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Characterization of Radionuclide Concentrations Along the N-Springs Shoreline for 1988

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Assistant Secretary for Defense Programs

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CHARACTERIZATION OF RADIONUCLIDE CONCENTRATIONS ALONG THE N-SPRINGS SHORELINE FOR 1988

1.0 SUMMARY

On August 21, 1988, a total of thirty-seven groundwater samples were collected from a series of seepage spots and wells along the Columbia River shoreline near N-Reactor. Twenty-three visible ground seepage spots, thirteen seepage sampling wells, and the composite sampling well were sampled. This shoreline characterization began at the 181-N intake structure and extended downstream for approximately two miles (see Figure 1). Data comparisons between the 1988 and the 1987 results were made to identify any changes that may be occurring in the groundwater pathways to the river originating from the 1325-N Liquid Waste Disposal Facility (LWDF).

N Reactor was placed in "standdown" status on January 7, 1987. Decreased flows to 1325-N LWDF are suspected to have resulted in smaller and fewer seepage upstream and among the N-Springs wells, yet more downstream seepage. The influence of natural groundwater movement coupled with a reduced mounding effect beneath the 1325-N may be the cause of this shift. This possibility was initially suspected during the 1987 shoreline characterization and remained evident during the 1988 investigation. The radionuclide concentrations detected in these downstream seeps were considerably lower than those detected upstream.

The total radionuclide concentrations were lower by 35% in 1988 as compared to 1987. Ruthenium 103, Ru-106 and I-131 decreased to less than detectable levels in all well and seep locations. Tritium concentrations along the shoreline sampling area were highly variable (see Figure 2). None of the samples exhibited H-3 concentrations in excess of the Derived Concentration Guide (DCG). Generally, Sr-90 concentrations were higher in the upstream sampling locations and decreased in the downstream sites, the net effect being an overall 23% increase compared to 1987 (see Figure 3). Three sample locations near the N-8T well exhibited Sr-90 concentrations in excess of the DCG. Analyses indicated that the concentrations of gamma-emitting radionuclides in all wells and seep spots were below the DCGs as well as lower than the concentrations measured in the continuously sampled well (N-8T).

Based on the data presented in this report, well N-8T adequately represents the distribution of radionuclide concentrations along the N-Springs shoreline. Reported releases are derived solely from the well N-8T analyses, and are conservatively large.

2.0 INTRODUCTION

Prior to 1985, radioactive liquid effluent from N Reactor had been discharged to the 1301-N LWDF; it has since been discharged exclusively to the 1325-N LWDF. The LWDFs were designed to remove radionuclides from the reactor effluent water using the natural ion-exchange and adsorption capacities of the soil. However, a small percentage of radionuclides remain mobile, not being fully captured in the soil column. Groundwater carrying these nuclides enters the Columbia River via a series of riverbank seepages, referred to as the N-Springs.

During 1982, routine sampling of the riverbank springs at 100-N indicated a noticeable increase in the concentrations of some radionuclides reaching the river. This condition pointed to a decrease in the effectiveness of the 1301-N LWDF to retain radionuclides in its soil column. As a corrective action, the 1325-N LWDF was constructed as a replacement facility for the 1301-N LWDF and has been in use since September of 1985.

Fifteen seepage sampling wells were installed in the fall of 1984 in the areas where N-Springs seepage occurs. A composite sampling well, N-8T, was placed into service in 1973, and analysis results from its water samples have been used since then for release reporting. Well N-8T is located approximately 50 feet inland from the shore, directly in the flow path having the shortest known travel-time from the 1301-N LWDF to the river.

Annual sampling and analysis of the seepage wells and other visible ground seepages are performed to characterize the concentrations of radionuclides in the water discharge emerging along the N-Area shoreline. The information provided in this report uses comparative data from 1987 and 1988 to assess the performance of the 1325-N LWDF and the composite sampling well, N-8T.

3.0 METHODS

Thirteen seepage wells were sampled, the samples being collected through the use of a portable Masterflex[R] peristaltic sampling pump. A weighted tube was carefully lowered into each well water column to avoid sediment suspension. Each well was purged to allow for sufficient groundwater recharge after which a four liter sample was collected. Also, a four-liter grab sample was collected from the N-8T composite well.

Twenty-three ground seepage spots were sampled from locations upstream, downstream and among the N-Springs wells. Using a shovel, a 4- to 10-inch deep depression was made in each seepage spot and allowed to fill with water. After the suspended solids had settled out from the pooled seepage water, four liters of that water were scooped into a beaker and poured into a sample container. Within 24 hours of collection, all liquid samples were labeled and transported to the 100-N radioanalytical lab in the 105-N building. Samples were analyzed for gamma-emitting radionuclides using gamma spectroscopy and an 8-hour counting time. The samples were then delivered to the the U. S. Testing Laboratory in Richland, Washington for analyses of H-3 and Sr-90.

4.0 RESULTS OF 1988 DATA

The prominent radionuclides identified were H-3, Co-60, Sr-90 and Sb-125 (see Tables 1 and 2). Some of the significant results of the analyses are described below.

- o Concentrations detected in the majority of the sampling locations were lower than the concentrations detected in well N-8T.
- o Sampling locations in close proximity to the N-8T well showed the highest radionuclide concentrations, while those samples taken downstream of this localized area showed reduced concentrations.
- o Tritium (H-3) concentrations exhibited a varied range along the entire sampled shoreline, with the higher concentrations generally seen in the more upstream sampling locations.
- o Strontium-90 concentrations were highest in wells 1 through 4 and seep spots 2 and 3.
- o Concentrations of Ru-103, Ru-106 and I-131 in all sampling locations were less than minimum detection limits.
- o The average concentrations of all the radionuclides in the wells were comparable to those in the seep spots.

5.0 COMPARISON OF 1987 VERSUS 1988 DATA

The 1987 and 1988 analyses were compared for the purpose of identifying any changes that may have occurred in the groundwater pathways to the river originating from the LWDFs (see Table 1 and 2). Summarized below are some of the significant results of these comparisons.

- o The total average radionuclide concentrations were lower by approximately 35% in 1988. This is mainly attributable to a 36% decrease in H-3 concentrations.

