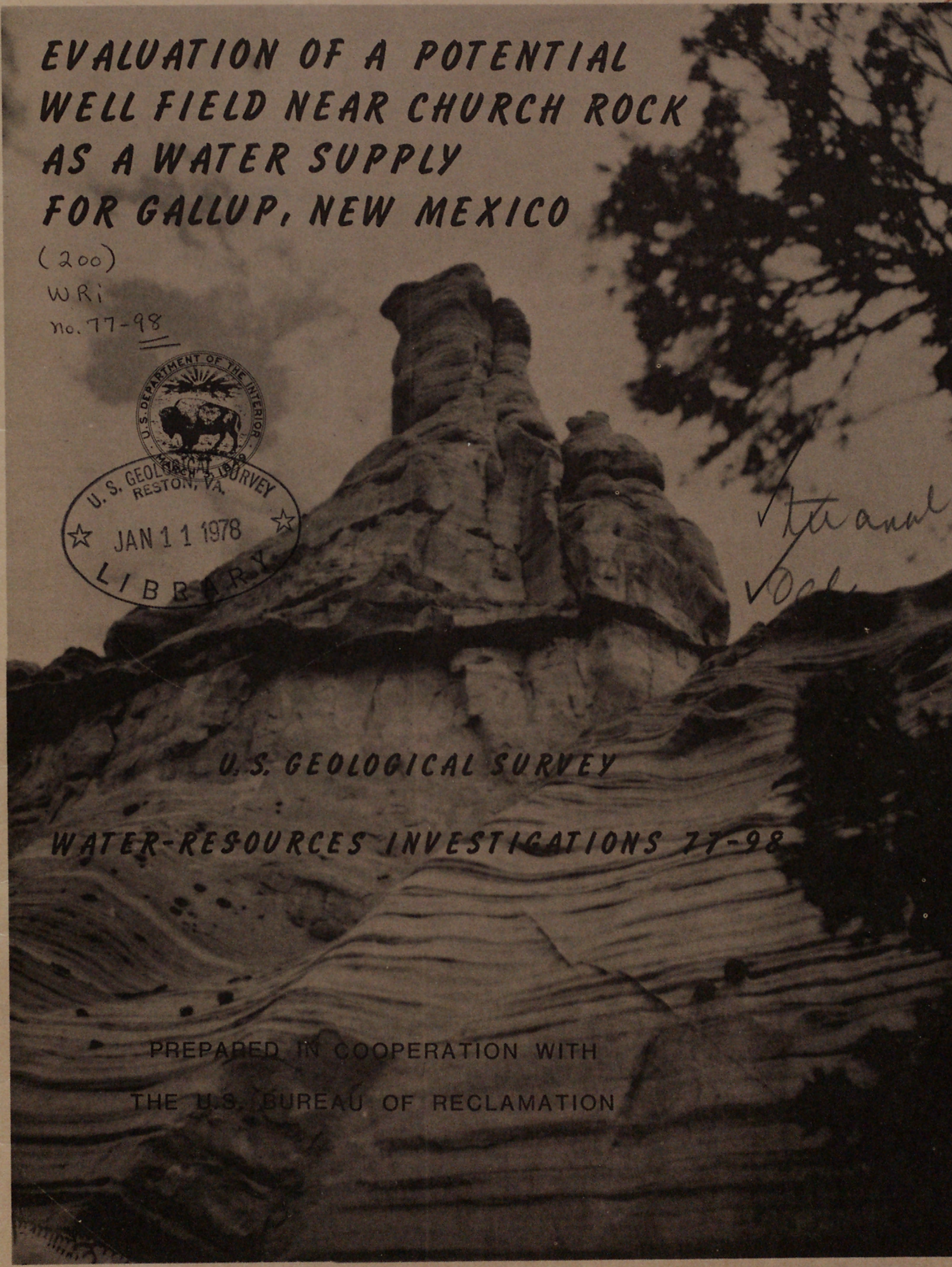

EVALUATION OF A POTENTIAL WELL FIELD NEAR CHURCH ROCK AS A WATER SUPPLY FOR GALLUP, NEW MEXICO

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS 77-98

PREPARED IN COOPERATION WITH

THE U.S. BUREAU OF RECLAMATION

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.

4. Title and Subtitle
Evaluation of a potential well field near Church Rock as a water supply for Gallup, New Mexico

5. Report Date
September 1977

6.

7. Author(s)
Glenn A. Hearne

8. Performing Organization Rept. No. USGS/WRI-77-98

9. Performing Organization Name and Address
U.S. Geological Survey, Water Resources Division
P. O. Box 26659
Albuquerque, N. Mex. 87125

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
U.S. Geological Survey, Water Resources Division
P. O. Box 26659
Albuquerque, N. Mex. 87125

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts

A digital model is used to evaluate the Westwater Canyon Member of the Morrison Formation near Church Rock, N. Mex. as the source for a potential well field to supply water to Gallup, N. Mex. The estimated values of the aquifer parameters are transmissivity, 300 feet squared per day; coefficient of confined storage, 0.0002; coefficient of unconfined storage, 0.10; and leakance, 10^{-7} per day. The model indicated that the ability of the potential well field to meet the projected needs of the city of Gallup depends on the future withdrawals of water from uranium mines in the area.

17. Key Words and Document Analysis. 17a. Descriptors

*Ground Water, *Water Supply, *Model Studies, *Mathematical Models.

