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Simple Models of the Saturated Zone at Yucca Mountain

G. E. Barr, W. B. Miller

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SIMPLE MODELS OF THE SATURATED ZONE AT YUCCA MOUNTAIN

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ABSTRACT

Head contours in the saturated zone underlying Yucca Mountain, Nevada, and its environs are derived on the basis of alternative interpretations of the influence of geologic structure on the flow of fluids. Numerical experiments examine the sensitivity of flow and transport to uncertainties in existing data and the response to assumed catastrophic changes in hydraulic conductivity. The calculations are intended to delineate the data that a performance assessment analyst might wish to ask for. From these experiments, it appears that faults controlling the flow are not a dominating feature.

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1. INTRODUCTION

Simple models of the hydrologic and geologic systems at and around Yucca Mountain, based on data and interpretations currently available, are needed to help guide further investigation. This document reports the development of several simple models of the saturated flow system that underlies the region around Yucca Mountain; it uses these models to examine the effects of hypothetical changes in the system. Because these models use a limited suite of data, namely the measurement of 26 heads and the inference of 1 hydraulic conductivity, these models are called simple. As more data are available, more complexity will be justified, and the models will become less naive. The discussion here is meant to be a preliminary interpretation of the saturated flow system in this vicinity.

Simple models and numerical experiments with them are important in the iterative process by which the performance of a geologic repository is assessed. In studying the future behavior of a repository, a performance assessment (PA) analyst must build an understanding of the site from interpretations of collected data. The data needed to improve that understanding are only weakly definable until hydrogeologic interpretations are available, but data that are not routinely supplied by the standard practices of hydrologists and geologists are likely to be required. Simple models, based on early data, allow the PA analyst to focus early on perceived problems that require new data and new interpretations. By studying those problems with simple models, the analyst can learn what data and interpretations are needed and can communicate those needs to the hydrologists and geologists, who are collecting data. New data can then be used to produce new understanding and new models, and the iterative process to reduce uncertainty can continue. Deferring performance assessment until all the data have been collected might not necessarily provide any nonstandard data and interpretations useful to the assessment.

This paper, then, is directed at the early focus on difficulties of interpretation. The simple models constructed here are constrained to be consistent with the regional interpretation of the saturated flow system already available from the USGS [Czarnecki, 1984, 1985; Robison, 1984]. The models must also satisfy the local data on which the USGS model is in part dependent. The relationship of the local area being modeled here to the larger regions already reported on by the USGS is shown in Figure 1 [modified from Czarnecki, 1985].

There are several points to be addressed in a first iteration of models of the saturated zone under Yucca Mountain. These points are the initial answers to a series of simple questions about the local hydraulics of the saturated zone. The questions are the following:

1. What does the potentiometric surface as described by the water-level contours look like? What is the spatial distribution of values of hydraulic conductivity for these potentiometric contours?

2. Could different hydrogeologic interpretations of the existing data be made?

3. Do these alternative interpretations describe systems that behave differently? For example, if the head distribution is controlled by certain geologic structures, will the fluid movement be much different if the controlling structures are changed?

4. Do these alternatives make a difference in the prediction of contaminant transport or of residence time?

5. Are there enough data to tell (a) whether the alternative interpretations are different and (b) whether the differences really matter?

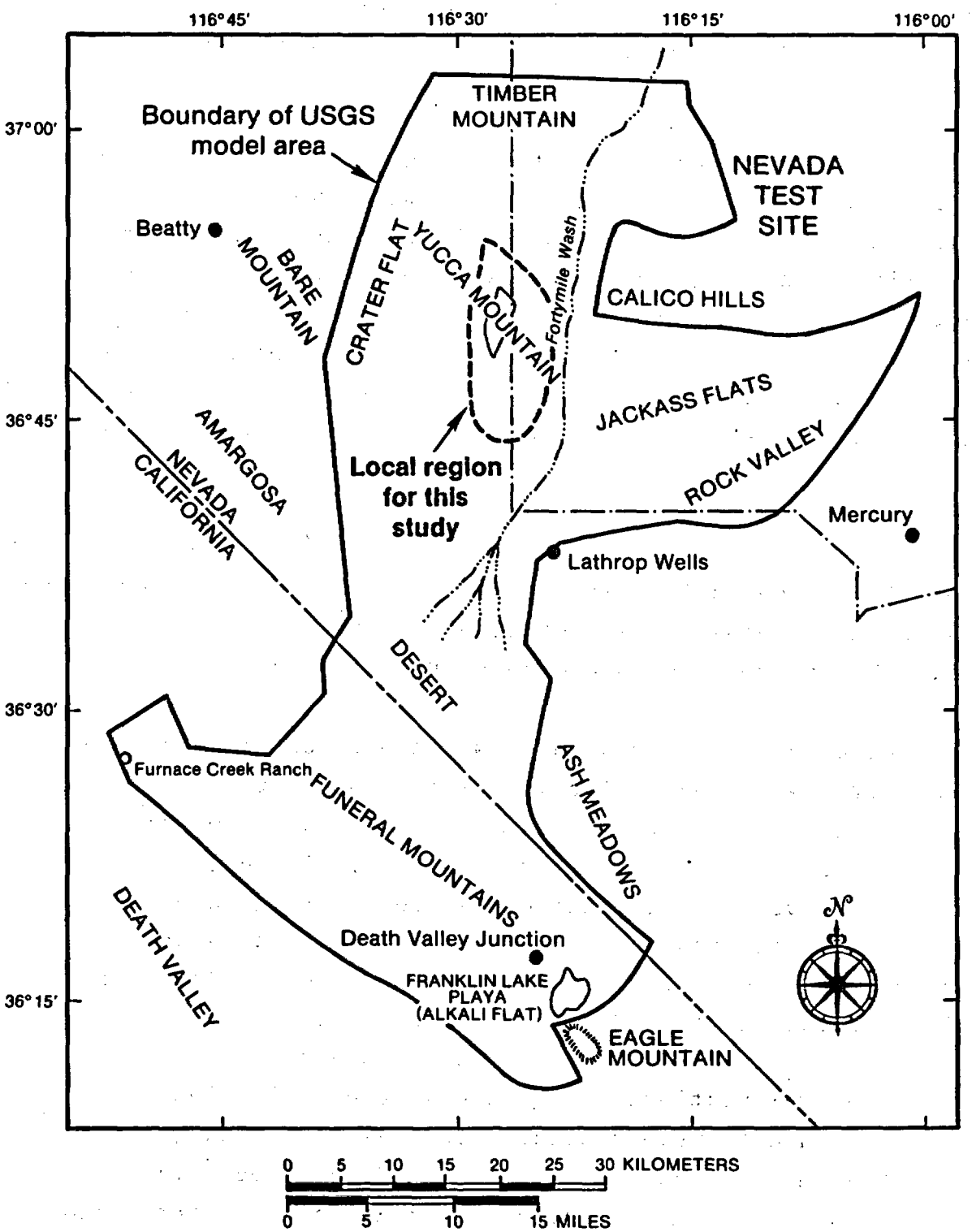

Figure 1. Location of Modeled Area in the Regional Area Studied by the USGS. (Modified from Czarnecki, 1985.)

6. Do catastrophic changes to hydraulic conductivity significantly alter transport or residence times?

The analyses here are directed at constructing simple models to attempt to answer these questions--to suggest what a PA analyst needs to think about and to aid by suggesting whether more data are needed. In the following sections, the results of the calculations for a series of models are presented. These models involve both no geologic-structural control and fault-control of the hydraulic system. Interpretations of all these calculations are presented together in a final section so that the reader may make comparisons in the sense of the questions mentioned in 1 through 6 above.

2. APPROACH

The simple models in this report are solutions to the classic inverse problem [Wang, 1982] for flow in a saturated, porous medium. They provide heads and concentrations over a two-dimensional, areal representation of the region. To derive these models, parameters of saturated flow, in particular hydraulic conductivity and the exact localization of boundary conditions, are adjusted to fit known data. Performing these adjustments requires the definition of a region of investigation; Figure 2 shows the region and the grid of elements chosen for carrying out the calculations. This region was selected to cover a large enough area in the inferred downstream direction, about 5 miles from the repository block, to include the zone of regulatory control, 5 km, and have a boundary far enough away so boundary conditions do not overwhelm the calculations. The general boundaries include the wells for which data were available in early 1986 and geologic features that might reasonably be expected to affect flow. The grid was chosen to have some consistency with known or inferred geologic features; such a choice facilitates examination of the presumption that these features effect some control over the hydraulics of the

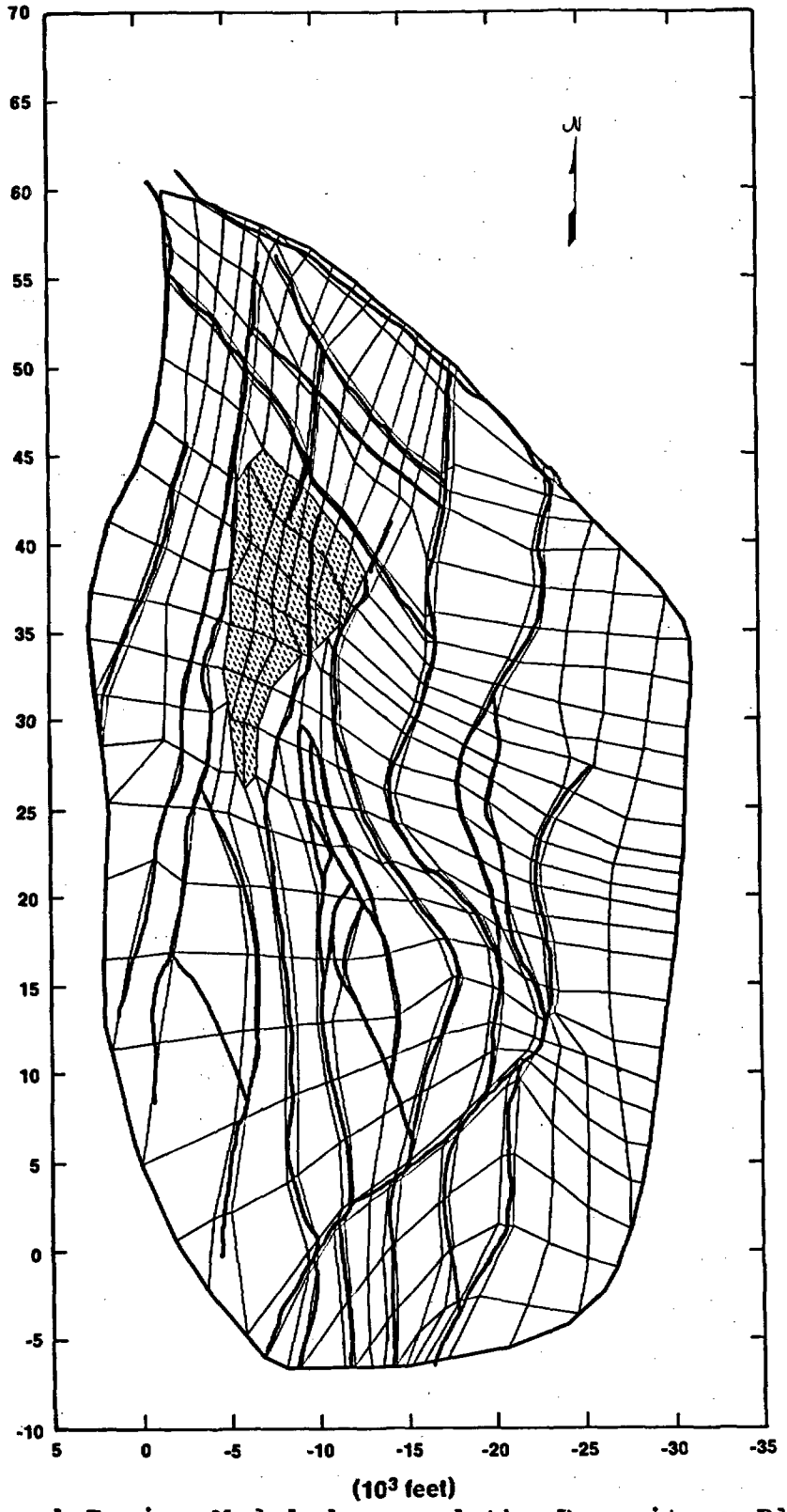

Figure 2. Local Region Modeled around the Repository Block and the Grid of Elements and Nodes Assigned for Calculations. (The repository block is indicated by cross-hatching, faults by solid black lines.)

water-table aquifer. While every grid block is a quadrilateral element, the size and apparent distortion are chosen to be related to the geologic features. In particular, the long, thin columns of similar elements oriented roughly north-south run along known or suspected faults at roughly the locations they are presumed to intersect the water table. The number of elements was chosen for adequacy of the representation of the geologic features and for convenience in computation. Any equivalent grid would be acceptable.

It is necessary to assign boundary conditions to the region to carry out calculations of head and concentration. These boundary conditions need to specify flux, head, or some combination along the entire boundary. Because the data available for the interior of the region are head data, we have chosen to specify heads along the boundary rather than flux--a quantity for which we have no direct, local measurements. Specifying head rather than flux means that the total amount of fluid entering or leaving the area could be relatively poorly controlled. These head boundary conditions (the location of the water table in feet relative to mean sea level) were chosen on two bases. The first basis was consistency with the USGS regional model as interpolated for this smaller region [Czarnecki, 1984]. That is, this small region was drawn within the larger model, and boundary head values were assigned by examining the intersection of the figure with USGS contours. The second basis was a determination of the boundary values by kriging the 26 head data [Barr, 1986] available for this local region. The results provided rough corroboration of the distribution of boundary values obtained by interpolation and are not discussed further here. Head boundary conditions--specific head values at specific boundary nodes--are treated as locally adjustable to help match the 26 head data more closely by reducing the residuals. A residual is defined as the difference between the computed value of head and the actual datum at a well. This adjustment is done only within the uncertainty of interpolation of the boundary and to eliminate structures unsupported by well data. Unsupported structures are "lumpy" deviations of head contour lines for which no underlying geologic structure is

suspected to exist. Reduction of the residuals--sometimes referred to as calibration of the model--is the method by which a self-consistent solution to the inverse problem is constructed. Since we are exploring the response of this region to changes in values of hydraulic conductivity (in particular), the residuals will be shown explicitly without mention of criteria that might be applied to decide when the residuals have been minimized.

The calculations on which these models depend are done using the code ISOQUAD, a two-dimensional, finite-element code [Pinder, 1976] with provision for vertical leakage and sources and sinks. The code calculates heads and the transport of a single nonreacting species of contaminant moving with the fluid. Calculation of movement of a single nonreacting species allows assessment of the relative importance of alteration of parameters to transport. No further discussion of this code is offered here. Models described here can be derived from a variety of similar codes.

3. MODELS

Two general classes of models are considered in these analyses, "smooth" models and "fault-controlled" models. In the "smooth" model, local structural controls--faults, washes, etc.--are ignored, and the model is simply consistent with the regional head structure. Smoothly varying geological structure is, of course, not ignored. In the "fault-controlled" model, local structural controls that extend through the water table are presumed to affect the hydraulics of the aquifer. As will be apparent in the analysis of the "smooth" model, a possible explanation for apparently steep head gradients is restriction of flow through faulted zones. The fault-controlled models in this paper are constrained to consistency with the USGS interpretation of heads for the larger region away from the local region.

3.1 Smooth Model

3.1.1 Reference Model

To produce the smooth model, a reference head distribution is derived for the water table aquifer. Since derivation of the model is an inverse problem of the classic sense [Wang, 1982], the principal parameter adjusted is the hydraulic conductivity, K, with the intent being to match the well data (heads) at the 26 known values. To determine when a "reasonable" match has been made, the residuals are calculated, and further adjustments of the values of K are made. The criterion for matching the data is arbitrary and subjective whether the matching is done directly in a code by a suitable algorithm (method of least squares, for example) or, as is done here, by interactively examining the results of each change in K for both direction and magnitude of the match. This does not necessarily minimize deviation from the data overall. Because the data are limited, being far fewer than the number of elements (grid blocks), changes to K are made over fairly large areas. This practice tends to help avoid instabilities in the calculation; however, it is also restricts changes to K to extend over several elements and limits our ability to reduce residuals. On the basis of a USGS radioactive-tracer flow survey (Thordarson, 1984), it is presumed that the aquifer is uniformly about 300 ft (100 m) thick. This presumption is unimportant for the calculation of heads as long as the thickness is uniform, and therefore the values of transmissivity (K • thickness) and the specifics of the flow system would become more important for a study of contaminant transport in more detail than the study reported here.

After repeated calculations, the head contours in Figure 3 were derived. Increase or decrease of K in large blocks from the values indicated produced larger residuals for most of the wells. Residuals corresponding to Figure 3 are listed in Table 1. Residuals are calculated for all models without explicit demonstration of any

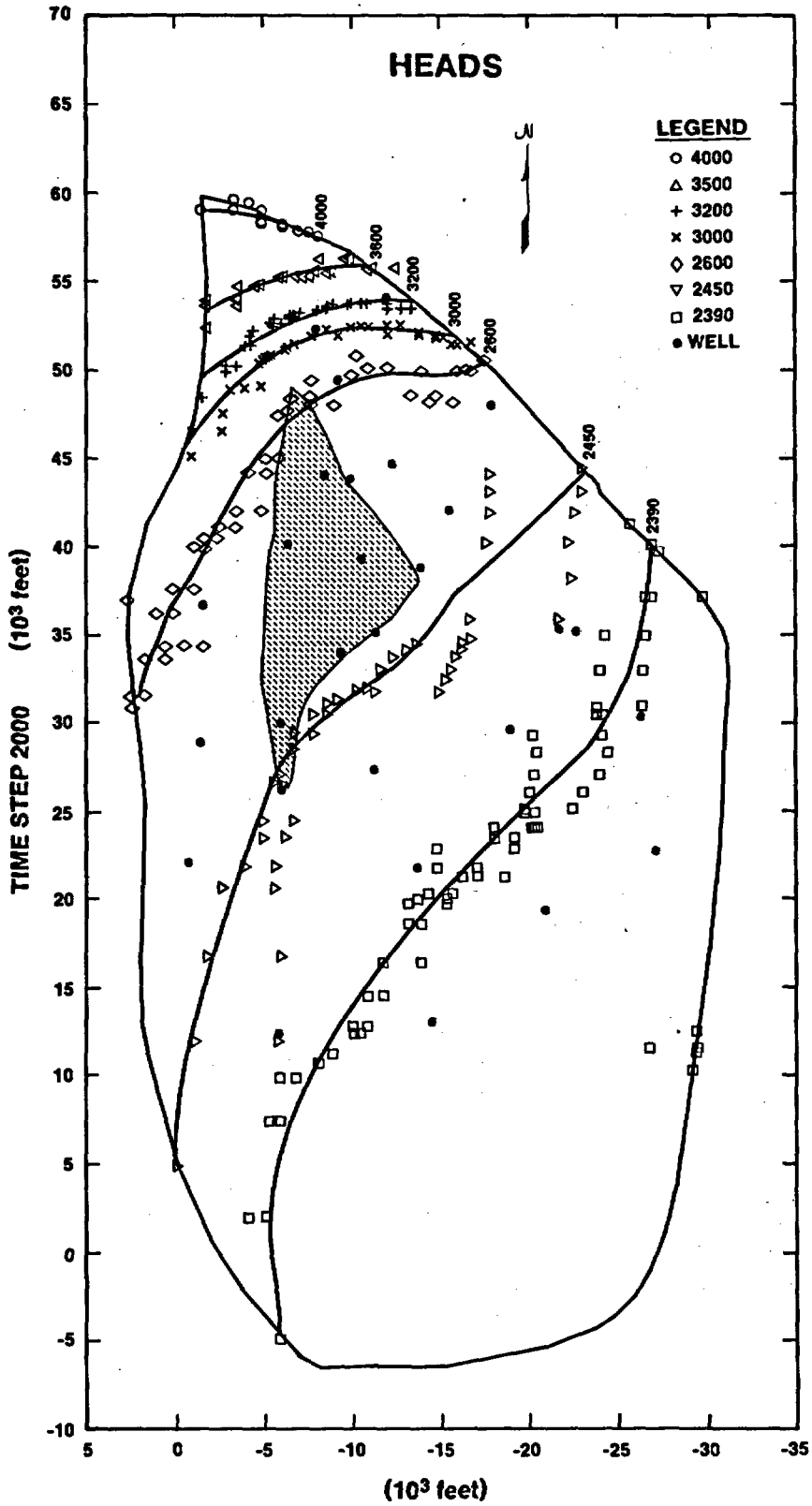

Figure 3. Head Contours for Smooth Reference Model, with the Proposed Repository Block Sketched in.

Table 1. Smooth Reference Case

X (feet)	Y (feet)	Head* (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2382.2	-15.77
7568.0	-5768.0	2395.67	135	USW WT-11	2413.5	17.83
17300.0	-694.0	2544.95	177	USW WT-10	2492.2	-52.75
14500.0	-20769.0	2393.37	183	UE25WT#3	2376.0	-17.37
16927.0	13618.0	2394.80	188	UE25WT#7	2396.1	1.30
21291.0	-5882.0	2395.67	214	USW G-3	2447.2	51.53
24084.0	-1299.0	2544.95	219	USW WT-7	2515.6	-29.35
22446.0	-11133.0	2396.33	231	USW WT-1	2410.7	14.37
25052.0	-5856.0	2402.89	236	USW H-3	2458.9	56.01
17740.0	-27037.0	2388.78	269	J-13	2357.1	-31.68
29189.0	-9314.0	2395.99	280	USW WT-2	2471.8	75.81
31760.0	-1466.0	2542.98	287	USW H-6	2540.1	-2.88
24675.0	-18869.0	2395.34	319	UE25P#1	2411.1	15.76
30109.0	-11274.0	2394.36	323	USW H-4	2468.8	74.44
35146.0	-6311.0	2541.67	330	USW H-5	2496.0	-45.67
34306.0	-10468.0	2395.01	348	USW G-4	2487.7	92.69
25347.0	-26221.0	2392.39	362	UE25WT#13	2373.0	-19.39
39009.0	-8373.0	2474.40	375	USW G-1	2509.2	34.80
30177.0	-22594.0	2395.67	410	UE25WT#14	2423.8	28.13
33759.0	-13799.0	2397.96	414	UE25B#1	2480.1	82.17
38756.0	-9788.0	2397.96	419	USW H-1	2501.3	103.34
37015.0	-15432.0	2396.30	437	UE25WT#4	2489.2	92.90
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	1.70
47310.0	-7892.0	3375.98	467	USW G-2	3065.9	-310.08
42942.0	-17770.0	2421.90	517	UE25WT#16	2477.5	55.60
49073.0	-11904.0	3383.20	525	UE25WT#6	3270.6	-112.60

* The values of head for the test wells are taken from Ortiz and from the site characterization plan (SCP) (see References). They have not yet been added to the Technical Data Base by the originators. Coordinates refer to the figures and are oriented with X vertical and Y horizontal.

minimization. Minimization, while possible, is unlikely, given the constraints of the models, and uniqueness is not possible in our circumstance for these inverse problems. In Figure 3, the proposed repository block is sketched in for reference; the repository would lie 100 to 200 m above the local water table [Sinnock, 1984]. The values for K corresponding to the heads in Figure 3 are listed in the appendix. Areas of specific values are also sketched in a following figure, Figure 6.

