Simulation of Ground-Water System Response to Proposed Withdrawals from 1993 to 2043 in the Northern Part of Juab Valley, Juab County, Utah

Water-Resources Investigations Report 98–4262

Prepared in cooperation with the Central Utah Water Conservancy District

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SIMULATION OF GROUND-WATER SYSTEM RESPONSE TO PROPOSED WITHDRAWALS FROM 1993 TO 2042 IN THE NORTHERN PART OF JUAB VALLEY, JUAB COUNTY, UTAH

By S.A. Thiros

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Salt Lake City, Utah
1999

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

Multiply	By	To obtain
acre-foot (acre-ft)	0.001233	cubic hectometer
	1,233	cubic meter
acre-foot per year (acre-ft/yr)	0.00003907	cubic meter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Information on the ground-water system in the northern part of Juab Valley, Utah, is needed by water managers to plan the optimal use of surface water that will be imported by the Central Utah Project and ground water pumped locally. The response of the ground-water system to an increase in withdrawal with no new sources of recharge was simulated to provide a baseline for comparing possible water-management plans and to determine their potential effects on wetlands in the area.

To assess the effects of additional withdrawal on the system, a 50-year-long stress period was added to the end of the existing three-dimensional, finite-difference, ground-water flow model. This stress period simulates recharge and discharge stresses determined for 1987-92. Another model was constructed by simulating 30 additional wells pumping a total of 4,000 acre-feet per year in the 50-year-long stress period. The 30 additional wells were simulated in a north-south trending line along the eastern part of the valley and as pumping from the bottom model layer. The difference between model-computed water-level changes after 10, 30, and 50 years with and without the additional pumped wells was calculated for the uppermost model layer.

Water-level declines of more than 6 feet were computed for layer 1 in the area east of Mona Reservoir, and natural sources of ground-water discharge in the northern part of the valley decreased in response to 30 years of additional pumping. Discharge from springs and seeps computed in 2022 of the revised model simulating additional pumping decreased by about 7 percent and computed discharge by evapotranspiration decreased by about 23 percent relative to the same time in the revised model simulating no additional pumping.

INTRODUCTION

Surface water is to be imported to the northern part of Juab Valley as part of the Central Utah Project. The Central Utah Project is a plan approved by Congress to transport water from the Colorado River drainage basin in Utah to areas along the western side of the Wasatch Range for irrigation. Information on the ground-water system is needed by water managers to develop plans for the optimal use of ground- and surface-water resources.

The hydrology of Juab Valley in central Utah (fig. 1) was studied from 1992 through 1994 by the U.S. Geological Survey in cooperation with the Central Utah Water Conservancy District and the East Juab Water Conservancy District (Thiros and others, 1996). A three-dimensional, finite-difference flow model (McDonald and Harbaugh, 1988) that simulated ground-water conditions during 1949-92 was developed to better understand the system.

The Central Utah Water Conservancy District requested that the existing flow model be modified to include 4,000 acre-ft/yr of withdrawal from 30 additional wells in the northern part of Juab Valley. The capacity of the pipeline transporting Central Utah Project water to the northern part of the valley had not been finalized at the time of the request (May 1997). The response of the ground-water system to an increase in withdrawal with no new sources of recharge was simulated to provide a baseline for comparing possible water-management plans and to determine the potential effects on wetlands in the area.

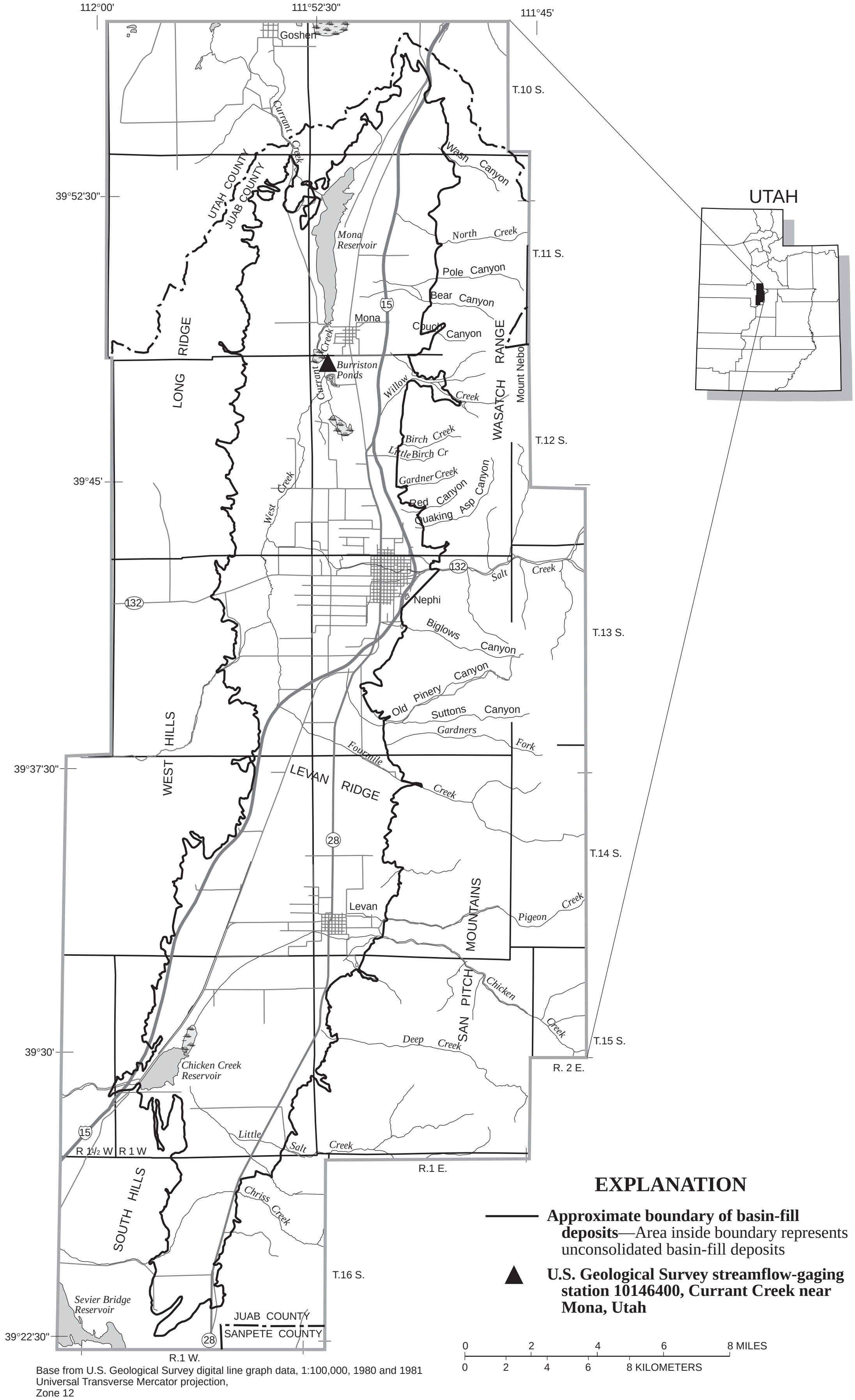


Figure 1. Location of Juab Valley, Utah.

