OFR 90-155

WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

PRINCIPAL RESULTS OF A GROUND-WATER STUDY OF HONEY LAKE VALLEY, CALIFORNIA AND NEVADA

BACKGROUND

Aquifers in Honey Lake Valley are under consideration as a potential source of public water supply for the growing populations of Lassen County, Calif., and Washoe County, Nev. To determine average quantities of water that are recharged to and discharged from this aquifer system annually and to evaluate possible hydrologic impacts of development, the U.S. Geological Survey, in cooperation with the California Department of Water Resources and the Nevada Division of Water Resources, evaluated the water resources of the area. The evaluation included "ground-water budgets" and a mathematical computer model of ground-water flow in the eastern part of the basin. A detailed discussion of the study (U.S. Geological Survey Water-Resources Investigations Report 90-4050) is "in press."

GROUND-WATER BUDGET FOR THE STUDY AREA

A ground-water budget is a useful summary of the components of ground-water flow in the area (table 1). The budget consists of estimates of recharge (inflow) to an area, minus estimates of discharge (outflow) from the area, plus or minus estimated changes in ground-water storage within the area.

Sources of ground-water recharge in the Honey Lake Valley study area are (1) direct infiltration of precipitation, mainly in upland areas; (2) infiltration of water from streamflow and irrigation; and (3) ground-water inflow from adjacent areas. The major sources are infiltration of streamflow in the south, west, and northwest parts of the basin and direct infiltration of precipitation in the uplands. The possibility of ground-water inflow from adjacent basins was investigated but could not be confirmed.

Annual precipitation within the study area ranges from more than 30 inches at high altitudes in the Sierra Nevada to less than 6 inches on the valley floor east of Honey Lake, and totals about 1.1 million acre-feet. (An acre-foot is the amount of water that would cover 1 acre to a depth of 1 foot, and is equivalent to 326,000 gallons.) Only about 5 percent of this quantity infiltrates directly to become ground-water recharge; the remainder runs off, evaporates, or is transpired by plants. Part of the water that runs off eventually infiltrates through stream channels and recharges the ground-water system.

Annual streamflow within Honey Lake Valley is about 230,000 acre-feet, including water that originates outside the study area in the drainage basins of the Susan River and Long Valley Creek. An estimated 54,000 acre-feet of the annual streamflow is diverted for irrigation, primarily on the southwestern and western parts of the valley floor, and 25 percent of the irrigation water is assumed to infiltrate and recharge the ground-water system. An additional source of ground-water recharge is infiltration of irrigation water that was withdrawn from the aquifer system by wells.

Ground water is discharged from the basin by (1) evaporation from soils and transpiration from plants, (2) withdrawals from wells for irrigation and other uses, (3) ground-water outflow, and (4) a minor amount of seepage to and subsequent evaporation from Honey Lake.

Direct evaporation of ground water, which occurs where the water table is within a few feet of land surface, averages 0.1 to 0.2 foot per year from bare soil. Transpiration of ground water by phreatophytes (plants that extend their roots beneath the water table) ranges from 0.2 to 2.0 feet per year, depending on depth to water and vegetation type. Evaporation and transpiration account for about 60 percent of total ground-water discharge from the basin (table 1).

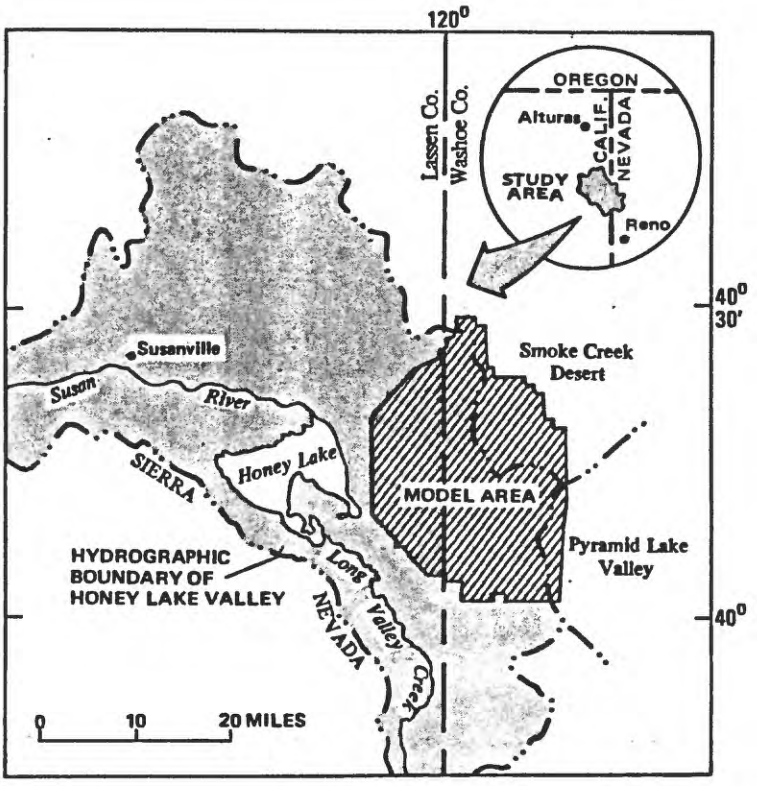

TABLE 1.--*Ground-water budget for the entire study area*

[Acre-feet per year, rounded to two significant figures]

Budget component	Estimated quantity
RECHARGE:	
Direct infiltration of precipitation	55,000
Infiltration of streamflow:	
from north and east	13,000
from south, west, and northwest	40,000
Irrigation return:	
from surface-water irrigation	14,000
from ground-water irrigation	11,000
Ground-water inflow	unknown [1]
TOTAL RECHARGE	130,000
DISCHARGE:	
Evapotranspiration from soil and native vegetation	85,000
Withdrawals from wells	53,000
Ground-water outflow	unknown [1]
TOTAL DISCHARGE [2]	140,000

[1] See text.