This particular configuration is the reference smooth configuration referred to in the rest of this paper. Since the inverse problem is nonunique, there exist many other configurations somewhat different from this one that will give reasonable residuals and fit well into the regional picture as well. The choice among these configurations is subjective, but small differences will not affect the conclusions that can be drawn from further studies based on this reference configuration.

To get an idea of what transport might be like in this water table aquifer, a source of unit concentration in the element was outlined (0.25 unit at each of the four corners) at the water table. No consideration was given here to how a source of contamination might reach the water table; the source was simply assumed to exist there at the start of the calculation. In calculating transport, because of numerical dispersion, round-off, and the peculiarities of parabolic equations, one often cannot simply ask when a given node (or grid block) first sees a nonzero value for the calculated concentration of contaminant; the answer, while not physically possible, is usually that the contaminant appears immediately. What one needs to know is when a certain fraction of the source arrives at a given node or what is the speed of advance of a "front" of contaminant at some level of contamination. In Figure 4 is displayed a contour of a contaminant level 10^{-2} of the source concentration, and discrete points at which the concentration is calculated at 10^{-1} or 10^{-2} are drawn in for a time of 420 years. Calculations like these are typically plagued

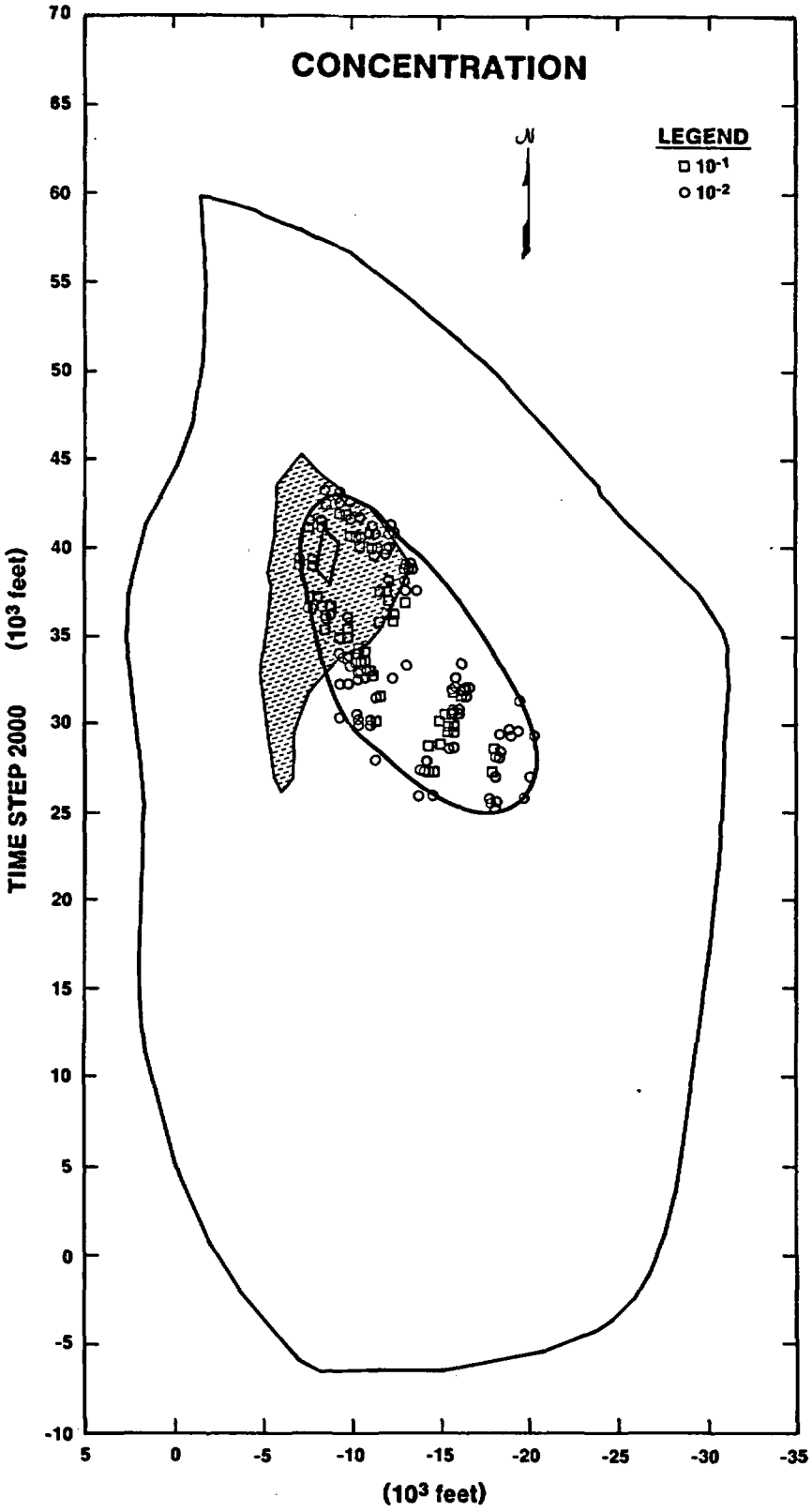

Figure 4. Contaminant Plume at 420 Years Sketched for 10^{-2} of Source Value. Concentration ratios (contaminant/source) are shown for two values, 10^{-1}, 10^{-2}.

by the appearance of nonphysical upstream dispersion of the contaminant, which occurs because the usual description of dispersion depends on the magnitude of the flow velocity irrespective of the direction upstream or downstream of the source. In the calculations reported here, this nonphysical motion was mechanically removed. To do this, the direction of flow was calculated, and on that basis, the dispersion and concentration were set to small numbers in elements that were clearly upstream from the source or could be reached only by diffusion. The slow movement of contaminants shown in Figure 4 is what would be expected intuitively from the low head gradients shown in Figure 3.

Having established a reference head distribution and a reference hydraulic conductivity distribution, one can move to a second step and explore the consequences that might be expected from changing the input. Two questions in particular come to mind: (1) What is the sensitivity of the potentiometric (head) contours to changes of K in the region and directly below the repository? (2) How would vertical leakage along structural features affect the potentiometric contours? These two questions are discussed in this section on smooth models. (An obvious third question about the effects of catastrophic changes is discussed in a section devoted solely to models involving that topic).

3.1.2 Altered Model

The sensitivity of the location of the potentiometric surface (water table contours) to the values of hydraulic conductivity, a measure of the robustness of a model, is relatively easy to investigate under two types of changes of particular interest. The first is the addition of a new datum. If a new well-test produces a newly derived value for K and a new head, the region effectively examined in the test is the order of a grid block in radius. The new datum would therefore alter values in one to four elements. Generally, unless the new values are drastically different from

those presumed (order of magnitude for K and more than 100 feet for head), there is little perceptible movement of the contours in this problem. However, for the second type of change, which is change of K over much larger regions, the effects are more noticeable. The head contours in Figure 5 have been altered from the reference (Figure 3) by adjusting values of K in large blocks so as to move the 2450-ft contour, which formerly passed south and east of the repository block, to a position north and west of the block. This particular example appeared in exploration of the effects of changing K while trying to reduce residuals, particularly for the region in the southeast that has almost constant head. The residuals for the heads from Figure 5 are given in Table 2.

Figures 6 and 7 show the values of K assigned to various regions for the reference case and the altered case, respectively. Notice that the changes are primarily south and east of the west boundary of the repository block and are typically changes of less than one order of magnitude. It should be noted that in the course of calculations, changes of K restricted to the repository block alone, by as much as a factor of 3, produced very little movement of contours from the reference case. For comparison, concentration values at 385 years after release to the water table are shown in Figure 8. The direction of the plume and its extent are of course somewhat different from the reference case because the local head contours, and therefore the local gradients, are somewhat different.

3.1.3 Vertical Leakage

Certain structural features, i.e., faults, are suspected of being conduits for fluid, either directly from the surface to the water table, from lower aquifers to the water table, or indirectly by intercepting dipping strata and conducting accumulated fluids to the water table. *A priori* it is not known whether the local water table is affected enough for such leakage to be detectable. These calculations are directed at trying to understand the possible

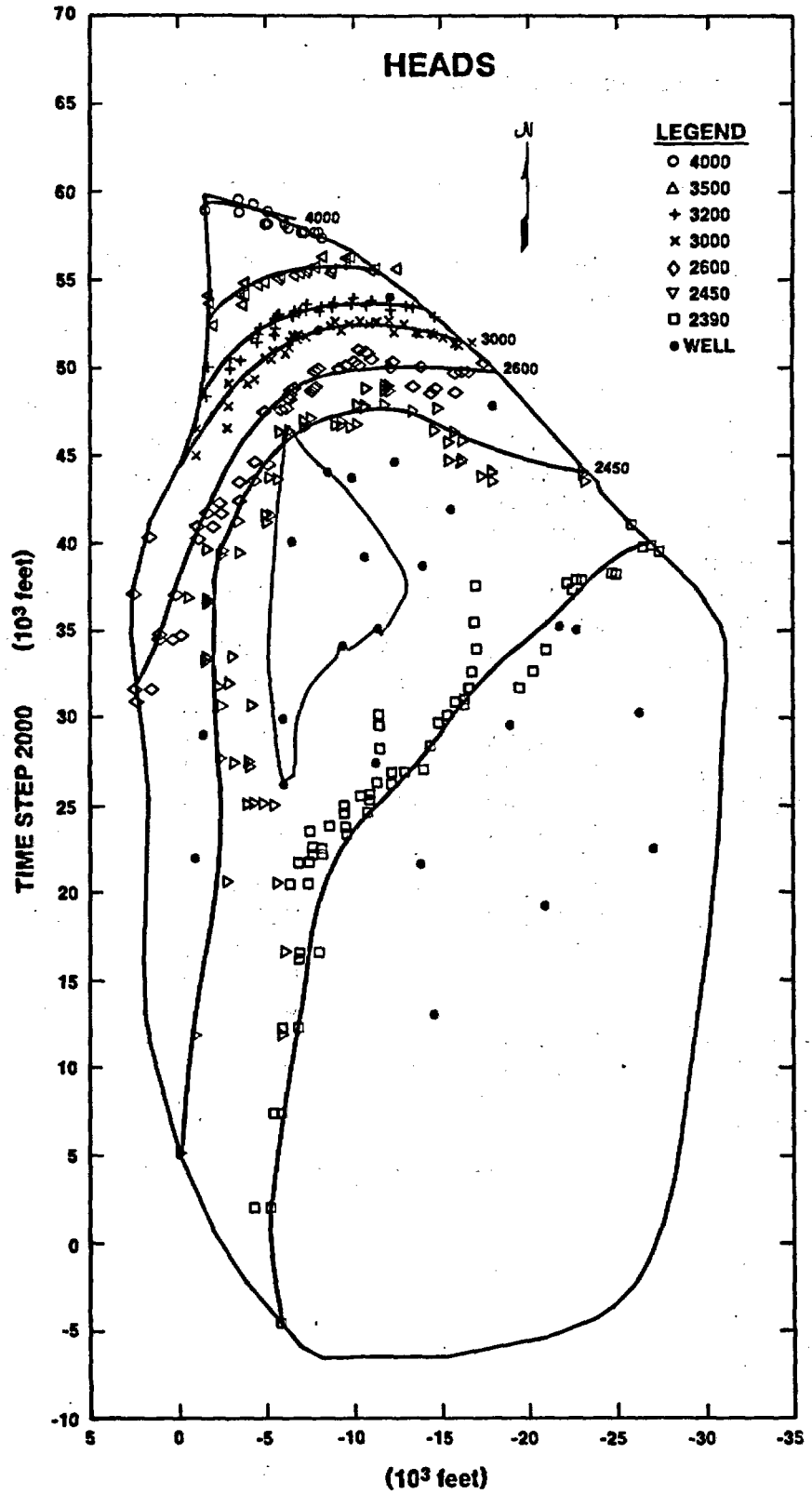

Figure 5. Head Contours for a Smooth Model with Block Changes of K from the Reference Model.

Table 2. Heads after Block Changes of K from Smooth Reference Model

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2370.6	-27.37
7568.0	-5768.0	2395.67	135	USW WT-11	2399.3	3.63
17300.0	-694.0	2544.95	177	USW WT-10	2489.2	-55.75
14500.0	-20769.0	2393.37	183	UE25WT#3	2364.5	-28.87
16927.0	13618.0	2394.80	188	UE25WT#7	2380.2	14.60
21291.0	-5882.0	2395.67	214	USW G-3	2400.2	4.53
24084.0	-1299.0	2544.95	219	USW WT-7	2502.5	-42.45
22446.0	-11133.0	2396.33	231	USW WT-1	2392.3	-4.03
25052.0	-5856.0	2402.89	236	USW H-3	2403.5	0.61
17740.0	-27037.0	2388.78	269	J-13	2350.8	-37.98
29189.0	-9314.0	2395.99	280	USW WT-2	2407.1	11.11
31760.0	-1466.0	2542.98	287	USW H-6	2448.4	-94.58
24675.0	-18869.0	2395.34	319	UE25P#1	2380.2	-15.14
30109.0	-11274.0	2394.36	323	USW H-4	2407.1	12.74
35146.0	-6311.0	2541.67	330	USW H-5	2421.1	-120.57
34306.0	-10468.0	2395.01	348	USW G-4	2418.6	23.59
25347.0	-26221.0	2392.39	362	UE25WT#13	2357.3	-35.09
39009.0	-8373.0	2474.40	375	USW G-1	2434.7	-39.70
30177.0	-22594.0	2395.67	410	UE25WT#14	2379.8	-15.87
33759.0	-13799.0	2397.96	414	UE25B#1	2415.3	17.34
38756.0	-9788.0	2397.96	419	USW H-1	2431.6	33.64
37015.0	-15432.0	2396.30	437	UE25WT#4	2423.8	27.50
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3027.2	-348.78
42942.0	-17770.0	2421.90	517	UE25WT#16	2476.3	54.40
49073.0	-11904.0	3383.20	525	UE25WT#6	3260.9	-122.30

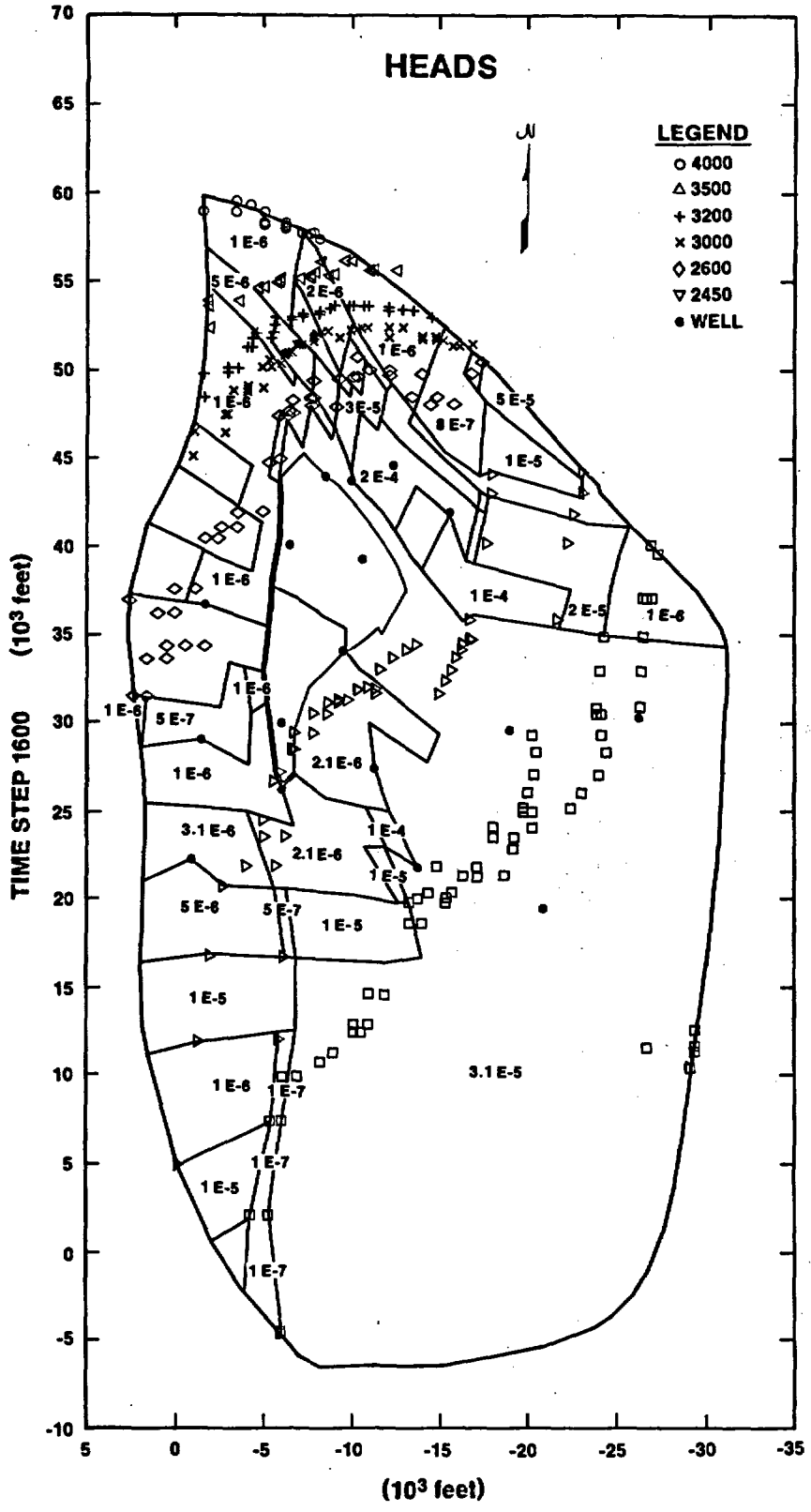

Figure 6. Values of K Assigned to Each Element for the Smooth Reference Model.

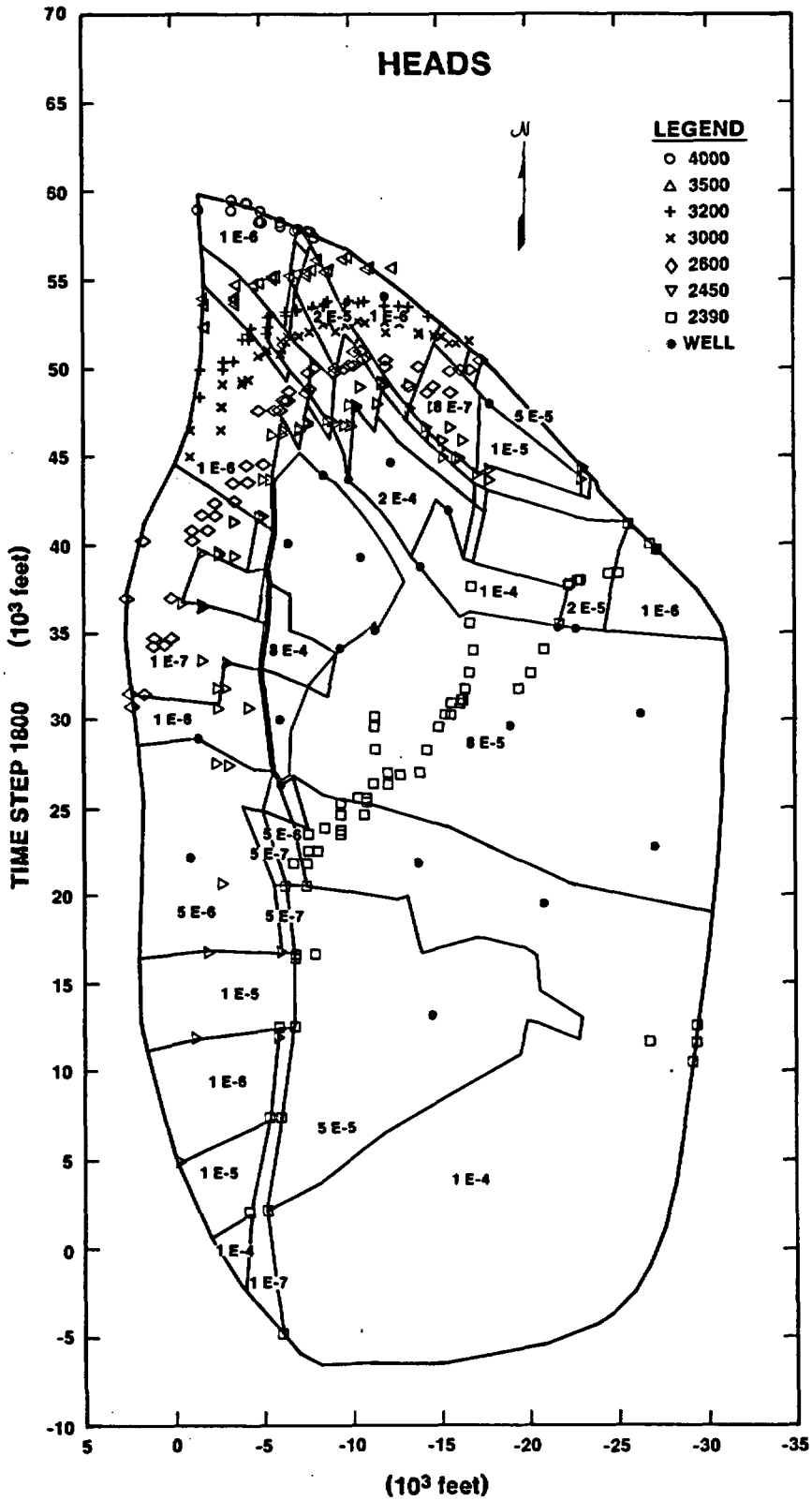

Figure 7. Values of K Assigned to Each Element for the Smooth Model with Block Changes of K from the Reference Model.

