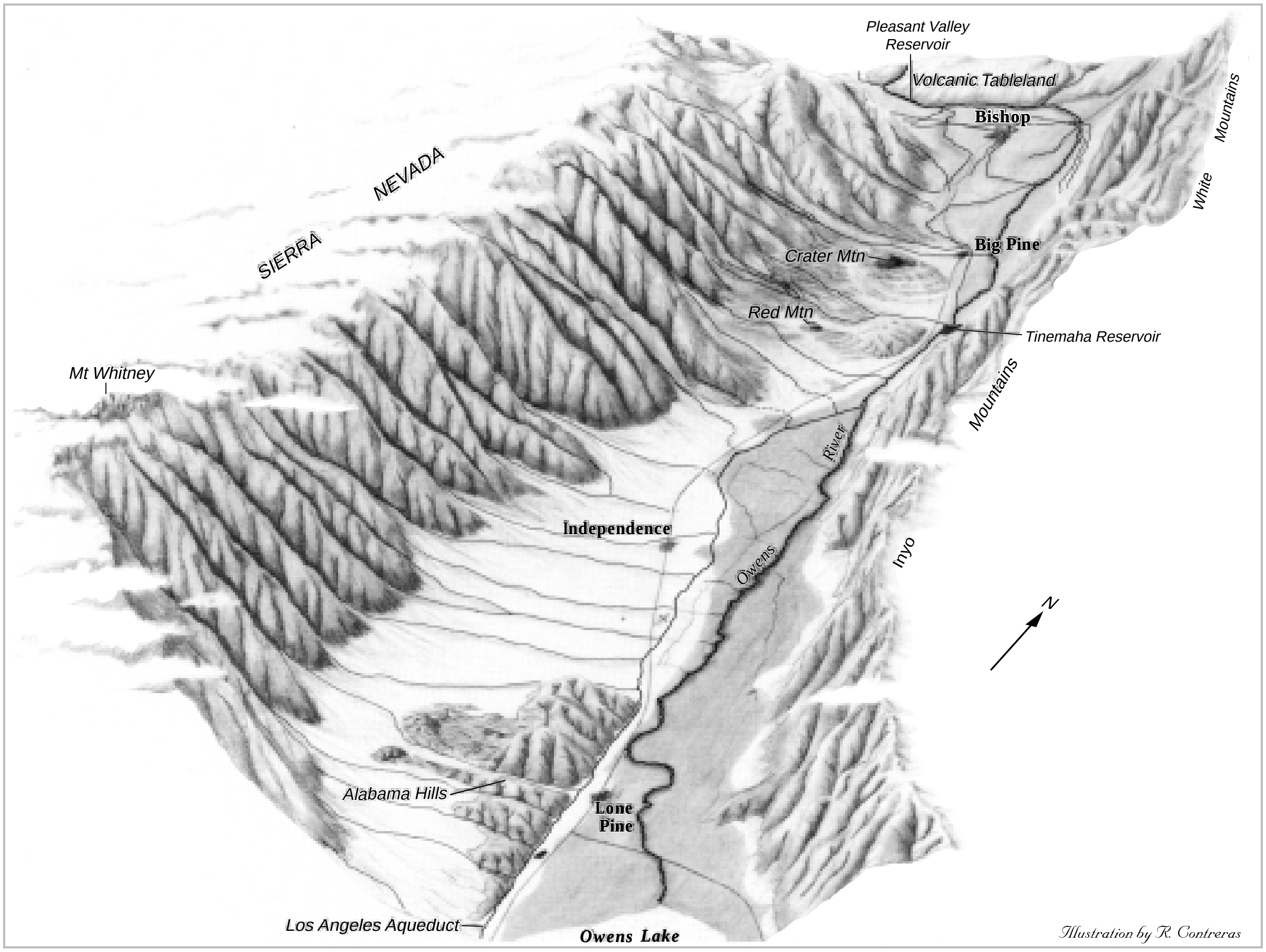

Frontispiece. Vertically exaggerated perspective and oblique view of the Owens Valley, California, showing the dramatic difference in topographic relief between the valley and the surrounding mountains.

