RADIOLOGICAL STATUS OF THE GROUNDWATER
BENEATH THE HANFORD PROJECT
JULY - DECEMBER 1972
by
K. L. Kipp, Jr.

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

August 1973

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INTRODUCTION

This report is prepared semi-annually to provide an evaluation of the status of groundwater contamination resulting from disposal of Hanford plant effluents. The data presented in this report were collected during the last six months of 1972; the previous report in this series was BNWL-1737⁽¹⁾

Of the wells that have been drilled to the groundwater on and adjacent to the Hanford Reservation, 306 were used during this report period for the routine surveillance of radionuclide movement through the sediments below the regional water table. Approximately one-third of the surveillance wells are located at disposal sites situated in or near the 200 Chemical Separations Areas. Many of these wells are used to determine when a disposal facility is to be retired. Almost all other surveillance wells are sampled to determine the status of contaminants within the groundwater system. A description of wells referred to in this report may be found by referring to the Hanford Wells document.⁽²⁾ All sampled wells outside and some of the wells inside the 100, 200, and 300 Areas are shown in Figures 1, 2 and 3.

The radionuclides ruthenium-106 and tritium, as well as the nitrate ion (NO_3^-), are readily transported by the groundwater and can be detected in groundwater at low concentrations relative to their respective drinking water standards. Therefore, these substances are used to trace the movement of contaminated groundwater away from the major disposal sites at the Chemical Separations Facilities (200 Areas). The only other radionuclide identified in the groundwater outside the 200 Areas during this report period was cobalt-60.

At the 100-N Reactor Area, radioactivity in the groundwater from ground disposal of wastes is predominantly tritium, iodine-131, ruthenium-106, strontium-90 and cobalt-60. At the 300 Laboratory Area, measurable radioactivity in the groundwater from fuel fabrication and laboratory waste disposal to ground is predominantly uranium.

The groundwater contamination pattern beneath Hanford at the present time can be divided into three source zones, based on the kinds and quantities of wastes disposed to ground at each location:

- 200 Areas (chemical processing areas) and associated 600 Area wells
- 100 Areas (production reactor areas) and associated 600 Area wells
- 300 Area (fuel fabrication and laboratory area) and associated 600 Area wells.

Groundwater concentration data for these three source areas are presented in this report. All groundwater samples reported here were taken by the Radiation Monitoring Section and were analyzed by the Technical Analysis Section as part of the Hanford environmental surveillance program conducted by the Environmental Evaluations Section of Battelle-Northwest.

SUMMARY

An evaluation of ^{106}Ru and ^3H concentrations measured near the surface of the unconfined groundwater during the last half of 1972 showed that zones of detectable contamination extended in an easterly to south-easterly direction from 200-E Area (Figure 1 and 2), as has been observed in the past.⁽¹⁾ Measurable tritium and nitrate ion concentrations were found along the Columbia River in the vicinity of the 100 Areas (Figures 2 and 3). A low groundwater mound showing uranium and nitrate ion continued to be observed in the 300 Area (Figure 3). The few locations for which average groundwater concentrations exceeded the Concentration Guide (CG) of 10 pCi/ml⁽³⁾ for ^{106}Ru were within either the 200-E or 200-W Areas. Significant concentrations of ^{106}Ru (over 10% of CG) were found only in the 200 Areas. Gross beta activity in the groundwater beneath the 100 Areas was detectable only at the 100-N Area from the effluent discharge to the 1301-N crib.

FIGURE 1.

FIGURE 2.

FIGURE 3.

A concentration of ^3H that exceeded the Concentration Guide of 3000 pCi/ml (outside the area boundaries) was found in Well 699-35-70 (outside the south-east corner of 200-W Area) as has been noted previously.⁽¹⁾

A moderate increase in tritium concentration levels and extent in the vicinity of 100-N area occurred during this report period due to processing of tritium bearing target elements. New data show that the tritium zone under the 100-F Area is separate from the plume that emanates from the 100-N Area.

Nitrate ion concentrations greater than 10% of the Public Health Service (PHS) recommended drinking water standard of 45 ppm⁽⁴⁾ were observed in most groundwater samples from wells within and in the immediate vicinity of the 100-F, 200 and 300 Areas. However, groundwater from these zones is not consumed by humans or animals. The 10% of PHS recommended drinking water standard nitrate concentration zone now includes well 699-14-E6-T southeast of 200 East Area. There are no major changes in other isopleth contours since the previous report period (January-June 1972).