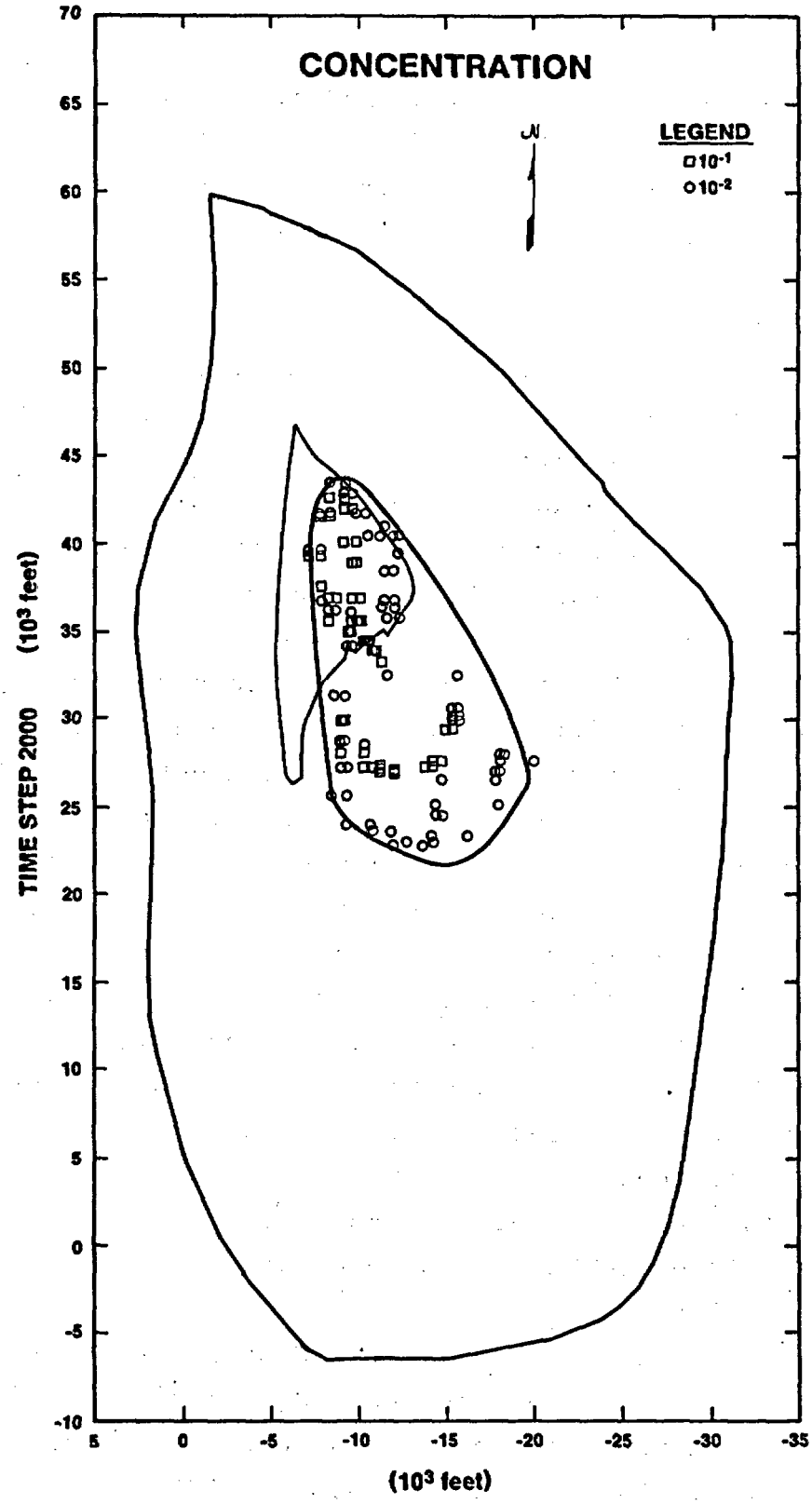

Figure 8. Contaminant Plume at 385 Years for 10^{-2} of Source Value. Concentration ratios (contaminant/source) are shown for two values, 10^{-1}, 10^{-2}.

amount of the leakage, if it exists, and the size of the effects it might have on the water table. Two different faults were selected for examination, Drill-Hole Wash fault and Solitario Canyon fault; these are sketched on Figure 9. It is assumed that the model is still smooth and that these faults enhance vertical leakage rather than act as barriers to it.

For Drill-Hole Wash, it is assumed that vertical leakage occurs in eight elements (grid blocks 370 through 377, see appendix for assignment of numbers) located along the northeast edge of the repository block. For leakage to occur it is necessary to have a driving head and a hydraulic conductivity for these faulted grid blocks. The local head for leakage is assumed to be 2600 feet (~100 to 150 feet above the base line) and the ratio K/ℓ is taken to be $10^{-3}sec^{-1}$, where $K \equiv$ vertical hydraulic conductivity and $\ell \equiv$ thickness of the aquifer providing the fluids (Pinder, 1977). This assumption means that K is large and conduction of fluids through the fault is rapid (a 100-foot head difference implies $K = 0.1$ ft/sec conductivity). The resulting head distribution shown in Figure 10 differs from the reference distribution for the region at and below the repository block. The contour for 2600 feet now passes just above the middle of the block. Residuals are listed in Table 3. The distribution of hydraulic conductivity values is that of the reference case; no changes were made to assignment of K to further minimize the head residuals. For comparison, the results of the calculation of concentration movement are displayed in Figure 11 for values of 10^{-1} and 10^{-2} of the source concentration. Changes in the plume from the reference case are ascribable to the changed head gradients.

To model a leaky fault in Solitario Canyon, the column of elements north to south along the west edge of the repository block and extending south was presumed to leak continually in elements 145, 164, 183, 203, 204, 225, 247, 269, 270, 292, 314, 336 and 358. As for the previous example, the local head for leakage is assumed to be 2600 feet (100 to 150 feet above the reference area), and the ratio K/ℓ is taken to be $10^{-3}sec^{-1}$. The head contours are

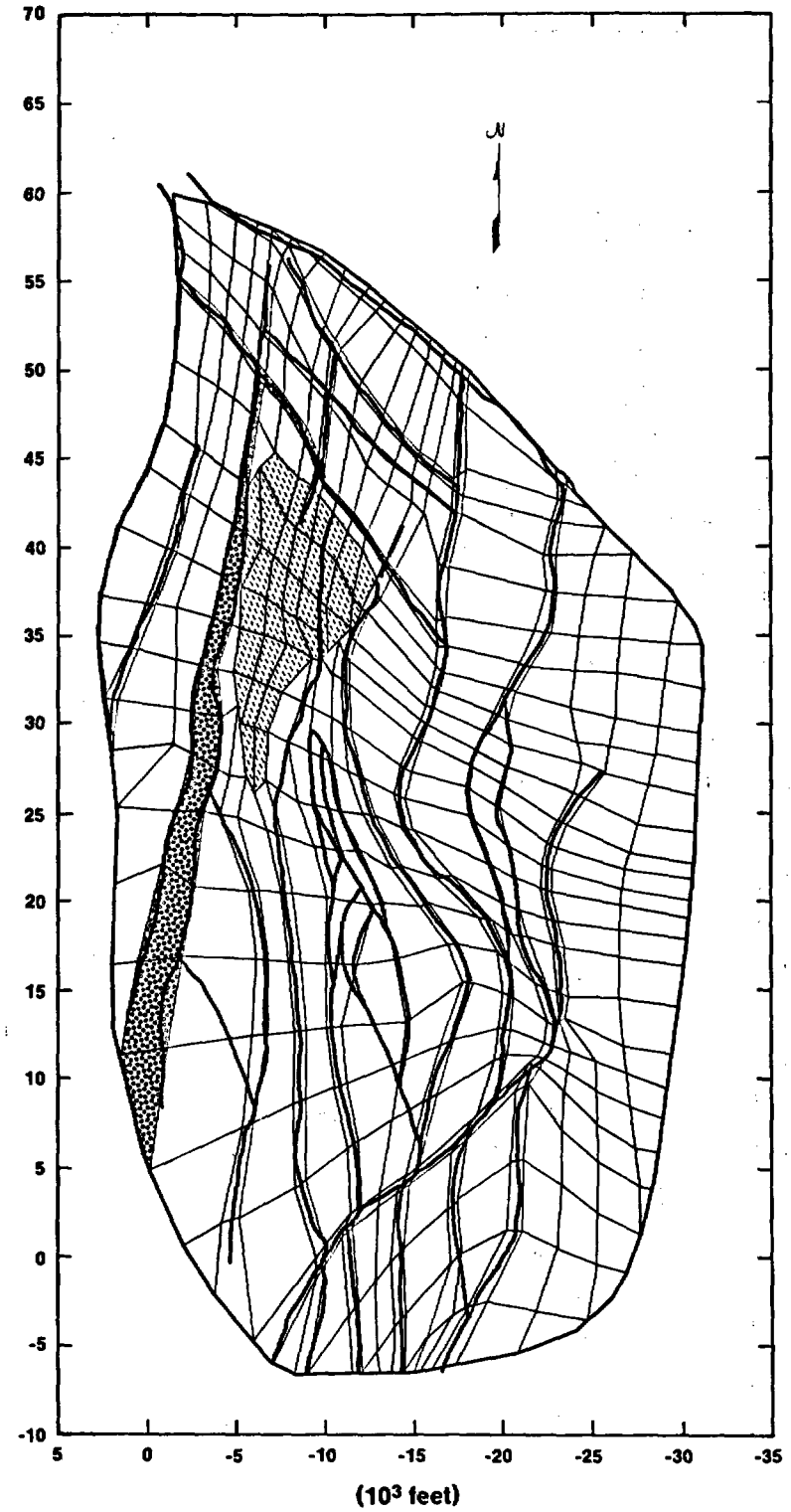

Figure 9. The Inferred Locations of the Faults in the Region Being Modeled (solid lines through elements). Drill-Hole Wash and Solitario Canyon fault are indicated by cross-hatched elements.

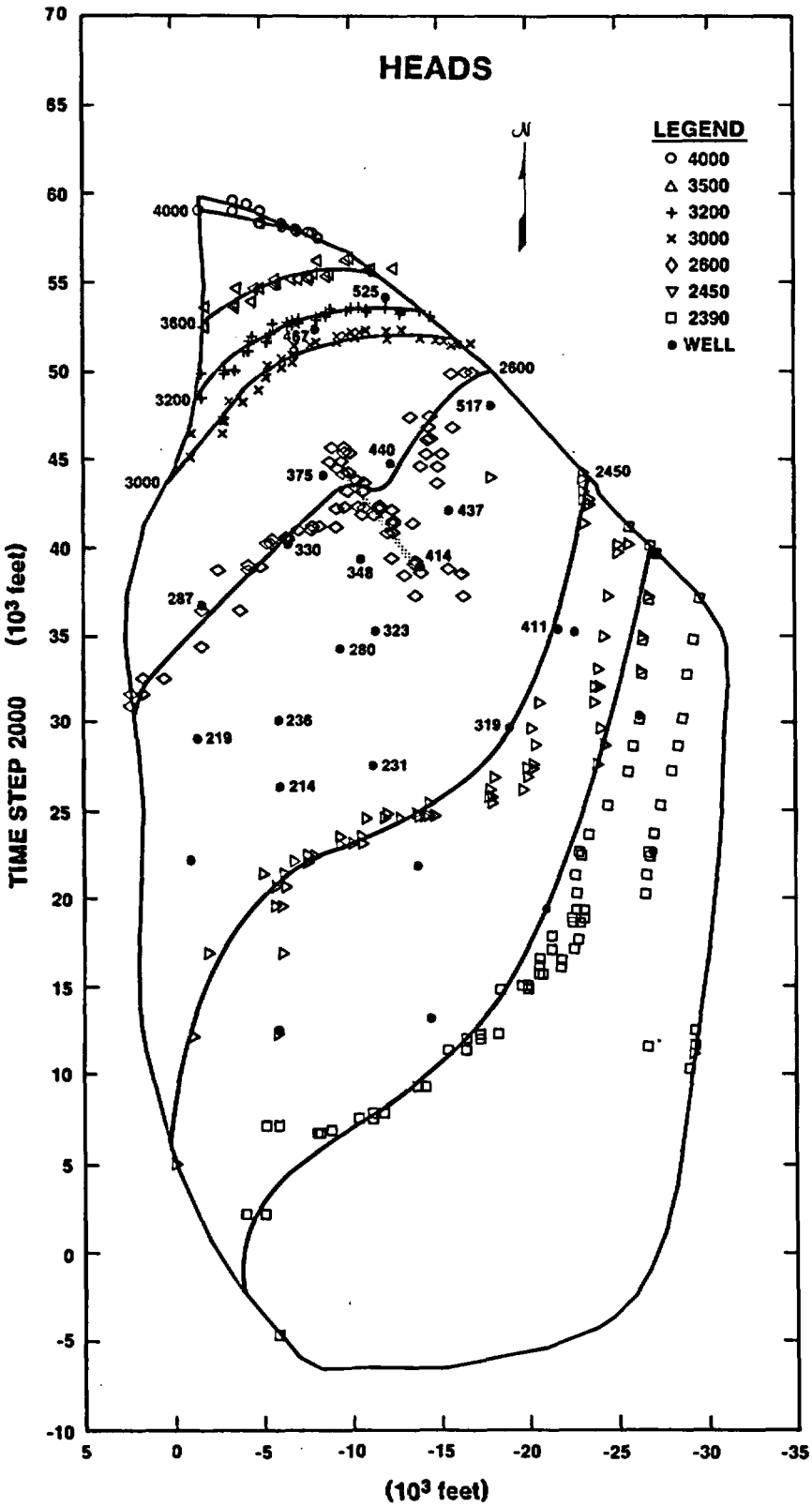

Figure 10. Head Contours for Vertical Leakage Down Drill-Hole Wash. Elements along Drill-Hole Wash are indicated.

Table 3. Vertical Leakage in Drill-Hole Wash for the K Distribution of the Smooth Reference Model

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2397.6	-.37
7568.0	-5768.0	2395.67	135	USW WT-11	2424.8	29.13
17300.0	-694.0	2544.95	177	USW WT-10	2498.4	-46.55
14500.0	-20769.0	2393.37	183	UE25WT#3	2400.3	6.93
16927.0	13618.0	2394.80	188	UE25WT#7	2437.4	42.60
21291.0	-5882.0	2395.67	214	USW G-3	2489.1	93.43
24084.0	-1299.0	2544.95	219	USW WT-7	2534.0	-10.95
22446.0	-11133.0	2396.33	231	USW WT-1	2470.7	74.37
25052.0	-5856.0	2402.89	236	USW H-3	2524.4	121.51
17740.0	-27037.0	2388.78	269	J-13	2370.5	-18.28
29189.0	-9314.0	2395.99	280	USW WT-2	2584.1	188.11
31760.0	-1466.0	2542.98	287	USW H-6	2605.3	62.32
24675.0	-18869.0	2395.34	319	UE25P#1	2484.4	89.06
30109.0	-11274.0	2394.36	323	USW H-4	2585.8	191.44
35146.0	-6311.0	2541.67	330	USW H-5	2598.8	57.13
34306.0	-10468.0	2395.01	348	USW G-4	2597.5	202.49
25347.0	-26221.0	2392.39	362	UE25WT#13	2405.3	12.91
39009.0	-8373.0	2474.40	375	USW G-1	2603.4	129.00
30177.0	-22594.0	2395.67	410	UE25WT#14	2505.6	109.93
33759.0	-13799.0	2397.96	414	UE25B#1	2600.0	202.04
38756.0	-9788.0	2397.96	419	USW H-1	2600.0	202.04
37015.0	-15432.0	2396.30	437	UE25WT#4	2595.9	199.60
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3111.9	-264.08
42942.0	-17770.0	2421.90	517	UE25WT#16	2479.4	57.50
49073.0	-11904.0	3383.20	525	UE25WT#6	3283.2	-100.00

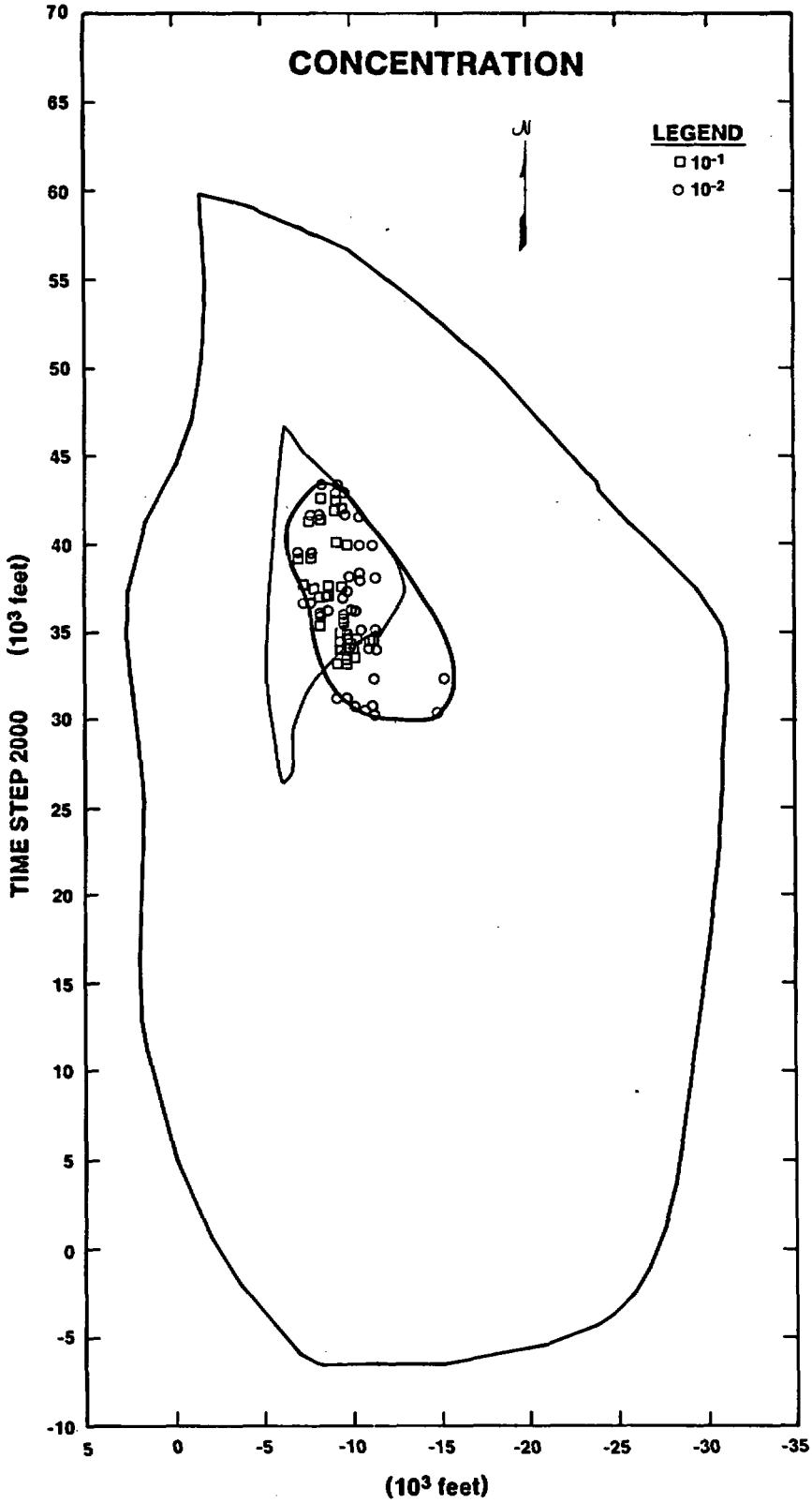

Figure 11. Contaminant Plume at 430 Years for 10^{-2} of Source Value. Concentration ratios (contaminant/source) are shown for two values, 10^{-1}, 10^{-2}.

shown in Figure 12 and the residuals are given in Table 4. The resulting plume, shown in Figure 13, is calculated to 258 years. The concentration calculation was terminated at this time because the plume has reached the boundary and further calculations reflect the boundary conditions.

One other type of vertical leakage was examined in these studies. In calculations leading to the smooth reference case it has been difficult to match the head at well USWG-2 (node 467). While the size of the elements around node 467 may be the cause, a possibility is that there is local vertical leakage in the vicinity of this well, raising the water table. Therefore, a number of calculations were made presuming a slow leakage for the elements surrounding this well (421, 422, 441, 442). When the hydraulic conductivity was altered (from elements 275 through 494, values of K = 3.1E-5 ft/s and 2.1E-6 ft/s were increased by an order of magnitude) in order to reduce residuals, head contours similar to the reference case were produced (Figure 14). For this result, K/ℓ was about $10^{-5}sec^{-1}$ and the heads at leaky nodes were set from 3.40E+3 to 3.36E+3 ft (see Pinder, 1977 for a discussion of leaky aquifers) to provide the driving force for the leakage. The resi- duals derived are shown in Table 5 and are somewhat smaller than the "smooth" reference case. This model with such localized vertical leakage was not taken as the reference case, because there is no independent evidence to confirm such leakage; until there are data to support such leakage, the model must be presumed an artifice.

