ARH-C-00017

HYDROLOGY MODEL EVALUATION
AT THE
HANFORD NUCLEAR WASTE FACILITY

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or 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.

INTERA Environmental Consultants Inc.
1201 Dairy Ashford, Suite 200
Houston, Texas 77079

CONSULTANT REPORT
THIS REPORT WAS PREPARED BY A CONSULTANT IN CONNECTION WITH WORK PERFORMED UNDER CONTRACT WITH THE U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION. THE FINDINGS, VIEWS AND RECOMMENDATIONS ARE SOLELY THE AUTHOR'S AND DO NOT NECESSARILY REFLECT THE POSITION OR POLICY OF THE CONTRACTOR OR OF THE ADMINISTRATION. THIS REPORT IS NOT TO BE INTERPRETED AS INDICATING OR IMPLYING THAT RECOMMENDED ACTIONS WILL BE TAKEN.

April 1977

This report is based on work sponsored by Atlantic Richfield Hanford Company under U. S. Energy Research and Development Administration Contract EY-76-C-06-2130.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

EBB

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.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

	<u>Page</u>
1.0 EXECUTIVE SUMMARY	1
2.0 INTRODUCTION	3
3.0 APPROACH	4
3.1 Description of the Model	4
3.2 Work Organization	7
4.0 RESULTS	9
4.1 Well Test Interpretation	9
4.1.1 Well 26-15	9
4.1.2 Well 36-61A	9
4.1.3 Well 35-9	12
4.2 Numerical Grid System	12
4.3 Flow Solution	19
4.4 Contaminant Solution	24
5.0 CONCLUSIONS	41
6.0 ADDITIONAL MODEL INPUT DATA NEEDED	42
7.0 REFERENCES	43
<u>APPENDIX A</u> SUMMARY OF EQUATIONS SOLVED	
<u>APPENDIX B</u> ARHCO SUPPLIED DATA USED IN THIS STUDY	
<u>APPENDIX C</u> TYPICAL MODEL OUTPUT	

LIST OF FIGURES

	<u>Page</u>
1. A Cross Section of the Aquifer Modeled	8
2. The Hanford Reservation Region Included in the INTERA Numerical Grid System	10
3. Pumping Test Potential Match for Well 26-15	11
4. Pumping Test Potential Match for Well 36-61A	13
5. Pumping Test Potential Match for Well 35-9	14
6. Aquifer Thickness, in feet, Measured from 580 Feet Above msl to Aquifer Bottom	16
7. Horizontal Hydraulic Conductivities for the Upper Ringold Aquifer	17
8. Numerical Grid System	18
9. Initial Potentials Used in the Numerical Model Runs (January, 1968)	21
10. Two-Dimensional Model Calculated Potentials for January, 1972	22
11. Three-Dimensional Model Calculated Potentials for January, 1972	23
12. a. Two-Dimensional Model, Horizontal Velocities	25
b. Three-Dimensional Model, Horizontal Velocities in the Top Layer, k=1	25
c. Three-Dimensional Model, Horizontal Velocities in the Middle Layer, k=2	25
d. Three-Dimensional Model, Horizontal Velocities in the Bottom Layer, k=3	26
e. An x-z Cross Section Showing Vertical Velocities, J=9	26
f. A y-z Cross Section Showing Vertical Velocities, I=16	26
13. Vertically Averaged Concentrations	28
14. Initial Tritium Concentrations Used in the Numerical Model Runs	30

LIST OF FIGURES (Continued)

	<u>Page</u>
15. Two-Dimensional Model Surface Tritium Concentrations, January, 1971	32
16. Two-Dimensional Model Surface Tritium Concentrations, January, 1974	33
17. Three-Dimensional Model Surface Tritium Concentrations, January, 1971	34
18. Three-Dimensional Model Surface Tritium Concentrations, January, 1974	35
19. Three-Dimensional Model Surface Tritium Concentrations Using Reduced Dispersivities, January, 1971	36
20. A Comparison of Observed and Calculated (Three-Dimensional, Reduced Dispersivities) Surface Tritium Concentrations, January, 1971	38
21. Comparison of Normalized Vertical Concentration Profiles	39

LIST OF TABLES

		<u>Page</u>
Table I	Source Locations and Their Identification	20
Table II	Reduction of Surface Concentrations to the Vertically Averaged Values	27

HYDROLOGY MODEL EVALUATION
AT THE
HANFORD NUCLEAR WASTE FACILITY

1.0 EXECUTIVE SUMMARY

The purpose for and approach to the hydrology model evaluation were as follows:

- (1) One and two-dimensional flow and contaminant transport computer models have been developed at Hanford to assess the rate and direction of contaminant movement from waste disposal sites. Recent field evidence, however, indicates there could be significant three-dimensional effects. The primary objective of this work was to evaluate the potential improvement in accuracy that a three-dimensional model might offer over the simpler one and two-dimensional models. INTERA's hydrology contaminant transport model was used for this evaluation.
- (2) Although this study was conceptual in nature, an attempt was made to relate it as closely as possible to Hanford conditions by selecting a 160 square mile areal section of the Hanford unconfined and semiconfined aquifer system for 6-year comparison simulations. This section included almost the entire area contaminated by more than 30 picoCuries per milliliter of radioactive tritium originating from the 200 East and West areas disposal sites. Currently available Hanford data, as well as best guess reasonable assumptions, were used in preparing the conceptual description upon which the model runs were based.
- (3) The model was also used to perform well test interpretations to confirm the areal distributions of hydraulic conductivity provided by Atlantic Richfield Hanford Company to extract, if possible, information regarding the vertical variation in hydraulic conductivity.
- (4) Two-dimensional model runs were performed over the period of 1968-1973 using estimates of waste discharge flows, tritium concentrations, vertically averaged values of aquifer properties and boundary conditions as supplied by ARHCO. Both flow and a single contaminant (tritium) transport were simulated.

- (5) Three-dimensional model runs were also conducted over the 1968-1973 period using the same values for waste discharges and boundary conditions but representing the unconfined aquifer by three vertical blocks. In this way, simulation of vertical movement of both liquid and contaminant was possible, which was not the case with the two-dimensional runs.
- (6) The two and three-dimensional runs were made on the same INTERA model to avoid any confusion over factors other than dimensionality.

The results can be summarized as follows:

- (1) The well test interpretation runs confirmed the applicability of the areal hydraulic conductivity distribution as supplied by ARHCO; but the well data were insufficient to obtain meaningful values of vertical hydraulic conductivity. A horizontal to vertical conductivity ratio of ten was assumed for subsequent modeling runs based upon INTERA's experience with geologically similar systems.
- (2) Velocity fields calculated by the two-dimensional and three-dimensional models were substantially different. The travel times for tritium particles to reach the river appear to be better characterized by the three-dimensional model based upon comparison with observed results.
- (3) Surface concentration profiles calculated by the two-dimensional and three-dimensional models show significant differences over most of the Hanford Reservation. Modeling results can be significantly improved by using a three-dimensional model.
- (4) Vertical concentration profiles calculated by a three-dimensional model show better qualitative agreement with the limited observed concentration profile data supplied by ARHCO.

In order to conduct a truly quantitative, three-dimensional model study of the Hanford Reservation additional data are needed for vertical hydraulic conductivities, field values of longitudinal and lateral dispersivities and vertical distribution of various contaminants.

The movement of waste liquid and associated contaminants from the surface and near surface waste disposal sites to the underlying aquifer contains considerable uncertainty. These are, however, important factors in providing accurate source input rates into a saturated flow and contaminant simulation of the Hanford groundwater system.

2.0 INTRODUCTION

Radioactive waste disposal at the Hanford nuclear waste facility has at times involved discharge of cooling and process water into surface level ponds. Waste water containing some radioactive and chemical contaminants including tritium has been discharged into covered, near surface disposal structures called cribs. Water and contaminants from these sources have slowly moved downward into underground aquifers.

To assess the rate and direction of contaminant movement from waste disposal sites, one and two-dimensional transport models have been developed at Hanford. However there is recent field evidence to indicate there could be significant three-dimensional effects. From piezometer data wastes from the 200 W area have been deduced by Ledgerwood and Deju¹ as flowing beneath those from 200 E. As a consequence vertically averaged flow and contaminant transport from a two-dimensional model might introduce substantial inaccuracies in waste disposal contingency plans. The primary objective of this work was to evaluate the potential improvement in accuracy that a three-dimensional model might offer over a two-dimensional one.

A three-dimensional model is capable of defining vertical concentration profiles and flow patterns, as opposed to vertically averaged concentrations and velocities used in a two-dimensional model. INTERA's three-dimensional hydrology contaminant transport model² is capable of evaluating the magnitudes of vertical velocities and the effects of these velocities on the concentration profiles and overall contaminant movement.

As a test case, the period 1968-1973 was selected for model calculations. These calculations covered almost the entire Hanford, near surface, ground water region containing at least 30 pci/ml of tritium originating from the 200 E and W areas disposal sites³. The aquifer properties, initial and boundary conditions used for the two-dimensional and three-dimensional runs were made totally consistent. A comparison was made of the calculated concentration profiles from each model to detect any significant differences and see whether improvement with observed results was experienced by using the three-dimensional INTERA model.

3.0 APPROACH

3.1 Description of the Model

The hydrology contaminant transport model consists of two basic parts. The first calculates the single phase flow of a slightly compressible liquid in a porous medium. The second part calculates the movement and hydrodynamic dispersion of a contaminant flowing in this velocity field.

The flow model is a numerical solution of the basic conservation of total aqueous mass partial differential equation. This equation is simply the combination of the equation of continuity and Darcy's law in a porous medium. The equations solved are completely three-dimensional. A completely heterogeneous description in terms of permeability, porosity, aquifer thickness and topographic surface is permitted. The basic assumptions are constant fluid density (i.e. independent of contaminant concentration) and constant net aquifer compressibility (sum of formation and fluid compressibilities).

The contaminant transport model is a numerical solution of the partial differential equation describing the conservation of a trace contaminant flowing in the water. The water flow rates calculated in the first part of the model are used to convect the contaminant and calculate the hydrodynamic dispersion.

The equations being solved in this model are discussed in Appendix A.

The initial potentials and concentrations can be specified in every grid block. The flux or potential boundary conditions can be specified by means of injection/production wells. Potentials in every boundary block for the entire period of simulation were specified in this study. In addition, the model offers the options to specify potentials along one edge of the aquifer and a migration velocity. However, these options were not used.

The model includes an option to enter thickness of each block for two-dimensional areal problems.

For unconfined aquifers, a free water surface can exist inside a grid block. Under these conditions the effective transmissibilities at the block edges and the filled pore volume are less than the total block transmissibility and the total pore volume. The transmissibility at a block edge is reduced by an arithmetic average ratio of the saturated water thickness of the two blocks to the total block thicknesses

at the beginning of each time step. Since the potential changes over each time step are small, it is not necessary to iterate over the change in transmissibilities. Diffusion transmissibilities do not change because of free water surface since hydrodynamic dispersivity is proportional to velocity (flow rate/cross section to flow), and the transmissibility is a product of hydrodynamic dispersivity and the cross section to flow. In addition to the flow transmissibilities, accumulation terms in both flow and concentration equations change. The net accumulation term for a confined

aquifer is $(PV)C_{WR} \frac{\partial h}{\partial t}$, where PV is the pore volume, C_{WR} is total water and rock compressibility and $\frac{\partial h}{\partial t}$ is the change in potential

with respect to time. For an unconfined aquifer, compressibility effects can be neglected and the accumulation term

reduced to $\frac{PV}{\Delta z} \frac{\partial h}{\partial t}$, where Δz is the "total" aquifer block

thickness. The accumulation term in the concentration equation is simply fluid volume multiplied by the rate of change of concentration. The fluid volume changes with the free water surface.

The model was modified to permit specification of the half-life of contaminant. The concentration equation can be solved at user option, by finite difference techniques or by the point tracking method of characteristics⁴.

The model also offers the option to solve two-dimensional flow and concentration equations by a line successive over-relaxation (LSOR) method or by a direct solution method⁵. An optimum overrelaxation parameter is calculated for each of the two equations. If the time step changes by a factor of two or more, the parameters are recalculated. This procedure, as opposed to the use of a constant LSOR parameter, results in considerably less iterations for the actual solution to converge. The convergence criterion is the change in dependent variable over the iteration divided by the change over the time step. The LSOR method was used for the convection-diffusion solution.

The boundary conditions for the flow solution included specification of potentials at each peripheral grid block for the entire period of calculations. This was done because only a subregion of the area included in the Hanford two-dimensional calculations was modeled in this work and consistency with the previous work was desired. The number of constraints caused a slight difficulty in convergence of the two-dimensional flow solution. The three-dimensional

solution was much more difficult to converge than the two-dimensional one because of substantial transmissibility contrast in the vertical direction versus that in the horizontal direction. Therefore it became necessary to solve both two-dimensional and three-dimensional flow solutions by a direct solution method. The model contained a two-dimensional direct solution for the concentration equation. Only a slight modification was needed to use the same routine for the flow solution. An ordered three-dimensional Gaussian (direct) solution routine was included for the three-dimensional flow solution. Because of relatively large storage requirements for the three-dimensional direct solution, the number of grid blocks had to be restricted to 840. The total core requirement for an 840 grid block problem was approximately 97000₁₀ words. The computer processing time taken was approximately 9 seconds per time step for solving both flow and concentration equations using 8,000 moving points for the point tracking method of characteristics. The number of grid blocks can be increased to approximately 1,250 if the contaminant transport equation was eliminated. Since the direct solution requires a large core storage, this number can be increased to roughly 2,800 if the direct solution is eliminated as well.

The model contains an (r,z) coordinate option to interpret vertical and horizontal conductivity from well tests. A well test simulation should account for pressure drop between the well and the numerical grid block center (node). This is accomplished by using a well index in the INTERA model. The well index concept is based upon a steady state radial flow equation pressure drop between the well and the grid block center. The well index should include any skin factor present which causes an increase or decrease in conductivity around the wellbore.

The well rates are treated in an implicit manner in the model. The rate of injection or production is calculated at the beginning of each time step and a term representing the change in the rate due to change in the grid block pressure is added to it.

$$q^{n+1} = q^n + \frac{dq}{dh} \cdot (h^{n+1} - h^n)$$

where

$$q^n = \text{rate of injection or production at the time level } n,$$

$$h^n = \text{potential at the time level } n.$$

The term q^n is added to the right-hand side of the flow equation and $\frac{dq}{dh}$ is added to the diagonal to make the well treatment implicit. The term $\frac{dq}{dh}$ is directly proportional to the well index. If a constant rate well is desired, the well index can be specified as a very small quantity. The specification of a constant potential well actually permits the rate to change signs depending upon the magnitude of the grid block potential.

3.2 Work Organization

The study was divided into four parts: (i) well test interpretation, (ii) calculational grid setup based upon review and analysis of data provided by ARHCO, (iii) model modifications, as discussed in the previous section, and flow solution runs to observe the velocity and potential behavior consistent with observations and (iv) comparison of two-dimensional and three-dimensional flow and contaminant solution runs.

No serious effort was made to precisely match the observed concentration profiles. The costs and time required were beyond the scope of this study. The primary objective was to evaluate the difference in the results obtained from two-dimensional and three-dimensional model runs and critically review the potential improvements offered by a three-dimensional description over that of a two-dimensional.

The Hanford Reservation is located in the Pasco Basin west of the Columbia River and north of the Yakima River. The waste disposal into surface ponds and cribs flows to the Columbia River through the underground aquifers. The uppermost unconfined aquifer through which most of the discharged fluids flow consists of the Ringold formation--sands, silts and gravel and clay layers at the bottom. The thickness of the Ringold formation varies from a few tens of feet to a few hundreds of feet in places, as shown in a geological cross section of the region in Figure 1 (taken from Reference 1). The water table varies from approximately 480 feet above sea level under the ponds on the west side of the reservation (200 W) to approximately 350 feet near the Columbia River.

The available aquifer lithology, well test data and two-dimensional aquifer description were reviewed for use in INTERA's model. A few well tests were selected for numerical simulation to estimate the hydraulic conductivities in the regions where the wells are located.

FIGURE 1

A CROSS SECTION OF THE AQUIFER MODELED
(Taken From Reference 1)

4.0 RESULTS

4.1 Well Test Interpretation

The objective of simulating the well tests was to test if model calculated hydraulic conductivities were consistent with the data provided by ARHCO. The primary interest was in the wells completed in the upper Ringold. The locations of the wells selected for pumping test simulations are shown in Figure 2.