Although water samples from several wells with piezometer tubes extending to deep aquifers were obtained and analyzed for tritium and nitrate ion during this report period, all samples had tritium concentrations less than the analytical limit of 1 pCi/ml and nitrate concentrations less than 1.5 mg/l. The one exception was well 699-59-80B, located just south of Gable Butte, whose average nitrate concentration increased from about 12 mg/l to 16 mg/l during this report period. An explanation of this occurrence is still being sought.

EVALUATION OF GROUNDWATER SURVEILLANCE DATA

Radionuclide concentrations in the groundwater beneath Hanford are evaluated in terms of their respective Concentration Guides (CG's)⁽³⁾ while the nitrate concentrations are compared to the PHS recommended drinking water standard.⁽⁴⁾ It is recognized that these guides are intended only for drinking water and at present no groundwater from zones having concentrations greater than the standards is used for human or animal consumption.

However, they do provide a rapid and meaningful method of evaluating the potential significance of most waterborne materials. The Concentration Guides used in this report are those which apply to individuals of the general public.⁽³⁾

The concentration zone boundaries shown in Figures 1 and 2 should not be interpreted as indicating that no radioactivity is present in the groundwater beyond these outer boundaries. It is probable that some radionuclides do in fact reach the river, but because of dilution and decay, the concentrations in the groundwater outside the lowest contour are below analytical detection levels. Tritium is measurable in the Columbia River from non-plant sources, but any contribution from the 200 Area plume is too low to be distinguished.

200 Area and Associated 600 Area Wells

Groundwater samples collected from wells within and near the zone in which 200 Area effluents have been detected are analyzed for gross beta, tritium and nitrate. Data for these substances from the sample wells in the 200 Area and associated 600 Area wells appear in Table 1 and 2 for both the present and previous report periods. The gross beta activity is calculated as $^{106}\text{Ru-Rh}$, since radiochemical analyses have shown that this nuclide-daughter combination accounts for a large fraction (~80%) of the radioactivity* in this groundwater zone. Under the direction of Atlantic Richfield Hanford Company groundwater samples from beneath some inactive and all of the active disposal sites within the 200 Areas are generally analyzed for gross alpha, ^{60}Co , ^{90}Sr , ^{137}Cs , and ^{106}Ru in addition to gross beta, ^3H and NO_3^- .

* Not including ^3H , whose low energy beta emission does not contribute to the gross beta activity measured. Other beta-gamma emitters which have been identified in the groundwater away from the disposal sites but within the gross beta contours of Figure 1 include ^{99}Tc , ^{60}Co , ^{51}Cr , ^{155}Eu and uranium.

TABLE 1. Average Gross Beta, Tritium, and Nitrate Ion Concentrations in 600 Area Wells Associated with the 200 Areas

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	20		3000		45	
699-S0-7				10.		*
S0-8				32		5.1
699-S3-E12			*	*	<1.7	0.8
S3-25			*	*	*	*
S6-E4C-0			*	*	*	2.4
S6-E14-0			*	*	*	*
S8-19			*	*	1.0	0.9
S12-29					*	*
S19-11					*	*
1-18			170	180	5.5	9.9
2-3			17	21	7.9	6.5
2-33-0			*	*	*	*
3-45					3.6	2.7
8-17	*	*	98	110	22	24
8-25	*	*	270	275	24	27
8-32			*	*	*	*
9-E2			*	*	*	*
10-E12-0					0.75	9.8
14-E6-T					<6.3	7.4
14-38-0			*	*	9.2	3.7
15-15-A-0	*		7.8		8.8	
15-15-B		*		*		8.2
15-26	0.18	0.20	410	420	30	27
17-5			*	*	5.9	<2.9
19-43					2.2	2.9
20-E5-T					*	*
20-E12-0					1.1	0.6
20-20	0.26	0.23	770	700	49	48
20-39-0			<2.7	*	<0.6	5.0
24-1-T			*	*	<0.6	*
24-33	*	*	420	420	2.0	8.1
24-46			*	*	3.5	2.4
25-70-0					2.4	4.4
26-15	0.52	0.58	1200	1300	52	56
26-89					*	2.7
27-8	0.26	0.30	960	1000	32	27
28-40-0	*	*	49	43	6.2	10
29-78			*	1.3	1.0	0.8
31-31-0	0.40	0.38	1900	1900	24	24
31-53B-0	*	*	*	1.1	6.2	5.9
31-65-0			0.98	1.1	5.8	12
32-22	0.36	0.63	1500	1500	45	59
32-43	0.32	0.23	790	760	33	38
32-62-0	*		*	*	*	*

