BattellePacific Northwest Laboratories
Richland, Washington 99352

AEC Research and Development Report

RADIOLOGICAL STATUS
OF THE GROUNDWATER
BENEATH THE HANFORD PROJECT
JULY-DECEMBER 1970

September 1971

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RADIOLOGICAL STATUS OF THE GROUNDWATER
BENEATH THE HANFORD PROJECT
JULY-DECEMBER 1970

By

T. H. Essig

Environmental Evaluations
Occupational and Environmental Safety Department

September 1971

BATTELLE
PACIFIC NORTHWEST LABORATORIES
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INTRODUCTION

This report is prepared semiannually 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 1970; the previous report in this series was BNWL-1539.⁽¹⁾

Of the wells that have been drilled to groundwater on the Hanford project, about 250 are used for the routine surveillance of radionuclide movement through the sediments both above and below the regional water table. Approximately one-third of the surveillance wells are located at disposal sites situated on the interior plateau 12 to 15 miles up-gradient from the nearest domestic water supply. 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. With the exception of a few new wells, the locations of wells referred to in this report may be found by referring to the Hanford Wells document.⁽²⁾

It is assumed that the radionuclides ^{106}Ru and ^3H and the nitrate ion (NO_3^-) move at essentially the same rate as groundwater. In addition, they can be detected in groundwater at low concentrations relative to their respective drinking water standards. Therefore, ^{106}Ru , ^3H , and NO_3^- are used to trace the groundwater flow paths away from the major disposal sites. All groundwater samples were analyzed by the Technical Analysis Section, Battelle-Northwest.

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

- 200 Area (chemical processing areas) and associated 600 Area wells

- 100 Area (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 zones are presented in this report.

SUMMARY

An evaluation of $^{106}\text{Ru-Rh}$ and ^3H concentrations measured in the unconfined groundwater during the second half of 1970 shows that the zones of detectable contamination extend in an easterly to southeasterly direction from 200-E Area (Figures 1 and 2), as observed in the past.⁽¹⁾ For the first time, ^3H concentrations were measured over a geographically extensive area in the vicinity of the 100 Areas (Figure 2). The few locations for which average groundwater concentrations exceeded the Concentration Guide (CG) for ^{106}Ru were all within either 200-E or 200-W Areas. Water from only one 600 Area well located outside limited area fences (well 699-35-70) indicated a ^3H concentration greater than the Concentration Guide. Gross beta activity concentrations in the groundwater beneath the 100 Areas decreased such that the only samples showing detectable beta activity were from wells located at 100-N Area. Concentrations of uranium, the principal radionuclide observed in 300 Area groundwater, averaged less than 0.5 pCi/ml (<3 percent CG).

Although water samples from several wells with piezometer tubes extending to deep aquifers were obtained and analyzed during this report period, all such samples had gross beta concentrations less than the analytical limit (0.2 pCi/ml).

Nitrate ion concentrations greater than 10 percent of the Public Health Service (PHS) recommended drinking water standard of 45 ppm⁽⁴⁾ were observed in most groundwater samples from wells within and surrounding the 200 and 300 Areas. However, groundwater from these zones is not consumed by humans or animals.

EVALUATION OF GROUNDWATER SURVEILLANCE DATA

Radionuclide concentrations in the groundwater beneath Hanford are evaluated in terms of their respective Concentration Guides (CG's), while the NO_3^- 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 >10 percent of the CG (Figures 1-3) is used for human or animal consumption. However, they do provide a rapid, meaningful method of evaluating the potential significance of most water-borne materials. The CG's used in this report are those which apply to individuals of the general public.⁽³⁾

Data from all 200 Area and associated 600 Area wells for which average total beta, ^3H , or NO_3^- concentrations were above the respective analytical limits, appear in Tables 2 and 3. All 100 Area and associated 600 Area wells routinely sampled are listed in Table 4 along with the concentration data for those wells showing detectable activity. In addition, the average concentration data for the second and first halves of 1970 are shown in Tables 2, 3, and 4 for rapid comparison of the respective trends. The analytical data for wells within or near the 300 Area appear in Table 5. A number of other wells, particularly those immediately adjacent to the outermost down-gradient contours shown in the accompanying figures, were sampled and analyzed on a routine schedule. However, because the results were below the respective analytical limits, no data were tabulated.

