Quincy

A DIGITAL MODEL FOR SIMULATION OF GROUND-WATER HYDROLOGY IN THE HOUSTON AREA, TEXAS

LP-103

Cooperators: TEXAS DEPARTMENT OF WATER RESOURCES
U. S. GEOLOGICAL SURVEY
CITY OF HOUSTON

TEXAS DEPARTMENT OF WATER RESOURCES

AUGUST 1979

A DIGITAL MODEL FOR SIMULATION OF GROUND-WATER HYDROLOGY IN THE HOUSTON AREA, TEXAS

by

Walter R. Meyer and Jerry E. Carr
U.S. Geological Survey

cooperators

Texas Department of Water Resources
U.S. Geological Survey
city of Houston

Texas Department of Water Resources

LP-103

August 1979

CONTENTS

CONTENTS

ILLUSTRATIONS

A DIGITAL MODEL FOR SIMULATION OF GROUND-WATER HYDROLOGY IN THE HOUSTON AREA, TEXAS

By

Walter R. Meyer and Jerry E. Carr
U.S. Geological Survey

ABSTRACT

This report documents the construction and calibration of a digital model for the simulation of hydrologic conditions in the Chicot and Evangeline aquifers in the Houston area of southeastern Texas. The model is a five-layer finite-difference model, with a grid pattern of 63 x 67 nodes representing an area of 27,000 square miles, for simulation of three-dimensional ground-water flow.

The hydrologic properties and processes modeled were ground-water withdrawals, transmissivities, storage coefficients of the aquifers and clays, quantity of water derived from storage in the clays, and vertical hydraulic conductivity and vertical leakage. The model, which simulates water-level declines, changes in storage in the clay layers, and land-surface subsidence, was calibrated by use of historical records from 1890 to 1975. It is very sensitive to variations in transmissivities and to variations in water-table and artesian storage. It is less sensitive to variations in clay storage.

The Texas Department of Water Resources makes copies of the model and documentation available through the Texas Natural Resources Information System. Please contact:

Texas Natural Resources Information System
P. O. Box 13087
Austin, Texas 78711
Telephone 1-(512)-475-3321

INTRODUCTION

Purpose and Scope of This Report

The purpose of this report is to document the construction and calibration of a digital model for the simulation of hydrologic conditions in the Chicot and Evangeline aquifers in the Houston area of southeastern Texas.

Although the report includes brief discussions of the geohydrology of the area and of the analog models constructed in 1965 and 1975, the scope is limited primarily to: (1) A description of the model and the boundary conditions imposed on the system; (2) a discussion of the hydrologic properties modeled and the techniques used in the modeling process, and (3) a discussion of the procedures used for calibration of the model.

For additional information on the geohydrology of the area and on the hydrologic problems related to the heavy withdrawals of ground water, the reader is referred to the reports listed in the section "Selected References."

History of Hydrologic Modeling in the Houston Area

The digital model documented in this report was developed as part of a continuing program of ground-water studies conducted by the U.S. Geological Survey in cooperation with the Texas Department of Water Resources (formerly the Texas Water Development Board and its predecessor agencies) and the city of Houston since about 1929. This continuing study was initiated because of the recognition of water-level declines, saltwater encroachment, land-surface subsidence, and other problems related to increasing demands for ground-water supplies.

The first hydrologic model of the aquifers in the area (Wood and Gabrysch, 1965) was an electrical-analog model of the "Houston district," which included about 5,000 square miles in Harris, Galveston, Brazoria, Fort Bend, Austin, Waller, Montgomery, Liberty, and Chambers Counties. This model, which was constructed on the basis of data collected since 1931, was used primarily to predict water-level declines under various conditions of pumping. The usefulness of the first analog model was limited because the simulations required that the aquifers be operated independently of each other and because the results of pumping in the western part of the area could not be simulated. Evaluation of the performance of the first model indicated that improvement in aquifer designation was needed and that the transmissivities of the aquifers and vertical leakage between the aquifers were not adequately modeled.

The second model (Jorgensen, 1975) was an electrical-analog model that incorporated additional hydrologic data and reflected more advanced concepts of the hydrologic system. The second model, which was also used primarily to predict water-level declines under various conditions of pumping, was expanded in area to about 9,100 square miles to minimize the boundary effects within the "Houston district" of Wood and Gabrysch (1965). This model was not designed to simulate the effects of one well over a short period of time, but was designed to simulate the effects of the withdrawals of water from a well field for periods of a year or longer.

Jorgensen (1975) noted that additional hydrologic data and modification of the model would be required for studies of such problems as salt-water encroachment and land-surface subsidence.

Metric Conversions

For those readers interested in using the metric system, the "inch-pound" units used in this report may be converted to metric units by the following factors:

From		Multiply by	To obtain	
Unit	Abbreviation		Unit	Abbreviation
cubic foot	--	0.02832	cubic meter	m^3
foot	--	.3048	meter	m
foot squared per day	ft^2/d	.0929	meter squared per day	m^2/d
inch	--	2.54	centimeter	cm
mile	--	1.609	kilometer	km
square mile	--	2.590	square kilometer	km^2

GEOHYDROLOGY OF THE HOUSTON AREA

The geologic formations from which most of the ground water is pumped in the Houston area are composed of sedimentary deposits of gravel, sand, silt, and clay. The formations, from oldest to youngest, that form important hydrologic units are: The Catahoula Sandstone of Oligocene and Miocene age and Fleming Formation of Miocene age; the Goliad Sand of Pliocene age; the Willis Sand, Bentley and Montgomery Formations, and Beaumont Clay of Pleistocene age; and alluvium of Quaternary age. The most important water-bearing units are the Chicot and Evangeline aquifers.

The Chicot aquifer is composed of the Willis Sand, Bentley Formation, Montgomery Formation, Beaumont Clay, and Quaternary alluvium. The Chicot includes all deposits from the land surface to the top of the Evangeline aquifer (fig. 1).

The basis for separating the Chicot aquifer from the underlying Evangeline aquifer is primarily a difference in hydraulic conductivity, which in part causes the difference in the altitudes of the potentiometric surfaces in the two aquifers.

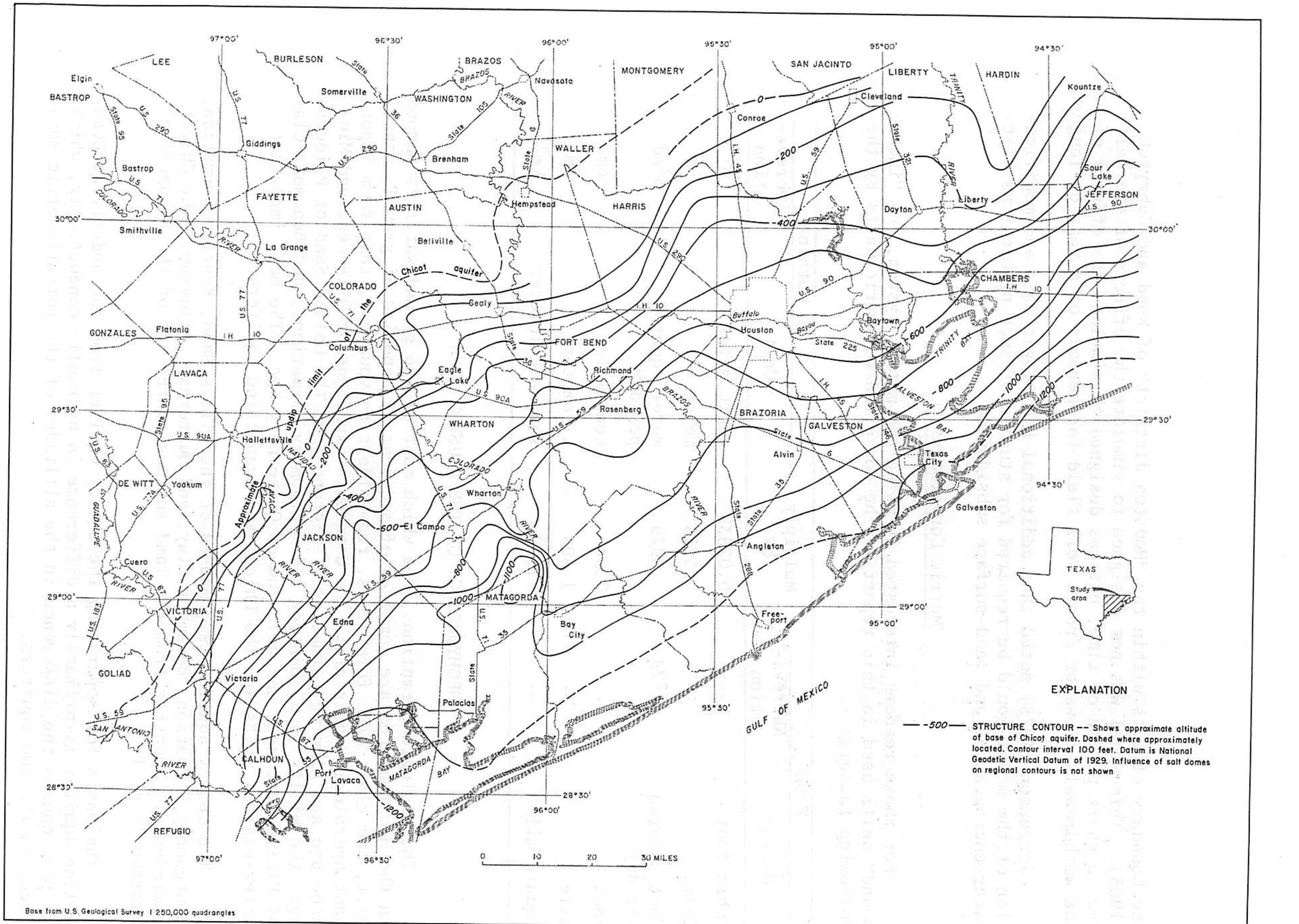


FIGURE 1.-Approximate altitude of the base of the Chicot aquifer

In most of the Houston area, the Chicot aquifer consists of discontinuous layers of sand and clay of about equal total thickness, and in some parts of the area, the aquifer can be separated into an upper and lower unit. Throughout most of Galveston County and southeast Harris County, the basal part of the Chicot aquifer is formed by a massive sand section with high hydraulic conductivity. This sand unit, which is heavily pumped, is known locally as the Alta Loma Sand (Alta Loma Sand of Rose, 1943). If the upper unit of the Chicot aquifer cannot be defined in a particular area, the aquifer is said to be undifferentiated.

The Evangeline aquifer (fig. 2), which is the most important source of fresh ground water in the Houston metropolitan area, consists of layers of sand and clay in the Fleming Formation and Goliad Sand that are present throughout the area except where the unit is pierced by salt domes. The aquifer is underlain by the Burkeville confining layer.

The geology and hydrology of the Houston area is discussed in detail in numerous reports listed in the references.

DESCRIPTION OF THE DIGITAL MODEL

The conceptual model (fig. 3) consists of five layers having a grid pattern of 63 x 67 nodes representing an area of approximately 27,000 square miles as compared to the 9,100-square-mile area of the analog model of Jorgensen (1975). The center of the area has a grid of 1 mile by 1 mile, which is expanded to a coarse grid at the extremities of the model. In ascending order, layer 1 is equivalent to the total thickness of the sand beds in the Evangeline aquifer; layer 2 is equivalent to the clay thickness between the centerline of the Chicot aquifer and the centerline of the Evangeline aquifer; layer 3 is mainly equivalent to the Alta Loma Sand where present, otherwise it is equivalent to the total thickness of the sand beds in the Chicot aquifer; layer 4 is equivalent to the clay thickness between the land surface and the centerline of the Chicot aquifer; and layer 5 is used as an upper boundary to simulate recharge to the system by precipitation and by return flow from irrigation and other souuces.

The digital model documented in this report (fig. 4) is a finite-difference model for simulation of three-dimensional ground-water flow as modified from Trescott (1975). The model converges to a solution rapidly because all equations are solved simultaneously rather than sequentially as in the quasi three-dimensional model of Bredehoeft and Pinder (1970). The iterative numerical technique used to solve the set of simultaneous finite-difference equations is the strongly implicit procedure (SIP) originally described by Stone (1968) for problems in two dimensions and later extended to three dimensions by Wienstein, Stone, and Kwan (1969).

The model of Trescott (1975) was modified by J. E. Carr for use in the Houston area by including methods to increase or decrease the values of storage in the clay layers at a head equivalent to preconsolidation stress to simulate land-surface subsidence. This reference head is arbitrarily

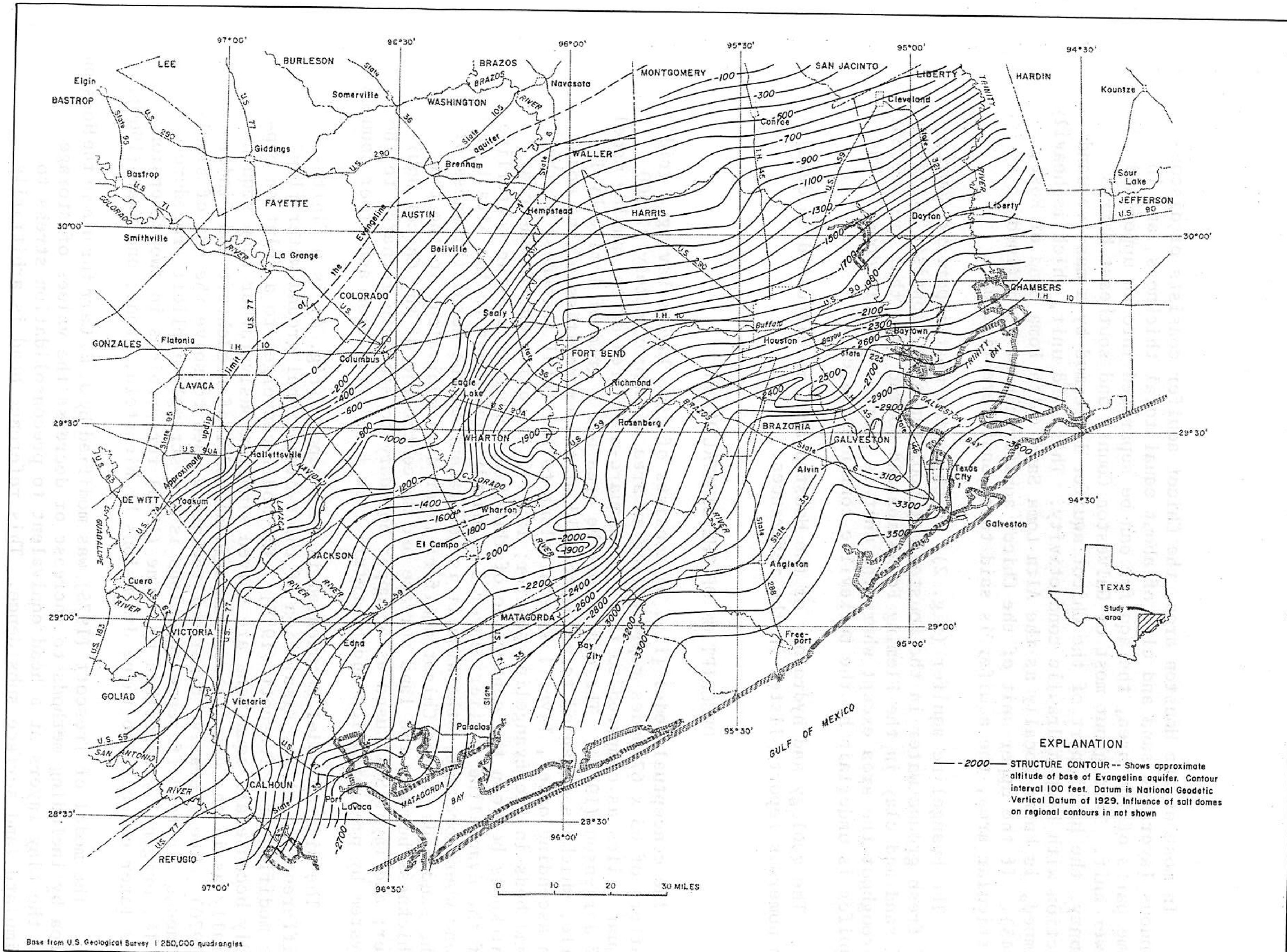


FIGURE 2.-Approximate altitude of the base of the Evangeline aquifer

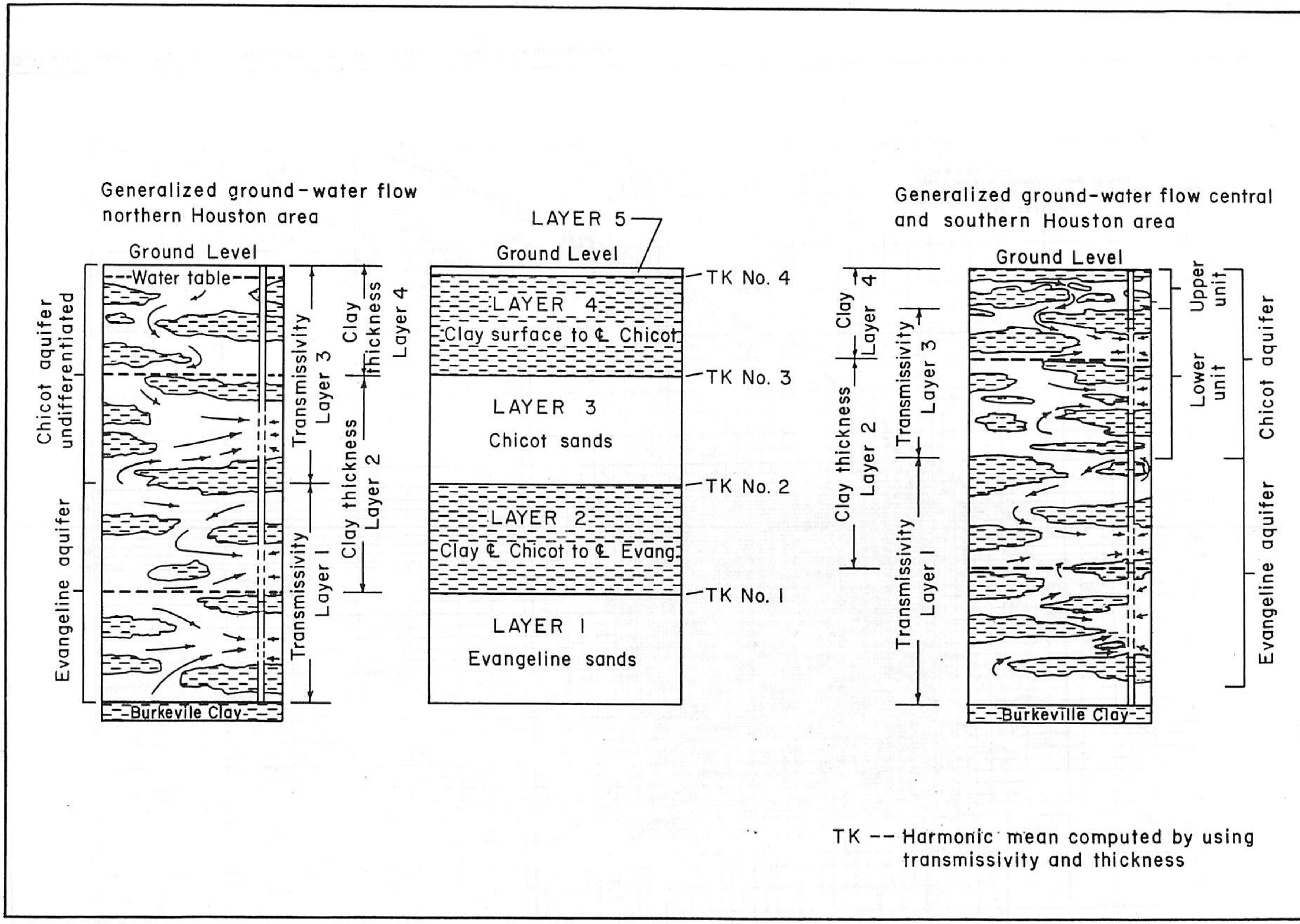
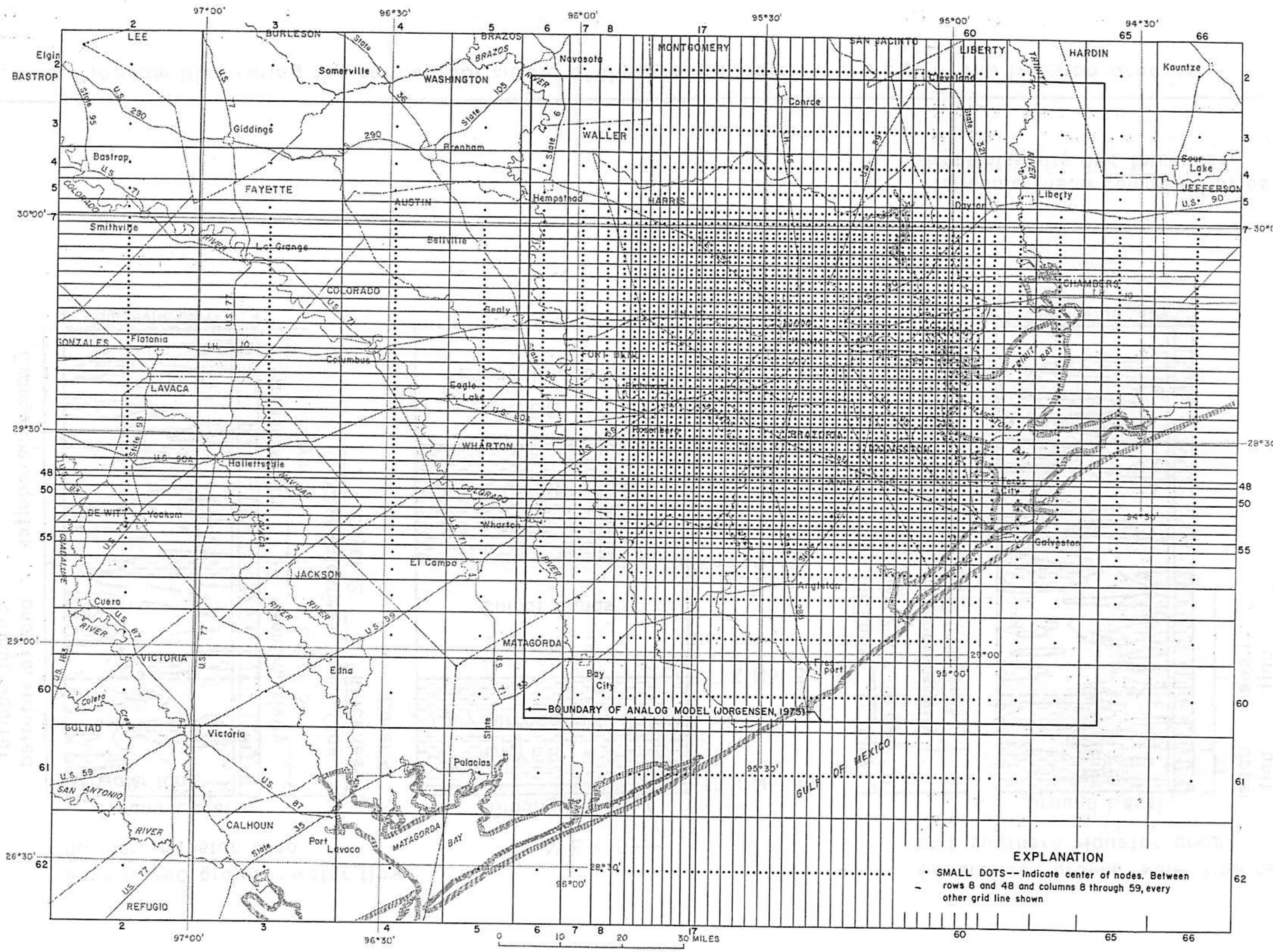


FIGURE 3.-Diagram illustrating the conceptual model of the ground-water hydrology of the Houston area



Base from U.S. Geological Survey 1:250,000 quadrangles

FIGURE 4.-Boundaries and grid pattern of the digital model and the boundaries of the analog model

referred to as "critical head" within the model listings. Different storage coefficients are used for elastic and inelastic compression, and these storage coefficients are made head-dependent. In addition, the modifications include accumulators for clay storage in layers 2 and 4. The model is also programed to obtain a printout of simulated subsidence (see appendixes I, II, and III).

Five arrays were added to the model: (1) One array accumulates land-surface subsidence in layers 2 and 4; (2) two arrays store the lowest head in layers 2 and 4; and (3) two index arrays maintain an account of the changes in clay storage in layers 2 and 4.

The Chicot and Evangeline aquifers form an extensive and continuous hydrologic system along the Gulf coast; therefore the horizontal boundary selection was arbitrary. The boundaries were extended outward to areas of minimal pumping to reduce the boundary effects and to eliminate the necessity of having flux boundaries.

The hydrologic boundaries in the model were simulated in two different ways. Primarily a no-flow boundary was used in the construction of the model; however, a constant-head boundary was used to check the boundary effects. The results showed very little difference at the northern, western, and southern extremities of the area. In comparing the average water-level declines along the eastern boundary for 1974-75, the constant-head boundary solution showed 48 percent less decline in the first row of nodes than the no-flow solution. However, the difference rapidly decreases to only 6 percent, or an average of about 3 feet, at the fourth row in. Only the simulations through row 63 are presented because farther east the declines are affected by the boundary conditions. In the rest of the modeled area, the differences in water-level declines vary from 0 to 2 feet and average about 1 foot.

Hydrologic Properties Modeled

Ground-Water Withdrawals

Ground-water withdrawals were compiled for seven historical periods: (1) 1890-1930, (2) 1931-45, (3) 1946-53, (4) 1954-60, (5) 1961-70, (6) 1971-73, and (7) 1974-75. The pumpage distribution by aquifer is proportioned by the amount of section screened in each aquifer; consequently a well screened in both aquifers is modeled as two wells pumping from both the Chicot and Evangeline aquifers.

Transmissivities of the Aquifers

All pumping tests within the modeled area were examined, and the average hydraulic conductivities were computed for each aquifer. Transmissivity distributions were computed by multiplying the sand thickness of the aquifer by the average hydraulic conductivity for a given area. The areal distribution of the transmissivities of the Chicot and Evangeline aquifers are shown on figures 5 and 6.

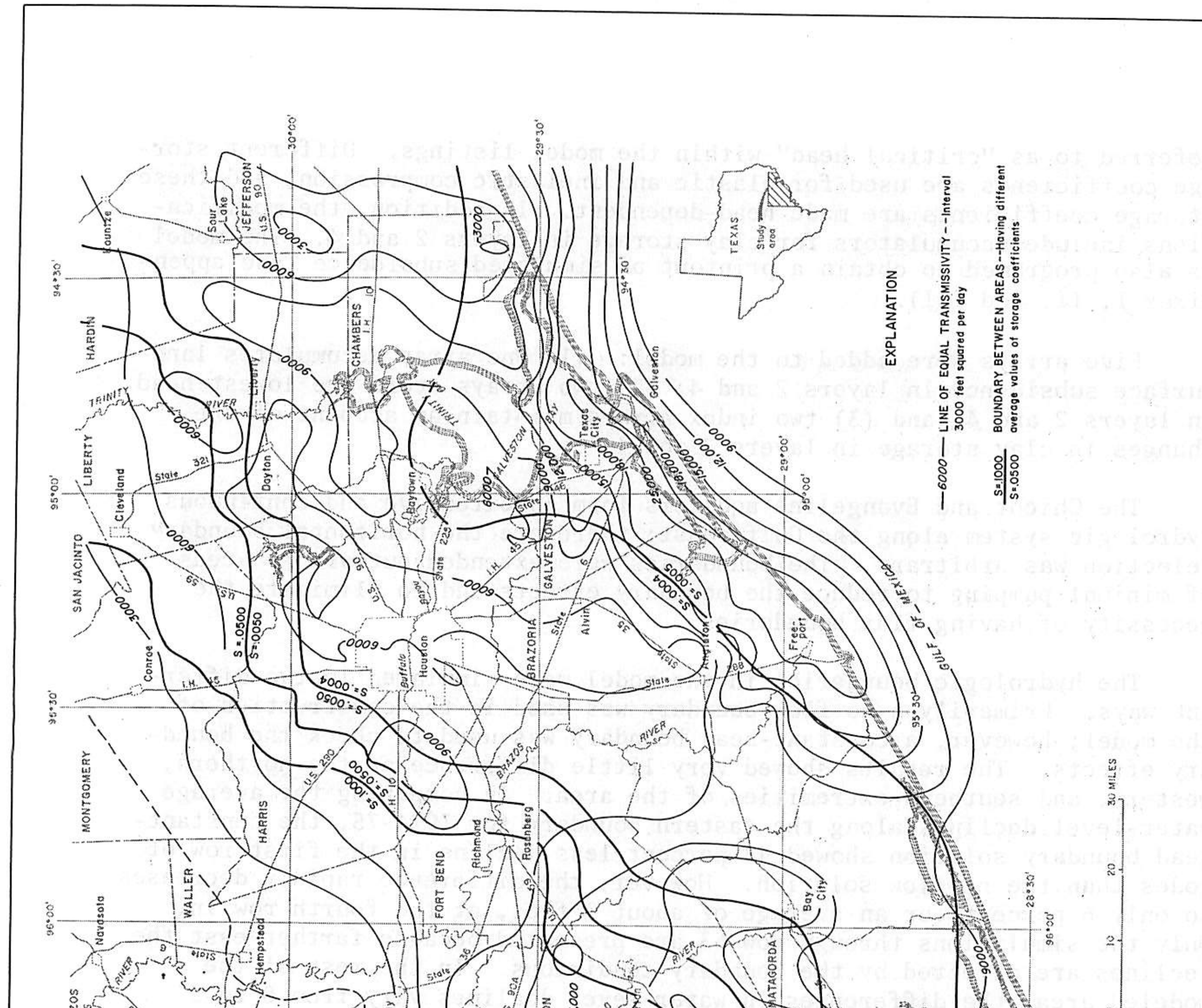
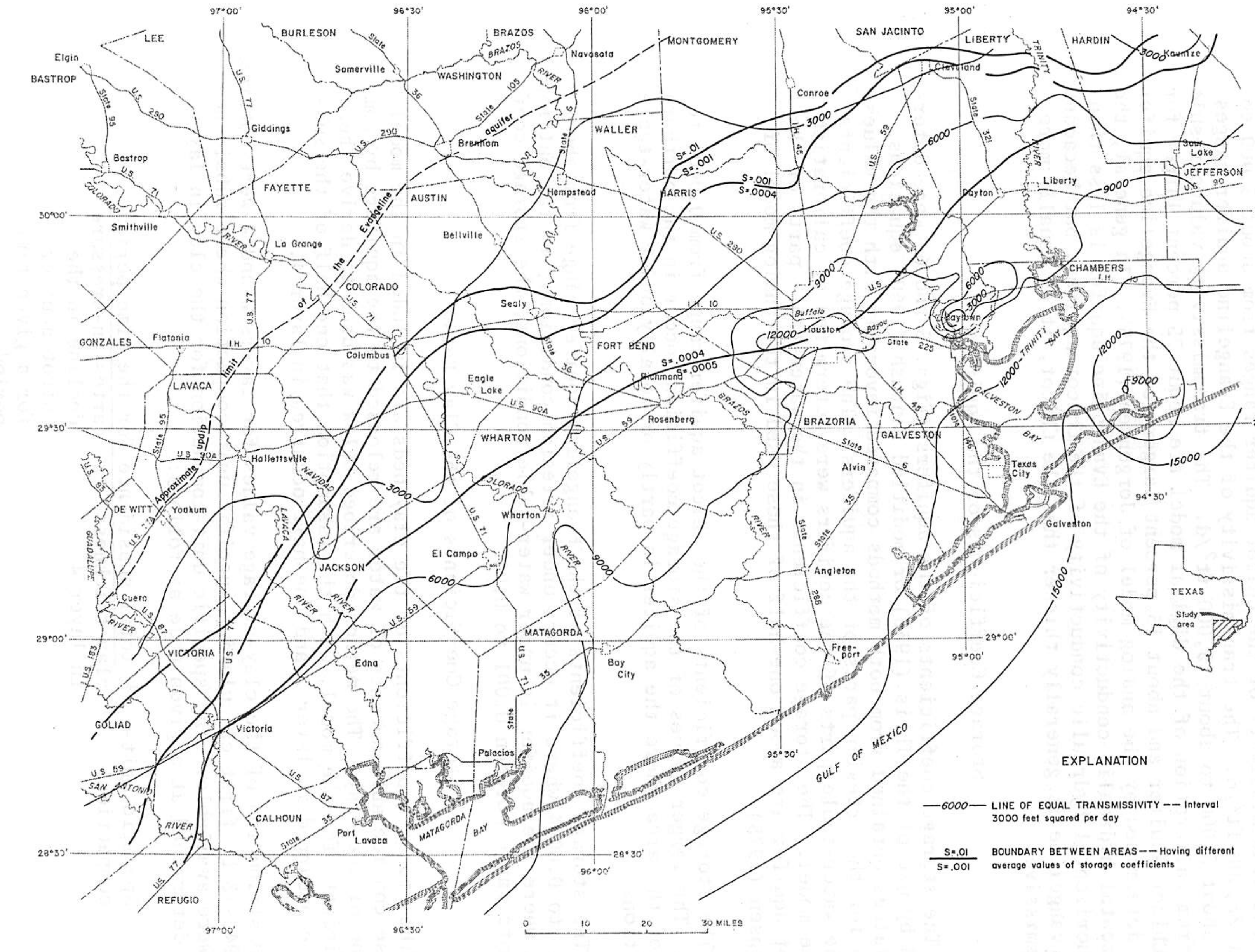


FIGURE 5.-Estimated transmissivities and storage coefficients of the lower unit of the Chicot aquifer and the Chicot aquifer undifferentiated



Base from U.S. Geological Survey 1:250,000 quadrangles

FIGURE 6.-Estimated transmissivities and storage coefficients of the Evangeline aquifer

The transmissivity of the Chicot aquifer ranges from about 3,000 to about 25,000 ft^2/d. The transmissivity of the Evangeline aquifer ranges from about 3,000 to about 15,000 ft^2/d. The transmissivity values resulting from calibration of the digital model are about 25 percent larger for the Chicot aquifer and about 15 percent larger for the Evangeline aquifer than determined by the analog model of Jorgensen (1975). In general, the horizontal hydraulic conductivity of the Evangeline aquifer is less than the horizontal hydraulic conductivity of the Chicot aquifer; but because the Evangeline is generally thicker than the Chicot, it is usually more transmissive.