17b. Identifiers/Open-Ended Terms

*San Juan Basin, *Morrison Formation, *Westwater Canyon Member, *Gallup, New Mexico.

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
No restriction on distribution	UNCLASSIFIED	26
	20. Security Class (This Page)	22. Price
	UNCLASSIFIED	

EVALUATION OF A POTENTIAL WELL FIELD NEAR CHURCH ROCK AS A WATER SUPPLY FOR GALLUP, NEW MEXICO

BY GLENN A. HEARNE

U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS 77-98

PREPARED IN COOPERATION WITH
THE U.S. BUREAU OF RECLAMATION

SEPTEMBER 1977

D✓
MDV✓
F-0

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

Vincent E. McKelvey, Director

For additional information write to:

U.S. Geological Survey
P. O. Box 26659
Albuquerque, New Mexico 87125

CONTENTS

ILLUSTRATIONS

TABLES

ENGLISH TO METRIC UNIT CONVERSION FACTORS

In this report figures for measurements are given in English units only. The following table contains factors for converting to metric units.

English	Multiply by	Metric
ft (feet)	.3048	m (meters)
ft^2/d (feet squared per day)	.0929	m^2/d (meters squared per day)
mi (miles)	1.609	km (kilometers)
mi^2 (square miles)	2.590	km^2 (square kilometers)
acre-ft (acre-feet)	1233	m^3 (cubic meters)
	1.233×10^{-3}	hm^3 (cubic hectometers)
gal/min (gallons per minute)	.06309	L/s (liters per second)

EVALUATION OF A POTENTIAL WELL FIELD NEAR CHURCH ROCK AS A WATER SUPPLY FOR GALLUP, NEW MEXICO

By Glenn A. Hearne

ABSTRACT

A digital model is used to evaluate the Westwater Canyon Member of the Upper Jurassic Morrison Formation near Church Rock, N. Mex. as the source for a potential well field to supply water to Gallup, N. Mex. The estimated values of the aquifer parameters are transmissivity, 300 feet squared per day; coefficient of confined storage, 0.0002; coefficient of unconfined storage, 0.10; and leakance, 10^{-7} per day. The model indicated that the ability of the potential well field to meet the projected needs of the city of Gallup depends on the future withdrawals of water from uranium mines in the area.

INTRODUCTION

The city of Gallup is in McKinley County in northwestern New Mexico (fig. 1). The present water supply of the city may meet the projected demand for only 10 to 15 more years. The U.S. Bureau of Reclamation is studying the feasibility of various plans to obtain additional water for municipal and industrial supplies. Water from the San Juan River has been considered the most likely potential source and 7,500 acre-feet of water from the Navajo Reservoir (fig. 1) has been reserved for Gallup's long-term needs to 2040. However, water withdrawn from any one of several aquifers might offer alternative short-range solutions. One such aquifer is the Westwater Canyon Member of the Upper Jurassic Morrison Formation near Church Rock, N. Mex.

This report is the result of a cooperative agreement between the U.S. Geological Survey and the U.S. Bureau of Reclamation to evaluate the potential of the Westwater Canyon Member as a source of water for the municipal supply of Gallup. The evaluation is made by using a digital model to simulate the effects of water withdrawal by a potential well field. This report describes both the calibration of the model and the response of the model to simulated withdrawals by a potential well field.