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 total beta, ^3H and NO_3^- . The total beta activity is calculated as ^{106}Ru , since radiochemical analyses have shown that this nuclide accounts for a large fraction (~80 percent) of the radioactivity* in this groundwater zone. In a joint program with ARHCO, groundwater samples from beneath some inactive and all of the active disposal sites (Table 1) generally are analyzed for total alpha, ^{60}Co , ^{90}Sr , and ^{137}Cs , in addition to total beta ^3H and NO_3^- .

* Not including ^3H , whose low energy beta emission does not contribute to the total beta activity measured.

TABLE 1. Active Disposal Sites--Cribs, Ditches, Ponds, Swamps

200 East Area Site Designation		200 West Area Site Designation	
Purex	B Plant	Redox	U Plant
216-A-6	216-B-2	216-S-6	216-U-4A
216-A-10	216-B-10B	216-S-11	216-U-10
216-A-25	216-B-12	216-S-16	216-U-12
216-A-27	216-B-50	216-S-19	216-U-14
216-A-30	216-B-55	216-S-23	
216-A-36B	216-B-57	216-S-24	Z Plant
	216-B-63		
		T Plant	216-Z-11
			216-Z-12
		216-T-1	216-Z-16
		216-T-4	216-Z-18
		216-T-19	

^{137}Cs concentrations were detected in the groundwater near the B-50 crib site during the second half of 1970. Samples collected from the vicinity of this site during November and December had ^{137}Cs concentrations of 0.7 pCi/ml, referenced to a CG of 20 pCi/ml. These concentrations, while above the detection limit of 0.03 pCi/ml,* were consistent with previous data for this site.

^{90}Sr concentrations averaged 0.05, 0.04, 19, and 0.12 pCi/ml in the groundwater near the 216-A-36B, -A-10, -S-1, and -S-2 crib sites, respectively, during the second half of 1970, referenced to a detection limit of 0.03 pCi ^{90}Sr /ml and a CG of 0.3 pCi/ml. During the first half of 1970,⁽¹⁾ approximately the same ^{90}Sr concentrations were detected at these same four crib sites.

* An improvement in the analytical techniques for ^{137}Cs was made in October which lowered the detection level from 0.7 to 0.03 pCi/ml.

TABLE 2. Average Total Beta, Tritium, and Nitrate Ion (NO_3^-) Concentrations in 600 Area Wells Associated With the 200 Areas