- The area showing the highest radionuclide concentrations has remained consistant for several years, i.e., between wells 2 and 4, including N-8T.
- Sampling done during both years indicates an area of slightly higher concentrations approximately 1/4 mile downstream of N-8T.
- Strontium-90 concentrations in the wells and corresponding seep spots sampled both in 1987 and 1988 showed an overall increase of 23% in 1988.

6.0 DISCUSSION

PNL hydrological analyses indicate that the groundwater flow-pathways from the 1301-N and the 1325-N LWDFs are complex systems. Water from these facilities may enter the river via the soil of the riverbed, as well as from the springs along the shoreline. Groundwater travel-times to the river appear to be shortest coming from the intersections of each respective crib and trench. Groundwater pathways may also parallel the river for one to two miles before actually entering the river. Previous radionuclide sampling and hydrological studies have shown that the most radioactive springwater enters the river via the shortest crib-to-river pathway. This has historically been in the area of well N-8T.

The 1325-N LWDF is about 1800' further inland than the old 1301-N LWDF. Due to the increased distance to the river from 1325-N, even the most direct groundwater pathways experience longer travel-times. The longer travel-times from 1325-N (allowing greater decay of soluble radionuclides) combined with the fresh soil column of this facility (giving high adsorption and ion-exchange rates) result in decreased concentrations for almost all radionuclides.

With the standdown status of N Reactor since January 1987, effluent flow rates to the 1325-N were reduced significantly. These decreased flows also altered the influence of 1325-N on the groundwater system at 100-N Area. Figures 4, 5 and 6 present groundwater elevation maps in approximately one year increments since 1986. Figure 4, prepared by PNL in August 1988, indicates a continued decrease from 1987 levels. Figures 5 and 6, developed by Golder Associates (Golder) exemplify the same trend for 1987 using 1986 as a baseline year for making comparisons. The details of the contours in Figures 4 and 5 indicate that currently most of the flow from the 1325-N moves in a generally northerly direction. This flow pattern is quite different from that of April 1986, which was generally westerly and more directly toward the river. The flow paths associated with these changes may be one explanation for the noticeable shift in seep spot locations seen in both the the 1987 and 1988 shoreline investigations. In shoreline characterizations prior to 1987, seep spots were identifiable not only upstream and downstream of the shoreline well locations, but were also readily visible between the well sites. The 1987 and 1988 shoreline inspections revealed far fewer and much smaller seep spots within the well site area, yet more seeps were found downstream of the wells. During the 1988 characterization, one of the usually reliable shoreline wells, NS-5, was found to be dry.

The seep spots located among the well sites were mostly in close proximity to the N-8T well and, as expected, showed higher radionuclide concentrations. The seeps found downstream of the wells, while greater in number, revealed significantly reduced radionuclide concentrations.

The data suggest that the groundwater which emerges in the vicinity of the N-8T is presently influenced by the residual radionuclide build-up in the soil column from years of use of the old 1301-N LWDF. These few remaining mobile radionuclides, notably Sr-90, are slowly, but continually, entering the groundwater in this area and are eventually emerging at the N-Springs. This possibility was confirmed by Golder in their appraisal of the 1987 N-Springs Characterization Report.

For this annual shoreline characterization study, thirty-seven groundwater samples were collected on August 21, 1988. These samples are not used for release reporting, only the samples collected weekly from the continuously compositing sampling system of well N-8T are analyzed for reporting of N-Springs releases. Well N-8T is located near the Columbia River shoreline within the most direct path to the river from the 1301-N LWDF. The composite samples from N-8T provide a conservatively large representation of the annual samples obtained from the other seepage wells and ground seepage spots.

The average total concentrations of the radionuclides sampled from the majority of the wells and seep spots were lower than those measured in well N-8T.

Well 3 and seep spot 3 showed Sr-90 concentrations slightly higher than the N-8T value. Each of these sample locations exhibited Sr-90 levels higher than those seen in 1987. This increase would be expected with the dissipation of the groundwater mound beneath the 1325-N which, during N-Reactor operation, may have acted as a source of dilution water for the residual Sr-90 inventory associated with the saturated soil column beneath the retired 1301-N facility. This lack of dilution water is consistant with the decreased number of seep spots detected in the upstream portion of the N-Springs shoreline as well as the reduced flows evident in these locations.

Several seep spots exhibited H-3 concentrations higher than the N-8T value. All but one of these seep spots were located a considerable distance downstream of the N-8T well. This is another indication of the suspected shift in groundwater migration pathways from the 1325-N to the river.

Ruthenium 103 and 106, and Iodine-131 concentrations were less than minimum detectable levels in all of the samples taken in 1988. This is due largely to the extended standdown status of N-Reactor and to the exclusive use of 1325-N (and the resulting increased travel-times to the river).

The concentrations for each of the radionuclides analyzed in well N-8T were compared to the average concentrations of each radionuclide in the other samples. Comparing the analysis results of well N-8T to those of both the wells and seep spots yielded ratios ranging from 1.7:1 for H-3 to 5.1:1 for Sr-90 (see Table 3 for both series of comparisons). Overall, well N-8T had higher radionuclide concentrations when compared to the averages of all other seepage sampling wells and ground seepage spots. This indicates that the releases reported based solely on N-8T sampling are conservatively large.

The composition of the discharges from the seepage sampling wells is influenced by the flow rates of the Columbia River. During low flows more seepage springs are exposed on the shoreline, and collecting samples from these sites, including wells, is more easily accomplished. The samples taken during low-flow conditions are also less likely to be diluted with river water. On the date the samples were taken (August 21, 1988), the daily flow rate of the Columbia River averaged 47,000 cfs.

In conclusion, based on data in this report, composite well N-8T adequately represents the total N-Springs discharge, and the reported releases derived solely from N-8T sampling are conservatively large.

