**Environmental Monitoring
Report on the Status of
Ground Water Beneath the
Hanford Site**

January-December 1975

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Battelle

Pacific Northwest Laboratories

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ENVIRONMENTAL MONITORING REPORT ON THE STATUS
OF GROUND WATER BENEATH THE HANFORD SITE
JANUARY-DECEMBER 1975

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PREFACE

This report is one of a series prepared annually to provide an evaluation of the status of ground-water contamination resulting from Hanford onsite discharges. This issue covers the data collected January through December 1975. The maps of the contamination plumes and the data tables are provided to allow comparison with previous report periods. The previous report in this series was BNWL-1970.⁽¹⁾ An additional parameter included in this report is the distribution of ground-water temperatures beneath the site.

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INTRODUCTION

Surveillance of ground water on the Hanford Site is one facet of the comprehensive Environmental Monitoring Program designed to evaluate existing and potential pathways of contaminant exposure from project operations. Objectives of the Ground-Water Monitoring Program, conducted by Battelle-Northwest for ERDA, are to measure and report the concentration and distribution of radioactive and chemical constituents in the ground water, determine the movement and transport of contaminants with time, and to determine the impact on man's environs.

All routine ground-water samples were taken by the Radiation Monitoring Section and were analyzed by the Technical Analysis Section as part of the Hanford Environmental Surveillance Program conducted by the Environmental Evaluations Section of Battelle-Northwest. Special samples for analysis by the U.S. Geological Survey were collected by the Resources Systems Section of BNW.

The Atlantic Richfield Hanford Company (ARHCO), ERDA's prime contractor for chemical processing and waste management activities on the Hanford site, has responsibility for operations within the 200 Areas. ARHCO conducts a Comprehensive Ground-Water Sampling and Analysis Program within the 200 Areas. Data obtained from the ARHCO program, except for a few analyses, are not included in this report.

SUMMARY

Evaluation of the Gross Beta (β_t), Tritium (^3H), and Nitrate (NO_3^-) concentrations in ground water sampled from near the surface of the unconfined ground-water system during 1975 indicates that zones of contamination extend in an easterly and southeasterly direction from the 200-E Area, as has been observed in the past.⁽¹⁾ Tritium and NO_3^- ion concentrations above background levels continue to be observed along the Columbia River in the vicinity of the 100 Areas. Ground water in the vicinity of the 300 Area continues to show NO_3^- ion and uranium concentrations above background levels. Gross Beta activity in the ground water beneath the 100 Areas was detectable only in the 100-N Area from effluent discharged to the 1301-N Crib and in the vicinity of 100-B Area. Analyses for other radionuclides such as ^{90}Sr , ^{60}Co , ^{129}I , ^{137}Cs and ^{106}Ru , show that they are present in various locations outside the 200 Areas but only in very low concentrations. Generally concentrations of radionuclides outside the 200 Areas are less than 10% of Concentration Guide.⁽²⁾

Nitrate ion concentrations greater than the Public Health Service (PHS) and Environmental Protection Agency (EPA) recommended drinking water standard⁽³⁾ of 45 mg/l continue to be observed in the ground water adjacent to and within the 200 Areas; in the vicinity of the 100-F and N areas; and in the east-central part of the Hanford Site. Ground water from these zones is not consumed by human beings or other animals.

Configuration and concentration of ground-water contamination has changed only slightly from the past reporting period. Additional data points have resulted in expansion of some zones of contamination.

BACKGROUND SUMMARY

PLANT OPERATIONS

Operations on the Hanford site since 1944 have resulted in ground disposal of large volumes of low-level and intermediate-level liquid radioactive wastes. Figure 1 shows the location and configuration of the site. Most of the liquid wastes have been disposed to the ground at the chemical separation areas (200 Areas) located on a plateau near the center of the site. Smaller amounts of wastes have been released at the reactor sites (100 Areas) located adjacent to the Columbia River, and at the laboratory and fuel fabrication area (300 Area). Only one reactor and associated disposal facility (100-N Area) is currently in operation. Ground disposal of liquid waste has been greatly reduced in the past several years due to the deactivation of all Hanford reactors (except N Reactor) with the resulting decrease in reactor fuel processing, coupled with improved treatment of several intermediate-level waste streams.

DISPOSITION OF WASTES

Liquid wastes disposed to the ground percolate laterally and downward through the 150 to 300 feet of unconsolidated glaciofluvial and lacustrine sands, silts and gravel overlying the ground-water table. As the wastes move through the sedimentary earth materials, adsorption and ion exchange reactions take place between the minerals in the sediments and the materials in the waste water. Some of the longer lived and more hazardous radionuclides such as strontium-90 (^{90}Sr), cesium-137 (^{137}Cs) and plutonium-239 (^{239}Pu) have favorable ion exchange characteristics and are effectively removed from the water. Some radionuclides such as ruthenium-106 (^{106}Ru), cobalt-60 (^{60}Co), technetium-99 (^{99}Tc), tritium (^3H) and nonradioactive materials such as nitrate (NO_3^-) do not have good ion exchange characteristics and move through the ground at varying rates to eventually enter the ground water. When the contaminants enter the water table, they move in a general down gradient direction with the ground water. As the radionuclides move in the ground water, their concentration is reduced by radioactive decay, ion exchange, diffusion and hydrodynamic dispersion.

FIGURE 1 Hanford Site

Disposal of more than 130 billion gallons of process cooling water and about 8 billion gallons of intermediate-level radioactive waste over the past 30 years has profoundly changed the water table. Ground-water mounds have been created near each of the chemical processing areas and in the 100-N Reactor Area from discharge of waste water. Ground-water levels have changed continuously over the years, depending upon variations in volumes and locations of waste water discharged to the ground. Movement of the ground water and associated contaminants also have changed with time reflecting the variation in waste water discharge.

MONITORING AND WELLS

Over 700 cased monitoring wells⁽⁴⁾ have been drilled to water since the beginning of disposal operations at Hanford. The structures provide access for obtaining water samples and for conducting in-well investigations. Some of the wells are drilled to basalt bedrock, others are drilled to the first semi-previous layer below the water table, and still others are drilled only a few tens of feet below the water table in the unconfined aquifer. Most of the wells were drilled as multipurpose structures to obtain geologic and hydrologic information as well as water quality data.

To provide an ideal structure for monitoring purposes, a well should be perforated throughout its length below the water table and the water in the aquifer should flow through the casing normal to the well at all depths. However, since the heterogeneity of the sediments beneath the Hanford site prevent this, each well structure must be evaluated individually as a monitoring facility.

Two hundred and twenty-two wells were used in the 1975 routine Ground-Water Monitoring Program; 875 well water samples were taken to provide 1864 analytical results for use in evaluating the effects of site operations on the ground water. These figures do not include ARHCO's monitoring efforts in the 200 Areas.

SAMPLING AND ANALYSIS

Sampling frequency varies from monthly to semiannually, depending on well location and the analyzed constituent. Most of the ground-water samples are collected near the water surface of the unconfined aquifer by lowering a glass bottle enclosed in a steel bail into the water. Usually, when contamination appears in a project well, the highest concentration is observed at the surface of the water table. A study to define vertical stratification of contaminants in the ground water has been initiated. At a few locations where appropriate well structures are available, samples are obtained from the confined aquifer zones. Submersible sampling pumps are being installed in key wells to obtain a more representative sample of the water in the aquifer adjacent to the well than is provided by a small-volume dipped sample.

The radionuclides represented by β_t measurement (calculated as ^{106}Ru) and ^3H , as well as NO_3^- ion are readily transported in the ground water with little decrease in concentration due to adsorption or ion exchange. They also can be detected in low concentrations in the ground water relative to their respective Concentration Guides (CG)⁽²⁾ or drinking water standards (DWS).⁽³⁾ Therefore, these substances are used as primary tracers to monitor the movement of contaminated ground water. In addition to β_t , ^3H , and NO_3^- , samples from selected wells are routinely analyzed at less frequent intervals for the radionuclides ^{90}Sr , ^{137}Cs , and ^{60}Co . Total alpha-emission is also determined. Selected samples are analyzed by gamma ray spectrometry. Ground water from several wells is analyzed for chemical water parameters to monitor broader changes in water quality. Analyses for uranium (^{238}U), fluoride (F^-) and hexavalent chromium ion (Cr^{+6}) are done on selected ground-water samples in and adjacent to the 300 Area because the fuel fabrication waste water disposed at this site contains these contaminants. Standard radiometric and chemical methods are used to analyze the routine ground-water samples. Well water analyses are obtained frequently from throughout the Hanford site. Other radionuclides, such as ^{129}I and ^{99}Tc , have been detected in the ground water beneath the Hanford site. These radionuclides also make excellent tracers of ground-water contamination, and are used to a limited extent, but they generally occur in very low concentrations.

EVALUATION OF GROUND-WATER SURVEILLANCE DATA

Radionuclide concentrations in the ground water beneath Hanford are evaluated in terms of their respective Concentration Guides (CGs) while non-radioactive materials are compared to the U.S. Public Health Service recommended drinking water standards (DWS). While these guides pertain to drinking water, at present no ground water from zones having concentrations greater than the standards is used for human or animal consumption. However, the comparison provides a conservative method of evaluating the potential significance of most water-borne materials. The Concentration Guides used in this report are those which apply to uncontrolled areas. Table 1 shows the detection limit and applicable CG or DWS for various materials analyzed for under the routine Ground-Water Monitoring Program.

