20	8	73	62
Kennewick, Wn.	230	55	12	100	150
Pasco, Wn.	280	28	22	110	120
Walla Walla, Wn.	500	71	22	210	170
Yakima, Wn.	240	48	27	110	100
Spokane, Wn.	470	61	53	190	210
Seattle, Wn.	130	77	24	80	42
Lewiston, Idaho	450	45	7	180	170
Boise, Idaho	590	100	48	260	210
Meacham, Ore.	240	51	12	97	140
Klamath Falls, Ore.	520	70	44	220	200
Great Falls, Mont.	200	47	65	110	230

[redacted]

Concentrations of radioactive particles in the atmosphere followed the same general trend as the filterable beta particle emitters summarized in Table III. Monthly average values at project and off-site locations decreased significantly during November and December after high measurements caused by bomb fallout during October.

The activity density of radioactive iodine in the atmosphere was determined from the radiochemical analysis of caustic scrubber solutions through which air was passed at rates of 2 to 2.5 cfm for periods ranging from one to seven days. The results obtained from these measurements are summarized in Table VII.

TABLE VII

CONCENTRATIONS OF IODINE DETECTED BY AIR SCRUBBERS

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-12} $\mu c/ml$

Location	October	November	December	Quarterly Average	Weekly Maximum
200 Areas and Vicinity					
200 East Southeast	0.2	0.3	<0.1	0.2	0.7
200 East - Semi-Works	0.2	0.1	0.2	0.2	0.4
200 West - Redox	<0.1	0.1	0.3	0.2	0.4
200 West East Center	0.1	<0.1	0.2	0.1	0.4
200 West West Center	<0.1	<0.1	0.2	0.1	0.7
Gable Mountain	<0.1	<0.1	0.1	<0.1	0.2
Outlying Areas					
100-K Area No. 3	0.1	<0.1	<0.1	<0.1	0.3
100-H Area	0.1	<0.1	<0.1	<0.1	0.2
White Bluffs	0.2	<0.1	<0.1	0.1	0.5
300 Area	0.1	<0.1	<0.1	<0.1	0.3
1100 Area	0.1	<0.1	<0.1	<0.1	0.2
Richland	<0.1	<0.1	<0.1	<0.1	0.1
Benton City	0.1	<0.1	<0.1	<0.1	0.2
Pasco	<0.1	<0.1	<0.1	<0.1	0.2

Quarterly average iodine concentrations were similar to those measured previously. Monthly average values revealed slight trends. The high values of September caused by radioactive iodine in fallout material was not repeated this quarter. Occasional high I^{131} emission rates from A and S-plants (Section I) were reflected in slight increases in the November average at 200 East Southeast and the December average at Redox 614 Building.

[redacted]

SECTION IV

RADIOACTIVE CONTAMINATION IN HANFORD WASTES

The magnitude and extend of radioactive contamination in Hanford wastes were determined from the results of over 2700 measurements. Solid and liquid samples were obtained directly from open waste areas at frequencies varying from daily to monthly; these samples were analyzed radiochemically for the activity densities of gross alpha and beta particle emitters. Specific isotopic analyses were performed when measurements indicated unusual contamination and were carried out routinely on samples from locations which have a high probability of containing unusual quantities of certain contaminants. These measurements were supplemented with data obtained from portable instrument surveys around the perimeter of the waste storage areas and over open terrain at various locations on the plant.

The results of these measurements are summarized for each of the manufacturing areas.

100 AREA WASTE

Radioactive contamination discharged to the Columbia River from the reactor areas was determined by analyzing samples collected daily from the outlets of the effluent water retention basins. The samples were analyzed within twelve hours after collection and the measured counting rates of beta particle emitters were corrected for decay. A summary of the activity of beta particle emitters discharged to the river per unit of time is given in Table I.

[redacted]

[redacted]

TABLE I

BETA PARTICLE EMITTERS DISCHARGED TO RIVER IN REACTOR EFFLUENT WATER

1956

Units of 10^3 μc/sec

Location	No. Samples	October Max.	October Avg.	November Max.	November Avg.	December Max.	December Avg.	Quarterly Max.	Quarterly Avg.
100-B	5	---	---	---	---	19	15	19	15
100-C	55	33	27	60	35	45	35	60	32
100-KW	57	33	24	42	27	39	25	42	25
100-KE	53	31	22	50	34	26	17	50	24
100-D	58	17	14	12	8	17	14	17	12
100-DR	61	23	16	16	12	19	18	23	15
100-H	61	24	17	21	16	15	10	24	14
100-F	55	14	9	16	11	11	9	16	10

The average curies per day of total beta activity in cooling water discharged to the river from all reactors increased from 11,200 curies last quarter to 12,500 curies per day during the current quarter. This increase reflects increasing power levels noted in several reactors.

The activity density of I^{131} in waste discharged to the Columbia River from the Biology Farm at 100-F Area was measured by analyzing composite samples collected from the sump in the waste discharge line. An average of 45 μc/day was discharged to the river during the quarter.

200 AREA WASTES

Liquid and solid samples were collected directly from the waste sources in the separations areas and analyzed for gross alpha and beta particle emitters. A summary of the results is given in Table II.

[redacted]

TABLE II

RADIOACTIVE CONTAMINATION IN 200 AREA WASTE SYSTEMS
OCTOBER, NOVEMBER, DECEMBER
1956

Liquid Samples

Location	No. Samples	Alpha Particle Emitters, Units of 10^{-8} $\mu c/ml$		Beta Particle Emitters, Units of 10^{-7} $\mu c/ml$	
		Maximum	Average	Maximum	Average
T-Ditch	13	<0.5	<0.5	180	80
T-Swamp	13	0.8	<0.5	510	140
Laundry Ditch	26	7.8	1.0	35	8.3
U-Ditch Inlet	13	12	2.6	6300	490
231 Ditch	26	2800	200	14	4.7
234-5 Ditch	13	91	6.5	11	4.3
U-Swamp	26	66	9.2	5800	510
B-Ditch	12	<0.5	<0.5	12	5.8
B-Swamp	25	<0.5	<0.5	26	5.6
Purex	25	20	1.2	24	9.1
222-S Swamp	10	73	21	22	7.1

Solid Samples

Location	No. Samples	Units of 10^{-6} $\mu c/gm$		Units of 10^{-5} $\mu c/gm$	
T-Ditch	13	23	13	12000	5200
Laundry Ditch	13	9.9	4.6	76	23
234-5 Ditch	13	1800	690	19	4.2
B-Swamp	25	8.1	1.2	14	6.5
Purex	26	7900	790	25	5.6
222-S Swamp	9	350	220	410	260

The various increases and decreases noted when comparing the measurements summarized in Table II with the data collected during the preceding period were caused by the normally wide variation of concentrations in the waste systems.