4.1.1 Well 26-15

This well was completed vertically in 116 feet of Ringold formation. The well partially penetrated the clay layer in the lower Ringold. About 48 feet were in the sand and gravel layer in the upper Ringold. This test offered an opportunity to study the flow through the clay layers. The test consisted of a step drawdown followed by a recovery period. The hydraulic conductivity in this region was calculated analytically by Deju⁶ to be 200 feet/day.

Using a one layer model for the upper Ringold, hydraulic conductivity, well index and porosity were varied to obtain the best potential match during both drawdown and recovery periods. The final match, shown in Figure 3, was obtained by using a hydraulic conductivity of 250 feet/day and a well index representing a reduced conductivity up to 1 foot from the well of 17 feet/day. The porosity, as could be expected, had essentially no effect on the calculated potentials. The effect of the clay layer was studied by using a second layer with considerably reduced conductivity (a factor of 50 to 1,000). This also had virtually no effect on the calculated potentials indicating that only a small fraction of the flow was through the clay layer.

4.1.2 Well 36-61A

This well was completed in the upper Ringold. The well was perforated from a depth of about 19 feet below the water table to about 50 feet below the water table. Therefore it was decided to use a two layer model with the well completed in the lower layer. In this case horizontal and vertical hydraulic conductivities and the well index were varied to obtain the best match. The horizontal hydraulic conductivity calculated in this region of the aquifer was 65 feet/day with a well index representing a conductivity of 20 feet/day up to

FIGURE 2

THE HANFORD RESERVATION REGION INCLUDED IN THE
INTERA NUMERICAL GRID SYSTEM

FIGURE 3

PUMPING TEST POTENTIAL MATCH FOR WELL 26-15

1 foot from the well center. The calculated potentials were relatively insensitive to the vertical conductivity. The potential match for this well test is shown in Figure 4. In terms of sensitivity the conductivity could be decreased to 40 feet/day with a corresponding increase in the well index without changing the well potentials significantly.

4.1.3 Well 35-9

In this region of the aquifer 50 feet of the upper Ringold was saturated with water, but the well was perforated in only 15 feet. The well index was adjusted accordingly to represent the partial completion of the well in a one-dimensional model. It was a simple drawdown test at a constant rate of 64 GPM for 240 minutes. The best match was obtained with a hydraulic conductivity of 42 feet/day. No reduction in permeability around the wellbore was required (see Figure 5).

Hydraulic conductivities over the complete modeling region were provided to us by ARHCO. Thus we had three sets of hydraulic conductivity values available in the regions of the above three wells--ARHCO values, those calculated by Deju⁶ and INTERA model best potential match values. These values were in good agreement. The agreement indicated that the ARHCO horizontal conductivity values could be used in the INTERA model for this study. As discussed earlier, vertical permeabilities could not be calculated with the data available. Rather, pumping tests in one zone with observation in another zone would be necessary to better evaluate vertical communication.

4.2 Numerical Grid System

An area of roughly 16 x 10 miles was selected to be included in the numerical grid system. The area encompasses 200 E and W areas bounded on the south by Rattlesnake Ridge and on the northeast by the Columbia River. This river includes almost the complete region of tritium concentrations higher than 30 pci/ml. The x-axis was at an angle of 20° measured clockwise from the east. The Hanford Reservation region modeled in this study is shown in Figure 2. The grid blocks were 3,000 feet in both the x and y directions in the region of primary interest--where the waste discharge sources are located. The bottom of the unconfined aquifer was generally defined as the point where a clay layer was encountered. The aquifer bottom data estimated from well tests were provided to us by ARHCO. A variable thickness aquifer was described

FIGURE 4

PUMPING TEST POTENTIAL MATCH FOR WELL 36-61A

FIGURE 5

PUMPING TEST POTENTIAL MATCH FOR WELL 35-9

in the INTERA model by specifying a thickness measured from a fixed elevation (580 feet above msl) in the two-dimensional model and appropriately zeroing out pore volumes in the three layers of the three-dimensional model. Aquifer thickness contours used in the two-dimensional model are shown in Figure 6. The saturated aquifer thickness (aquifer in water = water table - aquifer bottom) varies from about 15 feet between Gable Butte and Gable Mountain to about 250 feet near Rattlesnake Ridge.

The hydraulic conductivity data were also provided for each grid block location by ARHCO. This was verified to be consistent with two-dimensional model calculations and analytically calculated values from well tests. The conductivity shows a tremendous contrast over the region to be modeled--higher than 10,000 feet/day between Gable Butte and Gable Mountain to less than 10 feet/day approximately 15-20,000 feet SSW of it. The waste discharge sites in 200 W area are located in a low permeability Ringold region and, consequently, this is the region where the highest potentials are calculated. The horizontal hydraulic conductivity contours for the upper Ringold aquifer in the Hanford Reservation are shown in Figure 7.

Vertical description for the three-dimensional runs was obtained by defining the bottom of the first layer at roughly 30 feet below the water table as measured during March, 1968. Two other layers below the first one were of 80 and 200 foot thickness. The numerical grid systems used for both the two-dimensional and three-dimensional model runs are shown in Figure 8. Note that for the two-dimensional system the top of the aquifer was fixed and the thickness was varied to describe the aquifer, whereas for the three-dimensional system the top of the aquifer was varied and the thickness of the first layer was kept approximately constant.

As discussed earlier, vertical hydraulic conductivity and porosity are not well defined. Ledgerwood and Deju¹ state in their report that vertical conductivity of the interbeds is at least an order of magnitude smaller than the horizontal conductivity. This same kind of reduced vertical conductivity might be expected for lower Ringold sands and gravels. It is our experience that this is generally the case for underground aquifers with interbedded shale or clay. Therefore vertical conductivity used in the three-dimensional model was assumed smaller than the horizontal conductivity by a factor of 10. Porosity data over much of the Hanford reservation are lacking. Our discussions with ARHCO personnel indicated that porosity varied from roughly 25% in the 200 E area to less than 10% in some areas, and was generally near 10% in the aquifer region modeled. Therefore a small region--I=10 to 14, J=4 to 7 and K=1--was assigned a 25% porosity and a constant value of 10% was assigned over the rest of the aquifer.

FIGURE 6
AQUIFER THICKNESS, IN FEET, MEASURED FROM
580 FEET ABOVE MSL TO AQUIFER BOTTOM

Scale 0 1 2 3 4 miles

FIGURE 7
 HORIZONTAL HYDRAULIC CONDUCTIVITIES FOR THE
 UPPER RINGOLD AQUIFER
 The values are in feet/day.

Two-Dimensional
Calculational Grid
(Areal) and Uppermost
Layer (Unconfined, $\gamma=1$)
for Three-Dimensional Grid

Three-Dimensional
Grid, $k=2$,
Thickness=80 feet

Three-Dimensional
Grid, $k=3$
Thickness=200 feet

Scale 1 2 3 4 5
miles

FIGURE 8
NUMERICAL GRID SYSTEM

4.3 Flow Solution

The observed potentials for every month from March, 1968, to December, 1973, at all the boundary blocks were made available by ARHCO for use in this study. We were also provided with fluxes at the boundary blocks calculated from these potentials. Since the INTERA model permits specification of block potentials by using constant potential injection/production wells, it was decided to use constant potential wells in all the boundary blocks. The boundary potentials in the three-dimensional model were kept constant in all three vertical layers. This implies no vertical flow in these blocks. This may not be the correct boundary condition for all the boundary blocks. This aspect needs further investigation. The distribution of horizontal and vertical velocities determines the time it takes for the discharge to reach the Columbia River. Also the dispersion coefficients are taken as directly proportional to the velocities. Therefore it is extremely important to numerically obtain the right velocity distribution in both horizontal and vertical directions.

The initial conditions for the model runs were taken as potentials during March, 1968. In the three-dimensional model, initially all three layers were assigned the same potential. However, tritium concentrations were available for January, 1968. Since the potentials do not vary significantly with time, the initial potentials were assumed to be for January, 1968. The initial potentials used in the model are shown in Figure 9.

Ninety-one separate sources were used to describe the boundary conditions. Source numbers 1 through 66 consisted of constant potential wells located in the peripheral boundary blocks. The remaining sources were represented by constant rates in interior grid blocks and these are listed in Table I. Since the actual sources are located near the ground surface and discharged water then seeps down to the water table, all these sources were placed in the uppermost vertical blocks ($k=1$). In this list, seven sources (numbers 85 through 91) contained tritium and their discharge rates are listed in Appendix B.

The highest potentials are in the 200 W area and the lowest are near the Columbia River. As mentioned earlier, the boundary potentials were entered for every month through December, 1973. The total simulation was 6 years. Potentials during January, 1972, calculated from the two-dimensional and the top layer of the three-dimensional models are compared in Figures 10 and 11, respectively. Since all the boundary potentials were fixed and the conductivities consistent, the potential distributions are very similar.

TABLE I
SOURCE LOCATIONS AND THEIR IDENTIFICATION

<u>Source Number</u>	<u>Block Number</u>	<u>Description</u>
	(I,J)	
67	3, 10	U-Plant, Laundry, Chemical Sewer, Power House, D-6 Waste from Plutonium, Reclamation, Lab Wastes
68	5, 8	222-U Building Water + Wastes from Decon Sink
69	6, 11	S-19: Redox Lab Cooling Water + Sink Wastes
70	12, 4	B-2-2E
71	13, 3	A-29
72	13, 9	A-29
73	4, 7	BWW Lab (340 Facility) Wastes
74	3, 6	242-T Evap. Condenser Cooling Water
75	12, 5	Critical Mass Lab Wastes, Semiworks Cooling Water
76	11, 5	B Plant R-13 Change House Decon Sink, Shower Waste, B Plant Cooling Water Diversion (Emergency)
77	3, 7	T Plant (Decontamination FAC) Wastes
78	4, 8	231-Z Building Waste
79	4, 10	SX Tank Farm Condensate
80	4, 11	202-S Process Cooling Water, Redox Process Vessel Cooling Water + Steam Condensate, 202-S Chemical Sewer
81	5, 11	202-S Chemical Sewer, Additional Water from Redox Plant
82	13, 4	A-6, A-37-1: Purex Coil + Steam Condensate
83	5, 10	Redox Lab + 207-56 Basin Wastes
84	14, 5	A-30: Purex Coil + Steam Condensate
85*	6, 9	Redox D-1 + D-2 Process Condensate Wastes, 224-U Plant Concentrator Condensate (S-9, S-23)
86*	12, 6	Purex F-Cell Process Condensate, Purex Lab Waste, Purex Dissolver, E-Cell Ammonia Scrubber Waste (A-10)
87*	13, 5	241-A Tank Farm Condensate (A-8)
88*	10, 5	B-Plant Steam Condensate (B-12, B-55, B-62)
89*	14, 4	B-Plant Cooling Water, CR Vault Cooling Water, Purex Chemical Sewer (B-3)
90*	11, 4	B-Plant Cooling Water, B-Plant Chemical Sewer, ITS-2 Cooling Water, In-Tank Solidification Condensate (B-50, B-57)
91*	3, 8	242-T Evap. Condensate (T-19)

* indicates a tritium source

Scale 0 1 2 3 4 miles

FIGURE 9

INITIAL POTENTIAL USED IN THE NUMERICAL MODEL RUNS (JANUARY 1968)
Feet above msl. Assumed identical to available March 1968 values.

FIGURE 10
TWO-DIMENSIONAL MODEL CALCULATED POTENTIALS
FOR JANUARY 1972
(Feet above msl)

Scale 0 1 2 3 4 miles

FIGURE 11
 THREE-DIMENSIONAL MODEL CALCULATED POTENTIALS
 FOR JANUARY, 1972
 (Feet above msl)

It is important to compare the velocities obtained from two-dimensional and three-dimensional models. Model calculated Darcy velocities during December, 1968, for a section of the numerical grid system are shown in Figure 12. The x-z cross section shown in Figure 12e is taken east of the 200 W area. The vertical velocities in both cross sections show a downward water movement in these regions. The three-dimensional results indicated a substantial downward movement of water from the 200 W area which would result in tritium concentrations in the bottom layer of the model. Thus the three-dimensional model, at least qualitatively, supports movement of discharge from the 200 W area at greater depths below the surface than those from the 200 E area.

The time taken by contaminant particles to reach the river depends upon the path taken by the particle. If a particle is carried down into the third layer it moves with much smaller horizontal velocities and has a longer path to reach the river. Similarly if a particle stays within the first layer all the way to the river it will have a much shorter arrival time at the river than if it traveled in the lower model layers. Velocity magnitudes and the flow paths described by these velocities indicate that the two-dimensional model is quite different from the flow patterns developed in the three-dimensional model.

4.4 Contaminant Solution

The INTERA model offers the option to use a finite difference method of solution or a point tracking method of characteristics for the concentration solution. A two-dimensional contaminant solution run was made for the first three years of simulation period to see the effect of numerical diffusion. As expected the tritium concentration front on the east side of the numerical grid system was more diffuse than a similar run using the point tracking method of solution. Therefore it was decided to use the method of characteristics for this study.

The Hanford Reservation discharges are into surface and near surface discharge sites from which water percolates down vertically through the partially saturated soil to the upper Ringold aquifer. Therefore there is a time lag between the discharge time and the time the discharged water reaches the aquifer. Since velocity is proportional to permeability, the time lag between 200 E and 200 W discharge sites based upon the contrast in horizontal permeability values could vary by as much as a factor of 1,000. The preliminary estimates of the ARHCO staff are that the time lags are of the order of 3 years. During a period of 3 years a contaminant with a

Figure 12a. Two-Dimensional Model
Horizontal Velocities

Figure 12b. Three-Dimensional Model
Horizontal Velocities in
the Top Layer

k=1

Figure 12c. Three-Dimensional Model
Horizontal Velocities in
the Middle Layer

k=2

FIGURE 12

CALCULATED DARCY VELOCITIES (FT/DAY) FOR
DECEMBER 1968

Figure 12d. Three-Dimensional Model
Horizontal Velocities in
the Bottom Layer
k=3

Figure 12e. An x-z Cross Section
Showing Vertical Velocities
J=9

Vertical to Horizontal Exaggeration = 50

Figure 12f. A y-z Cross Section
Showing Vertical Velocities
I=16

Vertical to Horizontal Exaggeration = 50

FIGURE 12 (Continued)

CALCULATED DARCY VELOCITIES (FT/DAY) FOR
DECEMBER 1968

half-life of 12.5 years reduces to 85% of its original concentration. Assuming that the source rates from 1968 on were representative of the rates of 3 years prior to 1968, the rates were used without a time lag but the concentrations were reduced to represent the radioactive decay during 3 years. However during 1972 some of the major tritium source discharges were discontinued. Therefore for 1972 and 1973 rates and concentrations for the years 1969 and 1970 were used.

The initial conditions for both two-dimensional and three-dimensional runs were assumed to be January, 1968, concentrations. The observed concentrations are, in our opinion, concentrations at the top of the water table and are not vertically averaged concentrations. For the model use it was necessary to obtain vertically averaged initial concentrations for the two-dimensional runs and concentrations in three layers for the three-dimensional runs. A vertical concentration profile in one well (31-31) was available. It is difficult to say how representative this profile is of the complete aquifer. However this information is very significant in terms of indicating the qualitative behavior. Tritium concentration drops rapidly with depth, but a significant concentration level is observed even 450 feet below the top of the water table. For consistency with the two-dimensional description, we modeled 310 feet of the saturated aquifer thickness for the three-dimensional runs. From physical considerations it is easy to see that the vertically averaged concentration is a function of the aquifer thickness. Since tritium concentrations penetrate to more than 450 feet of aquifer thickness, the calculated vertically averaged concentration based upon an aquifer thickness of 310 feet could be less than, equal to or even greater than the surface concentration. Figure 13 illustrates how the vertically averaged concentration could be less than the surface concentration. The larger the aquifer thickness the smaller the factor by which surface concentration should be multiplied to obtain the calculated vertically averaged value.

A somewhat arbitrary algorithm was thus deduced to reduce the measured concentrations to obtain estimates of vertically averaged concentrations to be used in the two-dimensional model. This algorithm is listed in Table II.