Storage Coefficients of the Aquifers

The storage coefficients of the aquifers (figs. 5 and 6) were determined by use of the Theis (1935) or modified Hantush (1960) equations. The values obtained from both methods compared favorably with the values shown for the artesian parts of the aquifers. The storage coefficients in the water-table parts of the aquifers were determined by calibration of the model. The storage coefficients in the water-table parts of the Chicot aquifer are about one-half of those used in the analog model of Jorgensen (1975).

The storage coefficients of the Chicot aquifer range from 0.0004 to 0.10. The larger values of the storage coefficient occur in the northern part of the area where the aquifer is partly or totally under water-table conditions.

The storage coefficients of the Evangeline aquifer range from about 0.001 to 0.0004 where it occurs under artesian conditions; in the outcrop area, where the aquifer is under water-table conditions, the storage coefficients range between 0.001 to 0.01.

Storage Coefficients of the Clay Beds

The storage coefficients of the clay beds are included in the model because considerable amounts of water are released to the aquifers by compaction of the clay. The method described below was used to derive these coefficients for the model, with the assumption that one-half of the subsidence occurred in layer 2 and one-half occurred in layer 4.

Distribution of the clay-storage values for layers 2 and 4 were obtained for 1943-73 by first calculating specific unit-compaction where subsidence data were available. The specific unit-compaction for the clay in layer 4 was determined at a given node as follows:

$$\text{Specific unit-compaction} = \frac{\tfrac{1}{2}\text{ total subsidence for the time period}}{\text{clay thickness in layer 4} \times \text{artesian-pressure decline in the Chicot aquifer for a given time period}}$$

The specific unit-compaction for the clay in layer 2 was determined in a similar manner by using the clay thickness in layer 2 and the artesian-pressure declines in the Evangeline aquifer.

The specific unit-compaction values were then averaged to compute a mean specific unit-compaction for layers 2 and 4. The mean value for each layer was then multiplied by the thickness of clay (figs. 7 and 8) at each node to obtain the storage-coefficient distribution for each layer.

The storage coefficients of the clay beds were used in the model to represent approximately the elastic response for stress less than the preconsolidation loading (1890-1943) and the inelastic response for stress exceeding the preconsolidation loading (1943-73).

A preconsolidation-stress variable (critical head, SUBH2 and SUBH4) is used in the model to control the initial change in clay storage at any given node as a function of head decline. This variable represents the maximum antecedent effective stress to which a deposit has been subjected and which it can withstand without undergoing permanent deformation. Stress changes in the range less than the preconsolidation stress produce elastic deformations of small magnitude, and the clay beds have smaller storage coefficients than they would if the preconsolidation stress were exceeded.

The initial preconsolidation stress approximates the maximum effective stress to which deposits within the study area have been subjected to before ground-water development. This initial preconsolidation stress as indicated by model calibration is 70 feet, which means that 70 feet of head decline must occur at a node before the model converts to an inelastic storage value. However, the lowest head value computed at a node is retained and becomes the control on changes in clay storage after the initial preconsolidation stress is reached.

The maximum effective stress to which the clay deposits at a node have been subjected is represented by the lowest head value. After the initial change in clay storage at a node, clay storage is allowed to return to preconsolidation storage when a rise in computed head occurs above the lowest head value retained. If the head drops below the lowest head value retained, storage is again changed to the consolidation value for that node.

Specific unit-compaction values are an approximation of specific storage if the resulting compaction approximates the ultimate compaction expected from an applied stress. The mean specific unit-compaction values determined for 1943-73 are 8.7×10^{-5} feet^{-1} for layer 4 and 1.5×10^{-5} feet^{-1} for layer 2.

At Moses Lake near Texas City, the laboratory weighted-average specific-storage values were 1.4×10^{-4} feet^{-1} (Gabrysch and Bonnet, 1976b, p. 28-30). Data from a borehole extensometer at this site, installed in the Chicot aquifer at a depth of 800 feet, gave values of 1.4×10^{-5} feet^{-1} for 1906-43 and 7.37×10^{-5} feet^{-1} for 1943-73. The laboratory average-weighted

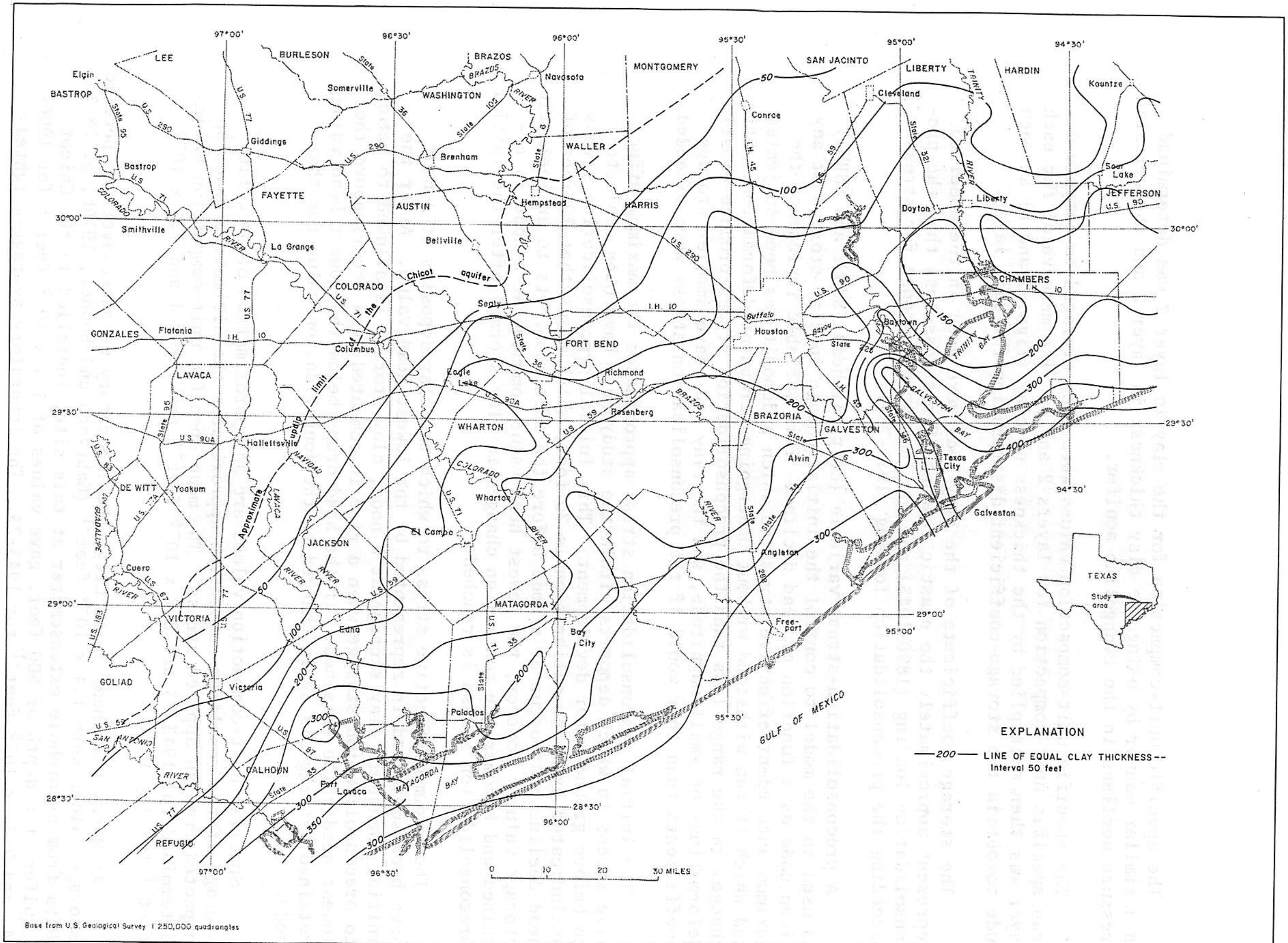


FIGURE 7.-Clay thickness from the land surface to the centerline of the Chicot aquifer

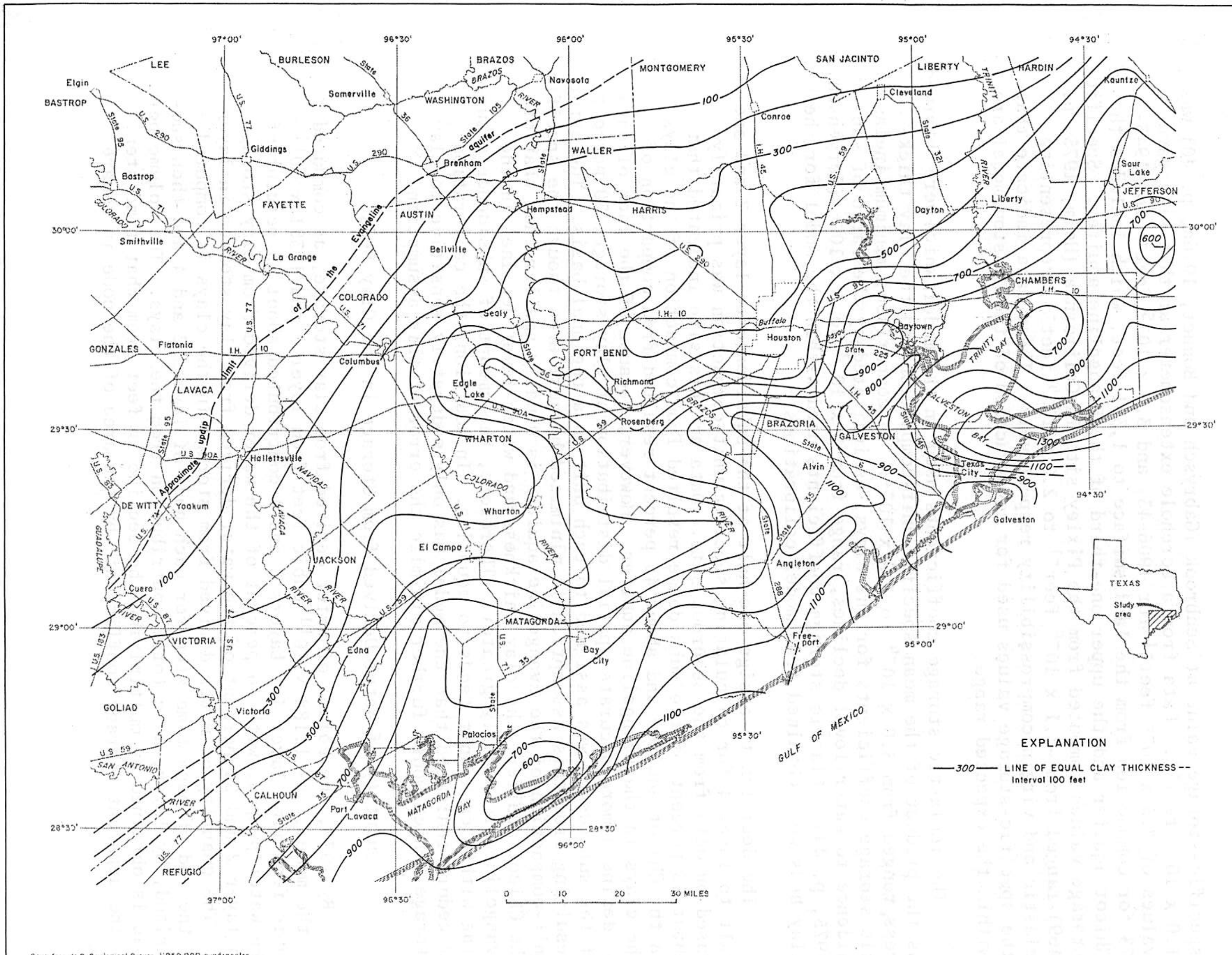


FIGURE 8.-Clay thickness from the centerline of the Chicot aquifer to the centerline of the Evangeline aquifer

specific-storage value at Seabrook (Gabrysch and Bonnet, 1976a, p. 40) was 1.0×10^{-4} feet^{-1}. Data from a borehole extensometer at this site gave values of 7.5×10^{-6} feet^{-1} for 1906-43, and 3.0×10^{-5} feet^{-1} for 1943-73 for compaction from the land surface to 1,381 feet, which includes the Chicot aquifer and the upper one-third of the Evangeline aquifer. Specific-storage values computed from the Pixley site in California (Helm, 1975, p. 469) ranged from -4.1×10^{-6} feet^{-1} to 2.0×10^{-4} feet^{-1}, representing elastic and virgin compressibility respectively. These data indicate that the specific-storage values used for construction of the Houston model are within the expected range.

The inelastic storage coefficients used in the model, which were obtained as the product of the mean specific unit-compaction and the clay thickness, ranged from 3.0×10^{-4} to 3.5×10^{-2}. In comparison, minimum inelastic storage coefficients for the clays, as indicated by the ratio of subsidence to water-level declines, range from 5×10^{-3} to 3×10^{-2} (Jorgensen, 1975, p. 44). Elastic storage coefficients used within the model for the clay beds were obtained from model calibrations.

The decision to assign one-half of the subsidence to layer 2 and one-half to layer 4 for calculating specific unit-compaction was primarily based on data from the Seabrook site. Data at this site indicated that about 55 percent of the subsidence resulted from compaction of the clays in the Chicot aquifer and about 45 percent resulted from compaction of the clays in the Evangeline aquifer. However, because of the lack of data to define a more accurate spatial distribution of clay storage, 50 percent of the subsidence was assigned to each unit on a regional basis. The error resulting from this assumption is minimized because even though the specific unit-compaction of the Evangeline aquifer is usually smaller than that of the Chicot aquifer, the clay thickness and water-level declines in the Evangeline are usually greater. Therefore, the amount of subsidence occurring within each unit tends to equalize. In addition, the calibration procedure indicated that the model was only moderately sensitive to clay storage, which would further minimize the error of this assumption.

Quantity of Water Derived from Storage in the Clay Beds

By 1973, the volume of water derived from clay storage, as computed by the model, was 1.188×10^{11} cubic feet from layer 2 and 1.391×10^{11} cubic feet from layer 4. Layers 2 and 4 contributed about 23 percent of the water pumped, with 46 percent of the water derived from clay storage in layer 2 and 54 percent of the water derived from clay storage in layer 4. The quantity of water derived from storage in the clays is computed at the end of each time step for each node of layers 2 and 4 and then summarized, by layer, as a total contribution from the clays. The volume per node is obtained by multiplying the decline in feet from that time step, by the apparent storage coefficient, by the area of the node in square feet.

Vertical Hydraulic Conductivity and Vertical Leakage

Vertical hydraulic conductivities as determined by calibration of the model ranged from 0.0046 to 0.00012 ft/d (feet per day). The vertical hydraulic conductivities from the land surface to the centerline of the Chicot aquifer ranged from 0.00012 ft/d in the areas in which the Chicot is overlain by confining beds in the Beaumont Clay to 0.0011 ft/d in the outcrop area of the aquifer. The vertical hydraulic conductivity from the centerline of the Chicot aquifer to the centerline of the Evangeline aquifer is 0.0046 ft/d.

The vertical leakage was computed at each node at the end of each time period. At the 1-square-mile nodes, the values of vertical leakage varied from 1,210 to 24,020 ft^3/d (cubic feet per day) for period 4. In period 7, the values varied from 1,624 to 40,000 ft^3/d, which is the equivalent of 0.25 to 6.25 inches per year of recharge.

Calibration and Sensitivity of the Model

The model was calibrated by simulating the historical hydrologic conditions and by comparing the computed values with the records of field measurements. Maps showing the approximate and simulated declines in the altitudes of the potentiometric surfaces in the lower unit of the Chicot aquifer, the Chicot aquifer undifferentiated, and the Evangeline aquifer were constructed for 1890-1953, 1890-1970, and 1890-1975 (figs. 9-14).

These maps (figs. 9-14) show that except in small areas in northwest and southeast Houston, the simulated records were generally in agreement with the historical records.

Most of the calibration of the model was accomplished on a mini-model of the Houston area that used a grid size of 22 x 24 x 5. Programs were written to transfer the data from the maxi-grid model to the mini-grid model and to establish the data files. This procedure permitted a large number of relatively inexpensive computations to be used in calibrating the model. When a satisfactory match was obtained on the mini-grid model, the same data were used in the maxi-grid model.

The model was also calibrated on the basis of the volume of water derived from clay compaction and the amount of land-surface subsidence. Figure 15 shows the approximate and simulated land-surface subsidence in feet for 1890-1973. The differences are apparent in the area where the model includes pumpage from the Alta Loma Sand only (lower part of the lower Chicot aquifer), and where the pumpage from the upper part of the lower Chicot is appreciable.

When tested for sensitivity to variations in storage, the model was found to be extremely sensitive to water-table storage, less sensitive to artesian storage, and only moderately sensitive to clay storage. When tested for sensitivity to variations in transmissivities, the model was found to be very sensitive.

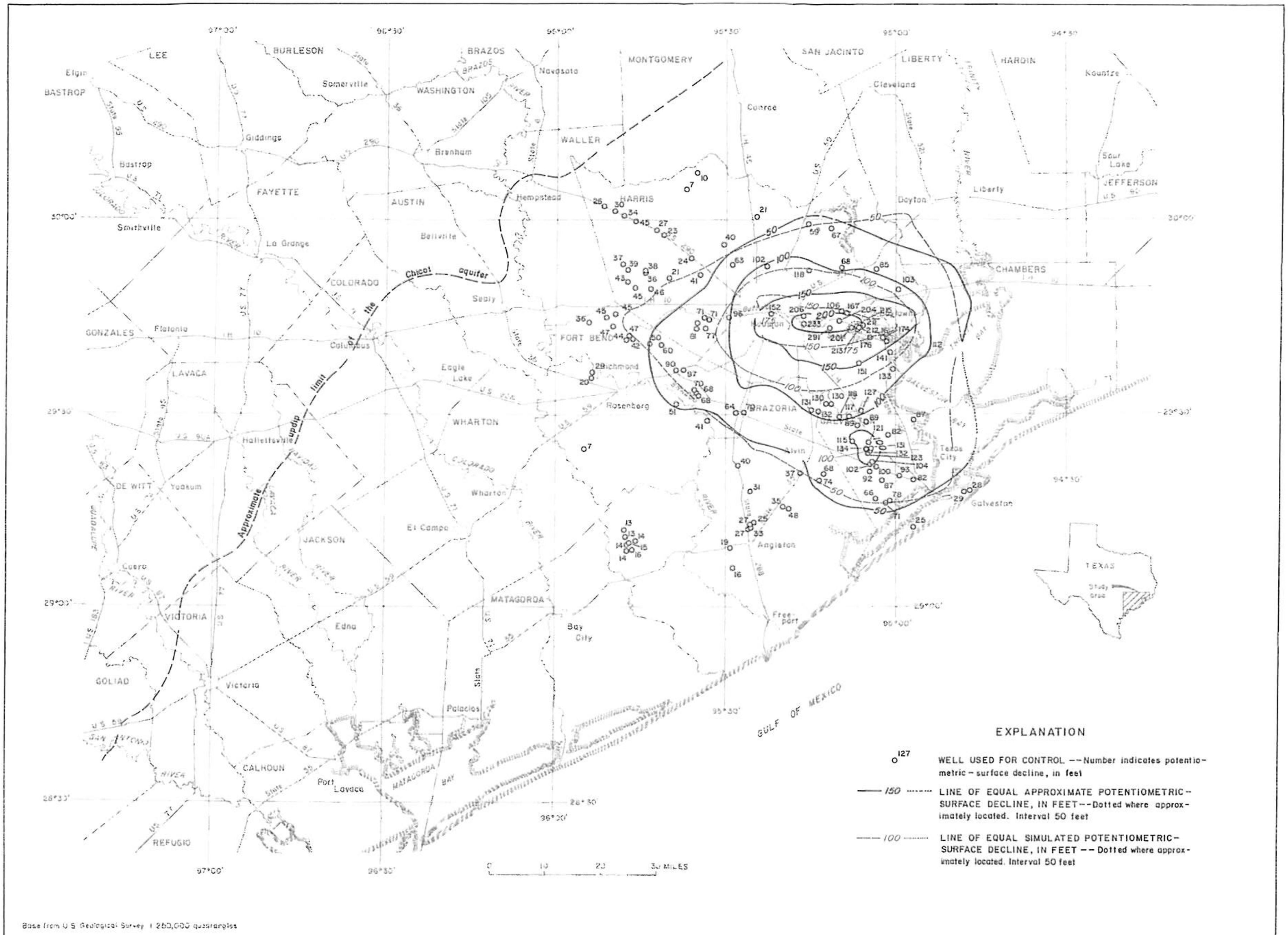


FIGURE 9.-Approximate and simulated decline in the altitude of the potentiometric surfaces of the lower unit of the Chicot aquifer and the Chicot aquifer undifferentiated, 1890-1953

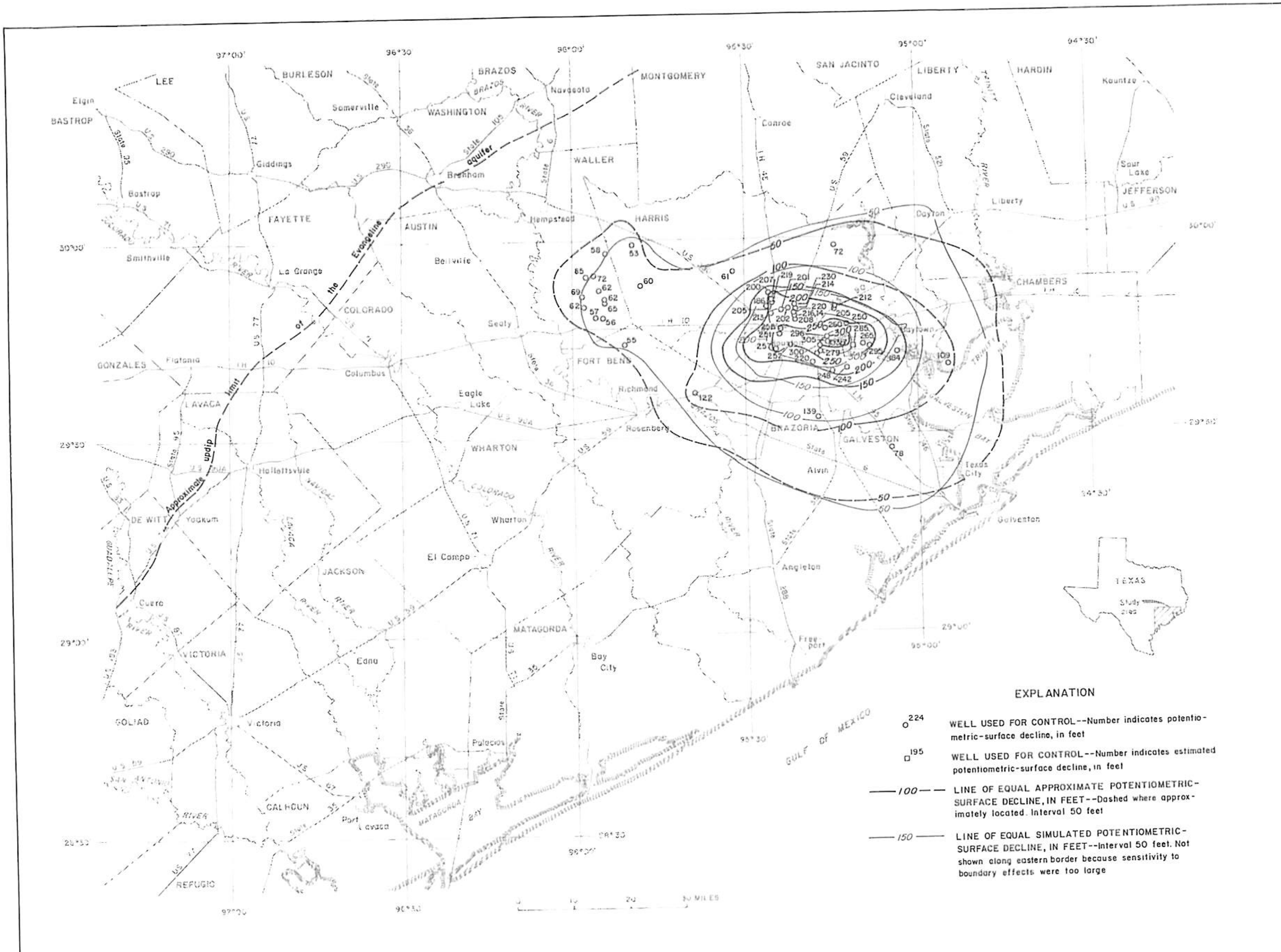


FIGURE 10.-Approximate and simulated decline in the altitude of the potentiometric surfaces of the Evangeline aquifer, 1890-1953

