

**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.



Figure 1. Drainage areas and physiographic and cultural features of the Owens Valley and the Mono Basin, California.

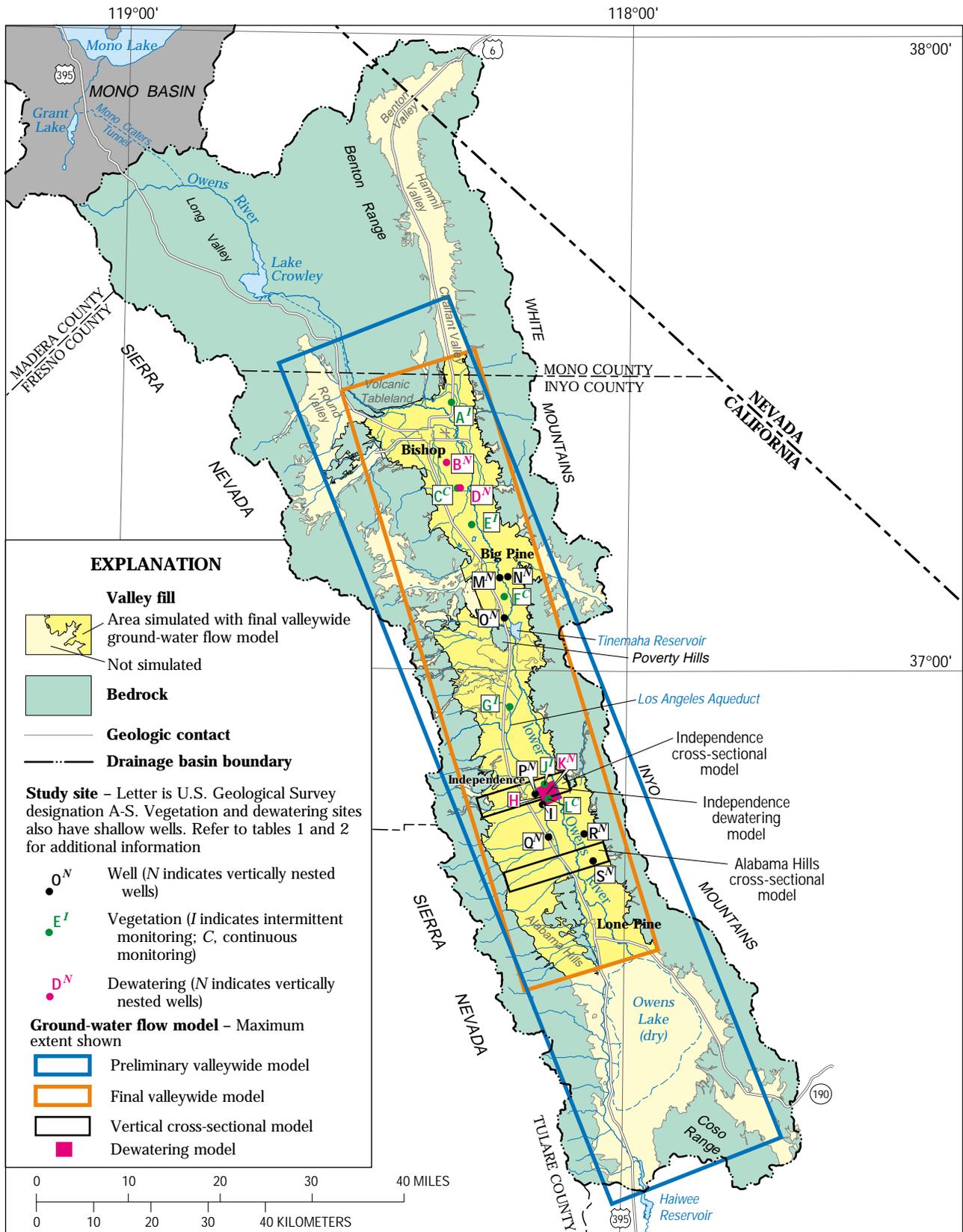
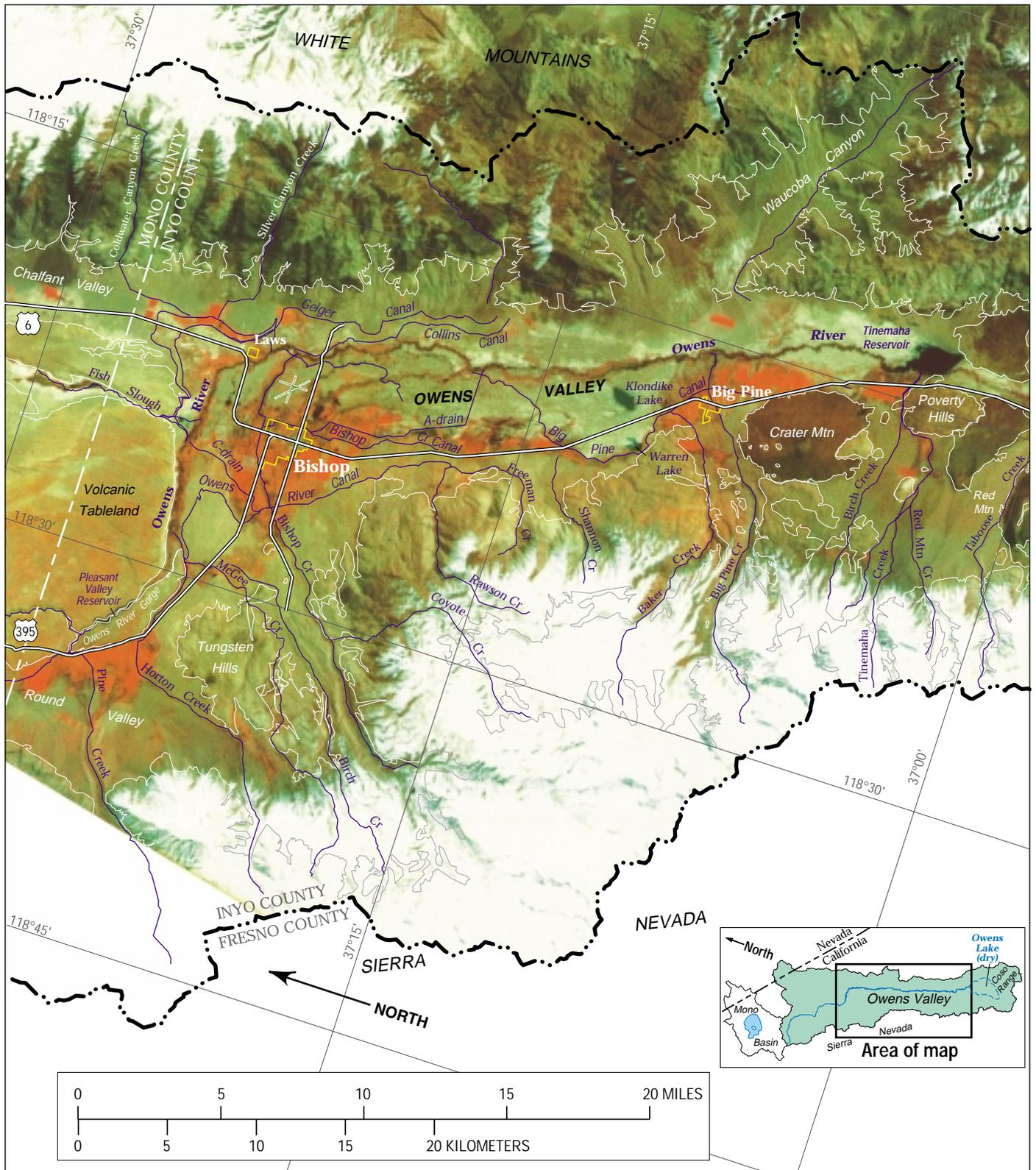


Figure 2. Location of detailed hydrologic investigations and ground-water flow models for the Owens Valley, California, 1982–88.



**Figure 3.** High-altitude infrared imagery showing major geologic, hydrologic, and cultural features of the Owens Valley, California. Image taken May 3, 1983, from Landsat by National Aeronautical and Space Administration. Processing and permission by EROS data center, Sioux Falls, South Dakota.

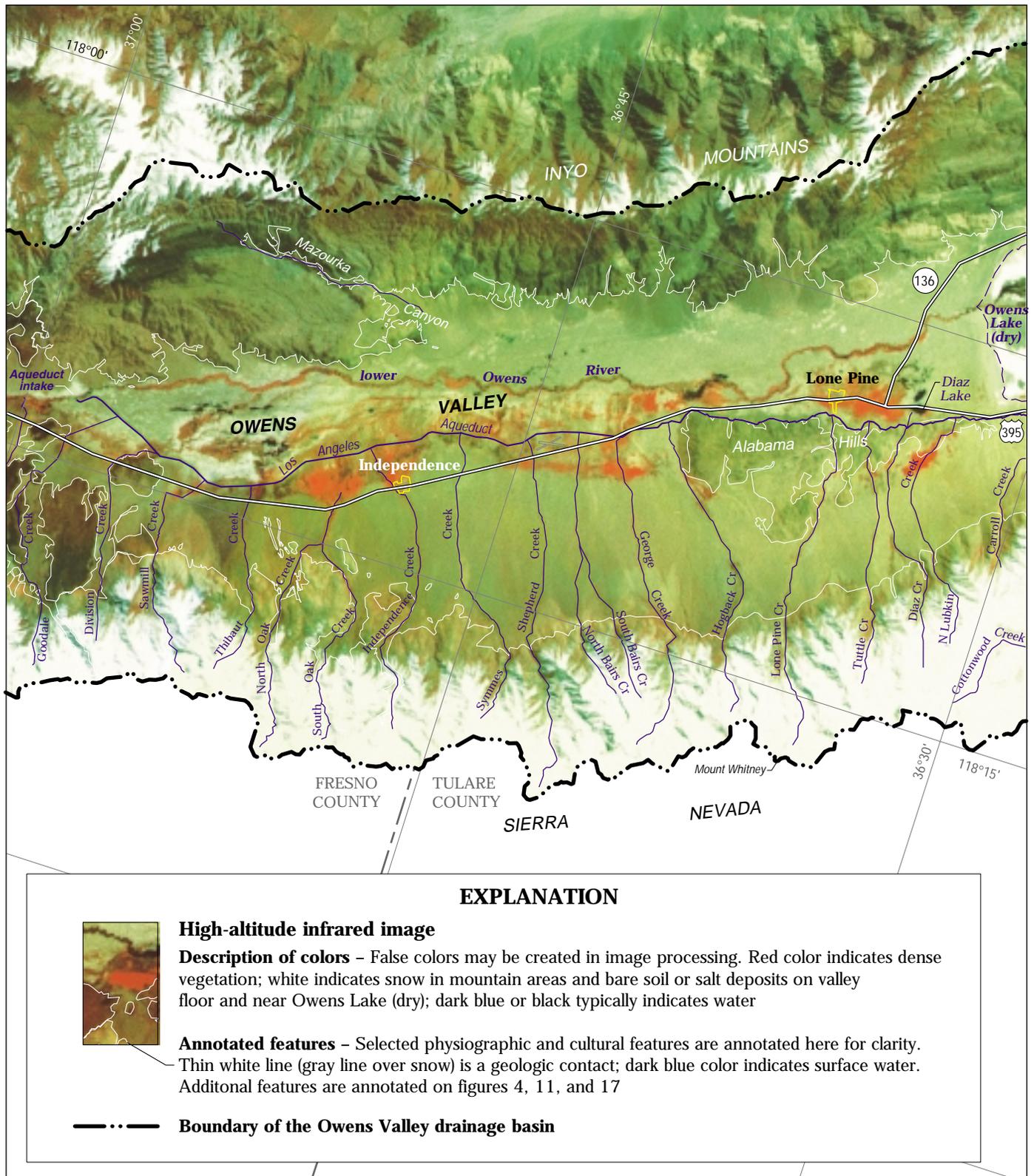


Figure 3. Continued.