Table II. Reduction of Surface Concentrations
to the Vertically Averaged Values

<u>Aquifer Thickness, Feet</u>	<u>Reduction Factor</u>
0 - 65	1.0
65 - 125	0.75
125 - 250	0.50
>250	0.25

FIGURE 13

VERTICALLY AVERAGED CONCENTRATIONS

The concentrations in the three-dimensional model were used in a consistent manner with the two-dimensional values. Since we do not expect a large variation in concentration over a depth of 30 feet, the concentrations in the uppermost layer were assigned the measured values at the top of the water table. Concentrations in the lower two layers were assigned such that the total contaminant in place was the same as the two-dimensional model. For example, if the two-dimensional aquifer thickness was h feet ($65 < h < 110$) and the concentration at the top was c_o pci/ml, then

the total contaminant in place in the two-dimensional model

$$= 0.75c_o h \Delta x \Delta y \phi$$

where

$$\phi = \text{porosity}$$

in the three-dimensional model:

$$\text{concentration in layer 1} = c_o$$

$$\begin{aligned} \text{concentration in layer 2} &= \frac{0.75c_o h \Delta x \Delta y \phi - c_o \phi \Delta x \Delta y (30)}{80 \Delta x \Delta y \phi} \\ &= \frac{c_o (0.75h - 30)}{80} \end{aligned}$$

$$\text{concentration in layer 3} = 0.$$

For the comparison of two-dimensional versus three-dimensional concentration profiles, two-dimensional concentrations were changed to surface values by using the ratios described in Table II and three-dimensional surface concentrations were taken as the values in the uppermost layer. The initial concentration contours used in the model runs are shown in Figure 14. Over 4,300 moving points were used for the two-dimensional run. The two-dimensional model run was carried out through the end of 1973. The dispersivity factors used for this run were 250 feet longitudinal and 100 feet transverse.

Scale 0 1 2 3 4 miles

- Tritium sources
- Sources with no tritium discharge

FIGURE 14

INITIAL TRITIUM CONCENTRATIONS USED IN THE
 NUMERICAL MODEL RUNS (JANUARY 1968)
 The values are in pci/ml.

Calculated two-dimensional model concentration profiles for January, 1971, and January, 1974, are shown in Figures 15 and 16, respectively. The profiles in Figures 15 and 16 represent surface concentrations back-calculated from the two-dimensional model results by the algorithm in Table II. It is of interest to note the spreading of the concentration contours in the 200 W area and reduction in the maximum concentration value. Over the entire period from 1968-1974 the tritium concentrations in the 200 W area discharge stream were lower than the 3,000 pci/ml maximum concentration observed. We believe that the time lag between the discharge and the time at which the discharged water reaches the aquifer is more than 3 years because of lower permeabilities in this region. We do not have the rate data prior to 1968, but if the tritium concentration in the water discharged into 200 W sites were significantly higher than concentrations after 1968, then this higher concentration water must be reaching the aquifer during the 6 years of the calculation period. Lowering the values of dispersion coefficients in the two-dimensional model runs would not necessarily result in higher tritium concentrations in the 200 W area because the vertical mixing would still be perfect and no concentration gradient could be calculated in that direction. Two tritium sources--numbers 85 and 91--are located in this area. During 1968 to 1971 the injection concentration of source number 85 was of the order of 30-500 pci/ml and roughly 300-1,500 pci/ml for source number 91.

A similar three-dimensional run was made by using approximately 7,700 moving points. The diffusion level was kept the same. The results for January, 1971, and January, 1974, are shown in Figures 17 and 18, respectively.

The differences in the two-dimensional and three-dimensional results are significant. The two-dimensional results show more spread out profiles. The three-dimensional results show a significant amount of contaminant has moved from the top layer to the second and third layers. The maximum concentrations in the 200 W area are much higher for the two-dimensional case. In the three-dimensional run the vertical mixing can occur due to three reasons: (i) relatively high permeability resulting in high vertical velocities, (ii) high longitudinal dispersion coefficient, (iii) relatively high lateral dispersion coefficient mixing because of high horizontal velocities in the uppermost layer. To see the effect of the dispersion coefficient, another three-dimensional run was made for the first 3 years. The dispersivity factors were reduced to 50 and 5 feet for the longitudinal and transverse values, respectively. The results are shown in Figure 19. These results are somewhat different from the previous three-dimensional run, particularly in the 200 W area. The important thing is that reduced vertical communication changes the results.

FIGURE 15
TWO-DIMENSIONAL MODEL SURFACE TRITIUM
CONCENTRATIONS, JANUARY 1971
Values are in pci/ml.

FIGURE 16
TWO-DIMENSIONAL MODEL SURFACE TRITIUM
CONCENTRATIONS, JANUARY 1974
Values are in pci/ml.

FIGURE 17

THREE-DIMENSIONAL MODEL SURFACE TRITIUM
CONCENTRATIONS, JANUARY 1971
Values are in pCi/ml.

FIGURE 18

THREE-DIMENSIONAL MODEL SURFACE TRITIUM
CONCENTRATIONS, JANUARY 1974
Values are in pci/ml.

FIGURE 19
 THREE-DIMENSIONAL MODEL SURFACE TRITIUM CONCENTRATIONS
 USING REDUCED DISPERSIVITIES, JANUARY 1971
 Values are in pci/ml.

A comparison of the calculated three-dimensional reduced dispersivity results with observed tritium concentrations are shown in Figure 20. The calculated values shown are the uppermost block (30 feet vertical dimension) concentrations. The observed results were provided by ARHCO and have been interpreted as surface concentrations from data which include samples taken from a range of vertical positions within the well. The comparison shows contours of 30, 300 and 3,000 pci/ml. No attempt has been made to match the observed results by adjusting the permeability or porosity distributions. However, based upon this comparison, it appears that quite a good match could be obtained with the three-dimensional model.

If the two-dimensional results are compared with the observed tritium concentrations, it is obvious that the 30 pci/ml contour has moved too far toward the Columbia River. The 300 pci/ml contour from the two-dimensional result actually matches the observed result better than the three-dimensional calculation on the south side but poorer on the north side. Contours in the 200 W area are much better represented by the three-dimensional reduced dispersivity result.

We believe that there is less vertical communication than we have actually used in the three-dimensional model. It should be noted that a two-dimensional model assumes perfect vertical mixing--exactly the opposite of what we believe is the case. Lesser vertical communication will give a broader distribution in the travel time of tritium particles from the discharge region to the river. A two-dimensional model assumes no distribution, again the opposite of what it appears is the case.

It is also of interest to compare vertical concentration profiles. As mentioned previously, data for May, 1975, are available for well (31, 31) located near grid block (18, 7). The two-dimensional and three-dimensional calculated results for January, 1971, in the block (18, 7) are compared with the available observed values for the well (31, 31) in Figure 21. The concentration profiles are normalized with the surface concentration values. Note that calculated concentrations in the first two layers are the same by using higher dispersivity values. As we mentioned earlier, vertical communication is a very important variable and reducing the dispersivities significantly improved the vertical concentration profile. The vertical concentration gradients are most pronounced near the disposal sites. As the tritium contaminated water moves away from the disposal sites it mixes vertically and by the time it reaches the periphery of the calculational grid, the vertical gradients are negligible.

FIGURE 20

A COMPARISON OF OBSERVED AND CALCULATED
 (THREE-DIMENSIONAL MODEL, REDUCED DISPERSIVITIES)
 SURFACE TRITIUM CONCENTRATIONS, JANUARY 1971
 Values are in pci/ml.

FIGURE 21

COMPARISON OF NORMALIZED VERTICAL CONCENTRATION PROFILES
 (The observed values are of May 1975 and the model values for January 1971)

The source rates and concentrations used as input parameters in the model runs are best estimates based upon the discharge rates into the ponds. The time lag to reach the aquifer should be calculated by using a three-dimensional model for the localized region immediately below the discharge sites. If this region is well characterized and thereby source rates better defined, the results should improve considerably.

5.0 CONCLUSIONS

- (1) Velocity fields calculated by the two-dimensional and three-dimensional models are substantially different. The travel times for tritium particles to reach the river appear to be better characterized by the three-dimensional model based upon comparison with observed results.
- (2) Surface concentration profiles calculated by the two-dimensional and three-dimensional models show significant differences except in the immediate vicinity of the 200 E area. Since the permeabilities in this region are high (~10,000 feet/day), good vertical mixing can be expected and a two-dimensional model may be adequate. But the permeabilities in the rest of the aquifer are considerably lower; results can be significantly improved by using a three-dimensional model.
- (3) Vertical concentration profiles calculated by a three-dimensional model show better qualitative agreement with the observed concentration profile for well 31-31.
- (4) Vertical hydraulic conductivity and dispersivity factors are important parameters; varying these values can change the results considerably. We believe the observed results could have been matched reasonably well by varying these parameters in a three-dimensional model.

6.0 ADDITIONAL MODEL INPUT DATA NEEDED

The following additional model input data are needed for quantitative three-dimensional modeling of the Hanford Groundwater System:

- (1) A part of the overall transport--from surface disposal sites to the aquifer--contains considerable uncertainty. The local regions should be modeled separately to better define the travel times which describe the source rates and concentrations which enter the aquifer.
- (2) Vertical hydraulic conductivities should be determined more accurately by conducting multiple layer pumping tests.
- (3) Field values of longitudinal and lateral dispersivities should be determined more accurately by conducting tracer tests. Dispersivity values for regional modeling should be obtained by conducting tests at three or preferably four sites in the Hanford Reservation. Generally speaking, dispersivity values would be independent of well spacings of roughly over 100 feet.
- (4) More wells should be sampled vertically to determine vertical concentration distributions in various regions of the aquifer.

7.0 REFERENCES

1. Ledgerwood, R.K., and Deju, R.A.: "Hydrology of the Uppermost Confined Aquifers Underlying the Hanford Reservation", prepared for the U. S. Energy Research and Development Administration under Contract E(45-1)-2130 by Atlantic Richfield Hanford Company, March, 1976.
2. Arnett, R.C., et al: "Conceptual and Mathematical Modeling of the Hanford Groundwater Flow Regime", ARH-ST-140, October, 1976.
3. Kipp, K.L, Jr.,: "Radiological Status of the Groundwater Beneath the Hanford Reservation, January-December, 1973", BNWL-1860, January, 1975.
4. Garder, A.O., Peaceman, D.W., and Pozzi, A.L.: "Numerical Calculation of Multidimensional Miscible Displacement by the Method of Characteristics", Soc. Pet. Eng. Jour., 26, March, 1964.
5. Price, H.S., and Coats, K.H.: "Direct Methods in Reservoir Simulation", SPE 4278 presented at the Third SPE Symposium on Numerical Simulation of Reservoir Performance of SPE of AIME, Houston, Texas, January, 1973.
6. Deju, R.A.: "The Hanford Field Testing Program", report prepared for the U. S. Energy Research and Development Administration under Contract AT(45-1)-2130 by Atlantic Richfield Hanford Company, September, 1974.

APPENDIX A

APPENDIX A
SUMMARY OF EQUATIONS SOLVED

A.1 FLOW MODEL

The flow model is a numerical solution of the partial differential equations describing single phase flow in porous rock of a slightly compressible liquid. The equations solved are completely three-dimensional.

The basic water flow equation can be written as:

$$-\nabla \cdot \rho \mathbf{v} = \frac{\partial \phi \rho}{\partial t} + q, \quad \text{for a confined aquifer} \quad (\text{A-1})$$

where ρ = fluid density,

ϕ = porosity,

q = source or sink term,

and $\mathbf{v}$ = fluid velocity which can be described by Darcy flow as

$$\mathbf{v} = -\frac{k}{\mu} (g_c \nabla P + \rho g \nabla Z) \quad (\text{A-2})$$

where P = pressure,

Z = height above a datum,

k = permeability,

and μ = fluid viscosity.

The right-hand side of Equation (A-1) changes to $\frac{1}{\Delta z} \frac{\partial (\phi h \rho)}{\partial t} + q$ for an unconfined aquifer, where h is fluid potential defined as

APPENDIX A (Continued)

$$h = \int_{P_d}^P \frac{g_c dP}{g\rho} + z$$

where P_d = pressure at datum.

Now assuming that $\rho = \rho(P)$ only and $\phi = \phi(P)$ equation (A-1) becomes:

$$\nabla \cdot \rho \frac{k}{\mu} \nabla (\rho gh) = \phi \rho \left[C_W \frac{\rho g}{g_c} + C_R \frac{\rho g}{g_c} \right] \cdot \frac{\partial h}{\partial t} + q \quad \text{for a confined aquifer} \quad (A-4)$$

$$\begin{aligned} \text{where } C_W &= \frac{1}{\rho} \frac{d\rho}{dP}, \text{ i.e. fluid compressibility,} \\ C_R &= \frac{1}{\phi} \frac{d\phi}{dP}, \text{ i.e. rock compressibility} \end{aligned}$$

and neglecting the compressibility term,

$$\nabla \cdot \rho \frac{k}{\mu} \nabla (\rho gh) = \frac{\phi \rho}{\Delta z} \frac{\partial h}{\partial t} + q \quad \text{for an unconfined aquifer} \quad (A-5)$$

or

$$\nabla \cdot K \nabla h = \phi C \frac{\partial h}{\partial t} + q \quad \text{for a confined aquifer} \quad (A-6)$$

and

$$\nabla \cdot K \nabla h = \frac{\phi}{\Delta z} \frac{\partial h}{\partial t} + q \quad \text{for an unconfined aquifer} \quad (A-7)$$

where K = hydraulic conductivity,

C = dimensionless change in formation volume per unit potential.

The above equations are written as a volume balance around each individual grid cell and solved as a finite difference algebraic equation.

APPENDIX A (Continued)A.2 COMPONENT BALANCE

The component balance is a numerical solution of the partial differential equations describing the movement and hydrodynamic dispersion of a dissolved constituent as it moves with the water. The basic equation for a single constituent flowing in the groundwater is:

$$\nabla \cdot E \nabla C - \nabla \cdot vC = \frac{\partial C}{\partial t} + qC \quad (A-7)$$

where C = concentration of constituent,

E = hydrodynamic tensor dispersion coefficient,

and other terms have been previously defined.

E has components defined by

$$E_{xx} = D_l \cos^2 \psi \cos^2 \theta + D_t (\sin^2 \theta \cos^2 \psi + \sin^2 \psi)$$

$$E_{xy} = (D_l - D_t) \sin \theta \cos \theta \cos^2 \psi$$

$$E_{xz} = (D_l - D_t) \sin \psi \cos \psi \cos \theta$$

$$E_{yx} = E_{xy}$$

$$E_{yy} = D_l \cos^2 \psi \sin^2 \theta + D_t (\cos^2 \theta \cos^2 \psi + \sin^2 \psi)$$

$$E_{yz} = (D_l - D_t) \sin \psi \cos \psi \sin \theta$$

$$E_{zx} = E_{xz}$$

$$E_{zy} = E_{yz}$$

$$E_{zz} = D_l \sin^2 \psi + D_t \cos^2 \psi$$

APPENDIX A (Continued)

$$\text{where } D_l \equiv \frac{\alpha_l}{\phi} |u|$$

$$D_t \equiv \frac{\alpha_t}{\phi} |u|$$

$|u|$ = the magnitude of the fluid velocity

α_l = longitudinal dispersivity factor

α_t = transverse dispersivity factor

ψ = angle of velocity vector from x-y plane

θ = angle of velocity vector in x-y plane
from x-axis

Flow and hydrodynamic dispersion of a dissolved constituent in a porous medium has been studied extensively. In some cases the flow or convection can dominate the effects due to hydrodynamic dispersion. Under other conditions dispersion can exert a larger or equal influence than does convection.

APPENDIX B

APPENDIX B

ARHCO SUPPLIED DATA USED IN THIS STUDY

Some of the data were provided by ARHCO for each grid block of a numerical system of 28 x 17 blocks (3,000 feet square on a side) in the aquifer region modeled. The actual grid system used in this work consisted of 23 x 14 rectangular blocks with block sizes from 3,000 feet in the source region to 7,500 feet toward the boundaries to the east and the south. Therefore per block input for the actual grid system was obtained by interpolating part of the data. The following data were supplied by ARHCO to be used in this study:

- (1) Horizontal hydraulic conductivities in gal/ft/day;
- (2) Aquifer bottom (feet above msl) and thickness;
- (3) Boundary potentials for the period 3-68 to 12-73;
- (4) Tritium surface concentrations during 1-68;
- (5) Aquifer potentials during 3-68;
- (6) Water and contaminant sources, locations and rates of discharge for the period 1-68 to 12-73.

