Ground-Water Surveillance at The Hanford Site for CY 1982

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76 RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

NTIS Price Codes
Microfiche A01

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

Ground-Water Surveillance at The Hanford Site for CY 1982

P.A. Eddy
L.S. Prater
J.T. Rieger

June 1983

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

ACKNOWLEDGEMENTS

The authors wish to acknowledge the individuals who contributed to the Ground-Water Surveillance Program in 1982 and also those who helped prepare this report.

Technical contributions to the program were made by S.C. Blair, C.S. Cline, C.R. Cole, D.W. Damschen, D. Gibson, P.J. Gutknecht, E.L. Hilty, V.L. McGhan, G.M. Petrie, A.E. Reisenauer, and D.A. Zimmerman.

The ground-water samples were collected by S. R. Bivins, K. Byrne, J. D. Harrison, D. L. Merrill, and W. W. King, under the direction of M. R. Quaders. The samples were analyzed by L. J. Kirby and F. P. Brauer.

Data management was performed by P. J. Blumer and L. E. Bisping.

Typing and secretarial support was provided by G. L. Dirkes and S. C. Canada. M. A. McKinney, S. Chadez-Hartley, the typesetting team, and the 300 Area word processing team (especially C. M. Gilbert) aided in the preparation of this report.

The authors also appreciate the assistance and the many valuable suggestions provided by M. J. Sula, W. D. McCormack, and other staff members of the Hanford Environmental Surveillance Program.

SUMMARY

Operations at the Hanford Site since 1944 have resulted in the discharge of large volumes of process cooling water and other waste waters to the ground. These effluents, which have reached the unconfined ground water, contain low levels of radioactive and chemical substances. The movement of these constituents in the unconfined ground water is monitored as part of the Ground-Water Surveillance Program.

During 1982, 324 monitoring wells were sampled at various times for radioactive and chemical constituents. Two of these constituents, tritium and nitrate, are readily transported in ground water; therefore, these substances are the primary ones used to monitor the movement of the ground water. This report, which is one of a series prepared annually to document and evaluate the status of the ground water at the Hanford Site, describes recent changes in the configuration of the tritium and nitrate plumes. The plumes change with time in response to ground-water flow, ionic dispersion, and radioactive decay.

The tritium plume continues to show increasing concentrations near the Columbia River. While it is mapped as having reached the Columbia River, its contribution to the river has not been distinguished from other sources at this time. The general plume configuration is much the same as in 1978, 1979, 1980, and 1981.

The size of the nitrate plume appears stable. Concentrations of nitrate in the vicinity of the 100-H Area continue to be high as a result of past leaks from an evaporation facility.

In addition to describing the present status of the ground water beneath the Hanford Site, this report describes the results of studies conducted in support of the ground-water surveillance effort during CY 1982. These studies provided data that will help to better characterize the ground-water system, refine the hydrologic and transport models, and determine the impact of Site operations on the environment.

CONTENTS

Acknowledgments	iii
Summary	v
Introduction	1
Site Description	3
Site Operations	3
Geology and Hydrology of the Site	4
Geology	4
Hydrology	5
Methods	7
Sample Collection	7
Sample Analysis	7
Distribution and Concentration of Radionuclides and Chemicals in the Ground Water	11
Evaluation of Ground-Water Surveillance Data	11
Tritium Concentration in the Unconfined Ground Water	12
Nitrate Concentration in the Unconfined Ground Water	17
Gross Beta Concentration in the Unconfined Ground Water	21
Radiological Impact	23
Ground Water	23
Columbia River	23
Results of Supporting Studies	25
Bank Storage Study	25
Clay Deposit Investigation	27
Geophysical Log Interpretation	30
Update of Input Data for the Variable Thickness Transient Model	31
Aquifer Transmissivities	31
Aquifer Bottom Elevations	34
Quality Control	37
References	39
Appendix A: Tritium and Nitrate Concentrations in the Ground Water (Unconfined Aquifer)	A.1
Appendix B: Gross Alpha, Strontium-90, Cesium-137, Cobalt-60, Uranium, Ruthenium-106, Chromium, and Fluoride Concentrations in the Ground Water (Unconfined Aquifer)	B.1
Appendix C: Chemical and Spectrographic Analyses from Various Wells Sampled	C.1

FIGURES

1	The Hanford Site	3
2	Generalized Geologic Cross Section of the Hanford Site	4
3	Water Table Elevations - December 1982	6
4	Locations of Selected Sampling Wells	8
5	Tritium Distribution in Unconfined Ground Water	13
6	Concentration History for Tritium in Well 699-40-1	14
7	Concentration History for Tritium in Well 699-35-9	14
8	Concentration History for Tritium in Well 699-31-31	15
9	Concentration History for Tritium in Well 699-41-23	15
10	Concentration History for Tritium in Well 699-2-3	16
11	Concentration History for Tritium in Well 699-9-E2	16
12	Concentration History for Tritium in Well 699-87-55	17
13	Nitrate Ion Distribution in Unconfined Ground Water	18
14	Concentration History for Nitrate in Well 699-32-43	19
15	Concentration History for Nitrate in Well 699-32-22	19
16	Concentration History for Nitrate in Well 199-H4-3	20
17	Concentration History for Nitrate in Well 699-S0-7	20
18	Concentration History for Nitrate in Well 699-40-1	21
19	Concentration History for Tritium in Well 699-S0-7	23
20	Locations of Selected Wells Used in the Bank Storage Study	25
21	Changes in the Water Level in Well 699-48-7 Compared with Changes in the River Stage at Priest Rapids Dam	26
22	A Comparison of Changes in the Water Levels in Wells 699-43-3, 699-45-4, and 699-48-7	26
23	Changes in Tritium Concentrations in Well 699-47-6 Compared with Changes in the Flow Rate of the Columbia River	27
24	Locations of Selected Sampling Wells Drilled in 1979	28
25	Locations of Selected Sampling Wells, Abandoned Wells, and the Clay Deposit	29
26	Changes in the Water Level in Well 699-39-1 Compared with Changes in the Flow Rate of the Columbia River	30
27	Changes in the Water Level in Well 699-45-4 Compared with Changes with in the Flow Rate of the Columbia River	30
28	Changes in Tritium Concentrations in Wells 699-47-6 and 699-41-1 Compared with Changes in the Flow Rate of the Columbia River	31
29	Six Natural Gamma Logs of Well 399-5-2	32
30	Eight Temperature Logs of Well 399-5-2	32
31	Locations of Wells Tested from 1973 to 1981	33
32	Transmissivity Contours Before and After the 1982 Update	35
33	Aquifer Bottom Contours Before and After the 1980 Update	36

TABLES

1	Minimum Detectable Concentrations and Lowest Applicable Concentration Guides or Drinking Water Standards for Various Radionuclides and Chemicals	11
2	Numerical Data on the Routine Ground-Water Monitoring Program, 1982	12

INTRODUCTION

Ground-water surveillance at the Hanford Site is a facet of the Hanford Environmental Surveillance Program, which is conducted by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE). This comprehensive program is designed to evaluate existing and potential pathways of exposure to radioactivity from Site operations. The objectives of the ground-water surveillance portion of this program are as follows: 1) measure and report the concentration and distribution of radioactive and other chemical constituents in the ground water, 2) determine the movement and transport of constituents with time, and 3) evaluate the impact of ground-water contamination on people and their environment.

To achieve these objectives, the Ground-Water Surveillance Program collects and analyzes ground-water samples and then interprets the results. The program also performs technical studies that provide additional information on the ground-water system and on the behavior of constituents within the system.

Each year, data collected by the Ground-Water Surveillance Program are evaluated, summarized, and published in an annual report. This document contains an evaluation of data collected during calendar year 1982. Data from past years are contained in reports similar to this one.

The primary purposes of this report are to describe the concentration and distribution of various constituents in the ground water and to assess their potential impact. In addition, the report describes the results of technical studies conducted in 1982.

Additional information on environmental surveillance at the Hanford Site may be found in two other reports issued annually. The most recent titles are:

- *Environmental Surveillance at Hanford for CY 1982* by Sula et al. (PNL-4657) and;
- *Environmental Status of the Hanford Site for CY 1981* by Sula, Blumer, and Dirkes (PNL-4212).

SITE DESCRIPTION

The Hanford Site, which is operated by DOE, is located in southeastern Washington. The Site, shown in Figure 1, occupies 1,476 km² (570 mi²) of the semiarid Pasco Basin, which is a large structural and topographic basin. The Site receives approximately 16 cm (6.3 in.) of precipitation annually, of which about 40% occurs during the winter months. The desert plains on which the Site is situated rise gradually from an altitude of about 400 feet above mean sea level in the southeastern part of the Site to about 700 feet in the northwestern part (Newcomb, Strand, and Frank 1972). In places along the boundaries and in the center of the Site, bedrock anticlines or ridges rise above the plains. The Columbia River flows through the northern part of the Site and forms part of its eastern boundary. The Yakima Ridges, Rattlesnake Mountain, and the Yakima River form the west and south boundaries of the Site. The cities of Richland, Pasco, and Kennewick, known as the Tri-Cities, are situated on the Columbia River downstream of the Site and have a combined population of about 90,000.

SITE OPERATIONS

The Hanford Site was established in 1943 under the Manhattan Project to produce plutonium for nuclear weapons. At one time, nine production reactors were in operation at the Site, but only one of these (N Reactor) is currently operating. N Reactor is a dual purpose reactor, producing both plutonium and steam for power production. Another reactor, called the Fast Flux Test Facility (FFTF), has been built onsite and is used for research. At present, the main activities at the Site include reactor operation, fuel fabrication, waste management, and energy-related research and development.

Site operations have resulted in the production of large volumes of waste water. Some of these effluents, including process cooling water and water containing low-level radioactive wastes, have been discharged to the ground. Subsurface structures such as cribs have been used for disposal of the water containing low-level radioactive wastes, while surface ponds and ditches

FIGURE 1. The Hanford Site

have been used for the disposal of the cooling water (Graham et al. 1981). These disposal facilities are located at the various operating areas shown in Figure 1, including the 100 Areas, 200 Areas, and 300 Area. The majority of waste water has been released through disposal facilities at or near the chemical separations area (200 Areas), which is located on a plateau near the center of the Site. Smaller amounts of waste water have been released through disposal facilities at the reactor sites (100 Areas) and at the fuel fabrication area (300 Area).

The disposal of waste water to the ground has been greatly reduced at Hanford in the past several years, primarily because of the deactivation of all reactors except the N Reactor, the cessation of reactor fuel processing, and the improved treatment of several waste streams.

GEOLOGY AND HYDROLOGY OF THE SITE

Geologic and hydrologic properties of the Site's subsurface affect the movement of the waste water that has been discharged to the ground. Therefore, brief descriptions of the geology and hydrology are given in the following sections.

Geology

The main geologic units beneath the Hanford Site include, in ascending order, the Columbia River Basalt Group, the Ringold Formation, and a series of glaciofluvial sediments. A generalized geologic cross section of the Site is shown in Figure 2.

The Columbia River Basalt Group, which is the bedrock beneath the Site, is a thick series of lava flows extruded from fissures. These basalts have

FIGURE 2. Generalized Geologic Cross Section of the Hanford Site (Modified from Tallman et al. 1979)

been warped and folded, producing anticlines that, in some places, crop out at the land surface. The Ringold Formation overlies the basalts, except in some localized areas where it has been removed by erosion. This formation is broken down into four units, the basal, lower, middle and upper units, which consist mainly of bedded silts and sands deposited in a lacustrine environment. Beneath the 200 West Area, sediments of the upper Ringold Formation have been reworked by the wind and redeposited as a silt layer called the Palouse soil. The glaciofluvial sediments rest atop the Ringold Formation or, in places where the Ringold has been removed, the basalts. These sediments were deposited by the ancestral Columbia River when it was swollen by glacial meltwater. The glaciofluvial sediments are composed primarily of gravels, sands, and some silts (Newcomb, Strand and Frank 1972).

Hydrology

Both confined and unconfined aquifers are present beneath the Hanford Site. The confined aquifers, in which the ground water is under pressure greater than that of the atmosphere, are found mainly within the Columbia River Basalts. The unconfined or water-table aquifer is the uppermost aquifer, and it consists primarily of the Ringold Formation and to a lesser extent the glaciofluvial sediments (Gephart et al. 1979). Of all the aquifers beneath the Site, the unconfined aquifer has been most affected by waste water disposal at Hanford; therefore, the ground-water surveillance effort is focused on this aquifer.

The unconfined aquifer reaches a thickness of over 70 m (230 ft) in some areas and pinches out along the flanks of the basalt anticlines. The bottom of the aquifer is the top of the basalt or, in some locations, the clay zones of the lower unit of the Ringold Formation (Graham et al. 1981). On the Hanford Site, the depth to the water table ranges from less than 0.3 m (1 ft) to over 106 m (350 ft). Studies have shown that natural recharge through the thick unsaturated zone is negligible. However, some natural recharge does occur, principally along the base of the bordering anticlines where precipitation and runoff infiltrate to the water table (Gephart et al. 1979). In addition, the aquifer is artificially recharged by the waste and cooling water released onsite.

Changes in the water table configuration during the past 39 years are the result of disposal to the ground of more than 6×10^{11} liters (160 billion gallons) of process cooling water and more than 3×10^{10} liters (8 billion gallons) of other waste waters. Ground-water mounds created by the discharge of water now exist near each of the chemical processing and waste management facilities (Figure 3). These mounds interrupt the general flow pattern in the aquifer, from the recharge areas in the west to the discharge areas (primarily the Columbia River) in the east. Ground-water levels have changed continuously over the years because of variations in the volume of waste water discharged to the ground. The movement of the ground water and its associated constituents has also changed with time and reflects the amount of effluent discharged.

FIGURE 3. Water Table Elevations - December 1982

METHODS

Over 2200 wells have been constructed on the Hanford Site from pre-Hanford Works days to the present. About 850 of these wells were drilled to the ground-water table, and about 780 still contain water. The others have become dry through infiltration of sediments or a general lowering of the water table in their vicinity (McGhan and Damschen 1979). These wells provide a means for obtaining ground-water samples and for conducting onsite investigations. Locations of selected sampling wells are shown in Figure 4.

Most of the wells drilled at Hanford are multi-purpose structures. As the wells are drilled, geologic and hydrologic information is obtained. After drilling is completed, the wells become sampling structures. Most of the wells are six or eight inches in diameter and have steel casings. The wells are usually perforated or screened along the upper portion of the saturated zone of the aquifer.

SAMPLE COLLECTION

Ground-water samples are obtained routinely from wells throughout the Hanford Site, according to a master schedule that is formulated each year (Blumer, Sula, and Eddy 1981). All routine ground-water samples for 1982 referred to in this report were taken by the Environmental Evaluations Section of the Occupational and Environmental Protection Department of PNL. For the 1982 routine Ground-Water Surveillance Program, 324 wells were sampled. From these, 1467 well-water samples were taken to provide 3741 analytical results for evaluating the effects of Site operations on the ground water. (These figures do not include the monitoring efforts of other DOE contractors on the Hanford Site.) The frequency of sampling is monthly, quarterly, semi-annually, or annually, depending on the location of the well and constituents to be analyzed. The volume of each sample is determined by the number of constituents for which that particular sample will be analyzed.

Most of the ground-water samples are collected using submersible pumps. These pumps have been installed in a majority of the regularly

sampled wells. Bailers are used to sample the wells that do not have pumps. Since the submersible pumps are left in the wells, this method prevents the possibility of cross contamination that may result from using a single bailer or pump to sample several wells.

When a bailer must be used, the sample is collected by lowering a plastic bottle enclosed in a steel bailer. The sample is collected just below the surface of the water table because this is where the greatest concentration of contaminants is usually observed (Eddy, Myers, and Raymond 1978).