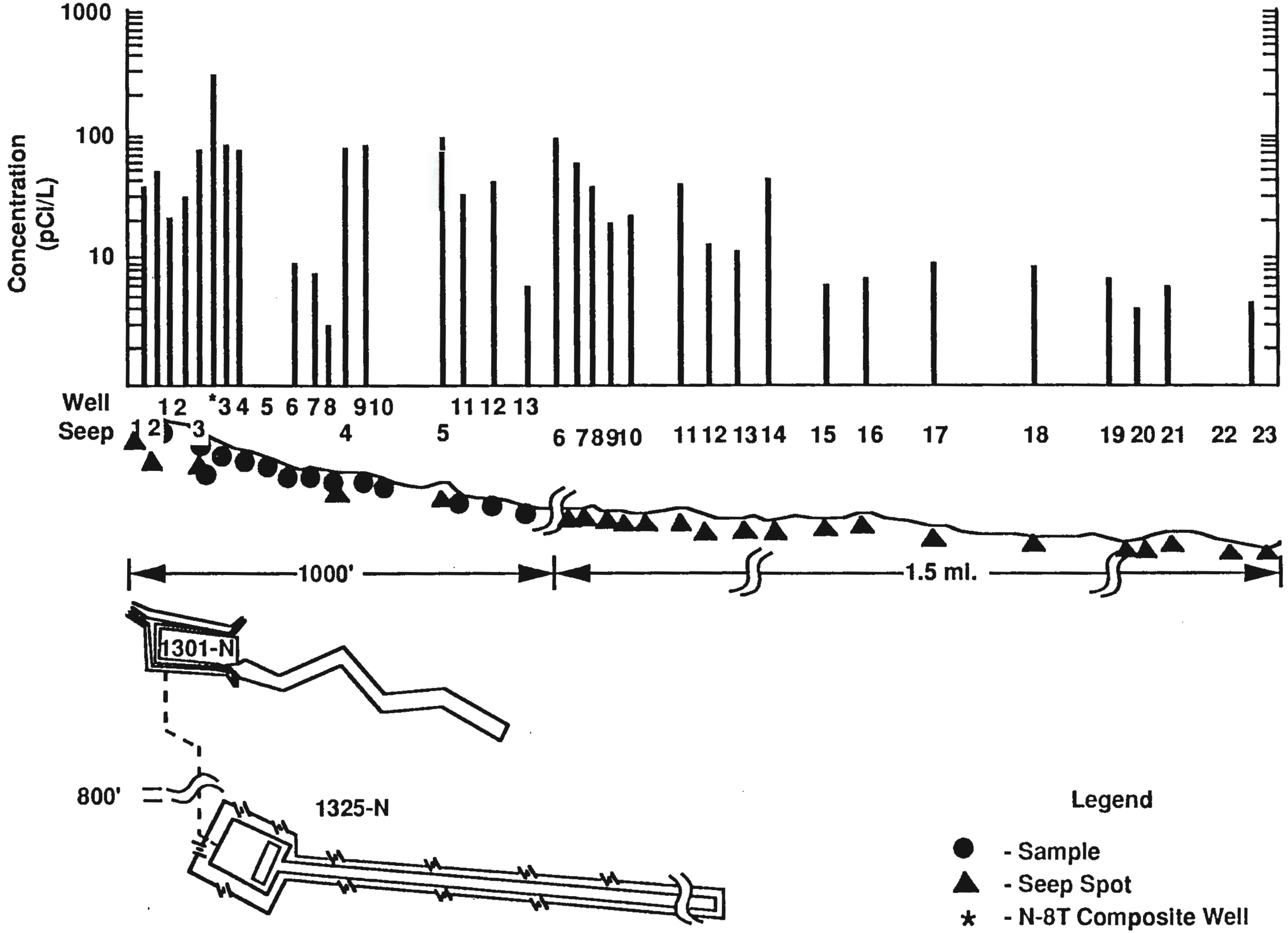

Figure 1. Total Detectable Gamma Activity (Co-60, Sb-125)