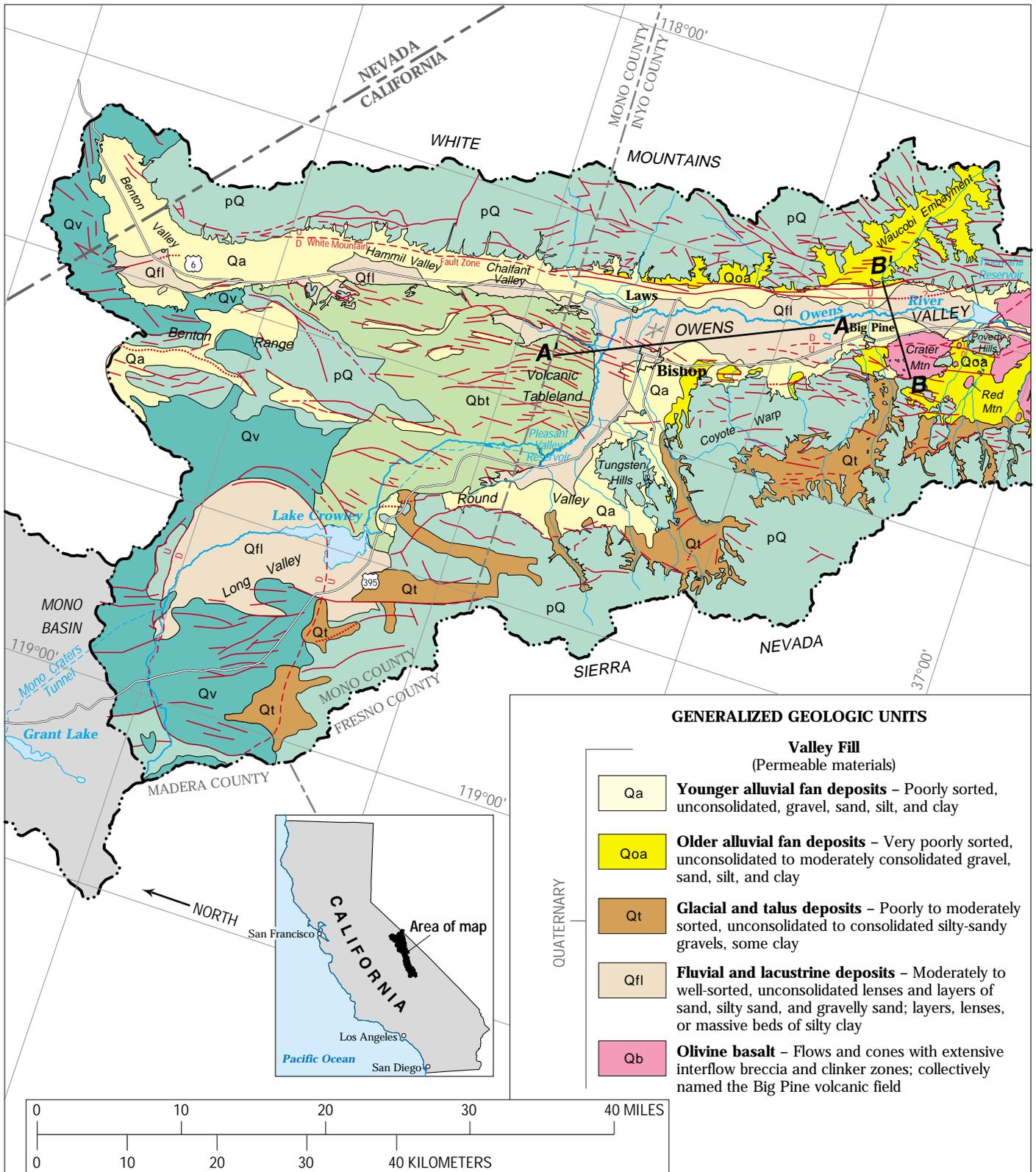
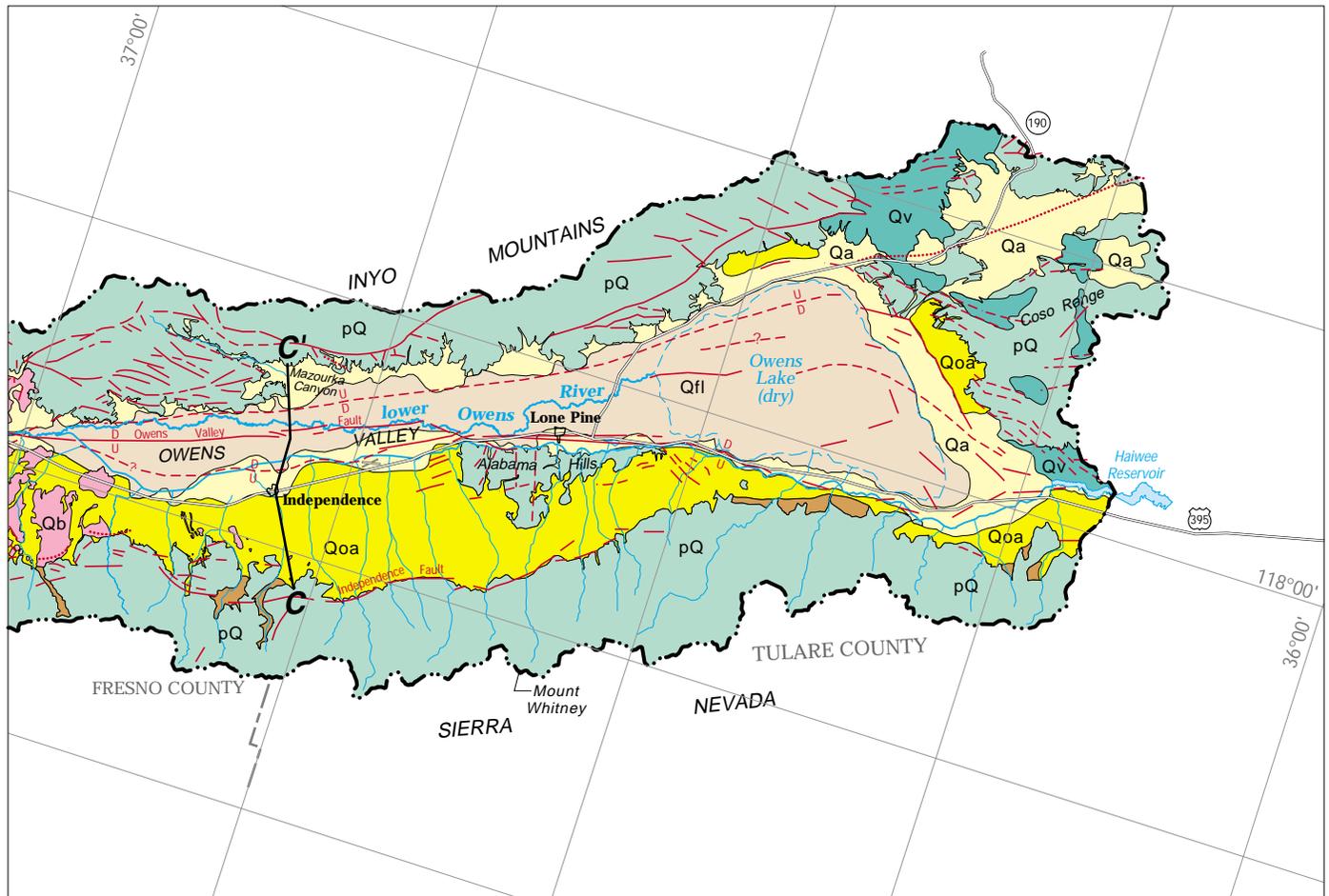


Figure 4. Generalized surficial geology of the Owens Valley drainage basin, California (modified from Hollett and others, 1991).



**GENERALIZED GEOLOGIC UNITS**

<p>QUATERNARY</p>	<p><b>Bedrock</b> (Impermeable or poorly permeable materials, not part of the Owens Valley ground-water basin)</p>	<p><b>Geologic contact</b></p>
<p>PRE-QUATERNARY</p>	<p><b>Qbt</b> <b>Bishop Tuff</b> – Bedrock member of the Bishop Tuff, commonly referred to as the Volcanic Tableland where exposed; composed of welded or agglutinated ash and tuff. Impermeable except where fractured; underlain by permeable members of the Bishop Tuff and valley-fill deposits</p>	<p><b>Fault</b> – Dashed where inferred, dotted where concealed, queried where uncertain. D, downthrown side; U, upthrown side; arrows indicate relative direction of lateral movement</p>
<p><b>Qv</b></p>	<p><b>Volcanic flows and pyroclastic rocks, undifferentiated</b> – Includes rocks of the Coso volcanic field. Storage and transmissive characteristics are largely unknown</p>	<p><b>A — A'</b> <b>Line of hydrogeologic section</b> (Shown in figure 5)</p>
<p><b>pQ</b></p>	<p><b>Undifferentiated sedimentary, metamorphic, and granitic rocks</b> – Consolidated and impermeable</p>	<p><b>— · · —</b> <b>Boundary of the Owens Valley drainage basin</b></p>

Figure 4. Continued.

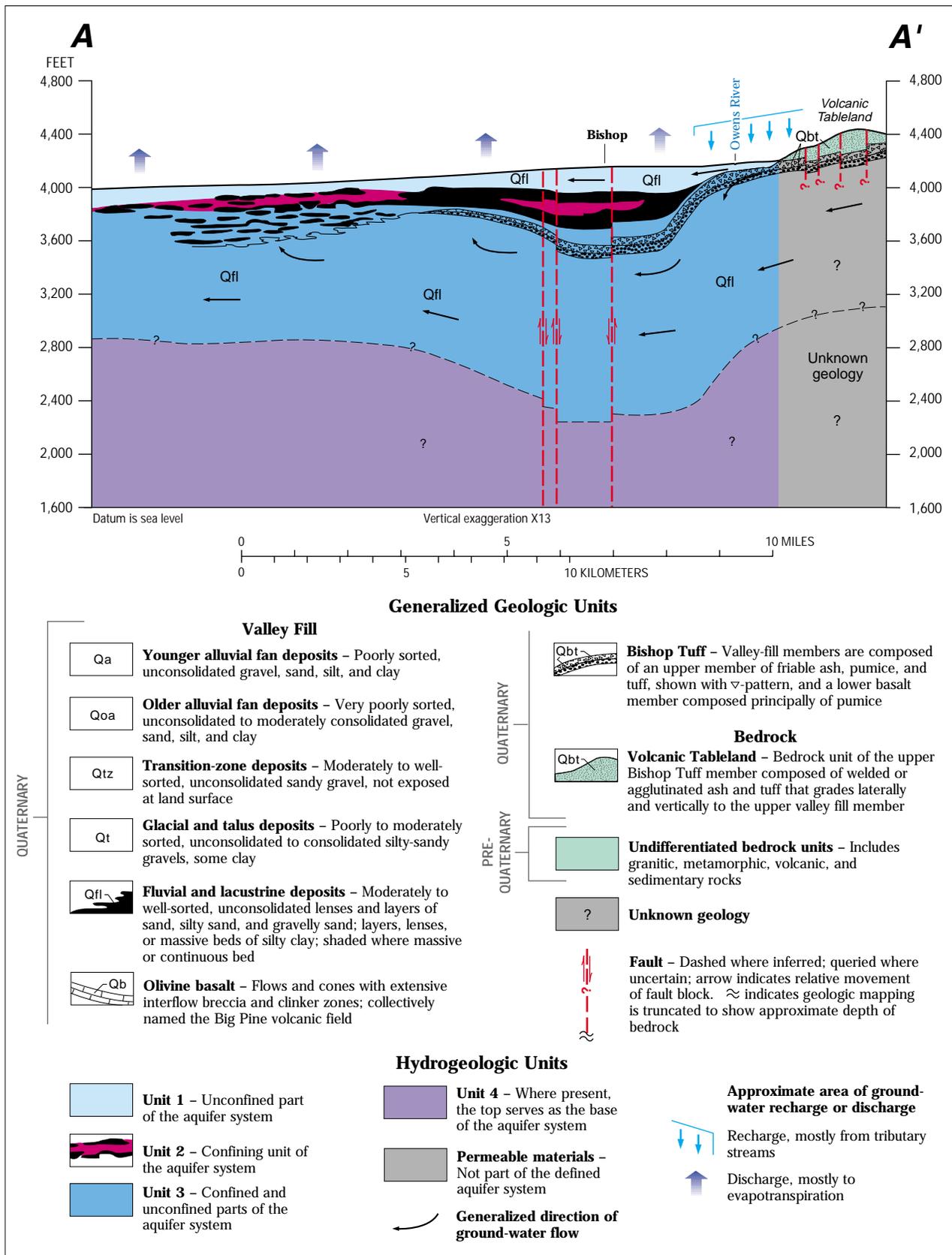


Figure 5. Typical hydrogeologic sections of the Owens Valley, California (modified from Hollett and others, 1991, plates 1 and 2). Sections located on figure 4.