Purpose and Scope

The objective of this study was to estimate, using modified versions of an existing ground-water model, the effects of an increase in ground-water withdrawal by pumped wells on water levels and on natural ground-water discharge to seeps and springs and by evapotranspiration in the northern part of Juab Valley. This report describes the effects on the simulated ground-water system in the northern part of the valley caused by the addition of a 50-year-long stress period to the end of the existing 1949-92 transient-state model. Another model was created by adding 30 wells pumped at a total rate of 4,000 acre-ft/yr to the 50-year-long stress period.

Although the southern part of Juab Valley is included in the model, changes to the ground-water system simulated there are not presented because they were not the focus of this study. Additional sources of recharge to the ground-water system were not simulated, and pumping rates used for existing wells in the northern part of the valley during the 1987-92 stress period of the original model also were used in the additional stress periods of the revised simulations. The effects of pumping from the additional wells were compared to the effects of pumping from the existing wells. The difference between model-computed water-level changes after 10, 30, and 50 years with and without the additional pumping wells was calculated for the uppermost model layer. Changes made to the existing model, the effects of these changes, and the limitations of the revised models are discussed in this report.

Ground-Water Hydrology

This section is a summary of the ground-water system in the northern part of Juab Valley. A more detailed discussion of the ground-water system is presented in Thiros and others (1996).

Saturated unconsolidated basin-fill deposits form the principal ground-water system in the northern part of Juab Valley. Ground water generally is unconfined near the mountain fronts and above the uppermost confining layer in the subsurface. The confining layers are mostly within 50 ft of land surface, although their depth, thickness, and presence in the valley are variable. Most wells drilled in the valley are less than 1,000 ft deep. Because the actual depth of the unconsolidated basin-fill deposits in Juab Valley is not known, the ground-water system is assumed to consist of the upper 1,000 ft of material.

Ground water in the unconsolidated basin-fill deposits in Juab Valley generally flows from recharge areas near the mountain fronts to discharge areas in the lower parts of the valley. The ground-water divide that separates the ground-water system into northern and southern parts has been determined to be just south of Levan Ridge (fig. 1), a topographic divide within the valley. The relatively small amount of water recharged at the ground-water divide flows in both the north and south directions.

Average recharge to the unconsolidated basin-fill deposits in the northern part of the valley was estimated to be about 42,000 acre-ft/yr for 1963-93. Sources of recharge are seepage from streams, unconsumed irrigation water, and distribution systems (51 percent); infiltration of precipitation (9 percent); and subsurface inflow from consolidated rocks that surround the valley (40 percent).

Discharge from the unconsolidated basin-fill deposits in the northern part of the valley is by wells (39 percent), springs and seeps (35 percent), evapotranspiration (24 percent), and subsurface outflow to consolidated rocks (2 percent). Ground water is used mostly to supplement surface water for irrigation, and pumping of wells capable of yielding large amounts of water generally begins after snowmelt runoff ends. The 1963-93 average annual ground-water discharge by pumped wells for irrigation and public supply is about 14,500 acre-ft/yr.

Ground-water discharge from springs and seeps occurs mostly in low-lying areas where the hydraulic head of the ground water is above land surface. This discharge provides much of the base flow in West and Currant Creeks and much of the inflow to Mona Reservoir. The area delineated as wetlands by the U.S. Department of Agriculture, Soil Conservation Service (written commun., 1993) is generally oriented along the axis of the valley and corresponds to where ground water is discharged by evapotranspiration. About 4,800 acres were mapped as wetlands in the northern part of the valley in 1988. Discharge by springs, seeps, evapotranspiration, and flowing wells has decreased in the valley in response to an increase in withdrawals from pumped wells as the ground-water system approaches a new equilibrium.

CHANGES TO EXISTING GROUND-WATER FLOW MODEL

The existing numerical ground-water flow model was calibrated to the transient-state conditions that existed in the ground-water system of Juab Valley during 1949-92. It contains eight multi-year stress periods that represent similar climatic and pumping conditions (Thiros and others, 1996, fig. 32). The length of each stress period was chosen on the basis of a visual inspection of the estimated annual ground-water pumpage from wells in Juab Valley. Recharge and discharge stresses to the system were averaged for the years within a stress period and then applied to the model on a yearly (time-step) basis. More information on the existing numerical ground-water flow model for Juab Valley is presented in Thiros and others (1996).

The hydrologic effects of additional pumping can be estimated by comparing changes in water levels and natural discharge with those of the model with no additional pumping. As a first step, the existing 1949-92 transient-state model was extended to 2042 using 1987-92 stresses. This was accomplished by adding one 50-year-long stress period consisting of 50 time steps to the end of the original model. The second step was to simulate the same 50-year-long period from 1993-2042 with an additional 4,000 acre-ft/yr of withdrawal from 30 proposed wells. Then, the results of these two simulations were compared to quantify and evaluate the effects of the proposed additional pumpage.

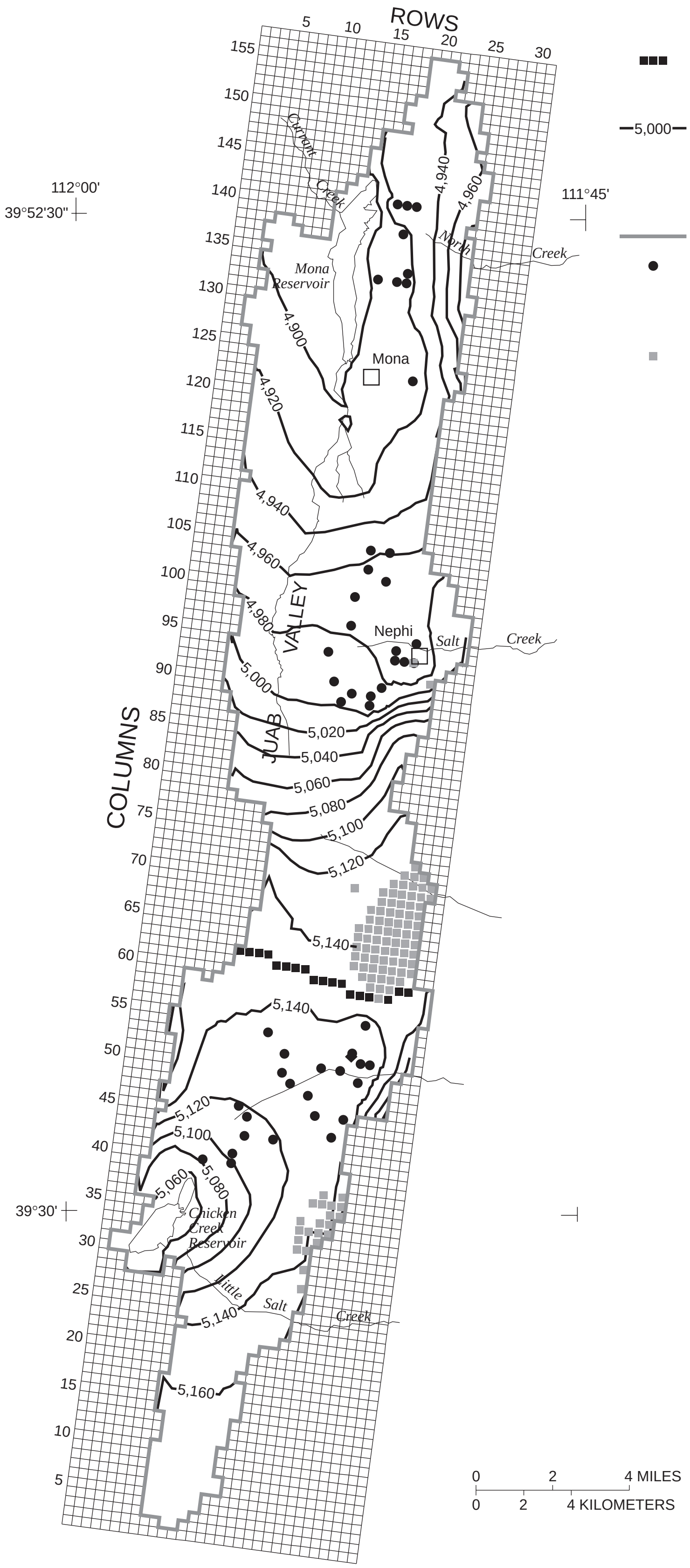
Recharge and natural discharge simulated in the stress period representing 1987-92 were generally less than the long-term average because of less-than-normal precipitation. Pumping for irrigation during this period was correspondingly greater than the 1963-93 average in both the southern and northern parts of Juab Valley. Therefore, the revised model simulates a prolonged period of less-than-normal precipitation and greater-than-average pumping. An averaged set of recharge and discharge stresses was not constructed for use in the revised model because of limitations in the scope of the study.