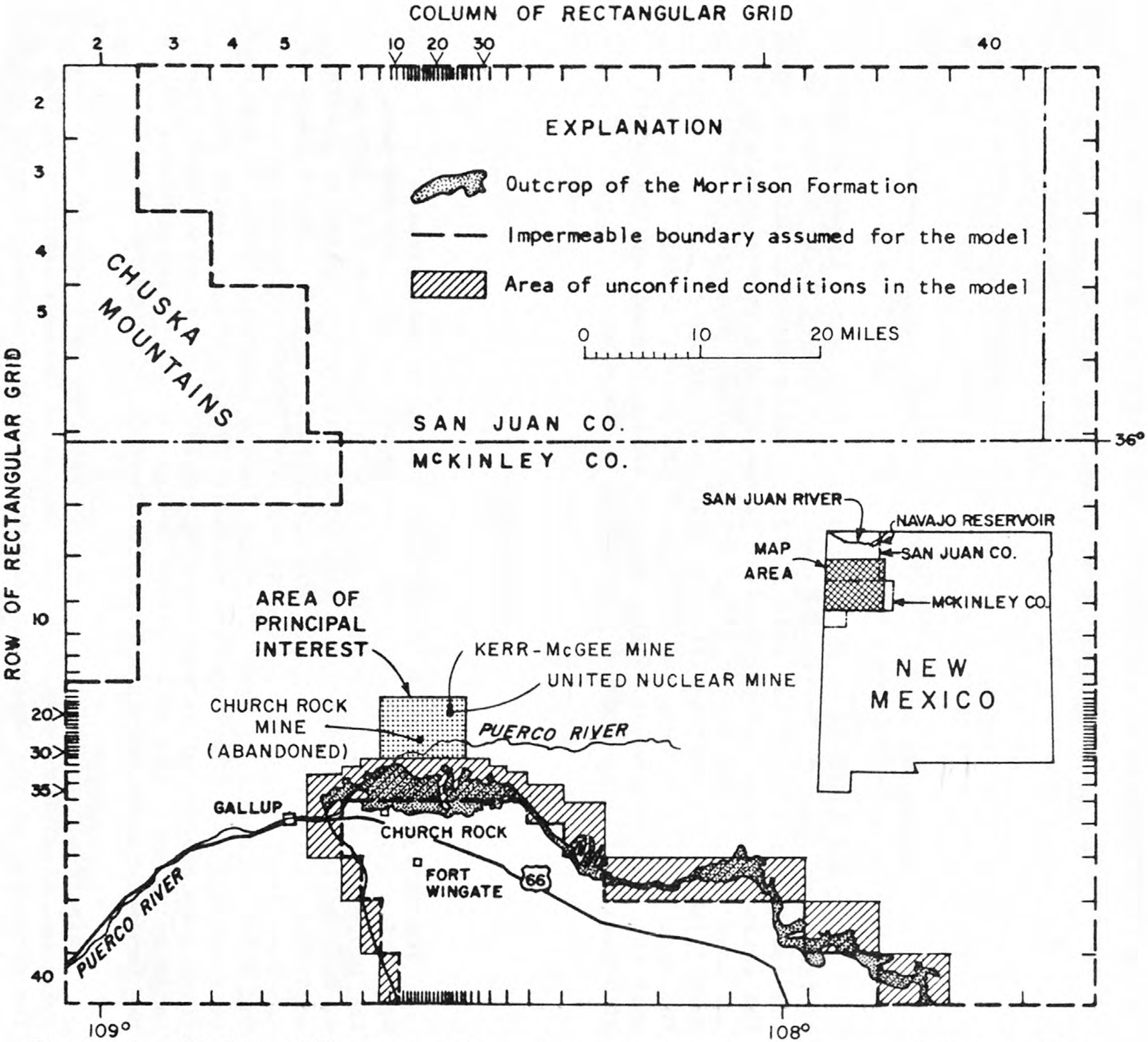

Figure 1.--Finite-difference grid and boundaries of the area modeled; McKinley and San Juan Counties, New Mexico.

The author gratefully acknowledges the assistance of various employees of the U.S. Bureau of Reclamation, particularly that of Phillip Kyburz, Gallup Project Planning Coordinator, who developed the capacity and production requirements for the potential well field. The author is also grateful to the United Nuclear Corp. and the Kerr-McGee Corp. who were very cooperative in granting access to their records.

HYDROGEOLOGIC SETTING

The principal area of interest is a 40-square mile area near Church Rock mine and 10 to 20 miles northeast of Gallup (fig. 1).

The Upper Jurassic Morrison Formation crops out south of the area of interest (fig. 1). The Westwater Canyon Member of the Morrison Formation intertongues with the underlying Recapture Shale Member and the overlying Brushy Basin Member northward and down dip from the outcrop area. In and near the outcrop area, water in the Westwater Canyon Member is unconfined. However, as the formation dips northward, the top of the Westwater Canyon Member is below the potentiometric surface. Consequently, the water is confined throughout most of the area of interest. The Westwater Canyon Member is a subsurface reservoir and is probably about 300 ft thick. It yields significant quantities of water to wells northwest and east of the study area. The adjacent members of the Morrison Formation partially restrict the hydraulic connection between the Westwater Canyon Member and underlying and (or) overlying reservoirs. More detailed descriptions are in Hilpert (1963, p. 14-16; 1969, plate 4, p. 19-20, 75-77), John and West (1963, p. 220), and Mercer and Cooper (1970, p. 40, 48-49).

Near Church Rock, the major withdrawals of water from the Westwater Canyon Member have resulted from the dewatering of uranium mines. The Church Rock mine (fig. 1) was operated from 1960 through 1962, but in 1963 the mine was allowed to flood and was abandoned (Hilpert, 1969, p. 44). In 1968 the United Nuclear Corp. started mining north of Church Rock and the nearby Kerr-McGee mine began operation in 1973 (fig. 1). At all three sites, ore was removed from the Westwater Canyon Member and water had to be withdrawn in order to operate the mines because this unit was saturated. The two mines in operation in January 1975 were withdrawing water at the combined rate of 2,850 gal/min.

Water pumped from a mine may contain some constituents that exceed U.S. Public Health Service (1962) recommended standards for drinking water and may require treatment for public supply use. The mines near Church Rock, for example, in 1975, produced water that exceeded the recommended limits for radium 226, vanadium, and selenium (Kaufman and others, 1976, p. 304). These high concentrations, however, are due in part to mining operations and practices. Water withdrawn from wells completed in the Westwater Canyon Member of the Morrison Formation near Church Rock is more likely to satisfy standards for drinking water.

DIGITAL SIMULATION MODEL

A digital model is a mathematical description of a real system. The validity of a digital model of a physical and hydrologic system depends on the extent to which the mathematical description reflects the complex structure of the prototype and the accurate quantification of hydrogeologic parameters, boundaries, and hydrologic stresses. The model cannot incorporate the full complexity of the prototype and the values of parameters are not well known. Consequently, the model is calibrated by adjusting the initial estimates of parameter values so that the response simulated by the model approximates the response of the prototype. For the model described below, the hydrogeologic parameters are the ability of the system to store and transmit water; the boundaries are the extent of the system and the relationship with other systems; and the hydrologic stress is withdrawal of water.

Mathematical description used for the model

The flow of water in the subsurface reservoir is three dimensional. That is, flow vectors can be resolved into three components: two horizontal components and a vertical component. Vertical components of flow within the reservoir will be modified most near the point of withdrawal. For the analysis of effects over a large area, the modification of these vertical components should be negligible. Therefore, a two-dimensional model is considered a reasonable approximation of the reservoir. The modification of vertical flow components in the confining units above and below the reservoir are probably significant and are included in the analysis. Flow to the reservoir from these sources is called leakage and is approximated in the two-dimensional model by assuming a constant head source separated from the reservoir by a confining unit.