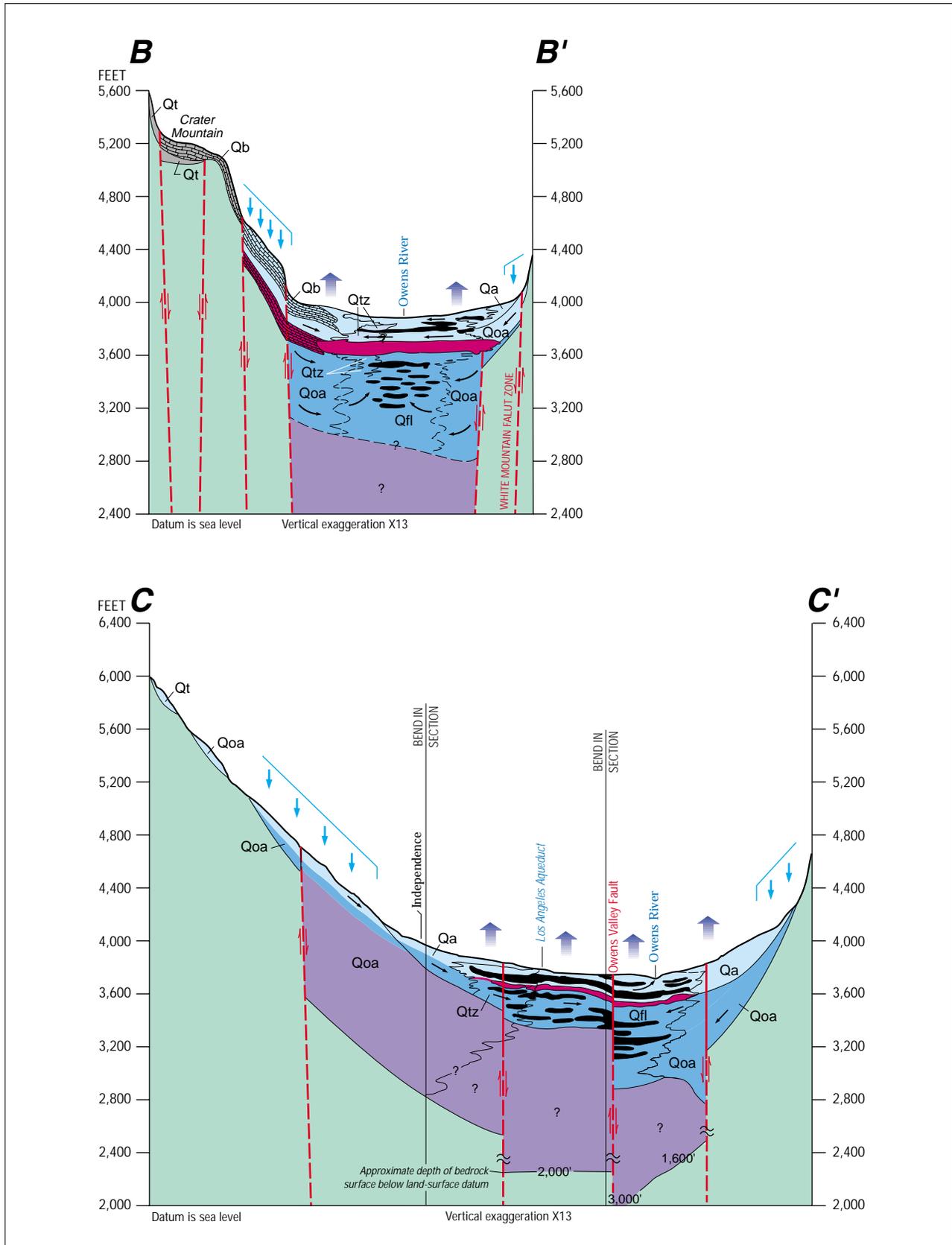
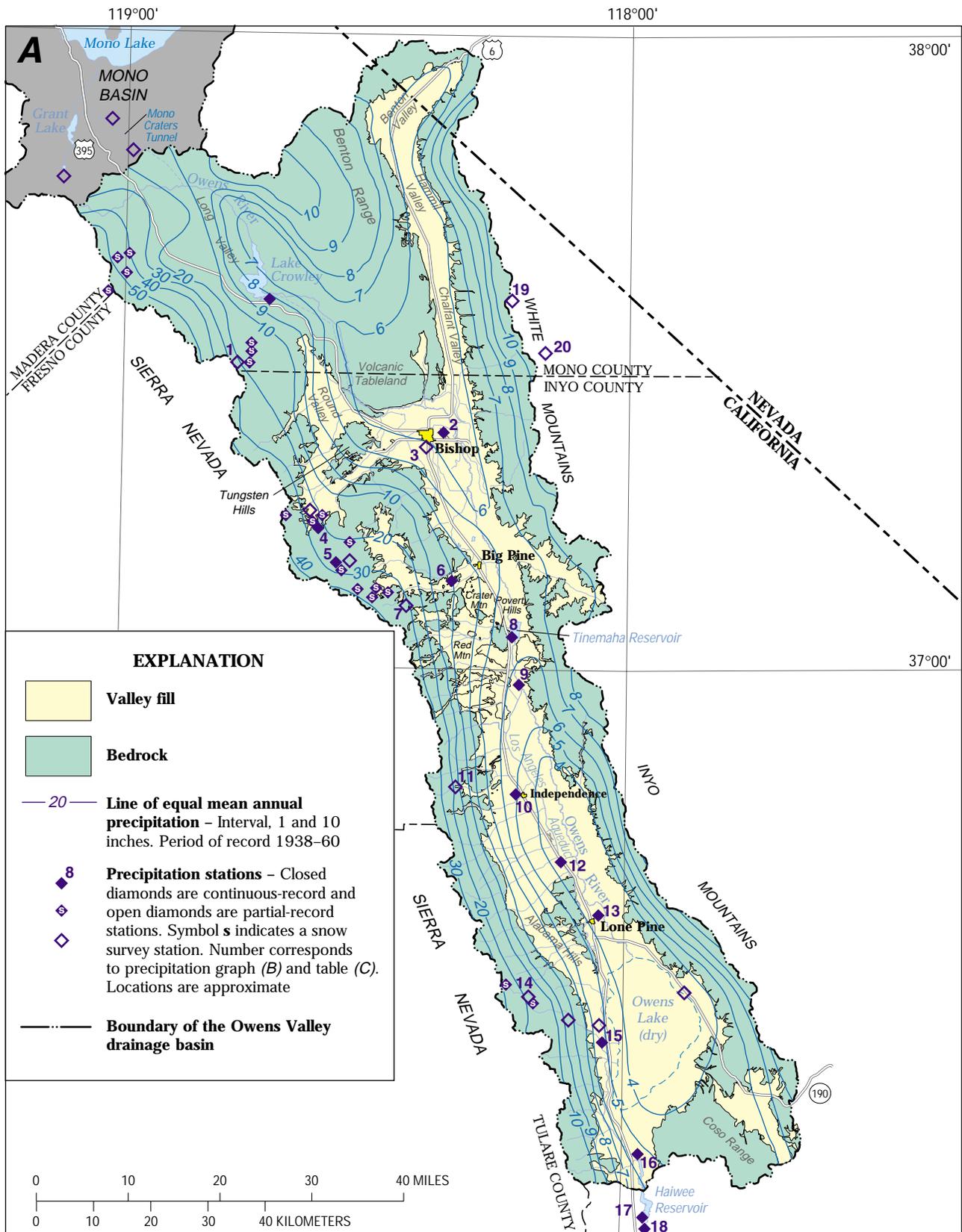


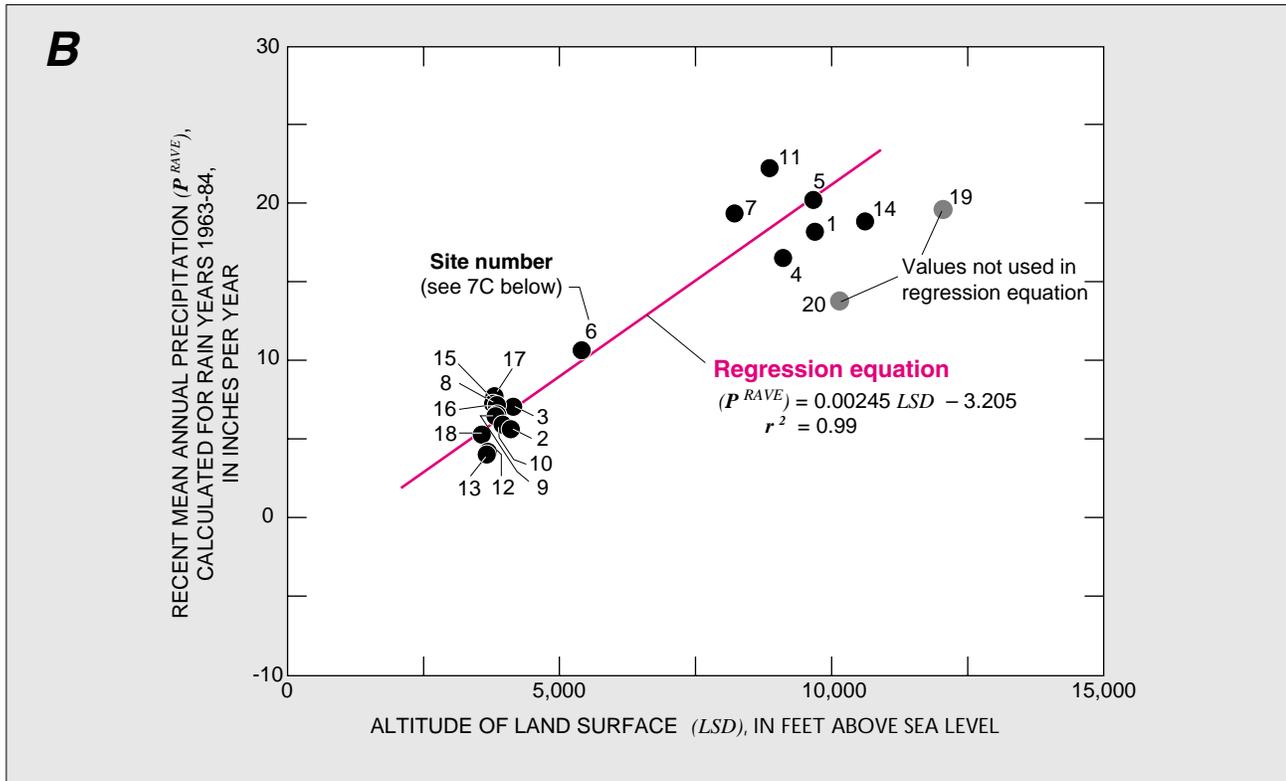
Figure 5. Continued.



**Figure 6.** Native plant communities in the Owens Valley, California. **A**, High-ground-water alkaline meadow. **B**, High-ground-water alkaline scrub. **C**, Dryland alkaline scrub. **D**, Dryland nonalkaline scrub.



**Figure 7.** (A) Contours of mean annual precipitation; (B) relation between recent mean annual precipitation and altitude; and (C) data for selected precipitation stations in the Owens Valley, California. Data from E.L. Coufal, Los Angeles Department of Water and Power, written commun., 1986, and oral commun., 1989. Map modified from Stetson, Strauss, and Dresselhaus, consulting engineers, written commun., 1961.



**C**

Site no.	Station name	Recent mean annual precipitation for rain		Altitude (feet)	Latitude (north)	Longitude (west)	Period of record (rain years)
		years 1963-84 (inches/year)					
1.	Rock Creek at store	18.30		9,700	37°27'	118°45'	1948-88
2.	U.S. Weather Bureau, Bishop	5.67		4,108	37°22'	118°22'	1931-88
3.	Bishop Yard	7.12		4,140	37°21'	118°24'	1931-88
4.	U.S. Weather Bureau, Lake Sabrina	16.56		9,100	37°13'	118°37'	1926-88
5.	U.S. Weather Bureau, South Lake	20.30		9,620	37°11'	118°34'	1926-88
6.	Big Pine Power House No. 3	10.72		5,400	37°08'	118°20'	1927-88
7.	Big Pine Creek at Glacier Lodge	19.45		8,200	37°06'	118°26'	1948-88
8.	Tinemaha Reservoir	7.20		3,850	37°04'	118°14'	1935-88
9.	Los Angeles Aqueduct at intake	6.49		3,825	36°58'	118°13'	1932-88
10.	U.S. Weather Bureau, Independence	5.98		3,950	36°48'	118°12'	1886-1988
11.	Onion Valley	<sup>1</sup> 22.77		8,850	36°46'	118°20'	1950-88
12.	Los Angeles Aqueduct at Alabama Gates	4.24		3,675	36°41'	118°05'	1931-88
13.	Lone Pine	4.06		3,661	36°36'	118°04'	1919-88
14.	Cottonwood at Golden Trout Camp	<sup>1</sup> 19.04		10,600	36°29'	118°11'	1948-81
15.	Cottonwood Gates	7.31		3,775	36°25'	118°02'	1928-88
16.	North Haiwee Reservoir	6.60		3,850	36°14'	117°58'	1931-88
17.	South Haiwee Reservoir	7.79		3,800	36°08'	117°57'	1924-88
18.	Haiwee Power House	<sup>1</sup> 5.34		3,570	36°07'	117°57'	1930-75
19.	White Mountain No. 2	<sup>1</sup> 19.73		12,070	37°35'	118°14'	1953-88
20.	White Mountain No. 1	<sup>1</sup> 13.94		10,150	37°30'	118°10'	1950-77

<sup>1</sup> Short or discontinuous record.

Figure 7. Continued.