The most significant changes were an increase in beta particle emitter activity in the U-plant waste ditch which was reflected in U-swamp waters and an increase in alpha activity in the 231-ditch waste waters which also feed U-swamp.

The results from specific analysis of 200 Area waste for uranium are reported in Table III.

TABLE III

RADIOACTIVE CONTAMINATION IN 200 AREA WASTE SYSTEMS
OCTOBER, NOVEMBER, DECEMBER
1956

Location	No. Samples	Uranium Units of 10^{-9} $\mu c/ml$ Maximum	Average
Liquid Samples			
U-Swamp	26	490	49
Laundry Ditch	26	110	13
U-Ditch Inlet	13	100	22
222-S Swamp	9	650	150
Solid Samples		Units of 10^{-6} $\mu c/gm$	
T-Ditch Inlet	11	5.8	1.1
Laundry Ditch	11	15	5.4
222-S Swamp	8	170	110
234-5 Ditch Pipe	10	35	13

The values listed in Table III for uranium in liquid and solid wastes do not show the increases in uranium corresponding to the increase in total alpha in the 231-ditch waters.

Portable instrument surveys using GM type meters were performed at the perimeter of all open waste zones in the separations areas. Counting rates obtained over mud showed values ranging from 200 to > 80,000 c/m at 200 West Area locations, with a maximum of 32 mrad around U-swamp. All 200 East locations showed counting rates of less than 500 c/m above background.

Readings obtained over the waters at the edge of the swamps and ditches ranged from 200 to 60,000 c/m at 200 West Area with background readings obtained in 200 East.

300 AREA WASTE

Radioactive contamination in waste in the 300 Area was measured in samples collected directly from the north pond inlet. Table IV summarizes the results obtained from the radiochemical analyses for alpha particle emitters, beta particle emitters, uranium, and plutonium.

TABLE IV

RADIOACTIVE CONTAMINATION IN 300 AREA POND INLET
OCTOBER, NOVEMBER, DECEMBER
1956

Units of 10^{-8} $\mu c/ml$

Liquid Samples	No. Samples	Maximum	Average
Beta Particle Emitters	53	16000	310
Alpha Particle Emitters	51	440	94
Uranium	49	420	83
Plutonium	59	18	1.4

Individual samples from the 300 Area pond varied widely in activity density, as was expected in this waste stream. The average uranium discharged to the pond decreased from 1.0×10^{-5} $\mu c/ml$ to 8.3×10^{-7} $\mu c/ml$.

[redacted]

ENVIRONS - GROUND CONTAMINATION

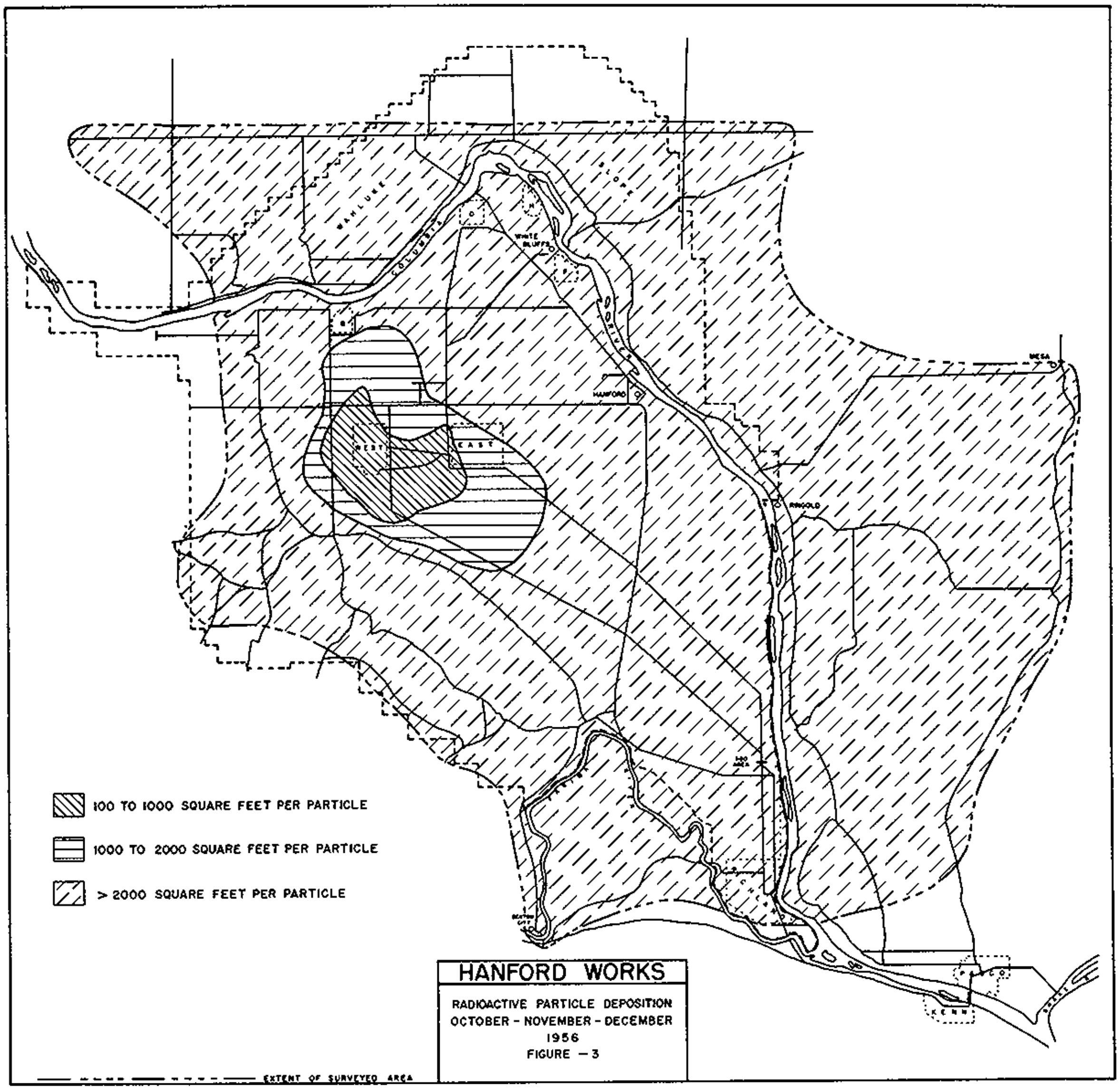
Ground surveys of selected locations in the Tri-City Area showed an average frequency of particles detectable by portable instruments of one particle per 14,000 square feet. This is only an approximation, since it is not practical to survey enough area to provide an accurate result. The pattern of general particle deposition on the project is illustrated in Figure 3.