Well No. (699-)	Total Beta (pCi/ml) ^(a)		Tritium (pCi/ml)		NO_3^- (ppm)	
	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70
Analytical ^(b) Limit	0.16		1.0		0.5	
S3-E12	NA ^(c)	-	-	-	2.2	2.1
S6-E4C-0	NA	NA	NA	-	<1.3	0.6
S6-E14	NA	NA	NA	NA	1.1	1.3
S8-19	NA	NA	NA	-	<2.2	<5.2
S11-E12-0	NA	NA	NA	NA	<0.6	<0.5
S12-3	NA	NA	NA	NA	1.3	<2.8
1-18	NA	-	120	100	<1.6	<0.6
2-3	-	NA	6.9	4.6	11	<0.6
2-33-0	NA	NA	NA	-	<0.6	<0.6
8-17	NA	-	42	37	24	22
8-32	NA	NA	-	-	1.3	1.4
9-E2	NA	NA	-	-	<0.75	0.6
10-E12-P	NA	NA	NA	-	<0.6	<0.5
14-E6-T	NA	NA	-	-	<0.8	<0.8
14-38-0	NA	NA	3.4	-	6.0	3.4
15-15	-	NA	7.9	NA	8.5	NA
15-26	0.37	0.40	530	540	33	30
17-5	NA	-	NA	-	<2.2	2.4
19-43	NA	NA	NA	NA	<0.8	<4.5
20-E5-P	NA	NA	-	-	<0.5	<0.6
20-E12-P	NA	NA	-	-	<0.6	<0.6
20-20	0.26	0.29	700	700	32	33
20-39-0	NA	NA	-	-	7.1	6.7
24-1-T	NA	NA	-	-	1.6	NA
24-33	0.21	0.24	510	480	4.6	8.8
24-46	NA	NA	NA	-	<3.2	3.7
25-55	NA	NA	NA	NA	<2.6	7.4
25-70-0	NA	NA	1.4	-	2.2	0.6
26-15	0.86	1	1500	1500	46	46
26-89	NA	NA	NA	NA	<0.7	NA
27-8	<0.18	<0.18	880	860	14	7.1
28-40	-	-	76	76	9.9	6.6
28-52	NA	NA	NA	NA	<1.1	<0.5
29-78	NA	-	1.1	1.6	1.5	1.4
31-31-0	0.38	0.59	1800	1900	14	13
31-53B-0	-	-	NA	-	4.2	5.6
31-65	NA	NA	-	-	<0.5	0.8
32-42	NA	-	470	485	<0.7	-

TABLE 2. (Continued)

Well No. (699-)	Total Beta (pCi/ml) ^a		Tritium (pCi/ml)		NO ₃ (ppm)	
	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70
Analytical ^b						
Limit	0.16		1.0		0.5	
32-43	0.46	0.59	690	740	25	29
32-62-0	-	-	-	-	<0.6	<0.5
32-70	NA	NA	30	NA	22	NA
32-72	NA	-	62	35	<0.8	<0.6
32-77	NA	-	-	1.1	13	18
33-42	NA	-	970	1100	<0.6	-
34-39A	<0.25	0.84	2000	2000	24	29
34-51	NA	NA	NA	5.6	4.0	5.1
34-88	NA	NA	<7.7	NA	4.9	4.5
35-9	-	-	12	9.4	5.6	6.6
35-66	NA	-	-	-	<0.7	<0.5
35-70	0.31	0.34	6600	6200	4.8	5.5
35-78	-	-	2	1.8	1.3	1.4
36-46-R	<0.27	0.29	2200	2100	1.2	5.4
36-61B-0	-	-	-	-	<0.6	<0.5
36-61B-P	NA	NA	5.9	4	1.2	2.2
36-93-0	NA	NA	-	NA	0.7	NA
37-43-0	NA	-	120	365	<0.52	3.6
37-82A-0	NA	NA	<1.6	-	<0.88	0.7
38-65-0	NA	NA	5.3	5	34	30
38-70-0	1.6	1.5	160	180	144	170
39-79	NA	NA	1.4	23	2	3.2
40-62	NA	NA	NA	NA	NA	NA
41-23	0.36	0.46	770	810	47	46
42-12	NA	-	140	110	17	14
42-42-0	NA	-	930	1100	41	22
44-64-0	NA	NA	4.3	NA	17	14
45-42	NA	-	1000	1000	5.5	7.4
45-69	NA	-	-	-	32	30
46-21	NA	-	-	-	3.3	3.8
47-35	NA	NA	-	41	2.5	2.2
47-46	NA	NA	-	-	19	14
47-60	NA	NA	-	-	7.2	5
48-71	NA	NA	-	-	-	3.8
49-57	NA	NA	1.6	3.6	1.6	1.6
49-79	NA	NA	-	-	38	42
50-28	-	-	-	<2.7	4.2	7.4
50-53	1.4	1.4	2.1	3.8	210	217
50-85	NA	NA	NA	NA	8.7	9
51-63	NA	NA	NA	1	<1.3	<5
51-75-0	NA	NA	NA	NA	NA	14

TABLE 2. (Continued)