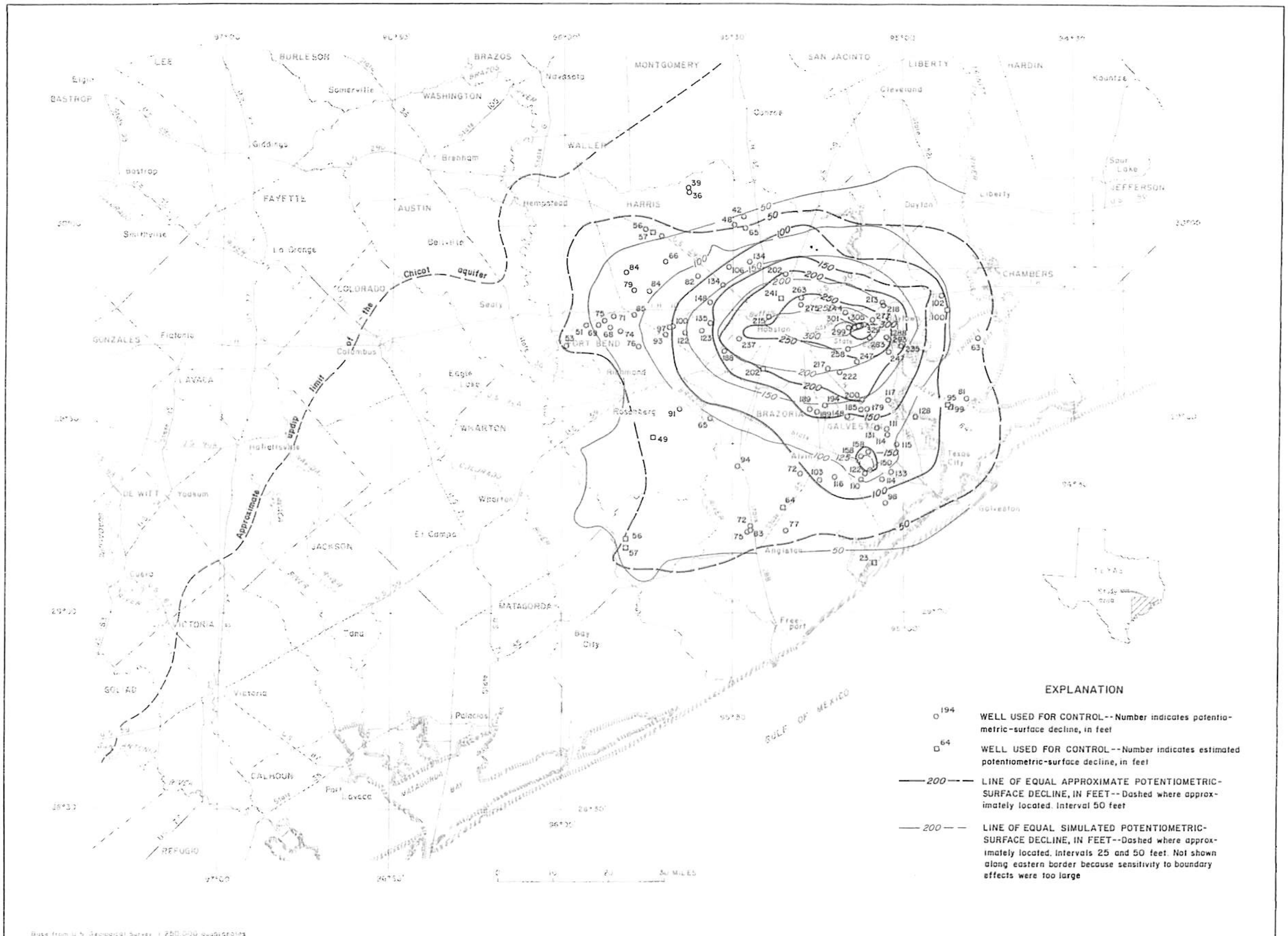
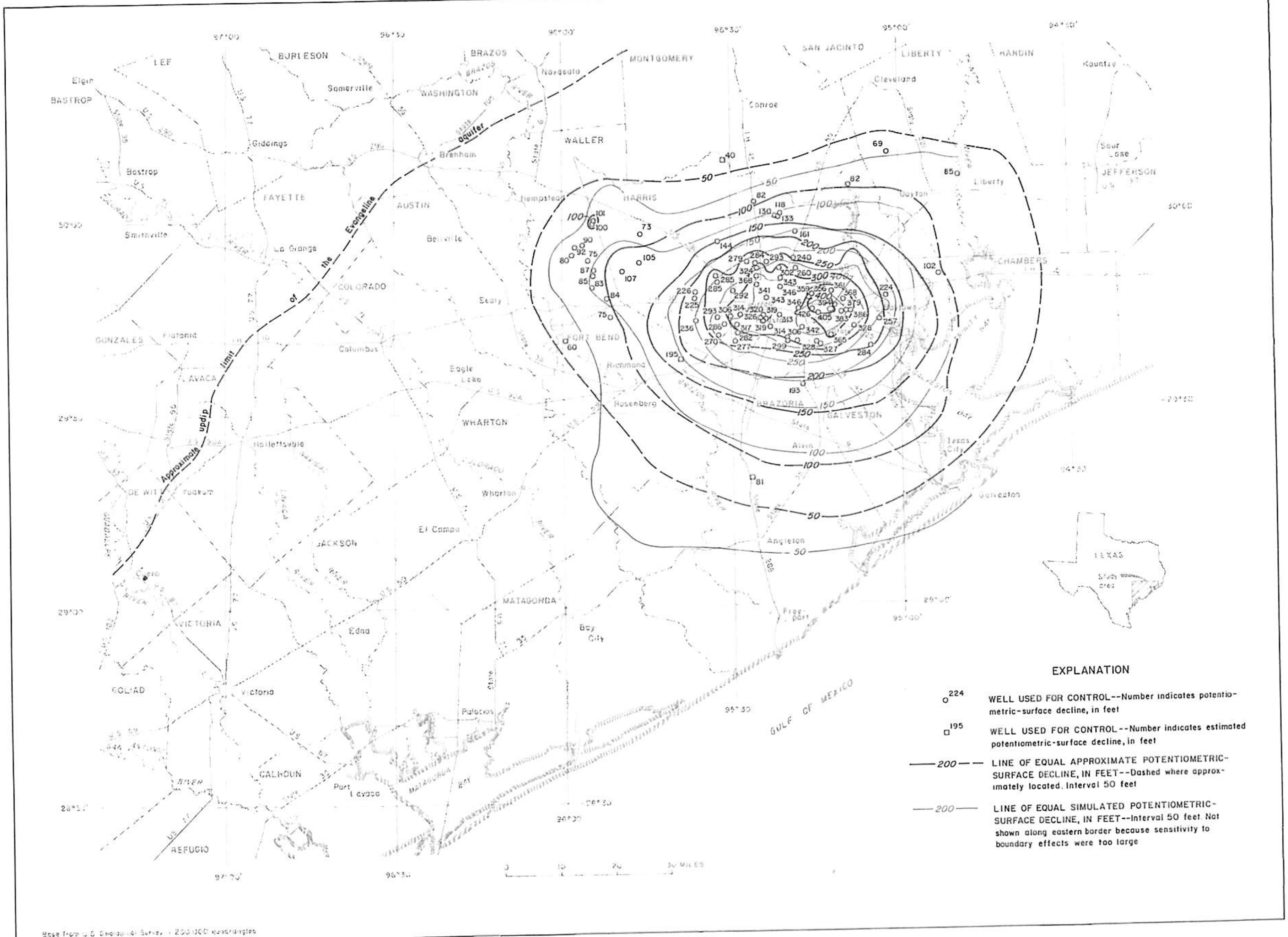
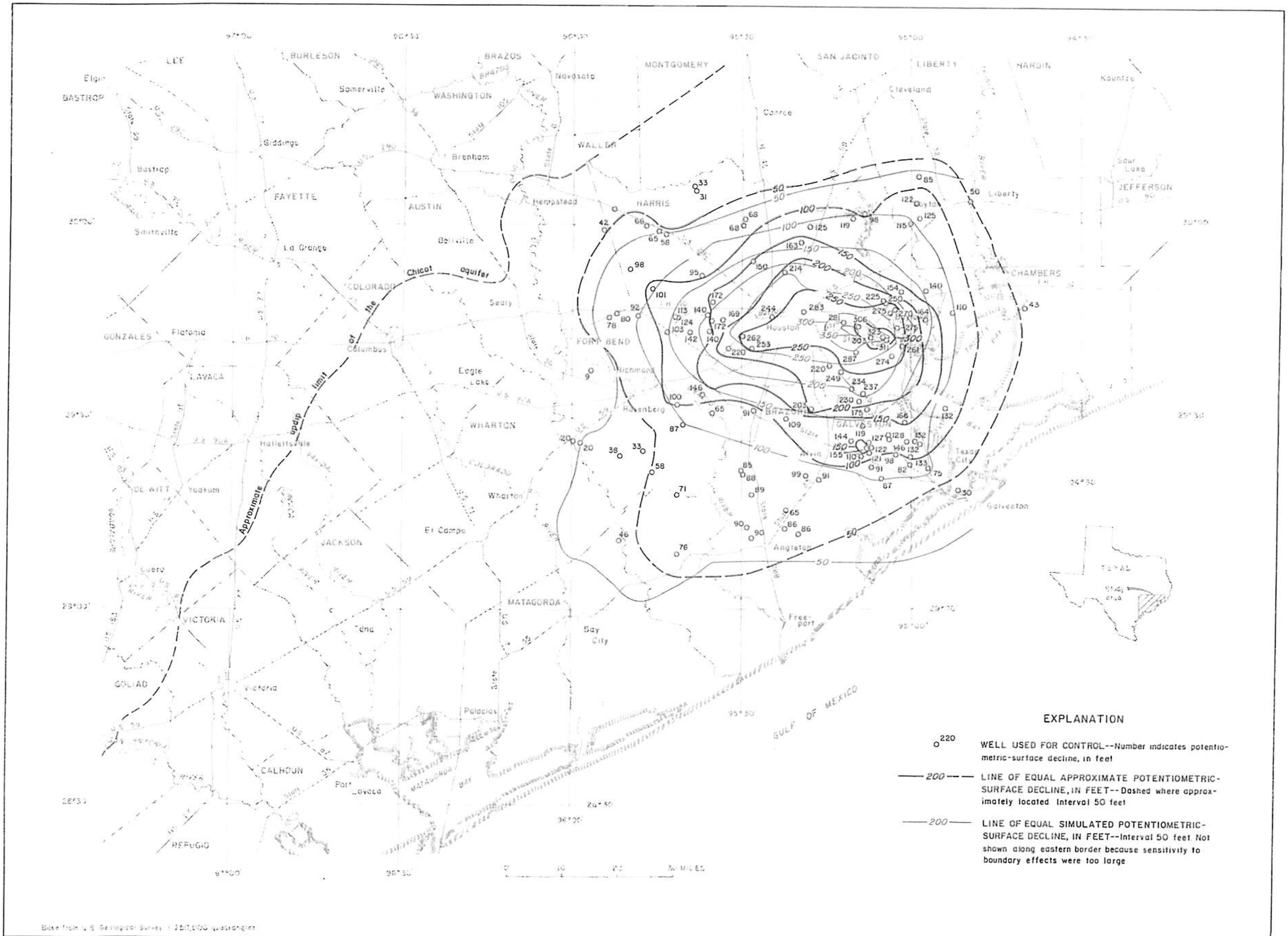


FIGURE 11.-Approximate and simulated decline in the altitude of the potentiometric surfaces of the lower unit of the Chicot aquifer and the Chicot aquifer undifferentiated, 1890-1970



Base from U.S. Geological Survey 1:250,000 quadrangles

FIGURE 12.-Approximate and simulated decline in the altitude of the potentiometric surface of the Evangeline aquifer, 1890-1970



Base from U.S. Geological Survey 1:250,000 quadrangles

FIGURE 13.-Approximate and simulated decline in the altitude of the potentiometric surfaces of the lower unit of the Chicot aquifer and the Chicot aquifer undifferentiated, 1890-1975

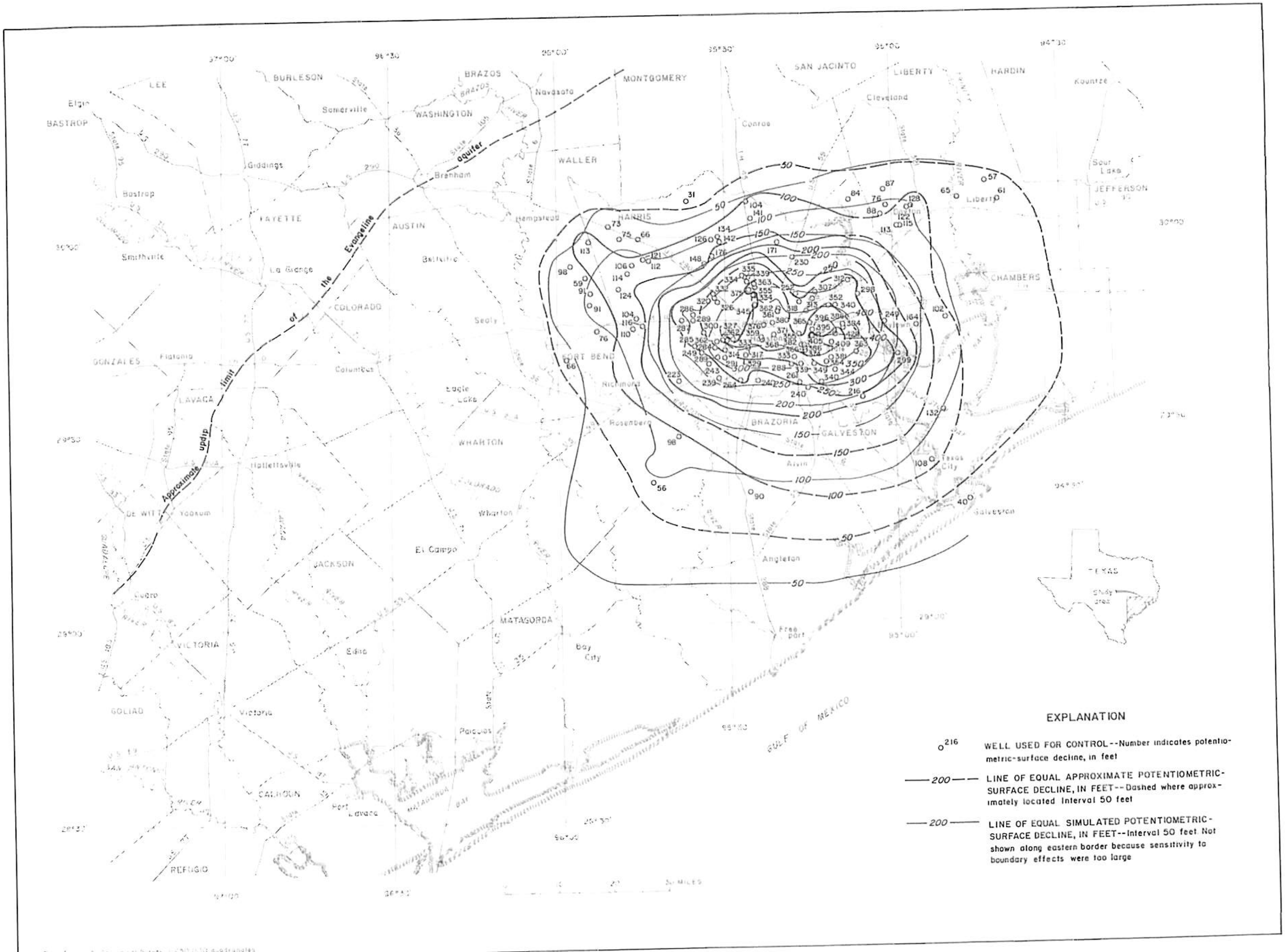


FIGURE 14.-Approximate and simulated decline in the altitude of the potentiometric surface of the Evangeline aquifer, 1890-1975

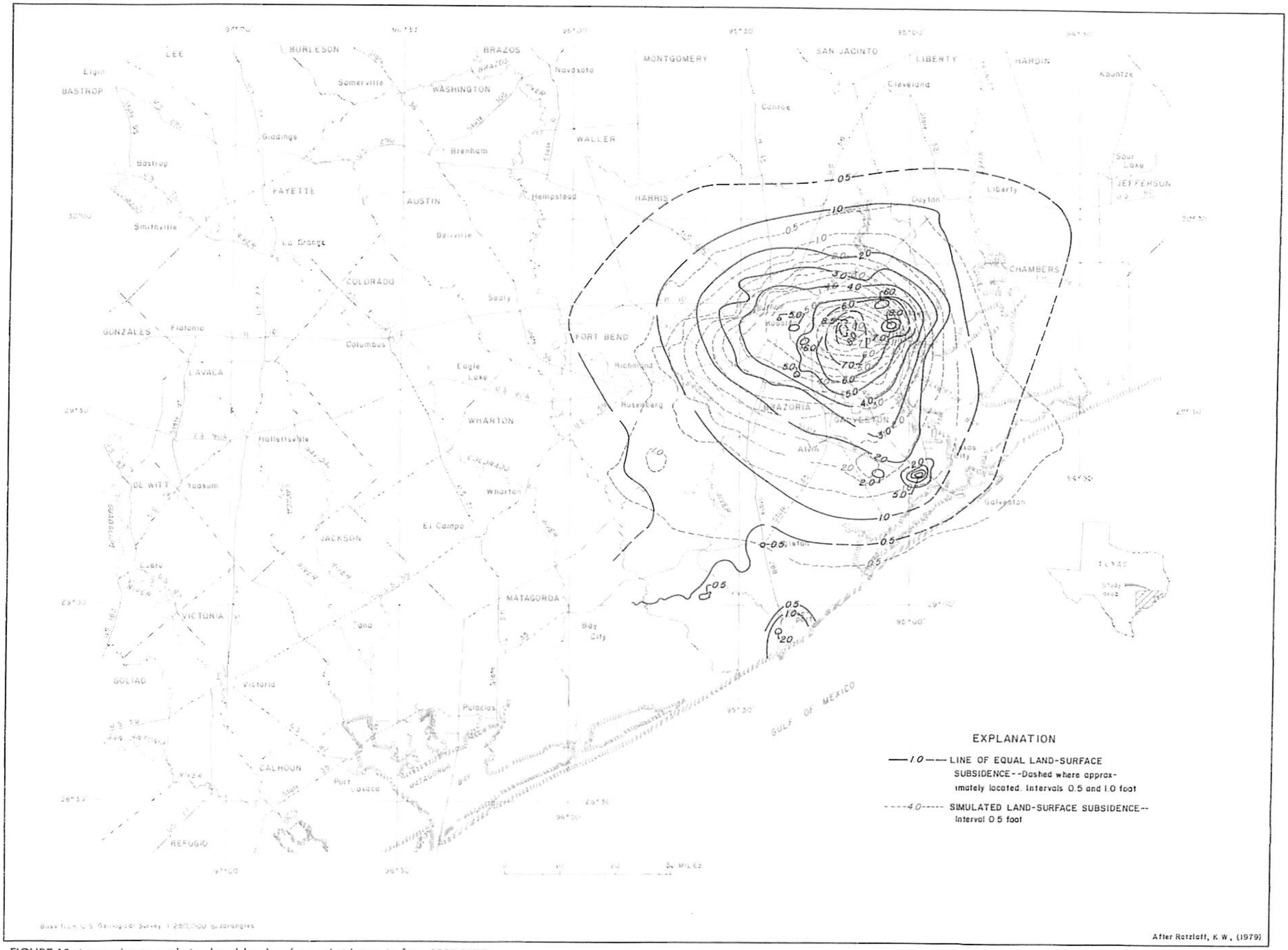


FIGURE 15.-Approximate and simulated land-surface subsidence in feet, 1890-1973

SELECTED REFERENCES

Anders, R. B., McAdoo, G. D., and Alexander, W. R., Jr., 1968, Ground-water resources of Liberty County, Texas: Texas Water Development Board Report 72, 154 p., 20 figs.

Baker, E. T., Jr., 1964, Geology and ground-water resources of Hardin County, Texas: Texas Water Commission Bulletin 6406, 199 p., 26 figs., 8 pls.

_____ 1965, Ground-water resources of Jackson County, Texas: Texas Water Development Board Report 1, 229 p., 31 figs., 4 pls.

Bredehoeft, J. D., and Pinder, G. F., 1970, Digital analyses of area flow in multiaquifer ground-water systems; a quasi three-dimensional model: Water Resources Research, v. 6, no. 3, p. 883-888.

Gabrysch, R. K., 1969, Land-surface subsidence in the Houston-Galveston region, Texas: Proceedings of International symposium on land subsidence, Tokyo, Japan, 1969, p. 43-54.

_____ 1972, Development of ground water in the Houston district, Texas, 1966-69: Texas Water Development Board Report 152, 24 p., 18 figs.

Gabrysch, R. K., and Bonnet, C. W., 1975, Land-surface subsidence in the Houston-Galveston region, Texas: Texas Water Development Board Report 188, 19 p., 12 figs.

_____ 1976a, Land-surface subsidence at Seabrook, Texas: U.S. Geological Survey Water-Resources Investigation 76-31, 108 p.

_____ 1976b, Land-surface subsidence in the area of Moses Lake near Texas City, Texas: U.S. Geological Survey Water-Resources Investigation 76-32, 90 p.

Hammon, W. W., Jr., 1969, Ground-water resources of Matagorda County, Texas: Texas Water Development Board Report 91, 180 p., 35 figs.

Hantush, M. S., 1960, Modification of the theory of leaky aquifers: Journal of Geophysical Research, v. 65, no. 11, p. 3713-3725.

Helm, D. C., 1975, One-dimensional simulation of aquifer system compaction near Pixley, California: American Geophysical Union Water-Resources Research, v. 11, no. 3, p. 465-478.

Jacob, C. E., 1950, Flow of ground water, in Rouse, H., ed., Engineering hydraulics: John Wiley, New York, p. 321-386.

Jorgensen, D. G., 1975, Analog-model studies of ground-water hydrology in the Houston district, Texas: Texas Water Development Board Report 190, 84 p., 40 figs.

Lang, J. W., Winslow, A. G., and White, W. N., 1950, Geology and ground-water resources of the Houston district, Texas: Texas Board of Water Engineers Bulletin 5001, 59 p., 15 figs., 3 pls.

Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.

Naftel, W. L., Fleming, Bobbie, and Vaught, Kenneth, 1976, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Chambers, Liberty, and Montgomery Counties, Texas, 1966-74: Texas Water Development Board Report 202, 63 p., 3 figs.

Naftel, W. L., Vaught, Kenneth, and Fleming, Bobbie, 1976a, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Brazoria, Fort Bend, and Waller Counties, Texas, 1966-74: Texas Water Development Board Report 201, 91 p., 3 figs.

______1976b, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Harris and Galveston Counties, Texas, 1970-74: Texas Water Development Board Report 203, 171 p., 2 figs.

Pettit, B. M., Jr., and Winslow, A. G., 1957, Geology and ground-water resources of Galveston County, Texas: U.S. Geological Survey Water-Supply Paper 1416, 157 p.

Popkin, B. P., 1971, Ground-water resources of Montgomery County, Texas: Texas Water Development Board Report 136, 149 p., 29 figs.

Rose, N. A., 1943, Progress report on the ground-water resources in the Texas City area, Texas: U.S. Geological Survey open-file report, 48 p., 4 figs.

Sandeen, W. M., 1968, Ground-water resources of San Jacinto County, Texas: Water Development Board Report 80, 100 p., 21 figs.

______1972, Ground-water resources of Washington County, Texas: Texas Water Development Board Report 162, 105 p., 21 figs.

Sandeen, W. M., and Wesselman, J. B., 1973, Ground-water resources of Brazoria County, Texas: Texas Water Development Board Report 163, 199 p., 29 figs.

Stone, H. L., 1968, Iterative solution of implicit approximations of multi-dimensional partial differential equations: Society for Industrial and Applied Mathematics, Journal for Numerical Analysis, v. 5, no. 3, p. 530-558.

Theis, C. V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: American Geophysical Union Transactions, v. 16, p. 519-524.

Trescott, P. C., 1975, Documentation of finite-difference model for simulation of three-dimensional ground-water flow: U.S. Geological Survey Open-File Report 75-438, 30 p.

Wesselman, J. B., 1971, Ground-water resources of Chambers and Jefferson Counties, Texas: Texas Water Development Board Report 133, 183 p., 28 figs.

______1972, Ground-water resources of Fort Bend County, Texas: Texas Water Development Board Report 155, 176 p., 33 figs.

Wienstein, H. C., Stone, H. L., and Kwan, T. V., 1969, Iterative procedure for solution of systems of parabolic and elliptic equations in three dimensions: Industrial Engineering Chemistry Fundamentals, v. 8, no. 2, p. 281-287.

Wilson, C. A., 1967, Ground-water resources of Austin and Waller Counties, Texas: Texas Water Development Board Report 68, 236 p., 27 figs.

Winslow, A. G., and Doyel, W. W., 1954, Land-surface subsidence and its relation to the withdrawal of ground water in the Houston-Galveston region, Texas: Economic Geology, v. 49, no. 4, p. 413-422.

Winslow, A. G., Doyel, W. W., and Wood, L. A., 1957, Salt water and its relation to fresh ground water in Harris County, Texas: U.S. Geological Survey Water-Supply Paper 1360-F, p. 375-407, 11 figs., 4 pls.

Winslow, A. G., and Wood, L. A., 1959, Relation of land subsidence to ground-water withdrawals in the upper Gulf Coast region, Texas: Mining Engineering, VII, no. 10, p. 1030-1034.

Wood, L. A., and Gabrysch, R. K., 1965, Analog model study of ground water in the Houston district, Texas: Texas Water Commission Bulletin 6508, 103 p., 43 figs.

APPENDIX I

Control Cards Added to Model

Two control cards are added to the Group II Scalar Parameters. They follow card 2. The following information describes these cards.

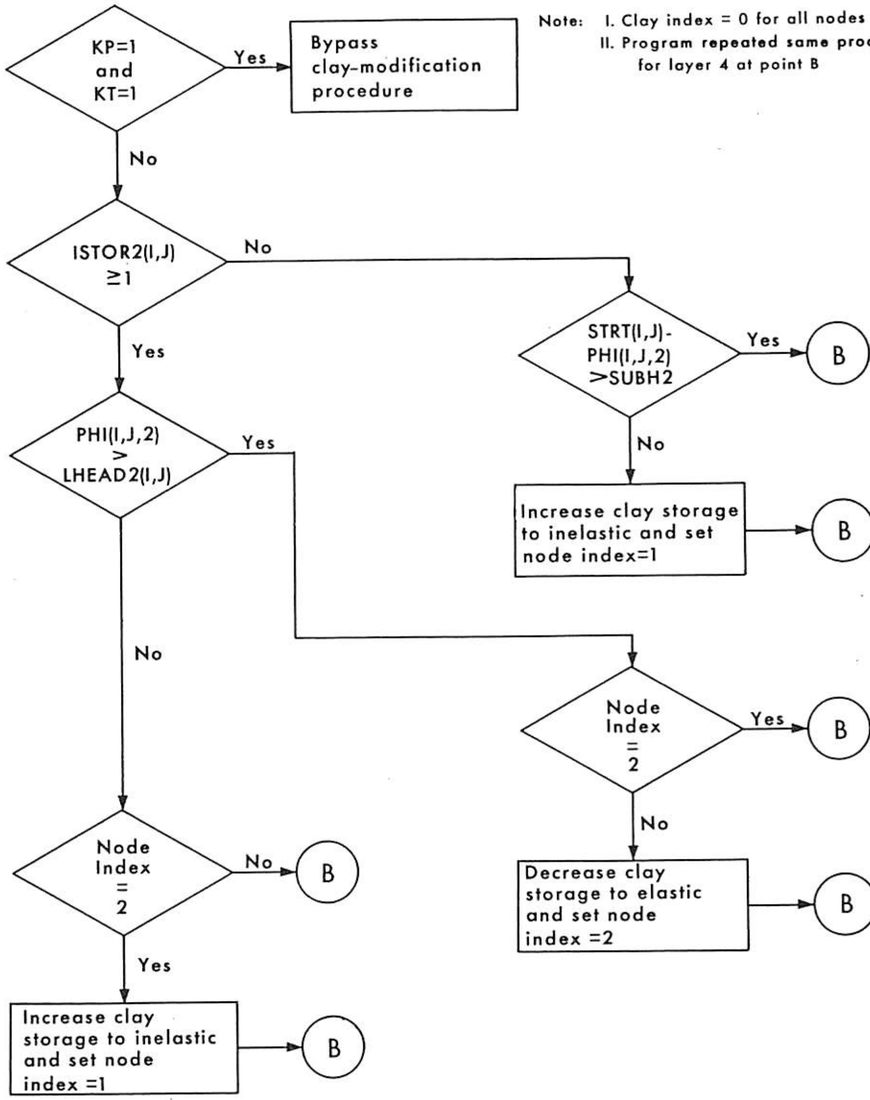
CARD	COLUMNS	FORMAT	VARIABLE	DEFINITION
2a	1-10	F10.0	IPWELL	Control printout of wells. 0 - prints all wells. 1 - prints no wells. 2 - prints 5 wells at start and 6 wells at end.
	11-20	F10.0	ICHPNT	Control parameter for printing constant head flux. 1 - no print of constant head flux. 0 - print constant head flux.
	21-30	F10.0	ILHEAD	Control parameter for printing lowest head matrix. 1 - print lowest head matrix. 0 - no print of lowest head matrix.
2b	1-10	F10.2	SFAC2	Factor to increase clay storage for layer 2 - at a decline equal to critical head. Clay storage at a given node is multiplied by this factor.
	11-20	F10.2	SFAC4	Same function as SFAC2 except value is for layer 4.
	21-30	F10.0	SUBH2	Critical head decline value for layer 2 at which clay storage is changed at given node.
	31-40	F10.0	SUBH4	Same function as SUBH2 except value is for layer 4.
2b	41-50	F10.0	ISS24	Index to write index arrays for clay storage. 0 - no print of index array. 1 - print of index array.