Surveys of the plots around Purex revealed one particle per 600 square feet with 65 per cent of the plots showing no particle deposition. The maximum number of particles found was 6 in 400 square feet.

Surveys of the plots around Redox in October and December showed a maximum of 20 particles in 400 square feet. The number of particles found in the Redox area continue to decrease slightly, but it is not expected that they will all disappear, since the Redox facility continues to discharge some particulate materials.

[redacted]

[redacted]



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RADIOACTIVE PARTICLE DEPOSITION
OCTOBER - NOVEMBER - DECEMBER
1956
FIGURE — 3

[redacted]

SECTION V

RADIOACTIVE CONTAMINATION IN THE COLUMBIA RIVER AND RELATED WATERS

Approximately 500 samples of water were collected from the Columbia, Yakima, and Snake Rivers to determine the radioactive contamination resulting from the discharge of reactor cooling water to the Columbia River. Daily and weekly 500 ml samples were collected at the Hanford Works and downstream to McNary Dam; monthly one gallon samples were collected from the Columbia River between McNary Dam and Portland. All samples were analyzed for gross beta emitters and all 500 ml samples of alpha particle emitters. The activity density of alpha particle emitters average below the detection limit of 5×10^{-9} μc/ml for nearly all river water locations sampled this quarter. One exception was the sampling location below 300 Area where one positive measurement of 5.5×10^{-9} μc/ml was obtained on November 26, 1956. Fluorophotometric analysis confirmed that all of the alpha activity was due to uranium.

Table I summarizes the activity density of beta particle emitters in river water samples.

 [redacted]

TABLE I

CONCENTRATIONS OF BETA PARTICLE EMITTERS IN RIVER WATER

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-8} $\mu c/ml$

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Columbia River						
Will's Ranch	< 5	6	< 5	< 5	< 5	12
181-B	< 5	< 5	< 5	< 5	< 5	< 5
181-C	< 5	< 5	≪5	< 5	< 5	5
181-KW	490	76	180	250	180	660
181-Ke	430	160	370	320	190	770
181-D	1250	1020	740	1000	650	2340
181-H	2060	1100	1540	1570	1010	3270
Below 100-H	1920	2170	2840	2310	1200	4620
181-F	2250	1990	2290	2180	1540	3070
Below 100-F	1760	2410	2400	2190	950	3590
Hanford	2500	3170	2900	2860	1200	4630
300 Area	970	1070	1070	1040	510	1730
Byer's Landing	510	790	800	700	250	1000
Richland	710	840	830	800	430	1240
Kennewick Highlands Pumping Station	250	660	630	520	300	880
Pasco Bridge (Kennewick Side)	410	550	560	510	240	850
Pasco Brige (Pasco Side)	450	480	520	480	270	720
Pasco Filter Plant Pumping Station	630	550	680	620	320	2080
Sacajawea Park	300	250	360	300	190	480
Below McNary Dam	56	56	65	59	24	82
Paterson	62	56	60	59	29	110
Snake River						
Mouth	< 5	< 5	6	< 5	< 5	13
Yakima River						
Prosser	< 5	< 5	< 5	< 5	< 5	< 5
Horn	< 5	< 5	< 5	< 5	< 5	7
Mouth	< 5	10	< 5	< 5	< 5	21

[redacted]

[redacted]

General increases in the beta particle emitter activity density of the Columbia River water were noted this quarter. These increases reflected the seasonal drop in Columbia River flow rates which resulted in decreased dilution of the reactor cooling water discharged to the river, and a slight increasing trend in the activity density of beta particle emitters discharged in the reactor coolant this quarter.

Average river flow rates for October, November, and December were 5.0×10^5, 5.0×10^5, and 4.9×10^5 gps, respectively. Average and maximum flow rates this quarter were 5×10^5 and 6.5×10^5 gps compared to values of 1.3×10^6 and 2.9×10^6 gps for the previous quarter. An unusually low minimum of 3.1×10^5 gps occurred on November 22. River flow rates for the period July to December, 1956, are shown in Figure 4.

The monthly one gallon samples collected from the Columbia River between McNary Dam and Portland revealed gross beta activity densities ranging from 8×10^{-8} to 5×10^{-7} $\mu c/ml$. This range is not significantly different from that found during the previous surveys. The maximum value of 5×10^{-7} $\mu c/ml$ occurred at Arlington, Oregon during December.

Thirteen water samples collected from the south bank of the Columbia River at the Hanford Ferry landing were analyzed for the activity density of I^{131}. Average and maximum results for the present quarter were 7.8×10^{-8} and 1.8×10^{-7} $\mu c/ml$, respectively, compared to values of 6.5×10^{-8} and 1.6×10^{-7} $\mu c/ml$, respectively, obtained during the previous quarter. These slight increases resulted from the decreased river flow rates mentioned above.

[redacted]

Over 300 river mud samples were collected from the Columbia River and nearby tributaries for measurement of gross alpha and beta particle emitters. Nearly all alpha particle emitter concentrations were below the reporting limit of 3×10^{-6} μc/gm. The highest quarterly average was obtained at the 300 Area shoreline sample location. The average measurement was $<3 \times 10^{-6}$ μc of gross alpha per gram of mud, with a maximum of 2.3×10^{-5} μc/gm on December 12, 1956. Uranium originating in the 300 Area wastes was responsible for the positive results found at this location. Table II summarizes the results of the gross beta activity density measurements.

[redacted]

TABLE II
CONCENTRATION OF BETA PARTICLE EMITTERS
IN RIVER MUD SAMPLES
OCTOBER, NOVEMBER, DECEMBER
1956
Units of 10^{-6} $\mu c/ml$

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Columbia River						
Will's Ranch						
Shore	22	20	18	20	21	34
5' Out	19	20	19	19	22	29
100-H Area						
Shore	120	100	220	150	67	540
5' Out	160	190	190	180	54	430
100-F Area						
Shore	78	44	120	79	55	280
5' Out	67	57	71	65	120	160
Hanford Ferry						
So. Shore	100	30	56	63	48	190
5' Out	110	41	88	81	140	230
300 Area						
Shore	44	54	50	49	40	87
5' Out	67	38	57	54	45	100
Byer's Landing-Shore	35	46	49	43	31	81
Richland						
Shore	28	32	56	39	25	138
5' Out	41	36	40	39	40	100
Kennewick Highlands Pumping Station						
Shore	26	55	29	37	16	87
5' Out	30	48	29	35	20	100
Pasco-Kennewick Bridge (Kenn. Side)						
Shore	60	59	51	57	21	170
5' Out	65	48	42	51	23	130
Sacajawea Park -5' Out	32	24	36	31	23	55
Below McNary Dam						
5' Out	20	17	16	18	17	27
Paterson - 5' Out	28	18	20	22	23	33
Snake River						
Near Mouth - 5' Out	20	20	25	22	23	32

[redacted]

[redacted]

[redacted]

TABLE II (Contd.)