TABLE 1 (contd)

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	20		3000		45	
699-32-70	*	*	34	39	17	17
32-72-0	*	*	71	71	<1.2	<0.8
32-77	*	*	1.7	1.5	3.3	6.9
33-56	*	*	*	*	*	*
34-39A	*	0.20	2000	1800	9.2	26
34-41	0.72	0.56	2000	1800	58	61
34-42	0.82	0.68	2000	1950	60	58
34-51	*	*	*	*	2.8	2.3
34-88-0	*	*	*	*	1.3	<0.61
35-9	*	*	32	35	12	*
35-66	*	*	2.1	2.1	*	*
35-70	*	0.20	6550	4040	1.2	2.8
35-78	*	*	2.2	1.8	0.8	1.1
36-46-R	*	*	2100	2000	2.7	1.0
36-61B-0	*	*	*	*	<0.6	*
36-93-0	*	*	*	*	*	*
37-43-0	*	*	84	73	*	*
37-82A-0	*	*	*	*	18	16
38-65-0	*	*	8.0	10	16	31
38-70-0	0.56	0.78	95	105	91	185
39-39	*	*	*	*	*	*
39-79-0	*	*	2.2	1.9	0.97	1.1
40-1	*	*	*	*	*	*
40-33	*	*	*	*	*	*
40-62	*	*	*	12.4	11	11
41-23	*	0.21	780	780	45	50
42-12	*	*	190	200	18	20
42-42-0	*	*	*	1000	14	12
43-42	*	*	330	330	*	*
43-89	*	*	*	*	26	29
44-64-0	*	*	*	*	9.6	12
45-42	*	*	*	880	4.2	5.2
45-69	*	*	*	*	32	38
46-21	*	*	*	*	3.9	4.2
47-35	*	*	*	*	1.7	1.0
47-46	*	*	*	*	18	20
47-60	*	*	*	*	6.0	7.1
48-71	*	*	*	*	<2.1	*
49-28	*	*	*	*	*	*
49-55	*	*	*	*	*	*
49-57	*	*	1.6	1.4	1.8	1.6
49-79	*	*	*	*	25	30
50-28	*	*	*	<1.1	4.6	4.4
50-30	*	*	*	*	*	*
50-42-0	*	*	*	*	*	*
50-53	0.35	0.22	1.3	1.3	14	28
50-85	*	*	*	*	11	15

TABLE 1 (contd)

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	20		3000		45	
699-51-63			*	*	1.2	0.9
51-75-0					*	13
53-47			2.6	4.2	*	*
53-55-0			1.8	1.5	*	*
54-42			*	*	3.5	3.0
54-45			*	*	*	
54-57			*	*	*	*
55-21					1.7	2.3
55-50A			2.6	2.3	1.4	0.75
55-70-0					*	*
55-76-0					*	*
55-89-0					*	*
55-95				*	1.9	*
55-83-0					*	*
59-58		*		4.6		*
59-80B					12	16
HAN-6			*	*	2.6	1.9
HAN-9					3.0	3.1
HAN-19			*	*	1.8	1.4

Gross Beta is calculated as $^{106}\text{Ru-Rh}$.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six-month period.

TABLE 2. Average Gross Beta, ^{60}Co , Nitrate, and ^{106}Ru Concentrations
In the Unconfined Groundwater Within the 200 Areas