TABLE 1 Lower Analytical Detection Limit
and Applicable CG or DWS

<u>Analysis</u>	<u>Detection Limit</u>	<u>CG or DWS</u>
β_t (as ^{106}Ru)	0.08 ^(a)	NA ^(b)
Gross Alpha (as ^{239}Pu)	0.017 ^(a)	NA ^(b)
^3H	1.0 ^(a)	3000 ^(a)
^{60}Co	0.02 ^(a)	30 ^(a)
^{90}Sr	0.03 ^(a)	0.3 ^(a)
^{106}Ru	0.06 ^(a)	10 ^(a)
^{125}Sb	0.06 ^(a)	100 ^(a)
^{131}I	0.01 ^(a)	0.3 ^(a)
^{137}Cs	0.02 ^(a)	20 ^(a)
NO_3^-	0.5 ^(c)	45 ^(c)
F^-	0.08 ^(c)	1.8 ^(c)
Cr^{+6}	3 ^(c)	50 ^(d)

(a) pCi/ml

(b) NA - Not Applicable. Significance of contaminations determined by specific radionuclide analysis.

(c) mg/l

(d) $\mu\text{g/l}$

Figures 2, 3 and 4 (in the pocket on back page) are maps that show the configuration and concentration of β_t , ^3H and NO_3^- , respectively, in the unconfined ground water beneath the Hanford site for CY-1975. The isopleths on the map show concentration zones rather than discrete concentration contours because the data do not justify the display of concentration isopleths in more detail. Data from waste disposal operations and ground-water contamination in the 200 Areas are not included in this report. However, data from the 200 Areas were used to provide continuity for the maps.

Appendix A contains tabular analytical data for CY-1975 on average, maximum and minimum concentrations of the primary tracers (gross beta, tritium and nitrate).

Appendix B contains data on routine analyses for materials other than the primary tracers. Appendix C contains results of ground-water analyses made for quality assurance or other special purposes during 1975. An effort to establish the chemistry of the ground water beneath the site has resulted in data concerning a broad spectrum of chemical constituents. Appendix D shows the results of chemical and spectrochemical analyses of water from selected wells.

Table 2 shows the number of wells, areal distribution, number of samples and number of analyses involved in the routine Ground-Water Monitoring Program to provide the data shown in Appendixes A and B.

TABLE 2. Numerical Data on the Routine Ground-Water Monitoring Program - CY-1975

<u>Area</u>	<u>Wells Sampled</u>	<u>Number of Samples</u>	<u>Number of Analyses</u>
100 Areas	19	60	166
200 Areas	38	191	324
300 Area	12	90	358
600 Area	148	524	996
Other	<u>5</u>	<u>10</u>	<u>20</u>
TOTAL	222	875	1864

GROSS BETA (β_t) CONCENTRATION IN THE UNCONFINED GROUND WATER

Figure 2 shows the configuration and concentration of β_t contamination in the unconfined ground water. Appendix A contains analytical data on the primary tracers for ground-water samples collected during CY-1975. The configuration of the β_t plume is static and shows essentially no change over the previous reporting period. The plume extends southeasterly about 7.8 miles from the 200 East Area. Concentrations within this plume in all locations external to the 200 East Area are less than 1.0 pCi/ml except for a small zone near the northwest corner of the 200 East Area and near the southeast corner of the 200-W Area, where concentrations above the 1.0 pCi/ml level. Gross beta concentrations are decreasing in most locations throughout the plume. Figure 5 shows a graph of the β_t concentration history for Well 699-15-26 which is located just south of the main plume. Gross beta concentrations have been decreasing at this location since about 1966 with an apparent half-life of 1.6 years. Figure 6 illustrates the gross beta history of Well 699-20-20. This well is currently showing gross beta values at the detection limit of 0.08 pCi/ml. Both of these wells show that the plume is effectively decaying and decreasing in size.

In addition to the 200 Area plumes, β_t contamination in the ground water is evident in the 100-N Reactor Area from liquid waste disposal to the 1301-N Crib. In the 100-B Area β_t activities are due to past operations. In the 300 Area β_t activity of the ground water is attributable to ^{60}Co from waste disposal facilities.

Gross beta activity in the ground water beneath the Hanford site has been calculated and reported for many years as ^{106}Ru (as was done for this report) since radiochemical analyses in the past have shown that this nuclide accounts for a large fraction of the β_t activity. This evaluation may still be valid near the 200 Area disposal sites, but with a half-life of one year, decay reduces the proportion of ^{106}Ru in the mixture of beta-emitters with distance (time) from the source areas (200 Areas). Initial evaluations to more fully characterize the concentration of beta-emitters that occur in ground water away from the 200 Areas (essentially southeast of the 200 East Area) indicate that ^{60}Co is the dominant nuclide.

FIGURE 6. Well 699-20-20 Concentration History (Total Beta)

Although analyses for β_t are reported in pCi/ml as ^{106}Ru and the evidence is that the predominant radionuclide is ^{60}Co , the values do provide a screening process with adequate sensitivity to detect occurrence and changes in one parameter of radioactivity in the ground water beneath the Hanford site. It thus serves as a valuable tool in the monitoring program. A special study to ascertain the actual distribution and relative concentration of the β contributors has been initiated.

TRITIUM (^3H) CONCENTRATION IN THE UNCONFINED GROUND WATER

Figure 3 shows the configuration and concentration of ^3H in the unconfined ground water. Appendix A contains tabular data on the minimum, maximum and average concentrations for samples collected in 1975. Configuration of the ^3H plume from the 200 E Area has changed little since the previous reporting period. The plume front has expanded toward the Columbia River in the vicinity of Well 699-40-1. Rehabilitation of this monitoring structure may account for the apparent increase in ^3H concentration. The 200-W Area contamination zone has remained essentially static as has the area north of Gable Mountain and Gable Butte. Concentrations of ^3H vary within these zones depending upon location.

Figure 7 is a graph of the ^3H concentration history for Well 699-35-66 which monitors the eastern edge of the 200-W Area plume. The graph of this well shows an increasing level of ^3H concentration, indicating that the plume is moving toward the well. Figure 8 shows a ^3H concentration history of Well 699-8-25. This graph shows that ^3H levels have been decreasing over the past several years but now appear to be leveling off, indicating that the tritium front is probably maintaining its position relative to this structure. Figure 9 is a graph for Well 699-2-3, located just south of the 200-E Area plume. Recent analyses for this well show an increase in ^3H levels, heralding the arrival of the plume.

FIGURE 7. Well 699-35-66 Concentration History (Tritium)

FIGURE 8. Well 699-8-25 Concentration History (Tritium)

FIGURE-9. Well 699-2-3 Concentration History (Tritium)

Residual ^3H is noted in the 100 Areas and contemporary ^3H occurs in and adjacent to the 100-N Area. The only location external to the 200 Areas where ^3H levels exceed 3000 pCi/ml CG is immediately adjacent to the south-east corner of the 200-W Area. Elsewhere ^3H is below the CG. Tritium travels through the soil column essentially unaffected by ion exchange or adsorption and thus provides the most representative tracer of ground-water movement.

NITRATE (NO_3^-) CONCENTRATION IN THE UNCONFINED GROUND WATER

Figure 4 shows the concentration and configuration of NO_3^- in the unconfined ground water. Appendix A contains NO_3^- data; some additional data is contained in Appendix C. Extension of the nose of the plume in a southerly direction toward the 300 Area and enlargement of the zone of high concentration in the central portion of the plume are the only significant changes in the configuration of the plume since the last reporting period. The data indicate that concentrations of NO_3^- are increasing in the vicinity of the FFTF and WPPSS sites as the plume moves toward the river in that vicinity.

Expansion of the isolated plume north of Gable Mountain and an apparent plume south of the 200 E Area near the mouth of Cold Creek are indicated by additional data collected. The causes of these isolated zones are not known, but their isolation indicates that they are probably due to natural phenomena.

Considerable scatter is observed in the NO_3^- data. Based upon the consistency of the ^3H and β_t data, this scatter must be due to the nature of the ion or the analytic procedure.

Nitrate concentrations in the ground water (external to the 200 Areas) above the DWS of 45 mg/l continue to be observed in the central part of the plume from 200 East Area, immediately north of the 200 East Area and in and adjacent to the 100-F Area. Small zones that show NO_3^- concentrations in

excess of 45 mg/l occur southeast of the 200 East Area (centered on Wells 699-34-42 and 34-41) and adjacent to the southeast corner of the 200 West Area.

Figure 10 is a graph of the NO_3^- concentration history of Well 699-27-8. Nitrate levels in this well have increased over the past five years to the point where they averaged 47.3 mg/l during 1975. The increase in NO_3^- levels at this location indicates that the zone of high NO_3^- ground water that has been present to the west of this area for several years, has extended to the east. Similarly the NO_3^- concentration in Well 699-17-5 has increased (Figure 11) to the point where it averages 53.5 mg/l.

Figure 12 shows the NO_3^- concentration history for Well 699-8-25. Nitrate levels in this well have held constant or decreased slightly, confirming the analyses for ^3H at this site.

ADDITIONAL RADIOCONTAMINANTS IN THE UNCONFINED GROUND WATER

Appendix B contains routine analyses made under the Ground-Water Monitoring Program for materials other than the primary tracers (β_t , ^3H , and NO_3^-). Analyses for Iodine-129 (^{129}I) which were made as part of a special study are included in Table 3. Iodine-129 is an excellent tracer of ground-water movement, however the analyses are extremely difficult and time consuming. None of the analyses show radionuclide concentrations in excess of the concentration guides for mixtures as set forth in ERDA Manual Chapter 0524.