The equation used in this model was:

$$\frac{\partial}{\partial x}\left[T(x,y)\frac{\partial h}{\partial x}\right] + \frac{\partial}{\partial y}\left[T(x,y)\frac{\partial h}{\partial y}\right] = S(x,y)\frac{\partial h}{\partial t} + Q(x,y,t) + L\ (H-h)$$

where

h is the hydraulic head (length);

T(x,y) is the transmissivity; that is, the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient (length squared per unit time);

S(x,y) is the storage coefficient; that is, the volume of water released from storage per unit surface area, per unit change in head in the aquifer (dimensionless);

Q(x,y,t) is the rate of withdrawal of water per unit area (length per unit time);

L(x,y) is called the leakance in this report and is used as a measure of the hydraulic connection of the principal aquifer with overlying and (or) underlying aquifers through semipervious units (per unit time);

H is the hydraulic head in the overlying and (or) underlying aquifers (length).

A rectangular grid is superimposed on a map, dividing the study area into rectangular subareas called nodes (fig. 1). Physical and hydrologic parameters are specified at each node. The above equation is approximated by a finite-difference equation by applying Taylor's theorem (Pinder and Bredehoeft, 1968). The finite-difference equation is solved for the hydraulic head in each node of the rectangular grid on a digital computer using the iterative alternating direction implicit (IADI) technique. These difference equations were solved on a CDC 6600[1/] computer using a program developed by Pinder (1970) and modified by Trescott (1973).

1/ The use of the brand name in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

The drawdown in a pumping well will exceed the areal decline of the water level simulated by the finite-difference model for the well node. The hydraulic head in a well is estimated by assuming that well loss is negligible and that in the node, which contains the well, the flow is laminar and can be described by a steady-state equation with no source term, the reservoir is homogeneous and isotropic, and one well fully penetrates the confined reservoir at the center of the node. Under these conditions, the hydraulic head in a pumping well can be approximated by (Trescott and Pinder, written commun. January 1975):

$$h_w = h - \frac{q_w}{2\pi\ T} \ln\ (r_e/r_w),$$

where

h_w is the hydraulic head in the pumping well (length);

h is the hydraulic head simulated for the well node (length);

q_w is the pumping rate for the well node (length cubed per unit time);

T is the transmissivity for the well node (length squared per unit time);

$r_e = r_1 / 4.81$ in which r_1 is the smallest horizontal dimension of the node (length);

and

r_w is the radius of the pumping well (length).

Physical and hydrologic systems assumed for the model

Construction of a hydrologic model requires describing the physical framework of the system and the hydrologic stress imposed on the reservoir. The physical framework is described by specifying the areal boundaries of the system and the values of hydrogeologic parameters within these boundaries.

The areal extent of the model is shown in figure 1. The irregular impermeable south boundary of the model is an approximation of where the Westwater Canyon Member ceases to be saturated (fig. 1). The irregular impermeable boundary to the northwest approximates the location of the Chuska Mountains. The remaining impermeable boundaries are arbitrarily located at a considerable distance from the area of interest. Although the actual boundaries may be even more distant, the assumed boundaries are sufficiently distant that the effect on the change in potentiometric surface in the area of interest is negligible.

The dip of the aquifer to the north is assumed to be uniform at three degrees. This declivity, which produces a decrease in altitude of over 1,000 feet from the outcrop to the existing mines, appears to be consistent with available data.

The aquifer is assumed to have a uniform thickness of 300 feet and to be unconfined in and near the outcrop, and confined throughout the rest of the modeled area (fig. 1). The remaining hydrogeologic parameters (transmissivity, coefficients of confined and unconfined storage, and leakance) are assumed to be uniform over the modeled area and are adjusted during the calibration procedure.

The aquifer was probably in a steady-state condition prior to 1960; that is, there had been no major withdrawals of water and no major changes in water levels, recharge, or discharge. From 1960 through 1962, water was withdrawn from the Church Rock mine (fig. 1). These withdrawals ceased in 1963 when the mine was abandoned. In this study, the author assumed that by 1968 the aquifer had returned to a steady-state condition.

Water has been withdrawn since 1968 from the aquifer at the United Nuclear mine, and, since 1973 at the Kerr-McGee mine (fig. 1). These stresses are used to calibrate the model. Withdrawals by the potential well field are assumed to begin in 1985, increase through 2005, and continue through 2015. It is assumed that other withdrawals from the aquifer are sufficiently distant from the Church Rock area to be negligible.

Calibration criteria and results

The data required to calibrate the model are the response (change in hydraulic head) to a known hydrologic stress (withdrawal of water). The hydrogeologic parameters are adjusted so that the response simulated by the model approximates the observed response. In this study, the parameters are assumed to be uniform throughout the aquifer.

The stress used to calibrate the model is that imposed by dewatering the United Nuclear and Kerr-McGee mines (fig. 1) through February 1975. Approximate rates of withdrawal of water were obtained from both companies. The withdrawal rates used for the calibration are shown in table 1.

The response to this stress has been measured only at the Church Rock mine (fig. 1). Personnel from United Nuclear Corp. provided the initial water levels and periodic measurements through 1973. The U.S. Geological Survey has maintained a water-level recorder on the Church Rock mine since 1974.