28904032.1M

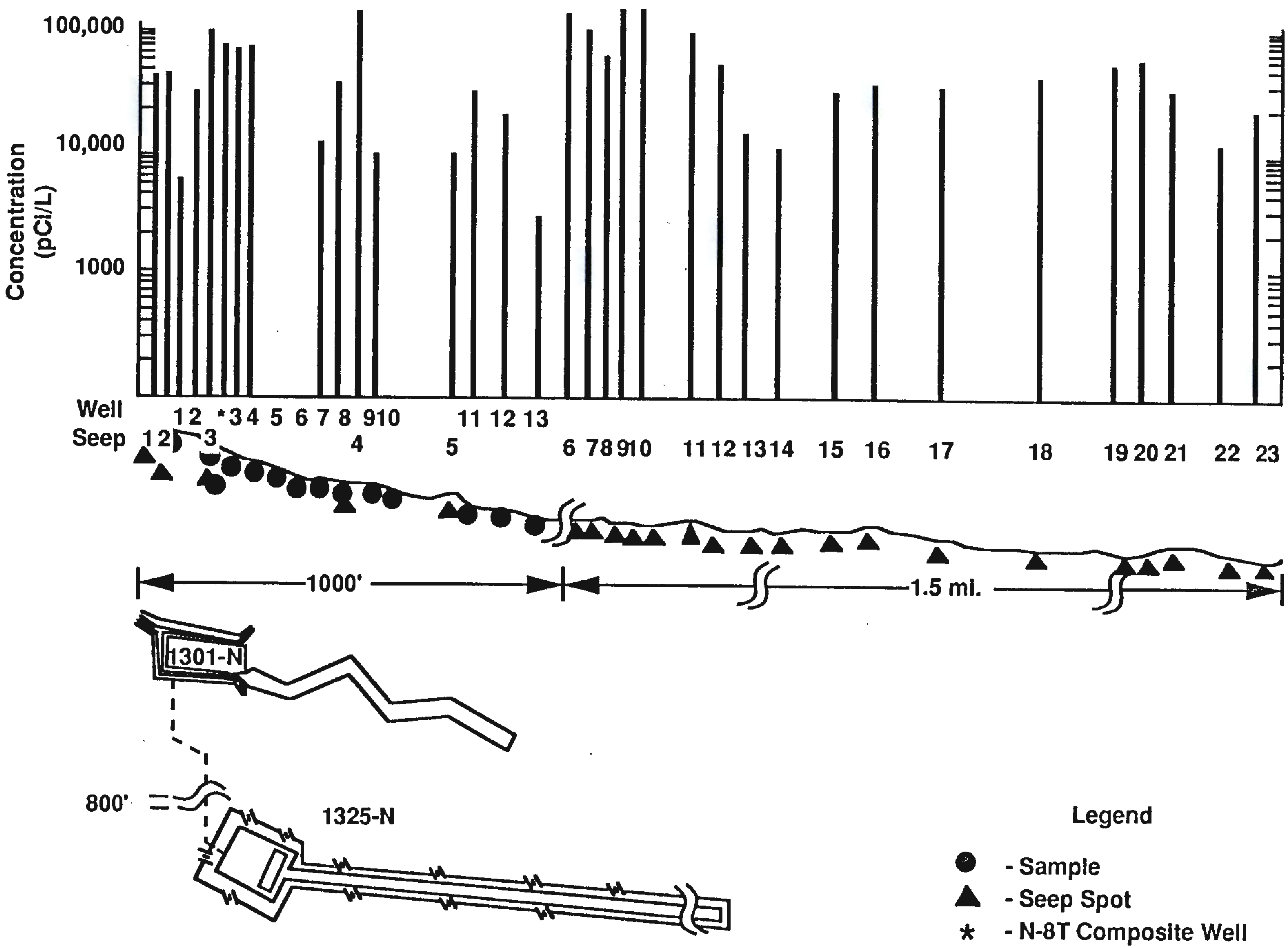

Figure 2. Activity Levels for Tritium (H-3)