Tritium source strengths (rates and concentrations) are listed in Table B.I.

TABLE B.1

TRITIUM SOURCE RATES AND CONCENTRATIONS

Source 85		Source 86		Source 87		Source 88		Source 89		Source 90		Source 91		Period	
Rate	Conc.	Rate	Conc.	Rate	Conc.	Rate	Conc.	Rate	Conc.	Rate	Conc.	Rate	Conc.	From	To
51873	0	41300	82178	2637	0	5274	0	483000	2307	2844	0	18695	0	1-68	3-68
52707	535	41300	75934	3472	0	4404	0	523400	1959	1921	0	18695	0	4-68	4-68
54338	180	36075	57476	3767	24410	4112	247	515300	1322	2780	13155	18695	2508	5-68	6-68
45800	768	2070	568756	1820	27853	5098	119	520800	746	2584	0	18695	2831	7-68	7-68
55289	222	37440	97634	1486	36136	3406	581	547200	2198	1503	5907	18695	2831	8-68	8-68
50032	18.7	18530	95173	2211	26055	2512	285	536400	1243	1503	18866	18695	2831	9-68	9-68
50032	73.0	43590	62458	2211	30884	2512	37.5	536400	1243	2685	7518	18695	2831	10-68	10-68
50032	20.1	15820	113961	2211	30884	4929	477	536400	1243	2685	7518	18695	950	11-68	12-68
38793	38.7	8579	163543	1930	13749	6760	262	342600	1313	2516	2134	17163	2084	1-69	2-69
48195	49.9	19703	108769	2360	27198	6127	335	380500	1855	2855	15208	17163	1614	3-69	5-69
48195	52.2	5520	162223	5098	31025	6127	359	380500	712	2855	20520	17163	1835	6-69	6-69
38486	10.1	2602	236566	1292	23351	4070	101	307600	2030	3463	25854	17163	1835	7-69	7-69
47394	15.6	15020	195508	2334	18314	5199	355	396400	1971	2813	19455	17163	1835	8-69	8-69
47394	198	15020	114832	2334	26169	19590	85.5	396400	1971	2813	19455	17163	1835	9-69	9-69
46153	46.2	14413	144695	2501	2391	1956	127	430300	1589	2723	13977	17163	203	10-69	12-69
34268	11.4	4461	339002	1991	40038	4808	31.6	372300	1331	2914	12934	12928	560	1-70	1-70
34025	3.96	4147	0	1226	27996	4861	31.3	301300	0	2760	13655	12928	560	2-70	2-70
34025	2.94	4147	77555	1226	15031	4861	31.3	301300	350	90521	416	12928	560	3-70	3-70
45520	3.15	8238	251393	2993	15031	9453	39.6	339433	1668	128384	159	12928	560	4-70	4-70
45520	3.15	8238	16913	2993	15031	9453	201	339433	0	30663	667	12928	2234	5-70	5-70
45520	3.15	3863	0	879	27327	9453	201	339433	0	17128	1563	12928	2234	6-70	6-70
33225	6.45	378	0	894	26869	5652	1.17	371430	0	17402	1580	12928	2234	7-70	7-70
33225	6.45	1863	0	894	26869	16044	27.3	371430	0	17402	2515	12928	1009	8-70	8-70
33225	6.45	8440	0	894	15073	16044	27.3	371430	0	17402	2515	12928	1009	9-70	12-70
29760	10.5	586	9179	951	4344	17667	15.1	333300	5.29	15617	3294	14208	1609	1-71	3-71
37296	0	12536	149855	2038	0	16893	6.05	439867	1243	14496	978	14208	1117	4-71	5-71
37296	1.40	12536	116025	2038	15470	16893	83.4	439867	1243	14496	1620	14208	1117	6-71	6-71
37296	1.40	5771	239700	2038	7803	16893	21.8	439867	1243	14496	371	14208	1117	7-71	7-71
37296	1.40	11748	177395	2038	19287	16893	21.8	439867	2899	50518	9254	14208	1809	8-71	10-71
37296	1.40	11748	177395	2038	21769	11591	7.23	439867	1476	50518	3539	14208	1167	11-71	12-71

The rates are in cubic feet/day and concentrations in pci/ml.

For the calculation period of 1972 and 1973, rates and concentrations of 1969 and 1970 were used.

APPENDIX C

APPENDIX C
TYPICAL MODEL OUTPUT

A typical model output is included in this report for illustration of the model use. The three-dimensional model input data printout and output at the end of the 6-year simulation period are shown here.

```

*****
HYDROLOGICAL MODEL=3D FLOW, 3D CONTAMINANT
*****

***** 3D FLOW AND POINT TRACKING CONTAMINANT SOLUTION *****

NUMBER OF X-DIRECTION BLOCKS.....23
NUMBER OF Y-DIRECTION BLOCKS.....14
NUMBER OF Z-DIRECTION BLOCKS.....3
NUMBER OF WELLS.....0
IPOS.....1
IDIFF.....1
IDCONC.....1
IU.....0
IV.....0
IW.....0
IRAD.....0
ICONT.....0

A ARRAY IN GAUSS3D IS DIMENSIONED = 15300

COMMON STORAGE REQ = 44535
COMMON PROGRAM STORAGE REQ = 96157

-----
BLOCK SIZES
-----
X-BLOCKS 1000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000.
3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000.
6000. 6000. 7500. 3000. 3000. 3000. 3000. 4500. 4500. 4500. 3000.
Y-BLOCKS 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000. 3000.
3000. 4500. 6000. 7500. 3000. 3000. 3000. 3000. 3000. 3000. 3000.
Z-BLOCKS 60. 80. 200.

NO ITERATIONS FOR OMEGA AND FLOW CALC = 5 50

MATERIAL BALANCE TOLERANCE = 0.00000

MAP CHARACTERISTICS
NORMALIZATION FACTOR FOR CONC MAP..... 0.0
X-DIRECTION MAP LENGTH..... 9.8
Y-DIRECTION MAP LENGTH..... 5.7
Z-DIRECTION MAP LENGTH..... 1.0
MAP ORIENTATION, 1, X INC ON PG, 0, UP PG..... 0
I=12 SUBREGION FROM 1 TO..... 23
J-DIR SUBREGION FROM 1 TO..... 14
K-DIR SUBREGION FROM 1 TO..... 1

```

```

INPUT ELEVATIONS
-----
NO OF CONSTANT REGIONS  NO OF INDIVIDUAL POINTS  CONVERSION FACTOR  UNITS
0 1 0. LEVATIONS ABOVE SEA LEVEL, FEET

1 2 3 4 5 6 7 8 9 10
1 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03
2 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03
3 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03
4 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03
5 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03
6 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03
7 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03
8 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03
9 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03
10 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03
11 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03
12 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03
13 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03
14 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03

11 12 13 14 15 16 17 18 19 20
1 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4400E+03 .4300E+03 .4300E+03 .4300E+03 .4200E+03 .4200E+03
2 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4500E+03 .4400E+03 .4400E+03 .4400E+03 .4300E+03 .4300E+03
3 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4600E+03 .4500E+03 .4500E+03 .4500E+03 .4400E+03 .4400E+03
4 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4700E+03 .4600E+03 .4600E+03 .4600E+03 .4500E+03 .4500E+03
5 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4800E+03 .4700E+03 .4700E+03 .4700E+03 .4600E+03 .4600E+03
6 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4900E+03 .4800E+03 .4800E+03 .4800E+03 .4700E+03 .4700E+03
7 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .5000E+03 .4900E+03 .4900E+03 .4900E+03 .4800E+03 .4800E+03
8 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5100E+03 .5000E+03 .5000E+03 .5000E+03 .4900E+03 .4900E+03
9 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5200E+03 .5100E+03 .5100E+03 .5100E+03 .5000E+03 .5000E+03
10 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5300E+03 .5200E+03 .5200E+03 .5200E+03 .5100E+03 .5100E+03
11 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5400E+03 .5300E+03 .5300E+03 .5300E+03 .5200E+03 .5200E+03
12 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5500E+03 .5400E+03 .5400E+03 .5400E+03 .5300E+03 .5300E+03
13 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5600E+03 .5500E+03 .5500E+03 .5500E+03 .5400E+03 .5400E+03
14 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5700E+03 .5600E+03 .5600E+03 .5600E+03 .5500E+03 .5500E+03

21 22 23
1 .4100E+03 .4100E+03 .4000E+03
2 .4200E+03 .4100E+03 .4000E+03
3 .4300E+03 .4200E+03 .4100E+03
4 .4400E+03 .4300E+03 .4200E+03
5 .4500E+03 .4400E+03 .4300E+03
6 .4600E+03 .4500E+03 .4400E+03
7 .4700E+03 .4600E+03 .4500E+03
8 .4800E+03 .4700E+03 .4600E+03
9 .4900E+03 .4800E+03 .4700E+03
10 .5000E+03 .4900E+03 .4800E+03
11 .5100E+03 .5000E+03 .4900E+03
12 .5200E+03 .5100E+03 .5000E+03
13 .5300E+03 .5200E+03 .5100E+03
14 .5400E+03 .5300E+03 .5200E+03

```

WATER COMPRESSIBILITY..... 0. /PSI
 ROCK COMPRESSIBILITY..... .60E-05/PSI
 WATER VISCOSITY..... 1.0CP
 DENSITY GRADIENT..... .433PSI/FT

DATUM PRESSURE..... 175.PSI

 TIME STEP INFO

TIME STEP DAY HOLD TIME DAY STOP TIME DAY CUM TIME DAY
 45.0 90.0 213.0 0.0

 CONTROL INDICFS

NO OF WELL CHANGES THIS STEP..... 2
 INDEX FOR POT COEFF PRINT..... 1
 INDEX FOR DIFF COEFF PRINT..... 0
 INDEX FOR CONC PRINTS AND MAPS..... 3
 INDEX FOR X-VEL PRINT..... 0
 INDEX FOR Y-VEL PRINT..... 0
 INDEX FOR Z-VEL PRINT..... 0

WELL NO	I	J	K1	K2	RATE	CONC	WI	INI	PW
1	6	1	1	2	0.0	0.00	10000000.	3	0.00
2	7	1	1	2	0.0	0.00	10000000.	3	0.00
3	8	1	1	2	0.0	0.00	10000000.	3	0.00
3	8	1	1	2	0.0	0.00	10000000.	3	0.00
4	9	1	1	2	0.0	0.00	10000000.	3	0.00
5	10	1	1	2	0.0	0.00	10000000.	3	0.00
6	11	1	1	2	0.0	0.00	10000000.	3	0.00
7	12	1	1	2	0.0	0.00	10000000.	3	0.00
8	13	1	1	2	0.0	0.00	10000000.	3	0.00
9	14	1	1	2	0.0	0.00	10000000.	3	0.00
10	17	1	1	2	0.0	0.00	10000000.	3	0.00
11	18	1	1	2	0.0	0.00	10000000.	3	0.00
15	21	1	1	2	0.0	0.00	10000000.	3	0.00
12	19	1	1	2	0.0	0.00	10000000.	3	0.00
13	20	1	1	2	0.0	0.00	10000000.	3	0.00
14	21	1	1	2	0.0	0.00	10000000.	3	0.00
15	22	1	1	2	0.0	0.00	10000000.	3	0.00
16	22	2	1	1	0.0	0.00	0.	1	0.00
17	2	2	1	2	0.0	0.00	10000000.	3	0.00
18	3	2	1	2	0.0	0.00	10000000.	3	0.00
19	4	2	1	2	0.0	0.00	10000000.	3	0.00
20	5	2	1	2	0.0	0.00	10000000.	3	0.00
21	15	2	1	1	0.0	0.00	10000000.	3	0.00
22	16	2	1	2	0.0	0.00	10000000.	3	0.00
23	23	1	1	1	0.0	0.00	10000000.	3	0.00
24	1	3	1	2	0.0	0.00	10000000.	3	0.00
25	23	3	1	2	0.0	0.00	10000000.	3	0.00
26	1	4	1	1	0.0	0.00	10000000.	3	0.00
27	23	4	1	2	0.0	0.00	10000000.	3	0.00
28	1	5	1	1	0.0	0.00	10000000.	3	0.00
29	23	5	1	2	0.0	0.00	10000000.	3	0.00
30	1	6	1	1	0.0	0.00	10000000.	3	0.00
31	23	6	1	2	0.0	0.00	10000000.	3	0.00
32	1	7	1	1	0.0	0.00	10000000.	3	0.00
33	23	7	1	2	0.0	0.00	10000000.	3	0.00
34	1	8	1	1	0.0	0.00	10000000.	3	0.00
35	23	8	1	2	0.0	0.00	10000000.	3	0.00
36	1	9	1	1	0.0	0.00	10000000.	3	0.00
37	23	9	1	2	0.0	0.00	10000000.	3	0.00
38	1	10	1	1	0.0	0.00	10000000.	3	0.00
39	23	10	1	2	0.0	0.00	10000000.	3	0.00
40	1	11	1	1	0.0	0.00	10000000.	3	0.00
41	23	11	1	2	0.0	0.00	10000000.	3	0.00
42	1	12	1	1	0.0	0.00	10000000.	3	0.00
43	23	12	1	2	0.0	0.00	10000000.	3	0.00
44	4	12	1	1	0.0	0.00	10000000.	3	0.00
45	5	12	1	1	0.0	0.00	10000000.	3	0.00
46	6	12	1	1	0.0	0.00	10000000.	3	0.00
47	7	12	1	1	0.0	0.00	10000000.	3	0.00
48	8	12	1	1	0.0	0.00	10000000.	3	0.00
49	9	12	1	1	0.0	0.00	10000000.	3	0.00
50	10	12	1	1	0.0	0.00	10000000.	3	0.00
51	2	13	1	2	0.0	0.00	10000000.	3	0.00
52	3	13	1	2	0.0	0.00	10000000.	3	0.00
53	11	13	1	1	0.0	0.00	10000000.	3	0.00
54	12	13	1	1	0.0	0.00	10000000.	3	0.00
55	13	13	1	1	0.0	0.00	10000000.	3	0.00
56	14	13	1	1	0.0	0.00	10000000.	3	0.00
57	15	13	1	1	0.0	0.00	10000000.	3	0.00
58	23	13	1	2	0.0	0.00	10000000.	3	0.00
59	16	13	1	1	0.0	0.00	10000000.	3	0.00
60	17	14	1	2	0.0	0.00	10000000.	3	0.00
61	23	14	1	2	0.0	0.00	10000000.	3	0.00
62	18	14	1	2	0.0	0.00	10000000.	3	0.00
63	19	14	1	1	0.0	0.00	10000000.	3	0.00
64	20	14	1	1	0.0	0.00	10000000.	3	0.00
65	21	14	1	2	0.0	0.00	10000000.	3	0.00
66	22	14	1	2	0.0	0.00	10000000.	3	0.00
67	3	10	1	1	0.0	0.00	0.	1	0.00
68	5	8	1	1	0.0	0.00	0.	1	0.00
69	6	11	1	1	0.0	0.00	0.	1	0.00
70	12	4	1	1	0.0	0.00	0.	1	0.00
71	13	3	1	1	0.0	0.00	0.	1	0.00
72	13	9	1	1	0.0	0.00	0.	1	0.00
73	4	7	1	1	0.0	0.00	0.	1	0.00
74	1	6	1	1	0.0	0.00	0.	1	0.00
75	12	5	1	1	0.0	0.00	0.	1	0.00
76	11	5	1	1	0.0	0.00	0.	1	0.00
77	3	7	1	1	0.0	0.00	0.	1	0.00
78	6	8	1	1	0.0	0.00	0.	1	0.00
79	4	10	1	1	0.0	0.00	0.	1	0.00
80	4	11	1	1	0.0	0.00	0.	1	0.00
81	5	11	1	1	0.0	0.00	0.	1	0.00
82	13	4	1	1	0.0	0.00	0.	1	0.00
83	5	10	1	1	0.0	0.00	0.	1	0.00
84	14	5	1	1	0.0	0.00	0.	1	0.00
85	6	9	1	1	0.0	0.00	0.	1	0.00
86	12	6	1	1	0.0	0.00	0.	1	0.00
87	13	5	1	1	0.0	0.00	0.	1	0.00
88	10	5	1	1	0.0	0.00	0.	1	0.00
89	14	4	1	1	0.0	0.00	0.	1	0.00
90	11	4	1	1	0.0	0.00	0.	1	0.00
91	3	8	1	1	0.0	0.00	0.	1	0.00