Part A: Wells Near Active Crib Sites, Ponds, Ditches

Well No. (299-)	Gross Beta (pCi/ml)		^{60}Co (pCi/ml)		NO_3^- (mg/l)		^{106}Ru (pCi/ml)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		0.02		0.5		0.06	
Concentration Guide	20		50		45		10	
E16-2	1.6	4.0			24	84		
E17-1	0.73	0.57	0.14	0.11	93	83	0.18	0.08
E17-4	1.5	4.0	0.19	0.24			0.49	0.38
E17-5	1.2	0.6	0.11	0.05	195	225	0.54	0.47
E17-6	*	*						
E17-7	1.6	0.63	0.15	0.06	250	253	0.71	0.43
E17-9	6.1	3.7	*	*			3.10	2.1
E17-10	1.4	0.58						
E24-2	0.67	0.43	0.04	*	200	170	0.26	0.12
E25-5	0.73	1.1						
E25-6	0.36	0.70	*	*	41	38	0.12	0.38
E25-9	*	*						
E25-11	1.8	3.6	*				0.79	2.3
E25-12	0.92	3.4						
E28-9	0.34	0.19	*	*	170	241	0.18	0.10
E28-12	*	1.3	*	*			*	0.75
E28-13	<0.21	*	*	*	71	56	*	0.07
E28-16			*	0.44	385	280	0.11	0.38
E28-17	<0.23	<0.18						
E33-7	7.8	8.6	9.0	10.3			0.17	0.19
E33-23	1.1	1.1	0.32	0.32	5.7	29	*	0.07
E33-24	3.6	3.5	2.4	2.9			0.51	0.95
E34-1					8.6	5.7		
W15-4	0.31	0.23	*	*	167	169	0.14	0.15
W15-10	*	*			1.0	.65		
W15-11	*	*						
W18-1	*	*						
W18-2	*	*						
W18-4	*	*						
W18-5	*	*			*	*		
W18-10	*	*						
W18-11	*	*						
W18-12	*	*						
W19-5	36	25	*	*	58	71	17	15
W19-7	*	*						
W22-22	1.3	0.95			*	*		
W22-38	*	*						
W26-3	*	*	*	*	3.5	3.2	0.08	0.09

TABLE 2. (contd)

Part B: Wells Near Inactive Crib Sites with Average Gross Beta
Concentrations Greater than 10% CG (1 pCi/ml)

Well No. (299-)	Gross Beta (pCi/ml)		⁶⁰ Co (pCi/ml)		NO ₃ ⁻ (mg/l)		¹⁰⁶ Ru (pCi/ml)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		0.02		0.5		0.06	
Concentration Guide	20		50		45		10	
E24-9	1.2	0.62			325	270		
E26-4	2.3	1.5			36	38	0.99	0.64
E33-9	9.4	7.6						
E33-25	0.81	1.8			47	30		
E33-26	0.99	1.1						
E33-27	11	10			<0.6	*		
W11-15	2.7	1.5	*	0.02			1.2	0.82
W14-2	7.9	5.2	0.046	0.037	570	560	3.3	3.0
W15-7	2.1	1.3	2.3	1.5	72	84		
W22-1	45	52			1.5	1.0		
W22-13	2.1	1.2	*	.02	6.4	5.2	0.90	0.68
W22-21	36	34						
W22-26	153	93	0.34	0.31	190	205	76	56

Gross Beta is calculated as ¹⁰⁶Ru-Rh.

* Indicates that the concentration was less than the analytical limit.

No entry indicates no analyses were performed during the six-month period.

Gross Beta Concentrations (Unconfined Aquifer)

Gross beta concentrations are shown in Figure 1 for zones of 1 to 10%, 10 to 100%, and >100% of the CG for $^{106}\text{Ru-Rh}$ (20 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 1%, 10%, and 100% CG isopleth, respectively. The lowest level shown 1% (CG) corresponds to a gross beta concentration of 0.2 pCi/ml.

It should be kept in mind that these isopleth contours represent averages of the data that were collected over a six-month period. Thus, apparent short-term fluctuations, both increases and decreases, are effectively filtered out in this pictorial representation. Furthermore, much of the topography of the concentration isopleth surface does not appear when only three or four CG isopleths are used to illustrate it.

A comparison of the CG isopleths for the six-month periods ending June 1972 and December 1972 indicates only a few minor adjustments. Well 299-E17-6 is now below detection limit for gross beta. In general the gross beta concentration levels are declining, particularly at the outer contour of the contamination plumes.

Tritium Concentrations (Unconfined Aquifer)

Tritium concentrations are shown in Figure 2 for zones of 0.03 to 1%, 1 to 10%, 10 to 100%, and >100% of the CG (3000 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 0.03%, 1%, 10%, and 100% CG isopleth, respectively. Comments made previously about the average nature of the isopleth contours apply here also.

A comparison of the CG isopleths for the six-month period ending June 1972 and December 1972 indicates that no major changes have occurred. There was a slight shift of the 200 East Area isopleth in the southeasterly direction based on newly sampled water supply wells at the FFTF site. Tritium was first detected in well 699-31-53-B during this report period. This makes the tritium contamination pattern analogous to the nitrate contamination pattern in this area. The adjustments to the tritium plume under the 200 West area reflect the detection of tritium in wells 699-40-62 and 31-65 between the 200 East and West Areas during this period.

Nitrate Ion Concentrations (Unconfined Aquifer)

Nitrate ion concentrations are shown in Figure 3 for zones of 10 to 100% and >100% of the U.S. Public Health Service drinking water standard, 45 ppm.⁽⁴⁾ The outer boundary of each zone is the down-gradient edge and represents 10% and 100% of the drinking water standard, respectively.