FIGURE 11. Well 699-17-5 Concentration History (Nitrate)

FIGURE 12. Well 699-8-25 Concentration History (Nitrate)

TABLE 3. Iodine-129 Analyses from Selected Deep Wells on the Hanford Site, June 1975

<u>Well Number</u>	<u>Sampling Depth (ft blw LSD)</u>	<u>^{129}I (pCi/l)</u>	
699-31-31	127	12	± 0.141
	270-284	3.3	± 0.1
	350-364	4.	± 0.41
	395-409	0.65	± 0.066
	>600	4.1	± 0.11
699-37-43	287-301	0.061	± 0.0018
	365-383	0.021	± 0.0006
	415-433	0.0073	± 0.00027
	465-483	0.00013	± 0.0000048
699-28-40	280-290	0.00082	± 0.000028
	340-350	0.0018	± 0.000048
	400-410	0.00057	± 0.000016
	450-460	0.00024	± 0.0000076

STATUS OF CONTAMINATION IN THE LOWER AQUIFER (CONFINED ZONES)

Analysis of ground water from wells tapping the lower or confined aquifer, sampled as part of the routine program, show no contamination attributable to Hanford operations. There are only a limited number of locations onsite where samples representative of the confined aquifer can be obtained. Samples from these wells, as shown in Table 4, show no contamination. A more comprehensive program to assess the status of the confined aquifer is initiated by ARHCO.

TABLE 4. Comparative Analyses, Lower Versus Upper Aquifer

<u>Well Number</u>	<u>^3H (pCi/l)</u>	<u>NO_3 (mg/l)</u>	<u>Bt (pCi/l)</u>
699-S11-E12AP	< 825*	8.5	
S11-E12A	<1000*	12	
14-E6P	< 670*	<0.5*	
14-E6S	< 950*	<0.5*	
36-46P	< 630*	<0.5*	<75*
36-46Q	< 915*	<0.5*	<75*

*Less than detection limit

THERMAL CONTAMINATION

Mapping the thermal contamination of the unconfined ground water is another tool that can be used to assess the effects of plant operations. The thermal contamination of the ground water is of interest because the permeability of the sediments can be affected by an increase or decrease in fluid temperature.

Figure 13, in the rear pocket, shows the distribution of ground-water temperatures measured in November and December of 1975. The temperature ranges shown are the result of: 1) natural temperature of the unconfined aquifer, about 15°C for the Hanford area; 2) changes due to natural phenomena such as bank storage near the Columbia River and discharge of ground-water from the warmer confined aquifers into the unconfined system; and 3) superimposed temperature gradients due to onsite operations.

The thermal plumes due to onsite operations are similar in shape and extent to the radionuclide plumes. Strikingly evident though, are the shut-down reactor areas where large quantities of hot water exit from ground disposal and retention basic leakage. Ground-water temperatures in the vicinity of the 100-B Area exceed 40°C.

The discharge of thermally contaminated ground water to the Columbia River has no noticeable effect on river temperatures. This is because only minor amounts of heated water reach the river.

QUALITY CONTROL

A program to institute quality control measures was initiated during 1974. This program reaches to all phases of the Ground-Water Monitoring Program. An extensive effort to insure that samples are representative of the aquifer system beneath the site includes: 1) well maintenance; 2) visual and geophysical inspection; and 3) installation of sampling pumps. In addition, a program of blind and duplicate samples to the BNW Technical Analysis Laboratory was initiated. Outside analysis of ground-water samples by the U.S. Geological Survey was continued. These programs have shown that data received as part of the routine monitoring program are within the set limits of accuracy. Data derived from external analyses are shown in Appendixes C and D. Table 5 compares analyses of the U.S. Geological Survey and Battelle Laboratories. The comparison of results obtained from different laboratories (Table 5) shows both the strengths and weaknesses inherent in the program. Radiological analyses compare favorably over the entire spectrum of concentrations while the nonradiological NO_3^- analyses do not. The weakness is being strengthened by changing the analytical techniques used, bringing them into line with accepted EPA procedures.

TABLE 5 Comparison of Analytical Results Between Laboratories

Well Number	NO ₃ (mg/l)		³ H ¹ (pCi/ml)		β _t ² (pCi/ml)	
	USGS	BNW	USGS	BNW	USGS	BNW
699-S11-E12A	22	~0.5	0.48	0.5		
S6-E4D			2.7	1.5		
2-3	22	18	46	62		
9-E2	1.2	0.5				
15-15B	16	13	0.48	0.5	0.011	0.08
8-32	9.3	0.5	0.48	1.		
17-5	53	37	0.48	0.53		
27-8	58	53	880	880	0.25	0.2
32-22	75	67	1500	1600	0.24	0.26
40-1	24	0.6	84	0.75		
41-23	53	50	890	880	.074	.075
42-12	28	30	230	280	.057	.080
49-55	12	0.5	0.48	0.5	.015	.075
49-79	44	34	0.48	0.8		
50-42	3.1	0.5	0.48	6.5		
69-38			0.48	0.5		
HAN 19	4.2	3.5	0.48	1.		

- (1) Minimum countable ³H for the laboratories is 0.48 and 1.0 respectively.
 (2) Gross beta is calculated differently by the two laboratories. The USGS analyses are calculated as ¹³⁷Cs and the BNW analyses are calculated as ¹⁰⁶Ru. Battelle Laboratories have a minimum count rate of 0.08 pCi/ml β_t.

RADIOLOGICAL IMPACT

Ground-water transport of contaminants on the Hanford site represents a potential pathway of exposure via water obtained from either 1) wells which tap the unconfined aquifer, or 2) the Columbia River into which the unconfined aquifer discharges. The following discussion examines these two potential pathways.

GROUND WATER

Presently the contaminant plumes are restricted to the Hanford site as shown in Figures 2, 3, and 4. As the plumes expand, concentrations within them will gradually decrease through additional dilution, adsorption for most of the constituents and in the case of radionuclides, decay.

Drinking water is obtained from the unconfined ground water at the FFTF and WPPSS sites. Monitoring is carried on at regular intervals at these sites. Only the ^3H and NO_3^- plumes extend to these locations. At the FFTF site, ^3H levels were 0.3% of the concentration guide and the NO_3^- levels averaged 16%⁽⁵⁾ of the DWS. At the WPPSS site, ^3H levels averaged 3% of CG and NO_3^- concentrations averaged 10% of DWS.

COLUMBIA RIVER

The unconfined aquifer empties into the Columbia along the Hanford reach with a calculated flow of less than 100 cubic feet per second (cfs). (These flows were based upon operation of the Hanford ground-water models.) Dissolved materials resulting from 200 Area Waste Disposal Operations are transported by this flow. Superimposed upon this flow is seepage from the 1301-N trench. The average flow of the Columbia River is 130,000 cfs. The combined effects of: 1) small flow of ground water entering the river; 2) low concentrations of possible contaminants; 3) release of much larger quantities of similar materials from the 1301-N trench; and 4) the large dilution factor of the Columbia River have precluded the detection of any impact of any contaminant transported by the ground water. Extensive

sampling of the Columbia River, above and below the Hanford reach, has shown no observable impact from known releases to the river due to seepage from the 1301-N trench during 1975.⁽⁶⁾

In summary, there has been no observable effect on the Columbia River by ground-water transported contaminants. All the concentrations observed to date are less than 10% of the most restrictive ERDA manual chapter guidelines. In fact, the values are less than concentrations of naturally occurring or worldwide fallout radioactivity in the Columbia River.⁽⁷⁾

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APPENDIX A

GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

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WELL NO.			GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----			-----	-----	-----
199	B3	1	MAX AVE<7.67E-02* MIN	MAX AVE 2.20E 00* MIN	MAX AVE MIN
199	B4	3	MAX AVE<7.50E-02* MIN	MAX AVE MIN	MAX AVE 5.40E 00* MIN
199	B4	4	MAX AVE 1.15E-01* MIN	MAX AVE 3.20E 00* MIN	MAX AVE 2.05E 00* MIN
199	B9	1	MAX AVE MIN	MAX AVE 2.10E 00* MIN	MAX AVE 3.60E 00* MIN
199	D2	5	MAX AVE MIN	MAX AVE 2.00E 01* MIN	MAX 5.60E 01 AVE 4.75E 01 MIN 4.20E 01
199	D5	12	MAX AVE 1.40E-01* MIN	MAX AVE 7.87E 00* MIN	MAX AVE 4.77E 01* MIN
199	D8	3	MAX AVE MIN	MAX 5.80E 00 AVE 4.97E 00 MIN 3.60E 00	MAX 6.70E 00 AVE 3.80E 00 MIN 5.00E-01
199	F5	1	MAX AVE MIN	MAX AVE 1.83E 02* MIN	MAX AVE 1.07E 00* MIN
199	F5	3	MAX AVE MIN	MAX AVE MIN	MAX AVE<5.00E-01* MIN
199	F5	4	MAX AVE MIN	MAX 2.60E 01 AVE 2.48E 01 MIN 2.30E 01	MAX 5.20E 01 AVE 4.85E 01 MIN 4.60E 01
199	F7	1	MAX AVE MIN	MAX AVE 3.35E 00* MIN	MAX AVE MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.			GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----			-----	-----	-----
199	FB	1	MAX AVE MIN	MAX AVE 1.97E 01* MIN	MAX AVE 4.80E 01* MIN
199	FB	2	MAX AVE MIN	MAX AVE 2.10E 01* MIN	MAX AVE 4.80E 01* MIN
199	H3	1	MAX AVE MIN	MAX AVE 1.35E 01* MIN	MAX 4.00E 01 AVE 2.90E 01 MIN 1.80E 01
199	K	11	MAX AVE MIN	MAX AVE 3.52E 02* MIN	MAX 1.40E 01 AVE 7.03E 00 MIN 1.00E 00
199	K	19	MAX AVE MIN	MAX 7.60E 00 AVE 6.58E 00 MIN 5.40E 00	MAX 3.50E 00 AVE 2.18E 00 MIN 1.60E 00
199	K	20	MAX AVE<7.75E-02* MIN	MAX 7.10E 00 AVE 6.25E 00 MIN 5.90E 00	MAX 1.70E 00 AVE 1.35E 00 MIN 1.10E 00
199	K	22	MAX AVE MIN	MAX 4.30E 00 AVE 2.90E 00 MIN 2.10E 00	MAX 6.00E-01 AVE 5.50E-01 MIN<5.00E-01
199	N	15	MAX 3.30E-01 AVE 2.34E-01 MIN 1.40E-01	MAX AVE 3.47E 01* MIN	MAX AVE 1.23E 01* MIN
299	E13	12	MAX<8.00E-02 AVE<7.92E-02 MIN<7.50E-02	MAX 4.60E 01 AVE 1.15E 01 MIN 5.00E-01	MAX AVE MIN
299	E16	2	MAX 9.00E-02 AVE 7.92E-02 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299	E17	5	MAX 1.10E-01 AVE 8.92E-02 MIN<7.50E-02	MAX AVE MIN	MAX 1.50E 02 AVE 1.05E 02 MIN<5.00E 01