APPENDIX II

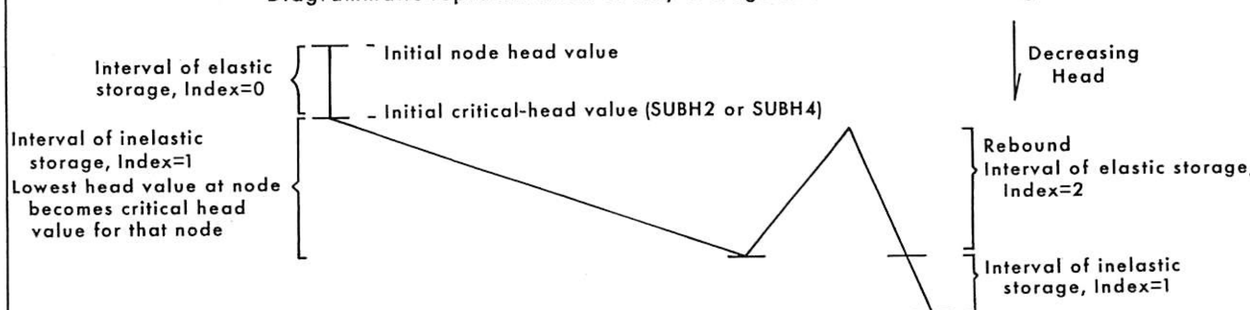
Generalized Flow Chart For Clay-Storage Modifications

Subroutine NEWSTP

Note: I. Clay index = 0 for all nodes initially
II. Program repeated same procedure for layer 4 at point B