The rectangular grid is constructed so that the Church Rock mine is located on the boundary between two nodes. Calibration proceeded by comparing the measured change in water level at the Church Rock mine with the simulated change in water level at the two adjacent nodes-row 26 and 27 of column 16. In this report the area between the simulated hydrographs for these two nodes is referred to as the calibration zone (fig. 2). The criteria is to have the calibration zone envelop the observed values.

Transmissivity is a measure of the ability of an aquifer to transmit water under a hydraulic gradient. The transmissivity of the Westwater Canyon Member of the Morrison Formation was initially estimated to be between 100 ft^2/d and 500 ft^2/d. During the calibration procedure the use of a transmissivity value of 300 ft^2/d more closely approximated the observed change in water level at the Church Rock mine.

The storage coefficient is the volume of water an aquifer releases or takes into storage per unit surface area of the aquifer per unit change in head. Water in the Westwater Canyon Member of the Morrison Formation occurs under both unconfined (water table) and confined (artesian) conditions (fig. 1). The coefficient of confined storage was estimated to be 0.0003 by multiplying the thickness in feet times 10^{-6} per foot (Lohman, 1972, p. 53). This initial estimate was revised to 0.0002 during calibration. The coefficient of unconfined storage (specific yield) was estimated to be between 0.05 and 0.20. An intermediate value of 0.10 produced satisfactory results for calibration.

Leakance is a measure of the hydraulic connection of the principal aquifer with overlying and (or) underlying aquifers through semipervious units. Leakance of 10^{-7} per day proved to be a satisfactory value for calibration.

In figure 2 the simulated decline in the potentiometric surface near the Church Rock mine is compared with the measured decline in water level in the mine. The values of hydrogeologic parameters used for the simulation shown in figure 2 and for the remainder of this report are transmissivity, 300 ft^2/d; coefficient of confined (artesian) storage, 0.0002; coefficient of unconfined (water-table) storage 0.10; and leakance, 10^{-7} per day.

Table 1.--Rate of withdrawal of water from mines near Church Rock

Year	Mine	Average pumping rate in gallons per minute[1]												Annual withdrawal (acre-ft/yr)
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1968	United Nuclear	-	-	-	-	-	-	-	-	-	100	200	250	-
1969	do.	650	1,050	1,450	1,450	1,700	1,850	1,750	1,850	1,850	1,800	1,850	1,850	2,550
1970	do.	2,000	1,950	2,000	1,950	1,950	2,000	2,000	2,000	2,000	2,000	2,050	2,050	3,200
1971	do.	2,200	2,200	2,250	2,200	2,250	2,300	2,250	2,250	2,200	2,200	2,250	2,250	3,600
1972	do.	2,250	2,300	2,300	2,200	2,350	2,350	2,400	2,400	2,350	2,400	2,400	2,450	3,800
1973	Kerr McGee	-	-	-	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	-
	United Nuclear	2,250	2,250	2,250	2,250	2,200	2,250	2,250	2,200	2,150	2,200	2,200	2,200	3,600
1974	Kerr McGee	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	2,250
	United Nuclear	2,200	2,150	2,150	1,450	1,450	1,450	1,500	1,500	1,500	1,450	1,600	1,650	2,700
1975	Kerr McGee	1,400	1,400	-	-	-	-	-	-	-	-	-	-	-
	United Nuclear	1,450	1,450	-	-	-	-	-	-	-	-	-	-	-

[1] Based on data supplied by Kerr-McGee Corp. and United Nuclear Corp.