Most of the samples are collected from the unconfined aquifer. However, at a few locations where appropriate wells are available, samples are obtained from the confined aquifers.

SAMPLE ANALYSIS

The ground-water samples collected in 1982 were analyzed by PNL's Technical Analysis Section and Analytical and Nuclear Research Section. In addition, the U.S. Geological Survey collected and analyzed samples from specific wells.

The ground-water samples are analyzed for a variety of radioactive and nonradioactive constituents. Most of these samples are analyzed for tritium (^3H) and nitrate (NO_3) because these two constituents are readily transported in ground water with little decrease in concentration from adsorption or ion exchange. In addition, samples from selected wells are routinely analyzed at less frequent intervals for the radionuclides strontium-90, cesium-137, and cobalt-60. Gross alpha (as ^{239}Pu) emission is also determined. Selected samples are analyzed by gamma spectrometry to identify the mixture of radionuclides present. Standard radiometric and chemical methods are used to analyze the routine ground-water samples (ASTM 1979).

Other radionuclides, such as iodine-129 and technetium-99, have been detected in the ground water beneath the Hanford Site. A small number of samples are analyzed for these constituents. In addition, analyses for natural ura-

nium, fluoride (F^-), and chromium (Cr^{+6}) are made on selected ground-water samples collected from areas where these substances are present.

Organic chemicals are not presently included in the list of routine analyses performed on the samples. However, a few special samples have been collected and analyzed for organics.

DISTRIBUTION AND CONCENTRATION OF RADIONUCLIDES AND CHEMICALS IN THE GROUND WATER

Liquid effluents released to the ground have percolated downward and laterally through 50 to 100 m (150 to 300 feet) of unconsolidated sediments that overlie the saturated portion of the unconfined aquifer. As the wastes have moved through these sedimentary materials, adsorption and ion exchange have taken place between the minerals in the sediments and the substances in the waste water. Some of the longer lived radionuclides, such as strontium-90, cesium-137, and plutonium-239, have good ion-exchange characteristics and have been effectively held in the soil column as the waste water has percolated downward. Other radionuclides, such as tritium, iodine-129 and technetium-99, have poor ion-exchange characteristics. These radionuclides have moved through the soil column at varying rates until eventually entering the ground water. Subsequently, they have moved in a general down-gradient direction at a rate nearly equal to the velocity of the ground water. As the radionuclides have moved with the ground water, their concentrations have been further reduced by radioactive decay, ion exchange, diffusion, and hydrodynamic dispersion.

Through the years, the Ground-Water Surveillance Program has monitored the constituents in the ground water and the ground-water movement. A discussion of the present (1982) distribution and concentration of radionuclides and chemicals in the ground water is contained in this chapter.

EVALUATION OF GROUND-WATER SURVEILLANCE DATA

Radionuclide concentrations in the ground water beneath the Hanford Site are evaluated in terms of their respective Concentration Guides (CGs) (U.S. Department of Energy 1981). Radioactive materials are also compared with drinking water standards (DWS) promulgated by the Environmental Protection Agency (EPA 40 CFR 141) and adopted by the state of Washington. The comparison between the actual concentration and the CGs provides a conservative method for evaluating the potential significance of most

water-borne materials. The CGs used in this report are those that apply to uncontrolled areas, even though the use of the ground water is controlled. Table 1 shows the minimum detectable concentrations (MDC) and applicable CGs or drinking water standards for primary radionuclides and various chemicals analyzed under the routine Ground-Water Surveillance Program.

This chapter includes sections describing the concentration and distribution of tritium, nitrate, and gross beta in the unconfined aquifer. Each section (except for the one on gross beta) contains a map showing the distribution of the radionuclide or chemical described in that section. The isopleths on the maps show concentration zones rather than discrete contours since the data do not justify the additional detail.

Appendix A contains tabular analytical data for 1982 on the maximum, average, and minimum

TABLE 1. Minimum Detectable Concentrations and Lowest Applicable Concentration Guides or Drinking Water Standards for Various Radionuclides and Chemicals

	MDC, pCi/ml	DWS, pCi/ml	CGs, pCi/ml
Radionuclides			
Gross Beta (as ^{106}Ru)	0.08	0.05	NA(a)
Total Alpha (as ^{239}Pu)	0.017	0.015	NA
^3H	0.5	20	3,000.0
^{60}Co	0.02	NA	30.0
^{90}Sr	0.03	0.008	0.3
^{106}Ru	0.06	NA	10.0
^{125}Sb	0.06	NA	100.0
^{129}I	1×10^{-8}	NA	0.06
^{131}I	0.01	NA	0.3
^{137}Cs	0.02	NA	20.0
U (Natural)	0.03 (mg/l)	NA	20
Chemicals			
NO_3^-	0.5 (mg/l)	45(b)(mg/l)	NA
F^-	0.08 (mg/l)	1.8 (mg/l)	NA
Cr^{+6}	0.01 (mg/l)	0.05 (mg/l)	NA

(a) NA - Not Applicable.

(b) Calculated as NO_3^-

concentrations of tritium and nitrate. The average concentrations of these constituents were used to generate the isopleth maps. While published data from the 200 Areas were used to provide continuity in the maps (Wilbur and Graham 1982), these data were not included in Appendix A.

Table 2 shows the number of wells sampled, the number of samples taken, and the number of analyses made as part of the 1982 Ground-Water Surveillance Program for each area of the Hanford Site. The data shown in Appendices A (tritium and nitrate) and B (selected constituents in ground water) were derived from the analysis of these samples. The numerical data in Table 2 do not include any special samples.

TABLE 2. Numerical Data on the Routine Ground-Water Monitoring Program, 1982

Area	Number of Wells Sampled	Number of Samples Taken	Number of Analyses Made
100	48	223	97
200	22	96	264
300	28	136	822
600(a)	226	1012	2558
	324	1467	3741

(a) The 600 Area encompasses all of the Hanford Site not included in the other operating areas (100, 200, 300 Areas).

TRITIUM CONCENTRATION IN THE UNCONFINED GROUND WATER

Because tritium (^3H) enters the ground-water system as part of the water molecule, it is carried along with the ground-water flow and remains almost unaffected by the geologic conditions that affect other radionuclides. Tritium, therefore, provides a good indication of the movement of ground water at the Hanford Site. Figure 5 shows the distribution of ^3H in the unconfined aquifer. Appendix A contains the concentrations of ^3H found in samples collected in 1982.

The configuration of the largest tritium plume, which lies between the 200 Areas and the

Columbia River, has changed very little in the past year. Concentrations of tritium in Well 699-40-1, shown in Figure 6, have increased only slightly since 1981, which indicates that the area of higher concentration (300 to ~ 850 pCi/ml) within this plume has not yet reached the Columbia River. Figure 7, which is a graphic illustration of the concentration history of tritium for Well 699-35-9, shows essentially the same results.

The area of higher concentration (300 to ~ 850 pCi/ml) within the largest plume is moving toward the river, as is indicated by the concentration histories of Wells 699-31-31 and 699-41-23 (Figures 8 and 9). The area of higher concentration has now passed by Well 699-31-31, as indicated by the decline in the tritium concentration to below 300 pCi/ml. While the concentration in Well 699-41-23 continues to decline, it has not yet dropped below 300 pCi/ml.

Concentration histories of wells elsewhere within the plume reflect local hydrogeological conditions. The concentration history of tritium in Well 699-2-3 (Figure 10) is in apparent equilibrium at or near 110 pCi/ml. Ground-water flow in the vicinity of this well is such that concentrations should remain at or near this level for several years.

Figure 11 shows that the tritium concentration in Well 699-9-E2 dropped through mid-1972, had a gradual increase until 1978, and then declined to the present low level. Although Wells 699-9-E2 and 699-2-3 show different concentration trends, both are used to monitor the southern portion of the tritium plume. Well 699-9-E2 represents an area of low hydraulic conductivity, which retards the movement of ground water. Well 699-2-3 represents an area of high hydraulic conductivity, through which ground water moves at a more rapid rate. These differences in the hydrogeology help to explain the observed differences in the concentration histories of these wells.

Figure 12 shows a concentration history for Well 699-87-55. The graph, with its sinusoidal pattern, illustrates a dynamic system affected by changes in river flow, precipitation, reactor operations, and hydrogeology. This well is located about 1.8 km from N Reactor.

FIGURE 5. Tritium Distribution in Unconfined Ground Water

FIGURE 6. Concentration History for Tritium in Well 699-40-1

FIGURE 7. Concentration History for Tritium in Well 699-35-9

FIGURE 8. Concentration History for Tritium in Well 699-31-31

FIGURE 9. Concentration History for Tritium in Well 699-41-23

FIGURE 10. Concentration History for Tritium in Well 699-2-3

FIGURE 11. Concentration History for Tritium in Well 699-9-E2

FIGURE 12. Concentration History for Tritium in Well 699-87-55

NITRATE CONCENTRATION IN THE UNCONFINED GROUND WATER

Figure 13 shows the concentration and distribution of nitrate (NO_3^-) in the ground water at Hanford. Appendix A contains data on the maximum, average, and minimum concentrations. Data collected in 1982 indicate little areal change in the nitrate plume. Zones of elevated nitrate concentrations persist in the vicinity of the 200-E, 200-W, 100-F, and 100-H Areas, and in the central portion of the main ground-water contamination plume. A decrease of nitrate concentration continues in Well 699-32-43 (Figure 14), where a cyclical pattern reflects the operational history of the 200-E Area. This cyclical pattern is also seen in the concentration history of Well 699-32-22 (Figure 15). The slight decline in the nitrate concentration in this well for the last few years may indicate that the area of higher concentration (>45 ppm) within the plume is about to pass the well.

Well 199-H4-3 was drilled specifically to monitor a solar evaporation facility at the 100-H Area. The

facility consists of a concrete basin used as a concentrator for waste generated by fuel fabrication activities in the 300 Area. Wastes placed in the basin normally contain copper, sodium, nitrate, and sulphate, with small amounts of other constituents, such as chromium. The wastes do not contain radioactive materials other than trace amounts of uranium. An unknown quantity of the solute leaked from the basin through joints or fractures in the concrete and eventually reached the ground water. Corrective action was initiated in 1979, which included sealing the leak in the basin. As shown in Figure 16, there has been a general decline in the nitrate concentration in Well 199-H4-3 since the corrective work was done.

Although the data appear to be scattered, the nitrate concentration in Well 699-SO-7 (Figure 17) is generally declining with time. The lowering of the nitrate level in this well is probably due to the development of a deeper portion of the aquifer that has a lower level of nitrate (Eddy, Myers, and Raymond 1978) rather than a decrease in the nitrate plume concentration in this area.

FIGURE 13. Nitrate Ion Distribution in Unconfined Ground Water

FIGURE 14. Concentration History for Nitrate in Well 699-32-43

FIGURE 15. Concentration History for Nitrate in Well 699-32-22

FIGURE 16. Concentration History for Nitrate in Well 199-H4-3

FIGURE 17. Concentration History for Nitrate in Well 699-S0-7

The configuration of the nitrate plume has not changed significantly. However, the high level of nitrate in Well 699-40-1 (Figure 18) indicates that the nitrate in the ground water resulting from plant operations has reached the Columbia River.

GROSS BETA CONCENTRATION IN THE UNCONFINED GROUND WATER

The concentration and distribution of gross beta radioactivity in the Hanford ground water have been decreasing for several years, as shown in previous years' reports (Eddy and Wilbur 1981). The concentrations are now at insignificant levels in most of the aquifer. The few remaining areas of higher levels are located mainly at or very near the 200 West and 200 East Areas and the 100-N reactor site. Since these areas are very small, a map of the gross beta distribution in the ground water was not generated for the 1982 calendar year.

Gross beta activity in and near the 200 Areas is the result of operating and maintaining the reprocessing facilities for irradiated uranium fuels and disposing of contaminated liquids to cribs (Wilbur and Graham 1982). The gross beta activity in or near the 100-N reactor site is caused by the reactor site operations and by the liquid waste disposal to the 1301-N trench/crib (Greager 1982).

The changes in gross beta activity in the unconfined ground water with time result from the cyclical nature of the Hanford plants as they start up and shut down their operations. The gross beta concentrations reached a peak in early 1971, and since then both the concentration levels and the overall size of the plume have decreased. This trend will probably continue until the fuel reprocessing facilities are returned to operation.

FIGURE 18. Concentration History for Nitrate in Well 699-40-1

RADIOLOGICAL IMPACT

Ground-water transport of radionuclides at the Hanford Site represents a potential pathway for exposure to radiation via water obtained from wells that tap the unconfined aquifer or from the Columbia River into which the unconfined aquifer discharges. The following discussion examines these potential pathways.

GROUND WATER

During 1982, drinking water for the FFTF was obtained from the unconfined aquifer. The drinking water at FFTF contains elevated concentrations of tritium from past effluent disposal in the 200 Areas (Figure 19).

The whole body dose attributable to the tritium in drinking water at FFTF in 1982 (average ~ 18 pCi/mL) is calculated to be 0.3 mrem, based on an ingestion rate of 250 l/yr (approximately half of the average adult water consumption per year). The 50-year dose commitment from tritium is the same as the annual dose because of

the relatively short biological half life of this radionuclide (~ 12 years). This estimated whole body dose from Hanford operations is less than the amount reported last year (Eddy, Cline, and Prater 1982). The calculated dose is less than 10% of the state of Washington drinking water standards.

Additional monitoring of drinking water systems at Hanford (including three systems that use ground water) is conducted by the Hanford Environmental Health Foundation. Information on this effort can be obtained from Maas (1982).

COLUMBIA RIVER

Ground water entering the Columbia River from the Hanford Site is diluted by several orders of magnitude because of the difference between the river and ground-water flow rates. During 1982, the average Columbia River flow rate at Priest Rapids Dam was reported by the U.S. Geological Survey (1983) as 140,000 cfs ($3965 \text{ m}^3/\text{sec}$).

FIGURE 19. Concentration History for Tritium in Well 699-S0-7

The flow rate from the unconfined aquifer into the Columbia River has been estimated to be about 100 cfs (2.8 m³/sec) (Myers 1978).

Tritium concentrations measured in wells near the river in 1982 were in the range of approximately 1 to 200 pCi/ml. In 1982, the average

tritium concentrations in the Columbia River were 0.2 pCi/ml (Sula et al. 1983). As discussed in PNL-4657 (Sula et al. 1983), the contribution of tritium to the Columbia River from the aquifer during 1982 was not sufficient to be accurately measured in the presence of the background concentrations resulting from worldwide fallout.

RESULTS OF SUPPORTING STUDIES

Several studies are conducted in support of the Ground-Water Surveillance Program. These studies provide additional data to help characterize the ground-water system, refine the hydrologic and transport models, and determine the impact of Site operations on the environment. The results of four studies conducted during CY 1982 are described in this chapter.

BANK STORAGE STUDY

When a river rises, ground-water levels are temporarily raised by inflow from the river. The volume of water stored and released after the river drops is called bank storage (Todd 1980).

Evaluation of bank storage began in October

1981 to obtain information about interactions of the Columbia River and the unconfined aquifer. Since the tritium and nitrate plumes have reached the Columbia River, knowledge of the aquifer/river interactions can assist in evaluating the effects of bank storage on the quantity of radionuclides and chemicals entering the Columbia River as a function of time.

One way to study bank storage is to compare changes in the water table at various distances from the river with changes in river level. As a means of doing this, continuous water-level recorders have been installed in wells near the old Hanford Townsite as shown in Figure 20. These wells are located 200 to 5000 feet from the river.