Diagrammatic representation of clay-storage and node-index changes



A P P E N D I X I I I

Computer Program

```
      OVERLAY(FD3D,0,0)
      PROGRAM MODEL (TINPUT,OUTPUT,TAPE4,TAPE5=TINPUT,TAPE6=OUTPUT,    FD3D    2
     1$TAPE10,TAPE11,TAPE12,TAPE13,TAPE14,TAPE15)                      FD3D    3
CC                                                                     FD3D    4
C     TAPE10=STRT      (WELL)                                          FD3D    5
C     TAPE11 = S (STOR. COEFF)                                         FD3D    6
C     TAPE12 = T (TRANSMISSIVITY)                                      FD3D    7
C     TAPE13 = TK  ( FROM GEN TK JOB)                                  FD3D    8
C     TAPE14 = PUMPAGE                                                 FD3D    9
C     TAPE4  = INPUT FOR MASS BAL DATA                                 FD3D   10
C     TAPE15 = OUTPUT FOR MASS BAL DATA                                FD3D   11
C                                                                      FD3D   12
C     -----------------------------------------------------------MAN  40 FD3D 13
C                                                                      FD3D   14
C     FINITE-DIFFERENCE MODEL FOR SIMULATION OF GROUND-WATER FLOW IN  MAN  20 FD3D 15
C     THREE DIMENSIONS, JANUARY, 1975 BY P.C. TRESCOTT, U. S. G. S.   MAN  30 FD3D 16
C                                                                      FD3D   17
C     CDC6600 VERSION BY HEARNE, POSSON, AND TRESCOTT                  FD3D   18
C                                                                      FD3D   19
C     ...........................................................MAN 160 FD3D 20
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  MAN 170 FD3D 21
C                                                                      SUBDEF  2
C                                                                      SUBDEF  3
C     SUBROUTINES ARE LISTED IN THE FOLLOWING SEQUENCE                 SUBDEF  4
C                                                                      SUBDEF  5
C                                                                      SUBDEF  6
C     CHECK : TO CHECK THE VOLUMETRIC BALANCE                          SUBDEF  7
C                                                                      SUBDEF  8
C     COEF1 : TO COMPUTE COEFFICIENTS USED IN SIP                      SUBDEF  9
C                                                                      SUBDEF 10
C     CWRITE: TO PRINT RESULTS OF VOLUMETRIC BALANCE                   SUBDEF 11
C                                                                      SUBDEF 12
C     ---------------------------------------------------------------- SUBDEF 13
C                                                                      SUBDEF 14
C     DATAIN: TO READ AND WRITE DATA                                   SUBDEF 15
C                                                                      SUBDEF 16
C     ITER  : TO COMPUTE AND PRINT ITERATION PARAMETERS                SUBDEF 17
C                                                                      SUBDEF 18
C     MAP   : TO PRINT MAPS OF DRAWDOWN AND HYDRAULIC HEAD             SUBDEF 19
C                                                                      SUBDEF 20
C     ---------------------------------------------------------------- SUBDEF 21
C                                                                      SUBDEF 22
C     NEWIT : TO INITIALIZE DATA FOR A NEW ITERATION                   SUBDEF 23
C                                                                      SUBDEF 24
C     NEWPER: TO READ AND WRITE DATA FOR A NEW PUMPING PERIOD          SUBDEF 25
C                                                                      SUBDEF 26
C     NEWSTP: TO INITIALIZE DATA FOR A NEW TIME STEP                   SUBDEF 27
C                                                                      SUBDEF 28
C     ---------------------------------------------------------------- SUBDEF 29
C                                                                      SUBDEF 30
C     OUTPRT: TO PRINT OUTPUT AT DESIGNATED TIME STEPS                 SUBDEF 31
C                                                                      SUBDEF 32
C     PIS   : TO COMPUTE SOLUTION WITH REVERSE SIP ALGORITHM           SUBDEF 33
C                                                                      SUBDEF 34
C     SIP   : TO COMPUTE SOLUTION WITH NORMAL SIP ALGORITHM            SUBDEF 35
C                                                                      SUBDEF 36
C     ---------------------------------------------------------------- SUBDEF 37
                                                                       SUBDEF 38
```

```
      C                                                                     SUBDEF  39
      C     SETMAP: TO INITIALIZE VARIABLES FOR PLOT                        SUBDEF  40
      C                                                                     SUBDEF  41
      C     TCOF  : TO COMPUTE T COEFFICIENTS FOR ALL LAYERS                SUBDEF  42
      C                                                                     SUBDEF  43
      C     TRANS : TO COMPUTE TRANSMISSIVITY FOR UNCONFINED UPPER UNIT     SUBDEF  44
      C                                                                     SUBDEF  45
      C     -------------------------------------------------------------  SUBDEF  46
      C                                                                     SUBDEF  47
      C     WTTCOF: TO COMPUTE T COEFFICIENTS FOR UNCONFINED UPPER UNIT     SUBDEF  48
      C                                                                     SUBDEF  49
      C     BLOCK DATA: TO INITIALIZE THE FOLLOWING -- BLANK, DIGIT , ICHK , SUBDEF  50
      C     N1 , N2 , N3 , NA , PRNT , SYM , TITLE , VF1 , VF2 , VF3 ,      SUBDEF  51
      C     XLABEL , XN1 , YLABEL                                           SUBDEF  52
      C                                                                     SUBDEF  53
      C                                                                     SUBDEF  54
      C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * SUBDEF  55
      C                                                                     SUBDEF  56
      C                                                                     VARDEF   2
      C     -------------------------------------------------------------  VARDEF   3
      C     -------------------------------------------------------------  VARDEF   4
      C                                                                     VARDEF   5
      C                                                                     VARDEF   6
      C     ------- GENERAL PROGRAM VARIABLES ------------------------------ VARDEF   7
      C             ------------------------                                VARDEF   8
      C                                                                     VARDEF   9
      C     -------------------------------------------------------------  VARDEF  10
      C     NEW ARRAYS ADDED TO PROGRAM TO HANDLE SUBSIDENCE AND REBOUND OF DEFI     1
      C     CLAY LAYERS BY JEC.                                        JEC  DEFI     2
      C     -------------------------------------------------------------  DEFI     3
      C     CSUB(I,J)     ACCUMULATIVE SUBSIDENCE FROM START OF SIMULATION JEC DEFI  4
      C                   TO END OF PUMPING PERIOD FOR LAYERS 2 + 4 .  JEC  DEFI     5
      C     ISTOR2(I,J)   INDEX ARRAY TO INDICATE IF CLAY STORAGE HAS BEEN JEC DEFI  6
      C                   CHANGED FOR A NODE--POSSIBLE VALUES 0,1,2.   JEC  DEFI     7
      C     ISTOR4(I,J)   LAYER 4 ARRAY SAME FUNCTION AS ISTOR2 FOR LAYER 2.    DEFI     8
      C     LHEAD2(I,J)   RETAINS LOWEST HEAD IN LAYER 2                    DEFI     9
      C     LHEAD4(I,J,)  RETAINS LOWEST HEAD IN LAYER 4                    DEFI    10
      C     SFAC2         FACTORS TO INCREASE CLAY STORAGE--AT A DECLINE EQUAL JEC DEFI 11
      C                   TO CRITICAL HEAD CLAY STORAGE AT A GIVEN NODE IS  DEFI    12
      C                   MULTIPLIED BY THIS FACTOR.                        DEFI    13
      C     SFAC4         SAME FUNCTION AS SFAC2.                           DEFI    14
      C     SUBH2         CRITICAL HEAD DECLINE VALUE AT WHICH CLAY STORAGE JEC DEFI 15
      C                   IS CHANGED AT A GIVEN NODE.                       DEFI    16
      C     SUBH4         SAME FUNCTION AS SUBH2.                           DEFI    17
      C     STORL2        ACCUMULATIVE CLAY STORAGE FOR LAYER 2 FROM START OF JEC DEFI 18
      C                   SIMULATION TO END OF THE PERIOD.                  DEFI    19
      C     STORL4        SAME FUNCTION AS STORL2 EXCEPT FOR LAYER 4.       DEFI    20
      C     PRINTOUT CONTROLS......                                         DEFI    21
      C     IPWELL IS A WELL VALUE PRINT CONTROL                            DEFI    22
      C     ISS24   CLAY STORAGE INDEX ARRAY PRINT CONTROL.            JEC  DEFI    23
      C     ILHEAD  LOW HEAD ARRAY CLAY LAYERS PRINT CONTROL.          JEC  DEFI    24
      C     -------------------------------------------------------------  JEC  DEFI    25
      C     -------------------------------------------------------------  DEFI    26
      C                                                                     VARDEF  11
      C     VARIABLE(DIMENSIONS)        DEFINITION                          VARDEF  12
      C                                                                     VARDEF  13
      C                                                                     VARDEF  14
```

```
C     ABOTTO(I*J)         1-DIMENSIONAL EQUIVALENT OF BOTTOM
C     AEL(I*J*K)          1-DIMENSIONAL EQUIVALENT OF EL
C     AFACT(K*3)          1-DIMENSIONAL EQUIVALENT OF FACT
C
C     AFL(I*J*K)          1-DIMENSIONAL EQUIVALENT OF FL
C     AGL(I*J*K)          1-DIMENSIONAL EQUIVALENT OF GL
C     AOLD(I*J*K)         1-DIMENSIONAL EQUIVALENT OF OLD
C
C     APERM(I*J)          1-DIMENSIONAL EQUIVALENT OF PERM
C     APHI(I*J*K)         1-DIMENSIONAL EQUIVALENT OF PHI
C     AQRE(I*J)           1-DIMENSIONAL EQUIVALENT OF QRE
C
C     AS(I*J*K)           1-DIMENSIONAL EQUIVALENT OF S
C     ASTRT(I*J*K)        1-DIMENSIONAL EQUIVALENT OF STRT
C     AT(I*J*K)           1-DIMENSIONAL EQUIVALENT OF T
C
C     ATC(I*J*K)          1-DIMENSIONAL EQUIVALENT OF TC
C     ATK(I*J*K)          1-DIMENSIONAL EQUIVALENT OF TK
C     ATR(I*J*K)          1-DIMENSIONAL EQUIVALENT OF TR
C
C     AV(I*J*K)           1-DIMENSIONAL EQUIVALENT OF V
C     AWELL(I*J*K)        1-DIMENSIONAL EQUIVALENT OF WELL
C     AXI(I*J*K)          1-DIMENSIONAL EQUIVALENT OF XI
C
C     ------------------------------------------------------------------
C
C     B                   TC(I-1,J,K)/DELY(I);
C     BLANK(60)           CONTAINS BLANK SYMBOLS;
C     BOTTOM(I,J)         ELEVATION OF THE BOTTOM OF THE UPPER UNIT;
C
C     ------------------------------------------------------------------
C
C     CDLT                MULTIPLYING FACTOR FOR THE TIME STEP;
C     CFLUX               INFLOW FROM RECHARGE WELLS (L**3/T);
C     CFLUXT              CUMULATIVE VOLUME OF WATER FROM RECHARGE WELLS
C                         (L**3);
C
C     CHD1                RATE OF OUTFLOW TO CONSTANT HEAD BOUNDARY
C                         (L**3/T);
C     CHD2                RATE OF INFLOW FROM CONSTANT HEAD BOUNDARY
C                         (L**3/T);
C     CHDT                CUMULATIVE DISCHARGE TO CONSTANT HEAD BOUNDARY
C                         (L**3);
C
C     CHST                CUMULATIVE VOLUME OF WATER INFLOW FROM CONSTANT
C                         HEAD BOUNDARY (L**3);
C
C     ------------------------------------------------------------------
C
C     D                   TR(I,J-1,K)/DELX(J);
C     DDN(IMAX)           VECTOR THAT CONTAINS DRAWDOWN VALUES (L);
C     DELT                TIME INCREMENT (T);
C
C     DELX(J)             GRID SPACING IN THE X DIRECTION (L);
C     DELY(I)             GRID SPACING IN THE Y DIRECTION (L);
C     DELZ(K)             GRID SPACING IN THE Z DIRECTION (L);
C
```

```
C      DIFF                ERROR IN MASS BALANCE (L**3)!                      VARDEF  72
C      DIGIT(122)          VECTOR CONTAINING NUMBERS 1 THRU 122               VARDEF  73
C                          IN HOLERITH FIELDS                                 VARDEF  74
C      DINCH               NUMBER OF MAP UNITS PER INCH!                      VARDEF  75
C                                                                             VARDEF  76
C      DIST                LOCATION OF NEXT COLUMN OF NODAL VALUES TO BE      VARDEF  77
C                          PRINTED!                                           VARDEF  78
C                                                                             VARDEF  79
C      ---------------------------------------------------------------------  VARDEF  80
C                                                                             VARDEF  81
C      EL(I,J,K)           ELEMENT OF UPPER TRIANGULAR FACTOR U!              VARDEF  82
C      ERR                 CLOSURE CRITERIA (L)!                              VARDEF  83
C      ETFLUX              EVAPOTRANSPIRATION RATE (L**3/T)!                  VARDEF  84
C                                                                             VARDEF  85
C      ETFLXT              CUMULATIVE DISCHARGE BY EVAPOTRANSPIRATION         VARDEF  86
C                          (L**3)!                                            VARDEF  87
C                                                                             VARDEF  88
C      ---------------------------------------------------------------------  VARDEF  89
C                                                                             VARDEF  90
C      F                   TR(I,J,K)/DELX(J)!                                 VARDEF  91
C      FAC                 USED IN INPUT OF DATA ARRAYS                       VARDEF  92
C                          IF IVAR=0, FAC IS CONSTANT VALUE OF PARAMETER      VARDEF  93
C                          IF IVAR=1, FAC IS MULTIPLICATION FACTOR TO         VARDEF  94
C                          CONVERT VALUES ON DATA CARDS TO VALUES IN ARRAY    VARDEF  95
C      FACT(K,N)           IF N=1, FACT = MULTIPLICATION FACTOR FOR           VARDEF  96
C                          TRANSMISSIVITY IN THE X DIRECTION                  VARDEF  97
C                          IF N=2, FACT = MULTIPLICATION FACTOR FOR           VARDEF  98
C                          TRANSMISSIVITY IN THE Y DIRECTION                  VARDEF  99
C                          IF N=3, FACT = MULTIPLICATION FACTOR FOR           VARDEF 100
C                          TRANSMISSIVITY IN THE Z DIRECTION                  VARDEF 101
C                                                                             VARDEF 102
C      FACT1               FACTOR FOR ADJUSTING VALUE OF DRAWDOWN PRINTED!    VARDEF 103
C      FACT2               FACTOR FOR ADJUSTING VALUE OF HEAD PRINTED!        VARDEF 104
C      FL(I,J,K)           ELEMENT OF UPPER TRIANGULAR FACTOR U!              VARDEF 105
C                                                                             VARDEF 106
C      FLOW(NCH)           FLOW RATE TO A CONSTANT-HEAD NODE (L**3/T)!        VARDEF 107
C      FLUX                RATE OF LEAKAGE DUE TO GRADIENTS AT THE START      VARDEF 108
C                          OF THE PUMPING PERIOD (L**3/T)!                    VARDEF 109
C      FLUXS               NET LEAKAGE RATE (L**3/T)!                         VARDEF 110
C                                                                             VARDEF 111
C    * FLUXT                                                                  VARDEF 112
C      FLXN                RATE OF DISCHARGE BY LEAKAGE (L**3/T)!             VARDEF 113
C      FLXNT               CUMULATIVE VOLUME OF WATER DISCHARGED BY LEAKAGE   VARDEF 114
C                          (L**3)!                                            VARDEF 115
C                                                                             VARDEF 116
C      FLXPT               CUMULATIVE VOLUME OF WATER INFLOW FROM LEAKAGE     VARDEF 117
C                          (L**3)!                                            VARDEF 118
C                                                                             VARDEF 119
C      ---------------------------------------------------------------------  VARDEF 120
C                                                                             VARDEF 121
C      GL(I,J,K)           ELEMENT OF UPPER TRIANGULAR FACTOR U!              VARDEF 122
C                                                                             VARDEF 123
C      ---------------------------------------------------------------------  VARDEF 124
C                                                                             VARDEF 125
C      H                   TC(I,J,K)/DELY(I)!                                 VARDEF 126
C      HEADING(33)         TITLE FOR SIMULATION!                              VARDEF 127
C                                                                             VARDEF 128
```

```
      C     ------------------------------------------------------------------   VARDEF 129
      C                                                                          VARDEF 130
      C     I              INDEX FOR Y DIRECTION  :  ROW LOCATION                VARDEF 131
      C     I0             NUMBER OF ROWS;                                       VARDEF 132
      C     I1             I0-1                                                  VARDEF 133
      C                                                                          VARDEF 134
      C     I2             I0-2                                                  VARDEF 135
      C     IC             INPUT UNIT 5 , CARD READER -- INPUT ON CARDS          VARDEF 136
      C     ICHK(13)       VECTOR CONTAINING PROBLEM OPTIONS;                    VARDEF 137
      C                                                                          VARDEF 138
      C     ID             INPUT UNIT 4 , DISK  -- INPUT OR OUTPUT ON DISK       VARDEF 139
      C     IDK1           OPTION TO READ HEAD DATA FROM DISK;                   VARDEF 140
      C     IDK2           OPTION TO WRITE RESULTS ON DISK;                      VARDEF 141
      C                                                                          VARDEF 142
      C     IDRAW          OPTION TO PRINT DRAWDOWN;                             VARDEF 143
      C     IERR           =2, PROGRAM HAS EXCEEDED PERMITTED ITERATIONS;        VARDEF 144
      C     IFINAL         =0 ALL TIME STEPS EXCEPT THE LAST;                    VARDEF 145
      C                    =1 LAST TIME STEP IN PUMPING PERIOD;                  VARDEF 146
      C                                                                          VARDEF 147
      C     IFLO           OPTION TO COMPUTE A VOLUMETRIC BALANCE;               VARDEF 148
      C     IHEAD          OPTION TO PRINT HEAD MATRIX;                          VARDEF 149
      C     IMAX           MAXIMUM OF I0,J0;                                     VARDEF 150
      C                                                                          VARDEF 151
      C     IPRN           USED IN INPUT OF DATA ARRAYS                          VARDEF 152
      C                    =0 IF INPUT DATA ARRAY IS TO BE PRINTED               VARDEF 153
      C                    =1 IF INPUT DATA ARRAY IS NOT TO BE PRINTED           VARDEF 154
      C     IPU1           OPTION TO READ HEAD AND MASS BALANCE VALUES FROM      VARDEF 155
      C                    CARDS;                                                VARDEF 156
      C     IPU2           OPTION TO PUNCH HEAD AND MASS BALANCE RESULTS         VARDEF 157
      C                    ON CARDS ;                                            VARDEF 158
      C                                                                          VARDEF 159
      C     IQRE           OPTION FOR RECHARGE;                                  VARDEF 160
      C     IT             ITERATION COUNTER;                                    VARDEF 161
      C     ITK            OPTION TO READ THE VALUES OF TK(I,J,K) FOR A          VARDEF 162
      C                    SIMULATION IN WHICH CONFINING LAYERS ARE NOT          VARDEF 163
      C                    REPRESENTED BY SEPARATE LAYERS OF NODES               VARDEF 164
      C                                                                          VARDEF 165
      C     ITMAX          MAXIMUM NUMBER OF ITERATIONS PER TIME STEP;           VARDEF 166
      C     ITMX1          ITMAX+1;                                              VARDEF 167
      C     ITTO(100)      VECTOR CONTAINING TOTAL NUMBER OF ITERATIONS PER      VARDEF 168
      C                    TIME STEP;                                            VARDEF 169
      C                                                                          VARDEF 170
      C     IVAR           USED IN INPUT OF DATA ARRAYS                          VARDEF 171
      C                    =0 IF ARRAY IS CONSTANT OVER SPACE                    VARDEF 172
      C                    =1 IF ARRAY IS VARIABLE OVER SPACE                    VARDEF 173
      C     IWATER         OPTION FOR WATER-TABLE CONDITIONS IN UPPER LAYER;     VARDEF 174
      C                                                                          VARDEF 175
      C     ------------------------------------------------------------------   VARDEF 176
      C                                                                          VARDEF 177
      C     J              INDEX FOR X DIRECTION  :  COLUMN LOCATION             VARDEF 178
      C     J0             NUMBER OF COLUMNS;                                    VARDEF 179
      C     J1             J0-1                                                  VARDEF 180
      C                                                                          VARDEF 181
      C     J2             J0-2                                                  VARDEF 182
      C     JFLO(NCH,3)    ARRAY CONTAINING LOCATION OF CONSTANT-HEAD NODES;     VARDEF 183
      C                                                                          VARDEF 184
      C     ------------------------------------------------------------------   VARDEF 185
```

```
C                                                                       VARDEF 186
C     K               INDEX FOR Z DIRECTION  :  LAYER LOCATION          VARDEF 187
C     K0              NUMBER OF LAYERS;                                 VARDEF 188
C     K1              K0-1                                              VARDEF 189
C                                                                       VARDEF 190
C     K2              K0-2                                              VARDEF 191
C     KHEAD           ADJUSTED VALUE OF DRAWDOWN OR HEAD;               VARDEF 192
C     KP              NUMBER OF THE PUMPING PERIOD;                     VARDEF 193
C                                                                       VARDEF 194
C     KT              TIME STEP COUNTER;                                VARDEF 195
C     KTH             NUMBER OF TIME STEPS BETWEEN PRINTOUTS;           VARDEF 196
C                                                                       VARDEF 197
C     -----------------------------------------------------------------VARDEF 198
C                                                                       VARDEF 199
C     LA              LAYER FOR WHICH A MAP IS BEING PRINTED;           VARDEF 200
C     LENGTH          NUMBER OF ITERATION PARAMETERS;                   VARDEF 201
C     LEVEL1(9)       VECTOR CONTAINING LAYERS FOR WHICH DRAWDOWN       VARDEF 202
C                     MAPS ARE TO BE PRINTED;                           VARDEF 203
C                                                                       VARDEF 204
C     LEVEL2(9)       VECTOR CONTAINING LAYERS FOR WHICH HEAD MAPS      VARDEF 205
C                     ARE TO BE PRINTED;                                VARDEF 206
C                                                                       VARDEF 207
C     -----------------------------------------------------------------VARDEF 208
C                                                                       VARDEF 209
C     N               INDEX FOR SYMBOLS;                                VARDEF 210
C     N1              NUMBER OF LINES PER INCH;                         VARDEF 211
C     N2              NUMBER OF CHARACTERS PER INCH;                    VARDEF 212
C                                                                       VARDEF 213
C     N3              NUMBER OF CHARACTERS PER LINE;                    VARDEF 214
C     N4              NUMBER OF LINES IN THE PLOT;                      VARDEF 215
C     N8              MAXIMUM NUMBER OF CHARACTERS IN Y DIRECTION;      VARDEF 216
C                                                                       VARDEF 217
C     NA(4)           INDICES FOR LOCATING X LABEL;                     VARDEF 218
C     NC              NUMBER OF BLANKS BEFORE GRAPH;                    VARDEF 219
C     NCH             NUMBER OF CONSTANT-HEAD NODES;                    VARDEF 220
C                                                                       VARDEF 221
C     NG              =1, FOR DRAWDOWN MAP;                             VARDEF 222
C                     =2, FOR HEAD MAP;                                 VARDEF 223
C     NPER            NUMBER OF PUMPING PERIODS;                        VARDEF 224
C     NUMT            NUMBER OF TIME STEPS;                             VARDEF 225
C                                                                       VARDEF 226
C     NWEL            NUMBER OF WELLS FOR A PUMPING PERIOD;             VARDEF 227
C     NXD             NUMBER OF INCHES IN THE X DIMENSION OF PLOT;      VARDEF 228
C     NYD             NUMBER OF INCHES IN THE Y DIMENSION OF PLOT;      VARDEF 229
C                                                                       VARDEF 230
C     -----------------------------------------------------------------VARDEF 231
C                                                                       VARDEF 232
C     OC              OUTPUT UNIT 7 , CARD PUNCH -- PUNCHED OUTPUT      VARDEF 233
C     OLD(I,J,K)      HEAD AT THE END OF THE PREVIOUS TIME STEP;        VARDEF 234
C     OP              OUTPUT UNIT 6 , LINE PRINTER -- PRINTED OUTPUT    VARDEF 235
C                                                                       VARDEF 236
C     -----------------------------------------------------------------VARDEF 237
C                                                                       VARDEF 238
C     PERCNT          PERCENT ERROR IN CUMULATIVE MASS BALANCE;         VARDEF 239
C     PERM(I,J)       HYDRAULIC CONDUCTIVITY OF THE UPPER UNIT;         VARDEF 240
C     PHI(I,J,K)      HYDRAULIC HEAD (L);                               VARDEF 241
C                                                                       VARDEF 242
```

```
      OVERLAY(FD3D,0,0)
      PROGRAM MODEL (TINPUT,OUTPUT,TAPE4,TAPE5=TINPUT,TAPE6=OUTPUT,    FD3D   2
     1$TAPE10,TAPE11,TAPE12,TAPE13,TAPE14,TAPE15)                      FD3D   3
CC                                                                     FD3D   4
C     TAPE10=STRT      (WELL)                                          FD3D   5
C     TAPE11 = S (STOR. COEFF)                                         FD3D   6
C     TAPE12 = T (TRANSMISSIVITY)                                      FD3D   7
C     TAPE13 = TK  ( FROM GEN TK JOB)                                  FD3D   8
C     TAPE14 = PUMPAGE                                                 FD3D   9
C     TAPE4  = INPUT FOR MASS BAL DATA                                 FD3D  10
C     TAPE15 = OUTPUT FOR MASS BAL DATA                                FD3D  11
C                                                                      FD3D  12
C     ------------------------------------------------------------MAN  40 FD3D  13
C                                                                      FD3D  14
C     FINITE-DIFFERENCE MODEL FOR SIMULATION OF GROUND-WATER FLOW IN   MAN  20 FD3D  15
C     THREE DIMENSIONS, JANUARY, 1975 BY P.C. TRESCOTT, U. S. G. S.    MAN  30 FD3D  16
C                                                                      FD3D  17
C     CDC6600 VERSION BY HEARNE, POSSON, AND TRESCOTT                  FD3D  18
C                                                                      FD3D  19
C     ............................................................MAN 160 FD3D  20
C                                                                      MAN 170 FD3D  21
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  SUBDEF  2
C                                                                      SUBDEF  3
C                                                                      SUBDEF  4
C     SUBROUTINES ARE LISTED IN THE FOLLOWING SEQUENCE                 SUBDEF  5
C                                                                      SUBDEF  6
C     CHECK  : TO CHECK THE VOLUMETRIC BALANCE                         SUBDEF  7
C                                                                      SUBDEF  8
C     COEF1  : TO COMPUTE COEFFICIENTS USED IN SIP                     SUBDEF  9
C                                                                      SUBDEF 10
C     CWRITE: TO PRINT RESULTS OF VOLUMETRIC BALANCE                   SUBDEF 11
C                                                                      SUBDEF 12
C     -------------------------------------------------------------    SUBDEF 13
C                                                                      SUBDEF 14
C     DATAIN: TO READ AND WRITE DATA                                   SUBDEF 15
C                                                                      SUBDEF 16
C     ITER   : TO COMPUTE AND PRINT ITERATION PARAMETERS               SUBDEF 17
C                                                                      SUBDEF 18
C     MAP    : TO PRINT MAPS OF DRAWDOWN AND HYDRAULIC HEAD            SUBDEF 19
C                                                                      SUBDEF 20
C     -------------------------------------------------------------    SUBDEF 21
C                                                                      SUBDEF 22
C     NEWIT  : TO INITIALIZE DATA FOR A NEW ITERATION                  SUBDEF 23
C                                                                      SUBDEF 24
C     NEWPER: TO READ AND WRITE DATA FOR A NEW PUMPING PERIOD          SUBDEF 25
C                                                                      SUBDEF 26
C     NEWSTP: TO INITIALIZE DATA FOR A NEW TIME STEP                   SUBDEF 27
C                                                                      SUBDEF 28
C     -------------------------------------------------------------    SUBDEF 29
C                                                                      SUBDEF 30
C     OUTPRT: TO PRINT OUTPUT AT DESIGNATED TIME STEPS                 SUBDEF 31
C                                                                      SUBDEF 32
C     PIS    : TO COMPUTE SOLUTION WITH REVERSE SIP ALGORITHM          SUBDEF 33
C                                                                      SUBDEF 34
C     SIP    : TO COMPUTE SOLUTION WITH NORMAL SIP ALGORITHM           SUBDEF 35
C                                                                      SUBDEF 36
C     -------------------------------------------------------------    SUBDEF 37
                                                                       SUBDEF 38
```

```
C      ABOTTO(I*J)        1-DIMENSIONAL EQUIVALENT OF BOTTOM                    VARDEF  15
C      AEL(I*J*K)         1-DIMENSIONAL EQUIVALENT OF EL                        VARDEF  16
C      AFACT(K*3)         1-DIMENSIONAL EQUIVALENT OF FACT                      VARDEF  17
C                                                                               VARDEF  18
C      AFL(I*J*K)         1-DIMENSIONAL EQUIVALENT OF FL                        VARDEF  19
C      AGL(I*J*K)         1-DIMENSIONAL EQUIVALENT OF GL                        VARDEF  20
C      AOLD(I*J*K)        1-DIMENSIONAL EQUIVALENT OF OLD                       VARDEF  21
C                                                                               VARDEF  22
C      APERM(I*J)         1-DIMENSIONAL EQUIVALENT OF PERM                      VARDEF  23
C      APHI(I*J*K)        1-DIMENSIONAL EQUIVALENT OF PHI                       VARDEF  24
C      AQRE(I*J)          1-DIMENSIONAL EQUIVALENT OF QRE                       VARDEF  25
C                                                                               VARDEF  26
C      AS(I*J*K)          1-DIMENSIONAL EQUIVALENT OF S                         VARDEF  27
C      ASTRT(I*J*K)       1-DIMENSIONAL EQUIVALENT OF STRT                      VARDEF  28
C      AT(I*J*K)          1-DIMENSIONAL EQUIVALENT OF T                         VARDEF  29
C                                                                               VARDEF  30
C      ATC(I*J*K)         1-DIMENSIONAL EQUIVALENT OF TC                        VARDEF  31
C      ATK(I*J*K)         1-DIMENSIONAL EQUIVALENT OF TK                        VARDEF  32
C      ATR(I*J*K)         1-DIMENSIONAL EQUIVALENT OF TR                        VARDEF  33
C                                                                               VARDEF  34
C      AV(I*J*K)          1-DIMENSIONAL EQUIVALENT OF V                         VARDEF  35
C      AWELL(I*J*K)       1-DIMENSIONAL EQUIVALENT OF WELL                      VARDEF  36
C      AXI(I*J*K)         1-DIMENSIONAL EQUIVALENT OF XI                        VARDEF  37
C                                                                               VARDEF  38
C      ------------------------------------------------------------------       VARDEF  39
C                                                                               VARDEF  40
C      B                  TC(I-1,J,K)/DELY(I);                                  VARDEF  41
C      BLANK(60)          CONTAINS BLANK SYMBOLS;                               VARDEF  42
C      BOTTOM(I,J)        ELEVATION OF THE BOTTOM OF THE UPPER UNIT;            VARDEF  43
C                                                                               VARDEF  44
C      ------------------------------------------------------------------       VARDEF  45
C                                                                               VARDEF  46
C      CDLT               MULTIPLYING FACTOR FOR THE TIME STEP;                 VARDEF  47
C      CFLUX              INFLOW FROM RECHARGE WELLS (L**3/T);                  VARDEF  48
C      CFLUXT             CUMULATIVE VOLUME OF WATER FROM RECHARGE WELLS        VARDEF  49
C                         (L**3);                                               VARDEF  50
C                                                                               VARDEF  51
C      CHD1               RATE OF OUTFLOW TO CONSTANT HEAD BOUNDARY             VARDEF  52
C                         (L**3/T);                                             VARDEF  53
C      CHD2               RATE OF INFLOW FROM CONSTANT HEAD BOUNDARY            VARDEF  54
C                         (L**3/T);                                             VARDEF  55
C      CHDT               CUMULATIVE DISCHARGE TO CONSTANT HEAD BOUNDARY        VARDEF  56
C                         (L**3);                                               VARDEF  57
C                                                                               VARDEF  58
C      CHST               CUMULATIVE VOLUME OF WATER INFLOW FROM CONSTANT       VARDEF  59
C                         HEAD BOUNDARY (L**3);                                 VARDEF  60
C                                                                               VARDEF  61
C      ------------------------------------------------------------------       VARDEF  62
C                                                                               VARDEF  63
C      D                  TR(I,J-1,K)/DELX(J);                                  VARDEF  64
C      DDN(IMAX)          VECTOR THAT CONTAINS DRAWDOWN VALUES (L);             VARDEF  65
C      DELT               TIME INCREMENT (T);                                   VARDEF  66
C                                                                               VARDEF  67
C      DELX(J)            GRID SPACING IN THE X DIRECTION (L);                  VARDEF  68
C      DELY(I)            GRID SPACING IN THE Y DIRECTION (L);                  VARDEF  69
C      DELZ(K)            GRID SPACING IN THE Z DIRECTION (L);                  VARDEF  70
C                                                                               VARDEF  71
```

```
C     PRNT(122)       CONTAINS THE ARRANGEMENT OF SYMBOLS FOR EACH
C                     LINE;                                               VARDEF 243
C     PUMP            DISCHARGE FROM WELLS (L**3/T);                      VARDEF 244
C     PUMPT           CUMULATIVE VOLUME OF WATER DISCHARGED BY PUMPING    VARDEF 245
C                     WELLS (L**3);                                       VARDEF 246
C                                                                         VARDEF 247
C     ------------------------------------------------------------------  VARDEF 248
C                                                                         VARDEF 249
C     QR              RECHARGE RATE(L/T);                                 VARDEF 250
C     QRE(I,J)        RECHARGE RATE (L/T);                                VARDEF 251
C     QREFLX          RECHARGE RATE (L**3/T);                             VARDEF 252
C                                                                         VARDEF 253
C     QRET            CUMULATIVE VOLUME OF WATER DERIVED FROM RECHARGE    VARDEF 254
C                     (L**3);                                             VARDEF 255
C                                                                         VARDEF 256
C     ------------------------------------------------------------------  VARDEF 257
C                                                                         VARDEF 258
C     RHO             S/DELT (1/T);                                       VARDEF 259
C     RHOP(20)        VECTOR CONTAINING ITERATION PARAMETERS;             VARDEF 260
C                                                                         VARDEF 261
C     ------------------------------------------------------------------  VARDEF 262
C                                                                         VARDEF 263
C     S(I,J,K)        STORAGE COEFFICIENT;                                VARDEF 264
C     SPACNG          CONTOUR INTERVAL (L);                               VARDEF 265
C     STOR            RATE OF CHANGE IN STORAGE FOR THE TIME STEP         VARDEF 266
C                     (L**3/T);                                           VARDEF 267
C                                                                         VARDEF 268
C     STORT           CUMULATIVE VOLUME OF WATER DERIVED FROM STORAGE     VARDEF 269
C                     (L**3);                                             VARDEF 270
C     STRT(I,J,K)     HYDRAULIC HEAD AT THE START OF THE SIMULATION;      VARDEF 271
C     SU              TK(I,J,K)/DELZ(K);                                  VARDEF 272
C                                                                         VARDEF 273
C     SUM             TOTAL ELAPSED TIME IN THE SIMULATION (T);           VARDEF 274
C     SUMP            TOTAL ELAPSED TIME IN THE PUMPING PERIOD (T);       VARDEF 275
C     SUMR            SUM OF RECHARGE AND DISCHARGE RATES FOR THE TIME    VARDEF 276
C                     STEP (L**3/T);                                      VARDEF 277
C                                                                         VARDEF 278
C     SYM(17)         VECTOR CONTAINING SYMBOLS USED IN THE PLOT;         VARDEF 279
C                                                                         VARDEF 280
C     ------------------------------------------------------------------  VARDEF 281
C                                                                         VARDEF 282
C     T(I,J,K)        TRANSMISSIVITY (L**2/T);                            VARDEF 283
C     TC(I,J,K)       TRANSMISSIVITY IN THE Y DIRECTION AT I+1/2,J,K      VARDEF 284
C                     COMPUTED AS HARMONIC AVERAGE OF T*FACT/DELY(L/T)    VARDEF 285
C     TEST            =0 CLOSURE CRITERIA SATISFIED;                      VARDEF 286
C                     =1 CLOSURE CRITERIA NOT SATISFIED;                  VARDEF 287
C                                                                         VARDEF 288
C     TEST3(ITMX1)    MAXIMUM CHANGE IN HEAD FOR THE TIME STEP;           VARDEF 289
C     TITLE(6)        TITLE FOR PLOT;                                     VARDEF 290
C     TK(I,J,K)       TRANSMISSIVITY IN THE Z DIRECTION AT I,J,K+1/2      VARDEF 291
C                     COMPUTED AS HARMONIC AVERAGE OF T*FACT/DELZ         VARDEF 292
C                     OR ENTERED AS INPUT IF ITK OPTION IS USED (L/T)     VARDEF 293
C                                                                         VARDEF 294
C     TMAX            NUMBER OF DAYS IN THE PUMPING PERIOD (T);           VARDEF 295
C     TOTL1           CUMULATIVE VOLUME OF WATER FROM ALL SOURCES         VARDEF 296
C                     (L**3);                                             VARDEF 297
C     TOTL2           CUMULATIVE VOLUME OF WATER DISCHARGED FROM THE      VARDEF 298
                                                                          VARDEF 299
```

```
C     PRNT(122)         CONTAINS THE ARRANGEMENT OF SYMBOLS FOR EACH
C                       LINE;                                            VARDEF 243
C     PUMP              DISCHARGE FROM WELLS (L**3/T);                   VARDEF 244
C     PUMPT             CUMULATIVE VOLUME OF WATER DISCHARGED BY PUMPING VARDEF 245
C                       WELLS (L**3);                                    VARDEF 246
C                                                                        VARDEF 247
C     ------------------------------------------------------------------ VARDEF 248
C                                                                        VARDEF 249
C     QR                RECHARGE RATE(L/T);                              VARDEF 250
C     QRE(I,J)          RECHARGE RATE (L/T);                             VARDEF 251
C     QREFLX            RECHARGE RATE (L**3/T);                          VARDEF 252
C                                                                        VARDEF 253
C     QRET              CUMULATIVE VOLUME OF WATER DERIVED FROM RECHARGE VARDEF 254
C                       (L**3);                                          VARDEF 255
C                                                                        VARDEF 256
C     ------------------------------------------------------------------ VARDEF 257
C                                                                        VARDEF 258
C     RHO               S/DELT (1/T);                                    VARDEF 259
C     RHOP(20)          VECTOR CONTAINING ITERATION PARAMETERS;          VARDEF 260
C                                                                        VARDEF 261
C     ------------------------------------------------------------------ VARDEF 262
C                                                                        VARDEF 263
C     S(I,J,K)          STORAGE COEFFICIENT;                             VARDEF 264
C     SPACNG            CONTOUR INTERVAL (L);                            VARDEF 265
C     STOR              RATE OF CHANGE IN STORAGE FOR THE TIME STEP      VARDEF 266
C                       (L**3/T);                                        VARDEF 267
C                                                                        VARDEF 268
C     STORT             CUMULATIVE VOLUME OF WATER DERIVED FROM STORAGE  VARDEF 269
C                       (L**3);                                          VARDEF 270
C     STRT(I,J,K)       HYDRAULIC HEAD AT THE START OF THE SIMULATION;   VARDEF 271
C     SU                TK(I,J,K)/DELZ(K);                               VARDEF 272
C                                                                        VARDEF 273
C     SUM               TOTAL ELAPSED TIME IN THE SIMULATION (T);        VARDEF 274
C     SUMP              TOTAL ELAPSED TIME IN THE PUMPING PERIOD (T);    VARDEF 275
C     SUMR              SUM OF RECHARGE AND DISCHARGE RATES FOR THE TIME VARDEF 276
C                       STEP (L**3/T);                                   VARDEF 277
C                                                                        VARDEF 278
C     SYM(17)           VECTOR CONTAINING SYMBOLS USED IN THE PLOT;      VARDEF 279
C                                                                        VARDEF 280
C     ------------------------------------------------------------------ VARDEF 281
C                                                                        VARDEF 282
C     T(I,J,K)          TRANSMISSIVITY (L**2/T);                         VARDEF 283
C     TC(I,J,K)         TRANSMISSIVITY IN THE Y DIRECTION AT I+1/2,J,K   VARDEF 284
C                       COMPUTED AS HARMONIC AVERAGE OF T*FACT/DELY(L/T) VARDEF 285
C     TEST              =0 CLOSURE CRITERIA SATISFIED;                   VARDEF 286
C                       =1 CLOSURE CRITERIA NOT SATISFIED;               VARDEF 287
C                                                                        VARDEF 288
C     TEST3(ITMX1)      MAXIMUM CHANGE IN HEAD FOR THE TIME STEP;        VARDEF 289
C     TITLE(6)          TITLE FOR PLOT;                                  VARDEF 290
C     TK(I,J,K)         TRANSMISSIVITY IN THE Z DIRECTION AT I,J,K+1/2   VARDEF 291
C                       COMPUTED AS HARMONIC AVERAGE OF T*FACT/DELZ      VARDEF 292
C                       OR ENTERED AS INPUT IF ITK OPTION IS USED (L/T)  VARDEF 293
C                                                                        VARDEF 294
C     TMAX              NUMBER OF DAYS IN THE PUMPING PERIOD (T);        VARDEF 295