Units of 10^{-6} μc/gm

Location	Oct. Avg.	Nov. Avg.	Dec. Avg.	Qtr. Avg.	Last Qtr. Avg.	Max. This Qtr.
Yakima River						
Horn						
Shore	22	21	18	20	23	34
5' Out	15	22	15	17	17	37
Prosser						
5' Out	15	17	19	17	21	23

The activity density of beta particle emitters in Columbia River mud samples increased this quarter at most locations from 100-H Area to Pasco. As during last quarter, no significant changes were noted in the activity density of mud samples collected above 100-H Area, below Pasco, or from the Snake and Yakima Rivers.

Increases were related to increased river water activity density and shifting shore lines caused by decreased river flow rates.

Over 150 samples of raw water were collected from the 183 and 283 Buildings in the reactor and separations areas for gross alpha and beta analysis. The activity density from gross alpha emitters was below the detection limit for all but two samples this quarter. One sample collected from 283-E Building on October 2, 1956, contained 1.4×10^{-8} μc/ml of alpha emitters; a sample collected from the 283-W retention pond on November 7, 1956, had 8.1×10^{-9} μc/ml of alpha emitters. Monthly and quarterly average values from these two locations were still below the detection limit of 5×10^{-9} μc/ml. Table III is a summary of the results of the gross beta particle emitter analysis in raw water.

[redacted]

TABLE III

CONCENTRATIONS OF BETA PARTICLE EMITTERS IN RAW WATER

RIVER EXPORT LINE

OCTOBER, NOVEMBER, DECEMBER

1956

Units of 10^{-8} $\mu c/ml$

Location	Oct. Ave.	Nov. Ave.	Dec. Ave.	Qtr. Ave.	Last Qtr. Avg.	Max. This Qtr.
183-B	9	6	< 5	6	< 5	23
183-C	< 5	5	< 5	< 5	< 5	11
183-KW	240	240	290	260	120	510
183-KE	300	270	320	300	140	490
183-D	870	1250	1120	1080	410	2000
183-DR	1060	880	1080	1010	440	1550
183-H	980	1710	1930	1540	580	3390
183-F	1260	1490	1760	1510	710	3300
283-East	380	560	280	410	130	770
283-West	450	290	290	350	53	710

The raw water samples represent water just prior to purification for drinking purposes; the activity generally follows the fluctuations in the activity density of the river water from which it is derived. The increased activity density of beta particle emitters in raw water this quarter reflects the increase in Columbia River water activity.

The maximum activity density of 3.4×10^{-5} $\mu c/ml$ was found at 183-H Building on November 14, 1956, during a period of below-average river flow rate this quarter.

[redacted]

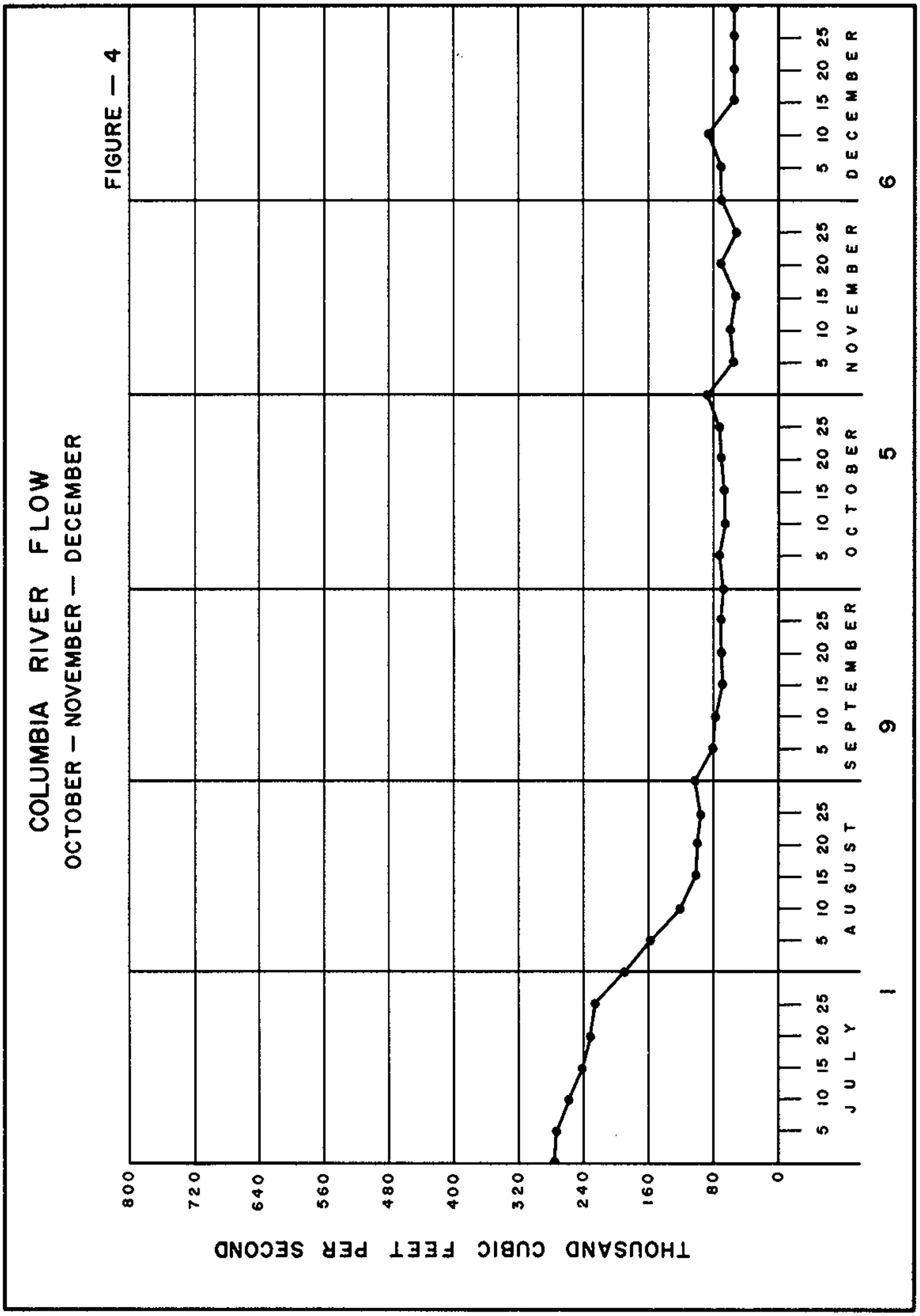

FIGURE — 4

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SECTION VI

RADIOACTIVE CONTAMINATION IN TEST WELLS

The average and maximum values for beta emitter activity densities in 124 test wells are presented along with average and maximum concentrations of uranium. Nitrate ion concentrations are given for 49 wells.