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.		GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----		-----	-----	-----
299 E17	8	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299 E24	2	MAX 1.00E-01 AVE 7.96E-02 MIN<7.50E-02	MAX 6.70E 03 AVE 5.47E 03 MIN 4.20E 03	MAX AVE MIN
299 E24	4	MAX<8.00E-02 AVE<7.67E-02 MIN<7.50E-02	MAX AVE 5.50E 02* MIN	MAX AVE 1.60E 01* MIN
299 E24	9	MAX 1.60E-01 AVE 1.23E-01 MIN 9.00E-02	MAX AVE MIN	MAX AVE MIN
299 E25	6	MAX<8.00E-02 AVE<7.71E-02 MIN<7.50E-02	MAX 3.80E 02 AVE 2.71E 02 MIN 2.10E 02	MAX AVE MIN
299 E25	11	MAX 2.30E-01 AVE 1.06E-01 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299 E26	2	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299 E26	4	MAX<8.00E-02 AVE<7.73E-02 MIN<7.50E-02	MAX 4.00E 02 AVE 3.63E 02 MIN 3.10E 02	MAX AVE MIN
299 E28	4	MAX AVE 8.00E-02* MIN	MAX AVE MIN	MAX AVE MIN
299 E28	5	MAX AVE<8.00E-02* MIN	MAX AVE 4.05E 01* MIN	MAX AVE 8.35E 00* MIN
299 E28	7	MAX AVE 2.15E 00* MIN	MAX AVE MIN	MAX AVE MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
299 E28 13	MAX<8.30E-12 AVE<7.75E-02 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299 E28 16	MAX 1.00E-01 AVE 8.17E-02 MIN<7.50E-02	MAX AVE MIN	MAX AVE MIN
299 E33 10	MAX AVE 2.60E-01* MIN	MAX AVE 1.03E 01* MIN	MAX AVE 1.55E 01* MIN
299 E33 14	MAX AVE 8.00E-02* MIN	MAX AVE 9.40E 00* MIN	MAX AVE 1.55E 01* MIN
299 E33 17	MAX AVE 2.85E-01* MIN	MAX AVE MIN	MAX AVE MIN
299 E33 25	MAX 1.40E 00 AVE 8.65E-01 MIN 5.10E-01	MAX 2.50E 02 AVE 1.90E 02 MIN 1.60E 02	MAX 2.90E 02 AVE 2.37E 02 MIN 1.50E 02
299 W6 1	MAX AVE MIN	MAX AVE 2.95E 01* MIN	MAX AVE MIN
299 W10 5	MAX AVE<7.50E-02* MIN	MAX AVE 2.25E 01* MIN	MAX AVE MIN
299 W11 7	MAX AVE 1.02E 00* MIN	MAX AVE 3.70E 02* MIN	MAX AVE MIN
299 W11 9	MAX AVE MIN	MAX AVE 5.40E 00* MIN	MAX AVE 5.00E 00* MIN
299 W11 12	MAX AVE<7.50E-02* MIN	MAX AVE 1.30E 02* MIN	MAX AVE MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
299 W11 17	MAX 1.50E-01 AVE 9.33E-02 MIN <7.50E-02	MAX AVE MIN	MAX AVE MIN
299 W12 1	MAX AVE MIN	MAX AVE 8.45E-01* MIN	MAX AVE 1.15E 02* MIN
299 W15 2	MAX AVE MIN	MAX AVE <6.10E-01* MIN	MAX AVE 1.50E 01* MIN
299 W15 7	MAX 8.90E-01 AVE 4.97E-01 MIN 1.20E-01	MAX AVE MIN	MAX AVE MIN
299 W18 5	MAX 1.90E-01 AVE 1.22E-01 MIN 7.50E-02	MAX AVE 8.80E 00* MIN	MAX AVE 1.20E 02* MIN
299 W19 3	MAX AVE <7.50E-02* MIN	MAX AVE 4.80E 01* MIN	MAX AVE 1.25E 01* MIN
299 W21 1	MAX AVE 4.25E 00* MIN	MAX AVE 6.65E 03* MIN	MAX AVE 8.75E 01* MIN
299 W22 1	MAX 2.90E 01 AVE 2.32E 01 MIN 1.30E 01	MAX AVE MIN	MAX AVE MIN
299 W22 13	MAX AVE 2.23E-01* MIN	MAX 6.40E 03 AVE 4.45E 03 MIN 3.00E 03	MAX 7.10E 02 AVE 1.23E 02 MIN 4.40E 00
299 W22 22	MAX 4.10E-01 AVE 3.32E-01 MIN 2.40E-01	MAX AVE 4.50E 02* MIN	MAX AVE <5.00E-01* MIN
299 W22 26	MAX 7.80E 00 AVE 3.60E 00 MIN 1.80E 00	MAX 1.30E 04 AVE 7.52E 03 MIN 4.80E 03	MAX AVE 1.20E 02* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.			GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----			-----	-----	-----
299 W23	4		MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX 2.84E 03 AVE 1.33E 03 MIN 4.30E 02	MAX AVE 1.90E 00* MIN
399	1	1	MAX 1.10E-01 AVE 8.00E-02 MIN<7.50E-02	MAX AVE MIN	MAX 1.60E 01 AVE 1.07E 01 MIN 3.90E 00
399	1	2	MAX 8.00E-02 AVE 7.75E-02 MIN<7.50E-02	MAX AVE MIN	MAX 1.60E 01 AVE 1.09E 01 MIN 7.90E 00
399	1	3	MAX<8.00E-02 AVE<7.87E-02 MIN<7.50E-02	MAX AVE MIN	MAX 2.70E 01 AVE 1.51E 01 MIN 9.70E 00
399	1	4	MAX<8.00E-02 AVE<8.00E-02 MIN<8.00E-02	MAX AVE MIN	MAX 2.60E 01 AVE 1.41E 01 MIN 7.90E 00
399	3	1	MAX<8.00E-02 AVE<7.58E-02 MIN<7.50E-02	MAX AVE MIN	MAX 3.30E 01 AVE 1.73E 01 MIN 9.90E 00
399	3	8	MAX 6.30E-01 AVE 3.05E-01 MIN 9.00E-02	MAX AVE MIN	MAX AVE 1.38E 01* MIN
399	4	1	MAX<8.00E-02 AVE<7.63E-02 MIN<7.50E-02	MAX AVE MIN	MAX 1.60E 01 AVE 1.03E 01 MIN 6.70E 00
399	4	7	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX AVE MIN	MAX 3.07E 01 AVE 1.07E 01 MIN 1.10E 01
399	5	1	MAX AVE MIN	MAX AVE MIN	MAX 1.50E 01 AVE 1.10E 01 MIN 1.00E 01
399	6	1	MAX AVE<8.00E-02* MIN	MAX AVE MIN	MAX 1.30E 01 AVE 1.10E 01 MIN 1.10E 01

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
399 8 2	MAX 8.00E-02 AVE 7.63E-02 MIN<7.50E-02	MAX AVE MIN	MAX 8.30E 00 AVE 7.80E 00 MIN 6.70E 00
399 6 3	MAX AVE MIN -	MAX AVE MIN	MAX 4.80E 00 AVE 3.92E 00 MIN 3.00E 00
699 S31 1	MAX AVE MIN	MAX 1.10E 00 AVE 7.55E-01 MIN<4.80E-01	MAX AVE 1.57E 00* MIN
699 S30E15A	MAX AVE MIN	MAX AVE MIN	MAX AVE 9.50E-01* MIN
699 S29 E12	MAX AVE MIN	MAX AVE MIN	MAX AVE 1.09E 01* MIN
699 S27 E14	MAX AVE MIN	MAX AVE MIN	MAX AVE 9.85E 00* MIN
699 S19 E13	MAX AVE<8.00E-02* MIN	MAX AVE 8.00E-01* MIN	MAX 7.50E 00 AVE 4.63E 00 MIN 2.10E 00
699 S19 11	MAX AVE MIN	MAX AVE MIN	MAX AVE 6.60E-01* MIN
699 S12 3	MAX AVE MIN	MAX 1.80E 00 AVE 1.08E 00 MIN<5.60E-01	MAX 6.20E 00 AVE 5.33E 00 MIN 4.40E 00
699 S12 29	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.30E-01* MIN
699 S11E12A	MAX AVE MIN	MAX 1.50E 00 AVE 8.72E-01 MIN<4.80E-01	MAX 1.80E 01 AVE 1.24E 01 MIN<5.00E-01