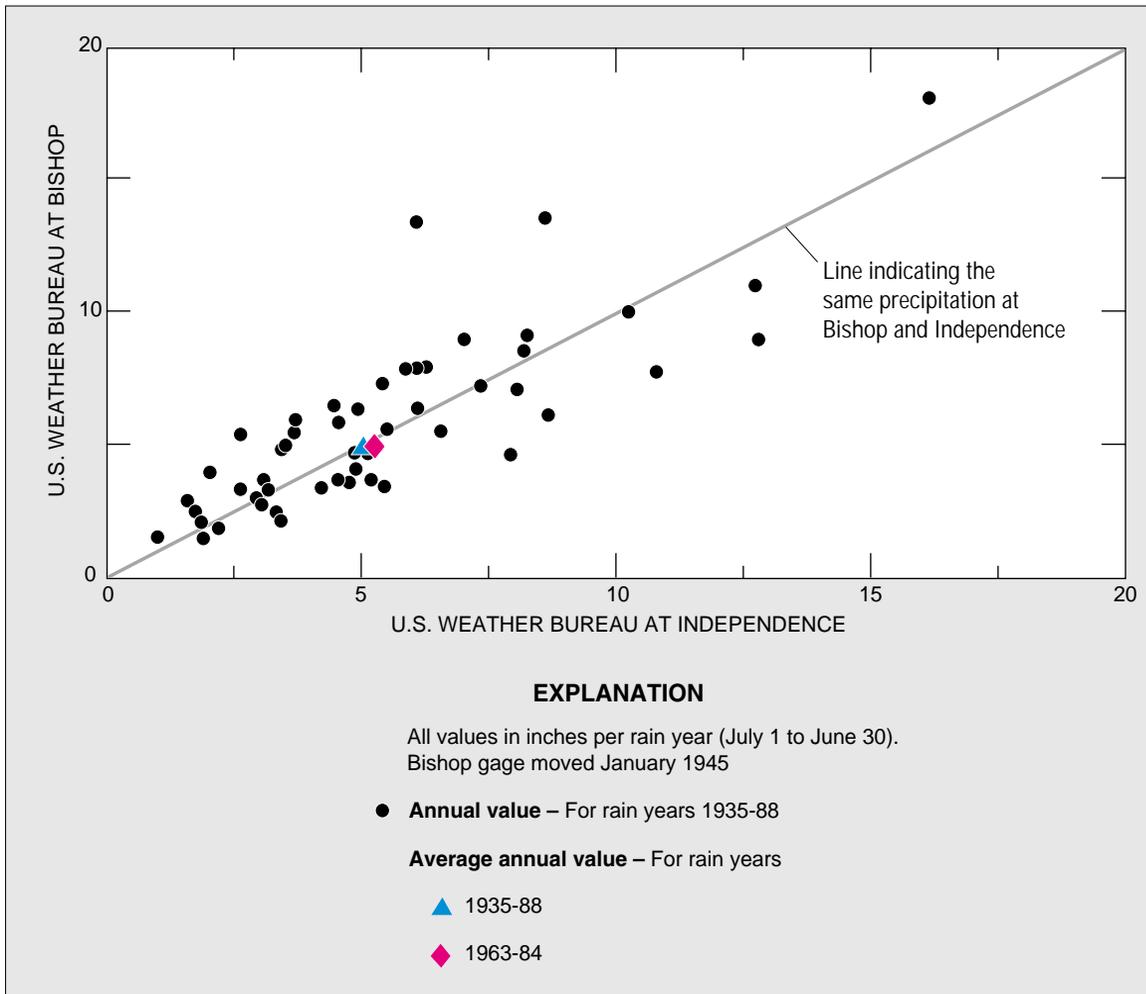
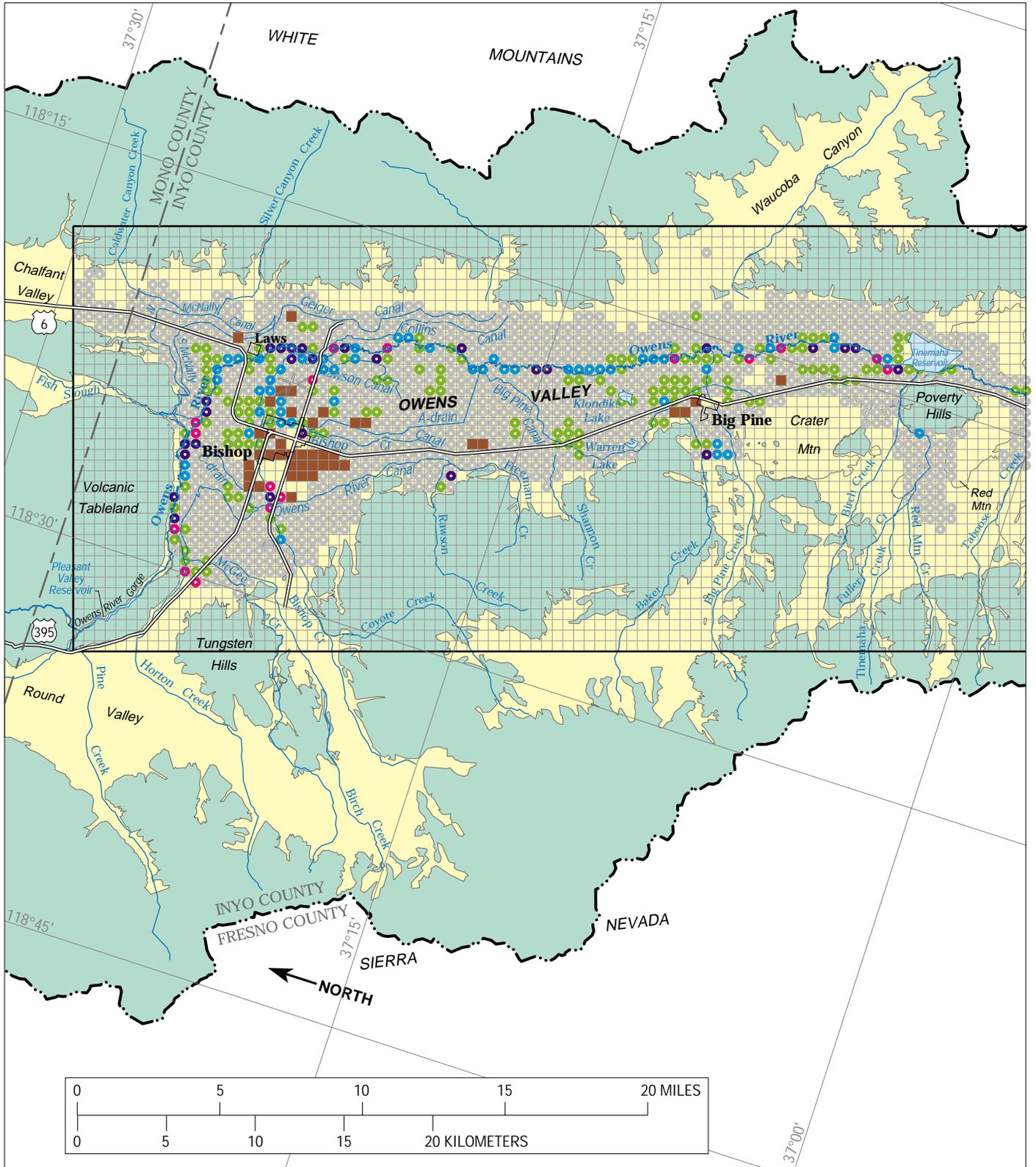


Figure 8. Annual precipitation as Bishop and Independence, California (sites 2 and 10, respectively, in figure 7).



**Figure 9.** Estimated average annual transpiration by native vegetation during water years 1983–87 in the Owens Valley, California. Map values derived from more than 14,000 point estimates of average annual evapotranspiration obtained from the Los Angeles Department of Water and Power (R.H. Rawson, written commun., 1988).

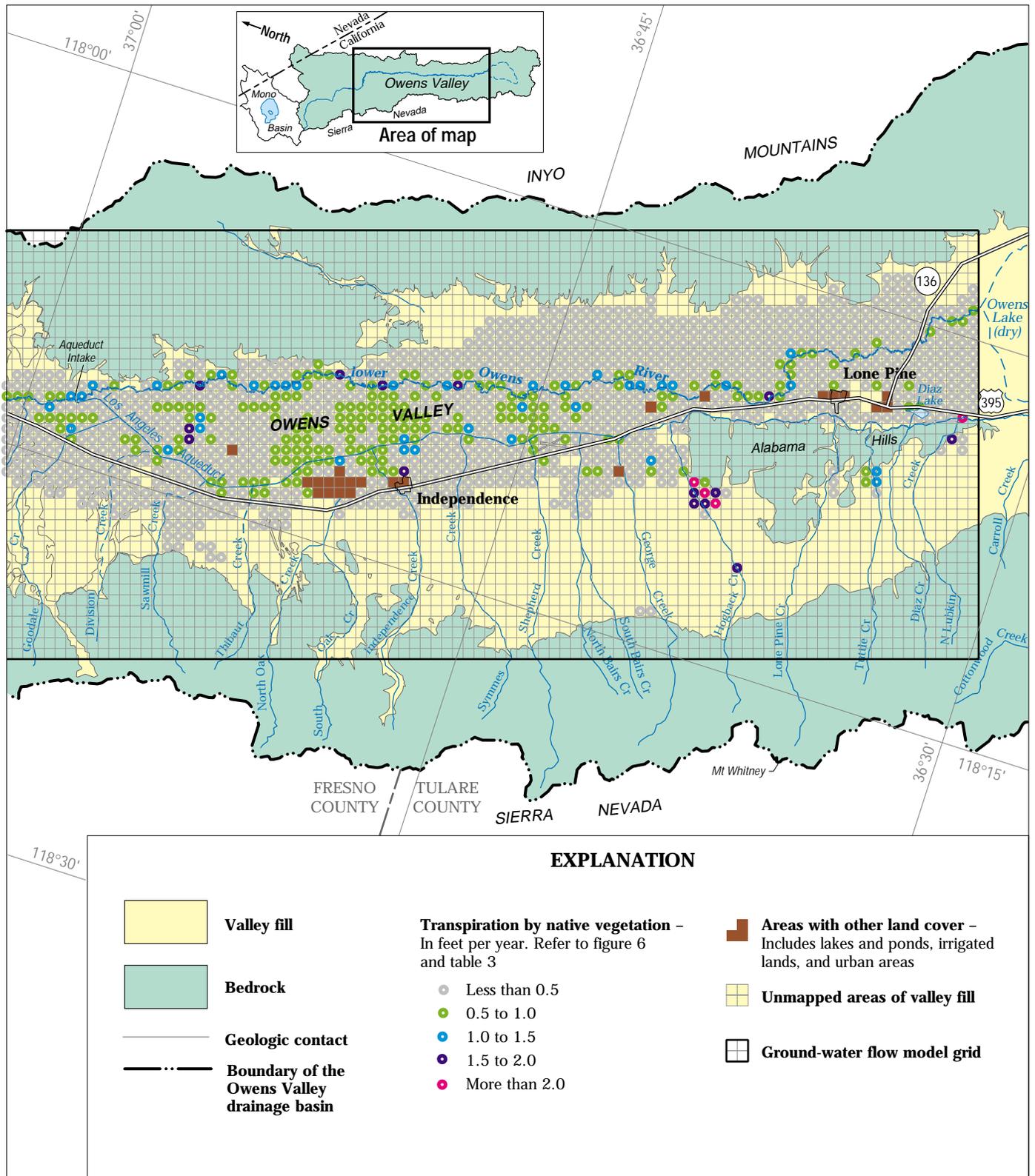


Figure 9. Continued.



**Figure 10.** Major surface-water features in the Owens Valley, California. **A**, Owens River just north of Bishop looking west toward the Tungsten Hills and Round Valley (photograph taken winter 1988). **B**, Los Angeles Aqueduct looking north toward the Sierra Nevada (photograph taken winter 1985). **C**, lower Owens River east of the Alabama Hills (photograph taken summer 1988). **D**, Owens Lake viewed from alluvial fan south of the Alabama Hills (photograph taken spring 1986).