Explanations for significant changes in activity levels on nitrate concentrations in well water are attempted by estimating the effects of large volumes of process waste materials on the local and regional hydrology and the effect of the regional geologic picture on the paths of movement of radioactive wastes. A change by a factor of five in the average of the results from a well is usually regarded as significant.

200 EAST AREA AND VICINITY

The locations of the wells in Table I through IV are shown in Figure 4 of the previous report.[8]

Table I includes wells which were originally drilled to monitor the 241-B-361 reverse well site. The wastes put into this site have decayed to a very low level.

[redacted]

 [redacted]

TABLE I

361-B REVERSE WELL AND 5-6 CRIB SITE WELL ACTIVITY DENSITIES OCTOBER, NOVEMBER, DECEMBER 1956

Well	Beta Emitters Units of 10^{-8} μc/ml			Uranium Units of 10^{-9} μc/ml	
	Maximum	Average	Last Quarterly Average	Maximum	Average
299-E28-1	14	<10	<10	3.3	2.4
299-E28-2	41	17	<10	5.1	3.0
299-E28-3	82	20	10	6.5	2.2
299-E28-4	21	<10	<10	<2.0	<2.0
299-E28-5	69	38	<10	<2.0	<2.0
299-E28-6	30	22	<10	<2.0	<2.0
299-E27-1	11	<10	<10	<2.0	<2.0
299-E28-7	16	<10	<10	24	18
299-E26-1	<10	<10	<10	<2.0	<2.0

These wells received significant amounts of beta emitter activity which originated in other sites. Wastes which moved southeast from the BY crib sites a year ago, before Purex operation, are now probably being moved westward by the rise of the 200 East ground water mound. The mound has been built up by an average of about six million gallons of Purex waste water per day added to the ground water for the last six months. Wastes from the C-plant Semi-Works cribs may be contributing to ground water contamination.

Table II lists wells which monitor the B-plant 2nd cycle cribs and the BY scavenged metal recovery waste cribs.

[redacted]

[redacted]

[redacted]

TABLE II

241-B 2ND CYCLE AND BY CRIB SITES, WELL ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS OCTOBER, NOVEMBER, DECEMBER 1956

Well	Beta Emitters Units of μc/ml Maximum	Beta Emitters Units of μc/ml Average	Uranium Units of 10^{-9} μc/ml Maximum	Uranium Units of 10^{-9} μc/ml Average	No_3 Concentration ppm
299-E33-18	6.8×10^{-6}	3.5×10^{-6}	29	15	1690
299-E33-16	2.3×10^{-2}	1.5×10^{-2}	8.5	5.5	--
299-E33-15	2.8×10^{-2}	1.5×10^{-2}	3.6	2.5	--
299-E33-12	4.8×10^{-2}	2.5×10^{-2}	4.3	3.4	--
299-E33-17	5.8×10^{-2}	3.9×10^{-2}	2.9	< 2.0	6320
299-E33-13	3.5×10^{-2}	2.3×10^{-2}	4.2	3.1	4420
299-E33-14	2.3×10^{-4}	1.5×10^{-4}	< 2.0	< 2.0	1415
299-E33-11	1.8×10^{-3}	1.2×10^{-3}	< 2.0	< 2.0	--
299-E33-19	2.0×10^{-6}	1.6×10^{-6}	97	73	5840
299-E33-20	3.0×10^{-4}	2.3×10^{-4}	6.7	5.1	5350
299-E33-8	8.3×10^{-7}	3.6×10^{-7}	< 2.0	< 2.0	--
299-E33-1	1.1×10^{-1}	5.6×10^{-2}	3.6	2.9	--
299-E33-2	1.0×10^{-2}	7.4×10^{-3}	< 2.0	< 2.0	--
299-E33-3	1.7×10^{-1}	1.3×10^{-1}	7.5	6.7	--
299-E33-4	9.9×10^{-2}	3.6×10^{-2}	3.2	2.4	--
299-E33-7	9.9×10^{-2}	3.9×10^{-2}	6.0	4.0	--
299-E33-10	4.8×10^{-6}	5.2×10^{-7}	2.3	< 2.0	--
299-E33-6	5.2×10^{-6}	4.9×10^{-6}	< 2.0	< 2.0	--
299-E33-5	3.0×10^{-2}	4.5×10^{-3}	2.8	2.3	3060

[redacted]

Changes in beta emitter activity density and NO_3 concentration in these wells were thought to have indicated westward movement of the wastes under the local westward ground water gradient. No definite traces of these wastes were detected elsewhere. It now appears that the increases in activity and nitrate concentrations in wells adjacent to the west side of the 216-BY cribs may not indicate westward movement of the wastes, but may only indicate lateral diffusion. The basis for this contention is the continued concentrations of Co^{60} in this site at MPC levels. Cobalt evidently moves easily through the soil and should show dilution if the wastes are moving away from the site.

The wells in Table III with the prefix 299 monitor the Purex cribs. The wells with the prefix 699 are adjacent to the Chemical Processing areas, and are likely to detect waste moving beyond the area boundaries.