3.2 Fault-Controlled Flow System

The area modeled in this report has faults typical of the Basin and Range province and of subsidence calderas (Sinnock, 1982). Faults are noted along the repository block (Solitario Canyon fault), through the block (Ghost Dance fault), and probably along the north edge (Drill-Hole Wash). The results of the discussion of the smooth model show steep hydraulic gradients to the north and to

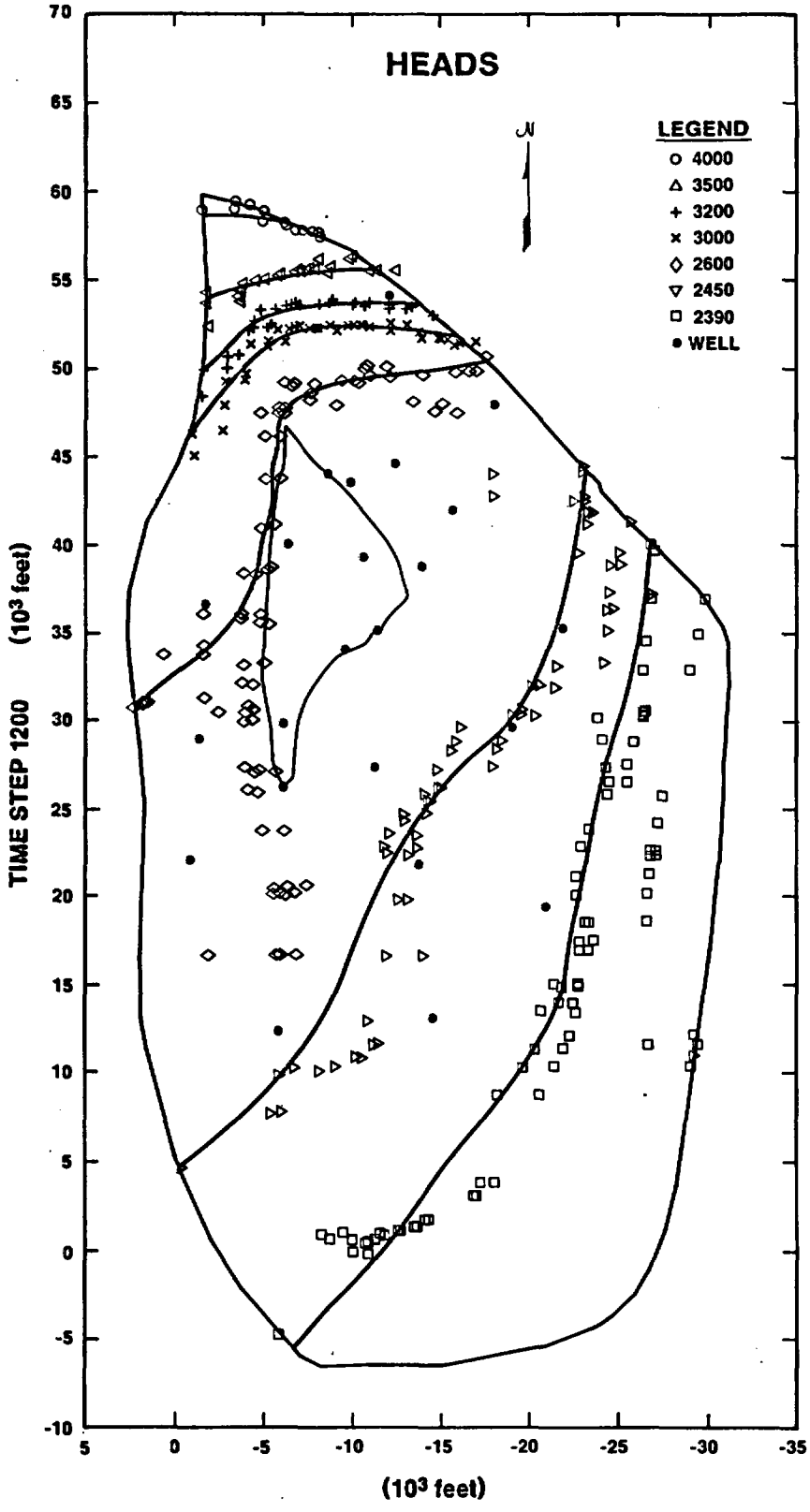

Figure 12. Head Contours for Vertical Leakage down Solitario Canyon Fault are Shown. Elements along Solitario Canyon fault are indicated.

Table 4. Vertical Leakage in Solitario Canyon for the K Distribution of the Smooth Reference Model

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2432.1	34.13
7568.0	-5768.0	2395.67	135	USW WT-11	2497.5	101.83
17300.0	-694.0	2544.95	177	USW WT-10	2546.2	1.25
14500.0	-20769.0	2393.37	183	UE25WT#3	2404.5	11.13
16927.0	13618.0	2394.80	188	UE25WT#7	2445.8	51.00
21291.0	-5882.0	2395.67	214	USW G-3	2581.8	186.13
24084.0	-1299.0	2544.95	219	USW WT-7	2585.2	40.25
22446.0	-11133.0	2396.33	231	USW WT-1	2461.9	65.57
25052.0	-5856.0	2402.89	236	USW H-3	2587.4	184.51
17740.0	-27037.0	2388.78	269	J-13	2367.6	-21.18
29189.0	-9314.0	2395.99	280	USW WT-2	2542.1	146.11
31760.0	-1466.0	2542.98	287	USW H-6	2616.8	73.82
24675.0	-18869.0	2395.34	319	UE25P#1	2447.6	52.26
30109.0	-11274.0	2394.36	323	USW H-4	2531.2	136.84
35146.0	-6311.0	2541.67	330	USW H-5	2590.5	48.83
34306.0	-10468.0	2395.01	348	USW G-4	2553.8	158.79
25347.0	-26221.0	2392.39	362	UE25WT#13	2388.9	-3.49
39009.0	-8373.0	2474.40	375	USW G-1	2573.2	98.80
30177.0	-22594.0	2395.67	410	UE25WT#14	2452.1	56.43
33759.0	-13799.0	2397.96	414	UE25B#1	2532.4	134.44
38756.0	-9788.0	2397.96	419	USW H-1	2556.9	158.94
37015.0	-15432.0	2396.30	437	UE25WT#4	2540.5	144.20
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3000.5	-375.48
42942.0	-17770.0	2421.90	517	UE25WT#16	2478.5	56.60
49073.0	-11904.0	3383.20	525	UE25WT#6	3269.5	-113.70

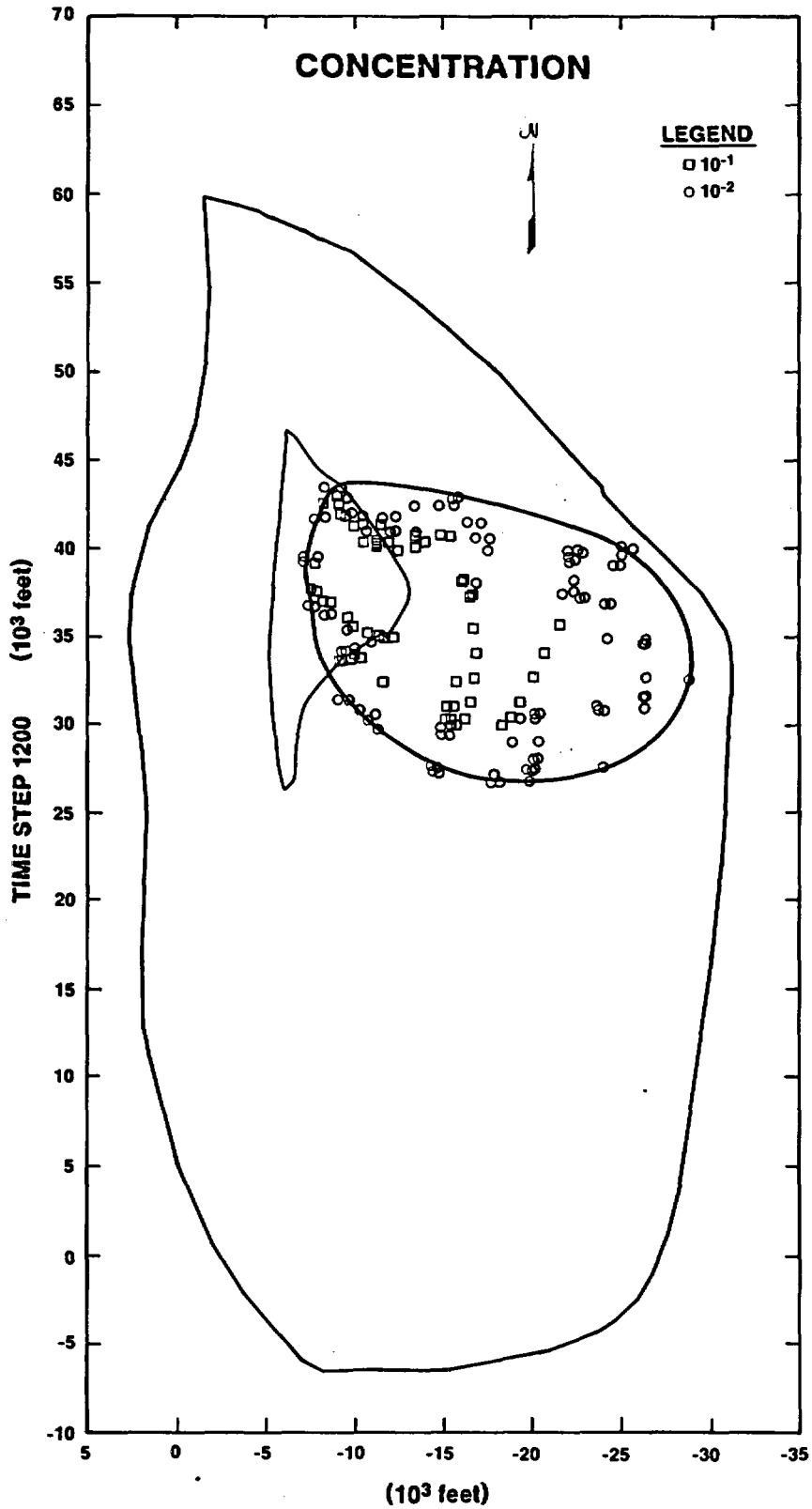

Figure 13. Contaminant Plume at 258 Years for 10^{-2} of Source Value. Concentration ratios (contaminant/source) are shown for two values, 10^{-1}, 10^{-2}.

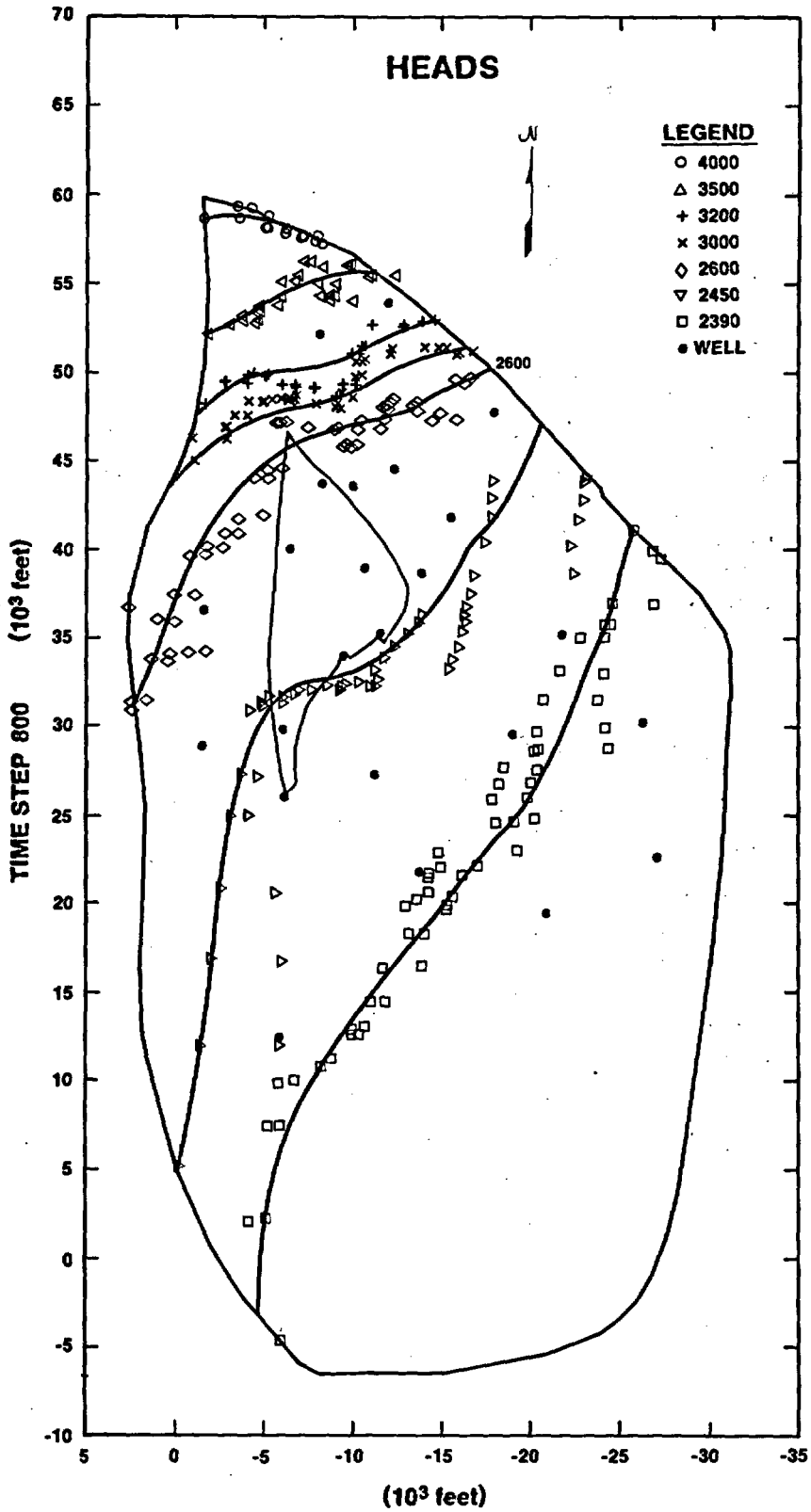

Figure 14. Head Contours for Vertical Leakage Localized around Well USW G-2.

Table 5. Localized Vertical Leakage around Well USW G-2

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2382.0	-15.97
7568.0	-5768.0	2395.67	135	USW WT-11	2413.4	17.73
17300.0	-694.0	2544.95	177	USW WT-10	2486.5	-58.45
14500.0	-20769.0	2393.37	183	UE25WT#3	2373.8	-19.57
16927.0	13618.0	2394.80	188	UE25WT#7	2396.9	2.10
21291.0	-5882.0	2395.67	214	USW G-3	2424.3	28.63
24084.0	-1299.0	2544.95	219	USW WT-7	2513.6	-31.35
22446.0	-11133.0	2396.33	231	USW WT-1	2406.9	10.57
25052.0	-5856.0	2402.89	236	USW H-3	2439.8	36.91
17740.0	-27037.0	2388.78	269	J-13	2355.0	-33.78
29189.0	-9314.0	2395.99	280	USW WT-2	2462.4	66.41
31760.0	-1466.0	2542.98	287	USW H-6	2540.0	-2.98
24675.0	-18869.0	2395.34	319	UE25P#1	2398.5	3.15
30109.0	-11274.0	2394.36	323	USW H-4	2462.2	67.84
35146.0	-6311.0	2541.67	330	USW H-5	2504.3	-37.37
34306.0	-10468.0	2395.01	348	USW G-4	2493.0	97.99
25347.0	-26221.0	2392.39	362	UE25WT#13	2364.0	-28.39
39009.0	-8373.0	2474.40	375	USW G-1	2525.6	51.20
30177.0	-22594.0	2395.67	410	UE25WT#14	2392.1	-3.57
33759.0	-13799.0	2397.96	414	UE25B#1	2477.6	79.64
38756.0	-9788.0	2397.96	419	USW H-1	2521.8	123.84
37015.0	-15432.0	2396.30	437	UE25WT#4	2506.7	110.40
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3379.8	3.82
42942.0	-17770.0	2421.90	517	UE25WT#16	2478.1	56.20
49073.0	-11904.0	3383.20	525	UE25WT#6	3333.2	-50.00

the west of the repository block. A possible reason for these steep gradients is that fluid movement is controlled by these faults; that is, hydraulic conductivity is small in the region of the fault. Such occurrences do not guarantee steep gradients, and there may be other geologic explanations, but faults are a possible explanation. The region to the southeast, even though thought to be faulted, does not appear to show such fault-controlled heads, according to the head data currently available.

Since the control of flow by fault systems is a reasonable hypothesis and steep gradients occur north and west of the repository block, calculations for a number of faults (three) in those locations were performed. In particular, the Solitario Canyon fault is presumed to bound on the west and Drill-Hole Wash on the north with an extension of the Ghost Dance fault (which passes in the north-south direction through the repository block) to the north of the repository block. Using roughly the same boundary conditions as in the reference smooth problem but inserting lower hydraulic conductivity, (K approximately 10^{-10} ft/s) for the faults, the analyses of the inverse problem were repeated to determine values for K that give "reasonable" residuals. One might expect residuals on the same order as for the smooth models if the models are indistinguishable or much smaller residuals if the faulted system is a better representation of the head structure of the flow regime. The specific values of hydraulic parameters assigned to each element for this reference fault-controlled case are given in the appendix. The results of this calculation for heads are shown in Figure 15. The corresponding plume of contaminants appears in Figure 16, for which it has been calculated to a time of 115 years. The residuals (Table 6) are in general quite large compared with those of the smooth models.

Heads were calculated for a number of alternative assignments of hydraulic conductivity to elements and, in particular, to elements representing faults in order to explore the affects of those

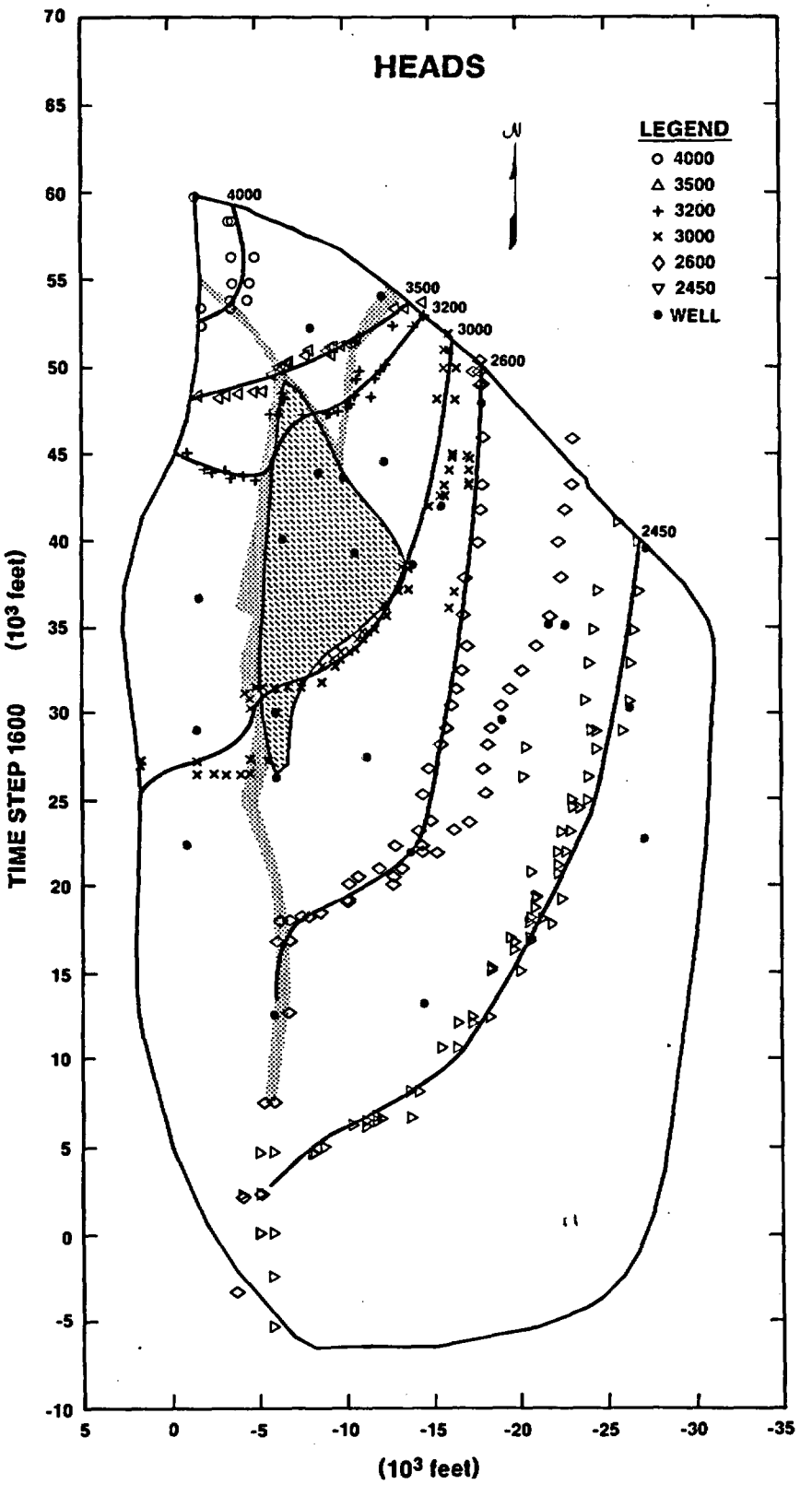

Figure 15. Head Contours Derived for the Fault-Controlled Model, K Altered To Improve Fit.