AVERAGING OVER 1 MONTHS									
1	6	1	1	2	0.00	27366.	3	407.70	
2	7	1	1	2	0.00	27366.	3	407.80	
3	8	1	1	2	0.00	27366.	3	408.20	
4	9	1	1	2	0.00	27366.	3	408.80	
5	10	1	1	2	0.00	27366.	3	409.40	
6	11	1	1	2	0.00	27366.	3	409.40	
7	12	1	1	1	0.00	27366.	3	407.60	
8	13	1	1	2	0.00	27366.	3	406.10	
9	14	1	1	2	0.00	27366.	3	407.70	
10	17	1	1	2	0.00	27366.	3	397.30	
11	18	1	1	2	0.00	27366.	3	394.70	
12	19	1	1	2	0.00	27366.	3	391.50	
13	20	1	1	2	0.00	27366.	3	388.60	
14	21	1	1	2	0.00	27366.	3	382.40	
15	22	1	1	2	0.00	27366.	3	374.00	
16	22	2	1	1	0.00	27366.	3	370.60	
17	2	2	1	2	0.00	27366.	3	423.90	
18	3	2	1	2	0.00	27366.	3	424.20	
19	4	2	1	2	0.00	27366.	3	417.20	
20	5	2	1	2	0.00	27366.	3	409.60	
21	15	2	1	1	0.00	27366.	3	408.30	
22	16	2	1	2	0.00	27366.	3	405.30	
23	23	1	1	1	0.00	27366.	3	365.60	
24	1	3	1	2	0.00	27366.	3	425.90	
25	23	3	1	2	0.00	27366.	3	370.00	
26	1	4	1	3	0.00	27366.	3	432.40	
27	23	4	1	2	0.00	27366.	3	373.70	
28	1	5	1	3	0.00	27366.	3	440.70	
29	23	5	1	2	0.00	27366.	3	377.00	
30	1	6	1	3	0.00	27366.	3	448.70	
31	23	6	1	2	0.00	27366.	3	381.30	
32	1	7	1	3	0.00	27366.	3	455.60	
33	23	7	1	2	0.00	27366.	3	383.50	
34	1	8	1	3	0.00	27366.	3	462.40	
35	23	8	1	2	0.00	27366.	3	385.00	
36	1	9	1	3	0.00	27366.	3	469.20	
37	23	9	1	2	0.00	27366.	3	386.50	
38	1	10	1	3	0.00	27366.	3	473.80	
39	23	10	1	2	0.00	27366.	3	398.10	
40	1	11	1	3	0.00	27366.	3	476.30	
41	23	11	1	2	0.00	27366.	3	389.30	
42	1	12	1	3	0.00	27366.	3	477.50	
43	23	12	1	2	0.00	27366.	3	360.10	
44	1	13	1	3	0.00	27366.	3	476.30	
45	5	12	1	3	0.00	27366.	3	470.40	
46	6	12	1	3	0.00	27366.	3	461.30	
47	7	12	1	2	0.00	27366.	3	452.50	
48	8	12	1	2	0.00	27366.	3	445.40	
49	9	12	1	2	0.00	27366.	3	438.40	
50	10	12	1	2	0.00	27366.	3	429.40	
51	2	13	1	2	0.00	27366.	3	478.10	
52	3	13	1	2	0.00	27366.	3	475.00	
53	11	13	1	1	0.00	27366.	3	421.50	
54	12	13	1	1	0.00	27366.	3	416.30	
55	13	13	1	1	0.00	27366.	3	411.60	
56	14	13	1	1	0.00	27366.	3	408.10	
57	15	13	1	1	0.00	27366.	3	404.60	
58	23	13	1	2	0.00	27366.	3	387.30	
59	16	13	1	1	0.00	27366.	3	404.20	
60	17	14	1	2	0.00	27366.	3	403.80	
61	23	14	1	2	0.00	27366.	3	388.50	
62	18	14	1	2	0.00	27366.	3	402.40	
63	19	14	1	1	0.00	27366.	3	400.30	
64	20	14	1	1	0.00	27366.	3	399.10	
65	21	14	1	2	0.00	27366.	3	397.60	
66	22	14	1	2	0.00	27366.	3	395.20	
67	3	10	1	1	-249254.0	0.00	0.	0.00	
68	5	8	1	1	-0.0	0.00	0.	0.00	
69	6	11	1	1	-3333.0	0.00	0.	0.00	
70	12	4	1	1	-0.0	0.00	0.	0.00	
71	13	3	1	1	-0.0	0.00	0.	0.00	
72	13	9	1	1	-0.0	0.00	0.	0.00	
73	4	7	1	1	-0.0	0.00	0.	0.00	
74	1	6	1	1	-74200.0	0.00	0.	0.00	
75	12	5	1	1	-1546.0	0.00	0.	0.00	
76	11	5	1	1	-55.4	0.00	0.	0.00	
77	3	7	1	1	-0.0	0.00	0.	0.00	
78	4	8	1	1	-2473.0	0.00	0.	0.00	
79	4	10	1	1	-0.0	0.00	0.	0.00	
80	4	11	1	1	-41571.0	0.00	0.	0.00	
81	5	11	1	1	-6090.0	0.00	0.	0.00	
82	13	4	1	1	-15635.0	0.00	0.	0.00	
83	5	10	1	1	-9.9	0.00	0.	0.00	
84	14	5	1	1	-13222.0	0.00	0.	0.00	
85	6	9	1	1	-51873.0	0.00	0.	0.00	
86	12	6	1	1	-41300.0	82178.00	0.	0.00	
87	13	5	1	1	-2637.0	0.00	0.	0.00	
88	10	5	1	1	-5274.0	0.00	0.	0.00	
89	14	4	1	1	-483000.0	2307.00	0.	0.00	
90	11	4	1	1	-2844.0	0.00	0.	0.00	
91	3	8	1	1	-18695.0	0.00	0.	0.00	

X-PERMEABILITY INPUT																			
NO OF CONSTANT REGIONS		NO OF INDIVIDUAL POINTS		CONVERSION FACTOR		UNITS													
0		1		.4880E+02		GAL/DAY/FT**2 CONVERTED TO MD													
K= 3																			
1	2	3	4	5	6	7	8	9	10										
1	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.2001E+04	.5446E+04	.6142E+04	.7954E+04	.2213E+04									
2	.4880E+02	.1513E+03	.9740E+02	.4880E+02	.5856E+02	.5856E+03	.4978E+04	.1274E+05	.2704E+05	.4597E+04									
3	.6344E+02	.6344E+02	.5368E+02	.3416E+02	.1952E+02	.1464E+02	.1172E+04	.1048E+05	.3855E+04	.2928E+03									
4	.6764E+03	.6812E+02	.6744E+02	.4880E+02	.3904E+02	.3904E+02	.1025E+03	.7440E+02	.4880E+03	.3511E+03									
5	.2194E+04	.1610E+04	.1220E+04	.8784E+03	.9760E+02	.6344E+02	.2586E+03	.7808E+03	.3416E+03	.9760E+03									
6	.2094E+04	.1694E+04	.1122E+04	.6832E+03	.4392E+03	.5368E+02	.1659E+03	.1172E+03	.772E+02	.272E+03									
7	.2194E+04	.1903E+04	.1318E+04	.1025E+04	.5368E+03	.1464E+03	.5368E+02	.1808E+03	.772E+03	.3465E+04									
8	.2782E+04	.2494E+04	.1757E+04	.1366E+04	.9272E+03	.4392E+03	.2928E+02	.6344E+02	.4880E+03	.272E+04									
9	.3514E+04	.2709E+04	.2294E+04	.1854E+04	.1659E+04	.1415E+04	.6344E+03	.8784E+02	.1171E+03	.3855E+03									
10	.4094E+04	.5075E+04	.3754E+04	.3806E+04	.4734E+04	.4148E+04	.272E+04	.1619E+04	.1952E+03	.1172E+03									
11	.3754E+04	.5075E+04	.6002E+04	.5954E+04	.575E+04	.4978E+04	.3271E+04	.1172E+04	.971E+02	.879E+02									
12	.2791E+04	.3727E+04	.3562E+04	.3026E+04	.2147E+04	.5856E+03	.8294E+02	.8294E+02	.4880E+02	.4880E+02									
13	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02									
14	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02									
11	12	13	14	15	16	17	18	19	20										
1	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.9760E+01	.9760E+01	.3416E+02	.9760E+01									
2	.1464E+03	.5556E+02	.1752E+02	.4880E+02	.4880E+02	.4880E+01	.4880E+01	.9760E+01	.9760E+01	.9760E+01									
3	.1072E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03									
4	.272E+03	.224E+03	.444E+03	.5368E+03	.1659E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03	.1464E+03									
5	.272E+03	.1562E+05	.8296E+04	.1659E+04	.1513E+04	.1806E+04	.3511E+04	.6930E+04	.5807E+04	.2492E+04									
6	.7794E+04	.275E+05	.1049E+05	.9028E+04	.9955E+04	.1430E+05	.1440E+05	.1171E+05	.741E+04	.2492E+04									
7	.7794E+04	.237E+05	.2918E+05	.3294E+05	.2782E+05	.4377E+06	.3572E+06	.1454E+06	.2586E+05	.3367E+06									
8	.4694E+04	.6734E+04	.9370E+05	.3040E+06	.7091E+06	.1315E+07	.1208E+07	.573E+06	.2716E+06	.1454E+06									
9	.7794E+04	.7613E+04	.2879E+05	.7613E+05	.1601E+06	.2972E+06	.3636E+06	.5773E+06	.5153E+06	.1346E+06									
10	.1464E+03	.2494E+03	.5856E+04	.2197E+05	.3660E+05	.4148E+05	.4782E+05	.1078E+06	.2494E+06	.2494E+06									
11	.4880E+02	.6744E+02	.1542E+03	.8296E+03	.5222E+04	.8150E+04	.1030E+05	.1845E+05	.4577E+05	.157E+06									
12	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.2440E+02	.5856E+02	.8296E+02	.1542E+03	.3747E+03	.1542E+03									
13	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02									
14	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02									
21	22	23																	
1	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02	.4880E+02									
2	.1952E+03	.3204E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02									
3	.4148E+03	.4784E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02									
4	.524E+03	.1610E+03	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02									
5	.6344E+03	.2294E+03	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02									
6	.3221E+03	.2733E+03	.6344E+02	.6344E+02	.6344E+02	.6344E+02	.6344E+02	.6344E+02	.6344E+02	.6344E+02									
7	.1122E+04	.312E+03	.8784E+02	.8784E+02	.8784E+02	.8784E+02	.8784E+02	.8784E+02	.8784E+02	.8784E+02									
8	.1562E+04	.3465E+03	.1074E+03	.1074E+03	.1074E+03	.1074E+03	.1074E+03	.1074E+03	.1074E+03	.1074E+03									
9	.534E+04	.4392E+03	.1610E+03	.1610E+03	.1610E+03	.1610E+03	.1610E+03	.1610E+03	.1610E+03	.1610E+03									
10	.4636E+05	.7320E+03	.2879E+03	.2879E+03	.2879E+03	.2879E+03	.2879E+03	.2879E+03	.2879E+03	.2879E+03									
11	.1181E+06	.1952E+04	.7320E+03	.7320E+03	.7320E+03	.7320E+03	.7320E+03	.7320E+03	.7320E+03	.7320E+03									
12	.1044E+06	.8882E+05	.2001E+04	.2001E+04	.2001E+04	.2001E+04	.2001E+04	.2001E+04	.2001E+04	.2001E+04									
13	.3514E+03	.1318E+04	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02	.4792E+02									
14	.2791E+03	.4636E+03	.4244E+03	.4244E+03	.4244E+03	.4244E+03	.4244E+03	.4244E+03	.4244E+03	.4244E+03									
21	22	23																	
1	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.1990E+06	.5446E+06	.6159E+06	.7954E+06	.2213E+06									
2	.4880E+03	.1492E+05	.9077E+04	.5026E+04	.6051E+04	.5719E+05	.4987E+06	.1276E+07	.2702E+07	.4597E+06									
3	.6744E+04	.6100E+04	.5514E+04	.3172E+04	.1704E+04	.1269E+04	.1172E+06	.1047E+07	.3836E+06	.2928E+05									
4	.6744E+04	.695E+04	.6100E+04	.5075E+04	.4099E+04	.3806E+04	.1010E+05	.2745E+06	.4880E+05	.3611E+05									
5	.555E+04	.5710E+04	.4792E+04	.3904E+04	.4685E+04	.6344E+04	.2586E+05	.7904E+05	.3416E+05	.9711E+05									
6	.5710E+04	.5710E+04	.352E+04	.7710E+04	.3465E+04	.5368E+04	.1659E+05	.1172E+05	.772E+04	.2058E+04									
7	.5441E+04	.5319E+04	.3754E+04	.2879E+04	.3074E+04	.3709E+04	.5368E+04	.1806E+05	.7464E+05	.345E+06									
8	.555E+04	.5514E+04	.385E+04	.2927E+04	.2830E+04	.2830E+04	.2928E+04	.6100E+04	.6929E+05	.2116E+06									
9	.6393E+04	.6464E+04	.3953E+04	.2928E+04	.3172E+04	.4587E+04	.7564E+04	.8784E+04	.1171E+05	.3846E+05									
10	.6978E+04	.8101E+04	.5661E+04	.5710E+04	.7808E+04	.9370E+04	.1093E+05	.1147E+05	.1015E+05	.1122E+05									
11	.6344E+04	.810E+04	.884E+04	.9418E+04	.1054E+05	.1254E+05	.1464E+05	.1337E+05	.9760E+04	.2928E+04									
12	.4782E+04	.6497E+04	.7662E+04	.7662E+04	.7906E+04	.1210E+05	.1172E+05	.8296E+04	.4880E+04	.9760E+03									
13	.4880E+03	.6344E+03	.2928E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03									
14	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03									
11	12	13	14	15	16	17	18	19	20										
1	.1464E+02	.9740E+01	.1464E+02	.5368E+03	.4880E+03	.4880E+03	.7320E+03	.8784E+03	.3318E+04	.1191E+05									
2	.1464E+02	.5856E+04	.1757E+04	.5856E+03	.3904E+03	.6344E+03	.5368E+03	.1074E+04	.9272E+04	.4714E+05									
3	.1952E+05	.1464E+05	.6599E+04	.2194E+04	.7808E+03	.1952E+04	.1269E+04	.5856E+04	.3754E+04	.1594E+04									
4	.272E+05	.224E+05	.1464E+05	.5368E+04	.1659E+05	.1479E+05	.1464E+05	.9126E+05	.2152E+06	.2001E+06									
5	.272E+05	.1562E+07	.8296E+06	.1659E+06	.1494E+06	.1815E+06	.3606E+06	.6929E+06	.5817E+06	.2474E+06									
6	.7794E+06	.275E+07	.1072E+07	.9038E+06	.9075E+06	.1428E+07	.1440E+07	.1192E+07	.7472E+06	.2645E+06									
7	.9101E+06	.237E+07	.2918E+07	.3296E+07	.3360E+07	.3243E+07	.2551E+07	.161E+07	.1011E+07	.3747E+06									
8	.4682E+06	.674E+06	.936E+06	.1643E+07	.2404E+07	.3465E+07	.3178E+07	.1855E+07	.1233E+07	.533E+06									
9	.765E+05	.127E+06	.1701E+06	.237E+06	.3521E+06	.6662E+06	.7362E+06	.1249E+07	.1705E+07	.6671E+06									
10	.1464E+05	.243E+05	.645E+05	.6622E+05	.7969E+05	.8589E+05	.9760E+05	.1225E+06	.6173E+06	.6611E+06									
11	.6432E+04	.6744E+04	.1576E+05	.2050E+05	.2547E+05	.2806E+05	.3265E+05	.4444E+05	.1114E+06	.793E+06									
12	.1464E+03	.9760E+02	.7662E+02	.2928E+03	.2440E+04	.5856E+04	.8296E+04	.1552E+05	.3367E+05	.1551E+06									
13	.4880E+03	.6344E+03	.2928E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03									
14	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03									
21	22	23																	
1	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03	.4880E+03									
2	.1952E+03	.3204E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02	.3416E+02									
3	.4148E+03	.4784E+02	.3416E+02	.3416E+02	.3416E+02														