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

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WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 S8 19	MAX AVE MIN	MAX 1.50E 00 AVE 9.73E-01 MIN<5.70E-01	MAX 2.40E 00 AVE 1.90E 00 MIN 1.00E 00
699 S6 E48	MAX AVE MIN	MAX 5.40E 00 AVE 3.72E 00 MIN 1.80E 00	MAX 1.20E 01 AVE 1.04E 01 MIN 8.60E 00
699 S6 E40	MAX AVE MIN	MAX AVE 2.90E 00* MIN	MAX 5.10E 00 AVE 3.55E 00 MIN 7.00E-01
699 S3 E12	MAX AVE MIN	MAX AVE<8.70E-01* MIN	MAX 2.40E 01 AVE 1.86E 01 MIN 1.60E 01
699 S0 8	MAX AVE MIN	MAX 1.10E 01 AVE 8.23E 00 MIN 6.70E 00	MAX AVE MIN
699 1 18	MAX AVE MIN	MAX AVE 9.85E 01* MIN	MAX 2.20E 01 AVE 2.08E 01 MIN 2.00E 01
699 2 3	MAX AVE MIN	MAX 6.70E 02 AVE 2.12E 02 MIN 5.60E 01	MAX 2.10E 01 AVE 1.57E 01 MIN 3.00E 00
699 2 33	MAX AVE MIN	MAX 1.80E 00 AVE 1.09E 00 MIN<4.80E-01	MAX AVE<5.00E-01* MIN
699 3 45	MAX AVE MIN	MAX AVE MIN	MAX AVE 6.35E 00* MIN
699 8 17	MAX AVE<8.00E-02* MIN	MAX AVE 1.65E 02* MIN	MAX AVE 2.50E 01* MIN
699 8 25	MAX<7.50E-02 AVE<7.50E-02 MIN<7.50E-02	MAX 1.70E 03 AVE 5.48E 02 MIN 1.60E 02	MAX AVE 1.95E 01* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
699 8 32	MAX AVE MIN	MAX AVE 8.57E-01* MIN	MAX 5.00E 00 AVE 2.67E 00 MIN<5.00E-01
699 9 E2	MAX AVE MIN	MAX AVE<9.65E-01* MIN	MAX 7.20E-01 AVE 5.55E-01 MIN<5.00E-01
699 10 E12	MAX AVE MIN	MAX AVE 7.40E-01* MIN	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 10 54	MAX AVE<8.00E-02* MIN	MAX AVE 9.50E-01* MIN	MAX AVE 4.90E 00* MIN
699 13 1	MAX AVE MIN	MAX AVE 6.77E 01* MIN	MAX 1.20E 01 AVE 4.78E 00 MIN 2.10E 00
699 13 1A	MAX AVE MIN	MAX AVE 2.42E 02* MIN	MAX AVE 2.10E 00* MIN
699 13 1B	MAX AVE MIN	MAX AVE 2.70E 01* MIN	MAX AVE 5.10E 00* MIN
699 14 E6P	MAX AVE MIN	MAX<1.10E 00 AVE<6.70E-01 MIN<4.80E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 14 E6Q	MAX AVE MIN	MAX<1.10E 00 AVE<7.45E-01 MIN<4.80E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 14 E6R	MAX AVE MIN	MAX 1.10E 00 AVE 7.65E-01 MIN<4.80E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 14 E6S	MAX AVE MIN	MAX<1.50E 00 AVE<9.52E-01 MIN<4.80E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 15 158	MAX AVE<8.00E-02* MIN	MAX AVE 1.21E 00* MIN	MAX AVE 7.97E 00* MIN
699 15 26	MAX 1.20E-01 AVE 9.50E-02 MIN<8.00E-02	MAX AVE 3.40E 02* MIN	MAX AVE 2.45E 01* MIN
699 17 5	MAX AVE MIN	MAX 4.40E 00 AVE 1.43E 00 MIN<4.80E-01	MAX 7.10E 01 AVE 5.35E 01 MIN 3.70E 01
699 19 43	MAX AVE MIN	MAX AVE MIN	MAX 6.20E 00 AVE 5.65E 00 MIN 5.10E 00
699 20 E50	MAX AVE MIN	MAX AVE 9.35E-01* MIN	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 20 E12	MAX AVE MIN	MAX AVE MIN	MAX AVE 5.50E-01* MIN
699 20 20	MAX 1.10E-01 AVE 8.63E-02 MIN<7.50E-02	MAX AVE 5.35E 02* MIN	MAX AVE 4.70E 01* MIN
699 20 39	MAX AVE MIN	MAX<1.30E 02 AVE<9.13E-01 MIN 7.00E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 24 10	MAX AVE MIN	MAX AVE 8.10E-01* MIN	MAX 2.00E 00 AVE 1.00E 00 MIN<5.00E-01
699 24 33	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX AVE 3.20E 02* MIN	MAX 3.00E 01 AVE 2.00E 01 MIN 2.00E 01
699 26 15	MAX 1.80E-01 AVE 1.73E-01 MIN 1.60E-01	MAX AVE 9.75E 02* MIN	MAX AVE 4.00E 01* MIN

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

APPENDIX A, GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
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WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 26 89	MAX AVE MIN	MAX AVE MIN	MAX AVE 4.00E 00* MIN
699 27 8	MAX 2.40E-01 AVE 2.00E-01 MIN 1.70E-01	MAX AVE 9.80E 02* MIN	MAX 5.50E 01 AVE 4.73E 01 MIN 2.80E 01
699 28 40	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX AVE 1.91E 01* MIN	MAX 4.10E 00 AVE 1.55E 00 MIN<5.00E-01
699 29 78	MAX AVE MIN	MAX 2.20E 00 AVE 1.25E 00 MIN 8.40E-01	MAX 1.50E 00 AVE 1.15E 00 MIN<5.00E-01
699 31 538	MAX AVE<7.50E-02* MIN	MAX<1.40E 00 AVE<9.10E-01 MIN<4.80E-01	MAX 1.00E 01 AVE 6.25E 00 MIN 3.70E 00
699 31 65	MAX AVE MIN	MAX AVE 1.02E 00* MIN	MAX AVE 1.32E 01* MIN
699 32 22	MAX AVE 1.97E-01* MIN	MAX AVE 1.40E 03* MIN	MAX AVE 6.20E 01* MIN
699 32 62	MAX AVE MIN	MAX AVE 7.10E-01* MIN	MAX AVE 7.60E 00* MIN
699 32 70	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX 8.80E 01 AVE 7.70E 01 MIN 6.70E 01	MAX AVE 1.80E 01* MIN
699 32 72	MAX 8.00E-02 AVE 7.63E-02 MIN<7.50E-02	MAX AVE 8.45E 01* MIN	MAX 2.10E 00 AVE 7.67E-01 MIN<5.00E-01
699 32 77	MAX<8.00E-02 AVE<7.70E-02 MIN<7.50E-02	MAX 2.70E 00 AVE 1.14E 00 MIN 7.10E-01	MAX 1.50E 01 AVE 1.17E 01 MIN 4.40E 00

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

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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
699 34 39A	MAX 1.20E-01 AVE 9.37E-02 MIN<8.00E-02	MAX AVE 1.60E 03* MIN	MAX 4.72E 01 AVE 3.65E 01 MIN 1.42E 01
699 34 42	MAX 1.80E-01 AVE 1.50E-01 MIN 1.30E-01	MAX 1.70E 03 AVE 1.38E 03 MIN 1.20E 03	MAX 7.50E 01 AVE 5.83E 01 MIN 3.52E 01
699 34 51	MAX AVE<7.50E-02* MIN	MAX AVE 2.80E 00* MIN	MAX 9.92E 00 AVE 8.02E 00 MIN 6.92E 00
699 35 9	MAX<8.00E-02 AVE<7.75E-02 MIN<7.50E-02	MAX 3.10E 01 AVE 2.58E 01 MIN 2.20E 01	MAX 2.32E 01 AVE 1.52E 01 MIN 1.22E 01
699 35 66	MAX AVE<7.75E-02* MIN	MAX 3.30E 02 AVE 1.19E 02 MIN 3.50E 01	MAX AVE 5.67E-01* MIN
699 35 70	MAX AVE 1.30E-01* MIN	MAX AVE 9.20E 03* MIN	MAX AVE 1.45E 01* MIN
699 35 78	MAX<8.00E-02 AVE<7.87E-02 MIN<7.50E-02	MAX 1.10E 00 AVE 8.70E-01 MIN 7.70E-01	MAX 6.72E 00 AVE 2.42E 00 MIN 1.32E 00
699 36 46P	MAX AVE 7.50E-02* MIN	MAX AVE 7.00E-01* MIN	MAX AVE 5.02E-01* MIN
699 36 460	MAX<8.00E-02 AVE<7.87E-02 MIN<7.50E-02	MAX 1.00E 00 AVE 7.10E-01 MIN<4.80E-01	MAX<5.22E-01 AVE<5.02E-01 MIN<5.02E-01
699 36 61A	MAX AVE<8.00E-02* MIN	MAX 3.40E 00 AVE 1.48E 00 MIN 5.60E-01	MAX 1.12E 01 AVE 1.24E 01 MIN 9.72E 00
699 37 43	MAX<8.00E-02 AVE<7.63E-02 MIN<7.50E-02	MAX 2.60E 00 AVE 1.29E 00 MIN<6.40E-01	MAX 5.32E-01 AVE 5.27E-01 MIN<5.02E-01