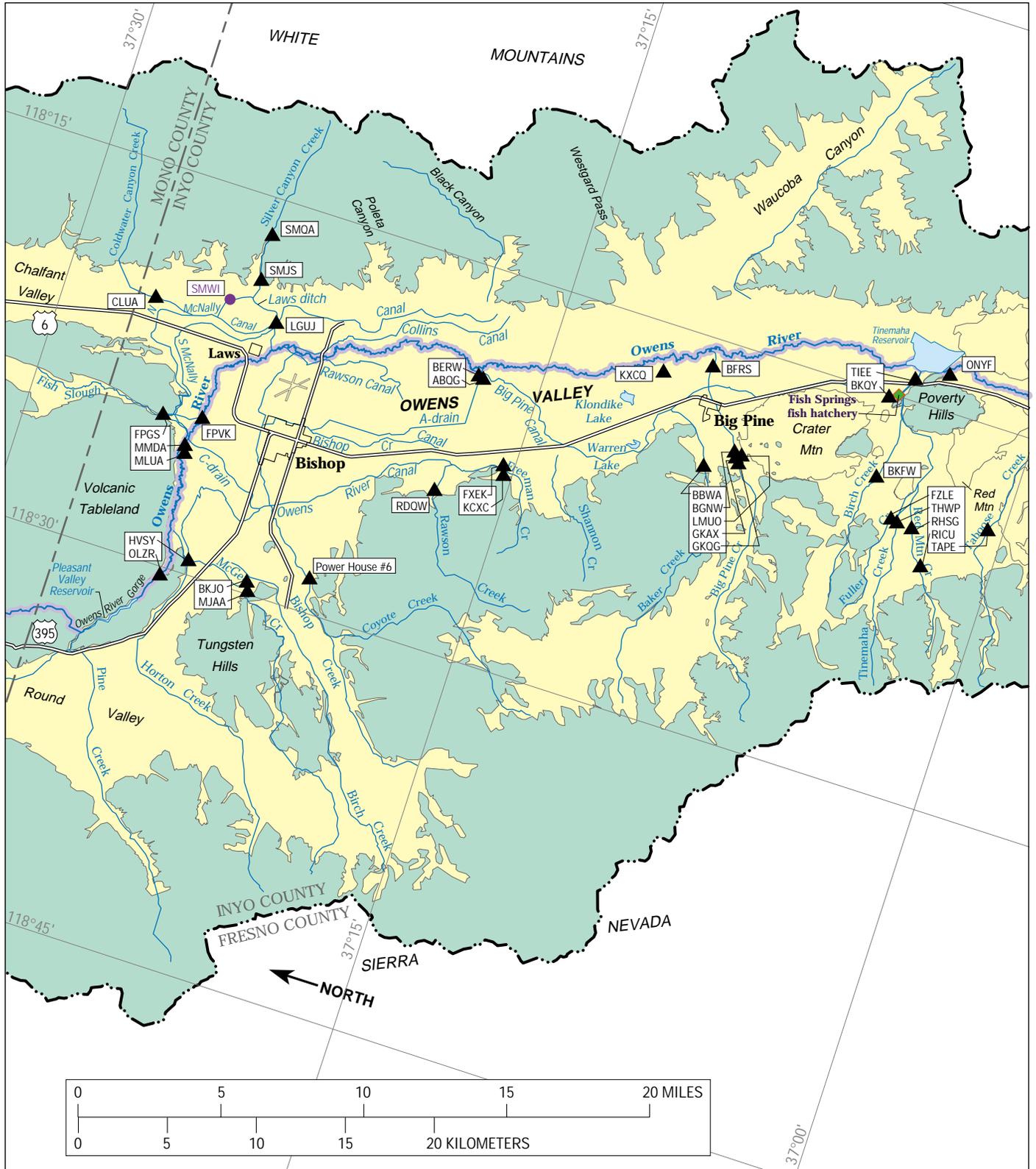


Figure 11. Location of the Owens River–Los Angeles Aqueduct system, the lower Owens River, tributary streams, lakes, reservoirs, spillgates, major gaging stations, and selected pumped wells in the Owens Valley, California.

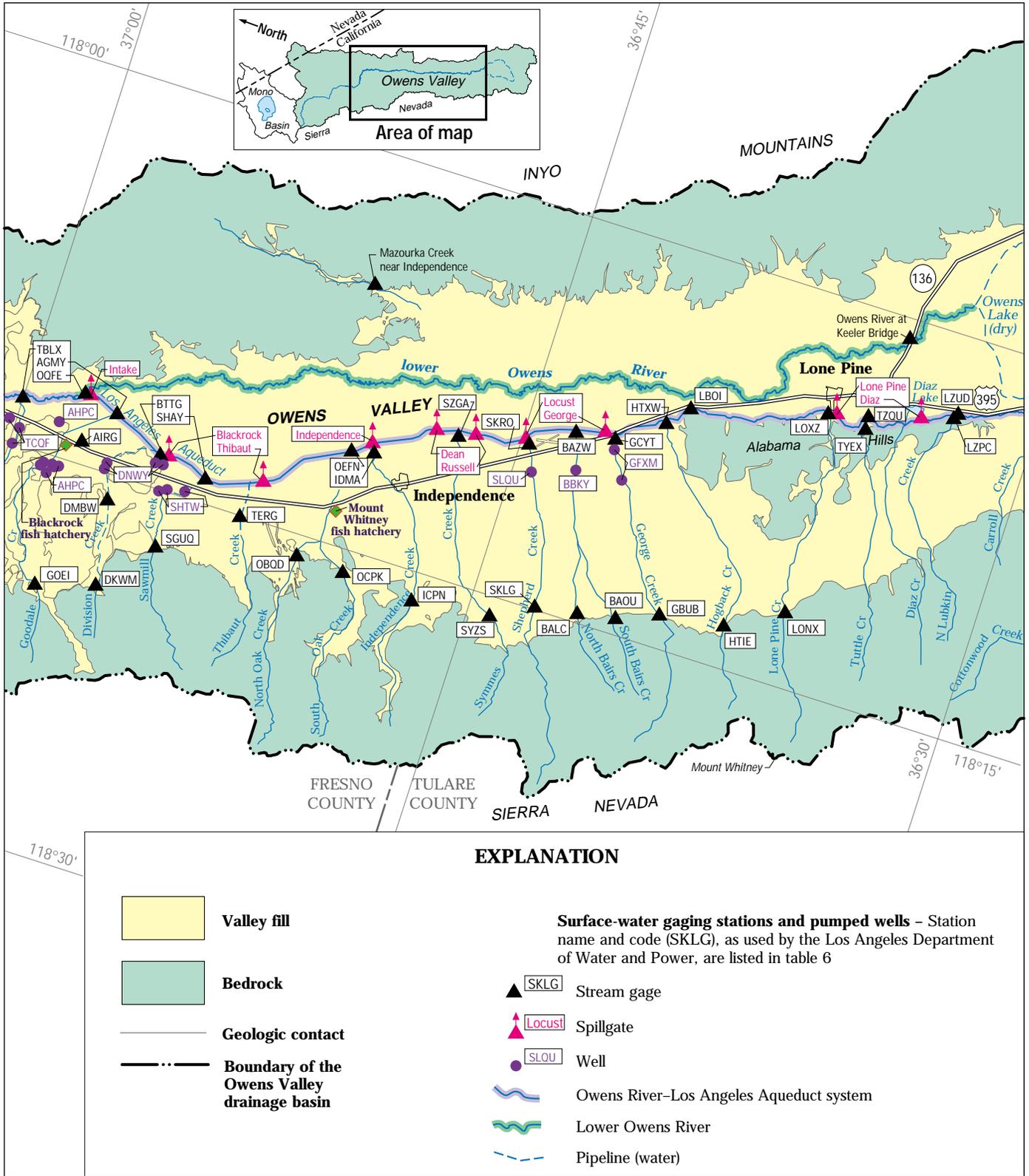
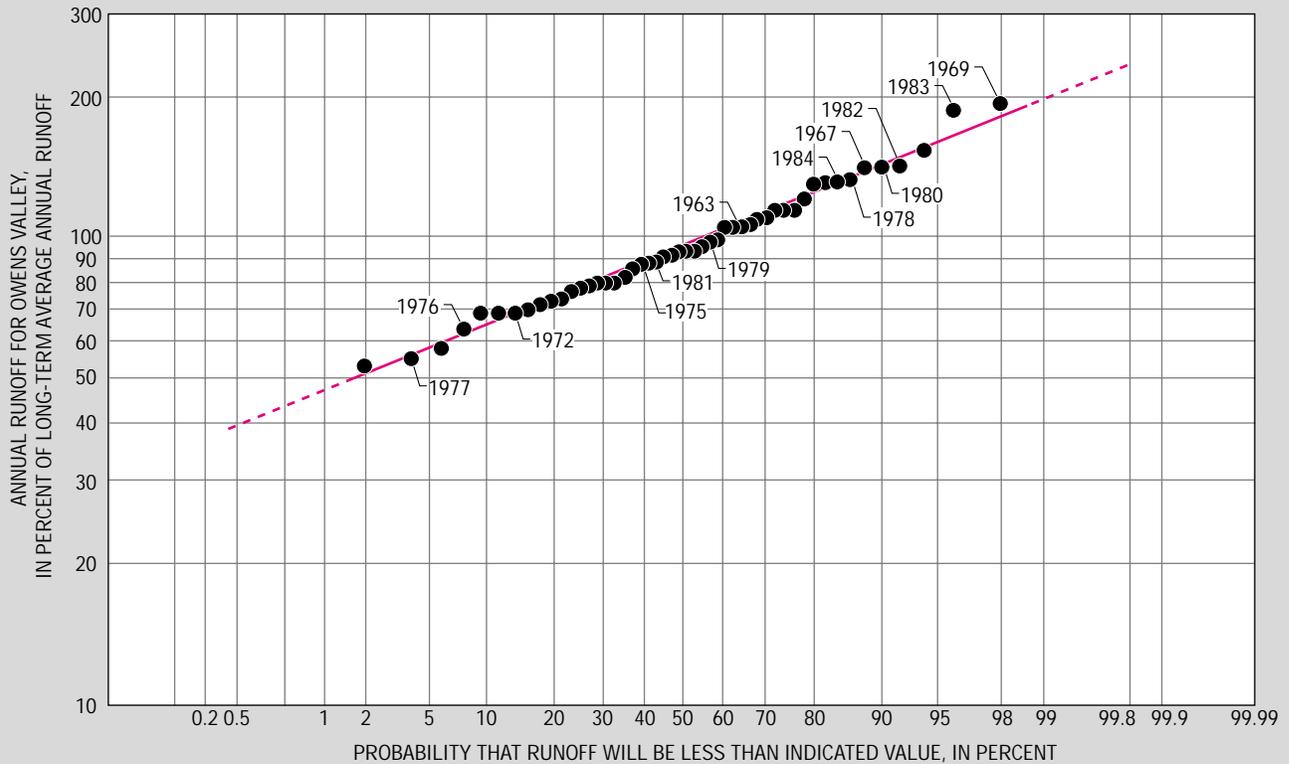


Figure 11. Continued.

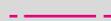


### EXPLANATION

Long-term average annual runoff for the Owens Valley was calculated for water years 1935-84 by the Los Angeles Department of Water and Power (station OUKR, table 6; M.L. Blevins, written commun., 1988). Annual runoff for the Owens Valley commonly is expressed as a percent of long-term average annual runoff and is referred to locally as percent valleywide runoff or percent runoff year. Refer to table 7 for annual values

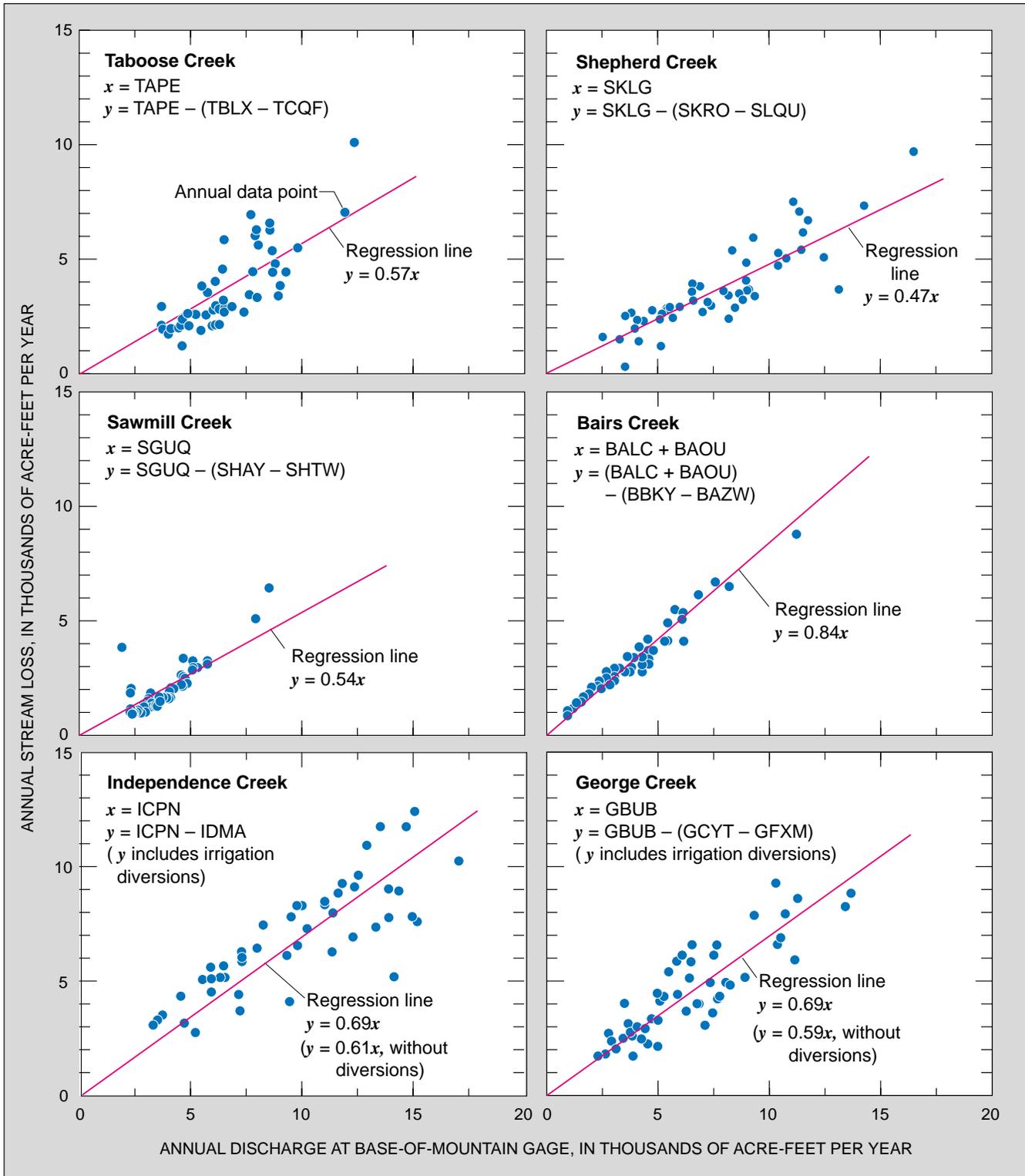


**Data point** – Selected water years are identified



**Best-fit line** – Dashed where less certain

Figure 12. Annual-runoff probability for the Owens Valley, California.