K= 1									
1	2	3	4	5	6	7	8	9	10
1	.4304E+04	.274E+06	.1291E+06	.1012E+06	.1138E+06	.2487E+06	.9111E+06	.1760E+07	.2783E+07
2	.9427E+05	.6954E+05	.3814E+05	.2860E+05	.3274E+05	.8633E+05	.5327E+06	.2835E+07	.4271E+07
3	.1542E+05	.1474E+05	.1620E+05	.1054E+05	.1254E+05	.3421E+05	.3930E+06	.3478E+07	.5115E+07
4	.874E+04	.7857E+04	.7418E+04	.6344E+04	.7417E+04	.7342E+05	.2698E+06	.2287E+07	.3477E+07
5	.5954E+04	.5710E+04	.4392E+04	.3904E+04	.4685E+04	.1337E+05	.1492E+06	.1269E+07	.3443E+07
6	.5717E+04	.5173E+04	.3562E+04	.2928E+04	.3455E+04	.6677E+04	.5807E+05	.4470E+06	.1521E+07
7	.5461E+04	.5173E+04	.3759E+04	.2879E+04	.3074E+04	.3709E+04	.1074E+05	.1307E+06	.5969E+06
8	.5955E+04	.5514E+04	.3855E+04	.2977E+04	.2830E+04	.2830E+04	.4431E+04	.1518E+05	.1345E+06
9	.6393E+04	.664E+04	.3953E+04	.2928E+04	.3172E+04	.4587E+04	.7564E+04	.1015E+05	.1493E+05
10	.6977E+04	.8101E+04	.5661E+04	.5710E+04	.7808E+04	.9370E+04	.1093E+05	.1147E+05	.1015E+05
11	.6344E+04	.8148E+04	.8188E+04	.9418E+04	.1054E+05	.1254E+05	.1464E+05	.1337E+05	.1078E+05
12	.4782E+04	.4490E+04	.7662E+04	.7466E+04	.7906E+04	.1210E+05	.1718E+05	.1971E+05	.1808E+05
13	.2440E+04	.7277E+04	.3318E+04	.3074E+04	.5514E+04	.1088E+05	.1762E+05	.2284E+05	.2294E+05
14	.1171E+04	.1562E+04	.1562E+04	.1513E+04	.1464E+04	.1415E+04	.1366E+04	.1318E+04	.1269E+04
orcomp									
11	12	13	14	15	16	17	18	19	20
1	.1023E+07	.1842E+06	.3133E+05	.1074E+05	.1103E+05	.6149E+04	.4538E+04	.4587E+04	.1371E+05
2	.1152E+07	.7611E+06	.1279E+06	.4075E+05	.3714E+05	.1723E+05	.5466E+04	.6588E+04	.3401E+05
3	.1353E+07	.7325E+06	.3509E+06	.1464E+06	.7569E+05	.3133E+05	.9321E+04	.2730E+05	.1147E+06
4	.1040E+07	.2250E+07	.1161E+07	.5363E+06	.2225E+06	.8442E+05	.6090E+05	.2210E+06	.4217E+06
5	.3740E+07	.2817E+07	.2135E+07	.8870E+06	.5223E+06	.4534E+06	.7034E+06	.1045E+07	.8177E+06
6	.3277E+07	.3397E+07	.2950E+07	.2191E+07	.1564E+07	.1705E+07	.1668E+07	.1403E+07	.9134E+06
7	.1776E+07	.2714E+07	.3154E+07	.3296E+07	.3460E+07	.3243E+07	.2551E+07	.1814E+07	.1011E+07
8	.5874E+06	.6709E+06	.9156E+06	.1643E+07	.7404E+07	.3466E+07	.3170E+07	.1858E+07	.1271E+07
9	.2542E+05	.1261E+06	.1701E+06	.2379E+06	.3521E+06	.6062E+06	.7342E+06	.1269E+07	.1105E+07
10	.1702E+05	.2894E+05	.4665E+05	.6622E+05	.7949E+05	.8589E+05	.9760E+05	.2252E+06	.6173E+06
11	.1044E+05	.1759E+05	.1576E+05	.2050E+05	.2547E+05	.2806E+05	.3265E+05	.4446E+05	.1114E+06
12	.1410E+05	.1277E+05	.1077E+05	.1171E+05	.1318E+05	.1396E+05	.1523E+05	.2225E+05	.3401E+05
13	.1074E+05	.7808E+04	.5369E+04	.8296E+04	.8296E+04	.6344E+04	.1083E+05	.1557E+05	.2146E+05
14	.1171E+04	.1122E+04	.1074E+04	.1025E+04	.9760E+03	.8979E+04	.1688E+05	.3074E+05	.6641E+05
21	22	23							
1	.5901E+05	.3006E+05	.9760E+04						
2	.8867E+05	.2782E+05	.7662E+04						
3	.1141E+06	.3182E+05	.6490E+04						
4	.1185E+06	.4119E+05	.6442E+04						
5	.1279E+06	.5030E+05	.7369E+04						
6	.1393E+06	.5724E+05	.1113E+05						
7	.1679E+06	.6246E+05	.1532E+05						
8	.1949E+06	.6422E+05	.1820E+05						
9	.2131E+06	.6612E+05	.2490E+05						
10	.2314E+06	.9555E+05	.4275E+05						
11	.3490E+06	.1997E+06	.1054E+06						
12	.4361E+06	.6341E+06	.2369E+06						
13	.5739E+05	.1377E+06	.4746E+05						
14	.1585E+06	.1061E+06	.4660E+05						

POROSITY INPUT									
.....									
NO. OF CONSTANT REGIONS		NO. OF INDIVIDUAL POINTS		CONVERSION FACTOR		UNITS			
27		0		0.					

	11	12	13	14	15	16	17	18	19	20
1	.1000F+00	.1000F+00	.1000F+00	.1000F+00			.1000F+00	.1000E+00	.1000F+00	.1000F+00
2	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00
3	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00	.1000F+00
4	.2500E+00	.2500E+00	.2500E+00	.2500E+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000F+00
5	.2500E+00	.2500E+00	.2500E+00	.2500E+00	.1000F+00	.1000E+00	.1000E+00	.1000F+00	.1000E+00	.1000E+00
6	.2500E+00	.2500E+00	.2500E+00	.2500E+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
7	.2500E+00	.2500E+00	.2500E+00	.2500E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
8	.1000F+00	.1000F+00	.1000F+00	.1000E+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
9	.1000F+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
10	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
11	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
12	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000F+00
13	.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000F+00	.1000F+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00
14						.1000E+00	.1000E+00	.1000E+00	.1000E+00	.1000E+00

	21	22	23
1	.1000E+00	.1000E+00	.1000E+00
2	.1000E+00	.1000E+00	.1000E+00
3	.1000E+00	.1000E+00	.1000E+00
4	.1000E+00	.1000E+00	.1000E+00
5	.1000E+00	.1000E+00	.1000E+00
6	.1000E+00	.1000E+00	.1000E+00
7	.1000E+00	.1000E+00	.1000E+00
8	.1000E+00	.1000E+00	.1000E+00
9	.1000E+00	.1000E+00	.1000E+00
10	.1000E+00	.1000E+00	.1000E+00
11	.1000E+00	.1000E+00	.1000E+00
12	.1000E+00	.1000E+00	.1000E+00
13	.1000E+00	.1000E+00	.1000E+00
14	.1000E+00	.1000E+00	.1000E+00

PCRF VOLUME 13F-11881

AQUIFER WATER MIGRATION RATE..... 0.00FT/DAY

NO. OF CONSTANT REGIONS	NO. OF INDIVIDUAL POINTS	CONVERSION FACTOR	UNITS
0	1	0.	INITIAL POTENTIALS, FEET

INITIAL POTENTIALS (FT)									
K= 1									
1	2	3	4	5	6	7	8	9	10
1									
2									
3									
4	432.0000								
5	441.0000	442.0000	442.0000	439.0000	430.0000				
6	449.0000	451.0000	452.0000	449.0000	442.0000				
7	456.0000	459.0000	463.0000	459.0000	452.0000	441.0000			
8	462.0000	467.0000	470.0000	468.0000	460.0000	449.0000			
9	469.0000	473.0000	476.0000	477.0000	465.0000	454.0000	443.0000		
10	474.0000	477.0000	479.9000	479.9000	468.0000	457.0000	448.0000	439.0000	429.0000
11	476.0000	479.0000	479.9000	477.0000	468.0000	459.0000	450.0000	442.0000	
12	477.0000	478.0000	478.0000	476.0000	469.0000	460.0000			
13									
14									
11	12	13	14	15	16	17	18	19	20
1									
2									
3									
4									
5									
6									
7			406.0000	405.0000	405.0000	404.0000	404.0000	403.0000	403.0000
8			405.0000	405.0000	404.0000	404.0000	404.0000	403.0000	403.0000
9	406.0000		406.0000	405.0000	404.0000	404.0000	403.0000	403.0000	402.0000
10		406.0000	406.0000	405.0000	404.0000	404.0000	403.0000	402.0000	401.0000
11			406.0000	405.0000	404.0000	403.0000	402.0000	402.0000	400.0000
12				406.0000	405.0000	404.0000	403.0000	402.0000	402.0000
13									
14									
21	22	23							
1									
2									
3									
4									
5									
6									
7									
8									
9	400.0000								
10	399.0000								
11	399.0000								
12	398.0000	396.0000	390.2000						
13									
14									
K= 2									
1	2	3	4	5	6	7	8	9	10
1					408.0000	408.0000	408.0000	409.0000	409.0000
2					408.0000	408.0000	408.0000	409.0000	409.0000
3	426.0000	431.0000	430.0000	424.0000	415.0000	409.0000	408.0000	408.0000	408.0000
4	432.0000	436.0000	435.0000	430.0000	422.0000	412.0000	409.0000	408.0000	408.0000
5	441.0000	442.0000	442.0000	438.0000	430.0000	417.0000	409.0000	408.0000	407.0000
6	449.0000	451.0000	452.0000	449.0000	442.0000	429.0000	414.0000	408.0000	407.0000
7	456.0000	459.0000	463.0000	459.0000	452.0000	441.0000	424.0000	411.0000	408.0000
8	462.0000	467.0000	470.0000	468.0000	460.0000	449.0000	435.0000	418.0000	410.0000
9	469.0000	473.0000	476.0000	477.0000	465.0000	454.0000	443.0000	431.0000	419.0000
10	474.0000	477.0000	479.9000	479.9000	468.0000	457.0000	448.0000	439.0000	429.0000
11	476.0000	479.0000	479.9000	477.0000	468.0000	459.0000	450.0000	442.0000	434.0000
12	477.0000	478.0000	478.0000	476.0000	469.0000	460.0000	452.0000	445.0000	437.0000
13		478.0000	478.0000						428.0000
14									
11	12	13	14	15	16	17	18	19	20
1	409.0000		406.0000	408.0000		397.4000	394.8000	391.6000	388.7000
2					405.0000	407.0000	399.0000	397.0000	394.0000
3					407.0000	404.0000	401.0000	400.0000	397.0000
4				407.0000	406.0000	404.0000	403.0000	401.0000	399.0000
5	407.0000	407.0000	407.0000	406.0000	405.0000	404.0000	403.0000	402.0000	401.0000
6	407.0000	406.0000	406.0000	406.0000	405.0000	404.0000	403.0000	402.0000	399.0000
7	408.0000	408.0000	408.0000	408.0000	408.0000	404.0000	403.0000	403.0000	402.0000
8	407.0000	404.0000	405.0000	405.0000	404.0000	404.0000	403.0000	403.0000	402.0000
9	407.0000	406.0000	406.0000	406.0000	404.0000	404.0000	403.0000	402.0000	401.0000
10	411.0000	407.0000	406.0000	406.0000	404.0000	404.0000	403.0000	402.0000	401.0000
11	415.0000	410.0000	408.0000	406.0000	405.0000	404.0000	403.0000	402.0000	400.0000
12				407.0000	405.0000	404.0000	403.0000	401.0000	400.0000
13						403.0000	403.0000	401.0000	399.0000
14					405.0000	403.9000	402.5000		398.0000
21	22	23							
1	392.5000	374.1000	366.7000						
2	392.0000	381.0000	366.7000						
3	395.0000	388.0000	370.1000						
4	397.0000	392.0000	373.8000						
5	399.0000	395.0000	377.9000						
6	402.0000	397.0000	381.4000						
7	400.0000	397.0000	383.6000						
8	400.0000	397.0000	385.1000						
9	400.0000	397.0000	386.6000						
10	399.0000	397.0000	388.2000						
11	399.0000	396.0000	389.4000						
12	398.0000	396.0000	390.2000						
13	397.0000	396.0000	389.4000						
14	397.0000	395.3000	388.6000						

	1	2	3	4	5	6	7	8	9	10
1						408.0000	408.0000	408.0000	409.0000	409.0000
2		424.0000	424.0000	417.0000	410.0000	408.0000	408.0000	408.0000	409.0000	409.0000
3	426.0000	431.0000	430.0000	424.0000	415.0000	409.0000	408.0000	408.0000	408.0000	408.0000
4	432.0000	435.0000	435.0000	430.0000	422.0000	412.0000	408.0000	408.0000	408.0000	407.0000
5	441.0000	442.0000	442.0000	439.0000	430.0000	417.0000	409.0000	408.0000	407.0000	407.0000
6	449.0000	451.0000	452.0000	449.0000	442.0000	429.0000	414.0000	408.0000	407.0000	407.0000
7	456.0000	457.0000	463.0000	459.0000	452.0000	441.0000	424.0000	411.0000	408.0000	407.0000
8	462.0000	467.0000	470.0000	468.0000	460.0000	449.0000	435.0000	418.0000	410.0000	407.0000
9	469.0000	473.0000	474.0000	477.0000	465.0000	454.0000	443.0000	431.0000	419.0000	410.0000
10	474.0000	477.0000	479.0000	479.0000	468.0000	457.0000	448.0000	439.0000	429.0000	419.0000
11	476.0000	479.0000	479.0000	477.0000	468.0000	459.0000	450.0000	442.0000	434.0000	425.0000
12	477.0000	478.0000	478.0000	476.0000	469.0000	460.0000	452.0000	445.0000	437.0000	428.0000
13		478.0000	478.0000							
14										

intercomp

	11	12	13	14	15	16	17	18	19	20
1	409.0000	408.0000	406.0000	408.0000			397.4000	394.6000	391.6000	388.7000
2	409.0000	409.0000	410.0000	410.0000	408.0000	407.0000	407.0000	399.0000	397.0000	394.0000
3	408.0000	408.0000	409.0000	410.0000	410.0000	407.0000	404.0000	401.0000	400.0000	397.0000
4	407.0000	407.0000	408.0000	409.0000	407.0000	406.0000	404.0000	403.0000	401.0000	399.0000
5	407.0000	407.0000	407.0000	406.0000	405.0000	405.0000	404.0000	403.0000	402.0000	401.0000
6	407.0000	406.0000	406.0000	405.0000	405.0000	404.0000	404.0000	403.0000	402.0000	401.0000
7	406.0000	406.0000	406.0000	405.0000	405.0000	404.0000	404.0000	403.0000	403.0000	402.0000
8	407.0000	406.0000	405.0000	405.0000	404.0000	404.0000	404.0000	403.0000	403.0000	402.0000
9	407.0000	406.0000	405.0000	405.0000	404.0000	404.0000	404.0000	403.0000	402.0000	401.0000
10	411.0000	407.0000	406.0000	405.0000	404.0000	404.0000	404.0000	403.0000	402.0000	401.0000
11	416.0000	410.0000	408.0000	406.0000	405.0000	404.0000	403.0000	402.0000	402.0000	400.0000
12	420.0000	414.0000	410.0000	407.0000	405.0000	404.0000	403.0000	401.0000	400.0000	400.0000
13	421.0000	416.0000	412.0000	408.0000	406.0000	404.0000	403.0000	401.0000	399.0000	398.0000
14						405.0000	403.0000	402.5000	400.4000	399.2000