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

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WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 37 82A	MAX AVE MIN	MAX 1.50E 00 AVE 9.55E-01 MIN<6.60E-01	MAX 6.20E 01 AVE 5.23E 01 MIN 4.50E 01
699 38 70	MAX 2.80E-01 AVE 2.30E-01 MIN 1.90E-01	MAX 5.40E 01 AVE 4.20E 01 MIN 3.00E 01	MAX 2.70E 02 AVE 2.54E 02 MIN 2.25E 02
699 39 79	MAX AVE MIN	MAX 1.40E 00 AVE 1.18E 00 MIN<1.00E 00	MAX 1.50E 00 AVE 1.20E 00 MIN 7.00E-01
699 40 1	MAX AVE MIN	MAX 7.80E 01 AVE 6.96E 01 MIN 6.40E 01	MAX AVE MIN
699 40 33	MAX AVE MIN	MAX 1.20E 00 AVE 1.03E 00 MIN<7.00E-01	MAX AVE 7.00E-01* MIN
699 40 62	MAX AVE MIN	MAX 3.40E 01 AVE 1.12E 01 MIN 1.70E 00	MAX AVE 1.27E 01* MIN
699 41 23	MAX AVE<7.67E-02* MIN	MAX AVE 8.00E 02* MIN	MAX AVE 4.70E 01* MIN
699 42 12	MAX AVE MIN	MAX AVE 2.70E 02* MIN	MAX 7.10E 01 AVE 3.45E 01 MIN 2.20E 01
699 42 42	MAX AVE MIN	MAX AVE 7.20E 00* MIN	MAX AVE 1.55E 00* MIN
699 43 42	MAX AVE MIN	MAX AVE 5.30E 02* MIN	MAX AVE MIN
699 43 89	MAX AVE MIN	MAX AVE 1.51E 00* MIN	MAX 4.00E 01 AVE 3.58E 01 MIN 3.20E 01

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
699 44 64	MAX AVE MIN	MAX<1.20E 00 AVE<8.43E-01 MIN 6.00E-01	MAX AVE 1.15E 01* MIN
699 45 42	MAX AVE MIN	MAX AVE 6.35E 02* MIN	MAX AVE<5.00E-01* MIN
699 45 69	MAX AVE MIN	MAX 3.30E 01 AVE 8.99E 00 MIN<7.90E-01	MAX AVE 3.73E 01* MIN
699 46 21	MAX<8.00E-02 AVE<7.87E-02 MIN<7.50E-02	MAX 6.70E 00 AVE 4.73E 00 MIN 3.30E 00	MAX 6.70E 00 AVE 5.98E 00 MIN 5.20E 00
699 47 35A	MAX AVE MIN	MAX 6.10E 00 AVE 2.25E 00 MIN<7.00E-01	MAX AVE MIN
699 47 46	MAX AVE MIN	MAX<1.20E 00 AVE<7.88E-01 MIN<5.50E-01	MAX AVE 1.02E 01* MIN
699 47 60	MAX AVE MIN	MAX 8.10E-01 AVE 6.92E-01 MIN<5.00E-01	MAX AVE 1.32E 01* MIN
699 48 71	MAX AVE MIN	MAX 1.20E 00 AVE 7.50E-01 MIN<4.80E-01	MAX AVE 7.33E-01* MIN
699 49 55	MAX AVE<7.50E-02* MIN	MAX<1.20E 00 AVE<7.86E-01 MIN 5.00E-01	MAX 9.00E 00 AVE 4.00E 00 MIN<4.00E-01
699 49 57	MAX AVE 1.53E 00* MIN	MAX 3.80E 02 AVE 2.68E 02 MIN 4.00E-02	MAX AVE 1.07E 02* MIN
699 49 79	MAX AVE MIN	MAX AVE<1.40E 00* MIN	MAX AVE 1.95E 01* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

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WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
699 50 28A	MAX AVE MIN	MAX<8.50E-01 AVE<7.23E-01 MIN<4.80E-01	MAX 7.10E 00 AVE 6.33E 00 MIN 5.70E 00
699 50 42	MAX AVE MIN	MAX AVE 1.60E 00* MIN	MAX AVE 1.43E 00* MIN
699 50 53	MAX AVE MIN	MAX 3.50E 00 AVE 2.23E 00 MIN 1.00E 00	MAX AVE 2.53E 01* MIN
699 51 63	MAX AVE MIN	MAX AVE 6.20E-01* MIN	MAX AVE 1.50E 00* MIN
699 51 75	MAX AVE MIN	MAX<1.30E 00 AVE<8.12E-01 MIN<5.50E-01	MAX AVE 1.60E 01* MIN
699 53 47	MAX AVE MIN	MAX 2.50E 00 AVE 1.24E 00 MIN 5.60E-01	MAX<5.00E-01 AVE<5.00E-01 MIN<5.00E-01
699 53 55A	MAX AVE MIN	MAX 3.00E 00 AVE 1.75E 00 MIN 7.90E-01	MAX AVE<5.00E-01* MIN
699 54 42	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE MIN
699 54 45	MAX AVE MIN	MAX 1.40E 00 AVE 9.82E-01 MIN 6.30E-01	MAX AVE MIN
699 54 57	MAX AVE MIN	MAX 4.70E 00 AVE 1.83E 00 MIN 7.00E-01	MAX AVE<5.00E-01* MIN
699 55 50C	MAX AVE MIN	MAX 1.30E 00 AVE 8.15E-01 MIN<4.80E-01	MAX 6.00E-01 AVE 5.56E-01 MIN<5.00E-01

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

APPENDIX A, GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

PAGE 16

WELL NO.	GROSS BETA (PCI/ML)	TRITIUM (PCI/ML)	NITRATE (MG/L)
-----	-----	-----	-----
699 55 70	MAX AVE MIN	MAX AVE MIN	MAX AVE<5.00E-01 MIN
699 55 76	MAX AVE MIN	MAX AVE MIN	MAX AVE<5.00E-01 MIN
699 57 83	MAX AVE MIN	MAX AVE MIN	MAX AVE<5.00E-01 MIN
699 59 58	MAX AVE MIN	MAX 4.80E 00 AVE 4.20E 00 MIN 3.50E 00	MAX AVE 6.23E-01 MIN
699 59 80R	MAX AVE MIN	MAX AVE MIN	MAX AVE 3.77E 01 MIN
699 60 57	MAX AVE MIN	MAX 2.60E 00 AVE 1.30E 00 MIN<4.80E-01	MAX AVE<5.00E-01 MIN
699 60 60	MAX AVE MIN	MAX 2.70E 00 AVE 2.28E 00 MIN 1.70E 00	MAX AVE 5.67E-01 MIN
699 61 62	MAX AVE MIN	MAX 2.30E 00 AVE 1.83E 00 MIN 1.30E 00	MAX AVE 6.33E-01 MIN
699 61 66	MAX AVE MIN	MAX<8.30E-01 AVE<6.47E-01 MIN<4.80E-01	MAX AVE MIN
699 62 31	MAX AVE MIN	MAX AVE MIN	MAX AVE<5.00E-01 MIN
699 62 43F	MAX AVE MIN	MAX AVE MIN	MAX AVE 1.10E 00 MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

PAGE 17

WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 63 58	MAX AVE MIN	MAX 3.70E 00 AVE 2.21E 00 MIN <7.30E-01	MAX AVE 5.03E-01* MIN
699 64 62	MAX AVE MIN	MAX 2.60E 00 AVE 1.76E 00 MIN 9.60E-01	MAX AVE 7.07E-01* MIN
699 65 50	MAX AVE MIN	MAX AVE 2.15E 00* MIN	MAX AVE 7.10E 00* MIN
699 65 59	MAX AVE MIN	MAX AVE 2.10E 00* MIN	MAX AVE <5.00E-01* MIN
699 65 72	MAX AVE MIN	MAX 1.70E 00 AVE 1.40E 00 MIN 1.20E 00	MAX AVE 3.30E 00* MIN
699 65 83	MAX AVE MIN	MAX 2.90E 00 AVE 2.48E 00 MIN 2.30E 00	MAX AVE 1.85E 00* MIN
699 66 23	MAX AVE MIN	MAX AVE MIN	MAX AVE <5.00E-01* MIN
699 66 39	MAX AVE MIN	MAX AVE MIN	MAX AVE <5.00E-01* MIN
699 66 58	MAX AVE MIN	MAX 2.90E 00 AVE 2.16E 00 MIN 1.40E 00	MAX AVE 5.73E-01* MIN
699 66 64	MAX AVE MIN	MAX 1.20E 00 AVE 9.60E-01 MIN 6.40E-01	MAX AVE 6.63E-01* MIN
699 67 51	MAX AVE MIN	MAX AVE 1.37E 00* MIN	MAX AVE 5.17E-01* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

PAGE 18

WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 67 86	MAX AVE MIN	MAX AVE 2.60E 00* MIN	MAX AVE 1.30E 00* MIN
699 67 98	MAX AVE MIN	MAX AVE<9.20E-01* MIN	MAX AVE 2.60E 00* MIN
699 68 105	MAX AVE MIN	MAX AVE 1.00E 00* MIN	MAX AVE 1.00E 00* MIN
699 69 38	MAX AVE MIN	MAX AVE 1.05E 00* MIN	MAX AVE 8.00E-01* MIN
699 69 45	MAX AVE MIN	MAX AVE 3.25E 00* MIN	MAX AVE<5.00E-01* MIN
699 70 68	MAX AVE MIN	MAX AVE 1.12E 00* MIN	MAX AVE 1.40E 00* MIN
699 71 30	MAX AVE MIN	MAX AVE 1.05E 00* MIN	MAX AVE 1.30E 00* MIN
699 71 52	MAX AVE MIN	MAX AVE 3.65E 00* MIN	MAX AVE 5.10E 00* MIN
699 71 77	MAX AVE MIN	MAX 1.70E 00 AVE 1.26E 00 MIN 8.40E-01	MAX AVE 1.30E 00* MIN
699 72 73	MAX AVE MIN	MAX AVE<1.00E 00* MIN	MAX AVE 1.60E 00* MIN
699 72 88	MAX AVE MIN	MAX AVE 1.00E 01* MIN	MAX AVE 1.40E 00* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