Model layer 1, the uppermost layer, represents unconfined ground-water conditions in the valley. Changes in simulated recharge and discharge cause the saturated thickness of the uppermost layer to vary. A result of using 1987-92 stresses for an extended period is that some water levels simulated in the valley dropped below the bottom of model layer 1 and model cells in those areas and layer became dewatered (inactive). Areal recharge was then applied to the cell in the next layer at that location. Adjacent cells in layer 1 can become dewatered because no flow is simulated across the interval between an inactive cell and any adjacent cell. Recharge from subsurface inflow from consolidated rocks and discharge from wells cannot be redistributed to the uppermost active cell in the event that cells become dewatered. These stresses applied to an inactive cell are not simulated.

As noted earlier, assessment of the effects of additional withdrawal on water levels in the northern part of Juab Valley was the focus of this investigation. Therefore, pumping simulated in the southern part was halved from 3,270 to 1,635 acre-ft/yr to reduce the number of dewatered cells so that the model could complete calculations for all nine stress periods. This change in the model did not substantially affect simulated water levels in the northern part of the valley because of the presence of the ground-water divide (fig. 2). An area south of Levan adjacent to the eastern mountain front still became dewatered during the additional stress period (fig. 2). This area received simulated recharge from infiltration of precipitation and subsurface inflow from consolidated rocks. No pumping wells were simulated in the dewatered area.

Areas where cells dewatered in the northern part of the revised model are northeast of Levan Ridge near the ground-water divide and near Nephi (fig. 2). The area near the ground-water divide does not contain large-yield wells but is affected by relatively small amounts of recharge and pumpage in the Nephi and Levan areas. The effects of these dewatered cells on water levels computed for the rest of the model is minor because of the small amount of recharge from subsurface inflow lost from the system. Dewatered model cells in layer 1 near Nephi resulted in a reduction of 480 and 310 acre-ft/yr in specified discharge from pumped wells beginning in 2018 and 2029, respectively. Therefore, specified discharge in 2022 and 2042 of the simulation with no additional pumping was 480 and 790 acre-ft/yr less, respectively, than was simulated in 2002 when there were no dewatered cells in the northern part of the valley.

The ground-water system in most of the northern part of Juab Valley approached equilibrium with the change in water levels stabilizing after about 25 years (2017) of the 50-year stress period (fig. 3). The change in water levels computed for selected cells in model layer 1 is similar to changes for the same cells in the other three layers shown in figure 3. Steady-state conditions result when the amount of simulated



EXPLANATION

- **Approximate location of ground-water divide determined from water levels computed for model layer 1, 1992 of the original model**
- 5,000 **Potentiometric contour**—Shows altitude of the potentiometric surface contoured from water levels computed for model layer 1, 2022 of the revised model simulating no additional pumping. Contour interval 20 feet. Datum is sea level
- **Boundary of active cells**
- **Location of existing pumped well simulated in 1992 of the original model and in 1993–2042 of the revised model simulating no additional pumping**
- **Location of dewatered model cell simulated in layer 1, 2022 of the revised model simulating no additional pumping**

Figure 2. Potentiometric surface for model layer 1 contoured from water levels computed for 2022 of the revised model simulating no additional pumping in Juab Valley, Utah.