Well No. (699-)	Total Beta (pCi/ml) ^(a)		Tritium (pCi/ml)		NO ₃ ⁻ (ppm)	
	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70
Analytical ^(b)						
Limit		0.16		1.0		0.5
52-47	NA	-	3	7.9	-	-
53-55-0	NA	-	1.8	2.4	-	-
54-42	NA	NA	NA	-	3.8	3.5
55-50A-0	NA	NA	2.5	2.5	-	-
55-70-0	NA	NA	NA	NA	<0.6	1.1
HAN-9	NA	-	NA	NA	2.1	2.5
HAN-19	NA	-	-	NA	<1.1	<0.6

a) Calculated as ¹⁰⁶Ru-Rh

b) A (-) indicates that the concentration was less than the analytical limit.

c) NA - no analyses were performed during six-month period

TABLE 3. Average Total Beta and ^{60}Co Concentrations in Unconfined Groundwater Within the 200 Areas at Crib Sites Active During January - December 1970

Well No. (299-)	Total Beta (pCi/ml) ^(a)		^{60}Co (pCi/ml)	
	July- Dec '70	Jan- June '70	July- Dec '70	Jan- June '70
Analytical Limit		0.16		(b) 0.03
E17-2	0.69	1.2	-	-
E17-5	23	37	0.94	1.1
E24-2	2.6	5.8	-	0.24
E25-3	<0.18	-	NA ^(c)	NA
E25-5	1.1	0.37	NA	NA
E25-11	0.82	0.65	NA	NA
E28-12	<0.18	<0.22	-	-
E28-16	0.64	0.81	-	-
E33-7	8.2	6.9	NA	NA
E33-24	14	12	NA	NA
W10-4	<0.19	-	-	-
W11-17	3.8	6.3	-	-
W15-4	2.6	4.4	NA	NA
W15-7	6.2	14	5.0	8.1
W15-10	-	-	NA	NA
W18-2	<0.21	<0.23	NA	NA
W19-5	68	100	-	-
W21-1	NA	NA	NA	NA
W22-4	NA	NA	NA	NA
W22-22	1.4	4.2	NA	NA
W26-3	0.59	0.88	-	-

a) Calculated as $^{106}\text{Ru-Rh}$

b) A (-) indicates that the concentration was less than the analytical limit.

c) NA - no analyses were performed during six-month period.

Total alpha concentrations averaged 0.03, 0.03, 0.03, 0.63, and 0.08 pCi/ml in the groundwater near the 216-A-27, B-10B, S-20, S-13, and S-21 crib sites, respectively during the second half of 1970, referenced to a detection limit of 0.02 pCi α /ml. The highest concentration found (216-S-13) was due entirely to uranium (with a CG of 20 pCi/ml), as has been the case in the past.⁽¹⁾

The highest average total beta concentrations beneath active disposal sites were observed at the 216-A-36B crib (48 pCi/ml) in 200-East Area and at the 216-S-23 crib (68 pCi/ml) in 200-West Area, as in the first half of 1970.⁽¹⁾

TOTAL BETA CONCENTRATIONS (UNCONFINED AQUIFER)

Total beta concentrations are shown in Figure 1 for zones of 2 to 10 percent, 10 to 100 percent, and >100 percent of the CG for ¹⁰⁶Ru (10 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 2 percent, 10 percent, and 100 percent CG isopleth, respectively. The lowest level shown (2 percent CG) corresponds to a total beta concentration of 0.2 pCi/ml.

A comparison of CG isopleths for the six-month periods ending June 1970 and December 1970 indicates that the inner isopleth (10 percent CG) located down-gradient from 200-East Area disappeared, and that the area encompassed by this isopleth within 200-East Area decreased in size. A general decrease was also noted in total beta concentrations in all wells in the primary plume extending from 200-East Area. The contamination contours for 200-West Area have changed little between June and December 1970.