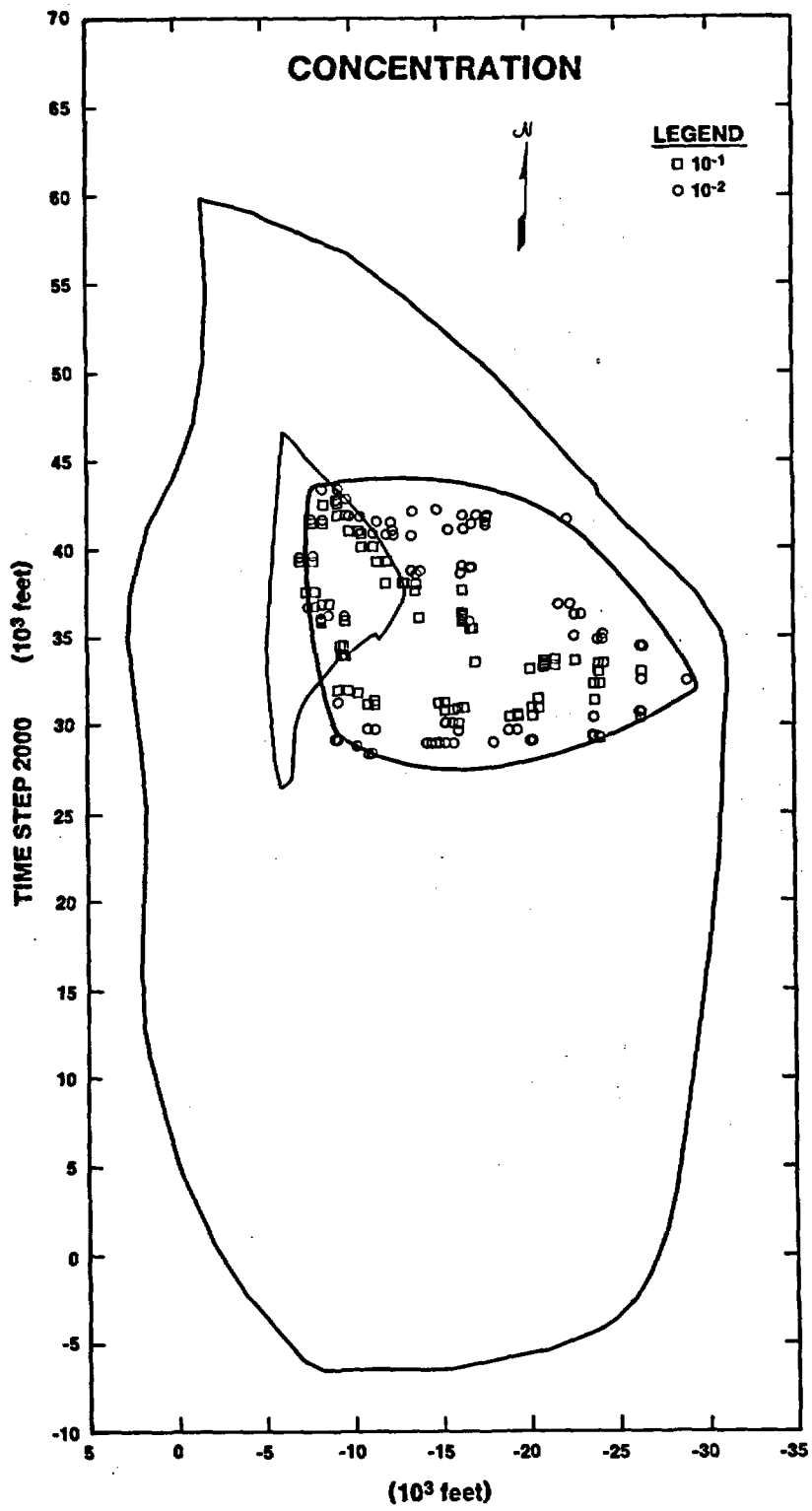

Figure 16. Contaminant Plume at 115 Years for 10^{-2} of Source Value. Concentration ratios (contaminant/ source) are shown for two values, 10^{-1}, 10^{-2}.

Table 6. Fault-Controlled Reference Model

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2403.0	5.03
7568.0	-5768.0	2395.67	135	USW WT-11	2540.1	149.43
17300.0	-694.0	2544.95	177	USW WT-10	2569.9	24.95
14500.0	-20769.0	2393.37	183	UE25WT#3	2393.4	0.03
16927.0	13618.0	2394.80	188	UE25WT#7	2450.2	55.40
21291.0	-5882.0	2395.67	214	USW G-3	2551.6	155.93
24084.0	-1299.0	2544.95	219	USW WT-7	2623.0	78.05
22446.0	-11133.0	2396.33	231	USW WT-1	2514.3	117.97
25052.0	-5856.0	2402.89	236	USW H-3	2586.8	183.91
17740.0	-27037.0	2388.78	269	J-13	2361.4	-27.38
29189.0	-9314.0	2395.99	280	USW WT-2	2613.4	217.41
31760.0	-1466.0	2542.98	287	USW H-6	2760.0	217.02
24675.0	-18869.0	2395.34	319	UE25P#1	2432.5	37.16
30109.0	-11274.0	2394.36	323	USW H-4	2604.8	210.44
35146.0	-6311.0	2541.67	330	USW H-5	2707.0	165.33
34306.0	-10468.0	2395.01	348	USW G-4	2664.2	269.19
25347.0	-26221.0	2392.39	362	UE25WT#13	2375.2	-17.19
39009.0	-8373.0	2474.40	375	USW G-1	2805.2	330.80
30177.0	-22594.0	2395.67	410	UE25WT#14	2413.4	17.73
33759.0	-13799.0	2397.96	414	UE25B#1	2598.9	200.94
38756.0	-9788.0	2397.96	419	USW H-1	2769.4	371.44
37015.0	-15432.0	2396.30	437	UE25WT#4	2596.3	200.00
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3271.1	-104.88
42942.0	-17770.0	2421.90	517	UE25WT#16	2492.7	70.80
49073.0	-11904.0	3383.20	525	UE25WT#6	3307.0	-76.20

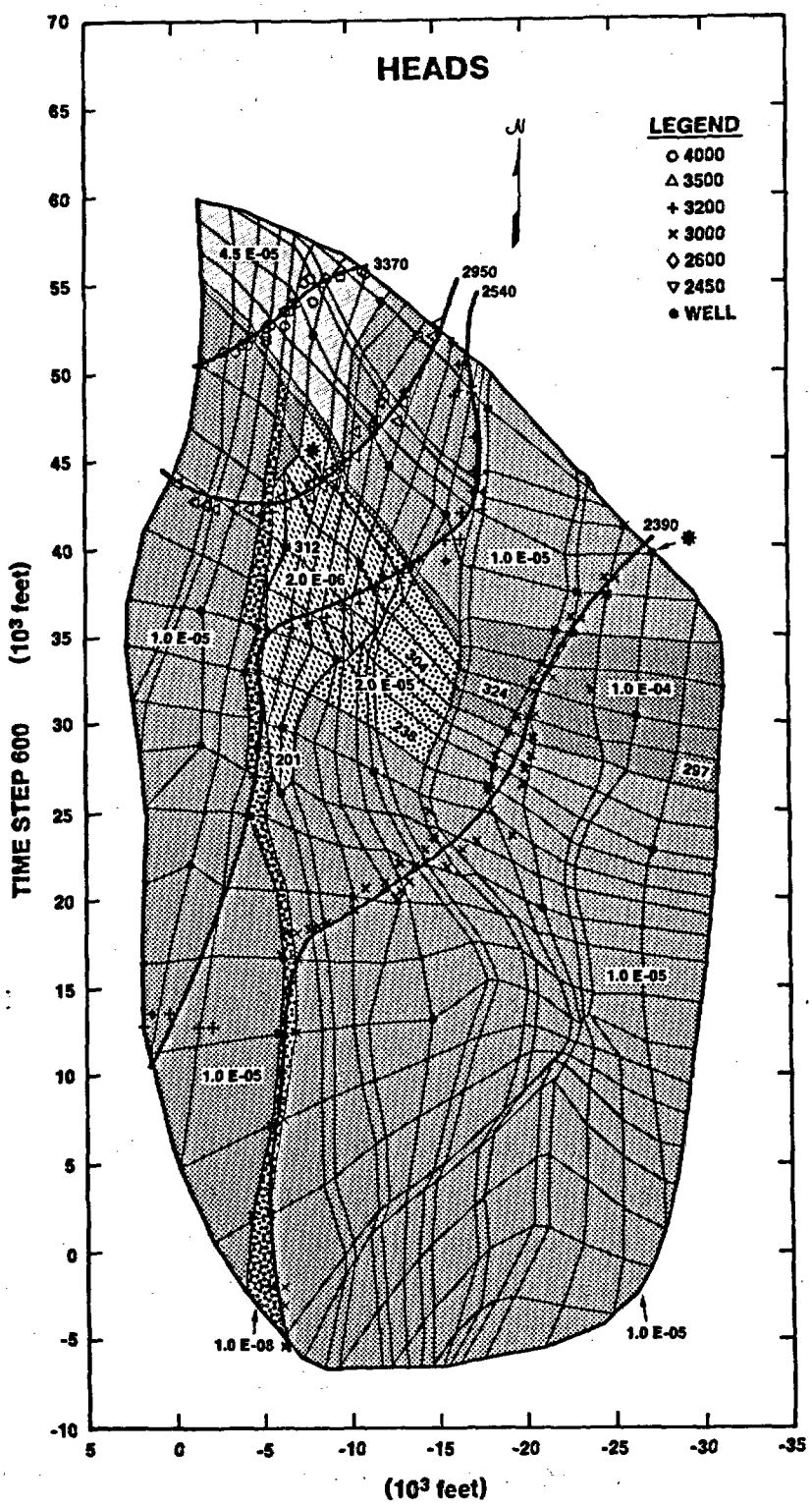

Figure 17. Head Contours for the First of Two Examples, with Values of K Assigned as Indicated.

assignments and the importance of these faults. Two examples are shown here. For Figure 17, heads were calculated with assignment of K as shown and produced the contours sketched. Notice that while the Solitario Canyon fault is assigned a low value of K, the Drill-Hole Wash fault and the extension of the Ghost Dance fault are merely boundaries between areas of differing K. The residuals are given in Table 7 and are noteworthy because they show some reduction from Table 6 and lead to the suggestion that data do not clearly support interpretations of Drill-Hole Wash and the extension of Ghost Dance fault as controlling faults.

The second example, shown in Figure 18, considers a case where all three faults as assigned low values of K(10^{-8} to 10^{-10} ft/s). Contours near the intersection of the faults are complex. However, the residuals, shown in Table 8, are not substantially different from those of the fault-controlled reference case.

In Section 2 of this document, comments were made about the correlation between the patterns of elements in Figure 2 and the location or inferred location of faults. The pattern of faults, which trend north-south and northwest-southeast, is fairly well distributed over the region of study, involving a large number of elements. We wish to see whether any control of the flow system can be distinguished from the reference cases on assignment of high values of K to these faults. Two specific numerical experiments are examined here.

For the first case, a nominal value of K of 3.8E-5 ft/s (1 m/da) is assigned to the entire region except for the faults. The hydraulic conductivity, K_f, of the faults is made to be 3.8E-4 ft/s (10 m/da), one order of magnitude greater than for the nonfaulted region. The distribution of faults and the corresponding head contours are shown in Figure 19. The residuals, shown in Table 9, are somewhat more extreme than those shown in Tables 7 and 8. For the second case, the value of K assigned to the set of faults is increased by a factor of 10 (K = 3.8E-3 ft/s) for the north-south trending faults and left at 3.8E-4 ft/s for the north-west-southeast

Table 7. Fault-Controlled First Example, with Low K for Solitario Canyon

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2372.0	-6.0
7568.0	-5768.0	2395.67	135	USW WT-11	2540.0	144.0
17300.0	-694.0	2544.95	177	USW WT-10	2570.0	25.0
14500.0	-20769.0	2393.37	183	UE25WT#3	2366.0	-27.0
16927.0	13618.0	2394.80	188	UE25WT#7	2390.0	-5.0
21291.0	-5882.0	2395.67	214	USW G-3	2412.0	16.0
24084.0	-1299.0	2544.95	219	USW WT-7	2623.0	78.0
22446.0	-11133.0	2396.33	231	USW WT-1	2415.0	19.0
25052.0	-5856.0	2402.89	236	USW H-3	2432.0	29.0
17740.0	-27037.0	2388.78	269	J-13	2352.0	-37.0
29189.0	-9314.0	2395.99	280	USW WT-2	2446.0	50.0
31760.0	-1466.0	2542.98	287	USW H-6	2760.0	217.0
24675.0	-18869.0	2395.34	319	UE25P#1	2394.0	-1.0
30109.0	-11274.0	2394.36	323	USW H-4	2455.0	61.0
35146.0	-6311.0	2541.67	330	USW H-5	2742.0	200.0
34306.0	-10468.0	2395.01	348	USW G-4	2631.0	236.0
25347.0	-26221.0	2392.39	362	UE25WT#13	2361.0	-31.0
39009.0	-8373.0	2474.40	375	USW G-1	2965.0	491.0
30177.0	-22594.0	2395.67	410	UE25WT#14	2385.0	-11.0
33759.0	-13799.0	2397.96	414	UE25B#1	2530.0	132.0
38756.0	-9788.0	2397.96	419	USW H-1	2862.0	464.0
37015.0	-15432.0	2396.30	437	UE25WT#4	2586.0	190.0
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-2.0
47310.0	-7892.0	3375.98	467	USW G-2	3308.0	-68.0
42942.0	-17770.0	2421.90	517	UE25WT#16	2496.0	74.0
49073.0	-11904.0	3383.20	525	UE25WT#6	3311.0	-72.0

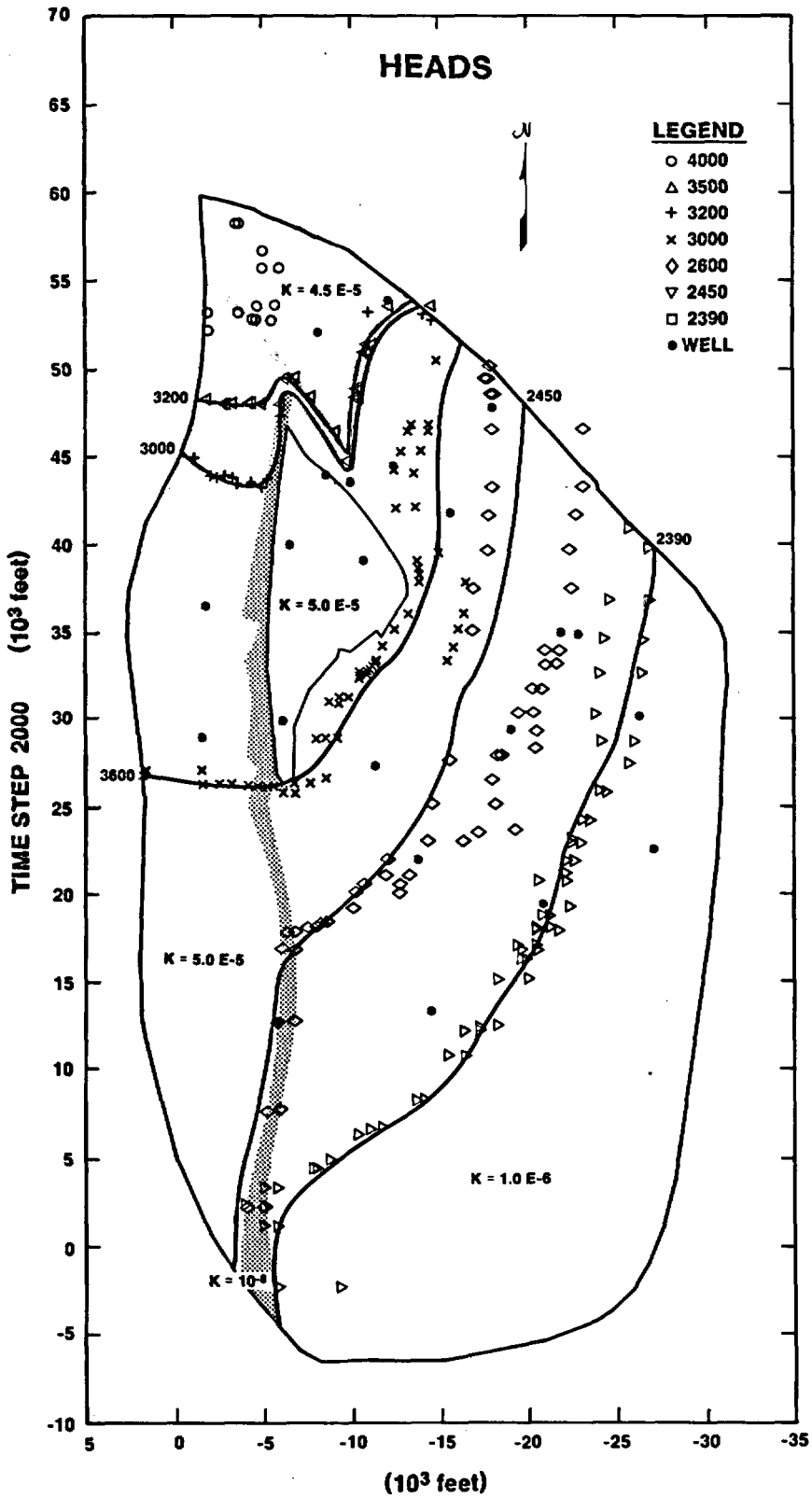

Figure 18. Head Contours for the Second of Two Examples for the Case of All Three Faults Assigned Low Values of K (1E-8 to 1E-10 ft/s).

Table 8. Fault-Controlled Second Example, All Three Assumed Faults Assigned Low Values of K

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2402.9	4.92
7568.0	-5768.0	2395.67	135	USW WT-11	2540.1	144.43
17300.0	-694.0	2544.95	177	USW WT-10	2569.9	24.95
14500.0	-20769.0	2393.37	183	UE25WT#3	2393.2	-0.17
16927.0	13618.0	2394.80	188	UE25WT#7	2449.7	54.90
21291.0	-5882.0	2395.67	214	USW G-3	2612.4	216.73
24084.0	-1299.0	2544.95	219	USW WT-7	2623.2	78.25
22446.0	-11133.0	2396.33	231	USW WT-1	2522.2	125.87
25052.0	-5856.0	2402.89	236	USW H-3	2620.2	217.31
17740.0	-27037.0	2388.78	269	J-13	2361.9	-26.88
29189.0	-9314.0	2395.99	280	USW WT-2	2624.8	228.81
31760.0	-1466.0	2542.98	287	USW H-6	2760.3	217.32
24675.0	-18869.0	2395.34	319	UE25P#1	2454.1	58.76
30109.0	-11274.0	2394.36	323	USW H-4	2624.3	229.94
35146.0	-6311.0	2541.67	330	USW H-5	2627.8	86.13
34306.0	-10468.0	2395.01	348	USW G-4	2629.4	234.39
25347.0	-26221.0	2392.39	362	UE25WT#13	2383.5	-8.89
39009.0	-8373.0	2474.40	375	USW G-1	2629.0	154.60
30177.0	-22594.0	2395.67	410	UE25WT#14	2434.1	38.43
33759.0	-13799.0	2397.96	414	UE25B#1	2597.1	199.14
38756.0	-9788.0	2397.96	419	USW H-1	2622.3	224.34
37015.0	-15432.0	2396.30	437	UE25WT#4	2555.2	158.90
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3440.7	64.72
42942.0	-17770.0	2421.90	517	UE25WT#16	2468.9	47.00
49073.0	-11904.0	3383.20	525	UE25WT#6	3365.6	-17.60

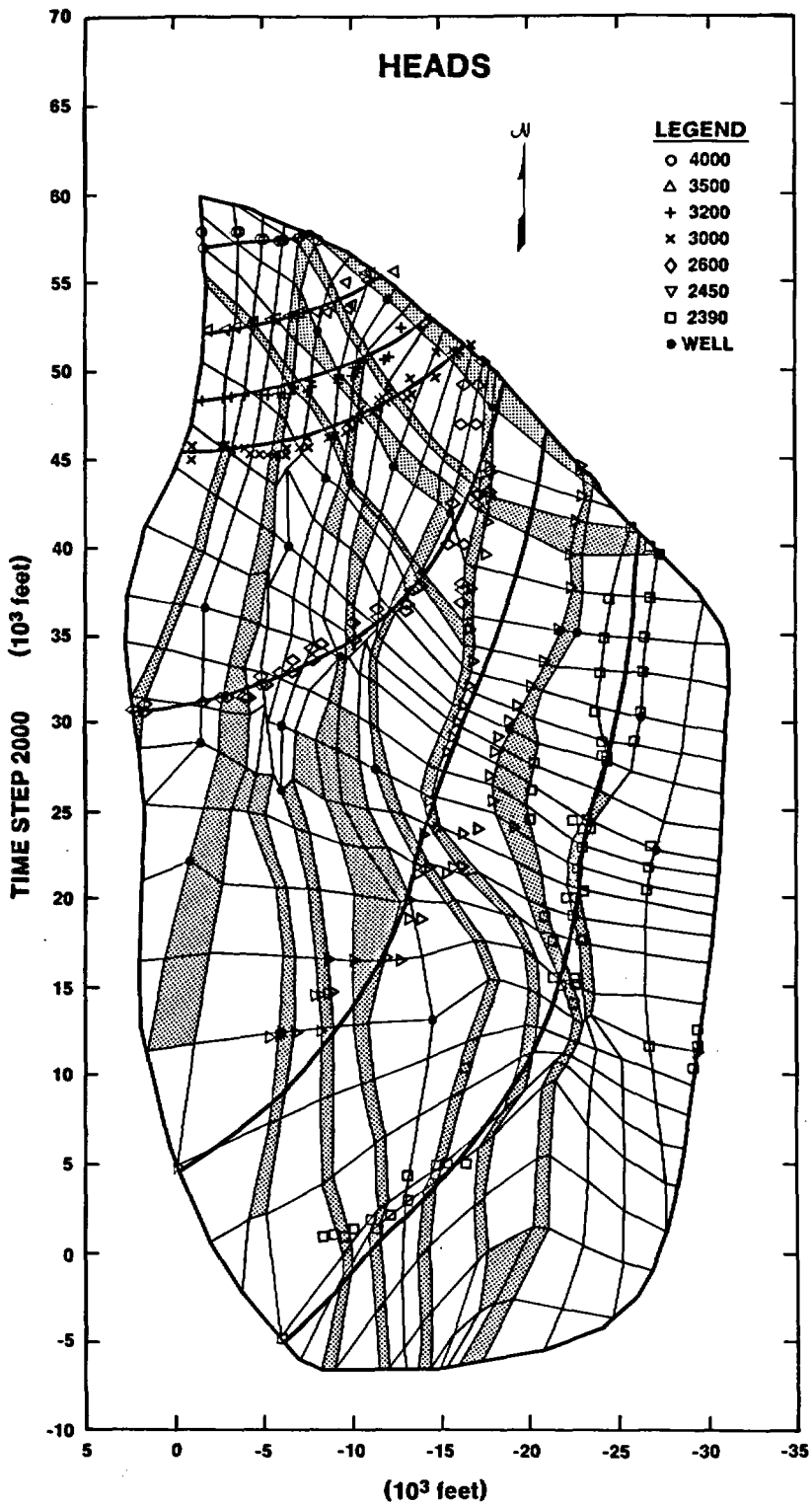

Figure 19. Distribution of Faults and the Head Contours Derived for the First Fault-Controlled Model (K = 1 m/da, K_f = 10 m/da).