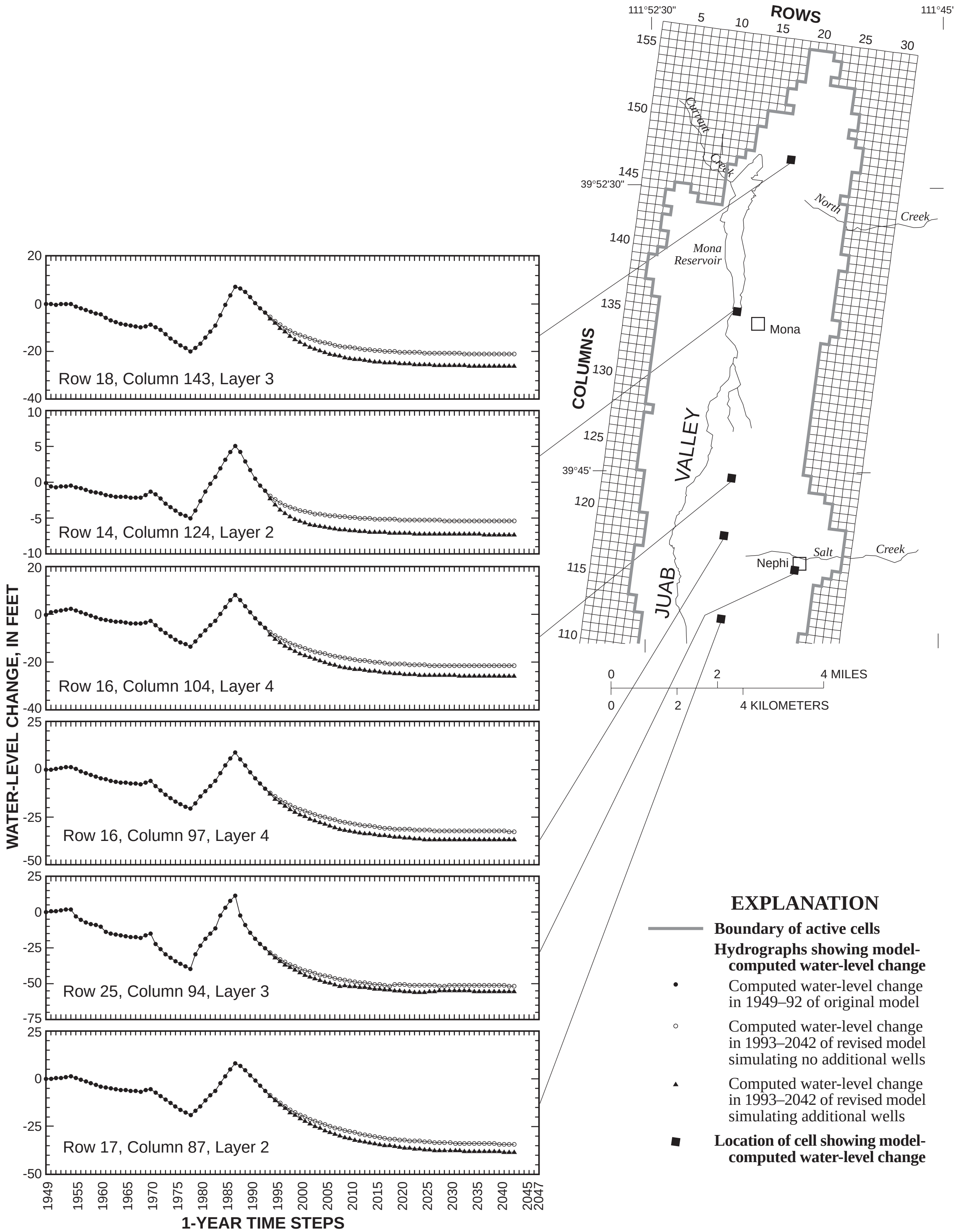


Figure 3. Model-computed water-level change in selected model cells in the northern part of Juab Valley, Utah.

recharge to the system is equal to the amount of simulated discharge—there is no net change in storage. About 810 acre-ft/yr of water was removed from storage (2 percent of simulated recharge) in 2022 and about 210 acre-ft/yr (0.5 percent of simulated recharge) in 2042 of the revised model simulating no additional pumping (table 1). Water-level declines simulated in layer 1 in 2022 of the revised model simulating no additional pumping generally ranged from about 5 ft in the area near Currant Creek to about 30 ft in the area south of Nephi (fig. 4).

Simulated discharge from springs, seeps, evapotranspiration, and flowing wells in the northern part of the valley decreased in response to the decline in water levels. Total model-computed discharge decreased about 38 percent (12,640 acre-ft/yr) from 33,610 acre-ft in 1992, the last year of the original model, to 20,970 acre-ft in 2022, the 30th year of the additional stress period (table 1). Model-computed discharge by evapotranspiration and from springs and seeps decreased by about 53 percent (6,070 acre-ft/yr) and 29 percent (6,260 acre-ft/yr), respectively, from 1992 to 2022. Simulated spring discharge includes ground-water discharge to Mona Reservoir, Burriston Ponds, West Creek, and Currant Creek. The budget element listed as ‘Seepage to Currant Creek upstream from streamflow-gaging station 10146400’ in table 1 includes simulated spring discharge to Burriston Ponds and seepage to West Creek. Although the decrease in model-computed discharge is substantial, it is thought to be acceptable for the purpose of determining the effects of additional pumping on the system.

SIMULATION OF ADDITIONAL PUMPING

To assess the effects of an additional 4,000 acre-ft/yr of pumping in the northern part of Juab Valley, 30 wells were added to stress period 9 (1993-2042) of the revised flow model. Each of the 30 wells was assigned a pumping rate of 133 acre-ft/yr. For a possible water-management option that requires the additional ground water during the month of July only, this equates to about 2.2 ft^3/s for each well. The wells were simulated in a line along the eastern part of the valley (fig. 5) where the unconsolidated basin-fill deposits probably are thicker and were screened in model layer 4 to tap the thickest and most transmissive part of the ground-water system. The spacing of the wells decreased in the area west of Nephi to take advantage of the large amount of simulated recharge by subsurface inflow from consolidated rocks. Wells were not added to the southern part of the valley.

Water-level declines of more than 5 ft were simulated in layer 1 in the area east of Mona Reservoir in response to 10 years of pumping the additional wells (fig. 6). Total model-computed discharge decreased by about 9 percent, from 24,130 acre-ft in 2002 of the revised model simulating no additional pumping to 22,000 acre-ft for the same time in the revised model simulating additional pumping (table 1). Model-computed discharge to head-dependent boundaries such as evapotranspiration, springs, and seeps decreased by about 16 percent (1,100 acre-ft/yr) and 6 percent (950 acre-ft/yr), respectively, for the same period because of reduced water levels. Model-computed discharge by flowing wells decreased by about 22 percent (80 acre-ft/yr). Water removed from storage was about 15 percent (5,540 acre-ft/yr) of the recharge specified in 2002 of the revised model simulating no additional pumping.

The model-computed water-level change that resulted from additional pumping and specified recharge and pumping rates representing 1987-92 conditions also approached equilibrium in most of the northern part of Juab Valley after about 25 years (fig. 3). About 1,200 acre-ft/yr of water was removed from storage in 2022 and about 260 acre-ft/yr in 2042 of the revised model simulating additional pumping (table 1). Water-level declines of more than 6 ft were computed for layer 1 in the area east of Mona Reservoir in response to 30 years of pumping from the additional wells (fig. 7).

A comparison between results of the two revised models indicates a decrease in model-computed discharge components caused by the additional pumping. Total model-computed discharge decreased by about 12 percent, from 20,970 acre-ft in 2022 of the revised model simulating no additional pumping to 18,550 acre-ft in 2022 of the revised model simulating additional pumping (table 1). Model-computed discharge from head-dependent boundaries such as evapotranspiration, springs, and seeps decreased by about 23 percent (1,230 acre-ft/yr) and 7 percent (1,100 acre-ft/yr), respectively, for the same comparison.

An inactive or dewatered cell cannot simulate recharge from subsurface inflow from consolidated rocks or discharge from pumping wells. Five cells became dewatered in the Nephi area during and after 2022 of the model simulating additional pumping. A consequence of the dewatered cells is that the total

Table 1. Specified ground-water recharge and discharge, model-computed discharge, and change in flow rates for the original and revised ground-water flow models, northern part of Juab Valley, Utah

Budget element	Flow, in acre-feet per year									
	1992 Time step 6, stress period 8	2002 Time step 10, stress period 9			2022 Time step 30, stress period 9			2042 Time step 50, stress period 9		
	Original and revised models	10th year of revised model with no addtional pumping	10th year of revised model with additional pumping	Difference between models	30th year of revised model with no additional pumping	30th year of revised model with additional pumping	Difference between models	50th year of revised model with no additional pumping	50th year of revised model with additional pumping	Difference between models
Specified recharge										
Seepage from streamflow, unconsumed irrigation, and infiltration from precipitation	23,310	23,310	23,310	0	23,310	23,310	0	23,310	23,310	0
Subsurface inflow to east side of Juab Valley	9,970	9,970	9,970	0	9,970	9,850	-120	9,970	9,840	-130
Subsurface inflow to west side of Juab Valley	3,790	3,790	3,790	0	3,790	3,790	0	3,790	3,790	0
Total specified recharge	37,070	37,070	37,070	0	37,070	36,950	-120	37,070	36,940	-130
Specified discharge										
Withdrawal from wells pumped for irrigation and public supply	17,220	17,220	21,220	4,000	16,740	20,430	3,690	16,430	19,800	3,370
Subsurface outflow to consolidated rock/ unconsolidated basin-fill deposits boundary	900	900	900	0	900	900	0	900	900	0
Total specified discharge	18,120	18,120	22,120	4,000	17,640	21,330	3,690	17,330	20,700	3,370
Model-computed discharge										
Springs and seeps										
Seepage to Mona Reservoir	8,800	7,230	6,490	-740	6,760	5,890	-870	6,700	5,820	-880
Seepage to Currant Creek upstream from streamflow-gaging station 10146400[1]	9,480	6,760	6,750	-10	5,800	5,790	-10	5,700	5,690	-10
Seepage to Currant Creek downstream from streamflow-gaging station 10146400	3,390	2,980	2,780	-200	2,850	2,630	-220	2,840	2,610	-230
Springs and seeps total	21,670	16,970	16,020	-950	15,410	14,310	-1,100	15,240	14,120	-1,120
Flowing wells	600	370	290	-80	290	200	-90	280	190	-90
Evapotranspiration	11,340	6,790	5,690	-1,100	5,270	4,040	-1,230	5,130	3,910	-1,220
Total model-computed discharge	33,610	24,130	22,000	-2,130	20,970	18,550	-2,420	20,650	18,220	-2,430
Water going out from storage	13,550	4,470	5,540	1,070	810	1,200	390	210	260	50
Water going into storage	60	0	0	0	0	0	0	0	0	0
Recharge from southern part of Juab Valley	2,050	2,270	2,290	20	2,400	2,450	50	2,360	2,420	60
Discharge to southern part of Juab Valley	620	600	600	0	570	570	0	560	550	-10