TRITIUM CONCENTRATIONS (UNCONFINED AQUIFER)

Tritium concentrations are shown in Figure 2 for zones of 0.03 to 1 percent, 1 to 10 percent, 10 to 100 percent, and >100 percent of the CG (3000 pCi/ml).⁽³⁾ The outer boundary of each zone is the down-gradient edge and represents the 0.03 percent, 1 percent, 10 percent, and 100 percent CG isopleth, respectively.

A comparison of CG isopleths for the six-month periods ending June 1970 and December 1970 indicates that several changes occurred. In 200-West Area, the outer contour now includes both well 699-37-82A (west side of 200-W) and the area delineated by the 480' MSL water table contour.

The outermost boundary (0.03 percent CG) of the CG isopleth extending southeastward from 200-East Area remained in the same general position; however, concentrations in most down-gradient wells increased somewhat during this report period. The portion of this isopleth (0.03 percent CG) immediately north of 200-East Area has been adjusted to show a more realistic continuous distribution of ^3H around the small basalt outcrop, even though two wells in this area (699-49-55 and -47-46) did not indicate detectable ^3H . The portion of the 0.03-1 percent isopleth north of well 699-54-57 represents a radical change from that reported in the past (see discussion under section entitled "100 Area and Associated 600 Area Wells").

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 are too low to be measured by current techniques in the groundwater or in the river.

NITRATE ION (NO_3^-) CONCENTRATIONS (UNCONFINED AQUIFER)

Nitrate ion (NO_3^-) concentrations are shown in Figure 3 for zones of 10 to 100 percent and >100 percent 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 percent and 100 percent of the drinking water standard, respectively. The 2 to 10 percent concentration isopleth is not shown in this report. It has been found that nitrate concentrations in this range are readily subject to misinterpretations as related to specific plant sources because of previous use of fertilizers for cultivation and occasional organic detritus in the wells.

A comparison of contamination contours for the six-month periods ending June 1970 and December 1970 indicates that the only changes which took place in the outer isopleth (10 percent of the drinking water standard) were the inclusion of wells 699-14-38 and 699-2-3. The increase in NO_3^- concentration in well 699-2-3 was attributed to the fact that large volumes of water were pumped out of this well during FFTF site preparation, thus

hastening the travel of the NO_3^- plume in this area. The changes shown in the >100 percent isopleth merely represent a more realistic interpretation of the areal extent of this isopleth.

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 detectable activity have not done so consistently with time. A few wells have exhibited ^3H concentrations detectable rather consistently; however, there is no certainty that the vertical separation of piezometer tubes is infallible and in fact, Eliason⁽⁵⁾ has shown that interaquifer transfer within a well may occur.

At present, it is believed that none of the deep aquifers being sampled contain any radioactivity at the points where they are sampled. Total beta concentrations in samples taken at various depths below the water table were all at or below the detection limit (<2 percent CG for ^{106}Ru) for the last six months of 1970. Tritium concentrations in these same samples were all below the detection limit except for one sample collected from 699-36-61B-P in a zone 210 feet below the water table. The ^3H concentration in this sample was 5.9 pCi/ml.

A study of the hydrostratigraphy of these aquifers is underway. One of the goals of this study is to establish a firmer base for evaluating radionuclide transport in aquifers which lie below the water table.

100 AREA AND ASSOCIATED 600 AREA WELLS

The presence of radioactivity in the groundwater beneath the 100 Areas is due primarily to disposal of wastes to trenches, although leaks in reactor effluent systems have contributed radioactivity to the groundwater in the past. Well water samples, collected from within and near the 100 Areas, were analyzed for ^{51}Cr .