28904032.2M

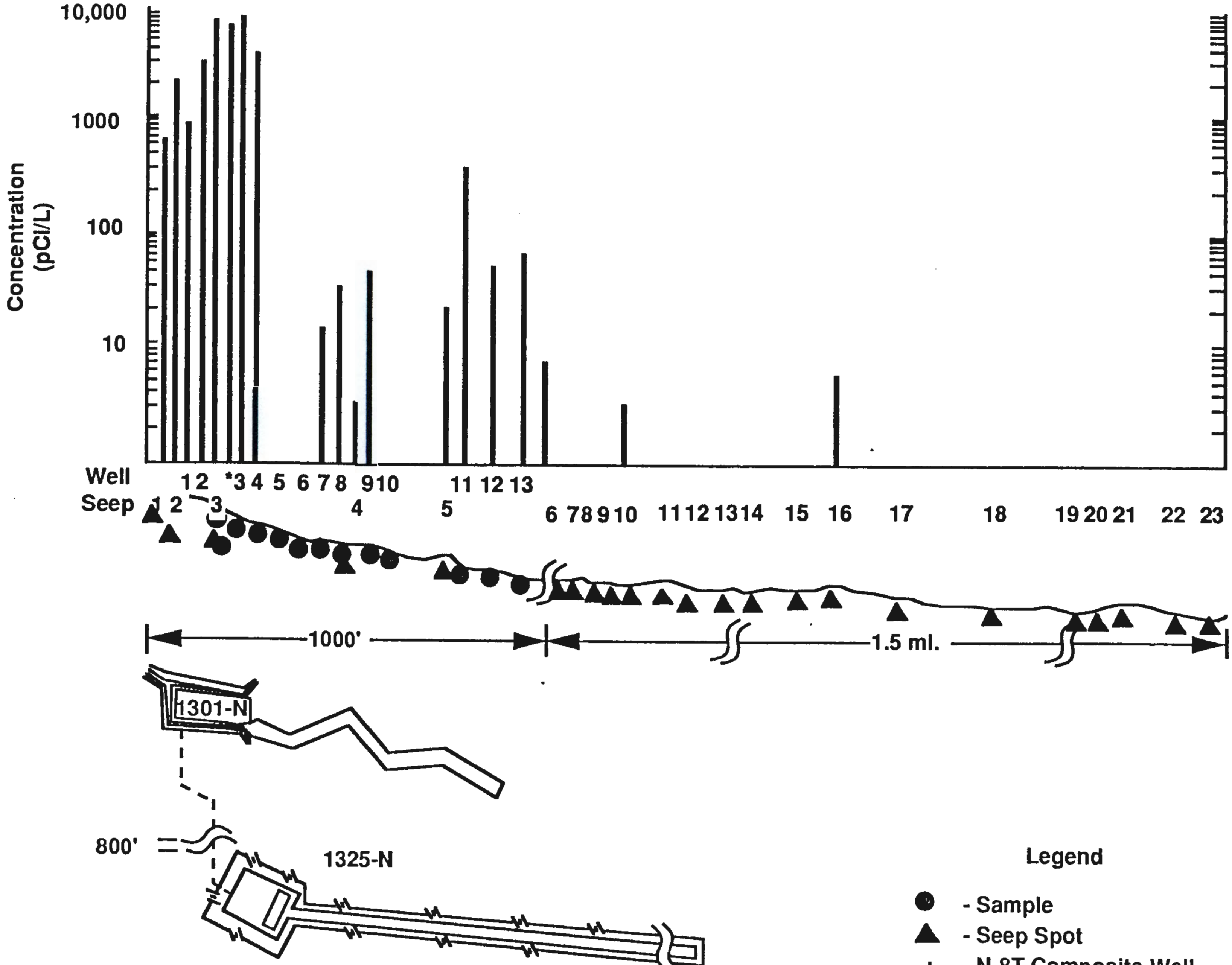

Figure 3. Activity Levels for Strontium 90

28904032.3M

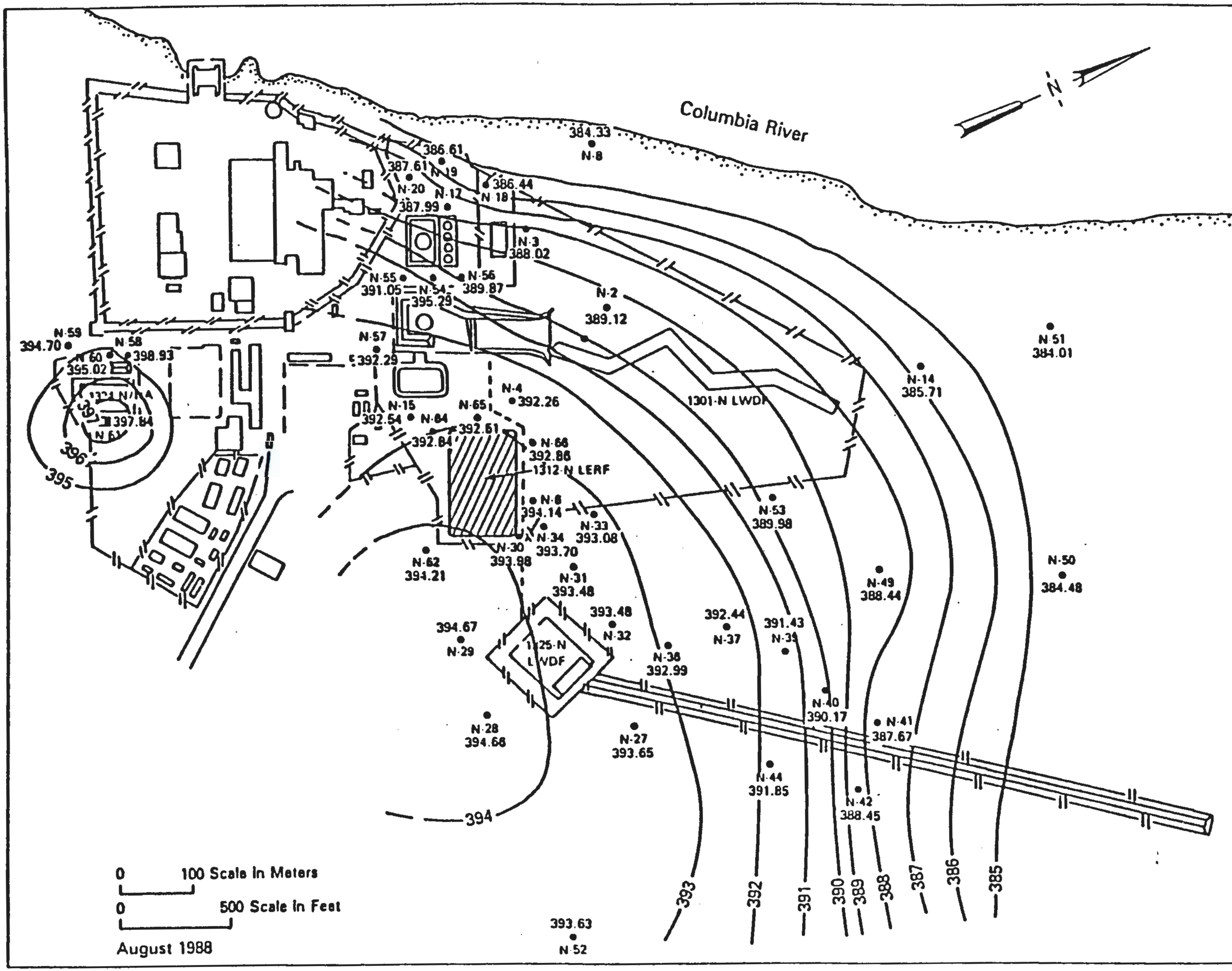

FIGURE 4 GROUNDWATER LEVELS IN THE VICINITY OF THE N-REACTOR, AUGUST 1988

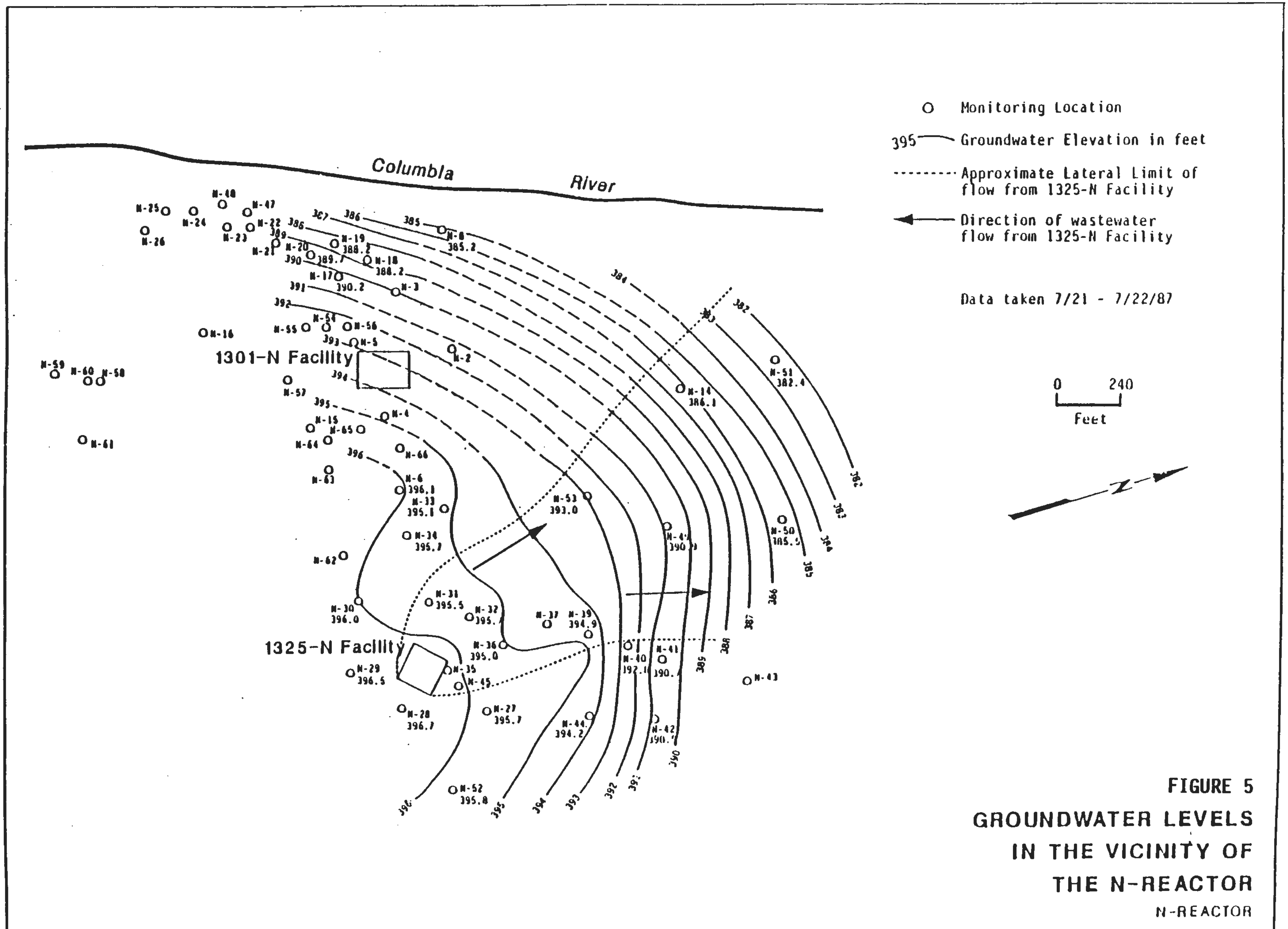

FIGURE 5

GROUNDWATER LEVELS IN THE VICINITY OF THE N-REACTOR

N-REACTOR