Chapter H

Evaluation of the Hydrologic System and Selected Water-Management Alternatives in the Owens Valley, California

By WESLEY R. DANSKIN

Prepared in cooperation with Inyo County and the
Los Angeles Department of Water and Power

U.S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2370

HYDROLOGY AND SOIL-WATER-PLANT RELATIONS IN OWENS VALLEY, CALIFORNIA

1998

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Acting Director

Library of Congress Cataloging in Publications Date

Danskin, Wesley R.
Evaluation of the hydrologic system and selected water-management alternatives in the Owens, Valley, California / by Wesley R. Danskin.
p. cm.—(U.S. Geological Survey Water-Supply Paper 2370-H)
"Prepared in cooperation with Inyo County and the Los Angeles Department of Water and Power."
Includes bibliographical references.
Supt. of Docs. no. : I 19.13: 2370-H
1. Water-supply—California—Owens River Valley—Management.
2. Groundwater—California—Owens River Valley. I. Inyo County (Calif.) II. Los Angeles (Calif.). Dept. of Water and Power. III. Title. IV. Series.
TD225.085D36 1998
333.91’15’0979487—dc21

98-29438
CIP
ISBN.0-607-90059-8

For sale by U.S. Geological Survey, Information Services
Box 25286, Federal Center
Denver, CO 80225

CONVERSION FACTORS

Multiply	By	To obtain
acre	0.405	square hectometer
acre-foot (acre-ft)	.001233	cubic hectometer
acre-foot per acre (acre-ft/acre)	.001233	cubic hectometer per hectometer
acre-foot per year (acre-ft/yr)	.001233	cubic hectometer per year
acre-foot per year per mile [(acre-ft/yr)/mi]	.0007663	cubic hectometer per year per kilometer
cubic foot (ft^3)	.02832	cubic meter
cubic foot per second (ft^3/s)	.02832	cubic meter per second
cubic foot per second per mile [(ft^3/s)/mi]	.0176	cubic meter per second per kilometer
foot (ft)	.3048	meter
foot per day (ft/d)	.3048	meter per day
foot per mile (ft/mi)	.1895	meter per kilometer
foot per second (ft/s)	.3048	meter per second
foot per year (ft/yr)	.3048	meter per year
foot squared per day (ft^2/d)	.0929	meter squared per day
gallon (gal)	3.785	liter
gallon per day per foot [(gal/d)/ft]	12.418	liter per day per meter
gallon per day per cubic foot [(gal/d)/ft^3]	.1072	liter per day per cubic meter
gallon per day per square foot [(gal/d)/ft^2]	.3516	liter per day per square meter
gallon per minute (gal/min)	.06308	liter per second
inch (in.)	25.4	millimeter
inch per year (in/yr)	25.4	millimeter per year
mile (mi)	l.609	kilometer
mile per hour (mi/h)	.447	meter per second
pound per square foot (lb/ft^2)	16.01846	kilogram per square meter
pound per square inch (lb/in^2)	11.1239	kilogram per square centimeter
square foot (ft^2)	.09294	square meter
square mile (mi^2)	2.590	square kilometer

Temperature is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by the following equation:

$$\text{Temp. }^\circ\text{C} = (\text{temp. }^\circ\text{F} - 32) / 1.8$$

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

ABBREVIATIONS AND DEFINITIONS

Abbreviations:

g/m^3	gram per cubic meter
m	meter
mg/L	milligram per liter
mL	milliliter
CEQA	California Environmental Quality Act
EIR	Environmental Impact Report
GIS	geographic information system
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

Definitions:

Calendar year	January 1 through December 31
Runoff year	April 1 through March 31
Rain year	July 1 through June 30
Water year	October 1 through September 30

Evaluation of the Hydrologic System and Selected Water-Management Alternatives in the Owens Valley, California

By Wesley R. Danskin

"We shall not cease from exploration and the end of all our exploring will be to arrive where we started and know the place for the first time."

—T.S. Eliot

Abstract

The Owens Valley, a long, narrow valley along the east side of the Sierra Nevada in east-central California, is the main source of water for the city of Los Angeles. The city diverts most of the surface water in the valley into the Owens River–Los Angeles Aqueduct system, which transports the water more than 200 miles south to areas of distribution and use. Additionally, ground water is pumped or flows from wells to supplement the surface-water diversions to the river–aqueduct system. Pumpage from wells needed to supplement water export has increased since 1970, when a second aqueduct was put into service, and local residents have expressed concerns that the increased pumping may have a detrimental effect on the environment and the native vegetation (indigenous alkaline scrub and meadow plant communities) in the valley. Native vegetation on the valley floor depends on soil moisture derived from precipitation and from the unconfined part of a multilayered ground-water system. This report, which describes the evaluation of the hydrologic system and selected water-management alternatives, is one in a series designed to identify the effects that ground-water pumping has on native vegetation and evaluate alternative strategies to mitigate any adverse effects caused by pumping.