TABLE 4. Average Total Beta and Tritium Concentrations in 100 Area and Associated 600 Area Wells

Well No.	Total Beta (pCi/ml) (a)		Tritium (pCi/ml)	
	Jul-Dec '70	Jan-Jun '70	Jul-Dec '70	Jan-Jun '70
Analytical Limit ^(b)		0.16		1.0
199-B3-1	-	NA ^(c)	NA	NA
-B3-2	<0.21	0.52	NA	NA
-B4-4	-	0.20	NA	NA
-B5-1	NA	-	NA	NA
-B9-1	NA	NA	2.8*	NA
-D5-12	-	0.23	10	NA
-F8-1	NA	NA	19*	NA
-H3-1	NA	NA	20*	NA
-K-11	NA	NA	120*	NA
-K-20	0.36 ^(d)	2.4	60	NA
-K-25	NA	-	NA	NA
-N-3	1.1	0.87	58	140
-N-4-0	-	NA	710	NA
-N-8-U	-	NA	750*	NA
-N-10-0	3.3	NA	88*	NA
699-60-60	NA	NA	1.0*	<1.1
-61-66	NA	NA	—*	—*
-65-50	NA	NA	—*	—*
-65-59	NA	NA	1.4*	—*
-65-72	NA	NA	1.6*	NA
-65-83	NA	NA	2.3*	NA
-67-51	NA	NA	<1.5	—*
-69-45-0	NA	NA	<1.1	NA
-70-68	NA	NA	2.9	NA
-71-52	NA	NA	6.5	NA
-71-77	NA	-	3.5*	NA
-71-84	NA	-	7.2*	NA
-72-73	NA	-	6.7	NA
-72-88	NA	NA	18*	NA
-74-44	NA	NA	—*	NA
-74-48	NA	NA	1.5*	NA
-77-36	NA	NA	-	NA
-77-54	NA	NA	-	NA
-78-62	NA	-	—*	NA
-80-43-S	NA	NA	1.1	NA
-81-58-0	NA	NA	—*	NA

TABLE 4. (Continued)

<u>Well No.</u>	<u>Total Beta (pCi/ml)^(a)</u>		<u>Tritium (pCi/ml)</u>	
	<u>Jul-Dec '70</u>	<u>Jan-Jun '70</u>	<u>Jul-Dec '70</u>	<u>Jan-Jun '70</u>
699-83-47-0	NA	NA	<9.1	NA
-84-35-0	NA	NA	<1.2	NA
-86-60	<0.19	0.35	250*	340*
-87-42A	NA	NA	1.4*	NA
-87-55	NA	NA	35*	NA
-89-35	NA	NA	-	NA
-90-45	NA	NA	67	NA
-96-49-0	NA	NA	9.9	NA
-97-43	NA	NA	20	NA

a) Calculated as ¹⁰⁶Ru-Rh

b) A (-) indicates that the concentration was less than the analytical limit.

c) NA - not analyzed.

d) ⁵¹Cr concentration.

* Single sample during the six-month period.

TOTAL BETA CONCENTRATIONS (UNCONFINED AQUIFER)

The estimated extent of detectable total beta radioactivity (excluding ^3H) 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 1970 and December 1970 indicates that the gross beta activity has dropped below the detection level (0.16 pCi/ml) in all areas except 100-N, due to reactor retirements and changes in waste management practices. Although not shown in Figure 1, ^{51}Cr was detected beneath 100-K Area at a concentration of 0.36 pCi/ml (well 199-K-20). This concentration of ^{51}Cr corresponds to a total beta concentration below the detection limit. The highest average total beta concentration was measured in well 199-N-10-0 (3.3 pCi/ml).

TRITIUM CONCENTRATIONS (UNCONFINED AQUIFER)

The estimated extent of detectable ^3H activity in the groundwater beneath the 100 Areas and vicinity is shown in Figure 2. A comparison of CG isopleths for the six-month periods ending June 1970 and December 1970 indicates major differences. It should be emphasized that these differences are only apparent in nature; i.e., ^3H activity has probably been distributed in the groundwater beneath the 100 Areas and vicinity to the extent shown in Figure 2 for several years.

Previous reports in this series (e.g., reference 1) have shown ^3H concentrations only in the immediate vicinity of 100-N Area because the only groundwater samples analyzed for ^3H were from this particular area. During the present report period, special samples were collected from a number of wells in the 100 Areas and vicinity and were analyzed for ^3H because it was suspected that ^3H may be more widely distributed than just the immediate vicinity of 100-N Area.