C     TOTL1             CUMULATIVE VOLUME OF WATER FROM ALL SOURCES      VARDEF 296
C                       (L**3);                                          VARDEF 297
C     TOTL2             CUMULATIVE VOLUME OF WATER DISCHARGED FROM THE   VARDEF 298
                                                                         VARDEF 299
```

```
C                          SYSTEM (L**3)I                                     VARDEF 300
C                                                                             VARDEF 301
C     TR(I,J,K)            TRANSMISSIVITY IN THE X DIRECTION AT I,J+1/2,K     VARDEF 302
C                          COMPUTED AS HARMONIC AVERAGE OF T*FACT/DELX(L/T)   VARDEF 303
C                                                                             VARDEF 304
C     ------------------------------------------------------------------      VARDEF 305
C                                                                             VARDEF 306
C     UNITS                NAME OF MAP LENGTH UNIT                            VARDEF 307
C                                                                             VARDEF 308
C     ------------------------------------------------------------------      VARDEF 309
C                                                                             VARDEF 310
C     V(I,J,K)             INTERMEDIATE VECTOR;                               VARDEF 311
C     VF1(6)               VARIABLE FORMAT FOR CENTERING PLOT                 VARDEF 312
C     VF2(6)               VARIABLE FORMAT FOR CENTERING PLOT                 VARDEF 313
C                                                                             VARDEF 314
C     VF3(7)               VARIABLE FORMAT FOR CENTERING PLOT                 VARDEF 315
C                                                                             VARDEF 316
C     ------------------------------------------------------------------      VARDEF 317
C                                                                             VARDEF 318
C     WELL(I,J,K)          WELL DISCHARGE (L**3/T);                           VARDEF 319
C     WIDTH                WIDTH OF MODEL (L);                                VARDEF 320
C                                                                             VARDEF 321
C     ------------------------------------------------------------------      VARDEF 322
C                                                                             VARDEF 323
C     X                    NET FLOW TO BOTTOM LAYER (L**3/T);                 VARDEF 324
C     XI(I,J,K)            ARRAY CONTAINING INCREMENTAL HEAD VALUES IN SIP    VARDEF 325
C                          SOLUTION (L);                                      VARDEF 326
C     XLABEL(3)            LABEL FOR X AXIS;                                  VARDEF 327
C                                                                             VARDEF 328
C     XN(100)              NUMBERS FOR X AXIS;                                VARDEF 329
C     XN1                  1 INCH/N1*2);                                      VARDEF 330
C     XSCALE               DIVISION FACTOR TO CONVERT MODEL                   VARDEF 331
C                          LENGTH UNIT TO UNIT USED IN X DIRECTION ON MAPS;   VARDEF 332
C                                                                             VARDEF 333
C     XSF                  X SCALE FACTOR;                                    VARDEF 334
C                                                                             VARDEF 335
C     ------------------------------------------------------------------      VARDEF 336
C                                                                             VARDEF 337
C     Y                    NET FLOW TO TOP LAYER (L**3/T).                    VARDEF 338
C     YDIM                 LENGTH OF AQUIFER IN Y DIRECTION (L).              VARDEF 339
C     YLABEL(6)            LABEL FOR Y AXIS;                                  VARDEF 340
C                                                                             VARDEF 341
C     YLEN                 LOCATION OF NEXT VALUE IN THE COLUMN TO BE         VARDEF 342
C                          PRINTED;                                           VARDEF 343
C     YN(13)               NUMBERS FOR Y AXIS;                                VARDEF 344
C     YSCALE               DIVISION FACTOR TO CONVERT MODEL LENGTH            VARDEF 345
C                          UNIT TO UNIT USED IN Y DIRECTION ON MAPS;          VARDEF 346
C                                                                             VARDEF 347
C     YSF                  Y SCALE FACTOR;                                    VARDEF 348
C                                                                             VARDEF 349
C     ------------------------------------------------------------------      VARDEF 350
C                                                                             VARDEF 351
C     Z                    TK(I,J,K-1)/DELZ(K).                               VARDEF 352
C     ZLINE                LOCATION OF NEXT LINE TO BE PRINTED.               VARDEF 353
C                                                                             VARDEF 354
C     ------------------------------------------------------------------      VARDEF 355
C                                                                             VARDEF 356
```

```
      C     -----------------------------------------------------------------     VARDEF 357
      C     -----------------------------------------------------------------     VARDEF 358
      C                                                                           VARDEF 359
      C                                                                           START   2
      C     -----------------------------------------------------------------     START   3
      C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *     START   4
      C     -----------------------------------------------------------------     START   5
      C                                                                           START   6
      C     SPECIFICATIONS*                                                       START   7
      C                                                                           START   8
      C                                                                           IOS     2
      C     --- THE FOLLOWING I/O DEVICES ARE USED ---                            IOS     3
      C                                                                           IOS     4
      C            * DEVICE *    * UNIT *      * NUMBER *                         IOS     5
      C                                                                           IOS     6
      C              CARD READER     IC           5                               IOS     7
      C              DISK            ID           4                               IOS     8
      C              CARD PUNCH      OC           7                               IOS     9
      C              LINE PRINTER    OP           6                               IOS    10
      C                                                                           IOS    11
            COMMON /IO/  IC , ID , OC , OP                                        IOS    12
      C                                                                           IOS    13
            INTEGER IC,ID,OC,OP                                                   IOS    14
            REAL LHEAD2, LHEAD4                                               JEC FIXDIM 33
      C                                                                           IOS    15
      C                                                                           CMT1    2
      C     --- THE FOLLOWING ARE INDEPENDENT OF MODEL DIMENSIONS ---             CMT1    3
      C                                                                           CMT1    4
            COMMON /CK/ CFLUXT , CHDT , CHST , ETFLXT , FLUXT , FLXNT ,          CCK     2
           1 PUMPT, QRET, STORT, STORL2, STORL4, SFAC2, SFAC4, SUBH2, SUBH4       CCK     3
      C                                                                       JEC FIXDIM 29
      C                                                                           CCK     5
            COMMON /DPARAM/  B , D , F , H , RHO , SU , Z                         CDPARAM 2
      C                                                                           CDPARAM 3
      C                                                                           CDPARAM 4
            COMMON /HDG/  HEADNG(33)                                              CHDG    2
      C                                                                           CHDG    3
      C                                                                           CHDG    4
            COMMON /INTEGR/ IQ, IO , I1 , I2 , IDK1 , IDK2, IDRAW , IERR ,       CINTEGR 2
           1 IFINAL , IFLO , IHEAD , IMAX , IPU1 , IPU2 , IQRE , IT , ITK ,      CINTEGR 3
           2 ITMAX , ITMX1 , IWATER , JQ, J0 , J1 , J2 , KQ, K0 , K1 , K2 ,      CINTEGR 4
           3 KP , KT , KTH , LENGTH , NCH , NPER , NUMT , NWEL                   CINTEGR 5
           4 , NPWELL, IPWELL, ISS24,ICHPNT,ILHEAD                               CINTEGR 6
      C                                                                       JEC FIXDIM 32
      C                                                                           CINTEGR 7
            COMMON /PR/ BLANK(60) , DIGIT(122) , DINCH , FACT1 , FACT2 ,         CPR     2
           1 N1 , N2 , N3 , NA(4) , PRNT(122) , SYM(17) , TITLE(6) , UNITS ,     CPR     3
           2 VF1(6) , VF2(6) , VF3(7) , XLABEL(3) , XN(100) , XN1 , XSCALE ,     CPR     4
           3 YLABEL(6) , YN(13) , YSCALE                                          CPR     5
      C                                                                           CPR     6
      C                                                                           CPR     7
            COMMON /SARRAY/ ICHK(13)                                              CSARRAY 2
      C                                                                           CSARRAY 3
      C                                                                           CSARRAY 4
            COMMON /SPARAM/ CDLT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX    CSPARAM 2
      C                                                                           CSPARAM 3
                                                                                  CSPARAM 4
```

```
      C                                                                         MAX1       2
      C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---      MAX1       3
      C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX  MAX1       4
      C                                                                         MAX1       5
      C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING       FIXDIM    34
      C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504          FIXDIM    35
      C            PARAMETER(DIMENSION)      BASED ON LIMIT OF                  MAX1       8
      C                                                                         MAX1       9
      C                 DDN(100)              MAXIMUM HORIZONTAL DIMENSION=100  MAX1      10
      C                 FLOW(100),JFLO(100,3) MAXIMUM CONSTANT HEAD NODES=100   MAX1      11
      C                 ITTO(100)             MAXIMUM TIME STEPS = 100          MAX1      12
      C                 LEVEL1(9),LEVEL2(9)   MAXIMUM LEVELS PRINTED IN MAPS=9  MAX1      13
      C                 RHOP(20)              MAXIMUM ITERATION PARAMETERS=20   MAX1      14
      C                 TEST3(101)            MAXIMUM ITERATIONS = 100          MAX1      15
      C                                                                         MAX1      16
            COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),                FIXDIM    38
           1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                            FIXDIM    39
      C                                                                         MAX1      29
      C                                                                         CGEN       2
      C     --- THE REMAINING SPECIFICATIONS DEPEND ON MODEL DIMENSIONS         CGEN       3
      C         AN APPROPRIATE SET OF SPECIFICATIONS MUST BE SELECTED AT        CGEN       4
      C         THE TIME THE PROGRAM IS COMPILED. THIS IS ACCOMPLISHED BY       CGEN       5
      C         A DEFINE STATEMENT IN UPDATE. AT THIS TIME SPECIFICATIONS       CGEN       6
      C         HAVE BEEN WRITTEN FOR THE FOLLOWING --                          CGEN       7
      C               NUMBER OF                                                 CGEN       8
      C       ROWS COLUMNS LEVELS      * DEFINE *                               CGEN       9
      C        20     25     2          D202502                                 CGEN      10
      C        22     24     5          D202504                             JEC FIXDIM    30
      C        63     67     5          D515002                             JEC FIXDIM    31
      C                                                                         CGEN      13
      C     --- IN ADDITION , FOR PROBLEMS WITH RECHARGE TO THE TOP LAYER,      CGEN      14
      C         DEFINE RECHARGE                                                 CGEN      15
      C                                                                         CGEN      16
      C     --- FOR PROBLEMS WITH AN UNCONFINED TOP LAYER ,                     CGEN      17
      C         DEFINE WATERTABL                                                CGEN      18
      C                                                                         CGEN      19
      C     --- THE SET HERE WAS GENERATED BY THE FOLLOWING CARDS               CGEN      20
      C         WITH * STARTING IN COLUMN 1                                     CGEN      21
      C               *DEFINE D515002                                           CGEN      25
      C                                                                         CGEN      32
      C                                                                         C515002    2
      C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION   FIXDIM    27
      C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)       FIXDIM    28
      C           , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---          C515002    5
      C                                                                         C515002    6
            COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)                   FIXDIM    13
            COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)                     FIXDIM    14
            COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)                  FIXDIM    15
            COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)                 FIXDIM    16
      C                                                                         515002A    6
            COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)                   FIXDIM    20
            COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)              FIXDIM    21
            COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),                FIXDIM    22
           1$ LHEAD4(63,67)                                                     FIXDIM    23
      C                                                                         515002B    5
            LEVEL 2  ,OLD,STRT,TC,EL,XI                                         515002B    6
      C                                                                         515002B    7
```

```
C
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNR     2
C       WITHOUT RECHARGE TO THE TOP LEVEL ---                           CMTNR     3
C       ------- ---------                                               CMTNR     4
C                                                                       CMTNR     5
C                                                                       CMTNR     6
      COMMON /RCHRG/ QRE(1,1)                                           NR        2
C                                                                       NR        3
C                                                                       NR        4
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNWT    2
C       IN WHICH THE TOP LEVEL IS CONFINED                              CMTNWT    3
C                                 --------                              CMTNWT    4
C                                                                       CMTNWT    5
      COMMON /TABLE/ BOTTOM(1,1)    , PERM(1,1)                         NWT       2
C                                                                       NWT       3
C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE      NWT       4
C       ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"      EQCOM     2
C                                                                       EQCOM     3
C                                                                       EQCOM     4
C       (ABOTTOM IS TRUNCATED TO SIX CHARACTERS AS ABOTTO)              EQCOM     5
C                                                                       EQCOM     6
      DIMENSION AFACT(15),AOLD(21105),APHI(21105),AS(21105),            515002AA  2
     1$ ASTRT(21105),AT(21105),ATC(21105),ATK(21105),ATR(21105),        FIXDIM   17
     2$ AWELL(21105)                                                    FIXDIM   18
C                                                                       FIXDIM   19
C                                                                       515002AA  6
      DIMENSION AEL(21105),AFL(21105),AGL(21105),AV(21105),AXI(21105)   515002BA  2
C                                                                       FIXDIM   24
C                                                                       515002BA  4
      DIMENSION  AQRE(1)                                                NRA       2
C                                                                       NRA       3
C                                                                       NRA       4
      DIMENSION  ABOTTO(1)    , APERM(1)                                NWTA      2
C                                                                       NWTA      3
C                                                                       NWTA      4
      EQUIVALENCE   (FACT,AFACT) , (OLD,AOLD) , (PHI,APHI) , (S,AS) ,   EQUIV     2
     1  (STRT,ASTRT) , (T,AT) , (TC,ATC) ,  (TK,ATK) , (TR,ATR) ,       EQUIV     3
     2  (WELL,AWELL) , (EL,AEL) , (FL,AFL) , (GL,AGL) , (V,AV) ,         EQUIV     4
     3  (XI,AXI) , (QRE,AQRE) , (BOTTOM,ABOTTO) , (PERM,APERM)          EQUIV     5
C                                                                       EQUIV     6
C                                                                       EQUIV     7
C     ---------------------------------------------------------------   ENDD      2
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   ENDD      3
C     ---------------------------------------------------------------   ENDD      4
C                                                                       ENDD      5
      COMMON /RIVR/ NRC(10),NADD(10),RQ(10),VK(20),RIVER(20),QMAX(20)   ENDD      6
     1,INDX(20,2),QRA(20,20),QS(10),NR ,NTOT,TQ(10)                     ENDD      7
C     ---ELIMINATE THE INTERPAGE GAP ---                                ENDD      8
C                                                                       FD3D     25
      PRINT 1000                                                        FD3D     26
 1000 FORMAT(1HQ)                                                       FD3D     27
C                                                                       FD3D     28
C                                                                       FD3D     29
C                                                                       FD3D     30
C                                                                       FD3D     31
C     ---READ AND WRITE DATA AND INITIALIZE VARIABLES---                FD3D     32
C                                                                       FD3D     33
                                                                        FD3D     34
```

```
      CALL DATAIN                                                       MAN1200 FD3D
C     ***********                                                               FD3D
C                                                                       MAN1210 FD3D
C     ---COMPUTE TRANSMISSIVITY FOR UNCONFINED LAYER---                 MAN1220 FD3D
C                                                                               FD3D
      IF (IWATER.EQ.ICHK(6)) CALL TRANS                                 MAN1230 FD3D
C     *********************************                                         FD3D
C                                                                       MAN1240 FD3D
C     COMPUTE T COEFFICIENTS FOR ALL LAYERS                                     FD3D
C                                                                               FD3D
      CALL TCOF                                                         MAN1260 FD3D
C     *********                                                                 FD3D
C                                                                       MAN1270 FD3D
C     ---COMPUTE AND PRINT ITERATION PARAMETERS---                              FD3D
C                                                                               FD3D
      CALL ITER                                                         MAN1290 FD3D
C     *********                                                                 FD3D
C                                                                       MAN1300 FD3D
C     ---READ TIME PARAMETERS AND PUMPING DATA FOR A NEW PUMPING PERIOD-MAN1310 FD3D
C                                                                               FD3D
   80 CALL NEWPER                                                       MAN1320 FD3D
C     ***********                                                               FD3D
C                                                                       MAN1330 FD3D
C     ---START NEW TIME STEP COMPUTATIONS---                            MAN1370 FD3D
C                                                                               FD3D
   90 CALL NEWSTP                                                       MAN1380 FD3D
C     ***********                                                               FD3D
C                                                                       MAN1390 FD3D
C     ---START NEW ITERATION IF MAXIMUM NO. ITERATIONS NOT EXCEEDED---  MAN1400 FD3D
C                                                                               FD3D
  100 CALL NEWIT                                                        MAN1430 FD3D
C     **********                                                                FD3D
C                                                                       SP31000 FD3D
C     ---COMPUTE TRANSMISSIVITY AND T COEFFICIENTS FOR UPPER            SP31010 FD3D
C     HYDROLOGIC UNIT WHEN IT IS UNCONFINED---                          SP31020 FD3D
C                                                                               FD3D
      IF (IWATER.NE.ICHK(6)) GO TO 120                                  SP31030 FD3D
C                                                                               FD3D
      CALL TRANS                                                        SP31040 FD3D
C     **********                                                                FD3D
C                                                                               FD3D
      CALL WTTCOF                                                               FD3D
C     ***********                                                               FD3D
C                                                                       SP31050 FD3D
C     ---CHOOSE SIP NORMAL OR REVERSE ALGORITHM---                      SP31060 FD3D
C                                                                               FD3D
  120 IF (MOD(IT,2)) 200,200,300                                        SP31070 FD3D
C                                                                               FD3D
  200 CALL SIP                                                                  FD3D
C     ********                                                                  FD3D
C                                                                               FD3D
      GO TO 400                                                                 FD3D
C                                                                               FD3D
  300 CALL PIS                                                                  FD3D
C     ********                                                                  FD3D
C                                                                               FD3D
  400 CONTINUE                                                                  FD3D
```

```
      C
      C     ---IF SOLUTION NOT OBTAINED START A NEW ITERATION---        FD3D
      C                                                         MAN1450 FD3D
            IF (TEST.EQ.1.) GO TO 100                                   FD3D
      C                                                         MAN1460FD3D
      C                                                         MAN1470 FD3D
      C     ---PRINT OUTPUT AT DESIGNATED TIME STEPS---         MAN1480 FD3D
      C                                                                 FD3D
            CALL OUTPT                                                  FD3D
      C     ***********                                                 FD3D
      C                                                                 FD3D
      C     ---IF PUMPING PERIOD NOT COMPLETED START A NEW TIME STEP--- MAN1500 FD3D
      C                                                                 FD3D
            IF (IFINAL.NE.1) GO TO 90                                   FD3D
      C                                                         MAN1520 FD3D
      C                                                         MAN1530 FD3D
      C     ---IF SIMULATION NOT COMPLETED START A NEW PUMPING PERIOD---    FD3D
      C                                                                 FD3D
            IF (KP.LT.NPER) GO TO 80                            MAN1550 FD3D
      C                                                         MAN1560 FD3D
      C     ---NORMAL TERMINATION---                                    FD3D
      C                                                                 FD3D
            STOP1                                               MAN1570 FD3D
      C                                                                 FD3D
            END                                                 MAN1720-FD3D
```

```
      SUBROUTINE CHECK                                                   FD3D  115
C                                                                        FD3D  116
C     ---------------------------------------------------------------CHK   30 FD3D  117
C                                                                        FD3D  118
C     COMPUTE A VOLUMETRIC BALANCE                                   CHK   40 FD3D  119
C                                                                        FD3D  120
C     ---------------------------------------------------------------CHK   50 FD3D  121
C                    * FOR SUBROUTINE CHECK *                            DCHECK  2
C                                                                        START   2
C     ----------------------------------------------------------------   START   3
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   START   4
C     ----------------------------------------------------------------   START   5
C                                                                        START   6
C     SPECIFICATIONS*                                                    START   7
C                                                                        START   8
C                                                                        IOS     2
C     --- THE FOLLOWING I/O DEVICES ARE USED ---                         IOS     3
C                                                                        IOS     4
C               * DEVICE *        * UNIT *        * NUMBER *             IOS     5
C                                                                        IOS     6
C              CARD READER          IC               5                   IOS     7
C              DISK                 ID               4                   IOS     8
C              CARD PUNCH           OC               7                   IOS     9
C              LINE PRINTER         OP               6                   IOS    10
C                                                                        IOS    11
      COMMON /IO/  IC , ID , OC , OP                                     IOS    12
C                                                                        IOS    13
      INTEGER IC,ID,OC,OP                                                IOS    14
      REAL LHEAD2, LHEAD4                                            JEC FIXDIM 33
C                                                                        IOS    15
C                                                                        CMT1    2
C     --- THE FOLLOWING ARE INDEPENDENT OF MODEL DIMENSIONS ---           CMT1    3
C                                                                        CMT1    4
C                                                                        CCK     2
      COMMON /CK/ CFLUXT , CHDT , CHST , ETFLXT , FLUXT , FLXNT ,        CCK     3
     1 PUMPT, QRET, STORT, STORL2, STORL4, SFAC2, SFAC4, SUBH2, SUBH4 JEC FIXDIM 29
C                                                                        CCK     5
C                                                                        CDPARAM 2
      COMMON /DPARAM/  B , D , F , H , RHO , SU , Z                      CDPARAM 3
C                                                                        CDPARAM 4
C                                                                        CHDG    2
      COMMON /HDG/  HEADNG(33)                                           CHDG    3
C                                                                        CHDG    4
C                                                                        CINTEGR 2
      COMMON /INTEGR/ IQ, IO , I1 , I2 , IDK1 , IDK2, IDRAW , IERR ,     CINTEGR 3
     1  IFINAL , IFLO , IHEAD , IMAX , IPU1 , IPU2 , IWRE , IT , ITK ,   CINTEGR 4
     2  ITMAX , ITMX1 , IWATER , JQ, J0 , J1 , J2 , KQ, K0 , K1 , K2 ,   CINTEGR 5
     3  KP , KT , KTH , LENGTH , NCH , NPER , NUMT , NWEL                CINTEGR 6
     4 , NPWELL, IPWELL, ISS24,ICHPNT,ILHEAD                         JEC FIXDIM 32
C                                                                        CINTEGR 7
C                                                                        CPR     2
      COMMON /PR/ BLANK(60) , DIGIT(122) , DINCH , FACT1 , FACT2 ,       CPR     3
     1  N1 , N2 , N3 , NA(4) , PRNT(122) , SYM(17) , TITLE(6) , UNITS ,  CPR     4
     2  VF1(6) , VF2(6) , VF3(7) , XLABEL(3) , XN(100) , XN1 , XSCALE ,  CPR     5
     3  YLABEL(6) , YN(13) , YSCALE                                      CPR     6
C                                                                        CPR     7
C                                                                        CSARRAY 2
```

```
      COMMON /SARRAY/ ICHK(13)                                          CSARRAY  3
C                                                                       CSARRAY  4
C                                                                       CSPARAM  2
      COMMON /SPARAM/ CDLT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX CSPARAM  3
C                                                                       CSPARAM  4
C                                                                       MAX1     2
C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---    MAX1     3
C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX MAX1    4
C                                                                       MAX1     5
C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING     FIXDIM  34
C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504        FIXDIM  35
C             PARAMETER(DIMENSION)    BASED ON LIMIT OF                 MAX1     8
C                                                                       MAX1     9
C          DDN(100)                 MAXIMUM HORIZONTAL DIMENSION=100    MAX1    10
C          FLOW(100),JFLO(100,3)  MAXIMUM CONSTANT HEAD NODES=100       MAX1    11
C          ITTO(100)                MAXIMUM TIME STEPS = 100            MAX1    12
C          LEVEL1(9),LEVEL2(9)      MAXIMUM LEVELS PRINTED IN MAPS=9    MAX1    13
C          RHOP(20)                 MAXIMUM ITERATION PARAMETERS=20     MAX1    14
C          TEST3(101)               MAXIMUM ITERATIONS = 100            MAX1    15
C                                                                       MAX1    16
      COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),              FIXDIM  38
     1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                          FIXDIM  39
C                                                                       MAX1    29
C                                                                       C515002  2
C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION FIXDIM  27
C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)     FIXDIM  28
C         , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---          C515002  5
C                                                                       C515002  6
      COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)                 FIXDIM  13
      COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)                   FIXDIM  14
      COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)                FIXDIM  15
      COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)               FIXDIM  16
C                                                                       515002A  6
      COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)                 FIXDIM  20
      COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)            FIXDIM  21
      COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),              FIXDIM  22
     1$ LHEAD4(63,67)                                                   FIXDIM  23
C                                                                       515002B  5
      LEVEL 2  ,OLD,STRT,TC,EL,XI                                       515002B  6
C                                                                       515002B  7
C                                                                       CMTNR    2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNR    3
C         WITHOUT RECHARGE TO THE TOP LEVEL ---                         CMTNR    4
C         ------ ---------                                              CMTNR    5
C                                                                       CMTNR    6
C                                                                       NR       2
      COMMON /RCHRG/ QRE(1,1)                                           NR       3
C                                                                       NR       4
C                                                                       CMTNWT   2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNWT   3
C         IN WHICH THE TOP LEVEL IS CONFINED                            CMTNWT   4
C                                        --------                       CMTNWT   5
C                                                                       NWT      2
      COMMON /TABLE/ BOTTOM(1,1)   , PERM(1,1)                          NWT      3
C                                                                       NWT      4
C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE      EQCOM    2
C         ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"    EQCOM    3
```

```
      C                                                                 EQCOM     4
      C                                                                 EQCOM     5
      C       (ABOTTOM IS TRUNCATED TO SIX CHARACTERS AS ABOTTO)        EQCOM     6
      C                                                                 515002AA  2
              DIMENSION AFACT(15),AOLD(21105),APHI(21105),AS(21105),    FIXDIM   17
             1$ ASTRT(21105),AT(21105),ATC(21105),ATK(21105),ATR(21105), FIXDIM  18
             2$ AWELL(21105)                                            FIXDIM   19
      C                                                                 515002AA  6
      C                                                                 515002BA  2
              DIMENSION AEL(21105),AFL(21105),AGL(21105),AV(21105),AXI(21105)  FIXDIM 24
      C                                                                 515002BA  4
      C                                                                 NRA       2
              DIMENSION AQRE(1)                                         NRA       3
      C                                                                 NRA       4
      C                                                                 NWTA      2
              DIMENSION ABOTTO(1) , APERM(1)                            NWTA      3
      C                                                                 NWTA      4
      C                                                                 EQUIV     2
              EQUIVALENCE  (FACT,AFACT) , (OLD,AOLD) , (PHI,APHI) , (S,AS) ,   EQUIV 3
             1  (STRT,ASTRT) , (T,AT) , (TC,ATC) ,  (TK,ATK) , (TR,ATR) ,      EQUIV 4
             2  (WELL,AWELL) , (EL,AEL) , (FL,AFL) , (GL,AGL) , (V,AV) ,       EQUIV 5
             3  (XI,AXI) , (QRE,AQRE) , (BOTTOM,ABOTTO) , (PERM,APERM)         EQUIV 6
      C                                                                 EQUIV     7
      C                                                                 COMBAL    2
              COMMON /BALNCE/ CFLUX,CHD1,CHD2,DIFF,ETFLUX,FLUX,FLUXS,FLXN,     COMBAL 3
             1 FLXPT ,PERCNT,PUMP,QREFLX,STOR,SUMR,TOTL1,TOTL2                 COMBAL 4
      C                                                                 COMBAL    5
      C                                                                 ENDD      2
      C       -------------------------------------------------------------------   ENDD 3
      C       * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *       ENDD 4
      C       -------------------------------------------------------------------   ENDD 5
      C                                                                 ENDD      6
              COMMON /RIVR/ NRC(10),NADD(10),RQ(10),VK(20),RIVER(20),QMAX(20)  ENDD 7
             1,INDX(20,2),QRA(20,20),QS(10),NR ,NTOT,TQ(10)             ENDD      8
      C                                                                 FD3D    123
      C       ---INITIALIZE VARIABLES---                        CHK 260 FD3D    124
      C                                                                 FD3D    125
              PUMP=0.                                           CHK 270 FD3D    126
              STOR=0.                                           CHK 280 FD3D    127
              FLUXS=0.0                                         CHK 290 FD3D    128
              CHD1=0.0                                          CHK 300 FD3D    129
              CHD2=0.0                                          CHK 310 FD3D    130
              FLAX = 0.0                                                FD3D    131
              QREFLX=0.                                         CHK 320 FD3D    132
              CFLUX=0.                                          CHK 330 FD3D    133
              FLUX=0.                                           CHK 340 FD3D    134
              ETFLUX=0.                                         CHK 350 FD3D    135
              FLXN=0.0                                          CHK 360 FD3D    136
              II=0                                              CHK 370 FD3D    137
      C                                                         CHK 390 FD3D    138
      C       ---COMPUTE RATES,STORAGE AND PUMPAGE FOR THIS STEP---     CHK 400 FD3D    139
      C                                                                 FD3D    140
              DO 220 K=1,K0                                     CHK 410 FD3D    141
              DO 220 I=2,I1                                     CHK 420 FD3D    142
              DO 220 J=2,J1                                     CHK 430 FD3D    143
      C                                                                 FD3D    144
      C       ---SKIP COMPUTATIONS IF NODE IS INACTIVE---               FD3D    145
```

```
C
      IF (T(I,J,K).EQ.0.) GO TO 220
      AREA=DELX(J)*DELY(I)
C
C     ---COMPUTE FLOW RATES TO AND FROM CONSTANT HEAD BOUNDARIES---
C
      IF (S(I,J,K).GE.0.) GO TO 180
      II=II+1
      FLOW(II)=0.
      JFLO(II,1)=K
      JFLO(II,2)=I
      JFLO(II,3)=J
C
C     ---WEST---
C
      IF (S(I,J-1,K).LT.0..OR.T(I,J-1,K).EQ.0.) GO TO 30
      X=(PHI(I,J,K)-PHI(I,J-1,K))*TR(I,J-1,K)*DELY(I)
      FLOW(II)=FLOW(II)+X
      IF (X) 10,30,20
   10 CHD1=CHD1+X
      GO TO 30
   20 CHD2=CHD2+X
C
C     ---EAST---
C
   30 IF (S(I,J+1,K).LT.0..OR.T(I,J+1,K).EQ.0.) GO TO 60
      X=(PHI(I,J,K)-PHI(I,J+1,K))*DELY(I)*TR(I,J,K)
      FLOW(II)=FLOW(II)+X
      IF (X) 40,60,50
   40 CHD1=CHD1+X
      GO TO 60
   50 CHD2=CHD2+X
C
C     ---DOWN---
C
   60 IF (K.EQ.1) GO TO 90
      IF (S(I,J,K-1).LT.0..OR.T(I,J,K-1).EQ.0.) GO TO 90
      X=(PHI(I,J,K)-PHI(I,J,K-1))*TK(I,J,K-1)*AREA*2./(DELZ(K)+DELZ(K-1
     1))
      FLOW(II)=FLOW(II)+X
      IF (X) 70,90,80
   70 CHD1=CHD1+X
      GO TO 90
   80 CHD2=CHD2+X
C
C     ---UP---
C
   90 IF (K.EQ.KO) GO TO 120
      IF (S(I,J,K+1).LT.0..OR.T(I,J,K+1).EQ.0.) GO TO 120
      X=(PHI(I,J,K)-PHI(I,J,K+1))*TK(I,J,K)*AREA*2./(DELZ(K)+DELZ(K+1))
      FLOW(II)=FLOW(II)+X
      IF (X) 100,120,110
  100 CHD1=CHD1+X
      GO TO 120
  110 CHD2=CHD2+X
C
C     ---NORTH---
```

```
                                                                          FD3D   203
      C                                                          CHK 850 FD3D   204
        120 IF (S(I-1,J,K).LT.0..OR.T(I-1,J,K).EQ.0.) GO TO 150
            X=(PHI(I,J,K)-PHI(I-1,J,K))*TC(I-1,J,K)*DELX(J)     CHK 860 FD3D   205
            FLOW(II)=FLOW(II)+X                                  CHK 870 FD3D   206
            IF (X) 130,150,140                                   CHK 880 FD3D   207
        130 CHD1=CHD1+X                                          CHK 890 FD3D   208
            GO TO 150                                            CHK 900 FD3D   209
        140 CHD2=CHD2+X                                          CHK 910 FD3D   210
      C                                                                  FD3D   211
      C     ---SOUTH---                                                  FD3D   212
      C                                                                  FD3D   213
        150 IF (S(I+1,J,K).LT.0..OR.T(I+1,J,K).EQ.0.) GO TO 220 CHK 920 FD3D   214
            X=(PHI(I,J,K)-PHI(I+1,J,K))*TC(I,J,K)*DELX(J)       CHK 930 FD3D   215
            FLOW(II)=FLOW(II)+X                                  CHK 940 FD3D   216
            IF (X) 160,220,170                                   CHK 950 FD3D   217
        160 CHD1=CHD1+X                                          CHK 960 FD3D   218
            GO TO 220                                            CHK 970 FD3D   219
        170 CHD2=CHD2+X                                          CHK 980 FD3D   220
            GO TO 220                                            CHK 990 FD3D   221
      C                                                          CHK1000 FD3D   222
      C     ---RECHARGE AND WELLS---                             CHK1010 FD3D   223
      C                                                                  FD3D   224
        180 IF (K.EQ.K0.AND.IQRE.EQ.ICHK(7)) QREFLX=QREFLX+QRE(I,J)*AREA   CHK1020 FD3D   225
            IF (WELL(I,J,K)) 190,210,200                         CHK1030 FD3D   226
        190 PUMP=PUMP+WELL(I,J,K)*AREA                           CHK1040 FD3D   227
            GO TO 210                                            CHK1050 FD3D   228
        200 CFLUX=CFLUX+WELL(I,J,K)*AREA                         CHK1060 FD3D   229
      C                                                          CHK1070 FD3D   230
      C     ---COMPUTE VOLUME FROM STORAGE---                    CHK1080 FD3D   231
      C                                                                  FD3D   232
      C     COMPUTE TOTAL STORAGE, CLAY STOR 2, CLAY STOR 4, AND ACCUMULATE   JEC  FIXFD   1
      C     SUBSIDENCE.                                              JEC  FIXFD   2
        210 XH = OLD(I,J,K) - PHI(I,J,K)                         JEC  FIXFD   3
            XS = S(I,J,K)                                        JEC  FIXFD   4
            TCS = XS * XH                                        JEC  FIXFD   5
            STORX = TCS * AREA                                   JEC  FIXFD   6
            STOR = STOR + STORX                                  JEC  FIXFD   7
            GO TO (215,202,215,204,215) K                        JEC  FIXFD   8
        202 STORL2 = STORL2 + STORX                              JEC  FIXFD   9
            CSUB(I,J) = CSUB(I,J) + TCS                          JEC  FIXFD  10
            GO TO 215                                            JEC  FIXFD  11
        204 STORL4 = STORL4 + STORX                              JEC  FIXFD  12
            CSUB(I,J) = CSUB(I,J) + TCS                          JEC  FIXFD  13