[1]Seepage to Current Creek upstream from streamflow-gaging station 10146400 includes simulated spring discharge to Burriston Ponds and seepage to West Creek.

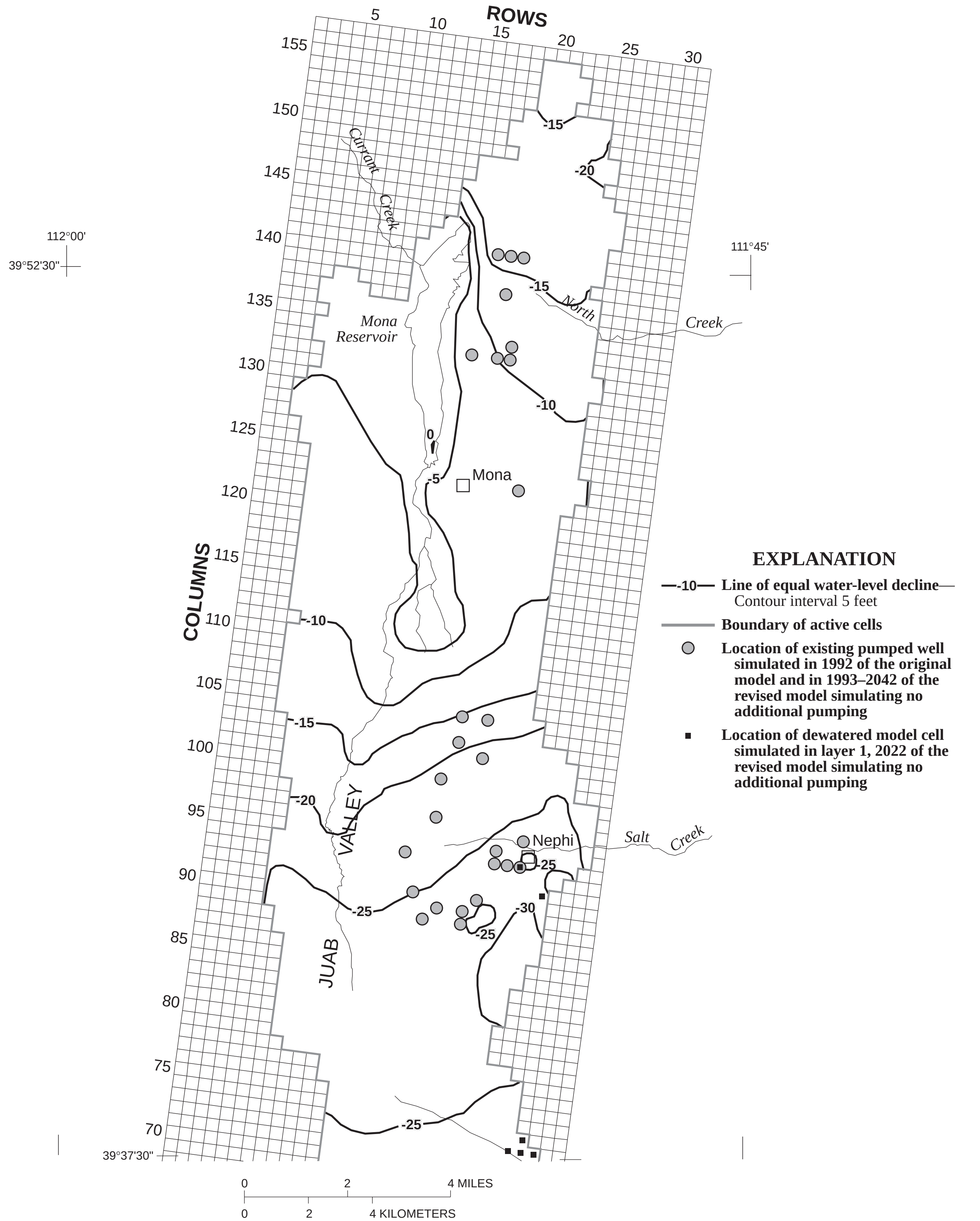


Figure 4. Computed water-level decline for model layer 1 between 1992 and 2022 of the revised model simulating no additional pumping in the northern part of Juab Valley, Utah.