Based on analyses of groundwater flowpaths prior to recent reactor shutdowns, it appears that the ^3H contamination in this region originated from waste disposal in the 100 Areas.

The main features to be pointed out in Figure 2 are that the higher ^3H concentrations (1 - 10 percent CG) are confined to a strip extending from

100-N westward to 100-K and eastward toward 100-H. The highest ^3H concentrations (10 - 100 percent CG) are confined to the immediate vicinity of 100-N Area. The highest average concentration was 750 pCi/ml (25 percent CG) in well 199-N-8-U. The interface zone for 100 and 200 Area effluents is not very well defined because ^3H concentrations were detected only intermittently in this zone. It should be pointed out that many portions of the ^3H CG isopleths shown in Figure 2 for the 199 and associated 699 wells are based on single analyses, and are subject to change as more data is collected.

In addition to the total beta activity (Figure 1) and the ^3H activity (Figure 2), a program was begun in early 1971 to evaluate the distribution of nitrate ion (NO_3^-) in 199 and associated 699 wells. A preliminary evaluation indicates that the NO_3^- concentration isopleths are distributed reasonably similar to the ^3H isopleths. A more complete treatment of this subject will appear in the next report in this series.

300 AREA AND ASSOCIATED 600 AREA WELLS

The presence of radioactive and nonradioactive contaminants in groundwater beneath the 300 Area arises primarily from the disposal of 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. The latter are probably due to the 300 Area usage of river water which has contained low concentrations of these nuclides.

The concentration of NO_3^- in much of the groundwater beneath the 300 Area (Table 5) is above the Public Health Service drinking water limit⁽⁴⁾ of 45 ppm. However, sampling of the river adjacent to the disposal sites has shown measurable increases in NO_3^- concentrations only intermittently at locations along the riverbank.

TABLE 5. Analytical Data - 300 Area and Associated 600 Area Wells
July - December 1970 Averages

<u>Well No.</u> <u>(399-)</u>	<u>Alpha</u> <u>pCi/ml</u>	<u>Beta</u> <u>pCi/ml</u>	<u>NO₃⁻</u> <u>ppm</u>	<u>Cr+6</u> <u>ppb</u>	<u>F⁻</u> <u>ppm</u>
Analytical Limit(a)	0.02	0.16	0.5	2	0.2
1-1	0.22	0.22	39	3.4	1.9
1-2	0.52	0.26	20	2.6	1.4
1-3	0.38	0.52	48	12	2.1
1-4	0.18	<0.34	15	3.2	2.2
3-1	0.51	0.63	92	19	4.2
4-1	0.14	0.36	40	4.5	3.6
4-7	0.36	1.0	73	4.8	5.4
5-1	0.03	NA(b)	15	2.2	1.7
6-1	0.04	NA	14	5.6	1.7
8-1	NA	NA	NA	NA	NA
8-2	-	NA	6.6	2.6	1.5
8-3	0.17	-	9.6	3.3	2.0
699- S27-E14	<0.035	NA	8.4	2.0	0.6

a) A (-) indicates that the concentration was less than the analytical limit.

b) NA - not analyzed.

FIGURE 1. Total Beta Concentrations Beneath the Hanford Project
Expressed as Percent of ^{106}Ru Concentration Guide (10 pCi/ml)

FIGURE 2. Tritium Concentrations Beneath the Hanford Project Expressed as Percent of ^3H Concentration Guide (3000 pCi/ml)

HANFORD PROJECT

NITRATE (NO_3) CONCENTRATIONS
(JULY-DECEMBER 1970)

10-100% PHS DRINKING WATER
STANDARD

> 100% PHS DRINKING WATER
STANDARD

FIGURE 3. Nitrate Ion Concentrations Beneath the Hanford Project Expressed as Percent of Public Health Service Drinking Water Standard (45 ppm)

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