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TABLE III

PUREX AND ADJACENT WELL ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS OCTOBER, NOVEMBER, DECEMBER 1956

Well	Beta Emitters Units of 10^{-8} μc/ml		Uranium Units of 10^{-9} μc/ml		NO_3 Concentration ppm
	Maximum	Average	Maximum	Average	
299-E25-1	22	15	4.8	3.1	25
299-E25-2	71	23	2.0	< 2.0	15
299-E24-1	75	< 10	2.9	2.6	20
299-E25-3	< 10	< 10	3.2	2.7	1.5
299-E17-1	26	< 10	3.3	2.3	40
299-E25-4	17	< 10	2.2	< 2.0	2.9
299-E24-5	69	13	3.6	2.8	19
699-38-43	30	< 10	< 2.0	< 2.0	4.0
699.19-43	< 10	< 10	< 2.0	< 2.0	< 1.0
699-25-56	< 10	< 10	< 2.0	< 2.0	1.3
699-34-51	10	< 10	< 2.0	< 2.0	4.0
699-36-61	39	11	< 2.0	< 2.0	< 1.0
699-47-60	< 10	< 10	< 2.0	< 2.0	< 1.0
699-54-57	< 10	< 10	< 2.0	< 2.0	2.0
699-35-70	68	15	< 2.0	< 2.0	23
699-45-69	< 10	< 10	< 2.0	< 2.0	23
699-31-30	< 10	< 10	2.0	< 2.0	11
699-42-42	< 10	< 10	3.3	< 2.0	---
699-2-3	< 10	< 10	---	---	---
699-55-70	< 10	< 10	< 2.0	< 2.0	3.0
699-49-79	12	< 10	< 2.0	< 2.0	14
699-60-60	11	< 10	< 2.0	< 2.0	2.0
699-34-39	13	< 10	< 2.0	< 2.0	15
699-49-57	86	13	< 2.0	< 2.0	---
699-62-43	67	< 10	< 2.0	< 2.0	---

[redacted]

DECLASSIFIED

[redacted]

Wells 299-E25-2 and 299-E24-5 showed sharp increases in beta emitter activity in December. These wells are located down the ground water gradient from the A-8 tank farm condensate crib. The A-8 crib has received more activity and much more volume than any other Purex unit. The waste from this crib appears to have reached ground water. Well 299-E25-2 monitors the A-1 crib which was never put into operation. At present, only one of the six Purex tanks is boiling with several more expected to be boiling within another year.

Well 699-35-70, along with two other wells east of the Redox crib sites in 200 West Area, showed a slight increase in beta emitter activity during the last month of the quarter indicating that low-activity wastes are moving east from the Redox area. The NO_3 concentration in well 699-35-70 also increased from 4 to 23 ppm. The 216-WR and U-plant cribs are also possible contributors to ground water contamination and are scheduled for exploratory drilling.

The wells listed in Table IV monitor the 216-BC crib and specific retention trench sites of disposal of similar wastes to those which formerly went to the BY cribs.

[redacted]

TABLE IV

216-BC CRIB SITES, WELL WATER ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS OCTOBER, NOVEMBER, DECEMBER

1956

Well	Beta Emitters Units of 10^{-8} µc/ml		Uranium Units of 10^{-9} µc/ml		No_3 Concentration
	Maximum	Average	Maximum	Average	ppm
299-E13-1	12	< 10	< 2	< 2	---
299-E13-2	23	< 10	< 2	< 2	---
299-E13-3	< 10	< 10	< 2	< 2	3.0
299-E13-4	17	< 10	< 2	< 2	---
299-E13-5	< 10	< 10	< 2	< 2	---
299-E-13-6	11	< 10	< 2	< 2	---
299-E13-8	< 10	< 10	< 2	< 2	---
299-E13-9	13	< 10	< 2	< 2	1.5
299-E13-11	16	< 10	< 2	< 2	---
299-E13-13	53	< 10	< 2	< 2	---

The average beta emitter density figures are at background levels as were the average and maximum levels for the third quarter of 1956. The maximum levels, however, are generally above background. These rises appeared in December and support increases in other wells probably effected by wastes moving eastward from 200 West Area disposal sites. High-nitrate BC or BY wastes do not appear to be in the ground water at this location. Redox and Purex wastes are generally low in NO_3 concentration.

200 WEST AREA AND VICINITY

The locations of the wells in Tables V through VII are shown in Figure 5 of the previous report.[8]

[redacted]

The wells in Table V monitor the T-plant 2nd cycle crib and tank farm area.

TABLE V

241-T CRIB SITES, WELL ACTIVITY DENSITIES AND NON-RADIOACTIVE SALT CONCENTRATIONS OCTOBER, NOVEMBER, DECEMBER 1956

Well	Beta Emitters Units of μc/ml Maximum	Beta Emitters Units of μc/ml Average	Uranium Units of 10^{-9} μc/ml Maximum	Uranium Units of 10^{-9} μc/ml Average	NO_3 Concentration ppm
299-W10-1	$< 1.0 \times 10^{-7}$	$< 1.0 \times 10^{-7}$	< 2.0	< 2.0	2
299-W10-2	2.6×10^{-4}	2.0×10^{-4}	24	20	8280
299-W10-3	1.1×10^{-5}	8.4×10^{-6}	19	17	2420
299-W10-4	6.2×10^{-5}	2.3×10^{-5}	7.5	7.1	2070
299-W11-11	7.6×10^{-5}	5.2×10^{-5}	21	15	----
299-W11-12	4.8×10^{-7}	3.1×10^{-7}	< 2.0	< 2.0	55
299-W11-14	2.8×10^{-6}	1.6×10^{-6}	6.9	5.7	2715
299-W10-5	1.1×10^{-7}	$< 1.0 \times 10^{-7}$	< 2.0	< 2.0	81
299-W15-2	1.1×10^{-7}	$< 1.0 \times 10^{-7}$	< 2.0	< 2.0	30
299-W15-1	1.3×10^{-7}	$< 1.0 \times 10^{-7}$	< 2.0	< 2.0	----
299-W15-3	2.2×10^{-5}	1.1×10^{-5}	14	12	3750
299-W14-2	9.4×10^{-6}	7.1×10^{-6}	19	16	3115
299-W15-4	4.2×10^{-4}	2.3×10^{-4}	< 2.0	< 2.0	4810

The wastes in this location were expected to move into wells north of 200 West Area under the developing local ground water gradient. No definite indications of this have occurred, possibly because of the probable difficulty of movement up-dip through the south-south-west-dipping Ringold strata.

[redacted]

A 15-fold increase in beta emitter activity density and an accompanying twenty-five per cent increase in NO_3 concentration was observed in well 299-W15-4, adjacent to the west of the 2nd cycle replacement crib. A slight increase in beta emitter activity was observed in well 299-W14-2 and an increase from 1400-2715 ppm NO_3 concentration was observed in well 299-W14-1. These wells are about 1000 feet down gradient from the replacement crib.

The following wells were drilled to monitor the 241-T-361 reverse well, in which the original waste has decayed to very low levels.