	21	22	23
1	382.5000	374.1000	366.7000
2	380.0000	381.0000	366.7000
3	385.0000	383.0000	370.1000
4	397.0000	392.0000	373.8000
5	399.0000	395.0000	377.9000
6	400.0000	396.0000	381.4000
7	400.0000	397.0000	383.6000
8	400.0000	397.0000	385.1000
9	400.0000	397.0000	386.6000
10	399.0000	397.0000	388.2000
11	398.0000	396.0000	389.4000
12	397.0000	396.0000	390.2000
13	397.0000	396.0000	389.4000
14	397.7000	395.3000	388.6000

CONSTANT POTENTIAL BOUNDARIES..... 0.000 0.000

INITIAL WATER IN PLACE +1069E+11 BBLs

** WARNING **

THE A ARRAY IN GAUSSO MUST BE DIMENSIONED AT LEAST 15199

INITIAL CONCENTRATIONS									
NO OF CONSTANT REGIONS	NO OF INDIVIDUAL POINTS	CONVERSION FACTOR		UNITS					
8	1	0.		PCI/ML					
1	2	3	Ka = 3 4	5	6	7	8-	9	10
1									
2									
3									
4									
5									
6									
7			.1000E+01	.1000E+01	.1000E+01				
8	.7000E+01	.1900E+02	.2800E+02	.6700E+02	.6200E+02	.1100E+02			
9	.4000E+01	.4900E+02	.2750E+03	.4450E+03	.4000E+03	.1400E+02			
10	.1200E+02	.1730E+03	.4800E+03	.7400E+03	.3650E+03	.2000E+02	.2400E+01		
11	.1300E+02	.1400E+03	.1350E+03	.9300E+02	.5500E+02	.4000E+01			
12	.4000E+01	.7000E+01	.6000E+01	.3000E+01					
13									
14									
	11	12	13	14	15	16	17	18	19
1									
2									
3									
4								.1000E+01	.1000E+01
5								.1000E+01	.2000E+01
6	.1000E+01	.3000E+01	.6000E+01	.3000E+01	.3000E+01	.3000E+01	.2000E+01	.4000E+01	.4000E+01
7	.9000E+01	.4000E+01	.1100E+02	.7000E+01	.4000E+02	.7300E+02	.4700E+02	.2400E+02	.8000E+01
8					.2000E+01	.6000E+01	.2000E+02	.4600E+02	.5000E+02
9					.2000E+01	.9000E+01	.2100E+02	.7500E+02	.1700E+03
10							.2000E+01	.1200E+02	.7200E+02
11								.1200E+02	.1210E+03
12									.9700E+02
13									.6000E+01
14									
	21	22	23						
1									
2									
3	.1000E+01								
4	.1000E+01	.1000E+01							
5	.6000E+01	.3000E+01							
6	.4000E+01	.3000E+01							
7	.6000E+01	.2000E+01							
8	.3000E+01	.1000E+01							
9	.1500E+02	.1000E+01							
10	.5200E+02	.1000E+01							
11	.7600E+02								
12	.3700E+02	.5000E+01							
13		.1000E+01							
14									
	1	2	3	Ka = 2 4	5	6	7	8	9
1									10 intercomp
2									
3									
4									
5									
6									.2600E+02
7			.2000E+01	.7000E+01	.2900E+02	.1500E+02			.1700E+02
8	.1600E+02	.4100E+02	.6200E+02	.7000E+03	.4000E+03	.1070E+03	.4000E+01		
9	.8000E+01	.8500E+02	.4300E+03	.8400E+03	.1300E+04	.1700E+03	.2300E+02		
10	.1900E+02	.2600E+03	.7100E+03	.1230E+04	.8200E+03	.7700E+02	.1100E+02		
11	.2100E+02	.2150E+03	.2150E+03	.1700E+03	.1400E+03	.1900E+02			
12	.8000E+01	.1400E+02	.1400E+02	.1200E+02					
13									
14									
	11	12	13	14	15	16	17	18	19
1								.1700E+02	.2900E+02
2				.1000E+01				.9000E+01	.1450E+03
3			.5000E+01	.4000E+01	.2000E+01	.4000E+01	.4300E+02	.1180E+03	.1730E+03
4		.2000E+01	.1000E+02	.1300E+02	.2300E+02	.2600E+02	.4800E+02	.2400E+03	.3500E+03
5	.5900E+02	.3200E+03	.6200E+03	.2830E+03	.2600E+03	.3200E+03	.3350E+03	.5250E+03	.6600E+03
6	.8750E+03	.4000E+03	.1130E+04	.7200E+03	.6000E+03	.8100E+03	.8450E+03	.8700E+03	.8500E+03
7	.6400E+03	.8400E+03	.9000E+03	.9800E+03	.5000E+03	.5000E+03	.5200E+03	.1330E+04	.8400E+03
8					.8000E+01	.1600E+02	.5300E+02	.1570E+03	.2800E+03
9					.4000E+01	.1900E+02	.4200E+02	.1650E+03	.7600E+03
10							.4000E+01	.2500E+02	.1650E+03
11								.2900E+02	.2850E+03
12								.2900E+02	.2650E+03
13								.1800E+02	.3300E+02
14									.1200E+02
	21	22	23						
1	.1500E+02	.1500E+02							
2	.1050E+03	.2200E+02	.1300E+02						
3	.4500E+02	.9500E+02	.1400E+02						
4	.5000E+03	.2700E+03	.3100E+02						
5	.4400E+03	.2700E+03	.3500E+02						
6	.5100E+03	.2900E+03	.2400E+02						
7	.6200E+03	.2750E+03	.1400E+02						
8	.2400E+03	.7000E+02							
9	.6100E+03	.8000E+02							
10	.2400E+03	.6300E+02							
11	.2100E+03	.3700E+02							
12	.1530E+03	.3600E+02							
13	.2900E+02	.6800E+02	.1900E+02						

	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

intercomp

	11	12	13	14	15	16	17	18	19	20
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

	21	22	23
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

IPT = 1 IDRUG = 0

POINT SPECIFICATION

REGION 1 23 1 14 1 3

POINT SPACING

X Y Z
3000.00 300.00 90.00

LONGITUDINAL DISPERSIVITY ALPHA..... 250.FT
 TRANSVERSE DISPERSIVITY ALPHA..... 100.FT
 MOLECULAR DIFFUSIVITY..... 0. FT*FT/DAY
 MINIMUM BLOCK RESIDUAL REQUIRED..... 0.000
 MINIMUM SUM OF RESIDUALS REQUIRED..... .001

HALF LIFE OF CONTAMINANT 4562.500 DAYS

WT FACTOR, CD=0.5, RD=1 OR 0..... 1.000

CRANK-NICHOLSON FACTOR 0

INITIAL CONTAMINANT IN PLACE8556E+13

TIME STEP INFO									
TIME STEP, DAY	MOLO TIME, DAY		STOPT TIME, DAY		CUM TIME, DAY				
122.0	2192.0		2192.0		2070.0				
CONTROL INDICES									
NO OF WELL CHANGES THIS STEP.....					1				
INDEX FOR POT COEFF PRINT.....					0				
INDEX FOR DIFF COEFF PRINT.....					0				
INDEX FOR CONC PRINTS AND MAPS.....					3				
INDEX FOR X-VEL PRINT.....					0				
INDEX FOR Y-VEL PRINT.....					0				
INDEX FOR Z-VEL PRINT.....					0				
WELL NO	I	J	K1 - K2	RATE	CONC	WI	IN1	PW	
AVERAGING OVER 4 MONTHS									
0	0	0	-1	0.0	0.00	0.	0	0.00	
1	6	1	1	2	0.00	27366.	3	402.48	
2	7	1	1	2	0.00	27366.	3	403.25	
3	8	1	1	2	0.00	27366.	3	403.98	
4	9	1	1	2	0.00	27366.	3	404.55	
5	10	1	1	2	0.00	27366.	3	404.98	
6	11	1	1	2	0.00	27366.	3	405.18	
7	12	1	1	1	0.00	27366.	3	405.58	
8	13	1	1	2	0.00	27366.	3	406.60	
9	14	1	1	2	0.00	27366.	3	406.90	
10	17	1	1	2	0.00	27366.	3	395.53	
11	18	1	1	2	0.00	27366.	3	391.10	
12	19	1	1	2	0.00	27366.	3	392.30	
13	20	1	1	2	0.00	27366.	3	391.23	
14	21	1	1	2	0.00	27366.	3	386.00	
15	22	1	1	2	0.00	27366.	3	377.20	
16	22	2	1	1	0.00	0.	1	372.60	
17	2	2	1	2	0.00	27366.	3	417.75	
18	3	2	1	2	0.00	27366.	3	418.38	
19	4	2	1	2	0.00	27366.	3	411.78	
20	5	2	1	2	0.00	27366.	3	404.70	
21	15	2	1	1	0.00	27366.	3	405.85	
22	16	2	1	2	0.00	27366.	3	404.10	
23	23	1	1	1	0.00	27366.	3	368.55	
24	1	3	1	2	0.00	27366.	3	431.00	
25	23	3	1	2	0.00	27366.	3	373.70	
26	1	4	1	3	0.00	27366.	3	434.75	
27	23	4	1	2	0.00	27366.	3	377.63	
28	1	5	1	3	0.00	27366.	3	441.30	
29	23	5	1	2	0.00	27366.	3	340.73	
30	1	6	1	3	0.00	27366.	3	450.05	
31	23	6	1	2	0.00	27366.	3	383.60	
32	1	7	1	3	0.00	27366.	3	454.03	
33	23	7	1	2	0.00	27366.	3	362.70	
34	1	8	1	3	0.00	27366.	3	466.45	
35	23	8	1	2	0.00	27366.	3	387.43	
36	1	9	1	3	0.00	27366.	3	471.93	
37	23	9	1	2	0.00	27366.	3	388.98	
38	1	10	1	3	0.00	27366.	3	475.55	
39	23	10	1	2	0.00	27366.	3	390.35	
40	1	11	1	3	0.00	27366.	3	477.53	
41	23	11	1	2	0.00	27366.	3	391.10	
42	1	12	1	3	0.00	27366.	3	478.15	
43	23	12	1	3	0.00	27366.	3	391.48	
44	4	12	1	3	0.00	27366.	3	477.80	
45	5	12	1	3	0.00	27366.	3	469.58	
46	6	12	1	3	0.00	27366.	3	461.18	
47	7	12	1	2	0.00	27366.	3	452.50	
48	8	12	1	2	0.00	27366.	3	444.93	
49	9	12	1	2	0.00	27366.	3	436.90	
50	10	12	1	2	0.00	27366.	3	427.40	
51	2	13	1	2	0.00	27366.	3	478.15	
52	3	13	1	2	0.00	27366.	3	478.28	
53	11	13	1	1	0.00	27366.	3	419.93	
54	12	13	1	1	0.00	27366.	3	415.23	
55	13	13	1	1	0.00	27366.	3	410.30	
56	14	13	1	1	0.00	27366.	3	406.93	
57	15	13	1	1	0.00	27366.	3	405.10	
58	23	13	1	2	0.00	27366.	3	388.90	
59	16	13	1	1	0.00	27366.	3	405.33	
60	17	14	1	2	0.00	27366.	3	399.40	
61	23	14	1	2	0.00	27366.	3	380.28	
62	18	14	1	2	0.00	27366.	3	396.60	
63	19	14	1	1	0.00	27366.	3	392.90	
64	20	14	1	1	0.00	27366.	3	389.85	
65	21	14	1	2	0.00	27366.	3	386.50	
66	22	14	1	2	0.00	27366.	3	383.40	
67	3	10	1	1	-192396.0	0.00	0.	0.00	
68	5	8	1	1	-6.6	0.00	0.	0.00	
69	6	11	1	1	-3342.0	0.00	0.	0.00	
70	12	4	1	1	-0.0	0.00	0.	0.00	
71	13	3	1	1	-0.0	0.00	0.	0.00	
72	13	9	1	1	-0.0	0.00	0.	0.00	
73	4	7	1	1	-0.0	0.00	0.	0.00	
74	3	6	1	1	-48718.0	0.00	0.	0.00	
75	12	5	1	1	-0.0	0.00	0.	0.00	
76	11	5	1	1	-0.0	0.00	0.	0.00	
77	3	7	1	1	-0.0	0.00	0.	0.00	
78	4	8	1	1	-15477.0	0.00	0.	0.00	
79	4	10	1	1	-0.0	0.00	0.	0.00	
80	4	11	1	1	-94045.0	0.00	0.	0.00	
81	5	11	1	1	-2665.0	0.00	0.	0.00	
82	13	4	1	1	-0.0	0.00	0.	0.00	
83	5	10	1	1	-0.0	0.00	0.	0.00	
84	14	5	1	1	-1960.0	0.00	0.	0.00	
85	6	9	1	1	-33225.0	6.45	0.	0.00	
86	12	6	1	1	-8440.0	0.00	0.	0.00	
87	13	5	1	1	-10000.0	27.05	0.	0.00	
88	10	5	1	1	-20000.0	21.89	0.	0.00	
89	14	4	1	1	-371430.0	0.00	0.	0.00	
90	11	4	1	1	-17402.0	2515.15	0.	0.00	
91	3	8	1	1	-12928.0	1008.95	0.	0.00	

TIME = 2192.000

```

-----
VELOCITY CALCULATION CONVERGENCE MEASURE
-----
WATER MATERIAL BALANCE..... 1.0039J00
NO OF ITERATIONS REQUIRED..... 1
WATER INJECTED..... .5015E+09 BBLs
WATER PRODUCED..... .5571E+09 BBLs
WATER IN PLACE..... .1064E+11 BBLs
AQUIFER FLUX AT X=0..... 0. BBLs
AQUIFER FLUX AT X=L..... 0. BBLs

NEW PTS AT SOURCE 7 0
NEW PTS AT SOURCE 9 0
NEW PTS AT SOURCE 9 0
NEW PTS AT SOURCE 18 1
4.0000
NEW PTS AT SOURCE 18 0
NEW PTS AT SOURCE 21 0
NEW PTS AT SOURCE 24 0
NEW PTS AT SOURCE 24 0
NEW PTS AT SOURCE 44 0
NEW PTS AT SOURCE 44 0
NEW PTS AT SOURCE 44 0
NEW PTS AT SOURCE 46 0
NEW PTS AT SOURCE 46 0
NEW PTS AT SOURCE 46 0
NEW PTS AT SOURCE 46 0
NEW PTS AT SOURCE 47 0
NEW PTS AT SOURCE 47 0
NEW PTS AT SOURCE 48 0
NEW PTS AT SOURCE 48 0
NEW PTS AT SOURCE 49 0
NEW PTS AT SOURCE 49 0
NEW PTS AT SOURCE 51 0
NEW PTS AT SOURCE 52 0
NEW PTS AT SOURCE 52 0
NEW PTS AT SOURCE 60 0
NEW PTS AT SOURCE 60 0
NEW PTS AT SOURCE 62 0
NEW PTS AT SOURCE 62 0
NEW PTS AT SOURCE 67 3
2.0000
3.0000
4.0000
NEW PTS AT SOURCE 68 0
NEW PTS AT SOURCE 74 1
4.0000
NEW PTS AT SOURCE 80 1
3.0000
NEW PTS AT SOURCE 84 0
NEW PTS AT SOURCE 85 0
NEW PTS AT SOURCE 86 0
NEW PTS AT SOURCE 87 0
NEW PTS AT SOURCE 88 0
NEW PTS AT SOURCE 89 5
3.0000
4.0000
5.0000
6.0000
7.0000
NEW PTS AT SOURCE 91 0
NO NEW PTS THIS STEP= 0 NO PTS DELETED THIS STEP= 279 TOTAL PTS BEFORE REINITIALIZATION 7740
ITN = 1 PARAM = .50712
ITN = 2 PARAM = .61001
ITN = 3 PARAM = .69322
ITN = 4 PARAM = .75130
ITN = 5 PARAM = .78366
CONC EQN = LSOR PARAM = 1.36507