        215 CONTINUE                                             JEC  FIXFD  14
      C                                                                  FD3D   234
      C     ---LEAKAGE---                                                FD3D   235
        216 IF (K .NE. K0 ) GO TO 220                                    FD3D   236
            IF(NR.EQ.0) GO TO 220                                        FD3D   237
            FLUXS=FLUXS+QRA(I,J)*AREA                                    FD3D   238
            IF(QRA(I,J).LT.0.) GO TO 217                                 FD3D   239
            FLAX=FLAX+QRA(I,J)*AREA                                      FD3D   240
            GO TO 220                                                    FD3D   241
        217 FLXN=FLXN-QRA(I,J)*AREA                                      FD3D   242
        220 CONTINUE                                                     FD3D   243
            FLXPT=FLXPT+FLAX*DELT                                        FD3D   244
            FLXNT=FLXNT+FLXN*DELT                                        FD3D   245
            STORT=STORT+STOR                                     CHK1150 FD3D   246
```

```
      COMMON /SARRAY/ ICHK(13)                                          CSARRAY  3
C                                                                       CSARRAY  4
C                                                                       CSPARAM  2
      COMMON /SPARAM/ CDLT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX CSPARAM  3
C                                                                       CSPARAM  4
C                                                                       MAX1     2
C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---    MAX1     3
C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX MAX1    4
C                                                                       MAX1     5
C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING     FIXDIM  34
C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504        FIXDIM  35
C            PARAMETER(DIMENSION)      BASED ON LIMIT OF                MAX1     8
C                                                                       MAX1     9
C        DDN(100)                    MAXIMUM HORIZONTAL DIMENSION=100   MAX1    10
C        FLOW(100),JFLO(100,3)  MAXIMUM CONSTANT HEAD NODES=100         MAX1    11
C        ITTO(100)                   MAXIMUM TIME STEPS = 100           MAX1    12
C        LEVEL1(9),LEVEL2(9)         MAXIMUM LEVELS PRINTED IN MAPS=9   MAX1    13
C        RHOP(20)                    MAXIMUM ITERATION PARAMETERS=20    MAX1    14
C        TEST3(101)                  MAXIMUM ITERATIONS = 100           MAX1    15
C                                                                       MAX1    16
      COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),              FIXDIM  38
     1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                          FIXDIM  39
C                                                                       MAX1    29
C                                                                       C515002  2
C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION FIXDIM  27
C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)     FIXDIM  28
C         , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---          C515002  5
C                                                                       C515002  6
      COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)                 FIXDIM  13
      COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)                   FIXDIM  14
      COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)                FIXDIM  15
      COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)               FIXDIM  16
C                                                                       515002A  6
      COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)                 FIXDIM  20
      COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)            FIXDIM  21
      COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),              FIXDIM  22
     1$ LHEAD4(63,67)                                                   FIXDIM  23
C                                                                       515002B  5
      LEVEL 2  ,OLD,STRT,TC,EL,XI                                       515002B  6
C                                                                       515002B  7
C                                                                       CMTNR    2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNR    3
C         WITHOUT RECHARGE TO THE TOP LEVEL ---                         CMTNR    4
C         ------- ---------                                             CMTNR    5
C                                                                       CMTNR    6
C                                                                       NR       2
      COMMON /RCHRG/ QRE(1,1)                                           NR       3
C                                                                       NR       4
C                                                                       CMTNWT   2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNWT   3
C         IN WHICH THE TOP LEVEL IS CONFINED                            CMTNWT   4
C                                   --------                            CMTNWT   5
C                                                                       NWT      2
      COMMON /TABLE/ BOTTOM(1,1)    , PERM(1,1)                         NWT      3
C                                                                       NWT      4
C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE      EQCOM    2
C         ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"    EQCOM    3
```

```
      C                                                          EQCOM    4
      C                                                          EQCOM    5
      C     (ABOTTOM IS TRUNCATED TO SIX CHARACTERS AS ABOTTO)   EQCOM    6
      C                                                          515002AA 2
            DIMENSION AFACT(15),AOLD(21105),APHI(21105),AS(21105),  FIXDIM  17
           1$ ASTRT(21105),AT(21105),ATC(21105),ATK(21105),ATR(21105),  FIXDIM  18
           2$ AWELL(21105)                                       FIXDIM  19
      C                                                          515002AA 6
      C                                                          515002BA 2
            DIMENSION AEL(21105),AFL(21105),AGL(21105),AV(21105),AXI(21105)  FIXDIM  24
      C                                                          515002BA 4
      C                                                          NRA      2
            DIMENSION  AQRE(1)                                   NRA      3
      C                                                          NRA      4
      C                                                          NWTA     2
            DIMENSION  ABOTTO(1)  , APERM(1)                     NWTA     3
      C                                                          NWTA     4
      C                                                          EQUIV    2
            EQUIVALENCE  (FACT,AFACT) , (OLD,AOLD) , (PHI,APHI) , (S,AS) ,  EQUIV  3
           1  (STRT,ASTRT) , (T,AT) , (TC,ATC) ,  (TK,ATK) , (TR,ATR) ,  EQUIV  4
           2  (WELL,AWELL) , (EL,AEL) , (FL,AFL) , (GL,AGL) , (V,AV) ,  EQUIV  5
           3  (XI,AXI) , (QRE,AQRE) , (BOTTOM,ABOTTO) , (PERM,APERM)  EQUIV  6
      C                                                          EQUIV    7
      C                                                          ENDD     2
      C     -------------------------------------------------------------  ENDD  3
      C     * * * * * * * * * * * * * * * * * * * * * * * * * * *  ENDD     4
      C     -------------------------------------------------------------  ENDD  5
      C                                                          ENDD     6
            COMMON /RIVR/ NRC(10),NADD(10),RQ(10),VK(20),RIVER(20),QMAX(20)  ENDD  7
           1,INDX(20,2),QRA(20,20),QS(10),NR ,NTOT,TQ(10)        ENDD     8
      C                                                          FD3D   272
      C     ---TRANSMISSIVITY COEFFICIENTS---                    FD3D   273
      C                                                          FD3D   274
      C     NORTH                                                FD3D   275
            B = TC(IQ-1,JQ,KQ) / DELY(IQ)                        FD3D   276
      C     EAST                                                 FD3D   277
            F = TR(IQ,JQ,KQ) / DELX(JQ)                          FD3D   278
      C     SOUTH                                                FD3D   279
            H = TC(IQ,JQ,KQ) / DELY(IQ)                          FD3D   280
      C     WEST                                                 FD3D   281
            D = TR(IQ,JQ-1,KQ) / DELX(JQ)                        FD3D   282
      C     UP                                                   FD3D   283
            SU=0.                                        COF 850 FD3D   284
            IF (KQ .NE. KO) SU = TK(IQ,JQ,KQ) / DELZ(KQ)         FD3D   285
      C     DOWN                                                 FD3D   286
            Z=0.                                         COF 860 FD3D   287
            IF (KQ .NE. 1) Z = TK(IQ,JQ,KQ-1) / DELZ(KQ)         FD3D   288
      C                                                          FD3D   289
      C     IN REVERSE ALGORITHM UP BECOMES DOWN AND NORTH BECOMES SOUTH  FD3D  290
      C                                                          FD3D   291
      C     ---STORAGE COEFFICIENT---                            FD3D   292
      C                                                          FD3D   293
            RHO = S(IQ,JQ,KQ) / DELT                             FD3D   294
      C                                                          FD3D   295
      C     ---RECHARGE COEFFICIENTS---                          FD3D   296
      C                                                          FD3D   297
         55 QR = 0.0                                             FD3D   298
```

```
            IF (KQ .NE. K0) GO TO 60                                    FD3D  299
            IF (IQRE .EQ. ICHK(7))  QR = QRE(IQ,JQ)                     FD3D  300
            IF (NR .NE. 0)  QR = QR + QRA(IQ,JQ)                        FD3D  301
         60 RETURN                                                      FD3D  302
      C                                                         COF 930 FD3D  303
            END                                                 COF 970-FD3D  304
```

```
      SUBROUTINE CWRITE                                                 FD3D  305
C                                                                       FD3D  306
C     ------------------------------------------------------------------FD3D  307
C                                                                       FD3D  308
C     ---PRINT RESULTS OF VOLUMETRIC BALANCE                            FD3D  309
C                                                                       FD3D  310
C     ------------------------------------------------------------------FD3D  311
C                 * FOR SUBROUTINE CWRITE *                             DCWRITE 2
C                                                                       START   2
C     ------------------------------------------------------------------START   3
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * START   4
C     ------------------------------------------------------------------START   5
C                                                                       START   6
C     SPECIFICATIONS#                                                   START   7
C                                                                       START   8
C                                                                       IOS     2
C     --- THE FOLLOWING I/O DEVICES ARE USED ---                        IOS     3
C                                                                       IOS     4
C         * DEVICE *        * UNIT *      * NUMBER *                    IOS     5
C                                                                       IOS     6
C          CARD READER        IC            5                           IOS     7
C          DISK               ID            4                           IOS     8
C          CARD PUNCH         OC            7                           IOS     9
C          LINE PRINTER       OP            6                           IOS    10
C                                                                       IOS    11
      COMMON /IO/ IC , ID , OC , OP                                     IOS    12
C                                                                       IOS    13
      INTEGER IC,ID,OC,OP                                               IOS    14
      REAL LHEAD2, LHEAD4                                          JEC  FIXDIM 33
C                                                                       IOS    15
C                                                                       CMT1    2
C     --- THE FOLLOWING ARE INDEPENDENT OF MODEL DIMENSIONS ---         CMT1    3
C                                                                       CMT1    4
C                                                                       CCK     2
      COMMON /CK/ CFLUXT , CHDT , CHST , ETFLXT , FLUXT , FLXNT ,       CCK     3
     1 PUMPT, QRET, STORT, STORL2, STORL4, SFAC2, SFAC4, SUBH2, SUBH4  JEC  FIXDIM 29
C                                                                       CCK     5
C                                                                       CDPARAM 2
      COMMON /DPARAM/ B , D , F , H , RHO , SU , Z                      CDPARAM 3
C                                                                       CDPARAM 4
C                                                                       CHDG    2
      COMMON /HDG/  HEADNG(33)                                          CHDG    3
C                                                                       CHDG    4
C                                                                       CINTEGR 2
      COMMON /INTEGR/ IQ, I0 , I1 , I2 , IDK1 , IDK2, IDRAW , IERR ,    CINTEGR 3
     1  IFINAL , IFLO , IHEAD , IMAX , IPU1 , IPU2 , IQRE , IT , ITK ,  CINTEGR 4
     2  ITMAX , ITMX1 , IWATER , JQ, J0 , J1 , J2 , KQ, K0 , K1 , K2 ,  CINTEGR 5
     3  KP , KT , KTH , LENGTH , NCH , NPER , NUMT , NWEL               CINTEGR 6
     4 , NPWELL, IPWELL, ISS24,ICHPNT,ILHEAD                       JEC  FIXDIM 32
C                                                                       CINTEGR 7
C                                                                       CPR     2
      COMMON /PR/ BLANK(60) , DIGIT(122) , DINCH , FACT1 , FACT2 ,      CPR     3
     1  N1 , N2 , N3 , NA(4) , PRNT(122) , SYM(17) , TITLE(6) , UNITS , CPR     4
     2  VF1(6) , VF2(6) , VF3(7) , XLABEL(3) , XN(100) , XN1 , XSCALE , CPR     5
     3  YLABEL(6) , YN(13) , YSCALE                                     CPR     6
C                                                                       CPR     7
C                                                                       CSARRAY 2
```

```
      COMMON /SARRAY/ ICHK(13)                                          CSARRAY  3
C                                                                       CSARRAY  4
C                                                                       CSPARAM  2
      COMMON /SPARAM/ CULT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX CSPARAM  3
C                                                                       CSPARAM  4
C                                                                       MAX1     2
C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---    MAX1     3
C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX MAX1    4
C                                                                       MAX1     5
C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING     FIXDIM  34
C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504        FIXDIM  35
C             PARAMETER(DIMENSION)     BASED ON LIMIT OF                MAX1     8
C                                                                       MAX1     9
C                DDN(100)             MAXIMUM HORIZONTAL DIMENSION=100  MAX1    10
C                FLOW(100),JFLO(100,3) MAXIMUM CONSTANT HEAD NODES=100  MAX1    11
C                ITTO(100)            MAXIMUM TIME STEPS = 100          MAX1    12
C                LEVEL1(9),LEVEL2(9)  MAXIMUM LEVELS PRINTED IN MAPS=9  MAX1    13
C                RHOP(20)             MAXIMUM ITERATION PARAMETERS=20   MAX1    14
C                TEST3(101)           MAXIMUM ITERATIONS = 100          MAX1    15
C                                                                       MAX1    16
      COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),              FIXDIM  38
     1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                          FIXDIM  39
C                                                                       MAX1    29
C                                                                       C515002  2
C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION FIXDIM  27
C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)     FIXDIM  28
C         , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---          C515002  5
C                                                                       C515002  6
      COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)                 FIXDIM  13
      COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)                   FIXDIM  14
      COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)                FIXDIM  15
      COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)               FIXDIM  16
C                                                                       515002A  6
      COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)                 FIXDIM  20
      COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)            FIXDIM  21
      COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),              FIXDIM  22
     1$ LHEAD4(63,67)                                                   FIXDIM  23
C                                                                       515002B  5
      LEVEL 2 ,OLD,STRT,TC,EL,XI                                        515002B  6
C                                                                       515002B  7
C                                                                       CMTNR    2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNR    3
C         WITHOUT RECHARGE TO THE TOP LEVEL ---                         CMTNR    4
C         ------ ---------                                              CMTNR    5
C                                                                       CMTNR    6
C                                                                       NR       2
      COMMON /RCHRG/ QRE(1,1)                                           NR       3
C                                                                       NR       4
C                                                                       CMTNWT   2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNWT   3
C         IN WHICH THE TOP LEVEL IS CONFINED                            CMTNWT   4
C                                   ---------                           CMTNWT   5
C                                                                       NWT      2
      COMMON /TABLE/ BOTTOM(1,1)    , PERM(1,1)                         NWT      3
C                                                                       NWT      4
C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE      EQCOM    2
C         ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"    EQCOM    3
```

```
      C                                                                        EQCOM    4
      C                                                                        EQCOM    5
      C          (ABOTTOM IS TRUNCATED TO SIX CHARACTERS AS ABOTTO)            EQCOM    6
      C                                                                        515002AA 2
            DIMENSION AFACT(15),AOLD(21105),APHI(21105),AS(21105),             FIXDIM  17
          1$ ASTRT(21105),AT(21105),ATC(21105),ATK(21105),ATR(21105),          FIXDIM  18
          2$ AWELL(21105)                                                      FIXDIM  19
      C                                                                        515002AA 6
      C                                                                        515002BA 2
            DIMENSION AEL(21105),AFL(21105),AGL(21105),AV(21105),AXI(21105)    FIXDIM  24
      C                                                                        515002BA 4
      C                                                                        NRA      2
            DIMENSION  AQRE(1)                                                 NRA      3
      C                                                                        NRA      4
      C                                                                        NWTA     2
            DIMENSION  ABOTTO(1)  , APERM(1)                                   NWTA     3
      C                                                                        NWTA     4
      C                                                                        EQUIV    2
            EQUIVALENCE  (FACT,AFACT) , (OLD,AOLD) , (PHI,APHI) , (S,AS) ,     EQUIV    3
          1  (STRT,ASTRT) , (T,AT) , (TC,ATC) ,  (TK,ATK) , (TR,ATR) ,         EQUIV    4
          2  (WELL,AWELL) , (EL,AEL) , (FL,AFL) , (GL,AGL) , (V,AV) ,          EQUIV    5
          3  (XI,AXI) , (QRE,AQRE) , (BOTTOM,ABOTTO) , (PERM,APERM)            EQUIV    6
      C                                                                        EQUIV    7
      C                                                                        COMBAL   2
            COMMON /BALNCE/ CFLUX,CHD1,CHD2,DIFF,ETFLUX,FLUX,FLUXS,FLXN,       COMBAL   3
          1  FLXPT ,PERCNT,PUMP,QREFLX,STOR,SUMR,TOTL1,TOTL2                   COMBAL   4
      C                                                                        COMBAL   5
      C                                                                        ENDD     2
      C     -------------------------------------------------------------------ENDD     3
      C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * *          ENDD     4
      C     -------------------------------------------------------------------ENDD     5
      C                                                                        ENDD     6
            COMMON /RIVR/ NRC(10),NADD(10),RQ(10),VK(20),RIVER(20),QMAX(20)    ENDD     7
          1,INDX(20,2),QRA(20,20),QS(10),NR ,NTOT,TQ(10)                       ENDD     8
      C                                                                        FD3D   313
            STORT24=STORL2 + STORL4                                            FD3D   324
            PERCN2 = ( STORL2/STORT24) *100.0                                  FD3D   325
            PERCN4 = ( STORL4/STORT24) *100.0                                  FD3D   326
            PERCN = (STORT24/PUMPT)*100.0                                      FD3D   327
            PERCNST = (STORT/PUMPT)* 100.0                                     FD3D   328
            PERCNCH = (CHST /PUMPT)* 100.0                                     FD3D   329
            WRITE(6,300) STORL2, PERCN2, STORL4, PERCN4                        FD3D   330
            WRITE(6,301) STORT24, PERCN                                        FD3D   331
      C     ---PRINT CUMULATIVE VOLUMES AND RATES---                           FD3D   332
      C                                                                        FD3D   333
            WRITE(OP,260)                                                      FD3D   334
            WRITE(OP,262) STORT,PERCNST,STOR,QRET,QREFLX,CFLUXT,CFLUX,CHST,    FD3D   335
          $ PERCNCH,PUMP,FLXPT,ETFLUX,TOTL1                                    FD3D   336
            WRITE(OP,264) CHD2,CHD1,ETFLXT,CHDT,FLUX,PUMPT,FLUXS,FLXNT,TOTL2,  FD3D   337
          $ SUMR,DIFF,PERCNT                                                   FD3D   338
      C                                                                        FD3D   339
      C     ---PRINT FLOW RATES TO CONSTANT HEAD NODES---                      FD3D   340
      C                                                                        FD3D   341
      C     ICHPNT = 0 PRINT CONSTANT HEAD FLUX                            JEC FIXFD   15
      C     ICHPNT = 1 NO PRINT OF CONSTANT HEAD FLUX                      JEC FIXFD   16
            IF(ICHPNT .EQ. 1) GO TO 240                                    JEC FIXFD   17
            IF (NCH.EQ.0) GO TO 240                                    CHK1400 FD3D   343
```

```
      WRITE(OP,270)
      WRITE(OP,280) ((JFLO(I,J),J=1,3),FLOW(I),I=1,NCH)
C
C     ---COMPUTE VERTICAL FLOW TO BOTTOM AND TOP LAYERS---
C
  240 X=0.
      Y=0.
C
C     ---RETURN IF ONLY ONE LAYER---
C
      IF (K0.EQ.1) RETURN
      DO 250 I=2,I1
      DO 250 J=2,J1
      X=X+(PHI(I,J,1)-PHI(I,J,2))*TK(I,J,1)*DELX(J)*DELY(I)*2./(DELZ(1)+
     1DELZ(2))
  250 Y=Y+(PHI(I,J,K1)-PHI(I,J,K0))*TK(I,J,K1)*DELX(J)*DELY(I)*2./(DELZ(
     1K1)+DELZ(K0))
      WRITE(OP,290) Y,X
C
      RETURN
C
C
C     ---FORMATS---
C
C
  260 FORMAT ("0",10X,"CUMULATIVE MASS BALANCE:",16X,"L**3",23X,"RATES F
     1OR THIS TIME STEP:",16X,"L**3/T",/11X,24("-"),43X,25("-"),16X,6("-
     2"),/17X,"SOURCES:",/17X,8("-"))
  262 FORMAT(" ",26X,"STORAGE =",1PE20.10,4X,0PF6.2,"% OF QUAN PUMPED",
     115X,"STORAGE =",  F20.4,/26X,"RECHARGE =",  F20.2,40X,"RECHARGE ="
     2,  F20.4,/21X,"CONSTANT FLUX ="  F20.2,35X,"CONSTANT FLUX =",  F20
     3.4,/21X,"CONSTANT HEAD =",1PE20.10,4X,0PF6.2,"% OF QUAN PUMPED",
     415X,"PUMPING =",  F20.4,/27X,"LEAKAGE =",  F20.2,30X,"EVAPOTRANSPI
     5RATION =",  F20.4,/21X,"TOTAL SOURCES =",1PE20.10,/90X,"CONSTANT H
     6EAD:")
  264 FORMAT(" ",16X,"DISCHARGES=",74X,"IN =",  F20.4,/17X,11("-"),70X,
     1"OUT =",  F20.4,/16X,"EVAPOTRANSPIRATION =",  F20.2,40X,"LEAKAGE:"
     2,/21X,"CONSTANT HEAD =" F20.2,20X,"FROM PREVIOUS PUMPING PERIOD =
     3",  F20.4,/19X,"QUANTITY PUMPED =",1PE20.10,43X,"TOTAL =",0PF20.4,
     4/27X,"LEAKAGE =",  F20.2,/19X,"TOTAL DISCHARGE =",1PE20.10,36X,"SU
     5M OF RATES =",0PF20.4,//17X,"DISCHARGE-SOURCES =",1PE20.10,/15X,
     6"PER CENT DIFFERENCE =",0PF20.2,/)
C
  270 FORMAT ("0FLOW RATES TO CONSTANT HEAD NODES:"/" ",34("-")//" ",3(9
     1X,"K",4X,"I",4X,"J",5X,"RATE (L**3/T)")/" ",3(9X,"-",4X,"-",4X,"-"
     2,5X,13("-"))/)
C
  280 FORMAT (/(1X,3(I10,2I5,E18.7)))
C
  290 FORMAT (1H0,19HFLOW TO TOP LAYER =, E15.7   , 25H   FLOW TO BOTTOM
     1LAYER =,E15.7,21H         POSITIVE UPWARD)
  300 FORMAT(" ","LAYER 2 STORAGE:",2X,1PE20.10,2X,0PF6.2,"%",8X,"LAYER
     14 STORAGE:",2X,1PE20.10,2X,0PF6.2,"%")
  301 FORMAT(" ","LAYER 2+4 STORAGE:",1PE20.10,17X,"STORAGE (2+4)/QUAN P
     1UMPED:",2X,0PF6.2,"%")
      END
```

```
      SUBROUTINE DATAIN                                                 FD3D 400
C                                                                       FD3D 401
C --------------------------------------------------------------DAT  30 FD3D 402
C                                                                       FD3D 403
C     READ AND WRITE DATA                                        DAT  40 FD3D 404
C                                                                       FD3D 405
C --------------------------------------------------------------DAT  50 FD3D 406
C                                                                DAT  60 FD3D 407
C                     * FOR SUBROUTINE DATAIN *                         DDATAIN 2
C                                                                       START  2
C ------------------------------------------------------------------   START  3
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   START  4
C ------------------------------------------------------------------   START  5
C                                                                       START  6
C     SPECIFICATIONS@                                                   START  7
C                                                                       START  8
C                                                                       IOS    2
C     --- THE FOLLOWING I/O DEVICES ARE USED ---                        IOS    3
C                                                                       IOS    4
C           * DEVICE *        * UNIT *        * NUMBER *                IOS    5
C                                                                       IOS    6
C          CARD READER          IC              5                       IOS    7
C          DISK                 ID              4                       IOS    8
C          CARD PUNCH           OC              7                       IOS    9
C          LINE PRINTER         OP              6                       IOS   10
C                                                                       IOS   11
      COMMON /IO/  IC , ID , OC , OP                                    IOS   12
C                                                                       IOS   13
      INTEGER IC,ID,OC,OP                                               IOS   14
      REAL LHEAD2, LHEAD4                                           JEC FIXDIM 33
C                                                                       IOS   15
C                                                                       CMT1   2
C     --- THE FOLLOWING ARE INDEPENDENT OF MODEL DIMENSIONS ---         CMT1   3
C                                                                       CMT1   4
C                                                                       CCK    2
      COMMON /CK/ CFLUXT , CHDT , CHST , ETFLXT , FLUXT , FLXNT ,       CCK    3
     1 PUMPT, QRET, STORT, STORL2, STORL4, SFAC2, SFAC4, SUBH2, SUBH4 JEC FIXDIM 29
C                                                                       CCK    5
C                                                                       CDPARAM 2
      COMMON /DPARAM/  B , D , F , H , RHO , SU , Z                     CDPARAM 3
C                                                                       CDPARAM 4
C                                                                       CHDG   2
      COMMON /HDG/  HEADNG(33)                                          CHDG   3
C                                                                       CHDG   4
C                                                                       CINTEGR 2
      COMMON /INTEGR/ IQ, I0 , I1 , I2 , IDK1 , IDK2, IDRAW , IERR ,    CINTEGR 3
     1  IFINAL , IFLO , IHEAD , IMAX , IPU1 , IPU2 , IQRE , IT , ITK ,  CINTEGR 4
     2  ITMAX , ITMX1 , IWATER , JQ, J0 , J1 , J2 , KQ, K0 , K1 , K2 ,  CINTEGR 5
     3  KP , KT , KTH , LENGTH , NCH , NPER , NUMT , NWEL               CINTEGR 6
     4 , NPWELL, IPWELL, ISS24,ICHPNT,ILHEAD                        JEC FIXDIM 32
C                                                                       CINTEGR 7
C                                                                       CPR    2
      COMMON /PR/ BLANK(60) , DIGIT(122) , DINCH , FACT1 , FACT2 ,      CPR    3
     1  N1 , N2 , N3 , NA(4) , PRNT(122) , SYM(17) , TITLE(6) , UNITS , CPR    4
     2  VF1(6) , VF2(6) , VF3(7) , XLABEL(3) , XN(100) , XN1 , XSCALE , CPR    5
     3  YLABEL(6) , YN(13) , YSCALE                                     CPR    6
C                                                                       CPR    7
```

```
      C                                                                 
            COMMON /SARRAY/ ICHK(13)                                    CSARRAY  2
      C                                                                 CSARRAY  3
      C                                                                 CSARRAY  4
            COMMON /SPARAM/ CDLT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX   CSPARAM  2
      C                                                                 CSPARAM  3
      C                                                                 CSPARAM  4
      C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---  MAX1     2
      C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX  MAX1     3
      C                                                                 MAX1     4
      C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING   MAX1     5
      C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504  FIXDIM  34
      C             PARAMETER(DIMENSION)     BASED ON LIMIT OF          FIXDIM  35
      C                                                                 MAX1     8
      C                DDN(100)             MAXIMUM HORIZONTAL DIMENSION=100   MAX1     9
      C                FLOW(100),JFLO(100,3) MAXIMUM CONSTANT HEAD NODES=100   MAX1    10
      C                ITTO(100)            MAXIMUM TIME STEPS = 100    MAX1    11
      C                LEVEL1(9),LEVEL2(9)  MAXIMUM LEVELS PRINTED IN MAPS=9   MAX1    12
      C                RHOP(20)             MAXIMUM ITERATION PARAMETERS=20    MAX1    13
      C                TEST3(101)           MAXIMUM ITERATIONS = 100    MAX1    14
      C                                                                 MAX1    15
            COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),        MAX1    16
           1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                    FIXDIM  38
      C                                                                 FIXDIM  39
      C                                                                 MAX1    29
      C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION  C515002  2
      C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)  FIXDIM  27
      C           , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---  FIXDIM  28
      C                                                                 C515002  5
            COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)           C515002  6
            COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)             FIXDIM  13
            COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)          FIXDIM  14
            COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)         FIXDIM  15
      C                                                                 FIXDIM  16
            COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)           515002A  6
            COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)      FIXDIM  20
            COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),        FIXDIM  21
           1$ LHEAD4(63,67)                                             FIXDIM  22
      C                                                                 FIXDIM  23
            LEVEL 2  ,OLD,STRT,TC,EL,XI                                 515002B  5
      C                                                                 515002B  6
      C                                                                 515002B  7
      C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM CMTNR    2
      C         WITHOUT RECHARGE TO THE TOP LEVEL ---                   CMTNR    3
      C         ------ ---------                                        CMTNR    4
      C                                                                 CMTNR    5
      C                                                                 CMTNR    6
            COMMON /RCHRG/ QRE(1,1)                                     NR       2
      C                                                                 NR       3
      C                                                                 NR       4
      C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM CMTNWT   2
      C         IN WHICH THE TOP LEVEL IS CONFINED                      CMTNWT   3
      C                                       --------                  CMTNWT   4
      C                                                                 CMTNWT   5
            COMMON /TABLE/ BOTTOM(1,1)   , PERM(1,1)                    NWT      2
      C                                                                 NWT      3
      C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE  NWT      4
                                                                        EQCOM    2
```

```
      C        ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"       EQCOM    3
      C                                                                         EQCOM    4
      C                                                                         EQCOM    5
      C      (ABOTTOM IS TRUNCATED TO SIX CHARACTERS AS ABOTTO)                 EQCOM    6
      C                                                                         515002AA 2
            DIMENSION AFACT(15),AOLD(21105),APHI(21105),AS(21105),              FIXDIM  17
           1$ ASTRT(21105),AT(21105),ATC(21105),ATK(21105),ATR(21105),          FIXDIM  18
           2$ AWELL(21105)                                                      FIXDIM  19
      C                                                                         515002AA 6
      C                                                                         515002BA 2
            DIMENSION AEL(21105),AFL(21105),AGL(21105),AV(21105),AXI(21105)     FIXDIM  24
      C                                                                         515002BA 4
      C                                                                         NRA      2
            DIMENSION  AQRE(1)                                                  NRA      3
      C                                                                         NRA      4
      C                                                                         NWTA     2
            DIMENSION  ABOTTO(1)   , APERM(1)                                   NWTA     3
      C                                                                         NWTA     4
      C                                                                         EQUIV    2
            EQUIVALENCE  (FACT,AFACT) , (OLD,AOLD) , (PHI,APHI) , (S,AS) ,      EQUIV    3
           1  (STRT,ASTRT) , (T,AT) , (TC,ATC) ,  (TK,ATK) , (TR,ATR) ,         EQUIV    4
           2  (WELL,AWELL) , (EL,AEL) , (FL,AFL) , (GL,AGL) , (V,AV) ,          EQUIV    5
           3  (XI,AXI) , (QRE,AQRE) , (BOTTOM,ABOTTO) , (PERM,APERM)            EQUIV    6
      C                                                                         EQUIV    7
      C                                                                         ENDD     2
      C     ------------------------------------------------------------------  ENDD     3
      C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *   ENDD     4
      C     ------------------------------------------------------------------  ENDD     5
      C                                                                         ENDD     6
            COMMON /RIVR/ NRC(10),NADD(10),RQ(10),VK(20),RIVER(20),QMAX(20)     ENDD     7
           1,INDX(20,2),QRA(20,20),QS(10),NR ,NTOT,TQ(10)                       ENDD     8
      C                                                                 DAT 300 FD3D   409
      C     ---READ TITLE, PROGRAM SIZE AND OPTIONS---                  MAN 180 FD3D   410
      C                                                                         FD3D   411
            READ(IC,960) HEADNG                                         MAN 190 FD3D   412
            WRITE(OP,950) HEADNG                                                FD3D   413
      C                                                                         FD3D   414
            READ(IC,920) I0,J0,K0,ITMAX,NCH                             MAN 210 FD3D   415
            WRITE(OP,940) I0,J0,K0,ITMAX,NCH                            MAN 220 FD3D   416
      C                                                                         FD3D   417
            READ(IC,970) IDRAW,IHEAD,IFLO,IDK1,IDK2,IWATER,IQRE,IPU1,IPU2,ITK MAN 230 FD3D   418
            WRITE(OP,980) IDRAW,IHEAD,IFLO,IDK1,IDK2,IWATER,IQRE,IPU1,IPU2,ITKMAN 240 FD3D   419
            IERR=0                                                      MAN 250 FD3D   420
      C                                                                 MAN 260 FD3D   421
      C     ---COMPUTE DIMENSIONS FOR ARRAYS---                         MAN 270 FD3D   422
      C                                                                         FD3D   423
            I1=I0-1                                                     MAN 290 FD3D   424
            J1=J0-1                                                     MAN 280 FD3D   425
            K1=K0-1                                                     MAN 300 FD3D   426
            I2=I0-2                                                     MAN 310 FD3D   427
            J2=J0-2                                                     MAN 320 FD3D   428
            K2=K0-2                                                     MAN 330 FD3D   429
            IMAX=MAX0(I0,J0)                                            MAN 340 FD3D   430
            ITMX1=ITMAX+1                                               MAN 360 FD3D   431
      C                                                                 MAN1160 FD3D   432
      C     ---READ AND WRITE SCALAR PARAMETERS---                      DAT 310 FD3D   433
      C                                                                         FD3D   434
```

```
           READ(IC,541) NPER,KTH,ERR,LENGTH
           WRITE(OP,560) NPER,KTH,ERR                                            FD3D  435
      C                                                                 DAT 330 FD3D  436
           READ(IC,760) XSCALE,YSCALE,DINCH,FACT1,(LEVEL1(I),I=1,9),FACT2,(LEDAT 340 FD3D  437
          1VEL2(I),I=1,9),UNITS                                         DAT 350 FD3D  438
           IF (XSCALE.NE.0.) WRITE(OP,810) XSCALE,YSCALE,UNITS,UNITS,DINCH,FADAT 360 FD3D  439
          1CT1,LEVEL1,FACT2,LEVEL2                                      DAT 370 FD3D  440
      C                                                                 DAT 380 FD3D  441
      C    CONTROL PARAMETERS FOR PRINTING WELLS. ----------                    FD3D  442
      C    IPWELL CONTROLS THE WELL PRINTOUT FOR EACH PERIOD. *******       JEC FIXFD   18
      C    IPWELL = 0 PRINT ALL WELLS                                       JEC FIXFD   19
      C    IPWELL = 1 PRINT NO WELLS                                        JEC FIXFD   20
      C    IPWELL = 2 PRINT 5 WELLS AT START AND 6 AT END.                  JEC FIXFD   21
      C                                                                     JEC FIXFD   22
      C    CONTROL PARAMETER FOR PRINTING CONSTANT HEAD FLUX.------------       FIXFD   23
      C    ICHPNT = 1 NO PRINT OF CONSTANT HEAD FLUX                        JEC FIXFD   24
      C    ICHPNT = 0 PRINT CONSTANT HEAD FLUX                              JEC FIXFD   25
      C    CONTROL PARAMETER FOR PRINTING LOWEST HEAD MATRIX.----------------JEC FIXFD   26
      C    ILHEAD = 1 PRINT OF LOW HEAD MATRIX                              JEC FIXFD   27
      C    ILHEAD = 0 NO PRINT OF LOW HEAD MATRIX                           JEC FIXFD   28
           READ(IC,920) IPWELL,ICHPNT,ILHEAD                                JEC FIXFD   29
      C                                                                     JEC FIXFD   30
      C    READ IN STOR COEF FACTORS AND CRITICAL HEAD VALUES ---------------   FIXFD   31
      C    ISS24 IS AN INDEX TO WRITE THE INDEX ARRAYS FOR CLAY STORAGE.    JEC FIXFD   32
           READ(IC,905) SFAC2, SFAC4, SUBH2, SUBH4, ISS24                   JEC FIXFD   33
           WRITE(OP,910) SFAC2, SFAC4, SUBH2, SUBH4                             FIXFD   34
       905 FORMAT(4F10.0,I10)                                                   FIXFD   35
       910 FORMAT(1H0,30X,"FACTORS TO CHANGE CLAY STORAGE AND CRITICAL HEAD V   FIXFD   36
          1$ALUES FOR STOR CHANGES:",/40X, "STOR COEF FACTOR 2 =",F10.2,/40X,JEC FIXFD   37
          2$"STOR COEF FACTOR 4 =",F10.2,/40X,"CRITICAL HEAD VALUE LAYER 2 =",JEC FIXFD   38
          3$F10.0,/40X,"CRITICAL HEAD VALUE LAYER 4 =",F10.0,/)             JEC FIXFD   39
      C    ---INITIALIZE ARRAYS---                                              FIXFD   40
      C                                                                         FD3D  443
           IF(IDK1 .EQ. ICHK(4)) GO TO 7                                        FD3D  444
           STORL2 = 0.0                                                     JEC FIXFD   41
           STORL4 = 0.0                                                     JEC FIXFD   42
           DO 6 I = 2,I1                                                    JEC FIXFD   43
           DO 6 J = 2, J1                                                   JEC FIXFD   44
           CSUB(I,J) = 0.0                                                  JEC FIXFD   45
           ISTOR2(I,J) = 0.0                                                JEC FIXFD   46
         6 ISTOR4(I,J) = 0                                                  JEC FIXFD   47
         7 CONTINUE                                                         JEC FIXFD   48
           DO 5 I=1,I0                                                      JEC FIXFD   49
           DO 5 J=1,J0                                                          FD3D  445
           DO 5 K=1,K0                                                          FD3D  446
           PHI(I,J,K)=0.0                                                       FD3D  447
           STRT(I,J,K)=0.0                                                      FD3D  448
           S(I,J,K)=0.0                                                         FD3D  449
           T(I,J,K)=0.0                                                         FD3D  450
           TR(I,J,K)=0.0                                                DAT 730 FD3D  451