A comparison of contamination contours for the six-month periods ending June 1972 and December 1972 indicates that a change in the 10% drinking water standard isopleth occurred. At the southeast portion of the nitrate plume emanating from the 200 East area, the nitrate concentration in well 699-14-E6-T increased from below detection limit to an average of 7 mg/l. This well had shown intermittent nitrate concentrations of up to 5 mg/l in 1970 and 1971. As mentioned in the previous report⁽¹⁾, well 699-17-5 still shows highly fluctuating values from below detection limit to about 10 mg/l. The southeastward extension of the outer contour toward well 699-S6-E4-C reflects newly detected nitrate in this well of 2.5 mg/l.

Minor contour changes illustrate the facts that well 299-E32-1 has shown no detectable nitrate ion during 1972 and that well 299-E16-2 had an average nitrate concentration of 84 mg/l. The latter well monitors the active 216-A-30 crib site.

Other Radionuclides (Unconfined Aquifer)

Certain wells in parts of the 600 Area associated with 200 Area disposal operations were also analyzed for ^{60}Co , ^{106}Ru , ^{137}Cs and ^{90}Sr . The only result above the detection limit was a concentration of ^{60}Co of 0.07 pCi/ml in well 699-32-43 and concentrations of ^{106}Ru of 0.10 to 0.18 pCi/ml in wells 699-20-20, -32-43, and -38-70-0.

Table 2 contains the results of gross beta, ^{60}Co , and ^{106}Ru concentration measurements in the (200) Chemical Separations Areas. The higher concentration levels of these radionuclides are listed by disposal site in Table 6, along with results from the previous reporting period. The gross beta activity above the concentration guide is at inactive disposal sites in the 200 West Area. No sites had ^{60}Co average concentrations above the

TABLE 3. Detectable Concentrations of Other Radionuclides in the Unconfined Groundwater Under the 200 Areas Listed by Disposal Site

		Average Concentration (pCi/ml)		Analytical Limit	Concentration Guide
		Site	Jan-June 1972	July-Dec 1972	
Gross Alpha				0.02	5
	216-S-13	I	1.41	2.57	
	S-21	I	0.07	0.06	
	A-27	I	0.04	0.035	
¹³⁷ Cs				0.02	20
	216-B46,50	A,I	0.64	0.55	
	216-A-24	I	0.076	0.15	
	216-S-9	I	<0.07	<0.06	
	216-A-36-B	A		0.042	
⁹⁰ Sr				0.03	0.3
	216-S-1	I	19.2	19.3	
	216-S-2	I	0.15	0.12	
	216-A-36-B	A	0.064	0.064	
	216-A-5	I	<0.032	0.042	
	216-A-10	A	<0.032	0.033	

Gross Alpha concentrations are calibrated for ²³⁹Pu.

A denotes active disposal site.

I denotes inactive disposal site.

TABLE 4. Active Disposal Sites--Cribs, Ditches, Ponds, Swamps200 East Area
Site Designation

<u>Purex</u>	<u>Associated Sample Wells</u>
216-A-8	299-E25-4, -E25-5, -E25-6, -E25-9
216-A-10	299-E17-1, -E24-2,
216-A-25	699-53-47, -55-50
216-A-29	-----
216-A-30	299-E25-11, -E25-12, -E16-2
216-A-36B	299-E17-4, -E17-5, -E17-6, -E17-7, -E17-9, -E17-10

B-Plant

216-B-2	299-E34-1
216-B-3	699-42-42, -43-42
216-B-10-B	299-E28-17
216-B-12	299-E28-9, -E28-16
216-B-50	299-E33-7, -E33-23
216-B-55	299-E28-12, -E28-13
216-B-57	299-E33-24
216-B-63	299-E34-1

Hot Semi-Works

216-C-7	-----
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TABLE 4. (contd)

<u>200 West Area Site Designation</u>	<u>Associated Sample Wells</u>
216-S-6	299-W26-3
216-S-11	699-32-77
216-S-16	-----
216-S-19	699-32-72
216-S-20	299-W22-19, -W22-20
216-S-23	299-W19-5, -W-19-6, -W19-7, -W22-38
<u>T-Plant</u>	
216-T-4	699-49-79
216-T-19	299-W15-4
<u>U-Plant</u>	
216-U-10	699-35-78
216-U-12	299-W22-22
216-U-14	-----
<u>Z-Plant</u>	
216-Z-12	299-W18-1, -W18-2, -W18-4, -W-18-5
216-Z-16	299-W15-10, -W15-11
216-Z-18	299-W18-10, -W18-11
216-Z-19	-----