PAGE 19

WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 72 92	MAX AVE MIN	MAX AVE 1.40E 01* MIN	MAX AVE 3.40E 00* MIN
699 74 44	MAX AVE MIN	MAX<8.40E-01 AVE<5.75E-01 MIN<4.80E-01	MAX AVE<5.00E-01* MIN
699 74 48	MAX AVE MIN	MAX 2.40E 00 AVE 1.84E 00 MIN 1.30E 00	MAX AVE 3.60E 00* MIN
699 74 60	MAX AVE MIN	MAX<1.10E 00 AVE<7.85E-01 MIN 5.00E-01	MAX AVE 7.00E-01* MIN
699 77 36	MAX AVE MIN	MAX 1.30E 00 AVE 8.65E-01 MIN 5.40E-01	MAX AVE 2.45E 02* MIN
699 77 54	MAX AVE MIN	MAX AVE<8.50E-01* MIN	MAX AVE 5.50E 00* MIN
699 78 62	MAX AVE MIN	MAX 1.10E 00 AVE 8.15E-01 MIN 5.70E-01	MAX AVE 4.30E 00* MIN
699 80 43S	MAX AVE MIN	MAX AVE 7.85E-01* MIN	MAX AVE 3.50E 00* MIN
699 81 58	MAX AVE MIN	MAX 1.10E 00 AVE 8.40E-01 MIN 5.00E-01	MAX AVE 9.00E-01* MIN
699 84 35A	MAX AVE MIN	MAX AVE<8.90E-01* MIN	MAX AVE 4.70E 00* MIN
699 87 55	MAX AVE MIN	MAX 1.00E 02 AVE 8.35E 01 MIN 7.20E 01	MAX AVE 9.95E 00* MIN

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

APPENDIX A. GROSS BETA, TRITIUM & NITRATE CONCENTRATIONS
IN THE GROUND WATER (UNCONFINED AQUIFER)

(CY-1975)

PAGE 20

WELL NO. -----	GROSS BETA (PCI/ML) -----	TRITIUM (PCI/ML) -----	NITRATE (MG/L) -----
699 89 35	MAX AVE MIN	MAX 8.70E-01 AVE 7.75E-01 MIN<7.30E-01	MAX AVE 5.80E 00* MIN
699 90 45	MAX AVE MIN	MAX AVE 3.00E 01* MIN	MAX AVE 1.40E 00* MIN
699 96 49	MAX AVE MIN	MAX AVE 1.70E 01* MIN	MAX AVE 5.20E 00* MIN
699 97 43	MAX AVE MIN	MAX AVE 7.90E 00* MIN	MAX AVE 3.85E 00* MIN
699 HAN 6	MAX AVE MIN	MAX 1.90E 00 AVE 1.04E 00 MIN<4.80E-01	MAX 3.50E 00 AVE 3.12E 00 MIN 2.70E 00
699 HAN 9	MAX AVE MIN	MAX AVE MIN	MAX 4.80E 00 AVE 3.72E 00 MIN 3.00E 00
699 HAN 19	MAX AVE MIN	MAX 1.70E 00 AVE 1.00E 00 MIN 5.00E-01	MAX AVE 2.23E 00* MIN

APPENDIX B

ROUTINE ANALYSES FOR MATERIALS OTHER THAN PRIMARY TRACERS

APPENDIX B

ROUTINE ANALYSES FOR MATERIALS OTHER THAN PRIMARY TRACERS

B-2

<u>WELL NUMBER</u>	<u>DATE</u> (1975)	<u>Cr⁺⁶</u> (ppb)	<u>F⁻</u> (ppm)	<u>U</u> (pCi/l)	<u>⁶⁰Co</u> (pCi/l)	<u>¹⁰⁶Ru</u> (pCi/l)	<u>¹³⁷Cs</u> (pCi/l)	<u>⁹⁰Sr</u> (pCi/l)
199-B3-1	5-28				36±24			
	11-25				<18	<110	<29	
B4-3	10-1				21±23	110±130	<39	
H4-3	1-27	1400	0.1					
	3-31	690	<0.1					
	5-27	260	<0.1		29	140		
	11-24	1600	0.6					
N-15	5-28				130	280		15
	11-25				97±27	350±120	<17	37±6.8
399 1-1	1-16		1.4					
	2-19	4	0.9	103				
	3-12		1.2					
	4-18	3.9	1.0	103				
	5-21		1.1					
	6-12		1.2	161				
	7-15		0.8					
	9-10		1.0					
	10-16	9.0	1.1					
	11-12		1.2					
	12-11		1.6	42.5				
1-2	1-27	<3.0	0.4					
	3-31	<3.0	0.7					
	5-27	9.1	1.0					
	7-28	<3.0	0.9					
	9-29	4.0	0.3					
	11-24	7.2	0.6					
1-3	1-16		1.4					
	2-19	<3.0	1.1	82				
	3-12		1.4					
	4-18	8.5	1.9	75.4				
	5-21		1.9					
	6-11		1.7	106				

WELL NUMBER	DATE (1975)	Cr ⁺⁶ (ppb)	F ⁻ (ppm)	U (pCi/l)	⁶⁰ Co (pCi/l)	¹⁰⁶ Ru (pCi/l)	¹³⁷ Cs (pCi/l)	⁹⁰ Sr	
399 1-4	7-15	<3.0	0.6						
	8-12	8.3	1.2	37					
	9-10		0.4						
	10-16	9.0	0.6						
	11-11		0.7						
	12-11		0.6	28.8					
	1-27	4.5	0.4						
	3-31	<3.0	0.5						
	7-28	<3.0	0.6						
	10-16	<3.0	0.5						
	3-1	1-16	1.8	1.4					
		2-19	30.	1.1	32.8				
	3-12	4.8	1.5						
	4-18	6.2	1.3	110					
	5-21	3.6	1.0						
	6-12	<3.0	1.0	52.8					
	7-15	<3.0	0.9						
	8-12	4.0	1.2						
	9-10	4.0	0.9						
	10-16	<3.0	1.2						
	11-12	2.2	1.3						
	12-11	<3.0	1.6	22.6					
	3-8	4-18	3.9	1.0					
		8-12	<3.0	0.5					
10-16		<3.0	0.8						
4-1		1-27	8.5	0.4					
		3-31	<3.0	0.6					
		5-27	11.0						
		7-28	<3.0	0.4					
		9-29	<3.0	0.5					
11-24		2.0							
4-7		1-27	6.3	0.6					
		5-27	11.0						
		7-28	<3.0	0.6					
		9-29	5.0	1.1					
	11-24	2.0							

B-4

WELL NUMBER	DATE (1975)	Cr ⁺⁶ (ppb)	F ⁻ (ppm)	U (pCi/l)	⁶⁰ Co (pCi/l)	¹⁰⁶ Ru (pCi/l)	¹³⁷ Cs (pCi/l)	⁹⁰ Sr
5-1	1-27	<3.0	0.1					
	3-31	4.8	0.3					
	7-28	6.8	0.2					
	9-29	6.0	0.3					
6-1	1-27	<3.0	0.1					
	3-31	<3.0	0.3					
	7-28	<3.0	0.3					
	8-12	<3.0	0.2					
399 8-2	9-29	<3.0	0.3					
	1-29	4.4	0.3					
	4-2	<3.0	0.3					
	8-1	<3.0	0.3		37±26	210±150		
8-3	10-2	<3.0	0.3					
	1-27	<3.0	0.3					
	3-31	<3.0	0.3					
	7-28	<3.0	0.3					
699-S6-E4B	9-29	<3.0	0.3					
	6-30			9.6				
	10-27			11				
	12-29			<3.4				
S19-E13	1-27	<3.0	0.3					
	3-26	<3.0	0.3					
	7-28	<3.0	0.2					
	9-29	<3.0	0.5					
S27-E14	1-29	<3.0	0.2					
	4-2	<3.0	0.3					
	8-1	<3.0	0.2					
	10-2	<3.0	0.3					
S29-E12	1-29	<3.0	0.2					
	4-2	<3.0	0.3					
	8-1	3.0	0.2					
	10-2	<3.0	0.3					
S30-E15A	1-29	<3.0	<0.1					
	4-2	<3.0	<0.1					
	8-1	<3.0	<0.1					
	10-2	<3.0	<0.1					
10-54	4-3					<140		
	10-1				33±24	<200	<32	