PROJECT NO 873-1204-000 DWG NO 10063 DATE 4-15-88 DRAWN CB APPROVED CW

Golder Associates

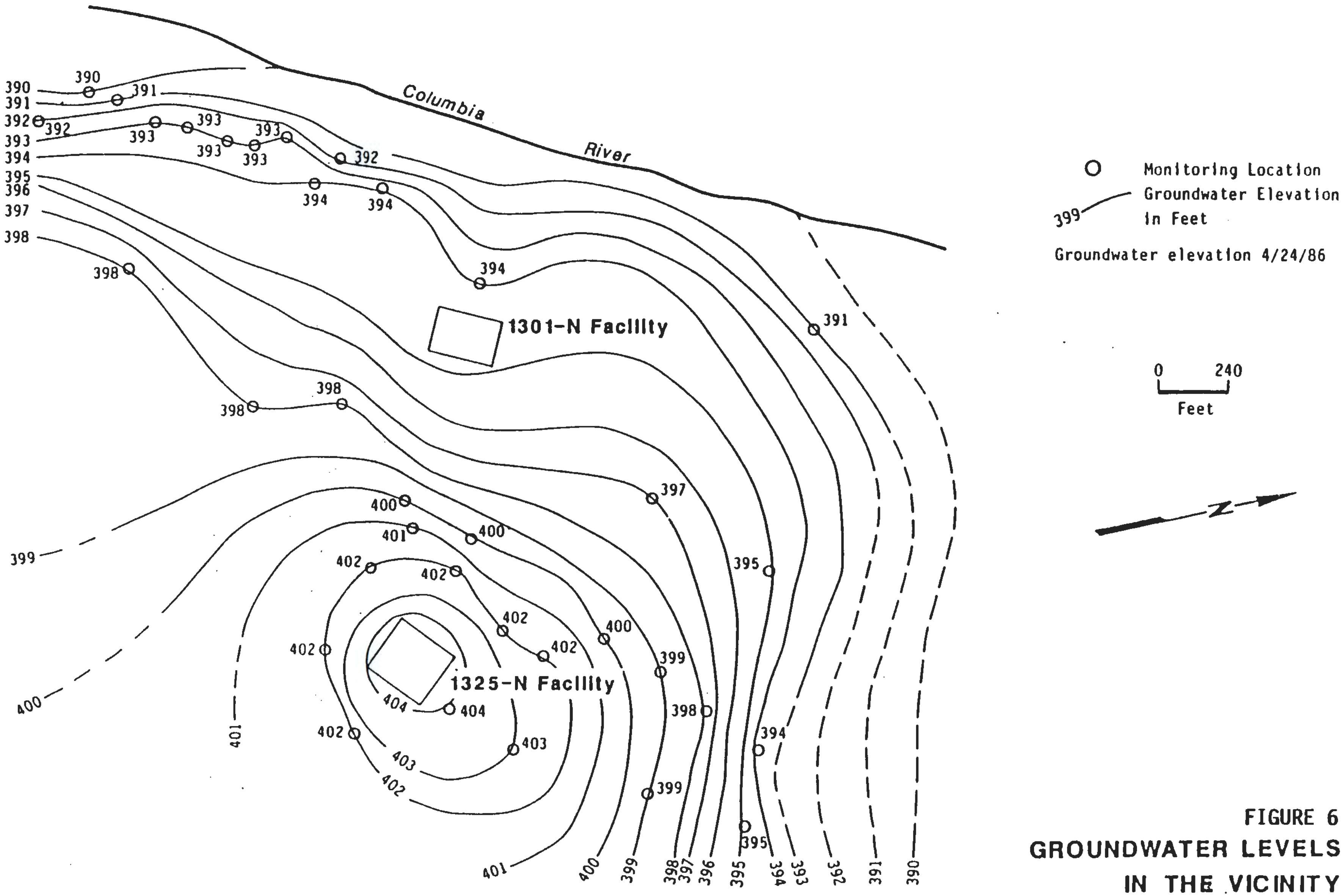

FIGURE 6
GROUNDWATER LEVELS IN THE VICINITY OF THE N-REACTOR
N-REACTOR

PROJECT NO 873-1204-000 DWG NO 6075 DATE 1/19/88 DRAWN ECR APPROVED CW

Golder Associates

TABLE 1

Radionuclide Concentrations in N-Springs Sampling Wells (pCi/L)