Table 9. Distributed Faults, K_f (Hydraulic Conductivity of Faults) = 10 m/da (3.8E-4 ft/s)

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2413.2	15.23
7568.0	-5768.0	2395.67	135	USW WT-11	2450.6	54.93
17300.0	-694.0	2544.95	177	USW WT-10	2514.4	-30.55
14500.0	-20769.0	2393.37	183	UE25WT#3	2400.9	7.53
16927.0	13618.0	2394.80	188	UE25WT#7	2453.0	58.20
21291.0	-5882.0	2395.67	214	USW G-3	2570.0	174.33
24084.0	-1299.0	2544.95	219	USW WT-7	2566.9	21.95
22446.0	-11133.0	2396.33	231	USW WT-1	2492.0	95.67
25052.0	-5856.0	2402.89	236	USW H-3	2543.1	140.21
17740.0	-27037.0	2388.78	269	J-13	2362.9	-25.88
29189.0	-9314.0	2395.99	280	USW WT-2	2586.2	190.21
31760.0	-1466.0	2542.98	287	USW H-6	2719.5	176.52
24675.0	-18869.0	2395.34	319	UE25P#1	2428.6	33.26
30109.0	-11274.0	2394.36	323	USW H-4	2582.0	187.64
35146.0	-6311.0	2541.67	330	USW H-5	2769.2	227.53
34306.0	-10468.0	2395.01	348	USW G-4	2700.0	304.99
25347.0	-26221.0	2392.39	362	UE25WT#13	2378.5	-13.89
39009.0	-8373.0	2474.40	375	USW G-1	2872.5	398.10
30177.0	-22594.0	2395.67	410	UE25WT#14	2436.8	41.13
33759.0	-13799.0	2397.96	414	UE25B#1	2621.2	223.24
38756.0	-9788.0	2397.96	419	USW H-1	2829.6	431.64
37015.0	-15432.0	2396.30	437	UE25WT#4	2659.8	263.50
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3408.9	32.92
42942.0	-17770.0	2421.90	517	UE25WT#16	2518.1	96.20
49073.0	-11904.0	3383.20	525	UE25WT#6	3369.5	-13.70

trending set. The distribution of faults and the head contours derived from the assignments of K are shown in Figure 20. The principal difference is that the 2600-foot head contour has been moved to a more southerly position in passing under the repository block. The corresponding residuals, listed in Table 10, are very similar to those in Table 9 and neither set provides a particularly close match to data. The plume for contaminant movement is shown in Figure 21 for the second case. At 4.1 years, the plume has moved a substantial distance south along the highly transmissive channel formed by the fault.

3.3 Catastrophic Changes

Yucca Mountain is in the "Basin and Range" province and consists of pyroclastic flows from volcanic systems (Sinnock, 1985). The area modeled in this report sees low seismic activity. It is not clear whether this moderate activity is likely to alter the saturated flow system significantly. Nevertheless, this study, because it is intended to suggest topics for further study, simply posits catastrophic changes that alter the flow system. It is not possible to predict specific changes and their location. However, in the saturated aquifer, the flow system can possibly experience two classes of changes, the gross effects of which can be examined in numerical experiments. These two classes are (1) alteration of hydraulic conductivity along and around faults and (2) connection of the saturated aquifer to new sources and sinks. Until more work has been completed on the unsaturated flow in the mountain, it is unclear what new sources, if any, there would be. This study, however, simply assumes leakage is suddenly initiated in some zone without specifying the origin of the fluids; and that sudden initiation and the sudden changes in K are referred to as "catastrophic." Whether the consequences are catastrophic in a more general sense is to be determined from a calculations.

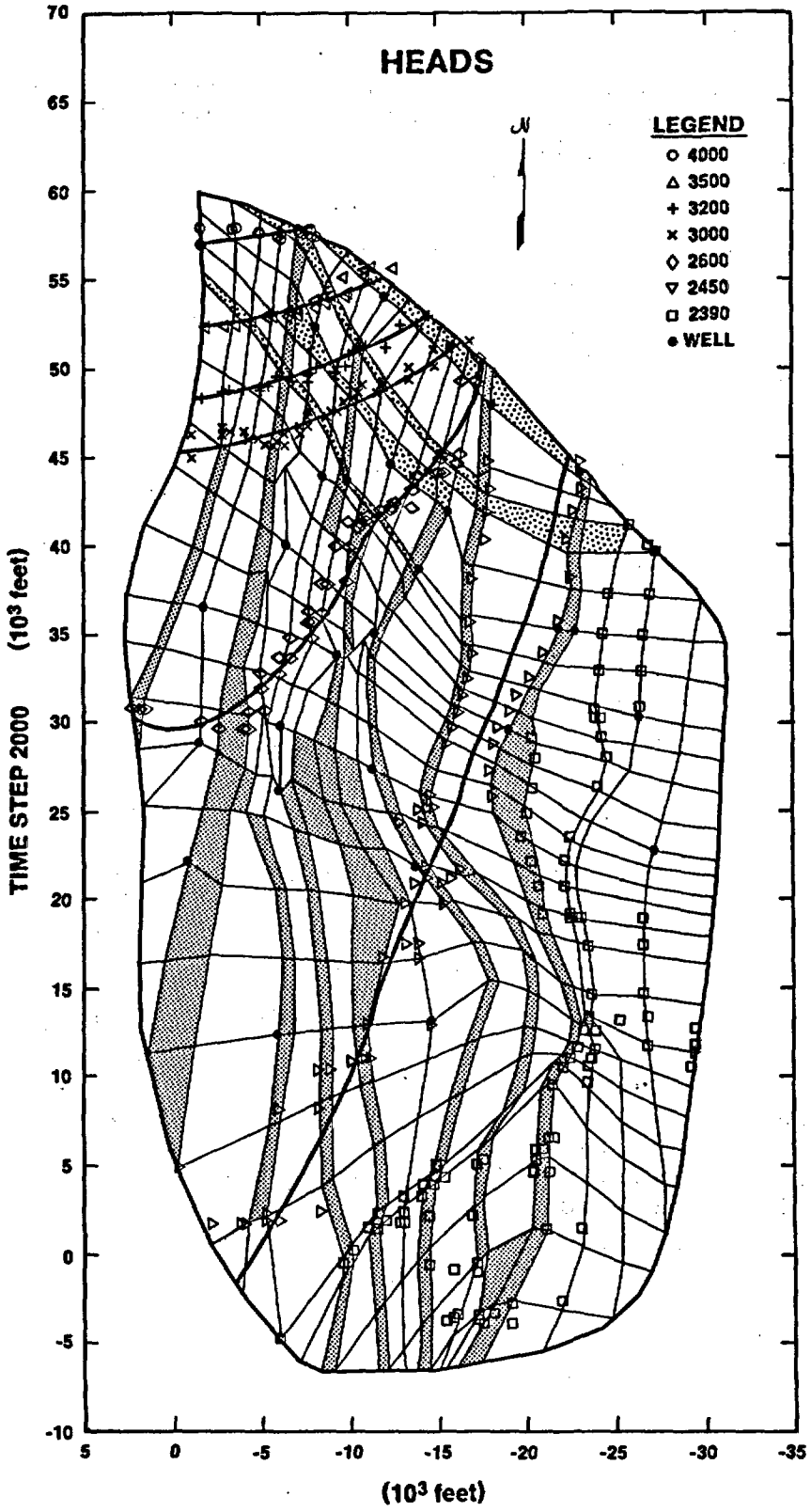

Figure 20. Distribution of Faults and the Head Contours Derived for the Second Fault-Controlled Model (K = 1 m/da, K_f = 100 m/da, 10 m/da as indicated).

Table 10. Distributed Faults, K_f = 100 m/da (3.8E-3 ft/s) for North-South Set of Faults and K_f = 10 m/da for Northwest-Southeast Trending Set

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2424.1	26.13
7568.0	-5768.0	2395.67	135	USW WT-11	2477.1	+81.43
17300.0	-694.0	2544.95	177	USW WT-10	2539.8	-5.15
14500.0	-20769.0	2393.37	183	UE25WT#3	2402.8	9.43
16927.0	13618.0	2394.80	188	UE25WT#7	2455.7	60.90
21291.0	-5882.0	2395.67	214	USW G-3	2491.4	95.73
24084.0	-1299.0	2544.95	219	USW WT-7	2587.2	42.25
22446.0	-11133.0	2396.33	231	USW WT-1	2477.6	81.27
25052.0	-5856.0	2402.89	236	USW H-3	2537.8	134.91
17740.0	-27037.0	2388.78	269	J-13	2361.7	-27.08
29189.0	-9314.0	2395.99	280	USW WT-2	2535.5	139.51
31760.0	-1466.0	2542.98	287	USW H-6	2724.4	181.42
24675.0	-18869.0	2395.34	319	UE25P#1	2407.8	12.46
30109.0	-11274.0	2394.36	323	USW H-4	2515.6	121.24
35146.0	-6311.0	2541.67	330	USW H-5	2739.6	197.93
34306.0	-10468.0	2395.01	348	USW G-4	2589.0	193.99
25347.0	-26221.0	2392.39	362	UE25WT#13	2373.6	-18.79
39009.0	-8373.0	2474.40	375	USW G-1	2771.0	296.60
30177.0	-22594.0	2395.67	410	UE25WT#14	2420.7	25.03
33759.0	-13799.0	2397.96	414	UE25B#1	2538.3	140.34
38756.0	-9788.0	2397.96	419	USW H-1	2704.3	306.34
37015.0	-15432.0	2396.30	437	UE25WT#4	2551.2	154.90
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3410.5	34.52
42942.0	-17770.0	2421.90	517	UE25WT#16	2516.7	94.80
49073.0	-11904.0	3383.20	525	UE25WT#6	3368.4	-14.80

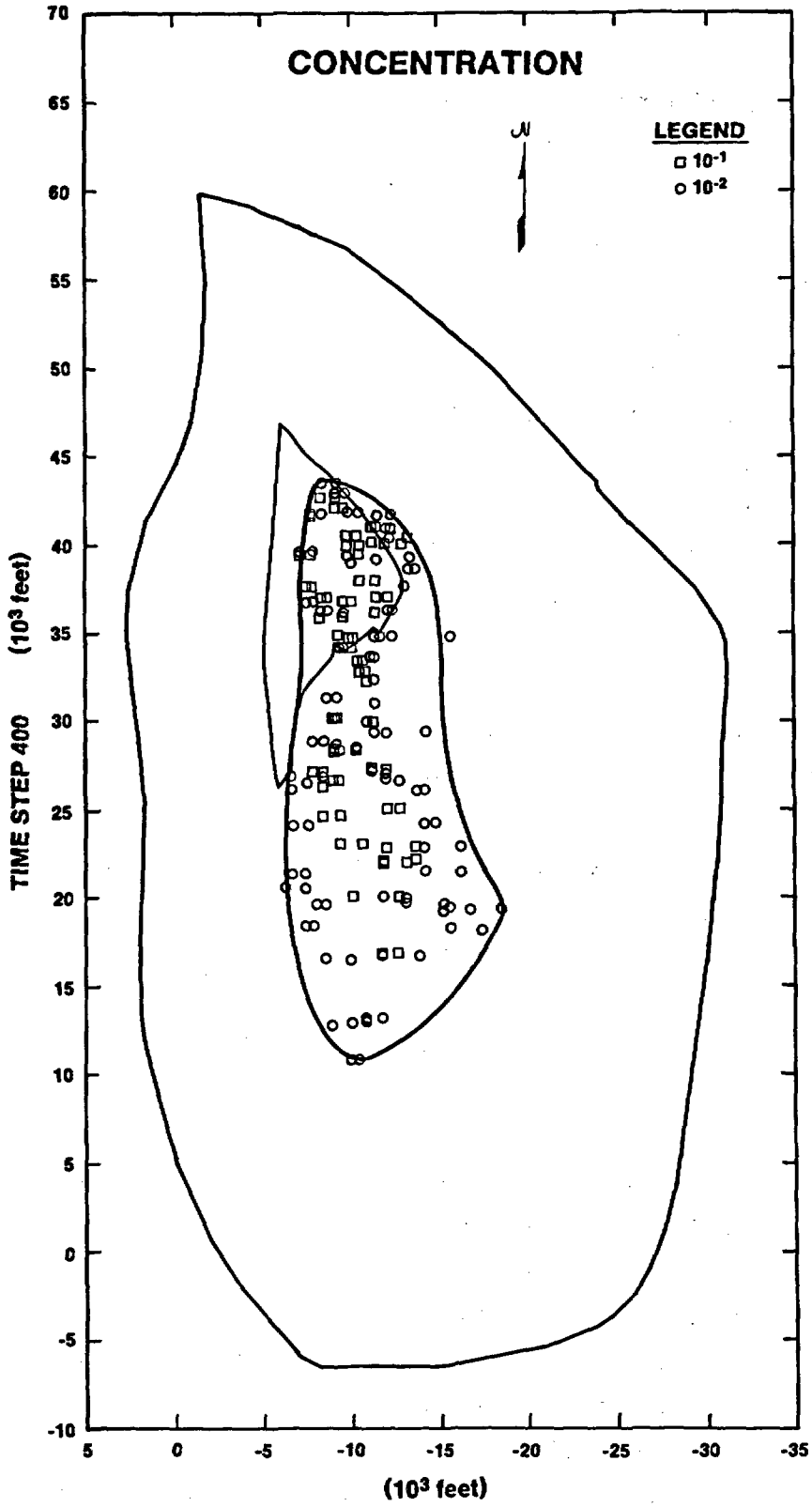

Figure 21. Contaminant Plume at 4.1 Years for 10^{-2} of Source Value. Movement is rapid and preferentially down the conduit formed by the fault, near the south end of the repository.

Numerical experiments based on these assumptions were constructed from the reference smooth and fault-controlled models. Using the reference smooth model as the initial state, two sets of calculations were performed. First, fluid leakage was suddenly initiated along Drill-Hole Wash, and changes to the water table and the effects on contaminant movement were calculated. The implicit assumption is that the initiating event for the leakage of fluid is also the initiating event for the movement of contaminant to the water table. Second, from the reference initial state, leakage was suddenly initiated along Solitario Canyon fault, and changes to the water table and transport of contaminants were calculated. Similarly, starting from the reference fault-controlled problem, the hydraulic conductivity along Solitario Canyon fault was suddenly increased, and changes in the water table and effects on contaminant movement were calculated. No calculation for changes in Drill-Hole Wash was performed, because the fault-controlled reference case does not recognize a fault that controls flow in that position. These calculations are discussed in the following paragraphs.

3.3.1 Smooth Model, Sudden Leakage Along Drill-Hole Wash

From the reference model, leakage to the water table is suddenly introduced in Drill-Hole Wash in elements (grid blocks) 370, 371, 372, 373, 374, 375, 376, and 377, a trapezoidal strip about 13,300 x 1300 x 800 feet. It was assumed that the local saturated head is about 100 feet above the water table and that the ratio K/ℓ is about 10^{-3} (ℓ = height of fluid above water table, K = vertical hydraulic conductivity). The results for the new potentiometric surface are shown in Figure 22. The 2600-foot contour has been moved somewhat south of the reference position. The residuals, shown in Table 11, are discernibly poorer matches to the data than those of the reference smooth case and a number of its variations. Leakage is presumed to persist at the elements representing Drill-Hole Wash for the duration of the problem. Such sudden changes in water table produce transient gradients that

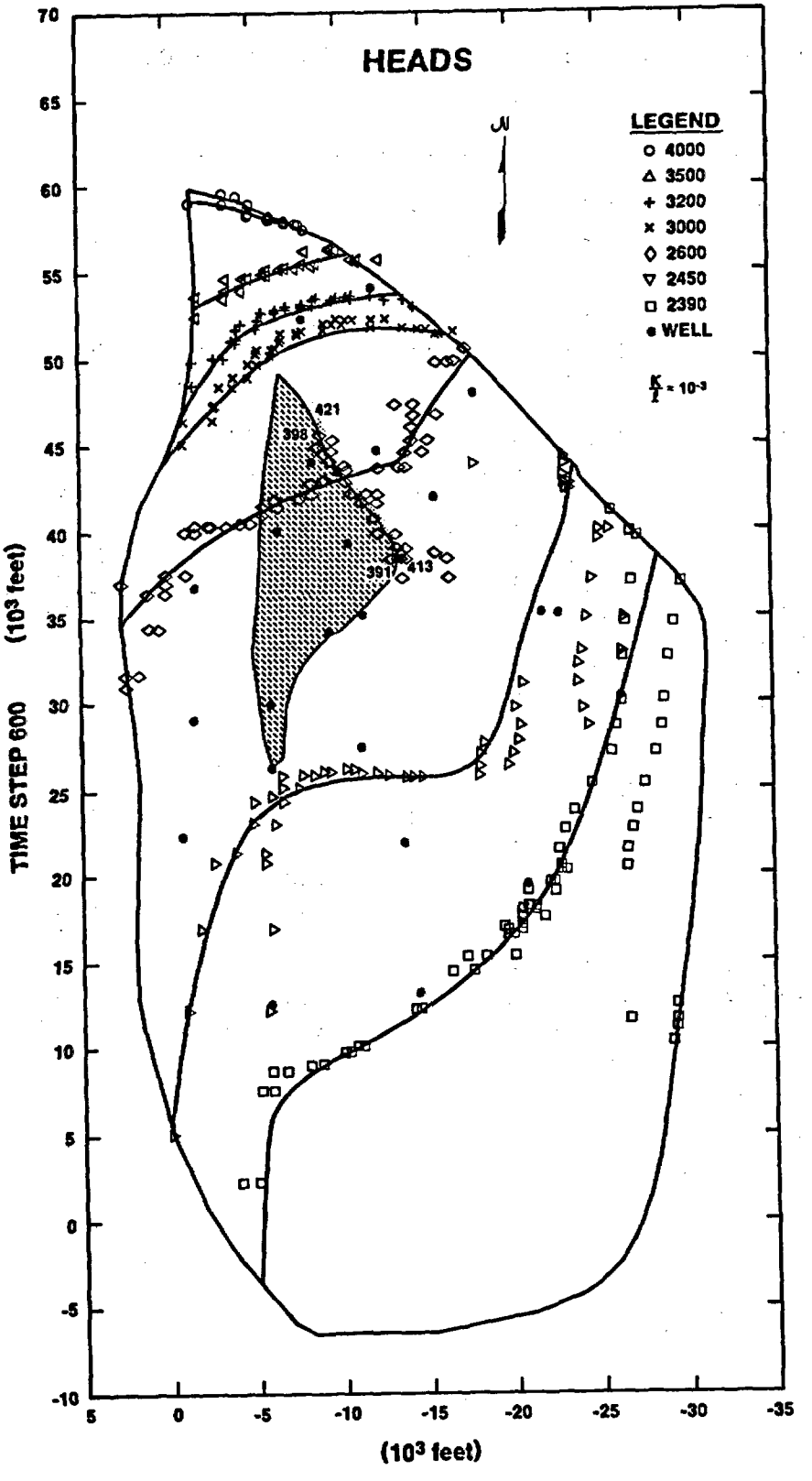

Figure 22. Head Contours, 125 Years after Sudden Initiation of Vertical Leakage along Drill-Hole Wash.