B-5

WELL NUMBER	DATE (1975)	Cr ⁺⁶ (ppb)	F ⁻ (ppm)	U (pCi/l)	⁶⁰ Co (pCi/l)	¹⁰⁶ Ru (pCi/l)	¹³⁷ Cs (pCi/l)	⁹⁰ Sr
20-20	8-1				85±27	220±130		
26-15	7-31					160±130		
33-42	4-3				66	390		
	10-3				46±26	150±130	<24	
34-51	5-27				27			
	11-24				<24	<96	<32	
36-46P	7-1				28±23			
	11-4				<21	<160	<22	
36-46Q	11-4				<32	<140	<25	
699-38-70θ	11-4				<17	120±120	<17	
40-33	1-16							1.8
	3-11							6
	5-20							3.5
	7-15							<3.0
	9-9							2.0±1.5
	11-14							2.5±1.0
42-42θ	2-10							<2.0
	4-14							1.8
	6-10							<3.2
	8-12							4.7±2.2
	10-14							4.3±1.9
	12-8							<2.0
43-42	1-21							32
	11-14							39.9±6.8
50-53	2-27					<140		
	5-30				120	190		
	8-28				170±32	<210	25±24	
	12-2					<120		
64-27	11-24		0.1					

APPENDIX C

SPECTROGRAPHIC AND RADIOCHEMICAL ANALYSES FROM VARIOUS WELLS SAMPLED

APPENDIX C

SPECTROGRAPHIC AND RADIOCHEMICAL ANALYSES FROM VARIOUS WELLS SAMPLED

JUNE 1975

ANALYSES BY U.S.G.S. LABORATORY, DENVER, COLORADO

Component	Well 699- 40-1	Well 699- S6-E40	Well 699- 33-42	Well 699- 15-158	Well 699- 50-42	Well 699- 41-23	Well 699- 9-E2	Well 699- 32-22	Well 699- 17-5	Well 699- 8-32	Well 699- 49-79
Aluminum µg/l	130	30	75	5	230	14	65	100	470	10	130
Barium µg/l	40	64	37	51	48	33	48	44	67	44	30
Beryllium µg/l	<.4	<.5	<.5	<.4	<.4	<.5	<.4	<.5	<.5	<.4	<.4
Bismuth µg/l	<2	<2	<2	<2	<2	<2	<2	<3	<2	<2	<2
Boron µg/l	16	20	30	20	16	20	20	15	15	17	12
Cadmium µg/l	<3	10	30	<4	<3	<4	<3	<5	<4	<4	<4
Chromium µg/l	3	<1	5	<1	<.8	1	<.8	4	1	<1	<1
Copper µg/l	22	4	25	2	10	2	7	5	4	2	7
Cobalt µg/l	<2	<2	<2	<2	<2	<2	<2	<3	<2	<2	<2
Gallium µg/l	<.8	<1	<1	<1	<.7	<1	<.7	<1	<1	<1	<1
Germanium µg/l	<2	<2	<2	<2	<2	<2	<2	<3	<2	<2	<2
Iron µg/l	300	330	1700	10	1500	350	250	250	4500	80	1200
Lead µg/l	4	4	10	3	5	<2	5	4	10	2	7
Lithium µg/l	6	7	7	6	6	5	10	5	5	6	3
Manganese µg/l	17	480	50	40	23	25	140	12	55	66	23
Molybdenum µg/l	2	5	7	3	5	7	7	3	<1	7	2
Nickel µg/l	2	5	5	<2	3	3	2	3	5	3	3
Silver µg/l	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.3	<.2	<.2	<.2
Strontium µg/l	220	220	200	200	190	260	190	270	190	190	150
Tin µg/l	<2	<2	<2	<2	<2	<2	<2	<3	<2	<2	<2
Titanium µg/l	12	<1	4	<1	40	<1	5	5	25	<1	10
Vanadium µg/l	15	2	11	10	18	10	<1	10	8	4	13
Zinc µg/l	10	1600	20	100	100	30	17	12	50	10	45
Zirconium µg/l	<4	<4	<5	<4	<4	<5	<4	<5	<5	<4	<4
Analyzed Solids mg/l	351	410	435	379	330	457	330	471	426	363	384
Tritium pCi/ml	84	2.7	1100	<.48	<.48	890	<.48	1500	<.48	<.48	<.48
Diss. Gross α µg/ml	31	8.6	11	16	13	24	45	13	12	5.6	5.6
Diss. Gross β as Sr/Y-90 pCi/ml	.025	.0085	.12	.0087	.01	.06	.018	.21	.0086	.0063	.0068
Diss. Gross β as ¹³⁷ Cs pCi/ml	.031	.011	.16	.011	.013	.074	.023	.24	.01	.0078	.0085
¹³⁷ Cs pCi/ml	.0032	.0002	.002	<.0001	.0006	.0013	.0002	.0048	<.0001	<.0001	.0004
⁹⁰ Sr pCi/ml	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

APPENDIX C

WATER QUALITY RESULTS FROM VARIOUS WELLS SAMPLED JUNE 1975 ANALYSIS BY CENTRAL LABORATORY, USGS, SALT LAKE CITY, UTAH

Quality Component	Well 699-40-1	Well 699-S6-E40	Well 699-33-42	Well 699-15-15B	Well 699-50-42	Well 699-41-23	Well 699-9-E2	Well 699-32-22	Well 699-17-5	Well 699-8-32	Well 699-49-79
Alk. Tot (CaCO ₃)	120	147	107	123	106	108	131	105	106	123	94
Arsenic Dissolved	4	1	1	4	4	2	10	3	4	1	0.
Bicarbonate	146	179	131	150	129	132	160	128	129	150	114
Bromide	0.1	0.2	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.3
Calcium Dissolved	40	45	41	47	31	48	24	53	61	40	44
Carbon Dioxide											
Carbonate											
Chloride Dissolved	6.9	3.4	3.1	6.0	11	15	3.5	17	14	5.5	11
Chromium Dissolved	0	10	10	0	10	10	0	10	0	0	0
Chromium Hexavalent	2	0	0	0	0	0	0	0	0	0	0
Color	0	5	4	2	2	1	2	2	0	3	0
Conductivity	357	416	448	408	330	507	322	533	457	361	388
Copper Dissolved	47	0	30	1	22	0	6	4	0	1	8
Cyanide	0	0	0	0	0	0	0	.01	0	0	0
Fluoride Dissolved	0.4	0.4	0.6	0.4	0.5	0.4	0.4	0.4	0.3	0.4	0.3
Hardness Noncarb	25	15	48	33	21	73	0	85	92	18	78
Hardness Total	150	160	160	160	130	180	100	190	200	140	170
Hydroxide	0	0	0	0	0	0	0	0	0	0	0
Iodide	0	.01	0	0	0	0	.01	.01	0	0	0
Iron Dissolved	180	130	730	20	970	310	130	120	3900	360	590
Iron Ferrous	190	100	560	30	700	310	130	120	1600	380	530
Magnesium Dissolved	11	12	13	9.3	12	15	9.7	14	11	10	15
Nitr. NO ₂ as NO ₂ Diss	.03	.03	0	0	0	.03	0	0	0	0	0
Nitr. NO ₃ as NO ₃ Diss	24	6.6	49	16	3.1	.53	1.2	75	53	9.3	44
Nitr. NH ₄ as N Tot	0	.01	0	.04	0	0	.06	0	0	0	0
Nitr. NO ₂ as N Tot	.01	.01	0	0	0	.01	0	0	0	0	0
Nitr. NO ₃ as N Diss	5.4	1.5	11	3.6	.71	12	.26	17	12	2.1	10
NO ₂ + NO ₃ as N Diss	5.4	1.5	11	3.6	.71	12	.26	17	12	2.1	10
PH	7.7	7.5	7.7	7.7	7.8	7.7	7.8	7.7	7.8	7.8	7.6
Phosphorus Tot as P	.07	.02	.03	.05	.03	.03	.04	.04	.07	.09	.04
Potassium Diss	6	6.6	6.9	7.2	5.9	7.3	6.9	7	6.4	5.9	4.2
Residue Diss Calc Sum	241	269	250	267	229	347	220	356	306	237	267
Residue Diss Ton/Aft	.33	.30	.34	.36	.31	.47	.30	.48	.42	.32	.36
SAR	0.6	0.8	1.1	0.7	0.7	1	1.3	1	0.4	0.7	0.3
Selenium Dissolved	2	2	3	7	5	3	0	2	3	2	5
Silica Dissolved	37	32	38	30	44	36	37	29	28	28	37
Sodium Dissolved	17	22	31	20	18	30	30	31	12	18	8.7
Sodium Percent	20	22	29	21	23	25	38	25	11	21	10
Sulfate Dissolved	26	2.2	2.4	57	39	77	28	66	53	45	45
Turbidity (JTV)	4	5	39	4	13	2	2	6	31	3	2
Water Temperature						17.7	17.9	18.5	16.2		

* All units in mg/l unless otherwise noted.

APPENDIX D

SPECIAL ANALYSES FOR QUALITY ASSURANCE

APPENDIX D

Special Analyses for Quality Assurance

Well #	Date	pCi/ml Beta	pCi/ml ³ H	pCi/ml ⁶⁰ Co	pCi/ml ¹⁰⁶ Ru	pCi/ml ¹³⁷ Cs	ppm NO ₃ ⁻
699-S3-25	10-28-75		<0.88 <1.0				<0.5 <0.5
699-37-82Aθ	10-28-75		0.92±0.88 1.3 ±0.92				55 1.4
699-15-15B	10-28-75	<0.08 <0.08	<1.0 <1.1				8.9 13
699-38-70	11-4-75	0.23 0.23	34 36	<0.017 .033±.022	0.12±0.12 0.16±0.12	<0.017 0.018±0.021	260 180
699-49-57	2-27-76	1.2 1.3	340 310				200 190
699-32-77	2-26-76	<0.08 <0.075	<1.2 <1.3				6.4 6.2
699-49-55	2-27-76	<0.08 <0.075	<1.4 <1.4				4.2 4.1
699-35-70	2-26-76	0.085 0.13	8600 8300				20 16

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FIGURE 4. NITRATE CONCENTRATIONS DEC, 1975