TABLE 5. Cited Inactive Disposal Sites

<u>200 East Area Site Designation</u>	<u>Associated Sample Wells</u>
<u>Purex</u>	
216-A-5	299-E24-10
216-A-24	299-E26-2, -E26-3, E26-4, E26-5
216-A-27	299-E17-2, -E17-3
<u>B Plant</u>	
216-B-36	299-E33-21
216-B-46	299-E33-4, -E33-23
216-B-49	299-E33-7
241-BX-1,2	299-E33-27
241-BY-1,2	299-E33-9
<u>200 West Area Site Designation</u>	
216-S-1	299-W22-1
216-S-2	299-W22-2
216-S-9	299-W22-25, -W22-26, -W22-27
216-S-13	299-W22-21
216-S-20	299-W22-19, -W22-20
216-S-21	299-W23-4
216-T-26	299-W14-1, -W14-2, -W14-3
216-Z-7	299-W15-7

TABLE 6. Highest Gross Beta, ^{60}Co , ^{106}Ru , Concentrations Under the 200 Areas Listed by Disposal Site

	Average Concentration (pCi/ml)		Concentration Guide
	Jan-June 1972	July-Dec 1972	
Gross Beta			20
Active Sites			
216-S-23	36	25	
216-B-56	7.8	8.6	
216-A-30	1.6	4.0	
216-A-36B	6.1	4.0	
Inactive Sites			
216-S-9	153	92	
S-1	45	52	
S-13	36	34	
241-BX-1,2	11	10	
241-BY-1,2	9.4	7.6	
^{60}Co			50
Active Sites			
216-B-50	9.0	10.3	
B-57	2.4	2.9	
Inactive Sites			
216-Z-7	2.3	1.5	
^{106}Ru			10
Active Sites			
216-S-23	17	15	
216-A-30	0.8	2.3	
216-A-36B	3.1	2.1	
Inactive Sites			
216-S-9	76	56	
216-T-26	3.3	3	

Gross Beta is Calculated as $^{106}\text{Ru-Rh}$.

concentration guide (50 pCi/ml). As expected, the highest concentration levels of ^{106}Ru were in 200 West Area at the same sites as the highest gross beta activity.

Detectable concentrations of gross alpha, ^{137}Cs and ^{90}Sr for this report period are listed by disposal site in Table 3. Average concentration trends are indicated by comparison with results from the previous reporting period. Tables 4 and 5 show the active and cited inactive disposal sites along with associated groundwater sampling wells.

A few changes in concentration levels of gross alpha, ^{137}Cs or ^{90}Sr occurred during July-December 1972. The alpha activity at the 216-S-13 crib, which nearly doubled during this period, was due entirely to an average uranium concentration of 3.1 pCi/ml (with a CG of 20 pCi/ml), as has been the case in the past. A detectable concentration of ^{137}Cs averaging 0.04 pCi/ml was measured at the 216-A-36B active crib site.

Analyses of Samples Taken from Deep Aquifers

Water samples from specific depths below the Hanford Reservation's regional water table are obtained from either vertically separated tubes (piezometers) contained within a single well or from piezometer tubes drilled as separate wells. Those few wells which have shown intermittently detectable gross beta or tritium activity have not done so consistently with time.

At present, it is believed that none of the deep aquifers being sampled contain measurable gross beta radioactivity at the points where they are sampled. Tritium concentrations in these same samples were all below the detection limit during this report period. A detectable nitrate ion concentration of 1.5 mg/l (essentially unchanged from previous report periods) was observed in well 699-38-65-P. This well lies between the 200 East and 200 West Areas.

from January 1970 through December 1972 the nitrate concentration in well 699-59-80B south of Gable Butte increased from less than 0.6 mg/l to 20 mg/l. The source of this increase is unknown at this time. It is

possible that this well taps part of the confined aquifer due to its proximity to Gable Butte. The matter is under further investigation.

100 Area and Associated 600 Area Wells

The presence of radioactivity in the groundwater beneath the 100 Areas is due primarily to disposal of low-level liquid wastes to trenches and cribs, although leaks in reactor effluent system have contributed radioactivity to the groundwater in the past. Table 7 contains the observed average concentrations of gross beta, tritium, and nitrate ion in 100 Area and associated 600 Area wells. Some groundwater samples in the 100-N were analyzed for ^{60}Co , ^{90}Sr , ^{106}Ru and ^{137}Cs . Average measured concentrations of these radionuclides are presented in Table 8.