TABLE VI
361-T REVERSE WELL SITE, WELL ACTIVITY DENSITIES
AND NON-RADIOACTIVE SALT CONCENTRATIONS
OCTOBER, NOVEMBER, DECEMBER
1956

Well	Beta Emitters Units of 10^{-8} μc/ml Maximum	Beta Emitters Units of 10^{-8} μc/ml Average	Uranium Units of 10^{-9} μc/ml Maximum	Uranium Units of 10^{-9} μc/ml Average	NO_3 Concentration ppm
299-W11-51	12	< 10	< 2.0	< 2.0	62
299-W11-1	20	< 10	3.6	2.5	--
299-W11-2	79	10	< 2.0	< 2.0	431
299-W11-3	57	< 10	< 2.0	< 2.0	212
299-W11-4	50	26	5.7	5.0	850
299-W11-5	94	23	3.7	3.1	--
299-W11-6	23	18	4.0	2.6	888
299-W11-7	67	10	< 2.0	< 2.0	42
299-W11-8	--	--	2.1	< 2.0	615
299-W11-9	37	19	< 2.0	< 2.0	--
299-W11-10	22	< 10	< 2.0	< 2.0	46
299-W12-1	30	< 10	< 2.0	< 2.0	--

[redacted]

Wastes which moved into these wells from the 2nd cycle site during operation of the T-plant have been reduced, essentially to background by decay and spreading, in the greater part of a year since T-plant shutdown.

The wells in Table VII were drilled to investigate the extent of ground and ground water contamination around the 216-S and 216-S-7 cribs and the 241-S and 241-SX tank farms.

TABLE VII
241-S CRIB SITES, WELL ACTIVITY DENSITIES
OCTOBER, NOVEMBER, DECEMBER
1956

Well	Beta Emitters Units of μc/ml Maximum	Beta Emitters Units of μc/ml Average	Uranium Units of 10^{-9} μc/ml Maximum	Uranium Units of 10^{-9} μc/ml Average
299-W23-1	5.0×10^{-7}	1.9×10^{-7}	--	--
299-W22-4	1.2×10^{-5}	6.6×10^{-6}	< 2.0	< 2.0
299-W22-64	1.1×10^{-2}	9.7×10^{-3}	3.4	2.6
299-W22-5	1.6×10^{-2}	1.0×10^{-2}	3.7	3.5
299-W22-6	4.5×10^{-7}	$< 1.0 \times 10^{-7}$	7.2	5.3
299-W22-7	7.5×10^{-6}	3.8×10^{-7}	< 2.0	< 2.0
299-W22-8	1.7×10^{-7}	$< 1.0 \times 10^{-7}$	2.0	< 2.0
299-W22-9	1.1×10^{-7}	$< 1.0 \times 10^{-7}$	< 2.0	< 2.0
299-W22-10	8.8×10^{-4}	7.0×10^{-4}	< 2.0	< 2.0
299-W22-11	2.3×10^{-6}	2.0×10^{-7}	< 2.0	< 2.0
299-W22-15	1.2×10^{-2}	7.9×10^{-3}	14.	10.
299-W22-16	8.4×10^{-5}	6.7×10^{-5}	8.7	7.0
299-W22-17	3.4×10^{-4}	2.9×10^{-4}	5.5	4.5
299-W23-2	6.6×10^{-7}	1.9×10^{-7}	2.7	2.2
299-W23-3	1.6×10^{-6}	4.1×10^{-7}	4.2	3.4
299-W22-12	3.5×10^{-3}	1.7×10^{-3}	4.5	2.9
299-W22-13	3.8×10^{-3}	2.9×10^{-3}	5.0	4.0
299-W22-14	3.7×10^{-3}	3.2×10^{-3}	9.1	7.9
299-W26-2	3.5×10^{-7}	2.5×10^{-7}	< 2.0	< 2.0
299-W26-3	3.7×10^{-7}	1.5×10^{-7}	< 2.0	< 2.0

[redacted]

The only changes in these wells are in the beta activity levels of wells 299-W23-2, which decreased to 1/450 of its former value, and well 299-W23-3, which decreased to 1/5. These wells detect surges of tank farm condensate from the 216-SX-1 and S-4 cribs. These cribs have a short soil column and discharge directly into the water table with the benefit of only slight decontamination by the soil.

OUTLYING SAMPLING LOCATIONS

The locations of the wells in the following two tables are shown in Figure 6 of the previous report.[8]

The wells in Table VIII monitor the 321 crib.

TABLE VIII

321 CRIB SITE, WELL ACTIVITY DENSITIES OCTOBER, NOVEMBER, DECEMBER 1956

	Beta Emitters Units of 10^{-8} μc/ml			Uranium Units of 10^{-9} μc/ml	
Well	Maximum	Average	Last Quarterly Average	Maximum	Average
699-S6-4B	< 10	< 10	< 10	2.6	2.2
699-S6-4D	< 10	< 10	< 10	2.0	< 2.0
699-S6-4E	< 10	< 10	< 10	10	8.0
699-S6-4F	< 10	< 10	< 10	21	17
699-S6-4G	< 10	< 10	< 10	< 2.0	< 2.0
699-S6-4H	< 10	< 10	< 10	14	13
699-S6-4J	< 10	< 10	< 10	< 2.0	< 2.0

No significant changes in activity levels are shown in well water samples from this site.

The wells listed in Table IX are located in the reactor areas.

[redacted]

TABLE IX

CONCENTRATIONS OF ALPHA AND BETA PARTICLE EMITTERS IN TEST WELLS

OCTOBER, NOVEMBER, DECEMBER

1956

Well	No. Samples	Alpha Particle Emitters Units of 10^{-9} μc/ml Maximum	Alpha Particle Emitters Units of 10^{-9} μc/ml Averge	Beta Particle Emitters Units of 10^{-8} μc/ml Maximum	Beta Particle Emitters Units of 10^{-8} μc/ml Average
199-B3-1	4	< 2	< 2	240	120
199-B3-2	4	< 2	< 2	200	130
199-B4-1	4	< 2	< 2	320	200
199-B4-2	4	< 2	< 2	240	180
199-D8-2	2	< 2	< 2	370	340
199-F5-1	4	< 2	< 2	14	8
199-F5-4	4	< 2	< 2	14	10
199-F5-5	3	---	---	70,040	39,840
199-F5-6	4	---	---	4	2
199-H4-1	4	< 2	< 2	58	24
199-K-19	4	< 2	< 2	28	18
199-K-20	4	< 2	< 2	740	92
199-K-21	4	< 2	< 2	310	150
199-K-22	2	---	---	260	170

Fluctuations in the activities of the above wells are common in locations of known retention basins and effluent line leaks. It is believed sufficient only to tabulate these figures as the activity detected by the wells will be decreased both by hold-up time and by filtration in the ground before reaching the Columbia River, probably at least as effective for decreasing activity in the effluents as the hold-up time they would undergo in the retention basins.