Radio-nuclide	(yr)	Well 1	2	3	4	5	6	7	8	9	10	11	12	13	N-8T
H-3	('87)	6.8E+04	7.6E+04	9.2E+04	9.4E+04	8.8E+04	7.9E+04	7.3E+04	4.6E+04	7.5E+04	4.0E+03	5.8E+04	2.1E+04	1.3E+03	9.5E+04
	('88)	5.7E+03	2.8E+04	6.9E+04	7.4E+04	DRY	N/A	1.1E+04	3.0E+04	1.0E+04	N/A	2.9E+04	1.9E+04	3.0E+03	7.5E+04
Co-60	('87)	6.5E+01	8.4E+01	1.3E+02	1.5E+02	<1.0E+00	1.9E+01	1.4E+02	3.2E+01	4.7E+01	9.0E+00	2.7E+01	1.0E+01	4.0E+00	1.5E+02
	('88)	1.4E+01	2.0E+01	4.7E+01	3.2E+01	DRY	8.5E+00	7.0E+00	2.1E+01	5.7E+01	N/A	1.5E+01	1.2E+01	6.6E+00	6.7E+01
Sr-90	('87)	1.7E+03	2.7E+03	8.3E+03	4.1E+03	9.5E+02	7.2E+02	1.3E+01	4.2E+01	2.4E+02	5.7E+01	6.6E+02	5.8E+01	5.0E+01	6.1E+03
	('88)	8.7E+02	3.0E+03	9.1E+03	3.5E+03	DRY	N/A	1.5E+01	3.2E+01	4.1E+01	N/A	3.4E+02	4.0E+01	5.8E+01	7.9E+03
Ru-103	('87)	<6.2E+00	<7.8E+00	<7.8E+00	<3.6E+00	<7.1E+00	<6.3E+00	<1.4E+01	<1.2E+01	<1.4E+01	<1.2E+01	<1.5E+01	<1.4E+01	<6.7E+00	<1.7E+01
	('88)	<9.8E+00	<9.8E+00	<1.5E+01	<1.1E+01	DRY	<6.2E+00	<1.0E+01	<1.1E+01	<1.9E+01	N/A	<1.1E+01	<1.3E+01	<1.4E+01	<6.2E+00
Ru-106	('87)	<5.4E+01	<6.3E+01	5.6E+01	<6.2E+01	<5.0E+01	<4.8E+01	<6.0E+01	<5.2E+01	<5.9E+01	<5.0E+01	<6.8E+01	<5.4E+01	<4.5E+01	1.2E+02
	('88)	<4.5E+01	<4.0E+01	<5.1E+01	<4.2E+01	DRY	<3.9E+01	<3.9E+01	<4.0E+01	<3.9E+01	N/A	<4.2E+01	<4.9E+01	<4.5E+01	<6.6E+01
Sb-125	('87)	4.6E+01	7.5E+01	9.5E+01	1.2E+02	2.1E+01	<2.2E+01	2.3E+01	2.8E+01	7.5E+01	<2.0E+01	1.1E+02	<2.2E+01	<2.1E+01	1.1E+02
	('88)	1.0E+01	1.2E+01	4.0E+01	3.9E+01	DRY	<1.3E+01	<1.3E+01	<1.4E+01	3.6E+01	N/A	1.5E+01	2.8E+01	<1.3E+01	4.7E+01
I-131	('87)	<8.4E+00	<9.4E+00	<9.5E+00	<8.8E+00	<1.2E+01	<1.0E+01	<9.5E+00	<9.5E+00	<9.5E+00	<9.5E+00	<9.5E+00	<9.5E+00	<1.3E+01	<9.5E+00
	('88)	<1.2E+01	<1.1E+01	<1.2E+01	<1.0E+01	DRY	<1.4E+01	<1.0E+01	<9.8E+00	<1.0E+01	N/A	<1.3E+01	<1.1E+01	<1.0E+01	<1.0E+01

N/A - No Analysis

TABLE 2

Radionuclide concentrations in N-Springs Seep Spots (pCi/L)

Radio-nuclide	(yr)	Seep Spot ('88/'87) 1/a*	2	3/b*	4	5/d*	6/e*	7	8/f*	9	10/g*	11/h*	12
H-3	('87)	5.8E+04		1.1E+05		6.8E+04	1.3E+05		5.8E+04		8.2E+04	7.4E+04	
	('88)	3.9E+04	4.0E+04	1.0E+05	1.1E+05	1.0E+04	1.1E+05	8.9E+04	6.8E+04	1.1E+05	1.1E+05	9.4E+04	4.7E+04
Co-60	('87)	5.5E+01		1.8E+02		5.7E+01	8.4E+01		3.2E+01		6.8E+01	2.7E+01	
	('88)	2.5E+01	2.9E+01	3.9E+01	6.6E+01	6.7E+01	6.5E+01	4.2E+01	3.5E+01	2.4E+01	2.7E+01	4.1E+01	1.4E+01
Sr-90	('87)	2.4E+02		8.2E+03		7.4E+02	4.6E+00		2.1E+00		<4.0E-01	<2.9E-01	
	('88)	5.9E+02	2.0E+03	8.4E+03	3.3E+00	2.7E+01	7.4E+00	<1.9E-01	<3.1E-01	<2.0E-01	3.3E+00	<1.4E-01	<1.5E-01
Ru-103	('87)	<1.0E+01		<8.5E+00		<1.2E+01	<1.3E+01		<9.9E+00		<1.3E+01	<1.2E+01	
	('88)	<1.1E+01	1.3E+01	1.2E+01	<1.3E+01	<1.2E+01	<1.1E+01	<1.0E+01	<1.1E+01	<1.1E+01	<1.0E+01	<1.0E+01	<8.9E+00
Ru-106	('87)	8.6E+01		<7.0E+01		<6.0E+01	<5.1E+01		<5.1E+01		5.3E+01	<5.8E+01	
	('88)	<4.7E+01	<4.8E+01	<4.4E+01	<4.4E+01	<4.4E+01	<4.5E+01	<4.0E+01	<5.2E+01	<4.2E+01	<4.4E+01	<4.4E+01	<4.4E+01
Sb-125	('87)	2.0E+01		7.5E+01		7.9E+01	5.7E+01		<2.0E+01		<2.3E+01	<1.9E+01	
	('88)	1.3E+01	2.4E+01	4.2E+01	1.7E+01	3.3E+01	3.9E+01	1.9E+01	1.3E+01	<1.3E+01	<1.3E+01	<1.3E+01	<1.2E+01
I-131	('87)	<1.3E+01		<1.3E+01		<1.3E+01	<1.3E+01		<1.3E+01		<1.3E+01	<1.3E+01	
	('88)	<1.2E+01	<1.3E+01	<1.2E+01	<1.1E+01	<1.2E+01	<1.2E+01	<1.3E+01	<1.2E+01	<1.1E+01	<1.3E+01	<1.2E+01	<1.2E+01

* - Corresponding Seep Spots Sampled in 1987 and 1988.