**Figure 13.** Streamflow relations for selected tributary streams in the Owens Valley, California. Annual data are for water years 1935–84. Station codes, such as TAPE, are shown in figure 11 and described in table 6.



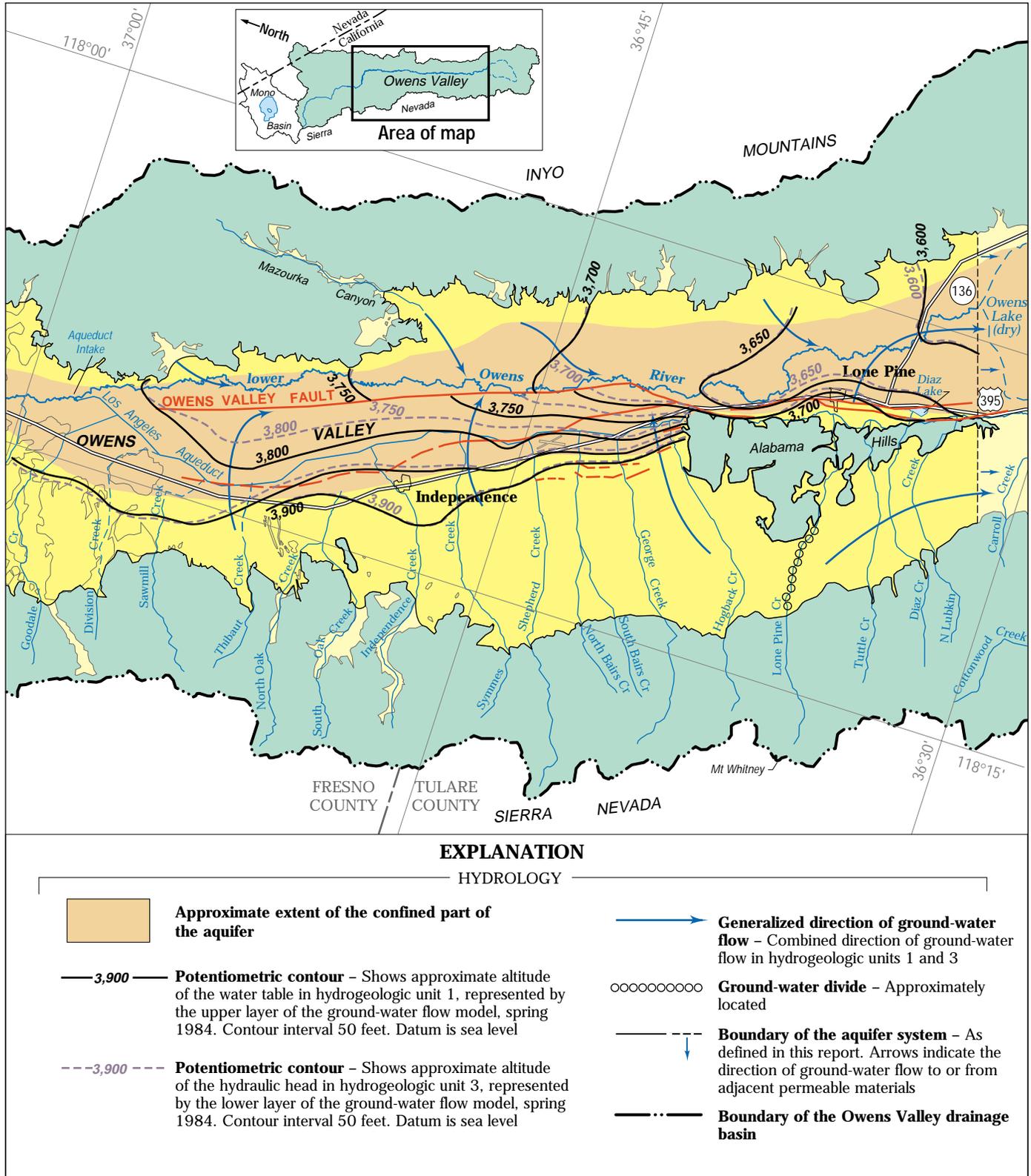


Figure 14. Continued.

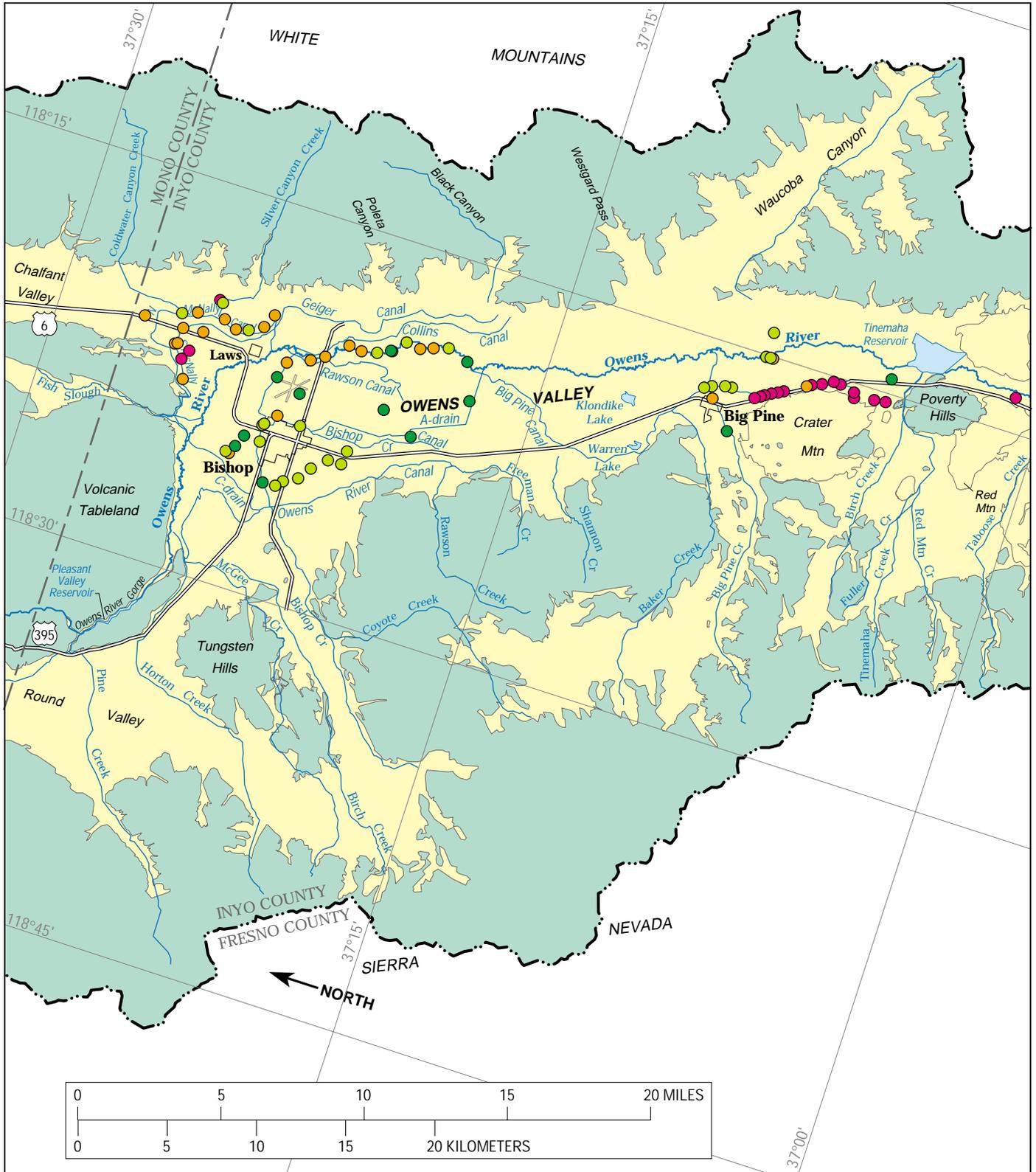


Figure 15. Transmissivity of valley-fill deposits as determined from aquifer tests in the Owens Valley, California.

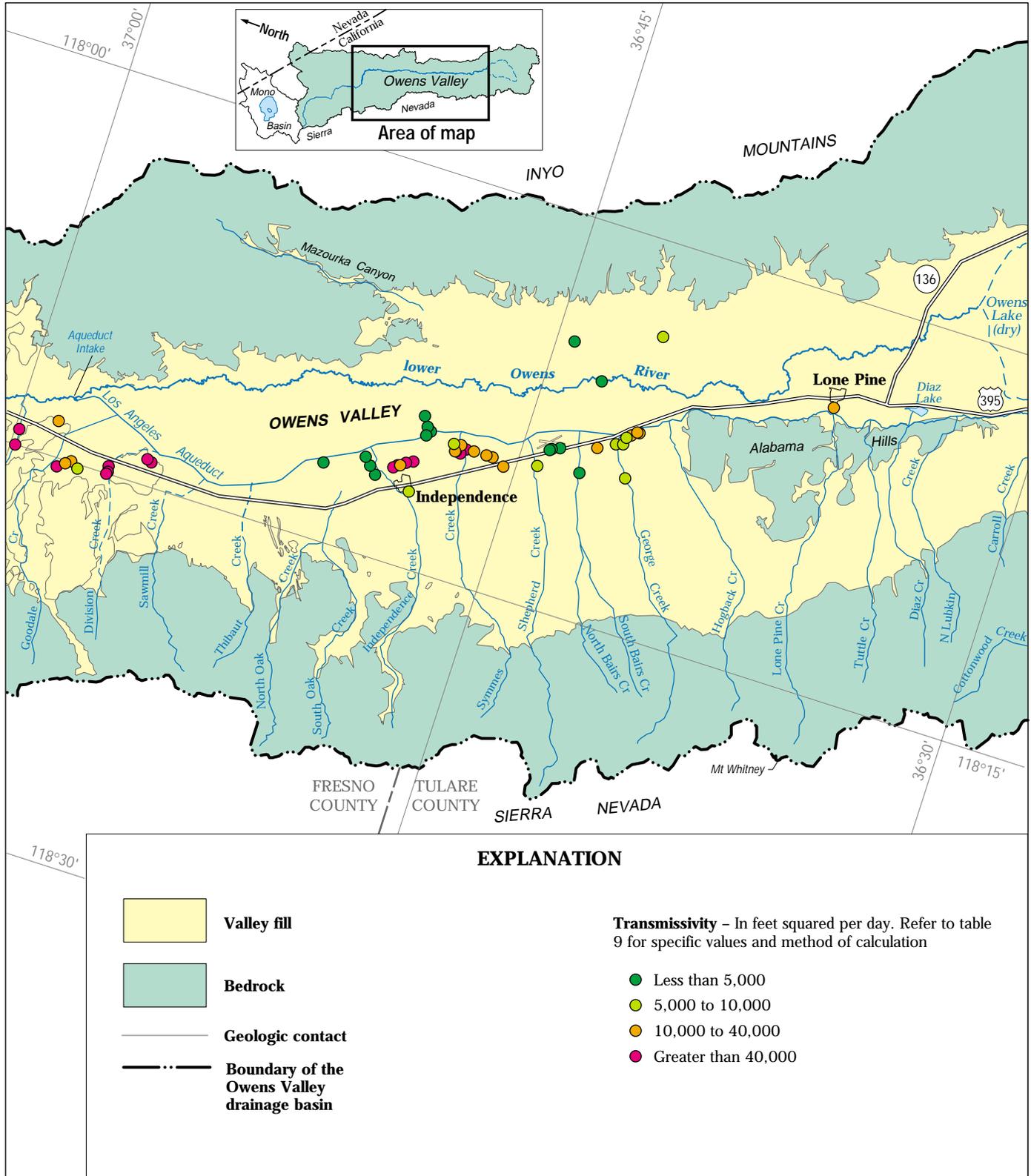


Figure 15. Continued.