[redacted]

 [redacted]

SECTION VII

RADIOACTIVE CONTAMINATION IN DRINKING WATER

The results of 541 samples of drinking water analyzed for gross alpha and beta particle emitters are presented in Table I.

TABLE I

CONCENTRATIONS OF ALPHA AND BETA PARTICLE EMITTERS IN WATER SUPPLIES OCTOBER, NOVEMBER, DECEMBER 1956

Location	No. Samples	Alpha Particle Emitters Units of 10^{-9} $\mu c/ml$		Beta Particle Emitters Units of 10^{-8} $\mu c/ml$	
		Max.	Avg.	Max.	Avg.
Mattawa Chev. Station	3	< 5	< 5	7	< 5
Midway and Vicinity	35	< 5	< 5	8	< 5
100-B Area	13	< 5	< 5	96	30
100-C Area	13	< 5	< 5	84	26
100-K Area	14	< 5	< 5	300	160
100-D Area	13	< 5	< 5	4800	720
100-DR Area	13	< 5	< 5	1600	480
100-H Area	13	< 5	< 5	1500	500
100-F Area	13	< 5	< 5	1200	460
White Bluffs Fire Hall	13	< 5	< 5	720	210
Pistol Range	2	< 5	< 5	< 5	≪5
PSN 21	9	9	6	6	< 5
B-Y Well	14	5	< 5	14	≪5
251 Building	14	< 5	< 5	66	32
200 East Area	39	5	< 5	200	120
200 West Area	52	5	< 5	310	140
300 Area, 3000 Area	23	< 5	< 5	< 5	< 5
Byers Landing Pump Station	11	40	< 5	< 5	< 5
Larson Farm	11	7	< 5	< 5	< 5
Richland	35	6	< 5	< 5	< 5
Prosser	12	< 5	< 5	5	< 5
Benton City	38	15	8	10	< 5
Headgate Well	13	< 5	< 5	8	< 5

[redacted]

TABLE I (Contd.)

Location	No. Samples	Alpha Particle Emitters Units of 10^{-9} $\mu c/ml$ Max.	Alpha Particle Emitters Units of 10^{-9} $\mu c/ml$ Avg.	Beta Particle Emitters Units of 10^{-8} $\mu c/ml$ Max.	Beta Particle Emitters Units of 10^{-8} $\mu c/ml$ Avg.
Enterprise	14	14	< 5	8	< 5
Kennewick	40	< 5	< 5	440	190
Pasco	26	6	< 5	290	110
Sacajawea	10	9	6	6	< 5
McNary	23	< 5	< 5	< 5	< 5
Paterson	12	9	6	< 5	< 5

Drinking water sampling locations were added at Mattawa, near the Priest Rapids Dam site, and PSN 21, an Army encampment near Hanford Townsite. Sample analyses from PSN 21 indicate an alpha particle emitter density slightly above the reporting limit. (See Table II). Samples from 300 Area and North Richland were combined, as were all samples from Kennewick and all samples from Pasco.

The Columbia River flow during the fourth quarter was the lowest of any period in the past several years; consequently, reactor effluents in the river have undergone less dilution.

Drinking water samples derived from Columbia River water downstream from the reactors have increased in average beta emitter activity density by two to seven times. The maximum value from 100-DR Area of 5×10^{-5} $\mu c/ml$ is ten times greater than the level of last quarter. Sanitary water with this maximum concentration of beta activity reported of reactor effluent origin would contribute about 1 per cent of the MPC and 1/2 per cent of the MPE on an annual basis. Analyses of drinking water from all 100 Areas show a Sr^{90} activity of less than the detection limit.

[redacted]

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The results of 79 samples of drinking water are compared below.

TABLE II

CONCENTRATIONS OF ALPHA PARTICLE EMITTERS IN DRINKING WATER OCTOBER, NOVEMBER, DECEMBER 1956

		Alpha Particle Emitters Units of 10^{-9} µc/ml			Uranium Units of 10^{-9} µc/ml	
Location	No. Samples	Max.	Avg.	No. Samples	Max.	Avg.
B-Y Well	12	5	< 5	12	3	2
PSN 21	9	9	6	9	8	7
Lee Boulevard (San)	11	6	< 5	11	5	3
Benton City Store	13	15	12	12	14	10
Benton City Water Company	12	15	11	12	17	11
Sacajawea Park	10	9	6	10	9	7
Paterson Store	12	9	6	12	11	8

Well PSN 21, recently added to the sampling schedule, is an Army installation near Hanford Townsite. It, and the BY well, are the only known drinking water sources within the plant boundary derived from ground water. Well PSN 21 evidently contains some natural uranium.

The Pistol Range well has been abandoned.

Results of samples collected from successive stages of the water treatment process of the Pasco Filter Plant are shown in Table III.

TABLE III

CONCENTRATIONS OF BETA PARTICLE EMITTERS AT THE PASCO FILTER PLANT OCTOBER, NOVEMBER, DECEMBER 1956

Type Sample	No. Samples	Maximum	Average
Water Entering Plant From River	37	2.1×10^{-5} μc/ml	6.2×10^{-6} μc/ml
Filter Bed Material	10	3.8×10^{-4} μc/gm	1.2×10^{-4} μc/gm
Backwash Activity (Soluble)	9	3.4×10^{-6} μc/ml	2.4×10^{-6} μc/ml
Backwash Activity (Insoluble)	9	1.2×10^{-1} μc/gm	3.6×10^{-2} μc/gm
Foam From Filter Beds	1	5.2×10^{-3} μc/gm	5.2×10^{-3} μc/gm
Water Leaving Plant	13	2.9×10^{-6} μc/ml	1.8×10^{-6} μc/ml

The results listed above, with the exception of the foam and the water leaving the plant, are generally twice as high as for the third quarter. This is no doubt the result of the low diluvial power of the river at its recent low volumes. The results on foam were not given last quarter. The water leaving the plant was 1.8×10^{-6} μc/ml, as compared to 1.1×10^{-6} μc/ml last quarter, reflecting the effect of low river volumes, but not indicating significantly higher activity.

Decay studies of samples taken at the Pasco Filter Plant reveal half-lives for the major components of approximately one, three, and twenty days.

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