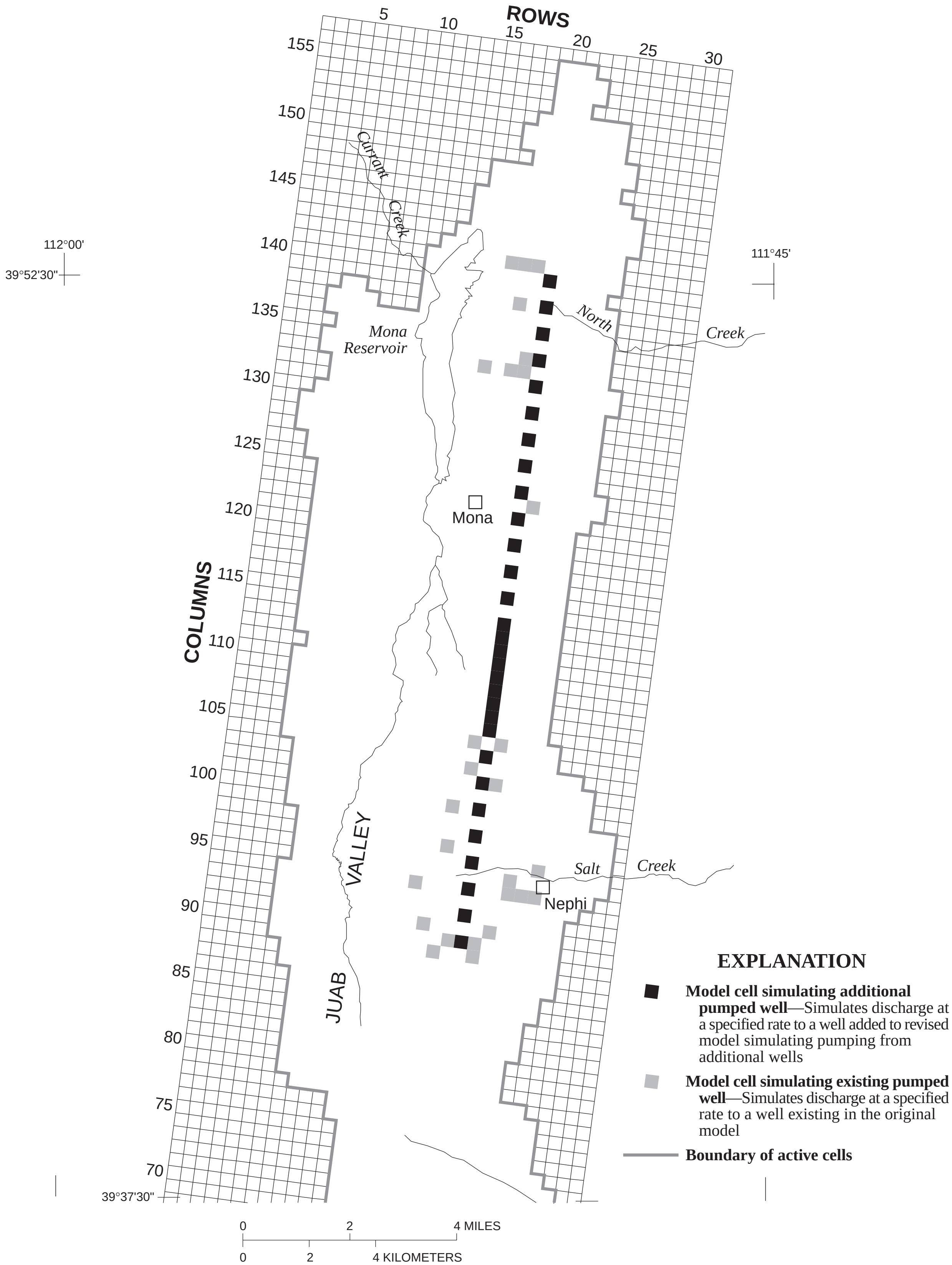


Figure 5. Location of 30 additional pumped wells in the northern part of Juab Valley, Utah.

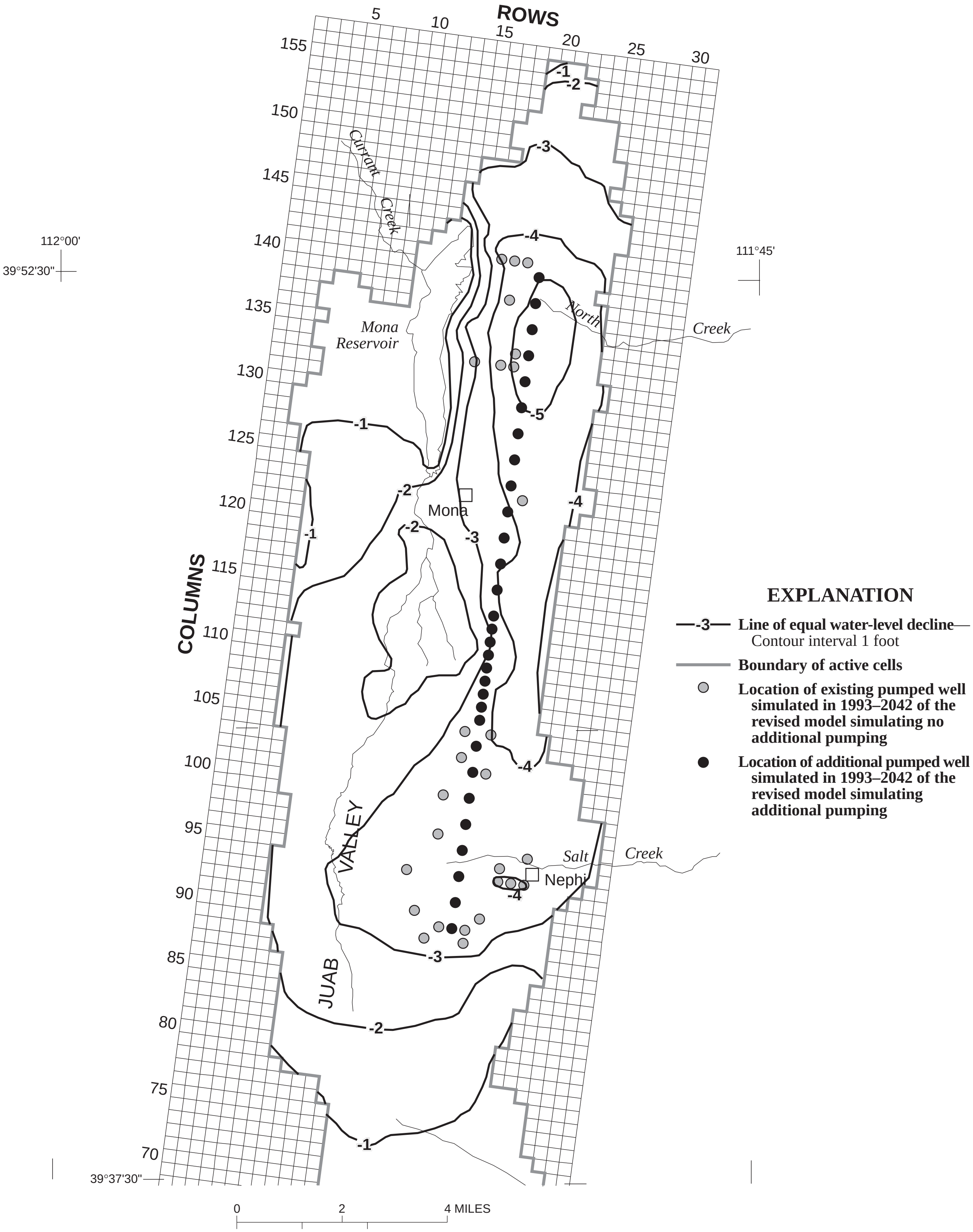


Figure 6. Computed water-level decline for model layer 1 between 2002 of the revised model simulating no additional pumping and 2002 of the revised model simulating additional pumping in the northern part of Juab Valley, Utah.