The hydrologic system of the Owens Valley can be conceptualized as having three parts: (1) an unsaturated zone affected by precipitation and evapotranspiration; (2) a surface-water system composed of the Owens River, the Los Angeles Aqueduct, tributary streams, canals, ditches, and ponds; and (3) a saturated ground-water system contained in the valley fill.

Analysis of the hydrologic system was aided by development of a ground-water flow model of the "aquifer system," which is defined as the most active part of the ground-water system and which includes nearly all of the Owens Valley except for the area surrounding the Owens Lake. The model was calibrated and verified for water years 1963–88 and used to evaluate general concepts of the hydrologic system and the effects of past water-management practices. The model also was used to evaluate the likely effects of selected water-management alternatives designed to lessen the adverse effects of ground-water pumping on native vegetation.

Results of the model simulations confirm that a major change in the hydrologic system was caused by the additional export of water from the valley beginning in 1970. Average ground-water pumpage increased by a factor of five, discharge from springs decreased almost to zero, reaches of the Owens River that previously had gained water from the aquifer system began losing water, and total evapotranspiration by native plants decreased by about 35 percent.

Water-management practices as of 1988 were defined and evaluted using the model. Simulation results indicate that increased ground-water pumpage since 1985 for enhancement and mitigation projects within the Owens Valley has further stressed the aquifer system and resulted in declines of the water table and reduced evapotranspiration. Most of the water-table declines are beneath the western alluvial fans and in the immediate vicinity of production wells. The water-table altitude beneath the valley floor has remained relatively constant over time because of hydrologic buffers, such as evapotranspiration, springs, and permanent surface-water features. These buffers adjust the quantity of water exchanged with the aquifer system and effectively minimize variations in water-table altitude. The widespread presence of hydrologic buffers is the primary reason the water-table altitude beneath the valley floor has remained relatively constant since 1970 despite major changes in the type and location of ground-water discharge.

Evaluation of selected water-management alternatives indicates that long-term variations in average runoff to the Owens Valley of as much as 10 percent will not have a significant effect on the water-table altitude. However, reductions in pumpage to an average annual value of about 75,000 acre-ft/yr are needed to maintain the water table at the same altitude as observed during water year 1984. A 9-year transient simulation of dry, average, and wet conditions indicates that the aquifer system takes several years to recover from increased pumping during a drought, even when followed by average and above-average runoff and recharge. Increasing recharge from selected tributary streams by additional diversion of high flows onto the alluvial fans, increasing artificial recharge near well fields, and allocating more pumpage to the Bishop area may be useful in mitigating the adverse effects on native vegetation caused by drought and short-term increases in pumpage.

Analysis of the optimal use of the existing well fields to minimize drawdown of the water table indicates no significant lessening of adverse effects on native vegetation at any of the well fields at the end of a 1-year simulation. Some improvement might result from pumping from a few high-capacity wells in a small area, such as the Thibaut–Sawmill well field; pumping from the upper elevations of alluvial fans, such as the Bishop well field; or pumping in an area surrounded by irrigated lands, such as the Big Pine well field. Use of these water-management techniques would provide some flexibility in management from one year to another, but would not solve the basic problem that increased ground-water pumpage causes decreases in evapotranspiration and in the biomass of native vegetation. Furthermore, the highly transmissive and narrow aquifer system will transmit the effects of pumping to other more sensitive areas of the valley within a couple of years.

Other possible changes in water management that might be useful in minimizing the short-term effects of pumping on native vegetation include sealing well perforations in the unconfined part of the aquifer system; rotating pumpage among well fields; continuing or renewing use of unlined surface-water features such as canals and ditches; developing recharge and extraction facilities in deeper volcanic deposits near Big Pine or in alluvial fan deposits along the east side of the valley; installing additional wells along the west side of the Owens Lake; and conjunctively using other ground-water basins between the Owens Valley and Los Angeles to store exported water for subsequent extraction and use during droughts.

INTRODUCTION

The Owens Valley, a long, narrow valley along the east flank of the Sierra Nevada in east-central California (fig. 1), is the main source of water for the city of Los Angeles. Precipitation in the Sierra Nevada and the Inyo and the White Mountains, which surround the valley, results in an abundance of water flowing into this high desert basin. Because the valley has no surface-water outlet, streams historically have flowed into the Owens Lake, a large saline body of water at the south end of the valley, and evaporated.