Gross Beta Concentrations (Unconfined Aquifer)

The estimated extent of detectable gross beta radioactivity (excluding tritium) in the groundwater beneath the 100 Areas and vicinity is shown in Figure 1. A comparison of data for the six-month periods ending June 1972 and December 1972 indicates that the total beta activity is below the detection level (0.16 pCi/ml) in all areas except 100-N, as was noted in the previous report period. The highest average total beta concentration was measured in well 199-N-10-0 (2.2 pCi/ml). This is a decrease of 25% from the previous report period.

Tritium Concentrations (Unconfined Aquifer)

The extent of detectable tritium activity in the groundwater beneath the 100 Areas and vicinity is shown in Figure 2. The 1 to 10% CG zone in the 100 Areas is actually in two zones as shown in Figure 2.

The extent of the 10-100% CG and the 1-10% CG zones in the 100 N Area continued to increase reflecting changes in the average tritium concentrations in the wells monitoring the 1301-N crib. The increased tritium concentration levels discharged to this crib are due to cladding removal operations from the tritium bearing target elements for the N reactor co-product program.

TABLE 7. Average Gross Beta, Tritium and Nitrate Concentrations in 100 Area and Associated 600 Area Wells

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	20		3000		45	
199-B4-4	*	*		4.5		
B9-1				1.9		
D2-5				16	33	66
D5-12	*	0.24	6.5	9.7	25	73
F5-1			*	1.4	0.6	1.1
F8-1			19	18	54	70
H3-1			17	16	12	13
K-11			98	96	*	*
K-20	*	*	8.8	8.6		1.1
N-3-0	3.7	0.77	1320	2460		
N-4-0	*	*	729	894	4.8	*
N-10-0	3.0	2.2	1450	1700		
699-59-32					*	*
60-32						*
60-57		0.21		*		*
60-60			1.5	1.3	0.83	0.63
61-62				1.1		*
61-66			*	*	2.4	2.7
62-31						*
62-43F					*	0.75
63-25					<0.6	0.77
63-55				*		*
63-58				1.1		*
63-90			*	*	3.1	3.1
64-62				*		*
65-50			*	*	*	0.6
65-59				2.4		0.6
65-72			*	1.1	*	*
65-83			1.8	2.5	0.8	0.9
66-23-0					*	*
66-38					*	*
66-39						*
66-58				2.4		0.6
66-64				*		1.0
67-51-0			*		<0.77	1.5
67-86			2.9	4.0	1.0	1.2
67-98			*	*	2.0	2.4
69-38			*	*	49	21
69-45-0			*	*	*	*
70-68			*	15	1.4	2.0
71-30			*	*	16	12
71-52			5.4	6.1	5.2	6.1
71-77			*	1.6	1.4	2.4

TABLE 7. (contd)

Well No.	Gross Beta (pCi/ml)		Tritium (pCi/ml)		Nitrate (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		1.0		0.5	
Concentration Guide	20		3000		45	
699-72-73			3.2	2.5	2.6	2.5
72-88			17	16.5	*	*
72-92-0			22	20	2.3	3.8
72-98				9.3		*
74-44				*	*	*
74-48			1.6	1.6	2.7	3.6
77-36			*	*	160	192
77-54			*	*	4.6	5.8
80-43S			*	*	0.9	0.9
81-58-0			11	12	1.4	0.8
83-47-0			*	*	*	*
84-35			*	*	4.6	11
86-60	0.40	*	810	1550	6.1	4.1
87-42A			1.1	1.0	0.7	0.77
87-55			36	100	6.0	9.2
89-35			*	*	5.2	5.6
90-45			52	52	*	*
96-49-0			7.0	8.0	<1.5	1.5
97-43-0			12	7.7	8.0	7.5

Gross Beta is calculated as $^{106}\text{Ru-Rh}$.

* Indicates that the concentration was less than the analytical limit.
No entry indicates no analyses were performed during the six-month period.

Other minor changes in the 100 Areas tritium contamination pattern are due to seasonal river fluctuations and their diluting effect during periods of riverbank recharge. Tritium concentration levels in well 699-60-60 averaged 1.3 pCi/ml, just above the analytical limit. Additional tritium results from wells that are not part of the routine sampling schedule indicate that the tritium zone under the 100-F Area is not connected to the tritium plume emanating from the 100-N Area.