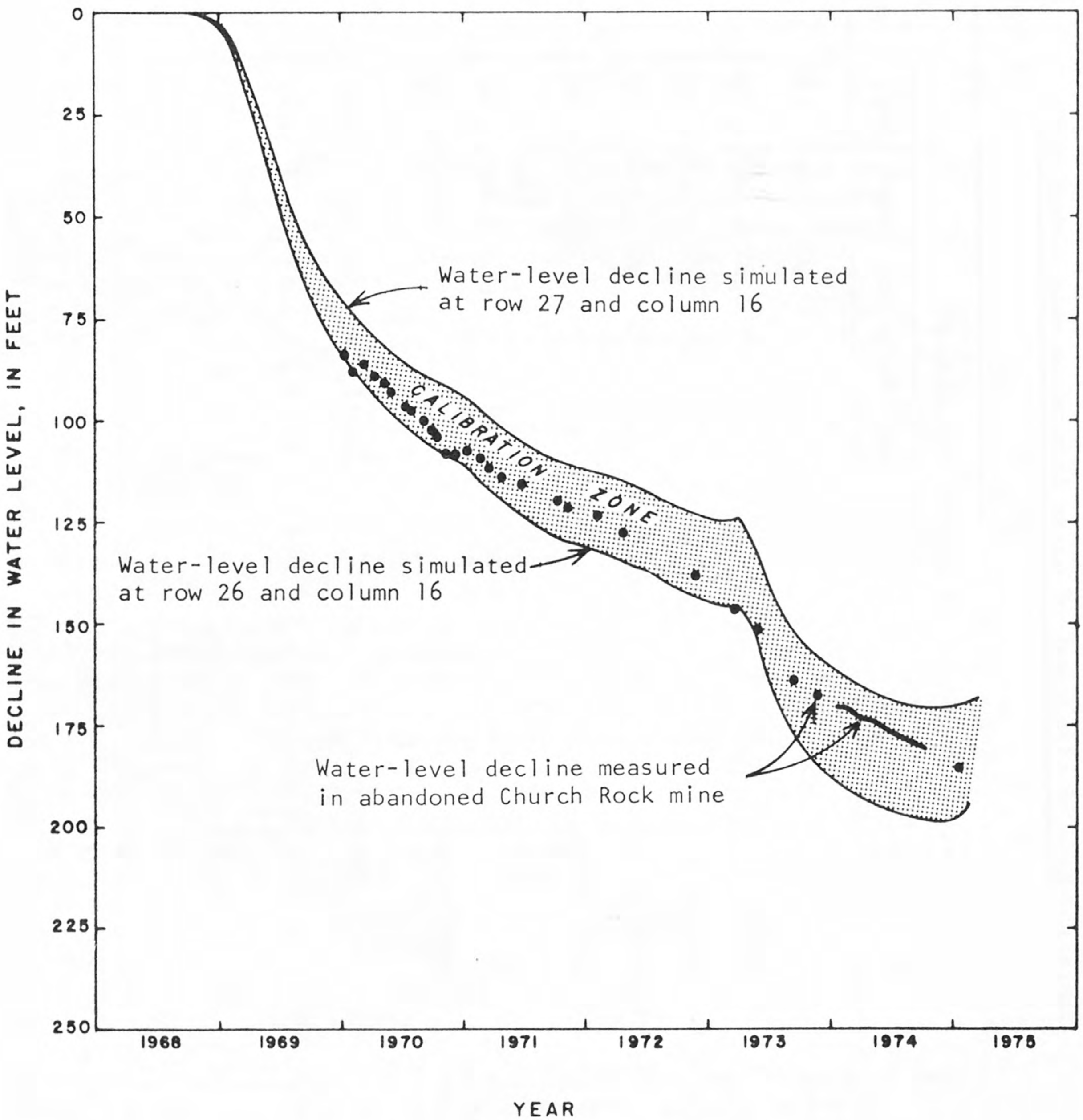

Figure 2.--Declines in water level measured at Church Rock mine compared with declines simulated by the digital model.

SIMULATION OF POTENTIAL WELL FIELD

The response to the stress of withdrawing water from the aquifer at the potential well field is simulated by the model through the year 2015. The model also simulates withdrawals of water from uranium mines in the Church Rock area, and two alternative assumptions are considered. One alternative is for the withdrawal of water from the mines to continue at the early-1975 rates. These withdrawals are shown in table 2. The second alternative is for the withdrawal of water from the mines to increase to more than the early-1975 rate. That is, for either the present mines to increase the rate of withdrawal or for additional mines to begin operation. An arbitrary increase of 10 percent beginning in 1985 is shown in table 3.

The simulated change in the potentiometric surface in response to the pumping stress is used to estimate whether the wells of the potential well field will be able to produce at the specified capacity. If the water level in a pumping well declines below the top of the aquifer, a chain reaction is initiated which is likely to limit the capacity of the well. Because of the decrease in saturated thickness, the transmissivity decreases. And, the greater head differential needed to maintain the same discharge can be achieved only by increased drawdown in the well. The cycle repeats until either a stable condition is achieved or the well is unable to produce at the specified rate. It is assumed that if the water level in a pumping well with a radius of one foot is below the top of the aquifer, the well will be unable to produce at the specified capacity. This is the criterion for success or failure of the well and the well field.

The U.S. Bureau of Reclamation (Kyburz, written commun., May 19, 1975) devised a schedule for developing a potential well field. It is based on projections of Gallup's future water needs, and a summary of the areas in which wells could be located according to a U.S. Bureau of Land Management land ownership map. The capacity and production requirements are shown in table 4. The areas available for the potential well field include sections 4, 8, 16, 30, and 32; the southeast quarter of section 18 and the north half and southeast quarter of section 20 in T.16 N., R.16 W. along with section 12 and the north half and southwest quarter of section 14, T.16 N., R.17. W.

Table 2.--Projected withdrawal of water from mines at the early-1975 rate

[Locations shown in figures 1 and 3]

Mine	Projected annual withdrawal (acre-ft/yr) beginning in 1975
Kerr-McGee	2,250
United Nuclear	2,350
Total withdrawals from mines	4,600

Table 3.--Projected withdrawal of water from mines at a rate 10 percent greater than the early-1975 rate

[Locations shown in figure 3]

Mine	Projected annual withdrawal (acre-ft/yr) beginning in	
	1975	1985
Kerr-McGee	2,250	1,700
United Nuclear	2,350	1,700
Additional mining	-	1,700
Total withdrawals by mines	4,600	5,100

Table 4.--Capacity and production requirements for the potential well field

Year	Required annual production (acre-ft/yr)	Required capacity (gal/min)	Number of wells required	Required capacity for each well (gal/min)
1985	150	420	1	420
1995	470	1,300	2	400
			1	500
2005	1,500	2,600	4	400
			2	500

The first alternative to be considered is that the withdrawals of water from mines continue at the early-1975 rate. A potential well field is designed to be capable of satisfying the production requirements. The capacity and annual withdrawal rates are shown in table 5. The northward dip of the aquifer and the dependence of the success of a well on the height of the hydraulic head above the top of the reservoir dictate that the wells be located in the northern part of the available areas. Locations of the wells are shown in figure 3. The calculated drawdowns in pumping wells in the potential well field are shown in table 6. Comparison of the calculated drawdowns (table 6) with the estimated height of the hydraulic head above the top of the aquifer (table 5) indicates that the plan is successful. That is, all the wells should be capable of producing at the specified capacity (table 5).