```

WELL NO	I	J	K	PRODUCTION/RATE/INJECTION	BHOLE PRESSURES	BLOCK CONCENTRATIONS
1	6	1	1	32631.9	0.0	.000
			2	31908.1	0.0	.000
			WELL TOTAL	64540.0	0.0	.000
2	7	1	1	28385.4	0.0	.000
			2	23281.6	0.0	.000
			WELL TOTAL	51667.1	0.0	.000
3	8	1	1	23678.4	0.0	.000
			2	12009.3	0.0	.000
			WELL TOTAL	35687.7	0.0	.000
4	9	1	1	14833.1	0.0	.004
			2	6756.5	0.0	.003
			WELL TOTAL	21589.6	0.0	.003
5	10	1	1	8224.7	0.0	.053
			2	2411.4	0.0	.025
			WELL TOTAL	10636.0	0.0	.046
6	11	1	1	6171.4	0.0	.060
			2	.1	0.0	.000
			WELL TOTAL	6171.5	0.0	.060
7	12	1	1	0.0	333.6	0.000
			WELL TOTAL	0.0	333.6	0.000
8	13	1	1	0.0	6984.9	0.000
			2	0.0	2.4	0.000
			WELL TOTAL	0.0	6987.2	0.000
9	14	1	1	0.0	691.7	0.000
			2	0.0	.8	0.000
			WELL TOTAL	0.0	692.5	0.000
10	17	1	1	2052.7	0.0	-.059
			2	284.5	0.0	-.075
			WELL TOTAL	2337.2	0.0	-.061
11	18	1	1	14438.6	0.0	12.652
			2	3545.4	0.0	12.063
			WELL TOTAL	17984.0	0.0	12.536
12	19	1	1	26675.1	0.0	82.979
			2	8605.7	0.0	81.505
			WELL TOTAL	35280.8	0.0	82.519
13	20	1	1	57837.4	0.0	299.729
			2	18076.6	0.0	285.785
			WELL TOTAL	75914.0	0.0	296.545
14	21	1	1	97158.5	0.0	193.384
			2	20992.9	0.0	184.744
			WELL TOTAL	118151.4	0.0	191.885
15	22	1	1	78553.3	0.0	35.133
			2	15914.8	0.0	36.692
			WELL TOTAL	94468.1	0.0	35.395
16	22	2	1	0.0	0.0	133.591
			WELL TOTAL	0.0	0.0	0.000
17	2	2	1	22008.5	0.0	.000
			2	7261.7	0.0	.000
			WELL TOTAL	29270.2	0.0	.000
18	3	2	1	0.0	6603.5	0.000
			2	0.0	1973.9	0.000
			WELL TOTAL	0.0	8577.4	0.000
19	4	2	1	14914.2	0.0	.000
			2	4031.4	0.0	.000
			WELL TOTAL	18945.6	0.0	.000
20	5	2	1	36687.1	0.0	-.002
			2	9759.5	0.0	-.001
			WELL TOTAL	46446.6	0.0	-.001
21	15	2	1	0.0	2790.4	0.000
			WELL TOTAL	0.0	2790.4	0.000
22	16	2	1	3319.0	0.0	-.8434
			2	72.9	0.0	6.891
			WELL TOTAL	3391.9	0.0	-.8105
23	23	1	1	37995.0	0.0	4.854
			WELL TOTAL	37995.0	0.0	4.854
24	1	3	1	0.0	4970.6	0.000
			2	0.0	3355.7	0.000
			WELL TOTAL	0.0	8326.3	0.000
25	23	3	1	17814.7	0.0	41.401
			2	11560.9	0.0	40.801
			WELL TOTAL	29375.7	0.0	41.165
26	1	4	1	461.8	0.0	.002
			2	652.2	0.0	.003
			3	465.6	0.0	.002
			WELL TOTAL	1579.6	0.0	.003
27	23	4	1	11593.2	0.0	37.592
			2	8240.0	0.0	37.277
			WELL TOTAL	19833.2	0.0	37.461
28	1	5	1	2258.9	0.0	-.009
			2	3083.4	0.0	-.010
			3	2719.2	0.0	-.000
			WELL TOTAL	8061.5	0.0	-.006
29	23	5	1	14170.4	0.0	48.124
			2	10845.0	0.0	47.979

30	WELL TOTAL	25035.4	0.0	380.7	48.061	
1	6	1	1490.0	0.0	-0.028	
		2	1979.7	0.0	-0.006	
		3	1797.0	0.0	+1.779	
	WELL TOTAL	5262.6	0.0	450.1	0.051	
31	23	6	1	16334.8	0.0	45.786
		2	12509.9	0.0	45.804	
	WELL TOTAL	28844.7	0.0	383.6	45.794	
32	1	7	1	283.4	0.0	2.657
		2	364.9	0.0	2.709	
		3	439.0	0.0	0.951	
	WELL TOTAL	1087.4	0.0	459.0	1.985	
33	23	7	1	19008.9	0.0	21.975
		2	14562.5	0.0	17.719	
	WELL TOTAL	33571.4	0.0	385.7	20.129	
34	1	8	1	664.9	0.0	4.707
		2	883.1	0.0	5.779	
		3	1155.3	0.0	4.636	
	WELL TOTAL	2703.3	0.0	466.4	5.027	
35	23	8	1	21426.3	0.0	8.458
		2	17024.3	0.0	9.304	
	WELL TOTAL	38450.6	0.0	387.4	8.832	
36	1	9	1	1737.0	0.0	9.879
		2	2318.2	0.0	8.107	
		3	3225.8	0.0	4.950	
	WELL TOTAL	7281.0	0.0	471.9	7.131	
37	23	9	1	25435.3	0.0	3.424
		2	21660.2	0.0	3.881	
	WELL TOTAL	47101.6	0.0	389.0	3.634	
38	1	10	1	2907.9	0.0	14.664
		2	3894.9	0.0	13.360	
		3	5802.0	0.0	4.309	
	WELL TOTAL	12604.8	0.0	475.6	9.522	
39	23	10	1	29789.7	0.0	5.559
		2	26758.7	0.0	5.952	
	WELL TOTAL	56548.4	0.0	390.4	5.745	
40	1	11	1	897.4	0.0	6.025
		2	1238.7	0.0	6.390	
		3	1904.2	0.0	7.012	
	WELL TOTAL	4040.4	0.0	477.5	6.602	
41	23	11	1	34498.0	0.0	6.222
		2	33504.2	0.0	6.041	
	WELL TOTAL	68002.3	0.0	391.1	6.234	
42	1	12	1	0.0	21.5	0.000
		2	20.7	0.0	1.749	
		3	130.2	0.0	1.398	
	WELL TOTAL	150.8	21.5	478.2	1.446	
43	23	12	1	33895.9	0.0	6.486
		2	37032.5	0.0	6.335	
		3	426.6	0.0	1.202	
	WELL TOTAL	71355.0	0.0	391.5	6.376	
44	4	12	1	0.0	8006.8	0.000
		2	0.0	10514.8	0.000	
		3	0.0	9947.7	0.000	
	WELL TOTAL	0.0	26469.4	477.8	0.000	
45	5	12	1	0.0	3902.7	0.000
		2	0.0	5008.9	0.000	
		3	0.0	1871.5	0.000	
	WELL TOTAL	0.0	10783.1	469.6	0.000	
46	6	12	1	0.0	7030.3	0.000
		2	0.0	8453.6	0.000	
		3	0.0	552.4	0.000	
	WELL TOTAL	0.0	16036.3	461.2	0.000	
47	7	12	1	0.0	4426.6	0.000
		2	0.0	3897.8	0.000	
	WELL TOTAL	0.0	8324.4	452.5	0.000	
48	8	12	1	0.0	6552.8	0.000
		2	0.0	3934.9	0.000	
	WELL TOTAL	0.0	10487.7	444.9	0.000	
49	9	12	1	0.0	6482.7	0.000
		2	0.0	2097.4	0.000	

50	10	12	1	0.0	8580.1	436.9	0.000
			2	1789.4	0.0		.002
				219.1	0.0		.001
				-----	-----	-----	-----
				WELL TOTAL	2008.5	0.0	.002
51	2	13	1	0.0	24.7	427.4	0.000
			2	1.6	0.0		.000
				-----	-----	-----	-----
				WELL TOTAL	1.6	24.7	.000
52	3	13	1	0.0	852.5	478.2	0.000
			2	0.0	120.8		0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	973.2	0.000
53	11	13	1	0.0	11090.7	478.3	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	11090.7	0.000
54	12	13	1	2377.3	0.0	419.9	0.000
				-----	-----	-----	-----
				WELL TOTAL	2377.3	0.0	.000
55	13	13	1	3666.2	0.0	415.2	.000
				-----	-----	-----	-----
				WELL TOTAL	3666.2	0.0	.000
56	14	13	1	3609.2	0.0	410.3	.000
				-----	-----	-----	-----
				WELL TOTAL	3609.2	0.0	.000
57	15	13	1	4640.2	0.0	406.9	.000
				-----	-----	-----	-----
				WELL TOTAL	4640.2	0.0	.000
58	23	13	1	30196.1	0.0	405.1	.000
			2	38206.8	0.0		14.543
				-----	-----	-----	-----
				WELL TOTAL	68402.9	0.0	14.543
59	16	13	1	0.0	8857.0	388.9	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	8857.0	0.000
60	17	14	1	0.0	7802.8	405.3	0.000
			2	0.0	877.2		0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	8680.0	0.000
61	23	14	1	78907.9	0.0	399.4	.849
			2	84666.3	0.0		.843
				-----	-----	-----	-----
				WELL TOTAL	163574.2	0.0	.846
62	18	14	1	0.0	1666.2	380.3	0.000
			2	0.0	67.4		0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	1733.6	0.000
63	19	14	1	12810.6	0.0	396.6	.031
				-----	-----	-----	-----
				WELL TOTAL	12810.6	0.0	.031
64	20	14	1	42909.3	0.0	392.9	1.522
				-----	-----	-----	-----
				WELL TOTAL	42909.3	0.0	1.522
65	21	14	1	85179.1	0.0	389.9	7.531
			2	16489.9	0.0		7.562
				-----	-----	-----	-----
				WELL TOTAL	101669.0	0.0	7.539
66	22	14	1	46689.9	0.0	386.5	12.450
			2	56635.7	0.0		12.526
				-----	-----	-----	-----
				WELL TOTAL	153325.6	0.0	12.730
67	3	10	1	0.0	192396.0	383.4	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	192396.0	0.000
68	5	8	1	0.0	6.6	*****	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	6.6	0.000
69	6	11	1	0.0	3342.0	24571.8	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	3342.0	0.000
70	12	4	1	0.0	0.0	12212871.7	339.847
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
71	13	3	1	0.0	0.0	405.4	96.192
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
72	13	9	1	0.0	0.0	405.6	2.154
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
73	4	7	1	0.0	0.0	404.7	22.023
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
74	3	6	1	0.0	48718.0	453.1	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	48718.0	0.000
75	12	5	1	0.0	0.0	*****	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
76	11	5	1	0.0	0.0	405.2	171.392
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
77	3	7	1	0.0	0.0	405.3	22.533
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
78	4	8	1	0.0	15477.0	460.3	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	15477.0	0.000
79	4	10	1	0.0	0.0	56556871.8	286.334
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
80	4	11	1	0.0	94045.0	477.7	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	94045.0	0.000
81	5	11	1	0.0	2665.0	*****	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	2665.0	0.000
82	13	4	1	0.0	0.0	9738972.6	734.233
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
83	5	10	1	0.0	0.0	405.5	384.263
				-----	-----	-----	-----
				WELL TOTAL	0.0	0.0	0.000
84	14	5	1	0.0	1960.0	466.6	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	1960.0	0.000
85	6	9	1	0.0	33225.0	7162682.2	6.452
				-----	-----	-----	-----
				WELL TOTAL	0.0	33225.0	6.452
86	12	6	1	0.0	8440.0	*****	0.000
				-----	-----	-----	-----
				WELL TOTAL	0.0	8440.0	0.000

87	13	5	1	0.0	8440.0	3084204.0	0.000
				0.0	10000.0		27.050
				0.0	10000.0	36542633.7	27.050
88	10	5	1	0.0	20000.0		21.890
				0.0	20000.0	73084862.2	21.890
89	14	4	1	0.0	371430.0		0.000
				0.0	371430.0	*****	0.000
90	11	4	1	0.0	17402.0		2515.150
				0.0	17402.0	63591191.3	2515.150
91	3	8	1	0.0	12928.0		1008.950
				0.0	12928.0	47242262.6	1008.950
				0.0	12928.0		
CUMULATIVE TOTALS				1689884.8	973803.7		

MATERIAL BALANCE SUMMARY AT TIME = 2192.0DAY

DIFF BAL = 1.615172 CUM BAL = .998882
 COMPONENT CUMULATIVES INJECTED .7552E+1288LS PRODUCED .1455E+1188LS IN PLACE .1718E+1388LS
 TOTAL FLUID CUMULATIVES INJECTED .5015E+0988LS PRODUCED .5571E+0988LS
 CONC SOLN = NO OF ITNS = 39 COMPONENTS REACTED = .3064E+13

	1	2	3	K= 1 4	5	6	7	8	9	10
1						.0002	.0001	.0003	.0038	.0527
2		.0000	.0002	.0001	-.0016	.0019	.0005	.0012	.0209	.1874
3	-.0000	.0001	.0063	.0002	-.0353	.0299	.0482	.0165	.1695	1.2316
4	.0023	.0000	.0721	.0087	-.1475	.6529	1.2568	1.0871	1.6841	11.7294
5	-.0086	.0536	.1062	.2655	.8708	.8846	4.3165	5.0163	1.9925	16.0664
6	-.0075	-.4302	.7449	1.3231	7.6680	25.6096	64.8186	27.8929	11.7743	24.0916
7	2.6568	12.7076	22.5332	22.0233	63.6989	157.8798	85.7425	58.8134	11.0335	6.7037
8	4.7069	29.2154	232.9588	162.6039	214.9013	300.6700	129.4471	56.0993	18.4428	5.6658
9	9.8794	22.8793	73.4556	352.2500	475.8250	391.7135	170.4821	79.2577	13.7440	1.3466
10	14.6640	41.2076	22.4211	286.3341	384.2627	247.6213	121.3560	25.4006	-.3713	.5519
11	6.0254	75.0483	133.3924	51.1554	72.0887	43.3705	18.4607	3.8227	1.7623	.2818
12	1.5954	5.5228	10.0805	7.8641	5.9234	2.2767	.7403	.1538	.0698	.0020
13		.0020	.0040							
14										
	11	12	13	14	15	16	17	18	19	20
1	.0604	.0491	.6168	1.1041			-.0587	12.6518	82.9789	299.6294
2	2.3378	9.4697	41.6614	111.8790	49.4164	-8.4344	3.5038	39.8515	234.8112	490.4890
3	30.1747	19.3027	96.1924	278.7994	168.6413	47.4068	34.3977	172.9096	426.0852	619.2821
4	55.0483	339.8470	734.2332	93.1347	429.0655	164.3263	133.1709	408.4260	615.3947	658.7046
5	171.3916	583.2581	983.2827	946.1100	722.2936	527.8407	430.2757	534.4079	513.1921	569.6024
6	429.4045	6206.5473	2594.5743	1215.2607	1655.7761	1685.6162	1062.6616	628.7326	265.8127	342.3550
7	136.4314	2431.3741	1852.1969	998.7043	1492.4049	2000.4826	921.4799	440.4080	177.1673	101.8688
8	6.3946	43.4941	120.1810	351.2664	217.5357	568.4308	509.1653	145.8277	105.8780	99.2025
9	.5029	1.0130	2.1542	5.0078	8.4290	23.2733	53.2320	39.8870	78.6864	125.8671
10	-.0634	.0282	.0120	.0292	.0408	.2241	4.1674	26.1854	81.2860	134.7107
11	.0042	.0006	.0001	.0001	.0001	.0006	.0193	.4181	22.2129	113.6160
12	.0004	.0000	.0000	.0000	.0000	.0000	.0004	.0884	15.4330	44.5133
13	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.1569	12.7908
14						.0000	.0000	.0001	.0306	1.5221
	21	22	23							
1	193.3845	35.1327	4.8536							
2	343.7328	133.5909	15.4180							
3	473.0532	266.5809	41.4014							
4	584.4728	355.4534	37.5924							
5	606.6891	398.3252	48.1242							
6	550.3984	344.1908	45.7859							
7	393.4219	214.0347	21.9753							
8	242.9100	135.7461	8.4580							
9	150.8033	152.0570	3.4241							
10	146.8287	99.5046	5.5590							
11	128.0042	92.3207	6.4217							
12	85.4017	53.1950	6.4862							
13	34.4829	45.1493	14.5927							
14	7.5306	12.8495	.8495							