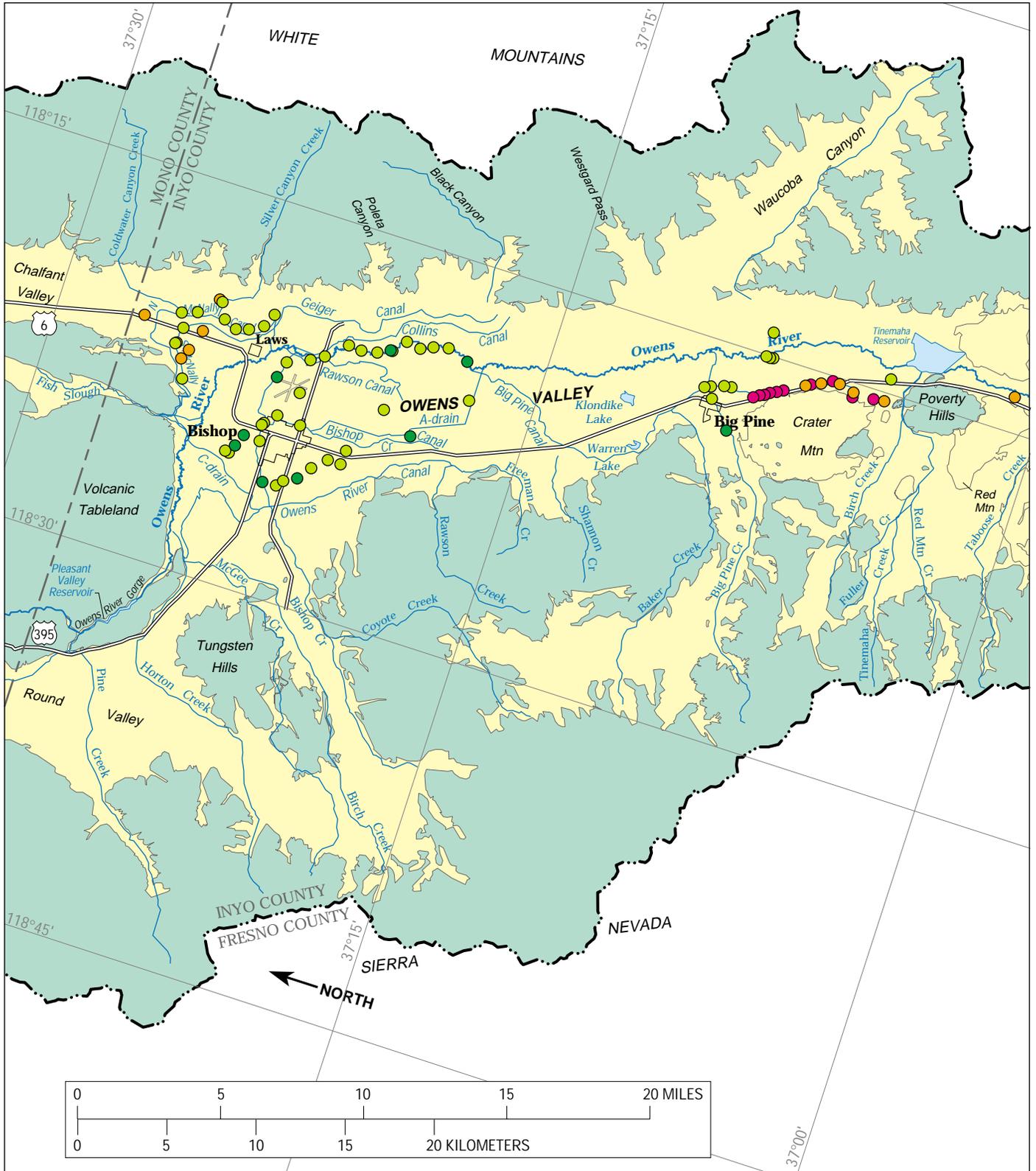


Figure 16. Average horizontal hydraulic conductivity of valley-fill deposits in the Owens Valley, California.

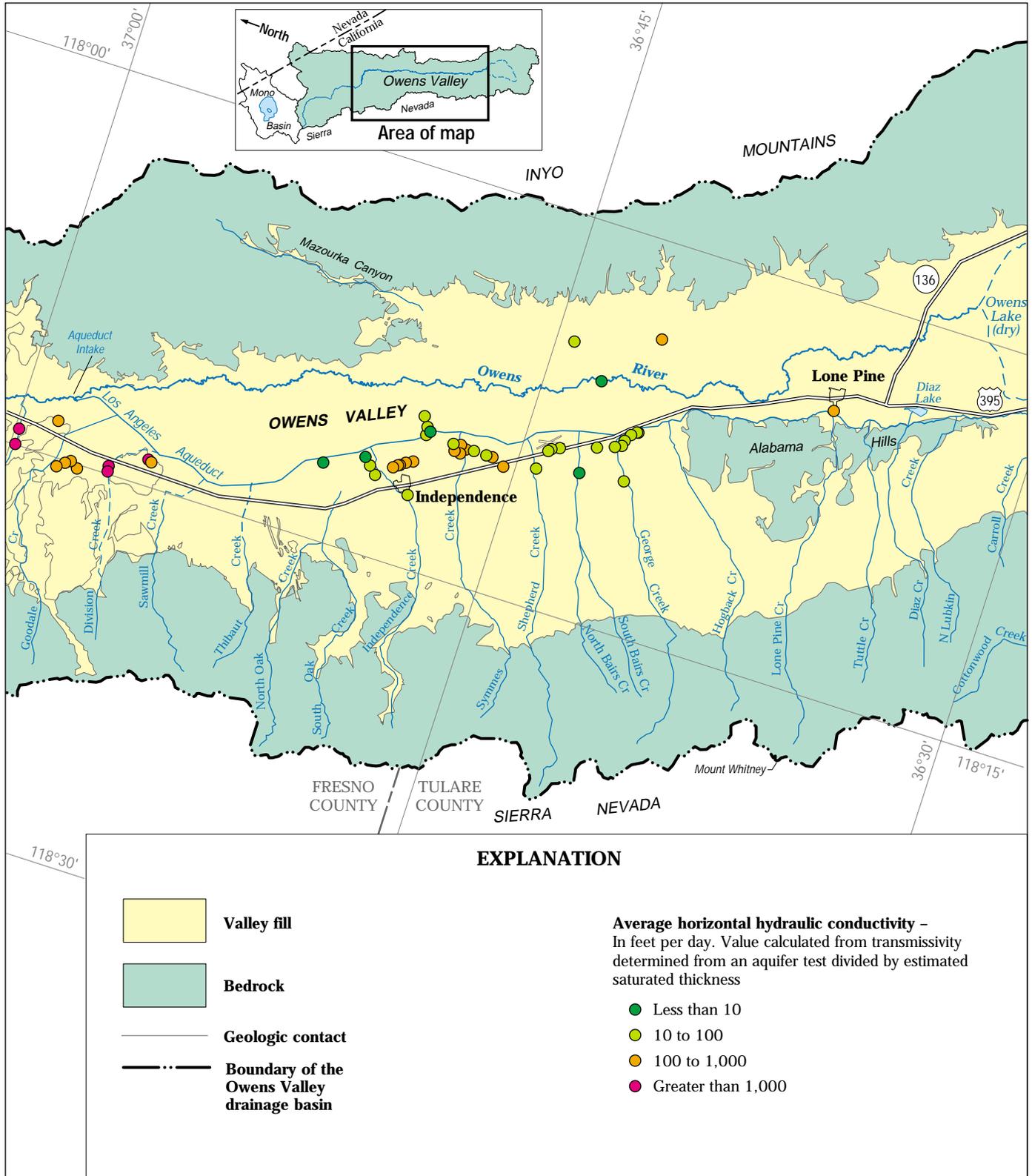
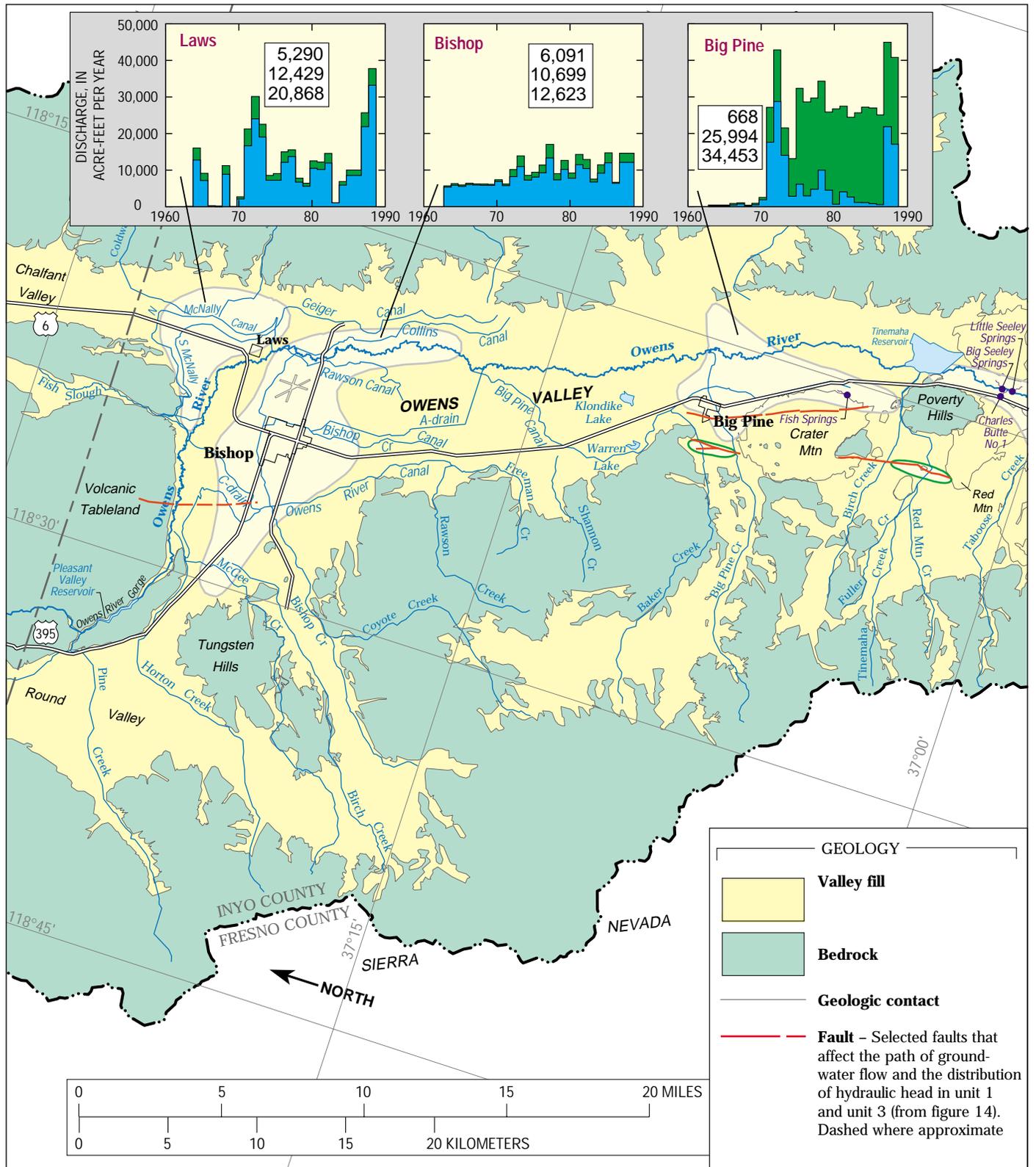


Figure 16. Continued.



**Figure 17.** Location of springs, seeps, pumped or flowing wells, and approximate area of well fields in the Owens Valley, California. Inset graphs show annual discharge from each well field for water years 1963–88.