FIGURE 20. Locations of Selected Wells Used in the Bank Storage Study

FIGURE 21. Changes in the Water Level in Well 699-48-7 Compared with Changes in the River Stage at Priest Rapids Dam

Figure 21 shows a one-week record of water levels in Well 699-48-7 compared to a record of the gage height of the Columbia River just below Priest Rapids Dam (approximately 35 miles upstream from the Hanford Townsite). Water level changes in the well follow the same pattern as the gage height changes in the river, although they are of a smaller magnitude. There is also a

FIGURE 22. A Comparison of Changes in the Water Levels in Wells 699-43-3, 699-45-4, and 699-48-7

lag between peak levels in the well and the river due to the travel time of the surge of water downstream and the time needed for river water to infiltrate the bank.

Figure 22 shows a comparison of the changes in water level in three wells. Well 699-48-7 is nearest to the river, and it shows the largest fluctua-

tions in water level. Well 699-43-3 is farthest from the river and shows the smallest changes. In addition, the lag time between peak level of the river and peak level in the well increases as the distance from the well to the river increases.

The bank storage effect is also indicated by seasonal fluctuations of the tritium concentrations in wells near the river. These concentrations decline as the river rises in the spring months and river water enters the bank; this trend is reversed when the river falls later in the year (Figure 23). Therefore, the analytical results of grab samples collected from wells near the river can vary greatly, depending on the time of year in which the samples are collected.

The Bank Storage Study will continue through FY 1983 with the study of water level changes, as well as a study of daily fluctuations in tritium concentrations in various wells.

CLAY DEPOSIT INVESTIGATION

An extensive, near-surface clay deposit that apparently acts as a partial barrier to groundwater flow has been discovered in the area southeast of the Hanford Townsite. This clay deposit was first encountered in 1980 when several new sampling wells were being installed near the river. A description of the clay deposit and an account of the special work conducted to define its areal extent are contained in the following paragraphs.

In 1979, several new sampling wells were constructed southeast of the townsite along a line running roughly parallel to the river (Figure 24). The following year, plans were made to construct a second line of wells closer to the river. The clay deposit was discovered when this second line of wells was drilled.

FIGURE 23. Changes in Tritium Concentrations in Well 699-47-6 Compared with Changes in the Flow Rate of the Columbia River

FIGURE 24. Locations of Selected Sampling Wells Drilled in 1979

In the first (i.e., northernmost) well to be drilled in the second line, a layer of brown, gray, and blue clay was encountered at a depth of about 9 meters (30 feet). This clay deposit extended down to a depth of about 21 meters (70 feet) where the drilling was stopped because no significant amount of water had been encountered. The depth to the unconfined ground water in this area is known to be about 7.5 to 10.5 meters (25-35 feet), so the clay deposit encountered in this well evidently prevents ground water from entering the well.

After pulling the casing for the first well, the driller filled in the hole and then moved further south to begin drilling another well. The same

materials were encountered in this well at about the same depths. This well was also filled in and abandoned since no water was found.

The driller subsequently moved inland and started a third well (699-44-4). Although brown clay was encountered in this well at a depth of about 12 meters (40 feet), there was a water-producing zone above the clay. The well was developed and added to the sampling network.

No additional drilling was done in this area until 1982 (two years later). At that time, the drilling effort was directed toward delineating the southern boundary of the clay deposit. For this purpose, three drilling sites further south from

the abandoned wells were selected. At the first two of these three sites, the clay deposit was encountered during drilling and the wells were found to be dry. As before, these wells were filled in and abandoned. However, in the third (i.e., southernmost) well, the clay layer was not encountered. Unconfined ground water was found at a depth of 8 meters (26 feet). This well (699-39-E3) was thoroughly developed and prepared for use as a sampling well. Figure 25 shows the locations of the wells drilled in 1980 and 1982.

The approximate extent of the clay deposit, as determined by this drilling effort, is also shown in Figure 25. For the purposes of this map, the clay deposit is assumed to be continuous between drilling sites where it was encountered, although this is not necessarily a valid assumption.

Other research has revealed that the clay deposit acts as a partial barrier to the ground-water flow between the river and the unconfined aquifer. In particular, data collected under the Bank

Storage Study indicate that water levels in wells to the west (i.e., on the inland side) of the clay deposit do not fluctuate much in response to river flow rate changes (Figure 26). In contrast, the water levels in wells that are approximately the same distance from the river, but are either north or south of the clay deposit, show marked fluctuations in response to river flow rate changes (Figure 27). The stability of the water level in the wells west of the clay deposit indicates that this deposit partially inhibits the intrusion of river water as bank storage. Additional evidence for this effect is provided by the analysis of ground-water samples from the wells in this area. In particular, tritium concentrations in wells west of the clay deposit do not show the seasonal fluctuations exhibited by wells to the north of the clay deposit (Figure 28). These seasonal fluctuations in tritium concentrations have been correlated with the bank storage of river water. As the river flow rate increases in the spring months and river water enters the bank, the tritium concentrations in the wells decline; this

FIGURE 25. Locations of Selected Sampling Wells, Abandoned Wells, and the Clay Deposit

FIGURE 26. Changes in the Water Level in Well 699-39-1 Compared with Changes in the Flow Rate of the Columbia River

trend is reversed when the river flow rate falls later in the year. The absence of this effect in wells west of the clay deposit is additional evidence that the deposit acts as a partial barrier to ground-water flow into the river.

GEOPHYSICAL LOG INTERPRETATION

Since 1958, the Ground-Water Surveillance Program has measured properties of the Hanford Site's subsurface through geophysical logging of the wells that have been drilled onsite. Geophysical logging basically consists of lowering sensory devices in a borehole and recording physical parameters that can be used to characterize the rocks, their contained fluids and the construction techniques used in the well (Keys and MacCary 1971). To date, nearly 800 wells have been logged (Blair, Law, and Lindberg, 1981). These logs constitute an important source of information on the subsurface environment at Hanford; however, until recently, no attempt had been made to consolidate the logging data and put them into a more useable form. In 1980, the Geophysical Log Interpretation task was established to meet these objectives. Under this task, a computerized data base system has been

FIGURE 27. Changes in the Water Level in Well 699-45-4 Compared with Changes in the Flow Rate of the Columbia River

developed for storing and retrieving the logging data (Petrie, Gibson, and Blair, 1983). In addition, a preliminary analysis of the logging data has been conducted. This analysis and its results are discussed in the following paragraphs.

The main objective of this preliminary statistical analysis was to study the variations between logs made on the same well on different days. This type of analysis can provide information on the relative accuracy of the data and can lead to identification of errors in data collection. In addition, it may indicate whether changes in the ground-water system with time can be detected using well log data.

The logs from Well 399-5-2 were the main source of information for this study because this well is used for calibration of the logging sondes and is therefore logged relatively often. Four log types were studied: temperature, natural gamma, neutron, and density.

FIGURE 28. Changes in Tritium Concentrations in Wells 699-47-6 and 699-41-1 Compared with Changes in the Flow Rate of the Columbia River

Of the four log types studied, the analysis indicated that natural gamma is the most accurate measurement because the statistical variation in the gamma logs with time is smallest. This point is illustrated in Figure 29, which shows six natural gamma logs of Well 399-5-2 made at different times. The six curves are almost identical in shape. Although there is some displacement of the curves, it is statistically small. In contrast, the displacement and variation of the eight temperature logs shown in Figure 30 are statistically much greater. One possible explanation for the observed variation is simple human or instrument error; however, this explanation is not likely because the temperature gradient (i.e., the slope of the curve) is about the same for each log. Additional work is needed to determine the source of this unexpected complexity in the data. One conclusion drawn from this preliminary analysis is that an economical way to improve the quality of the data would be to achieve better equipment calibration.

UPDATE OF INPUT DATA FOR THE VARIABLE THICKNESS TRANSIENT MODEL

The Variable Thickness Transient (VTT) model is used to predict the rate of ground-water flow in the unconfined aquifer at the Hanford Site. Two types of data used as input parameters for this digital model are aquifer transmissivities and aquifer bottom elevations. An update of the files containing these data was conducted during 1982. The results of this update, together with some background information on the data files, are discussed below.

Aquifer Transmissivities

Transmissivity is defined as the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is a property of both the aquifer and the contained fluid, and its value for a portion of an aquifer can be determined by a variety of techniques, including aquifer testing (Todd 1980).

FIGURE 29. Six Natural Gamma Logs of Well 399-5-2

Aquifer transmissivities are needed as input for the Hanford VTT ground-water model. The model represents the transmissivity distribution in the unconfined aquifer with a matrix of values; each element of the matrix represents the transmissivity of the aquifer at a particular location on the Site. This matrix is updated periodically, taking into consideration the new transmissivity data derived from recent aquifer tests. When a discrepancy exists between a new transmissivity value derived from a recent test and the old value contained in the matrix, the test data and other pertinent information are examined to determine whether the value in the matrix should be changed. If the test results appear to be valid and are substantiated by other information, then the old value contained in the matrix is replaced by the new value.

FIGURE 30. Eight Temperature Logs of Well 399-5-2

The most recent update of the Hanford transmissivity matrix was conducted in 1982. Aquifer tests performed between 1973 and 1981 were included in the update. A total of 27 tests (of about eight hours duration or longer) were conducted on 25 wells during this period. Locations of these wells are shown in Figure 31. Using standard methods, transmissivity values were calculated from the test data. Values could not be calculated for two of the tests because of insufficient data. The values calculated for the remaining 25 tests were compared with the old values contained in the matrix. For 17 of the tests, the new and old values for transmissivity showed reasonable agreement.

For the other eight tests, the new and old values differed significantly. These eight tests were re-examined individually, relying on both the test

FIGURE 31. Locations of Wells Tested from 1973 to 1981

data and other pertinent information such as special geological conditions or unusual circumstances connected with the test. Upon re-examination, only one of the eight tests (on Well 699-S3-25) provided sufficient evidence to warrant changing the transmissivity value in the matrix. The net effect of the change was a lowering of the transmissivities in the area near this well. The original and revised transmissivity contours are shown in Figure 32.

Aquifer Bottom Elevations

The aquifer bottom elevations constitute important input data for the VTT model because the saturated thickness of the aquifer at a given location is determined by subtracting the aquifer bottom elevation from the water table elevation. The saturated thickness is then used in the calculation of hydraulic conductivity, which is a key parameter for hydrologic models.

Periodically, the file containing aquifer bottom elevations is updated, taking into consideration geological data obtained during the drilling of new wells. To update the file, driller's logs from new wells are examined for evidence of a relatively impermeable layer that can be interpreted as the aquifer bottom. The elevations obtained by this examination are then compared with the

values in the data files. The well log is reexamined when the elevation estimated from a well log differs significantly (i.e., >50 ft) from the elevation in the file. When the elevation estimated from the log is judged to be more correct than the elevation in the file, the logs of other nearby wells are examined for supporting evidence. If sufficient supporting evidence is found, the value in the file is changed.

In 180, an update of this file was conducted, focusing primarily on wells drilled near the Hanford Townsite. Over 100 geological logs were examined. This examination resulted in significant alterations of the aquifer bottom elevations, including the discovery of a previously unknown outcrop of basalt above the water table. The original and revised aquifer bottom contours are shown in Figure 33.

In 1982, a second update was conducted. Geological logs of nearly 150 wells drilled on the Site from 1973 to 1981 were examined. In several of these logs, there was an impermeable layer that could be the aquifer bottom at an elevation much different from that in the file. However, these were mainly isolated wells that lacked supporting evidence. Therefore, no changes were made to the file as a result of this update.

FIGURE 32. Transmissivity Contours Before and After the 1982 Update

FIGURE 33. Aquifer Bottom Contours Before and After the 1980 Update

QUALITY CONTROL

The quality control effort of the Ground-Water Surveillance Program at PNL was initiated in 1974 and includes all phases of the program. Much effort is expended to ensure that samples are representative of the unconfined aquifer system beneath the Site. This includes: 1) well maintenance, 2) visual and geophysical inspection of wells, and 3) installation of sampling pumps. Blind and duplicate samples are analyzed at the PNL Technical Analysis Section to assure the quality of the analytical work. The U.S. Geological Survey, which also collects and analyzes ground water under a subcontract with PNL, has maintained a good quality assurance program. The quality control effort for the Ground-Water Surveillance Program shows that the data

received are within the expected analytical limits of accuracy.

In addition to providing quality assurance, the U.S. Geological Survey provides data on the chemistry of Hanford ground water. These data, including wet chemical and spectrographic analysis, represent background information used in assessing the effects of plant operations. The results of the analyses made in 1982 are shown in Appendix C.

At the laboratory level the documentation of instrument calibrations and all procedures is required. Documentation of field instrument calibration has also been implemented.

REFERENCES

- American Society for Testing and Materials (ASTM). 1979. **1979 Annual Book of ASTM Standards, Part 31: Water**. American Society for Testing and Materials, Philadelphia, Pennsylvania.
- Blair, S. C., L. S. Law, and J. W. Lindberg. 1981. **A Catalog of Borehole Geophysics on the Hanford Site, 1958 to 1980**. PNL-3504, Pacific Northwest Laboratory, Richland, Washington.
- Blumer, P. J., M. J. Sula, and P. A. Eddy. 1981. **Master Schedule for CY 1982 Hanford Environmental Surveillance Routine Program**. PNL-4120, Pacific Northwest Laboratory, Richland, Washington.
- Eddy, P. A., C. S. Cline, and L. S. Prater. 1982. **Radiological Status of the Ground Water Beneath the Hanford Site, January-December 1981**. PNL-4237, Pacific Northwest Laboratory, Richland, Washington.
- Eddy, P. A., D. A. Myers, and J. R. Raymond. 1978. **Vertical Contamination in the Unconfined Ground Water at the Hanford Site, Washington**. PNL-2724, Pacific Northwest Laboratory, Richland, Washington.
- Eddy, P. A., and J. S. Wilbur. 1981. **Radiological Status of the Ground Water Beneath the Hanford Site, January-December 1980**. PNL-3768, Pacific Northwest Laboratory, Richland, Washington.
- Gephart, R. E., et al. 1979. **Hydrologic Studies Within the Columbia Plateau, Washington: An Integration of Current Knowledge**. RHO-BWI-ST-5, National Technical Information Service, Springfield, Virginia.
- Graham, M. J., et al. 1981. **Hydrology of the Separations Area**. RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.
- Greager, E. M. 1982. **UNC Environmental Surveillance Report for the 100 Areas - FY 1982**. UNI-2226, UNC Nuclear Industries, Richland, Washington.
- Keys, W. S., and L. M. MacCary. 1971. **Application of Borehole Geophysics to Water-Resources Investigations**. Book 2, Chapter E1 of *Techniques of Water Resources Investigations of the United States Geological Survey*. U.S. Government Printing Office, Washington, D.C.
- Maas, L. J. 1982. **Hanford Sanitary Water Quality Surveillance, CY 1982**. HEHF 39, Hanford Environmental Health Foundation, Richland, Washington.
- McGhan, V. L., and D. W. Damschen. 1979. **Hanford Wells**. PNL-2894, Pacific Northwest Laboratory, Richland, Washington.
- Myers, D. A. 1978. **Environmental Monitoring Report on the Status of Ground Water Beneath the Hanford Site**. PNL-2624, Pacific Northwest Laboratory, Richland, Washington.
- Newcomb, R. C., J. R. Strand, and F. J. Frank. 1972. **Geology and Ground-Water Characteristics of the Hanford Reservation of the U.S. Atomic Energy Commission, Washington**. Geological Survey Professional Paper 717, U.S. Government Printing Office, Washington, D.C.
- Petrie, G. M., D. Gibson, and S. C. Blair. 1983. **User's Manual for Geophysical Well Logging Software Programs**. PNL-4562, Pacific Northwest Laboratory, Richland, Washington.
- Sula, M. J., P. J. Blumer, and R. L. Dirkes. 1982. **Environmental Status of the Hanford Site for CY 1981**. PNL-4212, Pacific Northwest Laboratory, Richland, Washington.
- Sula, M. J., et al. 1983. **Environmental Surveillance at Hanford for CY 1982**. PNL-4657, Pacific Northwest Laboratory, Richland, Washington.
- Tallman, A. M., et al. 1979. **Geology of the Separation Areas, Hanford Site, South-Central Washington**. RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.
- Todd, D. K. 1980. **Groundwater Hydrology**. 2nd ed. John Wiley and Sons, New York, New York.
- U.S. Department of Energy. 1981. "Requirements for Radiation Protection." In *DOE Order 5480.1, Chapter XI*. U.S. Department of Energy, Washington DC.
- U.S. Geological Survey. 1983. **Water Resources Data for Washington, Water Year 1982**. U.S. Geological Survey Water Data Report WA-82-2, Tacoma, Washington.
- Wilbur, J. S. 1983. **Water Table Measurements: Data Maps - December 1982**. Rockwell Hanford Operations, Richland, Washington.
- Wilbur, J. S., and M. J. Graham. 1982. **Results of the Separations Area Ground-Water Monitoring Network for 1981**. RHO-HS-SR-5 P, Rockwell Hanford Operations, Richland, Washington.