[2] The imbalance between total recharge and total discharge may be partly a result of undocumented ground-water flow into and out of the study area; it also may be partly due to rounding.

Ground water is pumped from the aquifer system for irrigation, public supply, domestic, industrial, and geothermal uses. About 80 percent of the estimated 53,000 acre-feet of annual pumpage is used for irrigation. About 25 percent of the irrigation water infiltrates back into the aquifer system; the rest discharges by evaporation and transpiration.

Water levels in wells in the eastern part of the study area indicate a generally eastward-sloping gradient from Honey Lake Valley to both Smoke Creek Desert and Pyramid Lake Valley. Results of the ground-water flow model indicate that annual ground-water outflow to these areas may total about 7,000 acre-feet. Results also indicate that some water deep in the aquifer system east of Honey Lake may flow westward.

Changes in water level are evidence of changes in storage. In a hydrologic system that is at or near equilibrium, increases and decreases in storage tend to "balance out" over time. Data from several years of water-level measurements at wells in Honey Lake Valley indicate that the ground-water system generally has been near equilibrium.

RESULTS OF A COMPUTER MODEL OF GROUND-WATER FLOW

The ground-water flow system in the part of the study area east of Honey Lake was simulated by a computer model to evaluate the ground-water budget and to estimate the hydrologic effects of present and proposed ground-water withdrawals from the Nevada part of the basin. Three sets of steady-state (equilibrium) conditions were simulated, and ground-water budgets for the model area were produced for each set of conditions (table 2).

First, the model was calibrated using estimates of mean annual rates of natural recharge and discharge and 1988 rates of ground-water withdrawals (table 2, column 1). This provided a steady-state representation of the system for the 1988 distribution of pumpage. At the western boundary of the model area, ground-water inflow and outflow were approximately in equilibrium. Within the model area, simulated net ground-water flow across the State line was eastward, at about 700 acre-feet per year.

Second, steady-state conditions likely to have existed before ground-water withdrawal began were simulated by removing the pumpage and irrigation-return components from the 1988 calibrated simulation (table 2, column 2). A comparison of the results of the 1988 and pre-pumpage simulations indicates that the principal effect of ground-water withdrawals through 1988 was a 25-foot maximum decline in water levels and a corresponding reduction in evapotranspiration of ground water in the vicinity of the pumped wells. At the State line, within the model area, the effect of simulated withdrawals through 1988 was a 300-acre-foot net increase in annual ground-water flow eastward (from 400 to 700 acre-feet) and a 10-foot maximum decline in water levels.

Third, the probable steady-state conditions resulting from the hypothetical increased pumpage were simulated to provide an example of the potential impacts of further development. The annual ground-water withdrawal was increased to 15,000 acre-feet, none of which was returned to the ground-water system (table 2, column 3). No attempt was made to determine the best number, location, and withdrawal rate of hypothetical wells, or to estimate the period required for the system to reach the new equilibrium.

POTENTIAL IMPACTS OF INCREASED DEVELOPMENT

A comparison of the model simulations for 1988 and for the hypothetical withdrawal of 15,000 acre-feet per year indicates that, if the assumptions upon which the model is based are correct, the system eventually would reach a new equilibrium. However, water levels eventually would decline more than 100 feet near the pumped wells; evapotranspiration by native vegetation would decrease about 10,000 acre-feet per year in the model area; and subsurface outflow of ground water eastward from the valley would decrease about 4,000 acre-feet per year. At the State line, within the model area, net ground-water flow eastward from California would increase about 1,600 acre-feet per year, and water levels would decline further, as much as 40 feet.

Increased development of the ground-water system is practical only to the extent that (1) ground-water storage in the aquifers is sufficient to maintain acceptable water levels, (2) aquifers are capable of maintaining required yields to wells, and (3) effects on local vegetation and water quality are acceptable. An evaluation of these aspects is beyond the scope of this study.

For information about water planning and management, contact:

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P.O. Box 607; 2440 Main Street
Red Bluff, CA 96080

Nevada Division of
Water Resources
123 West Nye Lane
Carson City, NV 89710

For more information about the Honey Lake Valley study, contact:

District Chief
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Carson City, NV 89701

TABLE 2.--*Simulated ground-water budgets for the flow-model area*

[Estimated quantities, in acre-feet per year, rounded to two significant figures]

Budget component	Model calibration (1988 withdrawals)	Predevelopment (no withdrawals)	Proposed development (hypothetical withdrawals)
RECHARGE:			
Direct infiltration of precipitation[1]	9,200	9,200	9,200
Infiltration of runoff	13,000	13,000	13,000
Irrigation return:			
from surface-water irrigation	0	0	0
from ground-water irrigation	1,500	0	0
Ground-water inflow to model area from Honey Lake area and Long Valley Creek area (in shallow layers of model)	580	570	660
TOTAL RECHARGE	24,000	23,000	23,000
DISCHARGE:			
Ground-water evapotranspiration	11,000	15,000	4,600
Withdrawals from wells (and number of simulated wells)	5,900 (5)	0 (0)	15,000 (18)
Ground-water outflow from model area westward to Honey Lake area (in deeper layers of model)	590	610	420
Ground-water outflow eastward to Smoke Creek Desert	5,300	5,500	2,000
Ground-water outflow eastward to Pyramid Lake Valley	1,500	1,500	700
TOTAL DISCHARGE	24,000	23,000	23,000

[1] Includes 5,000 acre-feet per year that was considered to be direct infiltration of precipitation, but may originate outside the southeast boundary of Honey Lake Valley.

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