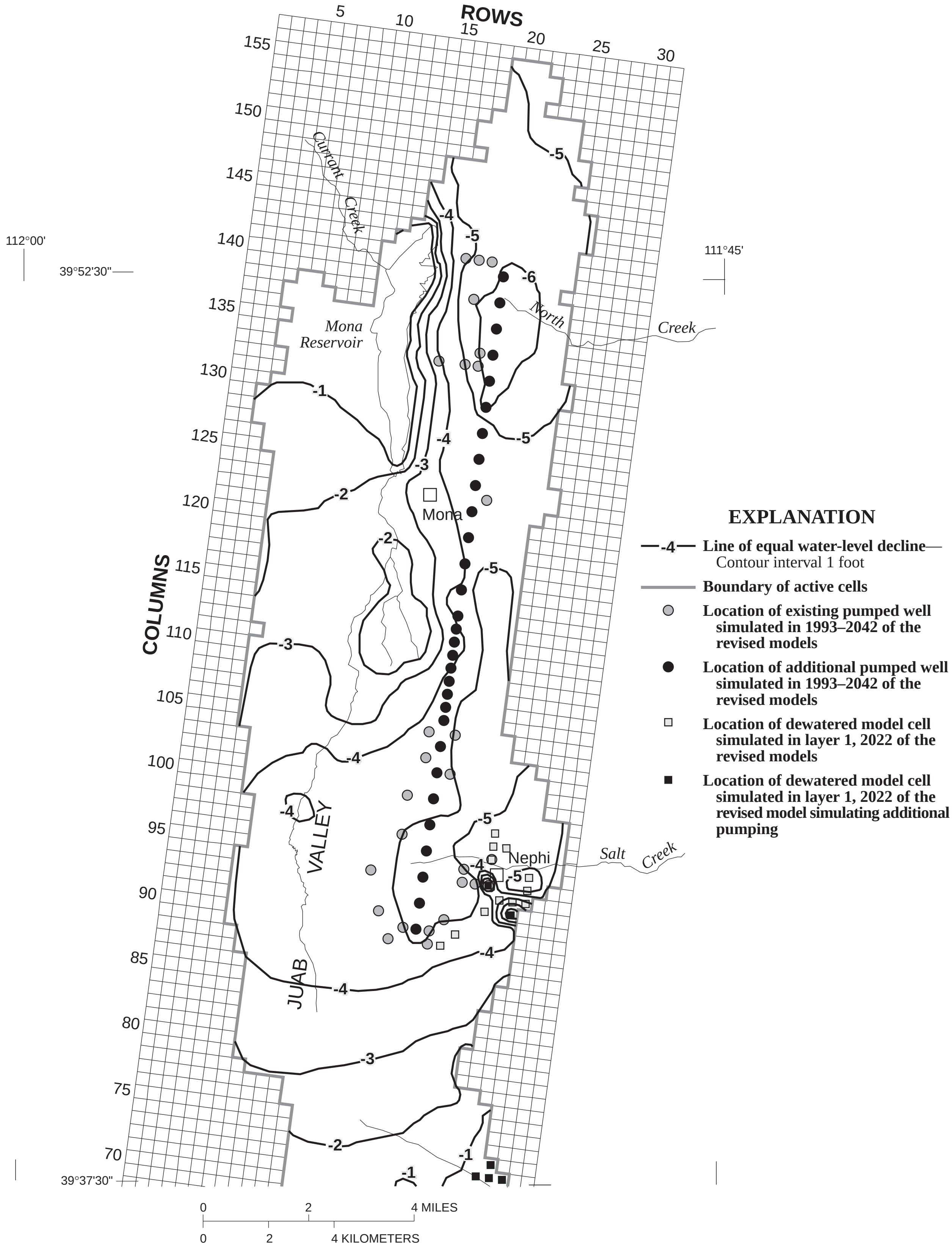


Figure 7. Computed water-level decline for model layer 1 between 2022 of the revised model simulating no addtional pumping and 2022 of the revised model simulating additional pumping in the northern part of Juab Valley, Utah.

specified recharge applied in 2022 and 2042 of the simulation with additional pumping was about 0.3 percent less (120 and 130 acre-ft/yr, respectively) than the amount applied in the simulation with no additional pumping. The loss of specified recharge from subsurface inflow caused by the dewatered cells results in more model-computed water-level decline than if the cells were active.

Dewatered model cells in layer 1 near Nephi resulted in 630 acre-ft/yr less specified discharge from pumped wells between 2022 and 2042 of the simulation with additional pumping. This is in addition to the 790 acre-ft/yr of specified discharge from pumped wells lost to dewatered cells in the simulation with no additional pumping. The loss of specified discharge caused by the dewatered cells results in a reduction in the amount of water-level decline computed by the model. Computed water-level declines would be greater if the simulated wells continued to withdraw water rather than becoming inactive.

The area where computed water levels for model layer 1 are less than or equal to 10 ft below land surface in 1992 and 2022 of the revised model simulations is shown in figure 8. Natural discharge by evapotranspiration and seepage to springs, streams, and Mona Reservoir generally occurs within this area. Discharge by evapotranspiration is dependent on the depth of the water table and is, therefore, a head-dependent process. The evapotranspiration rate varies linearly from a maximum when the water level is near or at land surface to zero when the water level is below a subjectively set extinction depth of 10 ft. The area decreased in size in the revised models, mostly because water levels declined throughout the additional stress periods. The area where ground water was within 10 ft of land surface as computed by the simulation with additional pumping was less than the area computed by the simulation with no additional pumping. The areas where model-computed water levels for model layer 4 are greater than for model layer 1 in the revised models is roughly similar to the areas shown in figure 8.

LIMITATIONS OF REVISED MODELS

This investigation compares the effects of pumping from existing and additional wells in the northern part of Juab Valley. To distinguish between the effects of the two simulations, specified recharge and specified discharge from existing wells was simulated until the resulting water-level changes stabilized. The application of the stresses used in the last stress period of the original model to the added stress period of the revised models caused relatively large changes in water levels and natural discharge. Because of limitations in the scope of the study, a more representative set of specified recharge and discharge stresses was not constructed for the revised models. This set of stresses could be derived from a more normal period of precipitation and from annual average pumping volumes for the wells that existed in 1992. Although the effects of pumping from existing wells are large in the revised models (some model cells became dewatered, and the model required about 25 years to approach equilibrium), the general effects of additional pumping on water levels and natural discharge could be estimated using these stresses.

Because yearly time steps are used in these simulations, the additional withdrawal of 4,000 acre-ft/yr is distributed equally throughout the year rather than seasonally or monthly as would be required by the hypothetical water-management option. In reality, pumping at a higher rate during the summer months would likely produce much greater localized drawdown than is simulated by the model using annualized pumping rates and yearly time steps.

Recharge to the valley from subsurface inflow from the surrounding consolidated rocks is simulated as specified flux. A specified-flux boundary condition fixes the amount of recharge and discharge across the boundary and does not allow more water to enter or leave the active model area as a result of head-gradient changes. Additional pumping simulated near the edges of the modeled area does not cause recharge from subsurface inflow at the model edge to increase or discharge by subsurface outflow at the model edge to decrease to compensate for the ground-water withdrawals. More water could recharge the system and simulated water-level declines would be less if a head-dependent boundary were used to simulate subsurface inflow from consolidated rocks instead of a specified-flux boundary.

Recharge from unconsumed irrigation water and distribution-system losses was assumed to be 10 percent of the ground water pumped from wells in the original model (Thiros and others, 1996, p. 58). The amount of recharge from unconsumed irrigation water and distribution-system losses specified in the revised model simulating additional pumping was not increased as a percentage of the additional ground water pumped. Assuming no changes in water-application practices used in the valley, the amount of water-