APPENDIX A

TRITIUM AND NITRATE CONCENTRATIONS IN THE GROUND WATER (UNCONFINED AQUIFER)

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
1	03	1	MAX AVE MIN	1.55E+00*
1	03	2P	MAX AVE MIN	<7.40E-01* 6.20E-01*
1	03	2G	MAX AVE MIN	<5.45E-01* <5.00E-01*
1	04	1	MAX AVE MIN	8.50E+00 9.00E+00 3.40E+00 7.13E+00 1.50E+00 4.80E+00
1	04	2	MAX AVE MIN	2.10E+00 7.80E+00 1.70E+00 6.20E+00 1.20E+00 5.10E+00
1	04	3	MAX AVE MIN	6.80E+00 9.30E+00 3.10E+00 6.63E+00 1.30E+00 5.10E+00
1	04	4	MAX AVE MIN	1.70E+00* 4.40E+00*
1	05	1	MAX AVE MIN	2.60E+00 5.70E+00 1.66E+00 4.48E+00 8.40E-01 3.90E+00
1	09	1	MAX AVE MIN	8.45E-01* 6.05E+00*
1	02	5	MAX AVE MIN	5.00E+00* 8.00E+01*
1	05	12	MAX AVE MIN	3.33E+00* 1.69E+01*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
1	DB	3	MAX AVE MIN	4.93E+00*	9.83E+00*
1	F5	1	MAX AVE MIN	<4.13E-01*	2.70E+00*
1	F5	3	MAX AVE MIN	<4.45E-01*	7.70E+00*
1	F5	4	MAX AVE MIN	2.60E+01*	1.58E+01*
1	F5	6	MAX AVE MIN	<6.10E-01*	8.87E-01*
1	F7	1	MAX AVE MIN	8.10E-01*	6.63E+01*
1	F8	1	MAX AVE MIN	1.47E+01*	8.93E+01*
1	F8	2	MAX AVE MIN	9.60E+00*	5.77E+01*
1	H3	1	MAX AVE MIN	5.17E+00*	3.12E+01*
1	H4	3	MAX AVE MIN	2.40E+00 1.90E+00 1.40E+00	1.80E+03 1.22E+03 7.20E+02
1	K	11	MAX AVE MIN	3.00E+00*	8.83E+00*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
1	K	19	MAX AVE MIN	2.14E+01*	1.57E+01*
1	K	20	MAX AVE MIN	1.11E+00*	3.80E+00*
1	K	22	MAX AVE MIN	1.01E+00*	1.77E+00*
1	K	27	MAX AVE MIN	4.53E+00*	1.93E+00*
1	K	28	MAX AVE MIN	3.43E+00*	1.14E+01*
1	N	29	MAX AVE MIN	8.50E+00*	<5.00E-01*
1	K	30	MAX AVE MIN	8.80E+02*	1.80E+01*
1	N	2	MAX AVE MIN	3.25E+01*	1.70E+01*
1	N	3	MAX AVE MIN	2.43E+01*	
1	N	4	MAX AVE MIN	2.10E+01*	1.53E+01*
1	N	5	MAX AVE MIN	2.40E+01*	1.33E+01*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
1	N	6	MAX AVE MIN	2.53E+01*
1	N	7	MAX AVE MIN	2.20E+01* 2.57E+00*
1	N	14	MAX AVE MIN	2.47E+01* 1.73E+01*
1	N	15	MAX AVE MIN	2.23E+01* 1.53E+01*
1	N	16	MAX AVE MIN	4.63E-01* 4.03E+00*
1	N	17	MAX AVE MIN	1.93E+01* <5.00E-01*
1	N	18	MAX AVE MIN	1.70E+01* <5.00E-01*
1	N	19	MAX AVE MIN	1.77E+01* 1.15E+01*
1	N	20	MAX AVE MIN	1.12E+01* 1.67E+01*
1	N	21	MAX AVE MIN	1.26E+01* 6.47E+00*
1	N	22	MAX AVE MIN	1.25E+00* 7.30E+00*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
1	N	23	MAX AVE MIN	1.12E+00*	4.37E+00*
1	N	24	MAX AVE MIN	2.92E+00*	6.77E+00*
1	N	25	MAX AVE MIN	<5.20E-01*	1.40E+01*
1	N	26	MAX AVE MIN	<4.20E-01*	1.40E+01*
2E	19	1	MAX AVE MIN	<4.20E-01 <3.40E-01 <3.00E-01	8.50E-01 6.78E-01 5.90E-01
2E	23	1	MAX AVE MIN	9.70E+00 8.93E+00 8.40E+00	1.40E+01 1.23E+01 1.10E+01
2E	24	7	MAX AVE MIN	1.40E+00 8.80E-01 5.60E-01	1.50E+01 1.08E+01 6.00E+00
2E	26	1	MAX AVE MIN	<7.40E-01 <5.33E-01 <3.00E-01	<5.00E-01 <5.00E-01 <5.00E-01
2E	26	3	MAX AVE MIN	1.60E+01 1.24E+01 9.60E+00	5.20E+00 4.03E+00 3.20E+00
2E	27	1	MAX AVE MIN	1.50E+01 8.40E+00 6.10E-01	8.50E+00 6.33E+00 5.00E+00
2E	28	1	MAX AVE MIN	1.40E+01 1.02E+01 4.80E+00	3.70E+01 1.67E+01 <5.00E-01

***3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
2E	28	5	MAX AVE MIN	<3.20E-01* 1.24E+01*
2E	33	14	MAX AVE MIN	<7.20E-01 <4.15E-01 <3.00E-01
2W	6	1	MAX AVE MIN	3.70E+01 3.68E+01 3.60E+01
2W	10	5	MAX AVE MIN	2.10E+01 1.95E+01 1.80E+01
2W	11	9	MAX AVE MIN	1.80E+00 1.44E+00 9.40E-01
2W	12	1	MAX AVE MIN	1.50E+00 1.05E+00 <6.80E-01
2W	18	3	MAX AVE MIN	<3.40E+01 <9.01E+00 <5.30E-01
2W	19	4	MAX AVE MIN	<5.80E-01* 7.15E+00*
2W	21	1	MAX AVE MIN	1.10E+03 9.80E+02 8.30E+02
2W	22	7	MAX AVE MIN	9.10E+02 7.88E+02 7.10E+02
2W	22	9	MAX AVE MIN	1.10E+04 1.03E+04 1.00E+04

***3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/NL -----	NITRATE MG/L -----
3	1	1	MAX	1.30E+01
			AVE	9.28E+00
			MIN	5.50E+00
3	1	2	MAX	1.80E+01
			AVE	1.40E+01
			MIN	1.00E+01
3	1	3	MAX	1.40E+01
			AVE	1.30E+01
			MIN	1.10E+01
3	1	4	MAX	1.90E+01
			AVE	1.22E+01
			MIN	5.20E+00
3	1	5	MAX	2.00E+01
			AVE	<5.30E-01*
			MIN	7.50E+00
3	1	6	MAX	1.40E+01
			AVE	1.03E+01
			MIN	6.50E+00
3	2	1	MAX	1.60E+01
			AVE	8.77E+00
			MIN	9.70E-01
3	2	2	MAX	2.10E+01
			AVE	1.37E+01
			MIN	7.60E+00
3	2	3	MAX	3.10E+01
			AVE	1.78E+01
			MIN	1.20E+01
3	3	1	MAX	1.50E+01
			AVE	1.02E+01
			MIN	5.10E+00
3	3	2	MAX	7.80E+00
			AVE	4.85E+00
			MIN	<5.00E-01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
3	3	3	MAX	7.70E+00
			AVE	5.95E+00
			MIN	4.70E+00
3	3	6	MAX	1.40E+01
			AVE	9.01E+00
			MIN	5.30E+00
3	3	7	MAX	1.40E+01
			AVE	8.86E+00
			MIN	5.70E+00
3	3	9	MAX	2.60E+01
			AVE	1.46E+01
			MIN	7.60E+00
3	3	10	MAX	1.10E+01
			AVE	6.48E+00
			MIN	9.10E-01
3	3	11	MAX	1.10E+01
			AVE	8.88E+00
			MIN	7.40E+00
3	3	12	MAX	1.90E+01
			AVE	1.29E+01
			MIN	1.00E+01
3	4	1	MAX	1.00E+01
			AVE	8.04E+00
			MIN	5.50E+00
3	4	7	MAX	1.80E+01
			AVE	1.25E+01
			MIN	9.70E+00
3	4	9	MAX	1.60E+01
			AVE	1.35E+01
			MIN	1.10E+01
3	4	10	MAX	1.80E+01
			AVE	1.30E+01
			MIN	8.80E+00

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
3	5	1	MAX	2.00E+01
			AVE	1.72E+01
			MIN	1.50E+01
3	6	1	MAX	1.50E+01
			AVE	1.26E+01
			MIN	8.90E+00
3	8	1	MAX	8.00E+00
			AVE	6.46E+00
			MIN	5.30E+00
3	8	2	MAX	9.40E+00
			AVE	7.80E+00
			MIN	5.20E+00
3	8	3	MAX	7.80E+00
			AVE	6.64E+00
			MIN	5.50E+00
3	8	4	MAX	9.80E+00
			AVE	8.28E+00
			MIN	7.50E+00
6 S31	1P	MAX	<4.27E-01*	1.18E+00*
		AVE		
		MIN		
6 S30E15A		MAX	1.90E+01	
		AVE	1.53E+01	
		MIN	1.10E+01	
6 S29 E12		MAX	1.50E+01	
		AVE	1.18E+01	
		MIN	8.20E+00	
6 S27 E14		MAX	1.90E+01	
		AVE	1.50E+01	
		MIN	6.80E+00	
6 S24	19	MAX	<5.00E-01*	
		AVE		
		MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.		TRITIUM PCI/ML -----	NITRATE MG/L -----
6 S19 E13	MAX		1.90E+01
	AVE		1.13E+01
	MIN		7.80E+00
6 S19 11	MAX		
	AVE		9.10E+00*
	MIN		
6 S15 51	MAX		
	AVE		<5.00E-01*
	MIN		
6 S14 20	MAX		
	AVE		1.20E+00*
	MIN		
6 S12 3	MAX	<6.60E-01	5.90E+00
	AVE	<4.74E-01	5.38E+00
	MIN	<3.70E-01	4.70E+00
6 S12 29	MAX		1.00E+01
	AVE		9.05E+00
	MIN		7.70E+00
6 S11E12A	MAX	6.50E-01	1.40E+01
	AVE	5.10E-01	7.32E+00
	MIN	<3.00E-01	<5.00E-01
6 S11E12AF	MAX	<5.50E-01	1.60E+01
	AVE	<4.45E-01	7.75E+00
	MIN	<3.00E-01	<5.00E-01
6 S5 19	MAX	<5.30E-01	3.10E+00
	AVE	<4.17E-01	2.75E+00
	MIN	<3.70E-01	2.30E+00
6 S7 34	MAX	9.40E-01	6.70E-01
	AVE	5.65E-01	5.43E-01
	MIN	<3.00E-01	<5.00E-01
6 S6E14A	MAX	2.80E+00	1.70E+00
	AVE	1.25E+00	8.80E-01
	MIN	<3.00E-01	<5.00E-01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML	NITRATE MG/L
			-----	-----
6	S6 E4B	MAX	2.40E+01	1.40E+01
		AVE	2.22E+01	1.03E+01
		MIN	2.00E+01	6.90E+00
6	S6 E4D	MAX	3.20E+01	1.60E+01
		AVE	3.06E+01	1.42E+01
		MIN	2.90E+01	1.20E+01
6	S3 E12	MAX	1.40E+00	1.40E+01
		AVE	1.01E+00	1.16E+01
		MIN	<6.70E-01	8.00E+00
6	S3 25	MAX	5.30E-01	<5.00E-01
		AVE	4.15E-01	<5.00E-01
		MIN	<3.70E-01	<5.00E-01
6	S1 7B	MAX	8.00E+01	6.70E+00
		AVE	5.90E+01	1.76E+00
		MIN	3.60E+01	<5.00E-01
6	S0 8	MAX	5.00E+01	4.80E+00
		AVE	2.82E+01	2.20E+00
		MIN	2.00E+01	1.20E+00
6	S0 7	MAX	5.20E+01	2.10E+01
		AVE	2.96E+01	6.12E+00
		MIN	2.00E+01	<5.00E-01
6	1 18	MAX	9.20E+01	2.00E+01
		AVE	8.85E+01	1.78E+01
		MIN	8.30E+01	1.60E+01
6	2 3	MAX	1.20E+02	2.60E+01
		AVE	1.19E+02	2.41E+01
		MIN	1.10E+02	2.10E+01
6	2 33A	MAX	<4.80E-01	1.40E+00
		AVE	<4.18E-01	8.45E-01
		MIN	<3.70E-01	<5.00E-01
6	3 45	MAX		
		AVE	<4.25E-01*	6.23E+00*
		MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----	
6	4	E6	MAX	<4.20E-01	7.00E+00
			AVE	<3.70E-01	6.20E+00
			MIN	<3.00E-01	5.20E+00
6	8	17	MAX	1.70E+02	2.70E+01
			AVE	1.65E+02	2.45E+01
			MIN	1.60E+02	1.90E+01
6	8	25	MAX	7.00E+01	1.70E+01
			AVE	6.60E+01	1.58E+01
			MIN	6.40E+01	1.50E+01
6	8	32	MAX		
			AVE	<4.53E-01*	3.27E+00*
			MIN		
6	9	E2	MAX	<6.40E-01	<5.00E-01
			AVE	<5.20E-01	<5.00E-01
			MIN	<3.70E-01	<5.00E-01
6	10	E12	MAX	3.40E+01	1.70E+01
			AVE	1.04E+01	1.54E+01
			MIN	1.20E+00	1.40E+01
6	13	10	MAX	<6.50E-01	<5.00E-01
			AVE	<4.78E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	13	64	MAX	<7.00E-01	1.10E+00
			AVE	<5.25E-01	7.00E-01
			MIN	<3.00E-01	<5.00E-01
6	14	E6P	MAX		
			AVE	<4.00E-01*	<5.00E-01*
			MIN		
6	14	E0T	MAX		
			AVE	2.47E+01*	9.23E+00*
			MIN		
6	14	38	MAX	<5.00E-01	1.80E+00
			AVE	<3.93E-01	1.68E+00
			MIN	<3.00E-01	1.50E+00