           TC(I,J,K)=0.0                                                DAT 740 FD3D  452
           IF (K.NE.K0) TK(I,J,K)=0.0                                   DAT 750 FD3D  453
           WELL(I,J,K)=0.0                                              DAT 760 FD3D  454
         5 CONTINUE                                                     DAT 770 FD3D  455
      C                                                                         FD3D  456
      C    ---READ CUMULATIVE MASS BALANCE PARAMETERS---                        FD3D  457
      C                                                                 DAT 390 FD3D  458
                                                                                FD3D  459
```

```
      READ(IC,710) SUM,SUMP,PUMPT,CFLUXT,QRET,CHST,CHDT,FLUXT,STORT,ETFLDAT 400 FD3D   460
     1XT,FLXNT                                                          DAT 410 FD3D   461
C                                                                               FD3D   462
C     ---CHECK FOR RESTART DATA ON DISK---                                      FD3D   463
C                                                                               FD3D   464
      IF (IDK1.EQ.ICHK(4)) GO TO 20                                     DAT 420 FD3D   465
C                                                                               FD3D   466
C     ---CHECK FOR RESTART HEAD VALUES ON CARDS---                              FD3D   467
C                                                                               FD3D   468
      IF (IPU1.NE.ICHK(8)) GO TO 50                                     DAT 430 FD3D   469
C                                                                       DAT 440 FD3D   470
C     ---READ RESTART HEAD VALUES FROM CARDS---                                 FD3D   471
C                                                                               FD3D   472
      DO 10 K=1,K0                                                      DAT 460 FD3D   473
      DO 10 I=1,I0                                                      DAT 470 FD3D   474
   10 READ(IC,620) (PHI(I,J,K),J=1,J0)                                  DAT 480 FD3D   475
      GO TO 30                                                          DAT 490 FD3D   476
C                                                                       DAT 500 FD3D   477
C     ---READ INITIAL HEAD AND MASS BALANCE PARAMETERS FROM DISK---     DAT 510 FD3D   478
C                                                                               FD3D   479
   20 READ(ID) PHI,SUM,SUMP,PUMPT,CFLUXT,QRET,CHST,CHDT,FLUXT,STORT,ETFLDAT 520 FD3D   480
     1XT, FLXNT, STORL2, STORL4, ISTOR2, ISTOR4,S, CSUB,LHEAD2,LHEAD4      JEC  FIXFD    50
      REWIND ID                                                         DAT 540 FD3D   482
C                                                                               FD3D   483
                                                                                FD3D   484
C                                                                               FD3D   485
   30 WRITE(OP,690) SUM                                                 DAT 550 FD3D   486
      DO 40 K=1,K0                                                      DAT 560 FD3D   487
      WRITE(OP,700) K                                                   DAT 570 FD3D   488
      DO 40 I=1,I0                                                      DAT 580 FD3D   489
   40 WRITE(OP,580) I,(PHI(I,J,K),J=1,J0)                               DAT 590 FD3D   490
C                                                                       DAT 600 FD3D   491
C                                                                               FD3D   492
C     ---READ DATA ARRAYS---                                                    FD3D   493
C     ************************                                                  FD3D   494
C     LOGIC IS SIMILAR FOR ALL VARIABLES---                                     FD3D   495
C     ONLY THE FIRST INPUT SEQUENCE IS DOCUMENTED                               FD3D   496
C                                                                               FD3D   497
C                                                                               FD3D   498
C     ............................ STRT (STARTING HEAD) .............DAT 610 FD3D   499
C                                                                               FD3D   500
C     ---INPUT ARRAYS BY LEVELS BEGINNING WITH THE BOTTOM LEVEL---              FD3D   501
C                                                                               FD3D   502
   50 DO 100 K=1,K0                                                     DAT 620 FD3D   503
C                                                                               FD3D   504
C     ---READ INPUT OPTIONS                                                     FD3D   505
C                                                                               FD3D   506
      READ(IC,542) FAC,IVAR,IPRN                                                FD3D   507
C                                                                               FD3D   508
C     ---IF VARIABLE DATA IS TO BE PRINTED WRITE LEVEL NUMBER---                FD3D   509
C                                                                               FD3D   510
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,530) K                      DAT 640 FD3D   511
      DO 90 I=1,I0                                                      DAT 650 FD3D   512
C                                                                               FD3D   513
C     ---IF VARIABLE DATA READ A ROW OF VALUES---                               FD3D   514
      IF (IVAR.EQ.1) READ(10,620)(STRT(I,J,K),J=1,J0)                           FD3D   515
C                                                                               FD3D   516
```

```
      C                                                          
      C     ---ADJUST INPUT VALUES---                                    FD3D   517
      C                                                                  FD3D   518
            DO 89 J = 1,J0                                          JEC  FIXFD   51
      C                                                                  FD3D   520
            IF (IVAR.NE.1) GO TO 60                           DAT 680   FD3D   521
      C                                                                  FD3D   522
      C     ---FOR VARIABLE DATA FAC IS A MULTIPLICATION FACTOR---       FD3D   523
      C                                                                  FD3D   524
            STRT(I,J,K)=STRT(I,J,K)*FAC                       DAT 690   FD3D   525
            GO TO 70                                          DAT 700   FD3D   526
      C                                                                  FD3D   527
      C     ---FOR CONSTANT DATA FAC IS THE CONSTANT VALUE---            FD3D   528
      C                                                                  FD3D   529
         60 STRT(I,J,K)=FAC                                   DAT 710   FD3D   530
         70 CONTINUE                                                     FD3D   531
      C                                                                  FD3D   532
      C     ---UNLESS THIS IS A RESTART PHI=STRT                         FD3D   533
      C                                                                  FD3D   534
         80 IF(IDK1 .NE. ICHK(4) .AND. IPU1 .NE. ICHK(8)) GO TO 81  JEC  FIXFD   52
            GO TO 89                                                JEC  FIXFD   53
         81 PHI(I,J,K) = STRT(I,J,K)                                JEC  FIXFD   54
      C     INITIALIZE LOW HEAD IN CLAY LAYERS.                     JEC  FIXFD   55
            GO TO (89,82,89,84,89),K                                JEC  FIXFD   56
         82 LHEAD2(I,J) = STRT(I,J,2)                               JEC  FIXFD   57
            GO TO 89                                                JEC  FIXFD   58
         84 LHEAD4(I,J) = STRT(I,J,4)                               JEC  FIXFD   59
         89 CONTINUE                                                JEC  FIXFD   60
      C                                                                  FD3D   536
      C     ---PRINT ROW OF VARIABLE DATA IF OPTION IS SELECTED---       FD3D   537
      C                                                                  FD3D   538
            IF (IVAR.EQ.0..OR.IPRN.EQ.1) GO TO 90             DAT 790   FD3D   539
            WRITE(OP,580) I,(STRT(I,J,K),J=1,J0)              DAT 800   FD3D   540
         90 CONTINUE                                          DAT 810   FD3D   541
      C                                                                  FD3D   542
      C     ---IF CONSTANT DATA PRINT VALUE                              FD3D   543
      C                                                                  FD3D   544
            IF (IVAR.EQ.0) WRITE(OP,460) FAC,K                DAT 820   FD3D   545
        100 CONTINUE                                          DAT 830   FD3D   546
      C     OPTION TO WRITE INITIAL LOW HEAD VALUES.                JEC  FIXFD   61
            IF(ILHEAD .EQ. 0) GO TO 105                             JEC  FIXFD   62
            WRITE(6,535)                                            JEC  FIXFD   63
            DO 106 I = 2,I1                                         JEC  FIXFD   64
        106 WRITE(6,581) I, (LHEAD2(I,J),J=2,J1)                    JEC  FIXFD   65
            WRITE(6,950)                                            JEC  FIXFD   66
            DO 108 I = 2,I1                                         JEC  FIXFD   67
        108 WRITE(6,581) I, (LHEAD4(I,J),J=2,J1)                    JEC  FIXFD   68
      C     ...........................S (STORAGE COEFFICIENT) ...........DAT 840 FD3D   548
      C                                                                  FD3D   549
        105 IF(IDK1 .EQ. ICHK(4)) GO TO 141                              FIXFD   69
            DO 140 K=1,K0                                     DAT 850   FD3D   550
            READ(IC,543)FAC,IVAR,IPRN                               JEC  FIXFD   70
            IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,610) K      DAT 870   FD3D   552
            DO 130 I=1,I0                                     DAT 880   FD3D   553
            IF (IVAR.EQ.1) READ(11,550) (S(I,J,K),J=1,J0)                FD3D   554
            DO 120 J=1,J0                                     DAT 900   FD3D   555
            IF (IVAR.NE.1) GO TO 110                          DAT 910   FD3D   556
            S(I,J,K)=S(I,J,K)*FAC                             DAT 920   FD3D   557
```

```
      GO TO 120                                                          DAT 930 FD3D   558
  110 S(I,J,K)=FAC                                                       DAT 940 FD3D   559
  120 CONTINUE                                                           DAT 950 FD3D   560
  130 IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,590) I,(S(I,J,K),J=1,J0)    DAT 960 FD3D   561
      IF (IVAR.EQ.0) WRITE(OP,470) FAC,K                                 DAT 970 FD3D   562
  140 CONTINUE                                                           DAT 980 FD3D   563
  141 CONTINUE                                                               JEC FIXFD   71
C     .............................. T(TRANSMISSIVITY) ................DAT 990 FD3D   565
C                                                                                FD3D   566
      DO 180 K=1,K0                                                      DAT1000 FD3D   567
      READ(IC,543) FAC,IVAR,IPRN,(FACT(K,I),I=1,3)                               FD3D   568
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,570) K,(FACT(K,I),I=1,3)    DAT1020 FD3D   569
      DO 170 I=1,I0                                                      DAT1030 FD3D   570
      IF(IVAR.EQ.1) READ(12,550) (T(I,J,K),J=1,J0)                              FD3D   571
      DO 160 J=1,J0                                                      DAT1050 FD3D   572
      IF (IVAR.NE.1) GO TO 150                                           DAT1060 FD3D   573
      T(I,J,K)=T(I,J,K)*FAC                                              DAT1070 FD3D   574
      GO TO 160                                                          DAT1080 FD3D   575
  150 T(I,J,K)=FAC                                                       DAT1090 FD3D   576
      IF (I.EQ.1.OR.I.EQ.I0.OR.J.EQ.1.OR.J.EQ.J0) T(I,J,K)=0.0          DAT1100 FD3D   577
  160 CONTINUE                                                           DAT1110 FD3D   578
  170 IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,590) I,(T(I,J,K),J=1,J0)    DAT1120 FD3D   579
      IF (IVAR.EQ.0) WRITE(OP,480) FAC,K,(FACT(K,I),I=1,3)              DAT1130 FD3D   580
  180 CONTINUE                                                           DAT1140 FD3D   581
      IF (ITK.NE.ICHK(10)) GO TO 230                                     DAT1150 FD3D   582
C                                                                                FD3D   583
C     .................................... TK ........................DAT1160 FD3D   584
C                                                                                FD3D   585
      DO 220 K=1,K1                                                      DAT1170 FD3D   586
      READ(IC,542) FAC,IVAR,IPRN                                                 FD3D   587
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,720) K                       DAT1190 FD3D   588
      DO 210 I=1,I0                                                      DAT1200 FD3D   589
      IF (IVAR.EQ.1) READ(13,559) (TK(I,J,K),J=1,J0)                             FD3D   590
      DO 200 J=1,J0                                                      DAT1220 FD3D   591
      IF (IVAR.NE.1) GO TO 190                                           DAT1230 FD3D   592
      TK(I,J,K)=TK(I,J,K)*FAC                                            DAT1240 FD3D   593
      GO TO 200                                                          DAT1250 FD3D   594
  190 TK(I,J,K)=FAC                                                      DAT1260 FD3D   595
  200 CONTINUE                                                           DAT1270 FD3D   596
  210 IF(IVAR .EQ. 1 .AND. IPRN .NE. 1)WRITE(OP,590)I,(TK(I,J,K),J=1,J0)    JEC FIXFD   72
      IF (IVAR.EQ.0) WRITE(OP,490) FAC,K                                 DAT1290 FD3D   598
  220 CONTINUE                                                           DAT1300 FD3D   599
  230 IF (IWATER.NE.ICHK(6)) GO TO 300                                   DAT1310 FD3D   600
C                                                                                FD3D   601
C     ................................ PERM (HYDRAULIC CONDUCTIVITY) ...DAT1320 FD3D   602
C                                                                                FD3D   603
      READ(IC,542) FAC,IVAR,IPRN                                                 FD3D   604
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,780)                         DAT1340 FD3D   605
      DO 260 I=1,I0                                                      DAT1350 FD3D   606
      IF (IVAR.EQ.1) READ(IC,550) (PERM(I,J),J=1,J0)                     DAT1360 FD3D   607
      DO 250 J=1,J0                                                      DAT1370 FD3D   608
      IF (IVAR.NE.1) GO TO 240                                           DAT1380 FD3D   609
      PERM(I,J)=PERM(I,J)*FAC                                            DAT1390 FD3D   610
      GO TO 250                                                          DAT1400 FD3D   611
  240 PERM(I,J)=FAC                                                      DAT1410 FD3D   612
      IF (I.EQ.1.OR.I.EQ.I0.OR.J.EQ.1.OR.J.EQ.J0) PERM(I,J)=0.          DAT1420 FD3D   613
  250 CONTINUE                                                           DAT1430 FD3D   614
```

```
      260 IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,770) I,(PERM(I,J),J=1,J0)  DAT1440 FD3D
          IF (IVAR.NE.1) WRITE(OP,730) FAC                                 DAT1450 FD3D
C                                                                                  FD3D
C         .......................................BOTTOM ...............DAT1460 FD3D
C                                                                                  FD3D
          READ(IC,542) FAC,IVAR,IPRN                                               FD3D
          IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,790)                       DAT1480 FD3D
          DO 290 I=1,I0                                                    DAT1490 FD3D
          IF (IVAR.EQ.1) READ(IC,550) (BOTTOM(I,J),J=1,J0)                 DAT1500 FD3D
          DO 280 J=1,J0                                                    DAT1510 FD3D
          IF (IVAR.NE.1) GO TO 270                                         DAT1520 FD3D
          BOTTOM(I,J)=BOTTOM(I,J)*FAC                                      DAT1530 FD3D
          GO TO 280                                                        DAT1540 FD3D
      270 BOTTOM(I,J)=FAC                                                  DAT1550 FD3D
      280 CONTINUE                                                         DAT1560 FD3D
      290 IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,580) I,(BOTTOM(I,J),J=1,J0) DAT1570 FD3D
          IF (IVAR.NE.1) WRITE(OP,740) FAC                                 DAT1580 FD3D
C                                                                                  FD3D
C         ........................................ QRE  ................DAT1590 FD3D
C                                                                                  FD3D
      300 IF (IQRE.NE.ICHK(7)) GO TO 340                                   DAT1600 FD3D
          READ(IC,542) FAC,IVAR,IPRN                                               FD3D
          IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,800)                       DAT1620 FD3D
          DO 330 I=1,I0                                                    DAT1630 FD3D
          IF (IVAR.EQ.1) READ(IC,550) (QRE(I,J),J=1,J0)                    DAT1640 FD3D
          DO 320 J=1,J0                                                    DAT1650 FD3D
          IF (IVAR.NE.1) GO TO 310                                         DAT1660 FD3D
          QRE(I,J)=QRE(I,J)*FAC                                            DAT1670 FD3D
          GO TO 320                                                        DAT1680 FD3D
      310 QRE(I,J)=FAC                                                     DAT1690 FD3D
      320 CONTINUE                                                         DAT1700 FD3D
      330 IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,770) I,(QRE(I,J),J=1,J0)   DAT1710 FD3D
          IF (IVAR.NE.1) WRITE(OP,750) FAC                                 DAT1720 FD3D
C                                                                                  FD3D
C         ................................ DELX ............................DAT1730 FD3D
C                                                                                  FD3D
      340 CONTINUE                                                                 FD3D
          READ(IC,542) FAC,IVAR,IPRN                                               FD3D
          IF (IVAR.EQ.1) READ(IC,540) (DELX(J),J=1,J0)                     DAT1750 FD3D
          DO 360 J=1,J0                                                    DAT1760 FD3D
          IF (IVAR.NE.1) GO TO 350                                         DAT1770 FD3D
          DELX(J)=DELX(J)*FAC                                              DAT1780 FD3D
          GO TO 360                                                        DAT1790 FD3D
      350 DELX(J)=FAC                                                      DAT1800 FD3D
      360 CONTINUE                                                         DAT1810 FD3D
          IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,630) (DELX(J),J=1,J0)      DAT1820 FD3D
          IF (IVAR.EQ.0) WRITE(OP,500) FAC                                 DAT1830 FD3D
C                                                                                  FD3D
C         ................................ DELY ............................DAT1840 FD3D
C                                                                                  FD3D
          READ(IC,542) FAC,IVAR,IPRN                                               FD3D
          IF (IVAR.EQ.1) READ(IC,540) (DELY(I),I=1,I0)                     DAT1860 FD3D
          DO 380 I=1,I0                                                    DAT1870 FD3D
          IF (IVAR.NE.1) GO TO 370                                         DAT1880 FD3D
          DELY(I)=DELY(I)*FAC                                              DAT1890 FD3D
          GO TO 380                                                        DAT1900 FD3D
      370 DELY(I)=FAC                                                      DAT1910 FD3D
```

```
  380 CONTINUE                                                      DAT1920 FD3D   672
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,640) (DELY(I),I=1,I0)   DAT1930 FD3D   673
      IF (IVAR.EQ.0) WRITE(OP,510) FAC                              DAT1940 FD3D   674
C                                                                           FD3D   675
C     ............................ DELZ ............................DAT1950 FD3D   676
C                                                                           FD3D   677
      READ(IC,542) FAC,IVAR,IPRN                                            FD3D   678
      IF (IVAR.EQ.1) READ(IC,540) (DELZ(K),K=1,K0)                  DAT1970 FD3D   679
      DO 400 K=1,K0                                                 DAT1980 FD3D   680
      IF (IVAR.NE.1) GO TO 390                                      DAT1990 FD3D   681
      DELZ(K)=DELZ(K)*FAC                                           DAT2000 FD3D   682
      GO TO 400                                                     DAT2010 FD3D   683
  390 DELZ(K)=FAC                                                   DAT2020 FD3D   684
  400 CONTINUE                                                      DAT2030 FD3D   685
      IF (IVAR.EQ.1.AND.IPRN.NE.1) WRITE(OP,650) (DELZ(K),K=1,K0)   DAT2040 FD3D   686
      IF (IVAR.EQ.0) WRITE(OP,520) FAC                              DAT2050 FD3D   687
C                                                                   DAT2060 FD3D   688
C     ...................... RIVER ...............................          FD3D   689
      FLXPT=0.0                                                             FD3D   690
C     NR     = NUMBER OF RIVERS                                             FD3D   691
C     NTOT   = TOTAL NUMBER OF RIVER BLOCKS                                 FD3D   692
      READ(5,21) NR,NTOT                                                    FD3D   693
      IF(NR.EQ.0)GO TO 46                                                   FD3D   694
C     VK     = VERTICAL CONDUCTIVITY/THICKNESS OF RIVER BED (1/T)           FD3D   695
C     RIVER  = ELEVATION OF WATER IN STREAM                                 FD3D   696
C     QMAX   = MAXIMUM INFILTRATION FOR A BLOCK (L**3/T)                    FD3D   697
C     INDX   = CONTAINS LOCATION OF BLOCK IN 2-D ARRAY                      FD3D   698
C                                                                           FD3D   699
      READ(5,23)(VK(I),I=1,NTOT)                                            FD3D   700
      READ(5,23)(RIVER(I),I=1,NTOT)                                         FD3D   701
      READ(5,23)(QMAX(I),I=1,NTOT)                                          FD3D   702
      READ(5,21)(INDX(I,1),INDX(I,2),I=1,NTOT)                              FD3D   703
C                                                                           FD3D   704
C     NRC    = NUMBER OF CELLS FOR EACH RIVER                               FD3D   705
C     NADD   = STREAM TO WHICH SURPLUS DISCHARGE IS TO BE ADDED             FD3D   706
C                                                                           FD3D   707
      READ(5,21)(NRC(I),I=1,NR)                                             FD3D   708
      READ(5,21)(NADD(I),I=1,NR)                                            FD3D   709
C                                                                           FD3D   710
C     RQ     = DISCHARGE FOR RIVER FOR THIS PUMPING PERIOD                  FD3D   711
C                                                                           FD3D   712
   21 FORMAT(20I4)                                                          FD3D   713
   23 FORMAT(8F10.0)                                                        FD3D   714
      WRITE(6,41)NR,NTOT                                                    FD3D   715
   41 FORMAT(*0NUMBER OF RIVERS =*,I5/*0TOTAL NUMBER OF RIVER BLOCKS =*,    FD3D   716
     1I5)                                                                   FD3D   717
      WRITE(6,42)                                                           FD3D   718
   42 FORMAT(*0STREAM    BLOCKS    SURPLUS*)                                FD3D   719
      WRITE(6,43)(I,NRC(I),NADD(I),I=1,NR)                                  FD3D   720
   43 FORMAT(I5,2I10)                                                       FD3D   721
      WRITE(6,44)                                                           FD3D   722
   44 FORMAT(*0BLOCK NO.  I , J     VK          RIVER      QMAX*)           FD3D   723
      DO 47 I=1,NTOT                                                        FD3D   724
   47 WRITE(6,45) I,INDX(I,1),INDX(I,2),VK(I),RIVER(I),QMAX(I)              FD3D   725
   45 FORMAT(*0*,I5,I7,I4,3E10.3)                                           FD3D   726
C     ---INITIALIZE VARIABLES---                                    DAT2070 FD3D   727
   46 B=0.                                                                  FD3D   728
```

```
      D=0.                                                              DAT2090 FD3D  729
      F=0.                                                              DAT2100 FD3D  730
      H=0.                                                              DAT2110 FD3D  731
      SU=0.                                                             DAT2120 FD3D  732
      Z=0.                                                              DAT2130 FD3D  733
C                                                                               FD3D  734
C     ---INITIALIZE VARIABLES FOR PLOT---                                       FD3D  735
C                                                                               FD3D  736
      IF (XSCALE.NE.0.) CALL SETMAP                                     DAT2140 FD3D  737
C                                                                               FD3D  738
      RETURN                                                            DAT2150 FD3D  739
C                                                                               FD3D  740
C                                                                               FD3D  741
C     ---FORMATS---                                                             FD3D  742
C                                                                               FD3D  743
C                                                                               FD3D  744
  920 FORMAT (8I10)                                                     MAN1630 FD3D  745
C                                                                               FD3D  746
  940 FORMAT ("0",62X,"NUMBER OF ROWS =",I5/60X,"NUMBER OF COLUMNS =",I5MAN1650 FD3D  747
     1/61X,"NUMBER OF LAYERS =",I5//39X,"MAXIMUM PERMITTED NUMBER OF ITEMAN1660 FD3D  748
     2RATIONS =",I5//48X,"NUMBER OF CONSTANT HEAD NODES =",I5)          MAN1670 FD3D  749
C                                                                               FD3D  750
  950 FORMAT ("1",33A4)                                                 MAN1680 FD3D  751
C                                                                               FD3D  752
  960 FORMAT (20A4)                                                     MAN1690 FD3D  753
C                                                                               FD3D  754
  970 FORMAT (16(A4,1X))                                                MAN1700 FD3D  755
C                                                                               FD3D  756
  980 FORMAT ("-SIMULATION OPTIONS:  ",11(A4,4X))                       MAN1710 FD3D  757
C                                                                               FD3D  758
  460 FORMAT (1H0, 63X,15HSTARTING HEAD =,E15.7,10H FOR LAYER , I3)             FD3D  759
C                                                                               FD3D  760
  470 FORMAT (1H0,57X,21HSTORAGE COEFFICIENT =,E15.7,10H FOR LAYER ,I3)         FD3D  761
C                                                                               FD3D  762
  480 FORMAT (1H0,62X,16HTRANSMISSIVITY =,E15.7 ,10H FOR LAYER, I3 /            FD3D  763
     1  39X,39HDIRECTIONAL MULTIPLICATION FACTORS, X = ,E15.7       /           FD3D  764
     2  75X,3HY = , E15.7  /  75X,3HZ = , E15.7 )                               FD3D  765
C                                                                               FD3D  766
  490 FORMAT (1H0,67X,11HTK MATRIX =,E15.7,10H FOR LAYER, I3)                   FD3D  767
C                                                                               FD3D  768
  500 FORMAT (1H0,72X, 6HDELX = , E15.7)                                        FD3D  769
C                                                                               FD3D  770
  510 FORMAT (1H0,72X, 6HDELY = , E15.7)                                        FD3D  771
C                                                                               FD3D  772
  520 FORMAT (1H0,72X, 6HDELZ = , E15.7)                                        FD3D  773
C                                                                               FD3D  774
  530 FORMAT ("1",55X,"STARTING HEAD MATRIX, LAYER",I3/56X,30("-"))     DAT2620 FD3D  775
C                                                                               FD3D  776
 535  FORMAT(1H1,30X,"INITIAL LOW HEAD MATRIX--LHEAD2 LISTED FIRST THAN     JEC FIXFD  73
     1S LHEAD4",//)                                                         JEC FIXFD  74
  540 FORMAT (8F10.0)                                                           FD3D  777
  541 FORMAT (2I10,F10.0,I10)                                                   FD3D  778
 542  FORMAT(F10.0,2I10,3F10.0)                                             JEC FIXFD  75
 543  FORMAT(E10.0,2I10,3F10.0)                                             JEC FIXFD  76
C                                                                               FD3D  781
  550 FORMAT (20F4.0)                                                   DAT2640 FD3D  782
 559  FORMAT( 5E15.6)                                                           FD3D  783
```

```
      C                                                                   FD3D   784
        560 FORMAT (1H0,51X,27HNUMBER OF PUMPING PERIODS =,I5 /           FD3D   785
           1  49X,30HTIME STEPS BETWEEN PRINTOUTS =,I5 //                 FD3D   786
           2  51X,28HERROR CRITERIA FOR CLOSURE =,E15.7 /)                FD3D   787
      C                                                                   FD3D   788
        570 FORMAT (1H1,59X,"TRANSMISSIVITY MATRIX, LEVEL",I3/60X,31("-")/20X,DAT2670 FD3D   789
           1"DIRECTIONAL MULTIPLICATION FACTORS, X=",F10.4," Y =",F10.4," Z ="DAT2680 FD3D   790
           2,F10.4)                                                   DAT2690 FD3D   791
      C                                                                   FD3D   792
        580  FORMAT(1H ,I2,2X,18F7.1/(5X,18F7.1))                     JEC FIXFD   77
        581  FORMAT(1H ,I2,2X,18F7.1/(5X,18F7.1))                     JEC FIXFD   78
      C                                                                   FD3D   794
        590  FORMAT(1H0,1P,I5,10E12.4/(1H ,5X,10E12.4))               JEC FIXFD   79
      C                                                                   FD3D   796
        600 FORMAT ("0",I5,10E12.5/(" ",5X,10E12.5))                  DAT2720 FD3D   797
      C                                                                   FD3D   798
        610 FORMAT (1H1,49X,"STORAGE COEFFICIENT MATRIX, LAYER",I3/50X,36("-")DAT2730 FD3D   799
           1)                                                         DAT2740 FD3D   800
      C                                                                   FD3D   801
        620   FORMAT(20F4.0)                                              FD3D   802
      C                                                                   FD3D   803
        630 FORMAT (1H1,46X,40HGRID SPACING IN PROTOTYPE IN X DIRECTION/47X,40DAT2760 FD3D   804
           1("-")//("0",12F10.0))                                     DAT2770 FD3D   805
      C                                                                   FD3D   806
        640 FORMAT (1H-,46X,40HGRID SPACING IN PROTOTYPE IN Y DIRECTION/47X,40DAT2780 FD3D   807
           1("-")//("0",12F10.0))                                     DAT2790 FD3D   808
      C                                                                   FD3D   809
        650 FORMAT (1H-,46X,40HGRID SPACING IN PROTOTYPE IN Z DIRECTION/47X,40DAT2800 FD3D   810
           1("-")//("0",12F10.0))                                     DAT2810 FD3D   811
      C                                                                   FD3D   812
        690 FORMAT (1H-,40X,27H CONTINUATION - HEAD AFTER , E20.7 ,       FD3D   813
           1  13H SEC PUMPING , / 42X, 58(1H-) )                          FD3D   814
      C                                                                   FD3D   815
        700 FORMAT ("1",55X,"INITIAL  HEAD MATRIX, LAYER",I3/56X,30("-"))  DAT2900 FD3D   816
      C                                                                   FD3D   817
        710 FORMAT (4E20.10)                                              FD3D   818
      C                                                                   FD3D   819
        720 FORMAT ("1",55X,"TK MATRIX, LAYER",I3/56X,19("-"))        DAT2920 FD3D   820
      C                                                                   FD3D   821
        730 FORMAT (1H0,43X,35HUPPER UNIT HYDRAULIC CONDUCTIVITY =, E15.7)  FD3D   822
      C                                                                   FD3D   823
        740 FORMAT (1H0,60X,18HBOTTOM ELEVATION =, E15.7)                 FD3D   824
      C                                                                   FD3D   825
        750 FORMAT (1H0,63X,15HRECHARGE RATE =, E15.7)                    FD3D   826
      C                                                                   FD3D   827
        760 FORMAT (3F10.0,2(F10.0,9I1,1X),A8)                            FD3D   828
      C                                                                   FD3D   829
        770 FORMAT (1H0,I5,10E11.3/(1H ,5X,10E11.3))                  DAT2970 FD3D   830
      C                                                                   FD3D   831
        780 FORMAT (1H1,52X,29HHYDRAULIC CONDUCTIVITY MATRIX/53X,29("-"))  DAT2980 FD3D   832
      C                                                                   FD3D   833
        790 FORMAT (1H1,43X,43HELEVATION OF IMPERMEABLE BASE OF UPPER UNIT/44XDAT2990 FD3D   834
           1,43("-"))                                                 DAT3000 FD3D   835
      C                                                                   FD3D   836
        800 FORMAT ("1",60X,"RECHARGE RATE"/61X,13("-"))              DAT3010 FD3D   837
      C                                                                   FD3D   838
        810 FORMAT (1H0,30X,18HON ALPHAMERIC MAP: /                       FD3D   839
```

```
          1  40X,39HMULTIPLICATION FACTOR FOR X DIMENSION =, E15.7 /         FD3D   840
          2  40X,39HMULTIPLICATION FACTOR FOR Y DIMENSION =, E15.7  /        FD3D   841
630       3  55X,23HMAP SCALE IN UNITS OF  , A11  /                          FD3D   842
          4  50X,10HNUMBER OF , A8 ,11H PER INCH =, E15.7 /                  FD3D   843
          5  43X,36HMULTIPLICATION FACTOR FOR DRAWDOWN =,E15.7,19H PRINTED FO FD3D  844
          6R LAYERS,9I2 /                                                    FD3D   845
          7  47X,32HMULTIPLICATION FACTOR FOR HEAD =,E15.7,19H PRINTED FOR LA FD3D  846
635       8YERS,9I2)                                                         FD3D   847
      C                                                                      FD3D   848
          END                                                         DAT3080-FD3D  849
```

```
      SUBROUTINE ITER                                                   FD3D 850
C                                                                       FD3D 851
C     ------------------------------------------------------------------FD3D 852
C                                                                       FD3D 853
C     ---COMPUTE AND PRINT ITERATION PARAMETERS---               SP3 290 FD3D 854
C                                                                       FD3D 855
C     ------------------------------------------------------------------FD3D 856
C                   * FOR SUBROUTINE ITER *                             DITER  2
C                                                                       START  2
C     ------------------------------------------------------------------START  3
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *  START  4
C     ------------------------------------------------------------------START  5
C                                                                       START  6
C     SPECIFICATIONS@                                                   START  7
C                                                                       START  8
C                                                                       IOS    2
C     --- THE FOLLOWING I/O DEVICES ARE USED ---                        IOS    3
C                                                                       IOS    4
C          * DEVICE *          * UNIT *        * NUMBER *               IOS    5
C                                                                       IOS    6
C               CARD READER        IC              5                    IOS    7
C               DISK               ID              4                    IOS    8
C               CARD PUNCH         OC              7                    IOS    9
C               LINE PRINTER       OP              6                    IOS   10
C                                                                       IOS   11
      COMMON /IO/  IC , ID , OC , OP                                    IOS   12
C                                                                       IOS   13
      INTEGER IC,ID,OC,OP                                               IOS   14
      REAL LHEAD2, LHEAD4                                           JEC FIXDIM 33
C                                                                       IOS   15
C                                                                       CMT1   2
C     --- THE FOLLOWING ARE INDEPENDENT OF MODEL DIMENSIONS ---         CMT1   3
C                                                                       CMT1   4
C                                                                       CCK    2
      COMMON /CK/ CFLUXT , CHDT , CHST , ETFLXT , FLUXT , FLXNT ,       CCK    3
     1 PUMPT, QRET, STORT, STORL2, STORL4, SFAC2, SFAC4, SUBH2, SUBH4 JEC FIXDIM 29
C                                                                       CCK    5
C                                                                       CDPARAM 2
      COMMON /DPARAM/  B , D , F , H , RHO , SU , Z                     CDPARAM 3
C                                                                       CDPARAM 4
C                                                                       CHDG   2
      COMMON /HDG/  HEADNG(33)                                          CHDG   3
C                                                                       CHDG   4
C                                                                       CINTEGR 2
      COMMON /INTEGR/ IQ, I0 , I1 , I2 , IDK1 , IDK2, IDRAW , IERR ,    CINTEGR 3
     1 IFINAL , IFLO , IHEAD , IMAX , IPU1 , IPU2 , IQRE , IT , ITK ,   CINTEGR 4
     2 ITMAX , ITMX1 , IWATER , JQ, J0 , J1 , J2 , KQ, K0 , K1 , K2 ,   CINTEGR 5
     3 KP , KT , KTH , LENGTH , NCH , NPER , NUMT , NWEL                CINTEGR 6
     4 , NPWELL, IPWELL, ISS24,ICHPNT,ILHEAD                        JEC FIXDIM 32
C                                                                       CINTEGR 7
C                                                                       CPR    2
      COMMON /PR/ BLANK(60) , DIGIT(122) , DINCH , FACT1 , FACT2 ,      CPR    3
     1 N1 , N2 , N3 , NA(4) , PRNT(122) , SYM(17) , TITLE(6) , UNITS ,  CPR    4
     2 VF1(6) , VF2(6) , VF3(7) , XLABEL(3) , XN(100) , XN1 , XSCALE ,  CPR    5
     3 YLABEL(6) , YN(13) , YSCALE                                      CPR    6
C                                                                       CPR    7
C                                                                       CSARRAY 2
```

```
      COMMON /SARRAY/ ICHK(13)                                          CSARRAY  3
C                                                                       CSARRAY  4
C                                                                       CSPARAM  2
      COMMON /SPARAM/ CDLT , DELT , ERR , QR , SUM , SUMP , TEST , TMAX CSPARAM  3
C                                                                       CSPARAM  4
C                                                                       MAX1     2
C     --- THE FOLLOWING ARE DIMENSIONED FOR THE FOLLOWING LIMITS ---    MAX1     3
C     --- IF OTHER LIMITS ARE NEEDED , ADD COMDECK MAX AND DEFINE NEWMAX MAX1    4
C                                                                       MAX1     5
C     MODEL IS DEFINED ON ARRAYS (63,67,5), OR (22,24,5)--DEPENDING     FIXDIM  34
C     ON THE DEFINE CARDS-- *DEFINE,D515002, OR *DEFINE, D202504        FIXDIM  35
C             PARAMETER(DIMENSION)     BASED ON LIMIT OF                MAX1     8
C                                                                       MAX1     9
C                DDN(100)                 MAXIMUM HORIZONTAL DIMENSION=100 MAX1 10
C                FLOW(100),JFLO(100,3) MAXIMUM CONSTANT HEAD NODES=100  MAX1    11
C                ITTO(100)                MAXIMUM TIME STEPS = 100      MAX1    12
C                LEVEL1(9),LEVEL2(9)      MAXIMUM LEVELS PRINTED IN MAPS=9 MAX1 13
C                RHOP(20)                 MAXIMUM ITERATION PARAMETERS=20 MAX1  14
C                TEST3(101)               MAXIMUM ITERATIONS = 100      MAX1    15
C                                                                       MAX1    16
      COMMON/MAX/DDN(67),FLOW(4221),ITTO(60),JFLO(4221,3),              FIXDIM  38
     1$ LEVEL1(9),LEVEL2(9),RHOP(20),TEST3(61)                          FIXDIM. 39
C                                                                       MAX1    29
C                                                                       C515002  2
C     --- THE FOLLOWING ARE DIMENSIONED FOR 63 NODES IN THE Y-DIRECTION FIXDIM  27
C     (I.E. 63 ROWS), 67 NODES IN THE X-DIRECTION (I.E. 67 COLUMNS)     FIXDIM  28
C         , AND 5 NODES IN THE Z-DIRECTION (I.E. 5 LEVELS) ---          C515002  5
C                                                                       C515002  6
      COMMON/ARRAY1/DELX(67),DELY(63),DELZ(5),FACT(5,3)                 FIXDIM  13
      COMMON/ARRA2/OLD(63,67,5),V(63,67,5),S(63,67,5)                   FIXDIM  14
      COMMON/ARRAY3/STRT(63,67,5),T(63,67,5),TR(63,67,5)                FIXDIM  15
      COMMON/ARRAY4/TC(63,67,5),TK(63,67,5),WELL(63,67,5)               FIXDIM  16
C                                                                       515002A  6
      COMMON/ARRAY5/EL(63,67,5),FL(63,67,5),GL(63,67,5)                 FIXDIM  20
      COMMON/ARRAY6/PHI(63,67,5),ISTOR2(63,67),ISTOR4(63,67)            FIXDIM  21
      COMMON/ARRAY7/XI(63,67,5),CSUB(63,67),LHEAD2(63,67),              FIXDIM. 22
     1$ LHEAD4(63,67)                                                   FIXDIM  23
C                                                                       515002B  5
      LEVEL 2  ,OLD,STRT,TC,EL,XI                                       515002B  6
C                                                                       515002B  7
C                                                                       CMTNR    2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNR    3
C         WITHOUT RECHARGE TO THE TOP LEVEL ---                         CMTNR    4
C         ------ ---------                                              CMTNR    5
C                                                                       CMTNR    6
C                                                                       NR       2
      COMMON /RCHRG/ QRE(1,1)                                           NR       3
C                                                                       NR       4
C                                                                       CMTNWT   2
C     --- THE FOLLOWING IS USED TO CONSERVE STORAGE FOR A PROBLEM       CMTNWT   3
C         IN WHICH THE TOP LEVEL IS CONFINED                            CMTNWT   4
C                                   --------                            CMTNWT   5
C                                                                       NWT      2
      COMMON /TABLE/ BOTTOM(1,1)    , PERM(1,1)                         NWT      3
C                                                                       NWT      4
C     --- THE FOLLOWING 1-DIMENSIONAL ARRAYS ARE EQUIVALENT TO THE      EQCOM    2
C         ABOVE ARRAYS WITH THE SAME NAME EXCEPT FOR THE LEADING "A"    EQCOM    3
```