Table 11. Sudden Leakage Initiated in Drill-Hole Wash

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2391.7	-6.27
7568.0	-5768.0	2395.67	135	USW WT-11	2418.2	22.53
17300.0	-694.0	2544.95	177	USW WT-10	2492.8	-52.15
14500.0	-20769.0	2393.37	183	UE25WT#3	2395.6	2.23
16927.0	13618.0	2394.80	188	UE25WT#7	2429.4	34.60
21291.0	-5882.0	2395.67	214	USW G-3	2459.8	64.13
24084.0	-1299.0	2544.95	219	USW WT-7	2516.2	-28.75
22446.0	-11133.0	2396.33	231	USW WT-1	2461.2	64.87
25052.0	-5856.0	2402.89	236	USW H-3	2489.9	87.01
17740.0	-27037.0	2388.78	269	J-13	2368.8	-19.98
29189.0	-9314.0	2395.99	280	USW WT-2	2579.9	183.91
31760.0	-1466.0	2542.98	287	USW H-6	2559.1	16.12
24675.0	-18869.0	2395.34	319	UE25P#1	2480.9	85.56
30109.0	-11274.0	2394.36	323	USW H-4	2583.1	188.74
35146.0	-6311.0	2541.67	330	USW H-5	2595.7	54.03
34306.0	-10468.0	2395.01	348	USW G-4	2596.0	200.99
25347.0	-26221.0	2392.39	362	UE25WT#13	2403.7	11.31
39009.0	-8373.0	2474.40	375	USW G-1	2602.6	128.20
30177.0	-22594.0	2395.67	410	UE25WT#14	2509.3	113.63
33759.0	-13799.0	2397.96	414	UE25B#1	2600.0	202.04
38756.0	-9788.0	2397.96	419	USW H-1	2600.0	202.04
37015.0	-15432.0	2396.30	437	UE25WT#4	2595.8	199.50
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3104.3	-271.68
42942.0	-17770.0	2421.90	517	UE25WT#16	2479.4	57.50
49073.0	-11904.0	3383.20	525	UE25WT#6	3281.1	-102.10

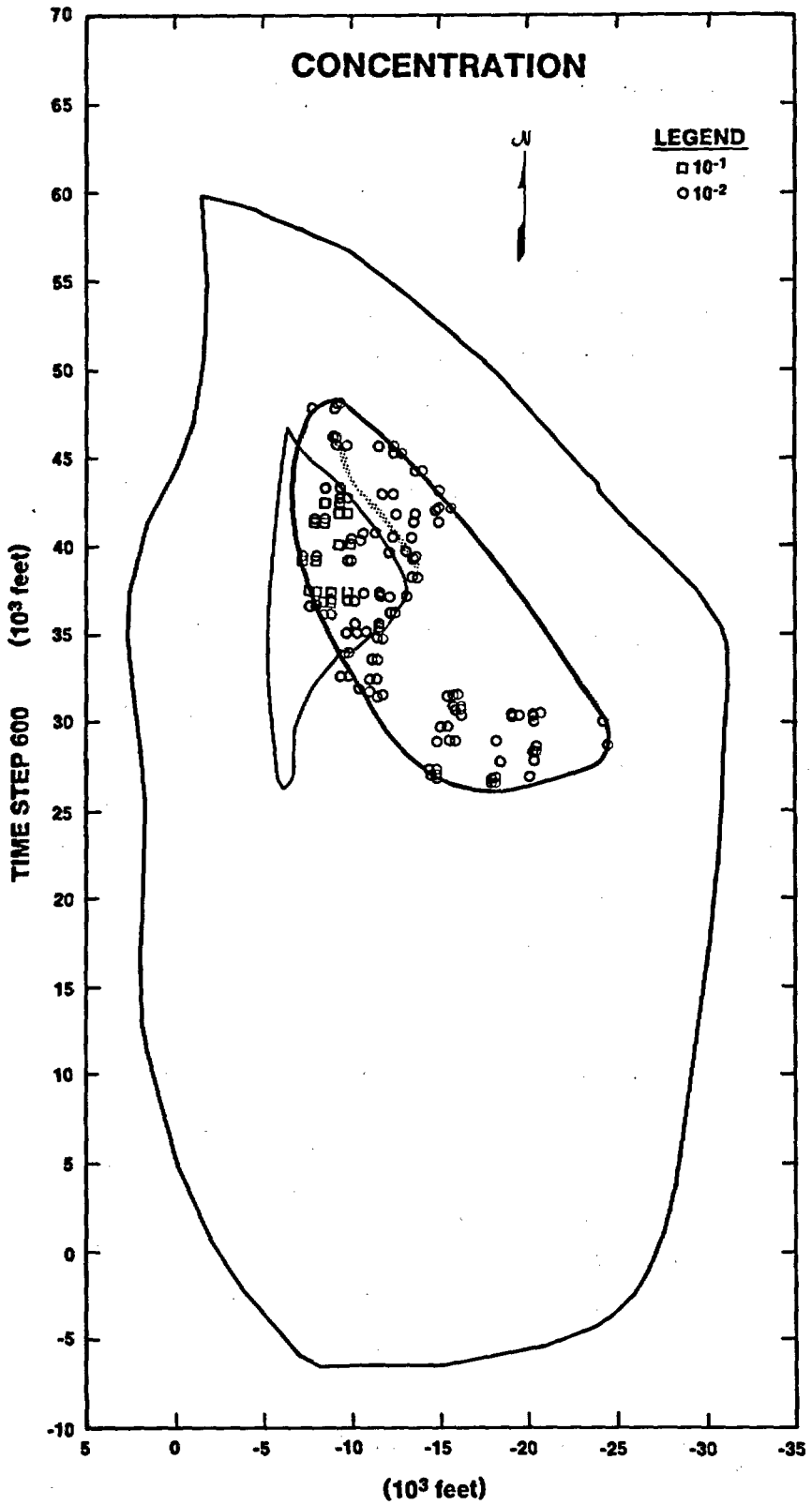

Figure 23. Contaminant Plume, 125 Years after Sudden Initiation of Vertical Leakage along Drill-Hole Wash, for 10^{-2} of Source Value.

dramatically influence the flow and transport. The plume of contaminants is displayed in Figure 23 for a time of 125 years after initiation of release. The plume initially moves more rapidly than it does in the reference case. The water table, as traced along an east-west line through the repository block, rose a maximum 110 ft, with most of the rise occurring in the first 40 years. The rise was continuing very slowly at some points of the trace at 125 years. However one should note that by 125 years, the head gradients are smaller for this case. So if release of contaminants is delayed until heads have stabilized, the rate of transport may in the long term be reduced.

3.3.2 Smooth Mode, Sudden Leakage across Solitario Canyon Fault

From the reference model, leakage across the fault was suddenly introduced along Solitario Canyon fault in elements 74, 91, 108, 126, 145, 164, 183, 203, 204, 225, 247, 269, 270, 291, and 314. As shown in Figure 24, the head contours are essentially the same as those of the reference case. The residuals are given in Table 12 and are quite similar to the reference residuals. The concentration plume has moved slightly farther in about the same time (Figure 25), t = 429 years, as in the 420 years for the reference case. Because leakage is assumed to persist for the 429 years along Solitario Canyon, the head contours of Figure 24 represent a long-term head distribution. The water table, as traced along an east-west line through the repository block rose 10 feet or less, with all but the last 1 foot of the rise completed within 60 years. If there were evidence for such leakage, this model would be as good (in the sense of residuals) as the reference case.

3.3.3 Fault-Controlled Model, Sudden Leakage across Solitario Canyon Fault

The reference model is the fault-controlled configuration discussed earlier. In this case, it is presumed that the elements

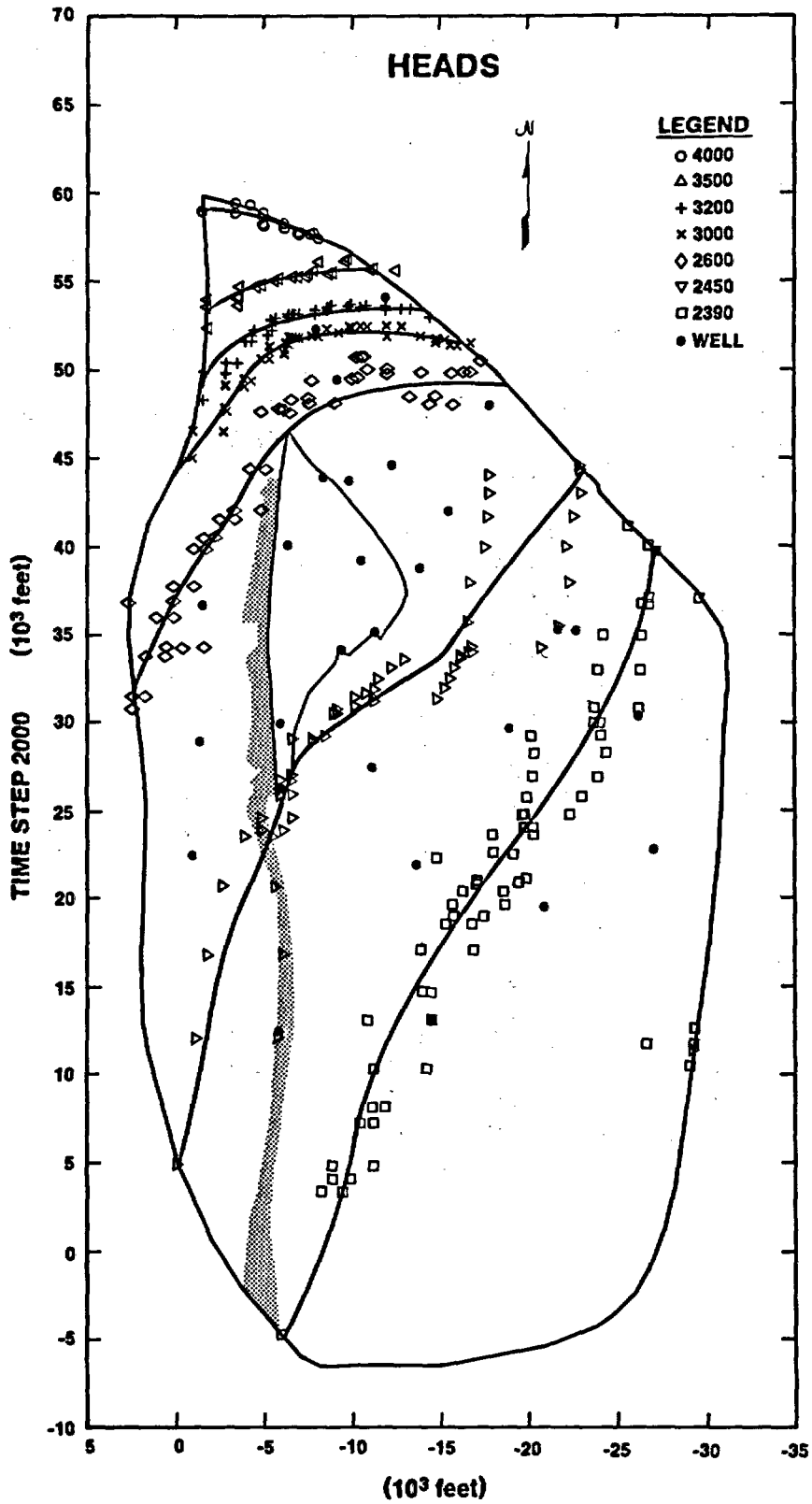

Figure 24. Head Contours, 420 Years after Sudden Initiation of Vertical Leakage along Solitario Canyon Fault.

Table 12. Sudden Leakage Initiated along Solitario Canyon in the Case of the Smooth Reference Model

X (feet)	Y (feet)	Head (feet)	Node	Well	Head Calc. Value (feet)	Residual (feet)
8226.0	-14411.0	2397.97	129	UE25WT#12	2388.5	-9.47
7568.0	-5768.0	2395.67	135	USW WT-11	2414.1	18.43
17300.0	-694.0	2544.95	177	USW WT-10	2489.7	-55.25
14500.0	-20769.0	2393.37	183	UE25WT#3	2379.0	-14.37
16927.0	13618.0	2394.80	188	UE25WT#7	2400.5	5.70
21291.0	-5882.0	2395.67	214	USW G-3	2451.70	56.03
24084.0	-1299.0	2544.95	219	USW WT-7	2512.00	-32.95
22446.0	-11133.0	2396.33	231	USW WT-1	2414.9	18.57
25052.0	-5856.0	2402.89	236	USW H-3	2465.5	62.61
17740.0	-27037.0	2388.78	269	J-13	2358.2	-30.58
29189.0	-9314.0	2395.99	280	USW WT-2	2478.3	82.31
31760.0	-1466.0	2542.98	287	USW H-6	2535.8	-7.18
24675.0	-18869.0	2395.34	319	UE25P#1	2414.8	19.46
30109.0	-11274.0	2394.36	323	USW H-4	2474.9	80.54
35146.0	-6311.0	2541.67	330	USW H-5	2505.5	-36.17
34306.0	-10468.0	2395.01	348	USW G-4	2494.7	99.69
25347.0	-26221.0	2392.39	362	UE25WT#13	2374.7	-17.69
39009.0	-8373.0	2474.40	375	USW G-1	2519.3	44.90
30177.0	-22594.0	2395.67	410	UE25WT#14	2427.4	31.73
33759.0	-13799.0	2397.96	414	UE25B#1	2485.9	87.94
38756.0	-9788.0	2397.96	419	USW H-1	2508.3	110.34
37015.0	-15432.0	2396.30	437	UE25WT#4	2495.1	98.00
34626.0	-27197.0	2391.70	453	UE25WT#15	2390.0	-1.70
47310.0	-7892.0	3375.98	467	USW G-2	3044.1	-331.88
42942.0	-17770.0	2421.90	517	UE25WT#16	2477.6	55.70
49073.0	-11904.0	3383.20	525	UE25WT#6	3269.3	-169.60

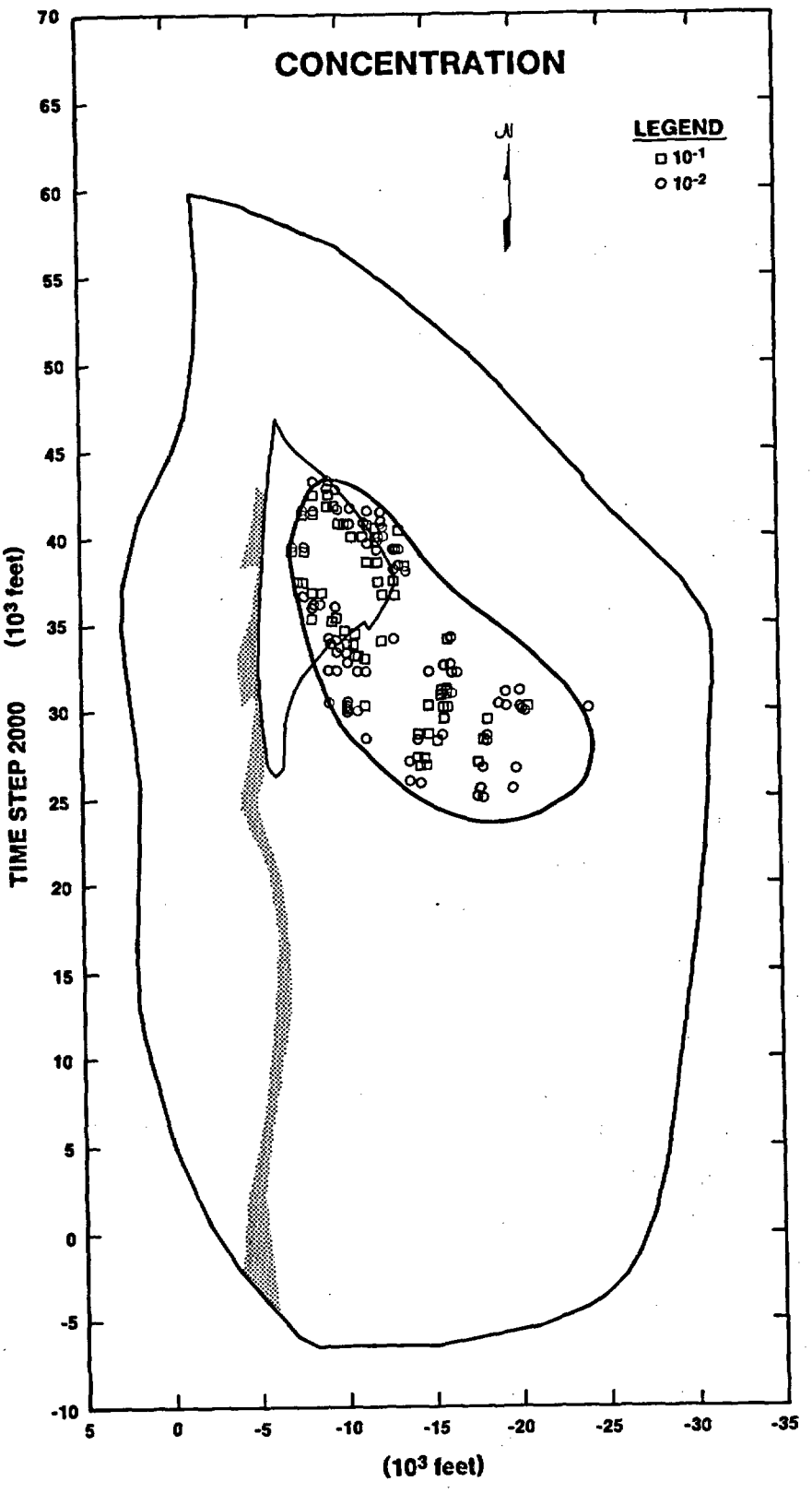

Figure 25. Contaminant Plume, 429 Years after Sudden Initiation of Vertical Leakage along Solitario Canyon, for 10^{-2} of Source Value.

along Solitario Canyon fault (74, 91, 108, 126, 145, 164, 183, 203, 204, 225, 247, 269, 270, 291, and 314) suddenly have their hydraulic conductivity altered to 10^{-5} ft/s from 10^{-8} ft/s. The head contours change to the form shown in Figure 26, while the concentration plume turns more easterly than earlier. It is shown in Figure 27 for 103 years after release. At this time (103 years), the plume is too close to the boundary of the problem to be unaffected by boundary values, and so the calculation is ended. Along an east-west line through the repository block, the water table was calculated to rise a maximum of 65 feet in 115 years. About 90 percent of the rise occurred in the first 50 years with only 1.5 foot increase in the last 23 years, at the end of the calculation.

4. INTERPRETATIONS

A number of numerical experiments were done on models derived as solutions to inverse problems (Wang, 1982) using limited data. Three kinds of models were examined, (1) smooth models with fluid flow not controlled by faults, (2) fault-controlled models with fluid flow controlled by faults, and (3) catastrophic changes to the first two.

The reference smooth model examined numerically here as an inverse problem yields a water table model that approximates the head data reasonably well, in the sense of small residuals, except perhaps at one datum. That datum (USWG-2) consistently provides the largest contribution to the residuals. The possible reasons include the scale of the elements, which may be too large for the necessary adjustment of K, vertical leakage in the vicinity, or some other hydrologic phenomenon. The effect of vertical leakage at USWG-2 was examined in a numerical experiment. The alteration to the hydraulic conductivity necessary to produce this improvement is an increase of one order of magnitude in a region roughly downstream from node 467 where USWG-2 is located. This suggests that more well-tests that allow inference of K in the downstream region could be helpful in

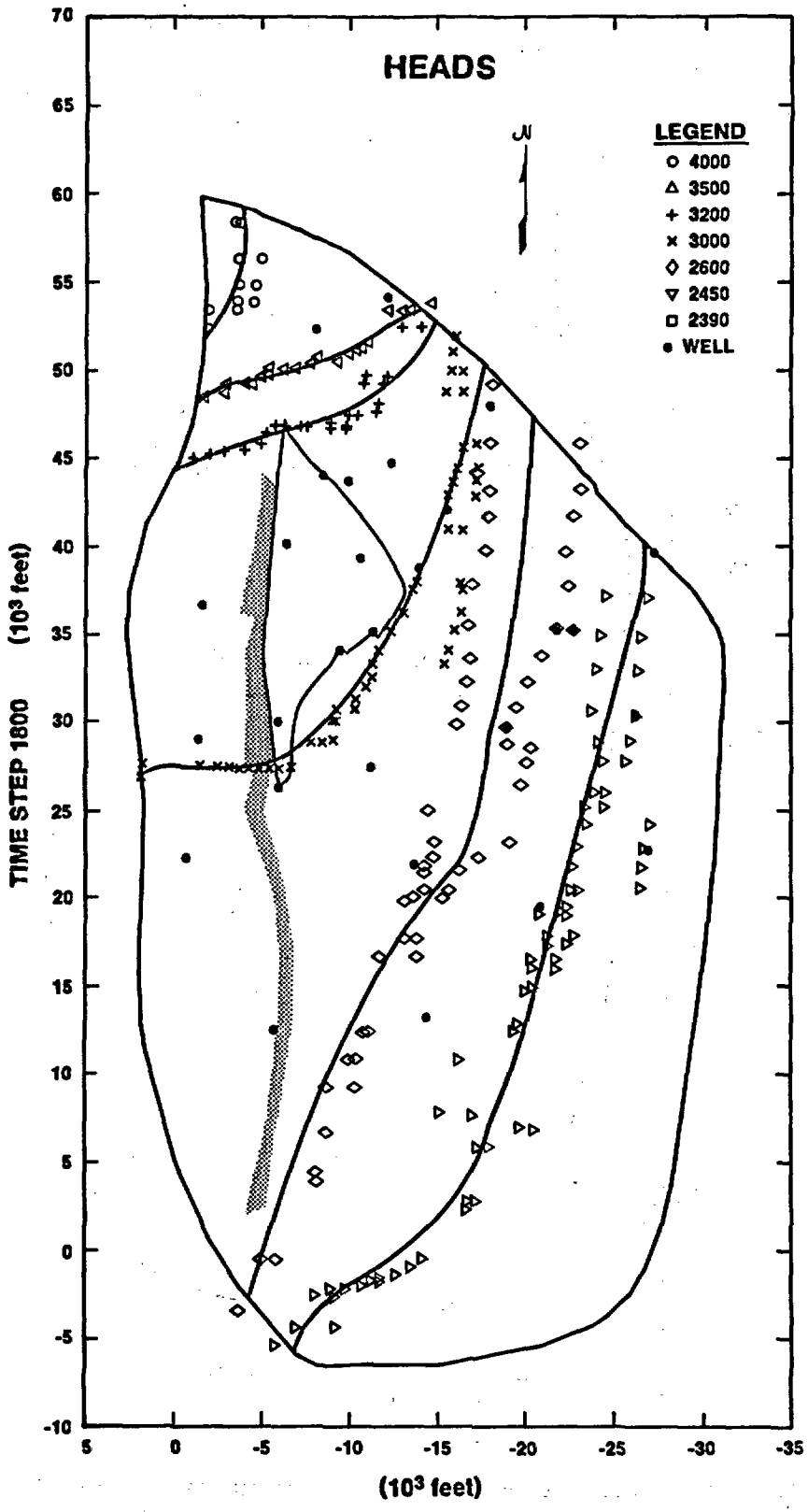

Figure 26. Head Contours, 103 Years after Sudden Initiation of Leakage across Solitario Canyon Fault.