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.		TRITIUM PCI/ML -----	NITRATE MG/L -----
6 14 47	MAX	<3.90E-01	6.80E-01
	AVE	<3.60E-01	5.55E-01
	MIN	<3.00E-01	<5.00E-01
6 15 15b	MAX	<5.40E-01	
	AVE	<4.03E-01	1.80E+01*
	MIN	<3.00E-01	
6 15 26	MAX	1.80E+02	2.20E+01
	AVE	1.68E+02	2.10E+01
	MIN	1.60E+02	2.00E+01
6 17 5	MAX	1.60E+00	5.50E+01
	AVE	6.84E-01	4.58E+01
	MIN	<3.70E-01	2.30E+01
6 17 47	MAX	4.50E-01	
	AVE	3.82E-01	1.87E+01*
	MIN	<3.00E-01	
6 17 70	MAX	<9.80E-01	3.20E+01
	AVE	<5.45E-01	2.95E+01
	MIN	<3.00E-01	2.70E+01
6 19 43	MAX	<4.30E-01	1.10E+01
	AVE	<3.73E-01	1.05E+01
	MIN	<3.00E-01	1.00E+01
6 19 58	MAX		<5.00E-01
	AVE		<5.00E-01
	MIN		<5.00E-01
6 19 88	MAX		
	AVE		7.47E-01*
	MIN		
6 20 ESA	MAX	3.00E+01	1.30E+01
	AVE	2.70E+01	1.22E+01
	MIN	2.30E+01	1.10E+01
6 20 ESP	MAX		
	AVE	<3.90E-01*	<5.00E-01*
	MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.		TRITIUM PCI/ML	NITRATE MG/L
		-----	-----
6 20 E50	MAX	<4.00E-01	9.80E-01
	AVE	<3.85E-01	6.20E-01
	MIN	<3.70E-01	<5.00E-01
6 20 E5H	MAX	<7.40E-01	5.30E-01
	AVE	<4.36E-01	5.07E-01
	MIN	<3.00E-01	<5.00E-01
6 20 E12	MAX		
	AVE	<3.67E-01*	1.15E+01*
	MIN		
6 20 E12P	MAX	<4.40E-01	<5.00E-01
	AVE	<3.75E-01	<5.00E-01
	MIN	<3.00E-01	<5.00E-01
6 20 20	MAX		
	AVE	4.43E+02*	4.07E+01*
	MIN		
6 20 39	MAX	2.70E+00	<5.00E-01
	AVE	9.70E-01	<5.00E-01
	MIN	<3.00E-01	<5.00E-01
6 20 82	MAX	<8.00E-01	1.50E+01
	AVE	<5.85E-01	1.43E+01
	MIN	<3.00E-01	1.30E+01
6 22 70	MAX	<7.60E-01	8.20E+00
	AVE	<4.50E-01	7.45E+00
	MIN	<3.00E-01	5.80E+00
6 23 7	MAX	5.00E+01	4.10E+01
	AVE	4.68E+01	3.85E+01
	MIN	4.50E+01	3.00E+01
6 24 1P	MAX	<4.80E-01	<5.00E-01
	AVE	<4.05E-01	<5.00E-01
	MIN	<3.70E-01	<5.00E-01
6 24 1W	MAX	<7.10E-01	5.60E-01
	AVE	<4.30E-01	5.12E-01
	MIN	<3.00E-01	<5.00E-01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML	NITRATE MG/L	
			-----	-----	
6	24	1W	MAX	<4.20E-01	<5.00E-01
			AVE	<3.72E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	24	1S	MAX	<5.10E-01	7.30E-01
			AVE	<3.90E-01	5.78E-01
			MIN	<3.00E-01	<5.00E-01
6	24	1T	MAX	5.80E+00	5.90E-01
			AVE	5.50E+00	5.10E-01
			MIN	5.20E+00	<5.00E-01
6	24	33	MAX	6.10E+01	1.60E+01
			AVE	5.53E+01	1.53E+01
			MIN	5.20E+01	1.40E+01
6	24	46	MAX	<7.10E-01	<5.00E-01
			AVE	<4.45E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	25	55	MAX	<7.00E-01	1.10E+01
			AVE	<4.64E-01	1.02E+01
			MIN	<3.00E-01	8.10E+00
6	25	70	MAX		
			AVE	1.30E+00*	1.20E+01*
			MIN		
6	26	15	MAX	6.00E+02	4.00E+01
			AVE	5.85E+02	3.78E+01
			MIN	5.50E+02	3.30E+01
6	26	89	MAX		
			AVE		1.90E+00*
			MIN		
6	27	4	MAX	8.80E+01	2.70E+01
			AVE	6.19E+01	2.18E+01
			MIN	3.30E+01	1.60E+01
6	27	8	MAX	7.10E+02	4.80E+01
			AVE	6.96E+02	4.60E+01
			MIN	6.80E+02	4.20E+01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML	NITRATE MG/L	
			-----	-----	
6	28	40	MAX	1.80E+01	1.00E+01
			AVE	1.36E+01	8.40E+00
			MIN	9.30E+00	7.20E+00
6	28	40P	MAX	6.80E-01	<5.00E-01
			AVE	4.28E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	28	52	MAX	<6.70E-01	<5.00E-01
			AVE	<4.92E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	29	78	MAX	7.40E-01	3.80E+00
			AVE	5.38E-01	3.40E+00
			MIN	<3.00E-01	3.00E+00
6	31	31	MAX	3.20E+02	2.60E+01
			AVE	2.98E+02	2.35E+01
			MIN	2.70E+02	2.20E+01
6	31	31P	MAX	2.60E+02	1.30E+00
			AVE	5.24E+01	6.94E-01
			MIN	<3.00E-01	<5.00E-01
6	31	53B	MAX		
			AVE	<3.00E-01*	3.70E+00*
			MIN		
6	32	22	MAX	8.80E+02	5.10E+01
			AVE	8.38E+02	4.00E+01
			MIN	7.90E+02	1.40E+01
6	32	42	MAX		
			AVE	2.45E+02*	<5.00E-01*
			MIN		
6	32	43	MAX	3.00E+01	1.40E+01
			AVE	2.65E+01	1.30E+01
			MIN	2.30E+01	1.20E+01
6	32	62	MAX		
			AVE	<5.20E-01*	2.50E+01*
			MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
6	32	70	MAX AVE MIN	2.63E+02*	1.23E+01*
6	32	77	MAX AVE MIN	1.04E+00*	4.33E+00*
6	33	42	MAX AVE MIN	1.20E+02 1.02E+02 8.90E+01	2.00E+01 1.60E+01 1.30E+01
6	33	56	MAX AVE MIN	<3.80E-01*	7.03E+00*
6	34	39A	MAX AVE MIN	1.90E+02 1.78E+02 1.60E+02	1.90E+01 1.78E+01 1.60E+01
6	34	41	MAX AVE MIN	1.70E+02 1.65E+02 1.50E+02	2.10E+01 1.95E+01 1.70E+01
6	34	42	MAX AVE MIN	1.57E+02*	2.59E+01*
6	34	51	MAX AVE MIN	<6.70E-01 <4.92E-01 <3.00E-01	7.00E+00 5.76E+00 4.50E+00
6	34	88	MAX AVE MIN	<6.50E-01 <5.18E-01 <3.00E-01	1.50E+01 1.28E+01 1.10E+01
6	35	9	MAX AVE MIN	1.40E+02 1.28E+02 1.20E+02	2.30E+01 1.96E+01 1.60E+01
6	35	66	MAX AVE MIN	1.03E+03*	2.10E+01*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
6	35	70	MAX AVE MIN	3.60E+03* 2.77E+01*
6	36	46P	MAX AVE MIN	4.70E-01* <5.00E-01*
6	36	460	MAX AVE MIN	<6.70E-01 <5.30E-01 <4.00E-01
6	36	61A	MAX AVE MIN	1.50E+01*
6	36	61B	MAX AVE MIN	<4.57E-01* <5.00E-01*
6	36	93	MAX AVE MIN	<4.15E-01* 3.61E+00*
6	37	43	MAX AVE MIN	6.50E+01 6.33E+01 6.20E+01
6	37	82A	MAX AVE MIN	<6.40E-01 <4.20E-01 <3.00E-01
6	38	65	MAX AVE MIN	1.60E+02* 1.01E+02*
6	38	70	MAX AVE MIN	3.87E+00* 2.50E+02*
6	39	1	MAX AVE MIN	2.50E+02 2.30E+02 2.20E+02

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
6	39	39	MAX AVE MIN	<4.95E-01* <5.00E-01*
6	39	79	MAX AVE MIN	6.90E+00 9.80E-01 2.13E+00 8.03E-01 <3.00E-01 <5.00E-01
6	40	1	MAX AVE MIN	2.30E+02 3.20E+01 2.28E+02 3.03E+01 2.20E+02 2.90E+01
6	40	33A	MAX AVE MIN	<5.25E-01* <5.00E-01*
6	40	62	MAX AVE MIN	1.43E+01* 2.00E+01*
6	41	1	MAX AVE MIN	2.30E+02 3.20E+01 2.22E+02 2.96E+01 2.00E+02 2.80E+01
6	41	23	MAX AVE MIN	5.30E+02 3.20E+01 5.16E+02 2.92E+01 4.80E+02 2.70E+01
6	42	2	MAX AVE MIN	2.20E+02 3.00E+01 1.98E+02 2.81E+01 1.90E+02 2.70E+01
6	42	12A	MAX AVE MIN	3.40E+02 3.30E+01 3.25E+02 3.18E+01 3.20E+02 3.10E+01
6	43	3	MAX AVE MIN	2.30E+02 2.90E+01 1.85E+02 2.43E+01 1.20E+02 1.60E+01
6	43	88	MAX AVE MIN	<9.20E-01 2.30E+00 <5.84E-01 1.36E+00 <3.00E-01 6.20E-01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML	NITRATE MG/L	
			-----	-----	
6	44	4	MAX	1.90E+02	2.70E+01
			AVE	1.46E+02	2.18E+01
			MIN	1.10E+02	1.70E+01
6	44	64	MAX		
			AVE	<4.65E-01*	2.10E+01*
			MIN		
6	45	4	MAX	1.10E+02	1.80E+01
			AVE	9.20E+01	9.17E+00
			MIN	8.10E+01	<5.00E-01
6	45	42	MAX	1.10E+02	3.80E+00
			AVE	1.03E+02	3.30E+00
			MIN	9.20E+01	2.20E+00
6	45	69	MAX		
			AVE	5.27E-01*	2.10E+01*
			MIN		
6	46	4	MAX		
			AVE	7.60E+01*	9.30E-01*
			MIN		
6	46	5	MAX	2.30E+02	2.80E+01
			AVE	1.75E+02	2.05E+01
			MIN	1.30E+02	1.60E+01
6	46	21	MAX	3.50E+01	1.30E+01
			AVE	3.34E+01	1.08E+01
			MIN	3.20E+01	7.10E+00
6	47	6	MAX	1.90E+02	2.20E+01
			AVE	1.08E+02	1.32E+01
			MIN	7.60E+00	1.40E+00
6	47	35A	MAX	<6.00E-01	5.00E+00
			AVE	<4.18E-01	2.53E+00
			MIN	<3.00E-01	<5.00E-01
6	47	46	MAX		
			AVE	<4.73E-01*	8.57E+00*
			MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
6	47	60	MAX AVE MIN	<3.83E-01* 1.43E+01*
6	48	7	MAX AVE MIN	3.10E+00* 4.20E+00*
6	48	18	MAX AVE MIN	<5.60E-01 <3.98E-01 <3.00E-01
6	48	71	MAX AVE MIN	<4.37E-01* 2.00E+01*
6	49	13	MAX AVE MIN	8.70E-01 6.43E-01 <3.00E-01
6	49	28	MAX AVE MIN	<6.10E-01 <4.38E-01 <3.00E-01
6	49	55	MAX AVE MIN	<6.93E-01* 2.13E+00*
6	49	57	MAX AVE MIN	3.43E+01* 2.03E+02*
6	49	79	MAX AVE MIN	<4.03E-01* 3.60E+01*
6	50	288	MAX AVE MIN	<7.30E-01 <5.50E-01 <3.00E-01
6	50	30	MAX AVE MIN	<4.70E-01 <3.78E-01 <3.00E-01

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML	NITRATE MG/L
				-----	-----
6	50	42	MAX	2.10E+00	5.20E-01
			AVE	1.73E+00	5.05E-01
			MIN	1.20E+00	<5.00E-01
6	50	53	MAX		
			AVE	<5.97E-01*	8.70E+00*
			MIN		
6	50	85	MAX		
			AVE	<4.63E-01*	1.80E+01*
			MIN		
6	51	63	MAX		
			AVE	<4.53E-01*	5.33E+00*
			MIN		
6	51	75	MAX		
			AVE	<4.27E-01*	9.67E-01*
			MIN		
6	53	35	MAX	<4.60E-01	<5.00E-01
			AVE	<3.95E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	53	103	MAX	<6.40E-01	<5.00E-01
			AVE	<4.87E-01	<5.00E-01
			MIN	<3.80E-01	<5.00E-01
6	54	18	MAX		
			AVE		2.75E+00*
			MIN		
6	54	34	MAX	<6.00E-01	8.20E-01
			AVE	<4.24E-01	6.35E-01
			MIN	<3.00E-01	<5.00E-01
6	54	37A	MAX	<5.50E-01	<5.00E-01
			AVE	<4.43E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	54	42	MAX		
			AVE	<4.25E-01*	1.12E+00*
			MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
6	54	45	MAX	<7.20E-01	3.80E+00
			AVE	<4.70E-01	2.10E+00
			MIN	<3.00E-01	<5.00E-01
6	54	57	MAX		
			AVE	<5.33E-01*	6.10E-01*
			MIN		
6	55	21	MAX		
			AVE	<7.90E-01*	3.80E+00*
			MIN		
6	55	40	MAX	<8.20E-01	<5.00E-01
			AVE	<4.65E-01	<5.00E-01
			MIN	<3.00E-01	<5.00E-01
6	55	44	MAX	<8.10E-01	<5.00E-01
			AVE	<4.90E-01	<5.00E-01
			MIN	<3.70E-01	<5.00E-01
6	55	50A	MAX	<8.00E-01	<5.00E-01
			AVE	<5.53E-01	<5.00E-01
			MIN	<3.70E-01	<5.00E-01
6	55	50C	MAX		
			AVE	<5.27E-01*	<5.00E-01*
			MIN		
6	55	50D	MAX	<6.00E-01	6.20E-01
			AVE	<4.78E-01	5.50E-01
			MIN	<3.90E-01	<5.00E-01
6	55	70	MAX		
			AVE	<4.10E-01*	<5.00E-01*
			MIN		
6	55	76	MAX		
			AVE		<5.00E-01*
			MIN		
6	55	89	MAX		
			AVE		1.60E+00*
			MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----	
6	56	43	MAX	<7.60E-01	5.20E-01
			AVE	<4.53E-01	5.05E-01
			MIN	<3.00E-01	<5.00E-01
6	57	25A	MAX		
			AVE	<5.87E-01*	1.60E+00*
			MIN		
6	57	29	MAX		
			AVE	6.53E-01*	9.77E-01*
			MIN		
6	57	83	MAX		2.00E+00
			AVE		1.37E+00
			MIN		9.60E-01
6	58	24	MAX		
			AVE	<5.00E-01*	1.93E+00*
			MIN		
6	59	32	MAX		
			AVE	1.22E+00*	1.16E+00*
			MIN		
6	59	58	MAX		
			AVE	1.87E+00*	6.87E-01*
			MIN		
6	59	808	MAX		
			AVE		<5.00E-01*
			MIN		
6	60	32	MAX		
			AVE	1.37E+00*	2.33E+00*
			MIN		
6	60	57	MAX		
			AVE	9.60E-01*	<5.00E-01*
			MIN		
6	60	60	MAX		
			AVE	1.37E+00*	9.60E-01*
			MIN		