To indicate the sensitivity of well-field success or failure to the projected future withdrawals of water from mines, a simulation is presented which assumes that withdrawals from mines exceed the early-1975 rate. The withdrawal rates assumed for the mines are shown in table 3. The location of the additional mining is shown in figure 3. These withdrawal rates are arbitrarily assumed to increase by 10 percent in 1985 and should not be construed as a prediction of the nature or extent of future mining development. The calculated drawdowns are shown in table 7. By 2005, wells numbered 1, 3, and 4 may be unable to produce at the specified capacity (table 5). The effect of the increased mining withdrawals can be seen by comparing the values in table 7 with those in table 6.

The model assumes that wells continue to operate according to the original plan. Any attempt to reduce the stress at a particular well by operating the well below capacity would require an increase in the stress on some other well.

These simulations indicate that the ability of the wells to produce at the required capacity is sensitive to the rate of withdrawal of water from mines. The well field design considered here is not presented as an optimal design; nor is the assumed increase in the rate of withdrawal of water from mines presented as the most probable future condition. The conclusion presented here is that any prediction of the well field's future capability must consider the future withdrawal of water from mines. This may not be particularly surprising as the annual withdrawals from mines in 1974 is about three times the annual production expected from the potential well field in 2005.

Table 5.--Projected withdrawal of water by the potential well field

[Locations shown in figure 3]

Well	Capacity (gal/min)	Annual withdrawal (acre-ft/yr) beginning in year						Extent of confinement[1/] (feet)
		1985	1990	1995	1998	2001	2004	
1	420	150	150	150	170	360	360	1,050
2	400	-	150	170	360	360	360	1,050
3	500	-	-	150	150	150	150	880
4	400	-	-	-	150	150	150	880
5	400	-	-	-	-	170	170	800
6	500	-	-	-	-	-	360	800
Total for well field	2,620	150	300	470	830	1,190	1,550	

1/ Estimated height of the hydraulic head above the top of the aquifer.

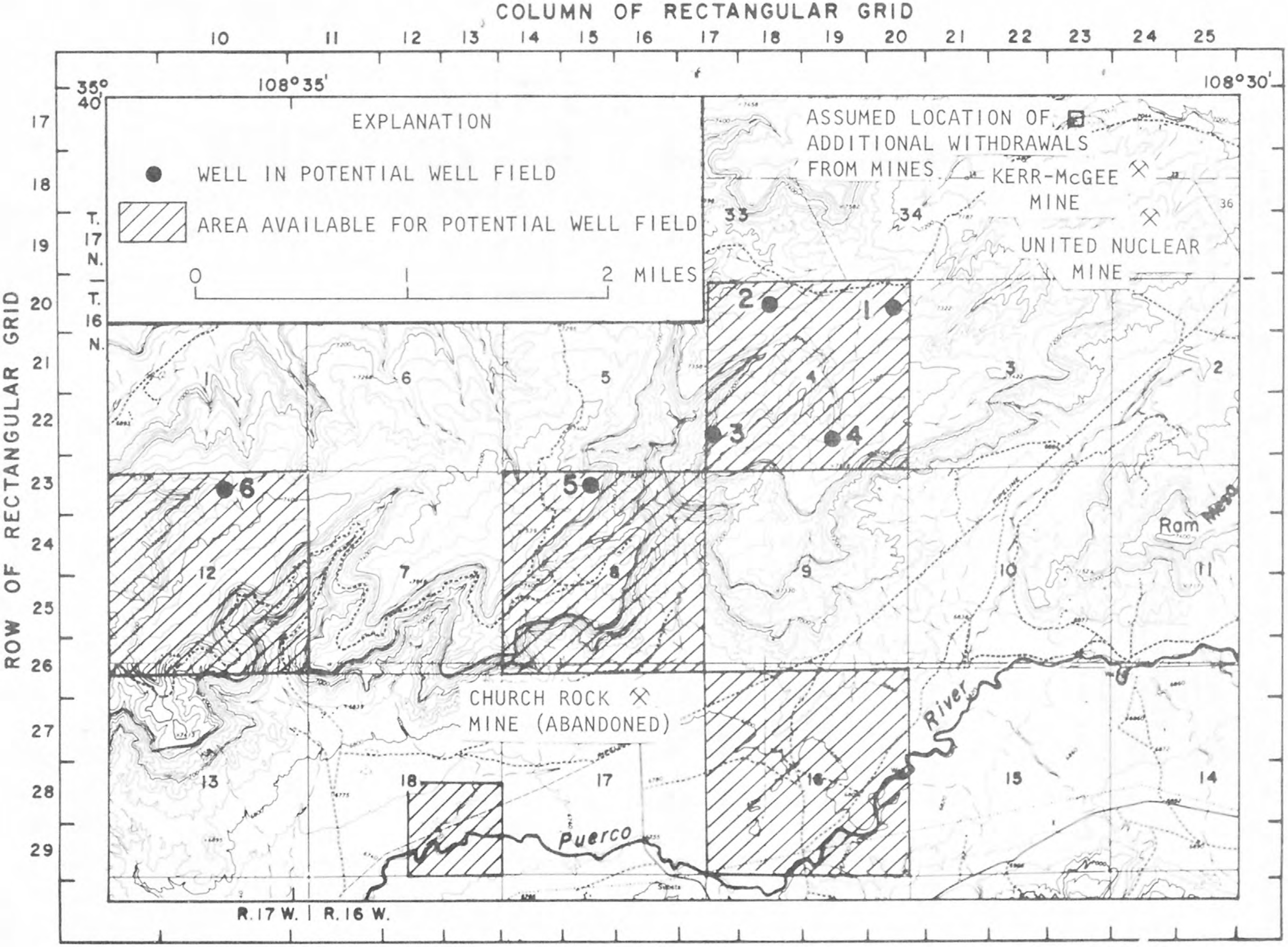

Figure 3.--Well locations for a potential well field.