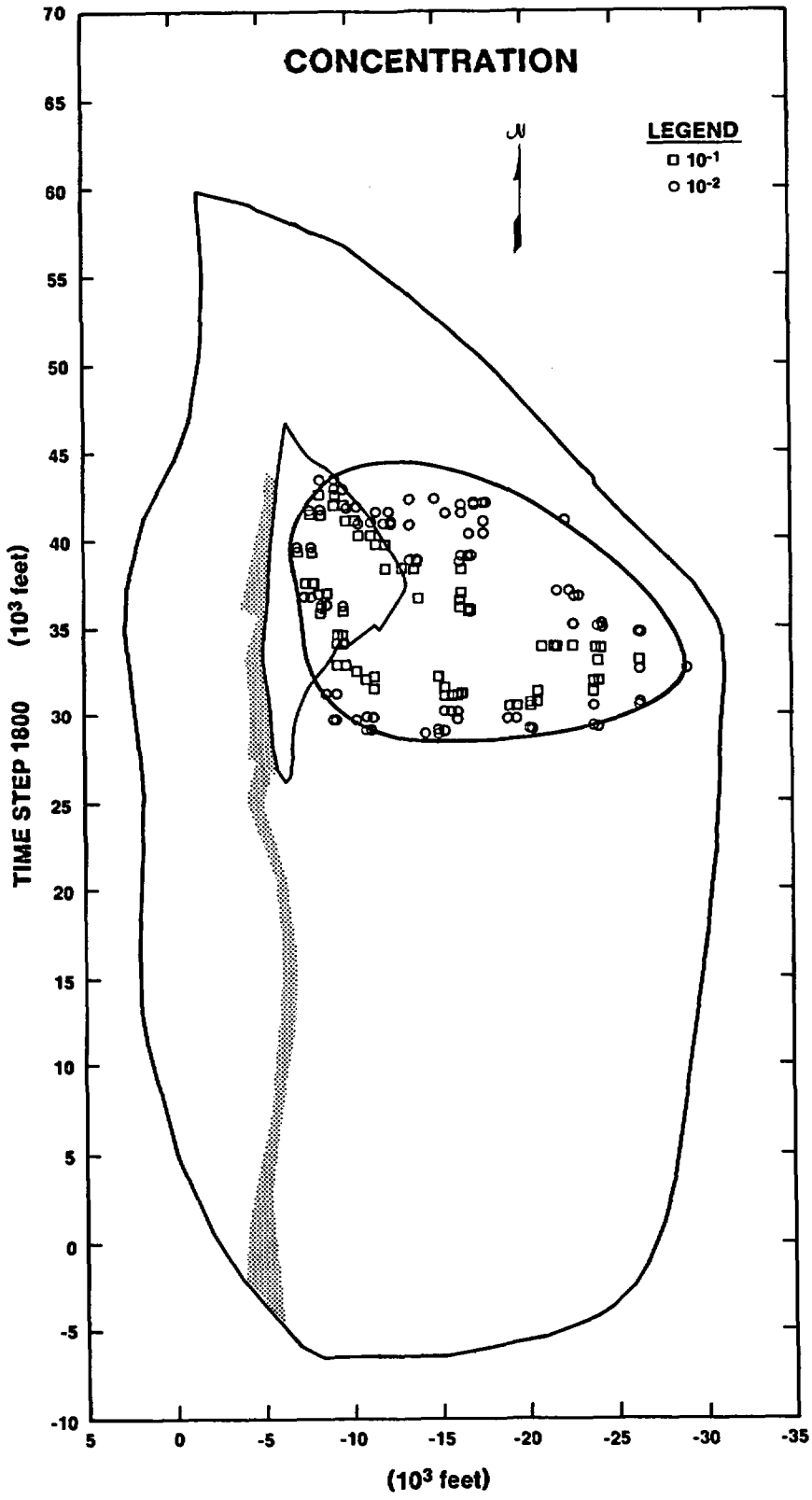

Figure 27. Contaminant Plume, 103 Years after Sudden Initiation of Leakage across Solitario Canyon Fault, for 10^{-2} of Source Value.

consistent with the well data. The current data appear inadequate to support a conclusion that flow in the saturated zone is controlled by faults.

Catastrophic alteration of hydraulic conductivity along pre-existing faults to higher values would produce less significant effects on heads than expected. New water table levels are established quickly--by calculation in tens of years. Head gradients, the driving force for flow, are low. The direction of flow may be altered and travel time reduced; however, transport is not extremely rapid since it is still controlled to a considerable extent by downstream hydraulics, which were not altered.

What the performance-assessment analyst gets from these analyses is a model for heads on which to base calculations, a model that ignores the presence of controlling faults. The analyst finds that a number of seemingly different interpretations of the flow system do not have results significantly different in the sense of matching head data and of transport. Transport takes 100 to 500 years in most models almost regardless of detail except for faults for which K is so large relative to the surrounding rocks that the faults act as diversion channels. These times appear short compared to groundwater travel times in the unsaturated zone (Lin, 1985) and should be construed as a crude reminder of the possible relative lack of importance of this barrier. The true contribution to the time can only be assessed from substantially more data then are currently available.

What was anticipated was that the hydraulics of this local region would exhibit some characteristics not typical of smooth models, which could be interpreted simply by assignment of either large or small values of K (relative to the unfaulted elements) to elements belonging to fault zones. Then the head contours might look like those shown in Figure 18. Further, movement of a contaminant plume would then be rapid and in the form of that shown in Figure 21. Instead, the analyst is left with a smooth model that is not terribly sensitive to changes in K. Only one anomaly, local leakage, is a question in that model, and that question has only an experimental answer.

justifying the presumption of vertical leakage near USWG-2. Because of the absence of any evidence of leakage, the somewhat better fit to the data is ignored, and the reference case is that without leakage. Leakage from along Solitario Canyon fault or Drill-Hole Wash generates head contours not dramatically different from the reference smooth case even though they are generated for an assignment of K values unaltered from the reference smooth case. With further manipulation of assignment of values of K the residuals would be reduced; these options--smooth models with vertical leakage along faults--could not be differentiated on the basis of current data. Plume movement is quite slow, about the same order as for the reference case--perhaps, then, the distinctions are moot for performance assessment.

Alteration of K in large blocks gives a rough idea of the robustness of the models to such changes. Calculations were performed with such changes. The interpretations of well-tests in one well, USWH-1, (Rush, 1984; Barr, 1985) provide values for K dependent on the type of test performed and different by at least a factor of two. We point out that if in performing the calculations for the inverse problems, the residuals derived do not allow a clear choice of model for a variation in K of more than a factor of 2, then we are indifferent to the arguments about which is the best representation. In the calculations with block alteration of K, the residuals are not much different, and the contaminant plumes are roughly the same.

In the fault-controlled models, manipulation of K at best produces poor approximations to the known heads. For the fault-controlled reference case, it is possible to regard Drill-Hole Wash fault and the extension of Ghost Dance fault as simply boundaries between areas of assignment of K. That is, these faults seem to be neither barriers of low K nor conduits of high K. The most extreme example shown (Figure 18), where K is quite small for all three faults, produces residuals like those of the reference case in spite of a rather startling appearance of contours for heads. Even the cases of distributions of faults with higher K did not produce heads

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APPENDIX

This appendix contains a Figure (Figure 28) showing the assignment of node and element numbers for the region of study. Also included are lists of hydraulic parameters used in the two reference models.

Data appearing in the tables in the text, in particular in columns 3 (heads) and 5 (well-locations), are taken primarily from USGS data in the SCP and these data should be added to the RIB. No head data were available in the RIB.

This report contains no candidate information for the Site and Engineering Properties Data Base.

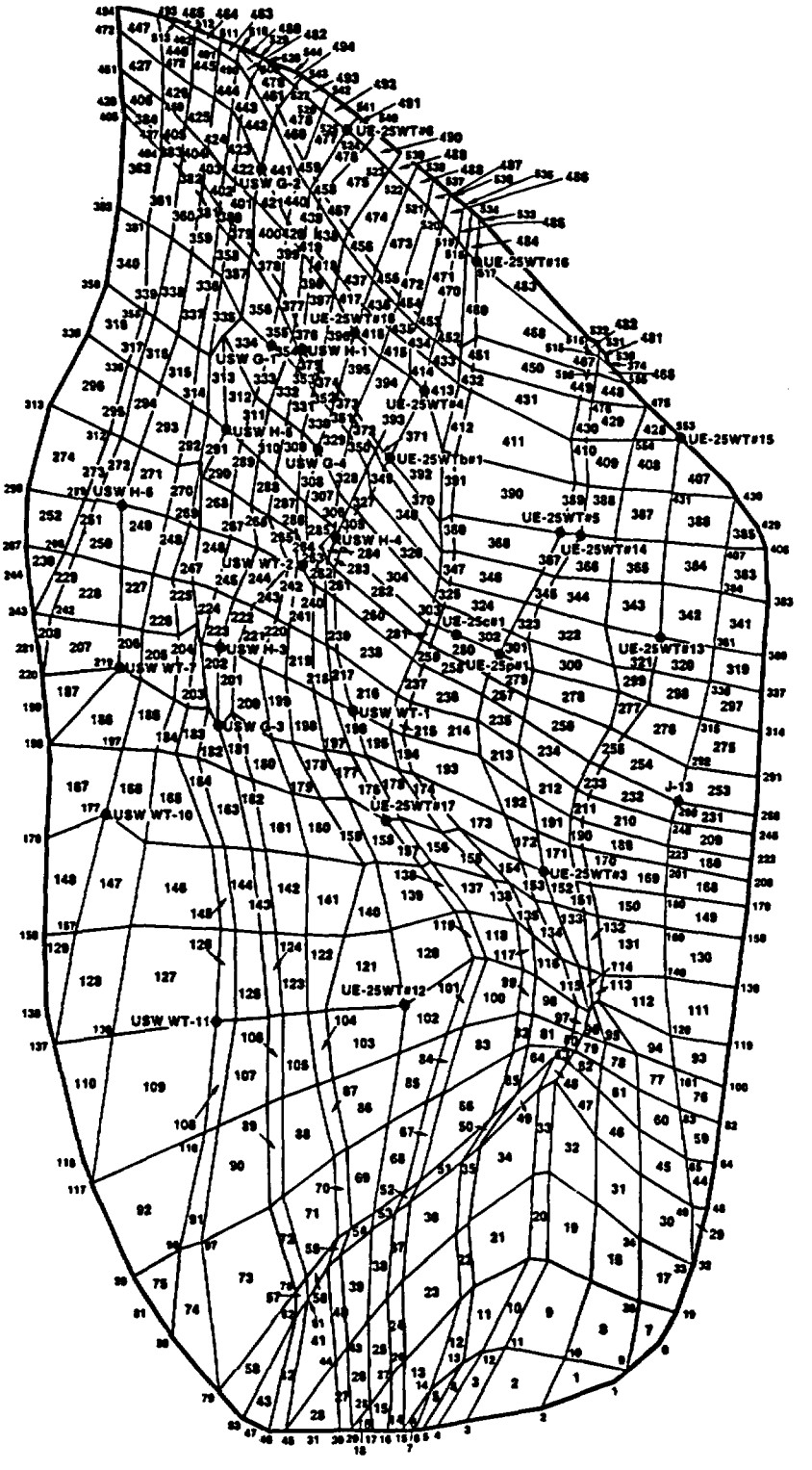

Figure 28. Finite Element Mesh with Assignment of Nodal and Element Numbers.

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL

ELEMENT PARAMETERS

ELEMENT	X-Hydraulic Conductivity	Y-Hydraulic Conductivity	STORAGE	POROSITY	DISPERSIVITY LONGITUDINAL	DISPERSIVITY TRANSVERSE	THICKNESS
1	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
2	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
3	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
4	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
5	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
6	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
7	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
8	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
9	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
10	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
11	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
12	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
13	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
14	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
15	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
16	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
17	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
18	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
19	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
20	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
21	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
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23	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
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33	1.020E-05	1.020E-05	2.000E-01	0.20	1.000E+01	1.000E+01	3.000E+02
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INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

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92	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
93	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
94	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
95	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
96	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
97	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
98	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
99	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
100	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
101	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
102	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
103	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
104	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
105	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
106	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
107	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
108	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
109	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
110	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
111	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
112	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
113	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
114	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
115	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
116	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
117	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
118	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
119	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

120	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
121	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
122	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
123	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
124	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
125	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
126	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
127	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
128	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
129	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
130	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
131	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
132	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
133	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
134	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
135	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
136	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
137	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
138	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
139	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
140	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
141	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
142	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
143	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
144	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
145	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
146	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
147	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
148	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
149	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
150	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
151	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	1.000E+01	3.000E+02
152	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	1.000E+01	3.000E+02
153	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
154	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
155	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
156	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
157	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
158	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
159	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
160	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
161	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
162	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
163	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
164	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
165	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
166	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
167	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
168	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
169	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
170	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
171	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
172	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
173	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
174	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
175	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
176	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
177	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
178	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
179	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
180	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
181	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
182	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

183	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
184	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
185	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
186	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
187	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
188	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
189	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
190	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
191	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
192	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
193	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
194	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
195	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
196	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
197	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
198	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
199	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
200	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
201	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
202	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
203	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
204	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
205	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
206	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
207	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
208	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
209	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
210	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
211	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
212	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
213	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
214	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
215	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
216	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
217	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
218	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
219	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
220	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
221	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
222	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
223	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
224	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
225	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
226	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
227	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
228	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
229	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
230	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
231	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
232	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
233	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
234	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
235	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
236	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
237	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
238	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
239	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
240	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
241	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
242	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
243	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
244	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
245	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

246	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
247	1.000E-08	1.000E-08	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
248	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
249	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
250	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
251	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
252	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
253	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
254	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
255	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
256	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
257	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
258	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
259	1.020E-05	1.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
260	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
261	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
262	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
263	2.020E-05	2.020E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
264	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
265	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
266	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
267	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
268	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
269	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
270	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
271	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
272	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
273	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
274	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
275	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
276	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
277	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
278	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
279	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
280	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
281	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
282	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
283	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
284	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
285	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
286	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
287	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
288	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
289	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
290	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
291	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
292	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
293	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
294	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
295	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
296	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
297	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
298	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
299	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
300	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
301	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
302	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
303	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
304	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
305	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
306	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
307	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
308	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

309	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
310	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
311	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
312	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
313	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
314	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
315	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
316	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
317	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
318	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
319	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
320	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
321	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
322	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
323	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
324	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
325	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
326	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
327	4.990E-05	4.990E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
328	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
329	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
330	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
331	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
332	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
333	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
334	4.990E-05	4.990E-05	2.000E-01	0.20	7.000E+00	7.000E+00	3.000E+02
335	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
336	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
337	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
338	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
339	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
340	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
341	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
342	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
343	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
344	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
345	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
346	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
347	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
348	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
349	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
350	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
351	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
352	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
353	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
354	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
355	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
356	2.020E-05	2.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
357	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
358	1.000E-08	1.000E-08	2.000E-05	0.20	7.000E+00	7.000E+00	3.000E+02
359	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
360	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
361	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
362	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
363	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
364	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
365	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
366	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
367	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
368	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
369	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
370	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
371	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

372	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
373	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
374	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
375	1.010E-04	1.010E-04	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
376	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
377	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
378	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
379	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
380	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
381	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
382	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
383	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
384	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
385	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
386	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
387	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
388	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
389	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
390	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
391	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
392	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
393	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
394	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
395	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
396	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
397	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
398	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
399	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
400	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
401	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
402	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
403	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
404	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
405	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
406	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
407	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
408	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
409	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
410	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
411	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
412	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
413	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
414	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
415	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
416	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
417	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
418	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
419	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
420	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
421	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
422	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
423	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
424	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
425	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
426	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
427	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
428	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
429	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
430	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
431	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
432	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
433	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
434	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE FAULT-CONTROLLED REFERENCE MODEL (cont.)

435	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
436	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
437	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
438	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
439	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
440	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
441	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
442	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
443	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
444	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
445	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
446	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
447	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
448	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
449	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
450	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
451	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
452	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
453	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
454	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
455	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
456	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
457	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
458	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
459	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
460	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
461	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
462	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
463	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
464	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
465	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
466	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
467	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
468	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
469	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
470	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
471	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
472	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
473	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
474	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
475	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
476	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
477	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
478	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
479	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
480	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
481	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
482	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
483	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
484	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
485	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
486	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
487	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
488	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
489	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
490	1.020E-05	1.020E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
491	1.000E-05	1.000E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
492	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
493	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02
494	4.500E-05	4.500E-05	2.000E-02	0.20	7.000E+00	7.000E+00	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL

ELEMENT PARAMETERS

ELEMENT	X-Hydraulic Conductivity	Y-Hydraulic Conductivity	STORAGE	POROSITY	DISPERSIVITY LONGITUDINAL	DISPERSIVITY TRANSVERSE	THICKNESS
1	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
2	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
3	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
4	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
5	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
6	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
7	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
8	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
9	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
10	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
11	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
12	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
13	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
14	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
15	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
16	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
17	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
18	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
19	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
20	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
21	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
22	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
23	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
24	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
25	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
26	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
27	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
28	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
29	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
30	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
31	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
32	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
33	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+02	1.000E+00	3.000E+02
34	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+02	1.000E+00	3.000E+02
35	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
36	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
37	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
38	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
39	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
40	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
41	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
42	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
43	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
44	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
45	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
46	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
47	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
48	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
49	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+02	1.000E+00	3.000E+02
50	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+02	1.000E+00	3.000E+02
51	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
52	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
53	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
54	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
55	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
56	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

57	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
58	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
59	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
60	3.000E-05	3.000E-05	2.000E-01	0.20	5.000E+01	1.000E+00	3.000E+02
61	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
62	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
63	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
64	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
65	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	1.000E+00	3.000E+02
66	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+02	1.000E+00	3.000E+02
67	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
68	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
69	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
70	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
71	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
72	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
73	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
74	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
75	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
76	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
77	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
78	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
79	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
80	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
81	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E+01	7.000E-01	3.000E+02
82	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
83	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
84	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
85	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
86	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
87	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
88	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
89	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
90	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
91	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
92	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
93	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
94	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
95	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
96	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
97	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
98	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
99	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
100	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
101	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
102	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
103	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
104	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
105	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
106	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
107	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
108	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
109	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
110	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
111	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
112	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
113	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
114	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
115	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
116	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
117	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
118	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
119	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

120	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
121	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
122	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
123	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
124	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
125	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
126	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
127	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
128	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
129	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
130	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
131	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
132	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
133	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
134	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
135	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
136	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
137	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
138	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
139	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
140	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
141	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
142	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
143	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
144	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
145	5.000E-07	5.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
146	5.000E-06	5.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
147	5.000E-06	5.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
148	5.000E-06	5.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
149	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
150	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
151	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	1.000E+00	3.000E+02
152	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	1.000E+00	3.000E+02
153	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
154	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
155	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
156	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
157	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
158	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
159	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
160	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
161	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
162	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
163	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
164	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
165	3.100E-06	3.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
166	3.100E-06	3.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
167	3.100E-06	3.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
168	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
169	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
170	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
171	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
172	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
173	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
174	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
175	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
176	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
177	1.000E-04	1.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
178	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
179	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
180	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
181	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
182	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

183	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
184	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
185	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
186	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
187	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
188	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
189	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
190	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
191	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
192	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
193	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
194	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
195	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
196	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
197	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
198	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
199	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
200	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
201	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
202	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
203	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
204	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
205	5.000E-07	5.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
206	5.000E-07	5.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
207	5.000E-07	5.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
208	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
209	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
210	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
211	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
212	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
213	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
214	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
215	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
216	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
217	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
218	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
219	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
220	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
221	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
222	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
223	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
224	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
225	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
226	5.000E-07	5.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
227	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
228	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
229	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
230	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
231	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
232	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
233	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
234	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
235	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
236	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
237	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
238	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
239	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
240	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
241	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
242	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
243	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
244	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
245	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

246	2.100E-06	2.100E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
247	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
248	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
249	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
250	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
251	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
252	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
253	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
254	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
255	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
256	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
257	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
258	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
259	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
260	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
261	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
262	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
263	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
264	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
265	2.100E-05	2.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
266	2.100E-05	2.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
267	2.100E-05	2.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
268	2.100E-05	2.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
269	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
270	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
271	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
272	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
273	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
274	1.000E-07	1.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
275	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
276	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
277	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
278	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
279	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
280	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
281	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
282	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
283	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
284	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
285	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
286	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
287	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
288	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
289	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
290	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
291	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
292	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
293	1.000E-07	1.000E-07	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
294	1.000E-07	1.000E-07	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
295	1.000E-07	1.000E-07	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
296	1.000E-07	1.000E-07	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
297	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
298	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
299	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
300	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
301	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
302	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
303	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
304	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
305	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
306	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
307	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
308	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

309	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
310	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
311	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
312	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
313	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
314	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
315	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
316	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
317	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
318	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
319	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
320	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
321	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
322	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
323	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
324	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
325	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
326	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
327	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
328	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
329	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
330	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
331	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
332	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
333	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
334	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
335	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
336	8.000E-07	8.000E-07	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
337	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
338	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
339	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
340	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
341	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
342	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
343	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
344	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
345	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
346	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
347	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
348	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
349	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
350	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
351	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
352	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
353	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
354	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
355	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
356	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
357	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
358	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
359	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
360	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
361	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
362	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
363	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
364	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
365	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
366	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
367	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
368	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
369	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
370	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
371	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

372	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
373	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
374	3.100E-05	3.100E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
375	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
376	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
377	3.100E-05	3.100E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
378	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
379	1.000E-06	1.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
380	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
381	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
382	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
383	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
384	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
385	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
386	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
387	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
388	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
389	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
390	1.000E-04	1.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
391	1.000E-04	1.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
392	1.000E-04	1.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
393	1.000E-04	1.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
394	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
395	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
396	2.000E-04	2.000E-04	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
397	2.000E-04	2.000E-04	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
398	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
399	3.000E-05	3.000E-05	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
400	8.000E-06	8.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
401	6.000E-06	6.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
402	6.000E-06	6.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
403	6.000E-06	6.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
404	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
405	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
406	5.000E-06	5.000E-06	2.000E-01	0.20	1.000E-05	1.000E-06	3.000E+02
407	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
408	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
409	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
410	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
411	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
412	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
413	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
414	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
415	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
416	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
417	2.000E-04	2.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
418	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
419	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
420	8.000E-06	8.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
421	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
422	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
423	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
424	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
425	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
426	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
427	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
428	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
429	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
430	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
431	2.000E-05	2.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
432	4.500E-05	4.500E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
433	3.000E-04	3.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
434	3.000E-04	3.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

INPUT FOR THE SMOOTH REFERENCE MODEL (cont.)

435	3.000E-04	3.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
436	3.000E-04	3.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
437	3.000E-04	3.000E-04	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
438	3.000E-05	3.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
439	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
440	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
441	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
442	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
443	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
444	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
445	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
446	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
447	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
448	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
449	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
450	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
451	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
452	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
453	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
454	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
455	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
456	4.500E-05	4.500E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
457	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
458	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
459	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
460	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
461	2.000E-06	2.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
462	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
463	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
464	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
465	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
466	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
467	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
468	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
469	1.000E-05	1.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
470	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
471	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
472	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
473	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
474	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
475	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
476	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
477	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
478	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
479	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
480	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
481	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
482	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
483	5.000E-05	5.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
484	5.000E-05	5.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
485	5.000E-05	5.000E-05	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
486	3.000E-06	3.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
487	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
488	8.000E-07	8.000E-07	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
489	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
490	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
491	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
492	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
493	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02
494	1.000E-06	1.000E-06	2.000E-01	0.20	7.000E+01	7.000E-01	3.000E+02

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