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
6	61	37	MAX AVE MIN	1.40E+00*
6	61	41	MAX AVE MIN	<4.47E-01* 8.53E-01*
6	61	62	MAX AVE MIN	7.50E+00 8.10E+00* 3.61E+00 5.50E-01
6	62	31	MAX AVE MIN	3.27E+00*
6	62	43F	MAX AVE MIN	1.32E+00* 8.57E-01*
6	63	25A	MAX AVE MIN	<4.83E-01* 9.00E+00*
6	63	51	MAX AVE MIN	<4.15E-01* <5.00E-01*
6	63	55	MAX AVE MIN	7.80E-01* 5.27E-01*
6	63	58	MAX AVE MIN	7.70E-01* 1.13E+00*
6	63	90	MAX AVE MIN	<7.30E-01 <4.90E-01 <3.30E-01 3.00E+00 2.60E+00 2.30E+00
6	64	27	MAX AVE MIN	4.45E-01* 2.37E+01*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----	
6	64	62	MAX AVE MIN	3.73E+00* 3.17E+00*	
6	65	23	MAX AVE MIN	<4.85E-01* 1.80E+00*	
6	65	50	MAX AVE MIN	1.25E+00* 6.77E-01*	
6	65	59	MAX AVE MIN	1.10E+00* <5.00E-01*	
6	65	72	MAX AVE MIN	2.50E+00 2.18E+00 1.60E+00	4.90E+00 4.05E+00 2.90E+00
6	65	83	MAX AVE MIN	2.00E+00 1.33E+00 9.20E-01	1.90E+00 1.73E+00 1.50E+00
6	65	38	MAX AVE MIN		<5.00E-01*
6	66	39	MAX AVE MIN		<5.00E-01*
6	66	58	MAX AVE MIN	1.06E+00*	9.10E-01*
6	66	64	MAX AVE MIN	2.10E+00*	1.77E+00*
6	66	103	MAX AVE MIN	4.45E-01*	<5.00E-01*

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
6	67	51	MAX AVE MIN	1.53E+00*	6.83E-01*
6	67	86	MAX AVE MIN	1.50E+00 1.22E+00 8.80E-01	2.30E+00 1.47E+00 8.70E-01
6	67	98	MAX AVE MIN	<5.40E-01 <4.20E-01 <3.30E-01	2.40E+00 2.03E+00 1.80E+00
6	68	105	MAX AVE MIN	<5.25E-01*	1.04E+00*
6	69	36	MAX AVE MIN	5.33E-01*	9.67E-01*
6	70	68	MAX AVE MIN	1.50E+00*	6.75E-01*
6	71	30	MAX AVE MIN	<4.15E-01*	1.45E+01*
6	71	52	MAX AVE MIN	1.57E+00*	3.10E+00*
6	71	77	MAX AVE MIN	1.75E+00*	1.75E+00*
6	72	73	MAX AVE MIN	1.40E+00*	1.03E+00*
6	72	88	MAX AVE MIN	5.50E+00 4.53E+00 3.80E+00	3.50E+00 2.75E+00 1.90E+00

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.				TRITIUM PCI/ML -----	NITRATE MG/L -----
6	72	92	MAX AVE MIN	3.85E+00*	2.70E+00*
6	72	98	MAX AVE MIN	<7.30E-01*	<5.00E-01*
6	73	61	MAX AVE MIN	<4.80E-01*	4.13E+00*
6	74	44	MAX AVE MIN	4.67E-01*	1.53E+00*
6	77	36	MAX AVE MIN	<5.47E-01*	9.23E+01*
6	77	54	MAX AVE MIN		4.80E+00*
6	78	62	MAX AVE MIN		2.45E+00*
6	80	43P	MAX AVE MIN		<5.00E-01*
6	80	43S	MAX AVE MIN		<5.00E-01*
6	81	58	MAX AVE MIN	<4.13E-01*	1.02E+00*
6	83	47	MAX AVE MIN	<6.80E-01*	

*--3 VALUES OR LESS, NO MAX OR MIN CALCULATED

WELL NO.			TRITIUM PCI/ML -----	NITRATE MG/L -----
6	84	35A0	MAX AVE MIN <5.05E-01*	7.85E+00*
6	87	55	MAX AVE MIN 1.67E+02*	1.00E+01*
6	89	35	MAX AVE MIN	5.13E+00*
6	90	45	MAX AVE MIN 1.10E+01*	1.32E+00*
6	96	49	MAX AVE MIN 2.23E+01*	5.50E+00*
6	97	43	MAX AVE MIN 1.07E+01*	6.83E+00*
6	97	51A	MAX AVE MIN 1.53E+01*	7.33E+00*
6	101	48B	MAX AVE MIN 4.60E-01*	<5.00E-01*
30	45	16	MAX AVE MIN <3.70E-01*	1.70E+01*

APPENDIX B

**GROSS ALPHA, STRONTIUM-90, CESIUM-137,
COBALT-60, URANIUM, RUTHENIUM-106, CHROMIUM,
AND FLUORIDE CONCENTRATIONS IN THE GROUND WATER
(UNCONFINED AQUIFER)**

(CY 1982)

PAGE 1

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	CORALY, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
1 83 1 12-MAY-82		4.95E-02						
1 84 1 12-MAY-82		2.34E-02						
1 84 4 12-MAY-82		5.14E-02						
1 85 1 12-MAY-82		<1.80E-03						
1 89 1 12-MAY-82		<2.70E-03						
1 84 3 05-JAN-82 26-FEB-82 20-MAY-82 05-AUG-82 27-OCT-82					5.50E-02 <6.70E-03 1.20E-01 1.20E-02 7.90E-02		2.70E+00 4.30E+00 2.90E+00 2.80E-01 3.50E-01	1.80E-01 1.70E-01 4.00E-02 4.10E-01 1.80E-01
1 84 2 04-MAY-82 14-MAY-82 11-AUG-82 03-NOV-82		2.20E+00 2.80E+00		5.10E-02 1.20E-01 7.10E-03 7.20E-02				
1 84 3 04-MAY-82 14-MAY-82 03-NOV-82		3.80E-01 3.60E-01		3.80E-02 5.00E-02 5.30E-02				

(CY 1982)

PAGE 2

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
1 N 4 04-MAR-82 14-MAY-82 03-NOV-82								
				2.70E-02				
			<4.60E-03	3.40E-02				
			3.20E-03	3.80E-02				
1 N 5 04-MAR-82 14-MAY-82 03-NOV-82								
				4.20E-02				
			1.70E-02	4.30E-02				
			3.90E-01	5.30E-02				
1 N 6 04-MAR-82 14-MAY-82 03-NOV-82								
				4.50E-02				
			3.00E-02	5.10E-02				
			3.30E-02	8.40E-02				
1 N 7 04-MAR-82 14-MAY-82 03-NOV-82								
				2.20E-02				
			3.20E-02	2.00E-02				
			4.10E-03	3.70E-02				
1 N 14 04-MAR-82 14-MAY-82 03-NOV-82								
				5.10E-02				
			1.60E-01	9.60E-02				
			1.60E-01	8.80E-02				
1 N 15 04-MAR-82 14-MAY-82 03-NOV-82								
				2.80E-02				
			3.50E-03	3.50E-02				
			7.70E-03	4.20E-02				
1 N 16 14-MAY-82 03-NOV-82								
				4.90E-03				
			<1.20E-03					
1 N 17 14-MAY-82 03-NOV-82								
				8.00E-03				
			1.20E-02	1.20E-02				

B.2

(CY 1982)

PAGE 4

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
24 10 5 26-JUL-82				1.30E-02				
24 19 4 11-OCT-82				6.30E-03				
24 21 1 27-JUL-82				2.30E-02				
24 22 9 11-OCT-82				7.80E-03				
24 22 10 29-JAN-82 26-APR-82 27-JUL-82 11-OCT-82	<1.70E-02 <1.70E-02 <1.70E-02 <1.70E-02	3.00E-03 4.80E-03 7.30E-03 3.30E-03						
3 1 1 13-JAN-82 06-APR-82 14-JUN-82 20-SEP-82 29-NOV-82					1.40E-02 1.80E-02 2.80E-02 2.10E-02 <6.70E-03		6.10E-03 9.00E-03 4.30E-03 9.50E-03 8.60E-03	4.20E-01 3.60E-01 3.00E-01 4.00E-01 4.60E-01
3 1 2 07-JAN-82 06-APR-82 15-JUN-82 16-SEP-82 24-NOV-82					<6.70E-03 4.40E-02 2.20E-02 2.40E-02 <6.70E-03		4.20E-03 1.30E-02 1.10E-02 3.20E-03	3.20E-01 <1.00E-01 3.20E-01 3.40E-01 3.90E-01
3 1 3 07-JAN-82 06-APR-82 14-JUN-82 20-SEP-82					2.00E-02 6.70E-02 3.90E-02 2.70E-02		4.30E-03 1.20E-02 1.20E-02 3.90E-03	3.40E-01 2.00E-01 2.80E-01 3.20E-01

B.4

(CY 1982)

PAGE 3

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	CORAL, T, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
1 N 18 14-MAY-82 03-NOV-82		2.90E-02 2.40E-02		1.00E-02				
1 N 19 14-MAY-82 03-NOV-82		6.00E-02 4.40E-02		2.00E-02				
1 N 20 14-MAY-82 03-NOV-82		3.70E-02 4.40E-02		1.10E-02 1.70E-02				
1 N 21 14-MAY-82 03-NOV-82		3.20E-03 5.00E-03		6.40E-03				
1 N 22 14-MAY-82		2.10E-02						
1 N 23 14-MAY-82 03-NOV-82		4.80E-03 <1.50E-03		5.20E-03				
1 N 24 14-MAY-82 03-NOV-82		1.20E-02 1.40E-02		1.70E-02				
1 N 25 14-MAY-82		5.00E-03						
1 N 26 14-MAY-82		7.60E-03						
2N 6 1 28-JAN-82				1.90E-02				

(CY 1982)

PAGE 5

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
3 1 3 29-NOV-82					2.10E-02		7.40E-03	3.50E-01
3 1 4 07-JAN-82 29-MAR-82 15-JUN-82 16-SEP-82 24-NOV-82					1.50E-02 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		3.50E-03 1.50E-02 2.30E-02 5.00E-03 4.30E-03	3.30E-01 3.90E-01 3.20E-01 3.60E-01 3.50E-01
3 1 5 13-JAN-82 05-FEB-82 06-APR-82 23-APR-82 14-JUN-82 16-JUL-82 09-AUG-82 20-SEP-82 19-OCT-82 29-NOV-82					2.00E-02 2.10E-02 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-02 <6.70E-03 <6.70E-03		3.60E-03 <3.00E-03 9.00E-03 8.50E-03 1.20E-02 3.00E-03 3.40E-03 3.70E-03 7.90E-03 6.10E-03	3.50E-01 3.90E-01 2.50E-01 3.00E-01 3.20E-01 4.60E-01 3.90E-01 2.50E-01 3.00E-01 4.00E-01
3 1 6 07-JAN-82 29-MAR-82 14-JUN-82 16-SEP-82 29-NOV-82				8.80E-03	1.00E-02 <6.70E-03 1.70E-02 <6.70E-03 <6.70E-03		<3.00E-03 4.80E-03 1.40E-02 6.70E-03 5.40E-03	2.90E-01 3.30E-01 2.50E-01 3.60E-01 3.50E-01
3 2 1 13-JAN-82 06-APR-82 14-JUN-82 20-SEP-82 29-NOV-82					<6.70E-03 <6.70E-03 1.40E-02 <6.70E-03 <6.70E-03		<3.00E-03 5.50E-03 5.80E-03 9.80E-03 3.60E-03	4.20E-01 3.20E-01 4.20E-01 2.50E-01 4.40E-01
3 2 2 13-JAN-82 06-APR-82				1.90E-02	1.60E-02 1.40E-02		<3.00E-03 4.20E-03	4.10E-01 2.40E-01

B.5

(CY 1982)

PAGE 6

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
3 2 2 14-JUN-82 20-SEP-82 29-NOV-82					2.60E-02 2.60E-02 1.70E-02		1.00E-02 4.30E-03 4.10E-03	4.70E-01 3.60E-01 2.10E-01
3 2 3 13-JAN-82 06-APR-82 14-JUL-82 20-SEP-82 29-NOV-82					<6.70E-03 1.00E-02 6.70E-03 6.70E-02 6.70E-03		<3.00E-03 3.30E-03 1.20E-02 3.40E-03 3.70E-03	2.90E-01 1.50E-01 3.00E-01 2.60E-01 3.00E-01
3 3 1 13-JAN-82 06-APR-82 14-JUN-82 20-SEP-82 29-NOV-82				7.90E-03	<6.70E-03 6.70E-03 6.70E-03 1.00E-02 6.70E-03		<3.00E-03 5.60E-03 5.00E-03 4.30E-03 4.30E-03	3.60E-01 3.00E-01 3.30E-01 2.60E-01 4.00E-01
3 3 2 13-JAN-82 05-FEB-82 23-APR-82 19-OCT-82				1.10E-02	1.50E-02 1.60E-02 1.40E-02 6.70E-03		7.60E-03 4.30E-03 1.10E-02 4.70E-03	2.60E-01 2.50E-01 1.90E-01 2.50E-01
3 3 3 13-JAN-82 05-FEB-82 23-APR-82 19-OCT-82					<6.70E-03 6.70E-03 6.70E-03 6.70E-03		<3.00E-03 4.30E-03 6.60E-03 9.80E-03	2.60E-01 2.40E-01 2.20E-01 2.30E-01
3 3 6 13-JAN-82 05-FEB-82 10-MAR-82 06-APR-82 23-APR-82 26-MAY-82 14-JUN-82				2.40E-02	<6.70E-03 6.70E-03 1.30E-02 6.70E-03 6.70E-03 1.40E-02 1.70E-02		6.00E-03 6.10E-03 7.40E-03 1.50E-02 9.00E-03 1.10E-02 1.20E-02	2.70E-01 3.20E-01 3.10E-01 2.70E-01 2.90E-01 3.10E-01 2.70E-01

B.6

(CY 1982)

PAGE 7

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	PLUTONIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
3 3 6								
15-JUL-82					1.00E-02		4.40E-03	3.30E-01
09-AUG-82							8.10E-03	3.00E-01
20-SEP-82				7.20E-03	1.10E-02		3.40E-03	5.00E-01
19-OCT-82					1.10E-02		1.10E-02	2.80E-01
24-NOV-82					1.10E-02		5.80E-03	3.40E-01
3 3 7								
13-JAN-82					1.00E-02		<3.00E-03	2.40E-01
05-FEB-82					<6.70E-03		4.50E-03	3.60E-01
19-MAR-82					<6.70E-03		3.70E-03	2.60E-01
06-APR-82					1.40E-02		8.20E-03	2.00E-01
23-APR-82					<6.70E-03		6.70E-03	1.60E-01
28-MAY-82					1.10E-02		1.00E-02	3.10E-01
14-JUN-82					1.70E-02		2.00E-02	3.80E-01
16-JUL-82					1.30E-02		7.40E-03	4.10E-01
09-AUG-82							4.10E-03	3.50E-01
20-SEP-82					1.40E-02		3.70E-03	3.10E-01
19-OCT-82					1.10E-02		5.30E-03	3.20E-01
24-NOV-82					1.60E-02		4.50E-03	3.00E-01
3 3 9								
07-JAN-82		<2.00E-03			1.80E-02		<3.00E-03	5.30E-01
05-FEB-82		2.00E-02			<6.70E-03		<3.00E-03	4.30E-01
23-APR-82		3.90E-03			1.00E-02		8.50E-03	5.30E-01
19-OCT-82		<3.00E-03			2.00E-02		<3.00E-03	2.90E-01
3 3 10								
07-JAN-82		1.10E-02			1.60E-02		<3.00E-03	4.00E-01
05-FEB-82		7.50E-03			1.60E-02		<3.00E-03	5.40E-01
23-APR-82		<2.60E-03			<6.70E-03		4.20E-03	4.30E-01
19-OCT-82		1.40E-02			2.60E-02		<3.00E-03	3.60E-01
3 3 11								
13-JAN-82		1.50E-02			3.20E-02		<3.00E-03	2.00E-01
05-FEB-82		1.20E-02			2.90E-02		<3.00E-03	3.60E-01
23-APR-82		9.90E-03		1.30E-02	1.50E-02		4.50E-03	3.60E-01
19-OCT-82		8.20E-03		7.90E-03	2.40E-02		3.30E-03	3.00E-01