Table 6.--Calculated drawdown in pumping wells in the potential well field, assuming withdrawals from mines continue at the early-1975 rate

[Locations shown in figure 3. Rates of withdrawal of water given in table 5 for wells and in table 2 for mines.]

Year	Drawdown, in feet, at well					
	1	2	3	4	5	6
1985	754	-	-	-	-	-
1990	804	668	-	-	-	-
1995	834	719	674	-	-	-
1998	856	748	723	713	-	-
2001	914	831	776	788	594	-
2004	988	880	824	835	662	533
2005	1,001	896	842	850	685	621
2015	1,022	918	866	873	710	645

Table 7.--Calculated drawdown in pumping wells in the potential well field, assuming withdrawals from mines exceed the early-1975 rate by 10 percent

[Locations shown in figure 3. Rates of withdrawal of water given in table 5 for wells and in table 3 for mines.]

Year	Drawdown, in feet, at well					
	1	2	3	4	5	6
1985	754	-	-	-	-	-
1990	859	717	-	-	-	-
1995	891	771	711	-	-	-
1998	915	801	762	754	-	-
2001	973	884	815	830	626	-
2004	1,047	934	864	877	694	556
2005	*	950	*	*	717	644
2015	*	975	*	*	745	669

* Well at specified capacity may fail in this location.

SUMMARY

A digital model was used to evaluate the Westwater Canyon Member of the Morrison Formation near Church Rock, N. Mex. as the source for a potential well field. The U.S. Bureau of Reclamation is studying the feasibility of such a potential well field for the municipal water supply of Gallup, N. Mex.

Calibration of the model provides the following estimates of the hydrogeologic parameters: a transmissivity of about 300 ft^2/d, a coefficient of confined storage of about 0.0002, a coefficient of unconfined storage of about 0.10, and a leakance of about 10^{-7} per day.

The response of the reservoir to withdrawals by the potential well field is simulated by the model for two alternative assumptions on the rate of future withdrawal of water from mines. The mines are first assumed to continue to withdraw water at the same rate as in early 1975. For this case, a well field is designed which can satisfy the production requirements. The designed well field, however, fails to satisfy the production requirements if the withdrawals from mines are arbitrarily assumed to increase by 10 percent in 1985. These results imply that the success or failure of any plan for the potential well field is sensitive to the location and rate of withdrawals from mines. Consequently, the capability of the potential well field to meet the projected water needs of the city of Gallup depends on the location and rate of future withdrawals of water from mines.

SELECTED REFERENCES

Cooley, M. E., Harshbarger, J. W., Akers, J. P., and Hardt, W. F., 1969, Regional hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 521-A, 61 p., 5 pl, 20 figs.

Hilpert, L. S., 1963, Regional and local stratigraphy of uranium-bearing rocks, in Geology and technology of the Grants uranium region: New Mexico Bur. Mines and Mineral Resources Mem. 15, p. 6-18.

———1969, Uranium resources of northwestern New Mexico: U.S. Geol. Survey Prof. Paper 603, 166 p., 4 pl, 20 figs.

Hiss, W. L., 1975, Evaluation and proposed study of potential ground-water supplies, Gallup area, New Mexico: U.S. Geol. Survey Open-File Report 75-522.

John, E. C. and West, S. W., 1963, Ground Water in the Grants district, in Geology and technology of the Grants uranium region: New Mexico Bur. Mines and Mineral Resources Mem. 15, p. 219-221.

Kaufman, R. F., Eadie, G. G., and Russell, C. R., 1976, Effects of uranuim mining and milling on ground water in the Grants mineral belt, New Mexico: Ground water, v. 14, no. 5, pp. 296-308.

Kelley, V. C., 1963, Tectonic setting, in Geology and technology of the Grants uranium region: New Mexico Bur. Mines and Mineral Resources Mem. 15, p. 19, 20.

Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geol. Survey Prof. Paper 708, 70 p., 9 pl., 47 figs.

Mercer, J. W. and Cooper, J. B., 1970, Availability of ground water in the Gallup-Tohatchi area, McKinley County, New Mexico: U.S. Geol. Survey open-file report, 182 p., 29 figs.

Pinder, G. F., 1970, A digital model for aquifer evaluation: U.S. Geol. Survey Techniques Water-Resources Inv., Book 7, Chap. CI, 18 p.

Pinder, G. F., and Bredehoeft, J. D., 1968, Application of the digital computer for aquifer evaluation: Water Resources Research, v. 4, no. 5, p. 1069-1093.

Shomaker, J. W., 1971, Water resources of Fort Wingate Army Depot and adjacent areas, McKinley County, New Mexico: U.S. Geol. Survey open-file report, 230 p., 13 figs.

Trescott, P. C., 1973, Iterative digital model: U.S. Geol. Survey open-file report, 63 p.

U.S. Public Health Service, 1962, Drinking Water Standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

☆ U. S. GOVERNMENT PRINTING OFFICE 1977-781-231/18 Reg. 8