N/A - No Analysis

TABLE 2 (cont.)

Radionuclide concentrations in N-Springs Seep Spots (pCi/L)

Radio-nuclide	(yr)	13	14/i*	15	16/j*	17/k*	18/l*	19/m*	20	21/n*	22/o*	23
		Seep Spot ('88/'87)										
H-3	('87)		2.6E+04		2.1E+04	3.4E+04	N/A	N/A		N/A	N/A	
	('88)	1.5E+04	1.0E+04	2.9E+04	3.3E+04	3.2E+04	3.6E+04	5.3E+04	5.5E+04	3.3E+04	1.2E+04	2.0E+04
Co-60	('87)		1.1E+01		1.0E+01	1.9E+01	4.0E+00	1.8E+01		<3.0E+00	3.9E+01	
	('88)	1.2E+01	4.4E+01	6.0E+00	7.0E+00	9.0E+00	8.5E+00	7.0E+00	4.0E+00	6.0E+00	<4.3E+00	4.0E+00
Sr-90	('87)		<3.1E-01		1.6E+00	1.1E+00	N/A	N/A		N/A	N/A	
	('88)	<1.6E-01	<1.3E-01	<2.9E-01	5.9E+00	<1.5E-01	<8.0E-02	<3.2E-01	<3.0E-02	<2.9E-01	<2.9E-01	<7.3E-01
Ru-103	('87)		<1.1E+01		<6.5E+00	<1.2E+01	<6.4E+00	<6.9E+00		<7.1E+00	<4.1E+00	
	('88)	<1.1E+01	<1.1E+01	<1.1E+01	<1.0E+01	<1.1E+01	<9.8E+00	<1.1E+01	<1.3E+01	<9.9E+00	<1.1E+01	<1.1E+01
Ru-106	('87)		<5.0E+01		<4.5E+01	<5.8E+01	<4.8E+01	<4.9E+01		<5.0E+01	<3.4E+01	
	('88)	<4.5E+01	<4.2E+01	<4.0E+01	<4.0E+01	<4.0E+01	<4.8E+01	<4.8E+01	<3.9E+01	<4.0E+01	<3.8E+01	<3.9E+01
Sb-125	('87)		<2.0E+01		<2.0E+01	<2.3E+01	<1.9E+01	<1.9E+01		<1.9E+01	<1.2E+01	
	('88)	<1.4E+01	<1.4E+01	<1.4E+01	<1.2E+01	<1.3E+01	<1.3E+01	<1.4E+01	<1.2E+01	<1.2E+01	<1.2E+01	<1.2E+01
I-131	('87)		<1.3E+01		<1.1E+01	<1.1E+01	<1.2E+01	<9.8E+00		<9.8E+00	<6.5E+00	
	('88)	<1.1E+01	<1.3E+01	<1.3E+01	<1.0E+01	<1.0E+01	<1.1E+01	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01	<1.0E+01

* - Corresponding Seep Spots Sampled in 1987 and 1988.

N/A - No Analysis

TABLE 3

1988 CONCENTRATIONS (pCi/L) IN WELL N-8T COMPARED TO AVERAGE CONCENTRATIONS IN SEEPAGE WELLS (W), GROUND SEEPAGE SPOTS (S), AND COMBINED W AND S CONCENTRATIONS

	CONCENTRATIONS			RATIOS		
Radionuclide	N-8T	W (avg)	S (avg)	N-8T : W	N-8T : S	N-8T : W+S
H-3	7.5E+04	3.7E+04	5.5E+04	2.0 : 1	1.4 : 1	1.6 : 1
Co-60	6.7E+01	2.2E+01	2.5E+01	3.0 : 1	2.7 : 1	2.9 : 1
Sr-90	7.9E+03	1.7E+03	1.4E+03	4.6 : 1	5.6 : 1	5.1 : 1
Sb-125	4.7E+01	2.6E+01	2.5E+01	1.8 : 1	1.9 : 1	1.8 : 1

TABLE 4

COMPARISON OF N-8T TO SEEPAGE WELL AND GROUND SEEPAGE SPOT RATIOS FOR 1987 AND 1988

Radionuclide	1987 RATIO	1988 RATIO
H-3	1.5 : 1	1.7 : 1
Co-60	2.8 : 1	2.8 : 1
Sr-90	4.0 : 1	5.1 : 1
Sb-125	1.9 : 1	1.8 : 1

TABLE 5

COMPARISON DATA
(Average concentrations in pCi/L)

WELLS 1-13 AND N-8T

Radionuclide	1988	1987	1988 TREND
H-3	2.8E+04	6.2E+04	- 55 %
Co-60	2.6E+01	6.2E+01	- 58 %
Sr-90	2.3E+03	1.8E+03	+ 28 %
Sb-125	2.8E+01	5.6E+01	- 50 %
	-------	-------	-------
Total Avg. Activity	3.0E+04	6.4E+04	- 53 %

CORRESPONDING SEEP SPOTS

H-3	5.3E+04	6.6E+04	- 20 %
Co-60	2.6E+01	4.7E+01	- 44 %
Sr-90	1.5E+03	1.3E+03	+ 15 %
Sb-125	2.8E+01	5.7E+01	- 51 %
	-------	-------	-------
Total Avg. Activity	5.5E+04	6.7E+04	- 19 %

SUMMARY

YEAR	TOTAL AVERAGE ACTIVITY	1988 TREND
1988	4.3E+04	- 35 %
1987	6.6E+04	

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CHARACTERIZATION OF RADIONUCLIDE CONCENTRATIONS
ALONG THE N-SPRINGS SHORELINE FOR 1988

WHC-SP-0480

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