(CY 1992)

PAGE 8

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
3 3 12								
07-JAN-82		1.50E-02			3.60E-02		4.30E-03	3.80E-01
05-FEB-82		<2.00E-03			2.60E-02		5.40E-03	3.40E-01
10-MAR-82		2.90E-03			3.40E-02		6.10E-03	3.90E-01
06-APR-82		<2.00E-03			2.50E-02		7.80E-03	3.00E-01
23-APR-82		<2.50E-03			1.40E-02		1.00E-02	3.50E-01
25-MAY-82		2.30E-03			1.50E-02		1.00E-02	3.20E-01
15-JUN-82		6.30E-02			1.60E-02		1.10E-02	2.60E-01
16-JUL-82					1.30E-02		6.70E-03	4.00E-01
20-SEP-82		<2.50E-03			4.90E-02		1.00E-02	3.10E-01
19-OCT-82		4.20E-03			4.40E-02		3.30E-03	2.50E-01
24-NOV-82		<1.90E-03			3.60E-02		5.40E-03	3.50E-01
3 4 1								
07-JAN-82					1.80E-02		7.60E-03	3.20E-01
19-MAR-82					1.80E-02		7.40E-03	3.50E-01
14-JUN-82					1.40E-02		1.30E-02	2.70E-01
20-SEP-82					1.50E-02		9.10E-03	2.40E-01
29-NOV-82					<6.70E-03		9.40E-03	3.10E-01
3 4 7								
07-JAN-82					3.70E-02		4.30E-03	4.60E-01
06-APR-82					2.30E-02		6.80E-03	3.40E-01
14-JUN-82					2.20E-02		8.10E-03	3.60E-01
20-SEP-82					1.90E-02		1.10E-02	3.60E-01
24-NOV-82					2.90E-02		9.10E-03	3.50E-01
3 4 9								
07-JAN-82		<3.00E-03			1.90E-02		<3.00E-03	3.80E-01
05-FEB-82		1.30E-02			2.40E-02		3.30E-03	3.70E-01
23-APR-82		6.70E-03			1.70E-02		5.30E-03	2.90E-01
19-OCT-82		<3.80E-03		6.40E-03	2.70E-02		7.10E-03	2.80E-01
3 4 10								
07-JAN-82					2.10E-02		<3.00E-03	3.80E-01
06-APR-82					1.60E-02		5.60E-03	3.30E-01
14-JUN-82					1.70E-02		7.10E-03	2.80E-01
20-SEP-82					1.40E-02		7.90E-03	2.70E-01
29-NOV-82					<6.70E-03		<3.00E-03	3.20E-01

B.8

(CY 1982)

PAGE 9

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
3 5 1 07-JAN-82 08-APR-82 15-JUN-82 20-SEP-82 24-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		3.50E-03 1.00E-02 8.00E-03 5.30E-03 43.00E-03	2.60E-01 1.90E-01 2.20E-01 1.70E-01 2.50E-01
3 6 1 13-JAN-82 19-MAR-82 15-JUN-82 16-SEP-82 24-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		4.50E-03 1.00E-02 1.20E-02 7.60E-03 6.10E-03	2.50E-01 3.10E-01 2.30E-01 2.30E-01 1.90E-01
3 8 1 07-JAN-82 19-MAR-82 15-JUN-82 16-SEP-82 24-NOV-82				1.00E-02	<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		43.00E-03 6.20E-03 5.80E-03 5.30E-03 43.00E-03	2.70E-01 3.10E-01 2.10E-01 2.30E-01 2.30E-01
3 8 2 07-JAN-82 19-MAR-82 15-JUN-82 16-SEP-82 24-NOV-82				9.30E-03	<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		3.20E-03 8.10E-03 1.50E-02 5.60E-03 43.00E-03	2.80E-01 3.00E-01 2.40E-01 2.40E-01 2.70E-01
3 8 3 07-JAN-82 19-MAR-82 15-JUN-82 16-SEP-82 24-NOV-82				1.10E-02	<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		43.00E-03 6.20E-03 1.10E-02 6.90E-03 43.00E-03	3.20E-01 3.10E-01 2.80E-01 2.80E-01 3.00E-01
3 8 4 07-JAN-82 05-FEB-82 23-APR-82					<6.70E-03 <6.70E-03 <6.70E-03		43.00E-03 3.20E-03 5.60E-03	2.90E-01 3.20E-01 2.30E-01

(CY 1982)

PAGE 10

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
3 8 4 16-JUL-82 19-OCT-82				7.40E-03	<6.70E-03 <6.70E-03		<3.00E-03 5.40E-03	2.20E-01 2.40E-01
b S30E15A 19-MAR-82 16-JUN-82 16-SEP-82 23-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		6.20E-03 5.60E-03 3.90E-03 3.40E-03	2.00E-01 1.30E-01 1.20E-01 1.30E-01
b S29 E12 19-MAR-82 16-JUN-82 16-SEP-82 23-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		5.60E-03	2.40E-01 1.90E-01 2.00E-01 2.50E-01
b S27 E14 05-FEB-82 19-MAR-82 23-APR-82 28-MAY-82 14-JUN-82 09-AUG-82 20-SEP-82 19-OCT-82 24-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 1.40E-02 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03		<3.00E-03 7.90E-03 8.20E-03 7.10E-03 8.80E-03 6.10E-03 <3.00E-03 <3.00E-03 5.20E-03	1.70E-01 2.20E-01 1.00E-01 1.70E-01 1.80E-01 2.00E-01 1.30E-01 2.20E-01 2.00E-01
b S19 E13 04-JAN-82 19-MAR-82 11-JUN-82 02-SEP-82 23-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03			3.00E-01 2.80E-01 2.30E-01 2.10E-01 2.50E-01
b S18 51 17-FEB-82 25-MAY-82 17-AUG-82								7.90E+00 6.60E+00 7.30E+00

B.10

(CY 1982)

PAGE 11

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
6 S6 E4B 05-JAN-82 26-MAR-82 17-JUN-82 07-SEP-82 30-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03			
6 S6 E4D 05-JAN-82 26-MAR-82 17-JUN-82 07-SEP-82 30-NOV-82					<6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03 <6.70E-03			
6 S1 7b 30-NOV-82			1.70E-02	1.50E-02				
6 S0 7 30-NOV-82			1.70E-02	1.40E-02				
6 13 1C 02-DEC-82				9.20E-03				
6 19 8B 06-JUL-82								2.90E-01
6 20 20 31-AUG-82 13-DEC-82				7.30E-03 6.20E-03				
6 26 15 06-DEC-82				1.20E-02				
6 27 8 04-JAN-82 19-MAR-82				1.80E-02 1.60E-02				

B.11

(CY 1982)

PAGE 12

WELL NO. DATE	TOTAL ALPHA, PCI/ML	STRONTIUM, PCI/ML	CESIUM, PCI/ML	COBALT, PCI/ML	URANIUM, MG/L	RUTHENIUM, PCI/ML	CHROMIUM, MG/L	FLUORIDE, MG/L
-----	-----	-----	-----	-----	-----	-----	-----	-----
6 27 8 02-SEP-82 07-DEC-82				1.40E-02 1.40E-02				
6 31 31 03-DEC-82				1.00E-03				
6 31 53B 25-MAY-82	<1.70E-02							
6 32 22 08-JUN-82 07-SEP-82 03-DEC-82				1.20E-02 1.20E-02 2.20E-02				
6 32 62 21-JAN-82	<1.70E-02							
6 32 70 30-SEP-82				1.80E-02				
6 33 42 03-DEC-82				2.00E-02				
6 33 56 17-MAR-82 31-AUG-82 09-DEC-82	<1.70E-02 <1.70E-02 <1.70E-02							
6 34 39A 03-DEC-82				1.10E-03				
6 36 46U 11-MAY-82				1.70E-02				

B.12

(CY 1982)

PAGE 13

WELL NO. DATE	TOTAL ALPHA, PCI/ML -----	STRONTIUM, PCI/ML -----	CESIUM, PCI/ML -----	COBALT, PCI/ML -----	URANIUM, MG/L -----	RUTHENIUM, PCI/ML -----	CHROMIUM, MG/L -----	FLUORIDE, MG/L -----
6 38 05 01-DEC-82				7.40E-03				
6 39 1 22-FEB-82 16-MAR-82 30-AUG-82 27-SEP-82 25-OCT-82				1.20E-02 1.40E-02 1.10E-02 1.00E-02 1.10E-02				
6 39 79 29-JAN-82 11-OCT-82				1.90E-02 1.60E-02				
6 42 12A 30-AUG-82 07-DEC-82				8.90E-03 8.60E-03				
6 45 42 27-JAN-82				2.30E-02				
6 45 69 01-DEC-82				7.00E-03				
6 49 55 25-JAN-82				1.40E-02				
6 49 57 25-JAN-82 15-APR-82 29-SEP-82				1.30E-01 1.70E-01 1.50E-01				
6 50 53 15-APR-82 29-SEP-82				1.30E-02 1.30E-02				

B.13

(CY 1982)

PAGE 14

WELL NO. DATE	TOTAL ALPHA, PCI/ML -----	STRONTIUM, PCI/ML -----	CESIUM, PCI/ML -----	COBALT, PCI/ML -----	URANIUM, MG/L -----	RUTHENIUM, PCI/ML -----	CHROMIUM, MG/L -----	FLUORIDE, MG/L -----
6 53 35 15-APR-82				1.10E-02				
6 07 86 12-MAY-82		0.00F-01						

APPENDIX C

**CHEMICAL AND SPECTROGRAPHIC ANALYSES
FROM VARIOUS WELL SAMPLES**

TABLE C.1 Chemical and Spectrographic Analyses from Various Wells Sampled

Constituents	Units	399-8-4	699-S3-E12	699-S3-25	699-S12-3	699-S30-E15A	699-1-18
Alk Tot Lab	mg/l	120	98	140	130	200	120
Aluminum	µg/l	<50	<50	50	<50	<50	70
Antimony	µg/l	<30	<30	30	<30	<30	30
Arsenic	µg/l	8	7	6	6	3	6
Barium	µg/l	50	30	70	30	50	50
Beryllium	µg/l	<1	<1	<1	<1	<1	<1
Bismuth	µg/l	<1000	<1000	<1000	<1000	<1000	<1000
Boron	µg/l	10	10	70	7	10	10
Bromide	mg/l	0.00	0.00	0.00	0.10	0.00	<0.01
Cadmium	µg/l	<1	<1	7	<1	<1	1
Calcium	mg/l	35	24	62	42	60	46
Chloride	mg/l	8.6	4.6	22	17	4.1	9.9
Chromium	µg/l	<50	<50	<50	<50	<50	<50
Chromium Hex.	µg/l	2	2	<1	2	<1	7
Cobalt	µg/l	<5	<5	5	<5	<5	5
Color	PT-CO	<1	<1	<1	<1	<1	<1
Copper	µg/l	<10	<10	<10	<10	<10	<10
Cyanide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/l	0.3	0.3	0.5	0.4	0.2	0.4
Gallium	µg/l	<30	<30	70	<30	<30	100
Germanium	µg/l	<30	<30	70	<30	30	70
Hardness	mg/l	120	93	220	140	200	160
Hardness Noncarb	mg/l	0	0	77	14	0	40
Iodide	mg/l	0.00	0.00	0.02	0.00	0.00	<0.01
Iron	µg/l	<5	10	30	10	7	10
Lead	µg/l	<30	<30	30	<30	<30	50
Lithium	µg/l	10	7	30	7	10	10
Magnesium	mg/l	7.2	8.1	15	9.6	12	11
Manganese	µg/l	3	3	100	1	1	3
Molybdenum	µg/l	<10	10	10	<10	<10	10
Nickel	µg/l	<50	<50	<50	<50	<50	<50
Nitr NO ₂ as N	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitr NO ₂ + NO ₃ - N	mg/l	2.5	3.2	0.28	1.9	4.5	5.9
Nitr NH ₄ as N	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Nitr NH ₄ as NH ₄	mg/l	0.08	0.08	0.08	0.08	0.08	0.08
pH Field		7.6	8.3	7.8	7.9	7.5	8.2
pH Lab		8.0	8.4	8.2	8.3	7.9	8.4
Phosphorus as P	mg/l	0.03	0.01	0.03	0.04	0.03	0.03
Phosphorus	mg/l	0.03	0.01	0.03	0.03	0.02	0.03
Potassium	mg/l	4.6	4.7	7.7	5.8	6.0	6.6
Residue Calc Sum	mg/l	214	176	351	261	289	302
Residue at 180 C	mg/l	228	187	356	254	306	293
Selenium	µg/l	1	3	6	2	<1	4
Silica	mg/l	35	33	33	32	32	40
Silver	µg/l	<10	<10	<10	<10	<10	<10
SAR		0.7	0.6	0.8	0.9	0.6	0.8
Sodium	mg/l	17	13	26	24	17	23
Sodium Percent		23	22	20	26	15	23
Sp Conductance Fld	µmhos	310	255	540	394	450	422
Sp Conductance Lab	µmhos	319	256	535	395	455	422
Strontium	µg/l	300	100	300	100	300	300
Sulfate	mg/l	23	15	99	44	18	67
Tin	µg/l	<50	<50	100	50	70	300
Titanium	µg/l	<5	<5	5	<5	<5	5
Turbidity	NTU	2.0	1.6	1.2	3.5	0.5	1.4
Vanadium	µg/l	<10	10	<10	10	10	10
Water Temp	°C	16.6		18.9	17.7	16.6	19.1
Zinc	µg/l	100	<9	10	<9	<9	10
Zirconium	µg/l	<5	<5	<5	<5	<5	<5
Cesium-137	pCi/l	<1	<1	<1	<1	<1	<1
Cobalt-60	pCi/l	<1	<1	<1	<1	<1	4
Gross Alpha, U-Nat	µg/l	<6.0	<4.7	<8.7	<8.4	<9.6	<7.2
Gross Beta, Cs-137	pCi/l	4.8	6.0	7.4	6.8	7.8	31
Gross Beta, Sr-90	pCi/l	4.6	5.7	7.1	6.5	7.4	30
Strontium-90	pCi/l	<0.6	<0.6	<0.6	<0.6	<0.6	4.3
Tritium	pCi/l	<200	1200	<200	<200	300	93000