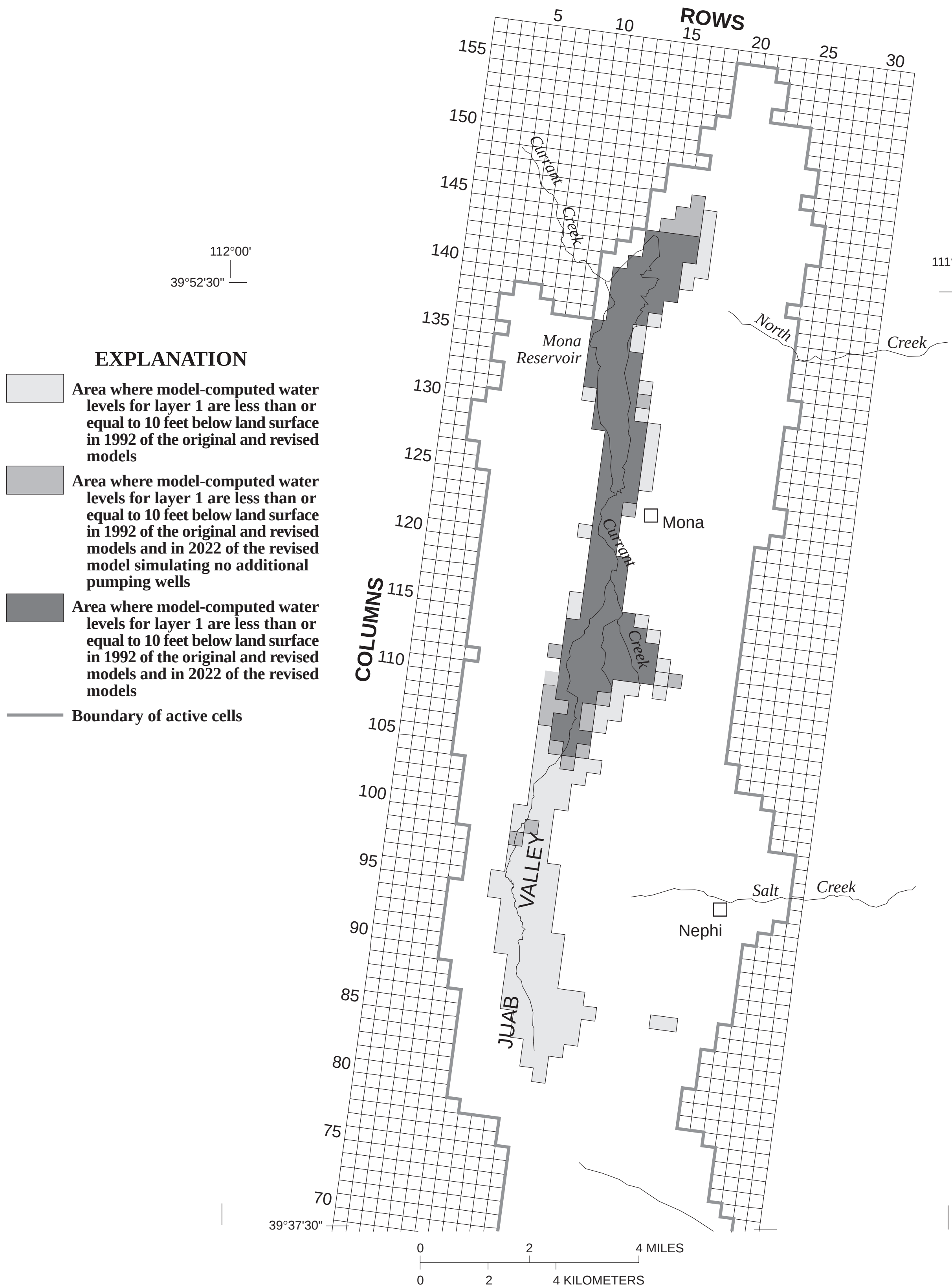


Figure 8. General location where computed water levels for model layer 1 are less than or equal to 10 feet below land surface in 1992 and 2022 of the revised model simulations in the northern part of Juab Valley, Utah.

level decline caused by the additional pumping is more than if recharge from unconsumed irrigation water and distribution-system losses were included.

Dewatered cells cause the loss of some recharge and discharge specified in the revised models. The loss of specified discharge from model layer 1 simulated by four existing pumped wells in the Nephi area resulted in less model-computed water-level decline than if the cells had not been dewatered. The effect of this underestimation extends to the head-dependent cells used to simulate discharge from springs, flowing wells, leakage to streams, and evapotranspiration. Therefore, model-computed discharge was increased by the amount of specified discharge not simulated by the dewatered cells with the existing pumped wells.

As was stated in the documentation of the original numerical ground-water flow model for Juab Valley, data are not available to estimate discharge to springs, evapotranspiration, and flowing wells. Therefore the numerical model was calibrated to match water levels rather than flow rates in discharge areas (Thiros and others, 1996, p. 96). The accuracy of model-computed flow for individual components of discharge is not known and should be considered an approximation. Additional data on recharge and discharge components are needed to improve the original ground-water flow model and any revisions to it.

SUMMARY

Information on the ground-water system in northern Juab Valley, Utah, is needed by water managers to plan the optimal use of surface water that will be imported by the Central Utah Project and existing ground and surface water. The response of the ground-water system to an increase in withdrawal with no new sources of recharge was simulated to provide a baseline for comparing possible water-management plans and to determine the potential effects on wetlands in the area. As a first step, the existing 1949-92 transient-state model was extended to 2042 using 1987-92 stresses. This was accomplished by adding one 50-year-long stress period to the end of the original model. The second step was to simulate the same 50-year-long period from 1993-2042 with an additional 4,000 acre-ft/yr of withdrawal from 30 proposed wells. Then, the results of these two simulations were compared to quantify and evaluate the effects of the proposed additional pumpage.

The ground-water system in most of the northern part of Juab Valley approached equilibrium with the change in water levels stabilizing after about 25 years of the 50-year stress period. Water-level declines simulated in layer 1 in 2022 of the revised model simulating no additional pumping generally ranged from about 5 ft in the area near Currant Creek to about 30 ft in the area south of Nephi. Simulated discharge from springs, seeps, evapotranspiration, and flowing wells in the northern part of the valley decreased in response to the decline in water levels. Total model-computed discharge decreased about 38 percent (12,640 acre-ft/yr) from 33,610 acre-ft in 1992, the last year of the original model, to 20,970 acre-ft in 2022, the 30th year of the additional stress period. Although the decrease in model-computed discharge is substantial, it is thought to be acceptable for the purpose of determining the effects of additional pumping on the system.

An additional 4,000 acre-ft/yr of pumping was simulated from 30 wells in the northern part of Juab Valley from 1993-2042. These wells were simulated in a line along the eastern part of the valley and were screened in model layer 4 to tap the thickest and most transmissive part of the ground-water system. The model-computed water-level change that resulted from additional pumping and specified recharge and pumping rates representing 1987-92 conditions also approached equilibrium in most of the northern part of the valley after about 25 years.

Water-level declines of more than 6 ft were computed for layer 1 in the area east of Mona Reservoir in response to 30 years of additional pumping. Total model-computed discharge decreased by about 12 percent, from 20,970 acre-ft in 2022 of the revised model simulating no additional pumping to 18,550 acre-ft in 2022 of the revised model simulating additional pumping. Discharge from springs and seeps computed in 2022 of the model with additional pumping decreased by about 7 percent and computed discharge by evapotranspiration decreased by about 23 percent relative to the same time in the model with no additional pumping. The area where the simulated depth to water was less than or equal to 10 ft below land surface decreased in size in the revised models.

A limitation of the revised models is that the application of the stresses determined for the last stress period of the original model to the added stress period of the revised models caused relatively large changes in water levels and natural discharge. Because of limitations in the scope of the study, a more representative set of specified recharge and discharge stresses was not

constructed for the revised models. More water could recharge the system and simulated water-level declines would be less if a head-dependent boundary were used to simulate subsurface inflow from consolidated rocks instead of a specified-flux boundary. The accuracy of model-computed flow for individual components of discharge is not known and should be considered an approximation. Additional data on recharge and discharge components are needed to improve the original ground-water flow model and any revisions to it.

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