Nitrate Ion Concentrations (Unconfined Aquifer)

There were no significant changes in the nitrate contamination zone contours in the vicinity of the 100 Areas during this report period. The only area greater than 100% of drinking water standard is southwest of 100-F Area, probably from the Battelle-Northwest animal research wastes. Average nitrate concentrations above the drinking water limit were observed in the two sampled 100-D Area wells during this report period.

The origin of the other zones of high nitrate ion concentration in the vicinity of the 100 Areas is not certain but it is believed to be associated with former agricultural sources rather than Hanford Plant Operations.

300 Area and Associated 600 Area Wells

The presence of radioactive and nonradioactive contaminants in the groundwater beneath the 300 Area arises primarily from the disposal of low-level fuel processing wastes to two process ponds located northeast and east of the 300 Area. Results of samples collected from 300 Area and associated 600 Area wells show that the radioactivity is primarily due to uranium, although ^{51}Cr , ^{60}Co , and ^{106}Ru have also been identified on occasion, as mentioned in previous reports. The results of 300 Area well sampling are presented in Table 9. The previously high average gross beta concentration in Well 399-3-8⁽¹⁾ showed a dramatic reduction during the latter half of 1972 to 0.64 pCi/ml.

TABLE 8. Other Radionuclides Observed in the Groundwater in the Vicinity of the 100 Areas

	⁶⁰ Co (pCi/ml)		⁹⁰ Sr (pCi/ml)		¹⁰⁶ Ru (pCi/ml)		¹³⁷ Cs (pCi/ml)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.02		0.03		0.06		0.02	
Concentration Guide	50		0.3		10		20	
100-N Area:								
199-N-3-0	0.054	<0.09	0.12	0.13	0.18	<0.35	*	<0.04
N-4-0	0.034	<0.15	*	*	*	0.07	*	<0.11

TABLE 9. Analytical Data - 300 Area and Associated 600 Area Wells

Well No.	Gross Beta (pCi/ml)		Nitrate (mg/l)		Gross Alpha (pCi/ml)		Cr ⁺⁶ (µg/l)		F ⁻ (mg/l)	
	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972	Jan-June 1972	July-Dec 1972
Analytical Limit	0.16		0.5		0.02		3		0.2	
Concentration Guide	20		45		5		50		1.5	
699-S11-E12-6			9.4	7.6						
S12-3			0.6	*						
S19-E13	*	*	4.8	4.6	*	*	<3.4	*	0.3	0.26
S27-E14			10	5.7	*	*	4.8	3.2	0.28	0.24
S29-E12			*	*	*	*			0.3	0.21
S30-E15A			<3.9	*	*	*			*	*
S31-1			4.3	3.2						
399-1-1	<0.21	0.30	42	25	<0.03	<0.026	<4.6	14	1.1	1.2
1-2	*	*	52	33	0.06	0.06	<4.0	<3.2	1.0	1.2
1-3	<0.22	0.26	118	42	0.10	0.05	8.4	4.3	2.2	1.7
1-4	*	0.30	26	22	0.04	0.04	<4.2	<3.2	0.9	0.7
3-1	*	*	74	19	0.05	0.06	<3.2	4.8	1.0	1.0
3-8	12	0.64	21	26	0.05	0.04	<3.1	5.5	0.9	0.8
4-1	*	*	11	29	0.06	0.06	<3.5	4.6	1.0	0.4
4-7	*	*	29	36	0.09	0.09	<4.4	<6	1.2	0.8
4-8	*	*	15	141	0.05	0.04	<4.2	<3.2	0.6	0.6
5-1			12	16	0.02	*	<3.2	<4.2	0.3	0.3
6-1			11	17	0.02	0.03	3.9	6.8	0.3	0.25
8-2			6.2	8.4	*	*	<3.6	<3.1	0.3	0.3
8-3			5.7	20	*	*	<3.2	<4.6	0.3	0.3

Gross Beta is calculated as ¹⁰⁶Ru-Rh.

Gross Alpha concentrations are calibrated for ²³⁹Pu.

* Indicates that the concentration was less than the analytical limit.

No entry indicates no analyses were performed during the six-month period.

The concentration of nitrate ion in some of the groundwater beneath the 300 Area (Table 9) is above the Public Health Service drinking water limit ⁽⁴⁾ of 45 ppm. However, during the July - December 1972 report period, all of the 300 Area wells had average nitrate concentrations below the drinking water limit with the exception of well 399-4-8 which monitors the Battelle Life Sciences Laboratory-I process waste trenches.

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