TABLE C.1. Contd

Constituents	Units	699-2-33	699-10-E12	699-11-45A	699-15-15B	699-15-26	699-17-5
Alk Tot Lab	mg/l	130	160	120	120	130	100
Aluminum	µg/l	70	<50	<50	<50	<50	<50
Antimony	µg/l	<30	<30	<30	<30	<30	<30
Arsenic	µg/l	6	9	3	8	9	3
Barium	µg/l	30	50	50	50	50	30
Beryllium	µg/l	<1	<1	<1	<1	<1	<1
Bismuth	µg/l	<1000	<1000	<1000	<1000	<1000	<1000
Boron	µg/l	10	50	10	10	30	10
Bromide	mg/l	0.20	0.00	0.00	<0.01	<0.01	0.20
Cadmium	µg/l	1	<1	<1	<1	<1	<1
Calcium	mg/l	42	45	33	54	48	70
Chloride	mg/l	5.8	8.2	5.2	6.7	9.9	19
Chromium	µg/l	<50	<50	<50	<50	<50	<50
Chromium Hex.	µg/l	<1	2	<1	<1	7	<1
Cobalt	µg/l	5	<5	<5	<5	<5	<5
Color	PT-CO	5	<1	<1	<1	<1	<1
Copper	µg/l	<10	<10	<10	<10	<10	<10
Cyanide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	mg/l	0.3	0.3	0.3	0.3	0.4	0.2
Gallium	µg/l	70	<30	<30	<30	<30	<30
Germanium	µg/l	70	<30	30	<30	50	<30
Hardness	mg/l	150	170	120	180	170	
Hardness Noncarb	mg/l	20	10	0	60	39	
Iodide	mg/l	0.00	0.00	0.00	<0.01	<0.01	<0.01
Iron	µg/l	30	10	50	10	10	30
Lead	µg/l	30	<30	<30	<30	<30	<30
Lithium	µg/l	10	7	7	10	10	7
Magnesium	mg/l	11	14	8.9	11	12	10
Manganese	µg/l	10	1	100	7	<1	1
Molybdenum	µg/l	10	10	<10	<10	10	10
Nickel	µg/l	<50	<50	<50	<50	<50	<50
Nitr NO ₂ as N	mg/l	<0.02	<0.02	0.04	<0.02	<0.02	<0.02
Nitr NO ₂ + NO ₃ - N	mg/l	0.57	3.8	0.96	4.7	5.8	1.4
Nitr NH ₄ as N	mg/l	<0.06	<0.06	1.0	<0.06	<0.06	<0.06
Nitr NH ₄ as NH ₄	mg/l	0.08	0.08	0.24	0.08	0.08	0.08
pH Field		7.7	7.8	7.7	7.9	7.9	7.9
pH Lab		8.2	8.2	8.0	8.2	8.2	8.2
Phosphorus as P	mg/l	0.02	0.01	0.01	0.02	0.02	0.01
Phosphorus	mg/l	0.02	0.01	0.02	0.02	0.04	0.02
Potassium	mg/l	4.4	5.5	4.6	6.4	6.3	
Residue Calc Sum	mg/l	228	277	183	308	299	
Residue at 180 C	mg/l	224	263	179	305	297	339
Selenium	µg/l	4	3	1	11	4	
Silica	mg/l	36	43	25	33	36	50
Silver	µg/l	<10	<10	<10	<10	<10	<10
SAR		0.5	0.7	0.5	0.7	0.8	
Sodium	mg/l	12	19	11	20	23	10
Sodium Percent		14	19	16	19	22	
Sp Conductance Fld	µmhos	335	408	290	445	445	505
Sp Conductance Lab	µmhos	310	403	293	446	447	494
Strontium	µg/l	100	100	100	300	300	100
Sulfate	mg/l	36	29	18	84	60	65
Tin	µg/l	100	70	70	<50	100	100
Titanium	µg/l	<5	<5	<5	<5	<5	<5
Turbidity	NTU	4.5	2.8	1.2	14	0.8	7.4
Vanadium	µg/l	10	<10	<10	10	10	30
Water Temp	°C	19.3	19.3	19.3	19.4	18.8	19.0
Zinc	µg/l	<9	100	700	30	<9	10
Zirconium	µg/l	5	<5	<5	<5	<5	<5
Cesium-137	pCi/l	<1	<1	<1	<1	<1	<1
Cobalt-60	pCi/l	<1	<1	<1	<1	6	<1
Gross Alpha, U-Nat	µg/l	<6.5	<8.8	<5.3	<8.4	<8.3	<8.7
Gross Beta, Cs-137	pCi/l	4.8	6.4	4.3	10	23	6.0
Gross Beta, Sr-90	pCi/l	4.6	6.1	4.2	9.8	22	5.7
Strontium-90	pCi/l	<0.6	<0.6	<0.6	<0.6	5.9	<0.6
Tritium	pCi/l	<200	6900	<200	<200	170000	<200

TABLE C.1 Contd

Constituents	Units	699-32-70	699-34-42	699-42-2	699-42-12	699-46-5	699-49-55
Alk Tot Lab	mg/l	120	110	120	120	120	40
Aluminum	µg/l	<50	50	100	<50	<50	70
Antimony	µg/l	<30	30	<30	<30	<30	<30
Arsenic	µg/l	4	6	6	5	5	4
Barium	µg/l	70	30	50	50	30	30
Beryllium	µg/l	<1	<1	<1	<1	<1	<1
Bismuth	µg/l	<1000	<1000	<1000	<1000	<1000	<1000
Boron	µg/l	10	30	50	10	10	30
Bromide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.20
Cadmium	µg/l	<1	1	<1	1	1	<1
Calcium	mg/l	34	32	41	43	43	67
Chloride	mg/l	12	11	11	12	12	22
Chromium	µg/l	<50	<50	<50	<50	<50	<50
Chromium Hex.	µg/l	30	<1	7	7	7	<1
Cobalt	µg/l	<5	5	<5	<5	5	<5
Color	PT-CO	5	<1	<1	<1	<1	25
Copper	µg/l	<10	<10	<10	<10	<10	<10
Cyanide	mg/l	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Fluoride	mg/l	0.4	0.6	0.3	0.4	0.4	0.4
Gallium	µg/l	<30	70	<30	<30	100	70
Germanium	µg/l	50	70	30	30	70	50
Hardness	mg/l	130	120	150	170	170	200
Hardness Noncarb	mg/l	10	11	32	49	45	160
Iodide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	µg/l	30	10	100	10	10	7
Lead	µg/l	<30	30	<30	<30	50	30
Lithium	µg/l	10	10	10	10	10	10
Magnesium	mg/l	11	9.9	12	15	14	8.3
Manganese	µg/l	1	1	1	7	1	10
Molybdenum	µg/l	10	10	<10	<10	30	30
Nickel	µg/l	<50	<50	<50	<50	<50	<50
Nitr NO ₂ as N	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	0.04
Nitr NO ₂ + NO ₃ - N	mg/l	3.8	5.9	7.1	8.3	6.7	0.92
Nitr NH ₄ as N	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	0.07
Nitr NH ₄ as NH ₄	mg/l	0.08	0.08	0.08	0.08	0.08	0.09
pH Field		7.7	7.9	7.9	7.9	7.8	8.8
pH Lab		8.1	8.2	8.2	8.2	8.2	8.8
Phosphorus as P	mg/l	0.05	0.03	0.02	0.02	0.02	0.02
Phosphorus	mg/l	0.04	0.03	0.01	0.01	0.02	0.02
Potassium	mg/l	4.1	6.1	5.3	5.4	4.7	13
Residue Calc Sum	mg/l	236	268	269	311	290	438
Residue at 180 C	mg/l	230	257	281	301	277	437
Selenium	µg/l	2	2	2	3	3	9
Silica	mg/l	43	43	39	40	40	24
Silver	µg/l	<10	<10	<10	<10	<10	<10
SAR		0.7	1.2	0.7	0.9	0.8	1.4
Sodium	mg/l	18	28	19	26	22	45
Sodium Percent		22	32	21	24	22	31
Sp Conductance Fld	µmhos	345	375	395	450	410	632
Sp Conductance Lab	µmhos	342	387	393	447	402	637
Strontium	µg/l	300	100	1000	300	300	300
Sulfate	mg/l	25	45	38	60	52	230
Tin	µg/l	100	100	50	70	300	100
Titanium	µg/l	<5	<5	10	<5	<5	<5
Turbidity	NTU	8.0	0.8	1.0	1.9	1.0	16
Vanadium	µg/l	10	30	<10	10	30	<10
Water Temp	°C	21.2	20.3	17.8	17.6	17.7	18.3
Zinc	µg/l	10	<9	<9	10	<9	<9
Zirconium	µg/l	<5	5	<5	<5	5	<5
Cesium-137	pCi/l	<1	<1	<1	<1	<1	<1
Cobalt-60	pCi/l	<1	7	9	10	8	<1
Gross Alpha, U-Nat	µg/l	<6.5	<7.6	<8.9	<8.6	<7.1	<9.5
Gross Beta, Cs-137	pCi/l	7.7	36	25	30	29	10
Gross Beta, Sr-90	pCi/l	7.4	35	24	29	<27	9.7
Strontium-90	pCi/l	<0.6	6.5	8.6	9.7	8.1	<0.6
Tritium	pCi/l	270000	180000	200000	330000	220000	<200

TABLE C.1 Contd

Constituents	Units	699-64-27	699-81-58
Alk Tot Lab	mg/l	150	96
Aluminum	µg/l	100	<50
Antimony	µg/l	30	<30
Arsenic	µg/l	4	2
Barium	µg/l	70	10
Beryllium	µg/l	<1	<1
Bismuth	µg/l	<1000	<1000
Boron	µg/l	10	<5
Bromide	mg/l	0.20	0.00
Cadmium	µg/l	1	<1
Calcium	mg/l	91	29
Chloride	mg/l	30	1.3
Chromium	µg/l	<50	<50
Chromium Hex.	µg/l	<1	2
Cobalt	µg/l	5	<5
Color	PT-CO	<1	<1
Copper	µg/l	<10	<10
Cyanide	mg/l	<0.01	<0.01
Fluoride	mg/l	0.2	0.1
Gallium	µg/l	100	<30
Germanium	µg/l	100	<30
Hardness	mg/l	310	100
Hardness Noncarb	mg/l	160	7
Iodide	mg/l	0.00	0.00
Iron	µg/l	10	5
Lead	µg/l	30	<30
Lithium	µg/l	30	5
Magnesium	mg/l	21	7.4
Manganese	µg/l	7	3
Molybdenum	µg/l	10	10
Nickel	µg/l	<50	<50
Nitr NO ₂ as N	mg/l	<0.02	<0.02
Nitr NO ₂ + NO ₃ - N	mg/l	6.8	0.38
Nitr NH ₄ as N	mg/l	0.06	<0.06
Nitr NH ₄ as NH ₄	mg/l	0.08	0.08
pH Field		7.8	8.0
pH Lab		8.1	8.2
Phosphorus as P	mg/l	0.03	<0.01
Phosphorus	mg/l	0.03	0.01
Potassium	mg/l	7.1	2.6
Residue Calc Sum	mg/l	545	135
Residue at 180 C	mg/l	542	129
Selenium	µg/l	4	1
Silica	mg/l	37	16
Silver	µg/l	<10	<10
SAR		1.3	0.2
Sodium	mg/l	48	4.0
Sodium Percent		24	8
Sp Conductance Fld	µmhos	775	214
Sp Conductance Lab	µmhos	759	213
Strontium	µg/l	700	100
Sulfate	mg/l	190	15
Tin	µg/l	300	50
Titanium	µg/l	7	<5
Turbidity	NTU	2.4	5.3
Vanadium	µg/l	10	<10
Water Temp	°C	17.7	16.6
Zinc	µg/l	10	<9
Zirconium	µg/l	5	<5
Cesium-137	pCi/l	<1	<1
Cobalt-60	pCi/l	<1	<1
Gross Alpha, U-Nat	µg/l	<14	<3.9
Gross Beta, Cs-137	pCi/l	6.9	3.1
Gross Beta, Sr-90	pCi/l	6.7	3.0
Strontium-90	pCi/l	<0.6	<0.6
Tritium	pCi/l	<200	<200

DISTRIBUTION

No. of Copies		No. of Copies
	OFFSITE	OFFSITE
	Kent Ashbaker Water Quality Division Oregon State Dept. of Environmental Quality P.O. Box 1760 Portland, OR 97207	Fred Hahn Washington State Department of Ecology MS PV-11 Olympia, WA 98504
	S. R. Arlt City of Richland Water and Sewer Department P.O. Box 190 Richland, WA 99352	Russell Jim, Councilman Attn: Erline Reber Yakima Indian Nation P.O. Box 151 Toppenish, WA 98948
	H. L. Cahn Benton-Franklin District Health Department 506 McKenzie Richland, WA 99352	W. A. Kiel Washington Public Power Supply System 3000 George Washington Way Richland, WA 99352
	D. E. Clark Exxon Nuclear Horn Rapids Road Richland, WA 99352	N. P. Kirner Washington State Department of Social and Health Services MS LF-13 Olympia, WA 98504
3	E. Cowan Environmental Protection Agency Region X 1200 6th Avenue/MS-533 Seattle, WA 98101	J. B. Martin Regional Administrator NRC Region V Suite 210 1450 Marie Lane Walnut Creek, CA 94596-5368
	Norman Dion U.S. Geological Survey 1201 Pacific Avenue, Suite 600 Tacoma, WA 98402	R. R. Mooney DSHS-Division of Health, Radiation Control Section 1409 Smith Tower, B17-9 Seattle, WA 98104
27	DOE Technical Information Center	
	S. R. Elliott DOE Office of Safety and Health P.O. Box 14100 Las Vegas, NV 89114	D. W. Moos Washington State Department of Ecology MS PV-11 Olympia, WA 98504
	L. A. Forsythe/DP-226 DOE Office of Military Application Washington, DC 20545	G. G. Outtersen Section 543 Battelle Memorial Institute 505 King Avenue Columbus, OH 43201
12	G. L. Fiedler Washington State Department of Ecology MS PV-11 Olympia, WA 98504	R. D. Paris Oregon State Health Division 1400 S.W. Fifth Avenue Portland, OR 97201
	M. O. Fretwell Water Resources Division U.S. Geological Survey 345 Middlefield Road, MS-66 Menlo Park, CA 94025	4 D. E. Patterson/EP-32 DOE Office of Operational Safety Washington, DC 20545

**No. of
Copies**

OFFSITE

J. K. Price
Washington Public Power Supply System
P.O. Box 968 MS 540
Richland, WA 99352

J. B. Robertson
U.S. Geological Survey
MS-410
Reston, VA 22092

T. Strong
Washington State Department of Social
and Health Services
MS LF-13
Olympia, WA 98504

G. Toombs
Oregon State Health Division
P.O. Box 231
Portland, OR 97207

Washington State Department of Ecology
Library PV-11
Olympia, WA 98504

C. G. Welty/EP-323
DOE Office of Operational and
Environmental Safety
Washington, DC 20545

ONSITE

23

DOE Richland Operations Office

R. E. Austin (5)
O. J. Elgert (2)
D. R. Elle (10)
R. E. Gerton
H. E. Ransom
A. J. Rizzo
J. L. Rhoades
F. R. Standerfer
M. W. Tiernan

2

Hanford Environmental Health Foundation

L. J. Maas
R. J. Gilmore

12

Rockwell Hanford Operations

K. A. Gasper
M. J. Graham (4)
H. A. Haerer
A. G. Law
M. M. McCarthy
W. H. Price
B. J. Saueressig
J. S. Wilbur
RHO File

**No. of
Copies**

ONSITE

9

United Nuclear Corporation

P. A. Carlson
L. P. Diediker
J. J. Dorian
E. M. Greager
D. L. Renberger
A. P. Vinther
E. A. Weakley
W. G. Westover
UNC File

3

Westinghouse Hanford Company

R. O. Budd
R. B. Hall
D. O. Hess

68

Pacific Northwest Laboratory

G. E. Backman
S. C. Blair
P. J. Blumer
P. E. Bramson
F. P. Brauer
J. M. Carlile
C. S. Cline
J. P. Corley
D. W. Damschen
R. L. Dirkes
D. W. Dragnich
P. A. Eddy (20)
P. J. Gutknecht
E. L. Hilty
C. T. Kincaid
L. J. Kirby
H. V. Larson
T. L. Liikala
W. D. McCormack
V. L. McGhan
M. A. McKinney
G. M. Petrie
L. S. Prater (5)
K. R. Price
M. R. Quaders
J. R. Raymond
J. T. Rieger (5)
D. J. Sommer
M. J. Sula
P. D. Thorne
C. M. Unruh
L. L. Wendell
D. A. Zimmerman
Technical Information (5)
P. E. Bramson-Historical File
Publishing Coordination (2)