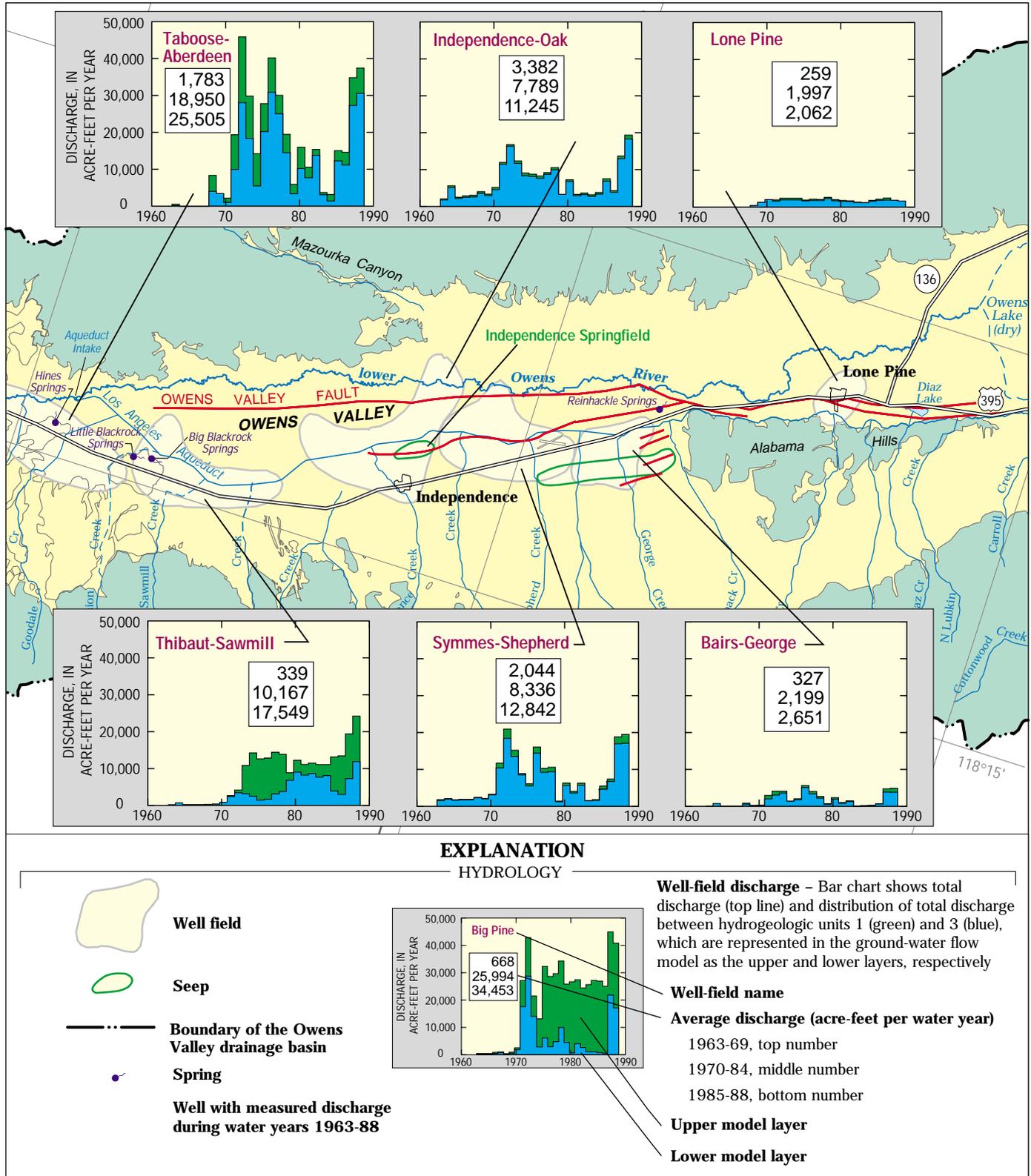


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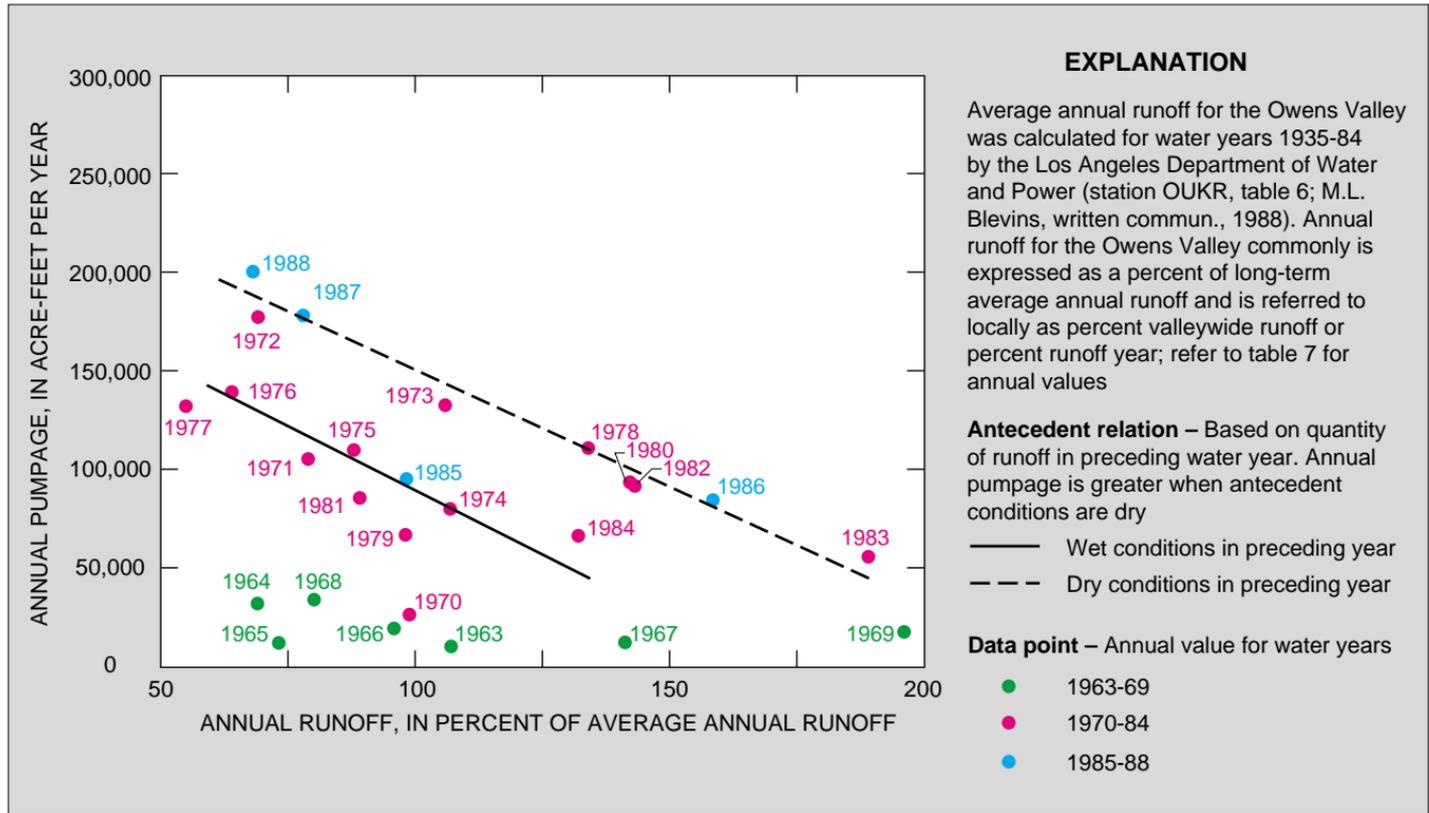
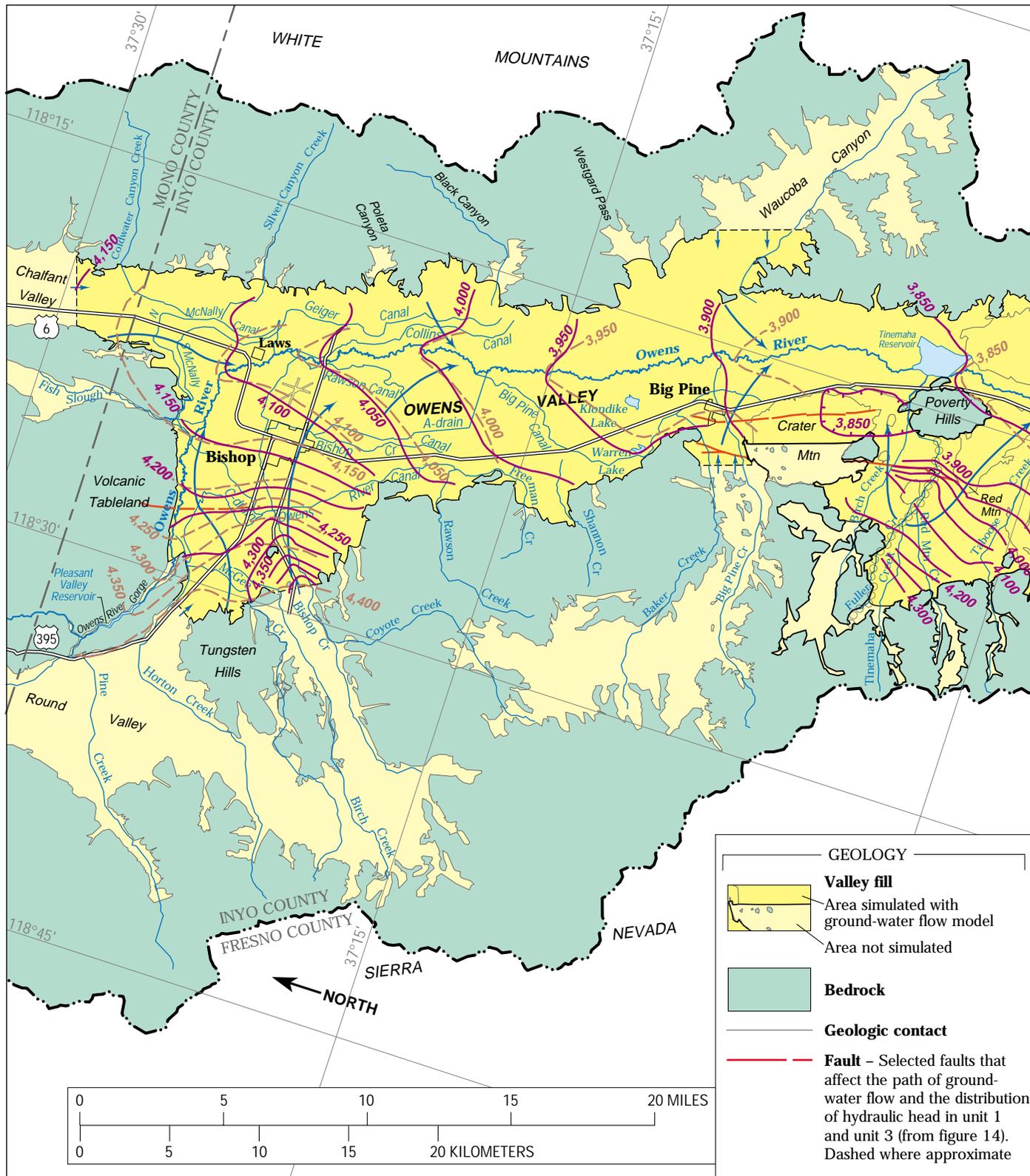


Figure 18. Relation between annual pumpage and annual runoff for the Owens Valley, California.



**Figure 19.** Measured and simulated potentiometric surfaces for hydrogeologic unit 1 (upper model layer) in the Owens Valley, California, spring 1984.

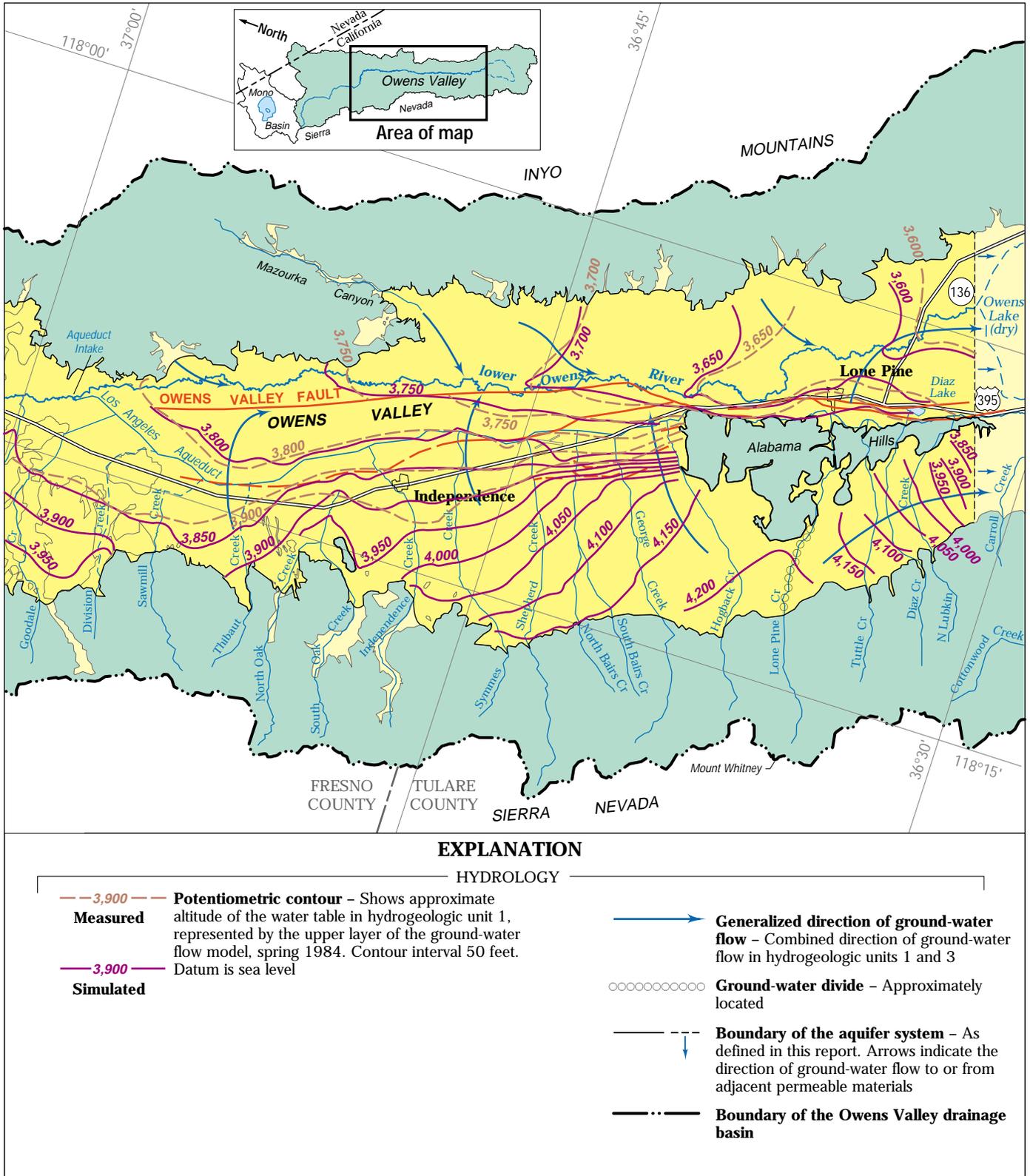


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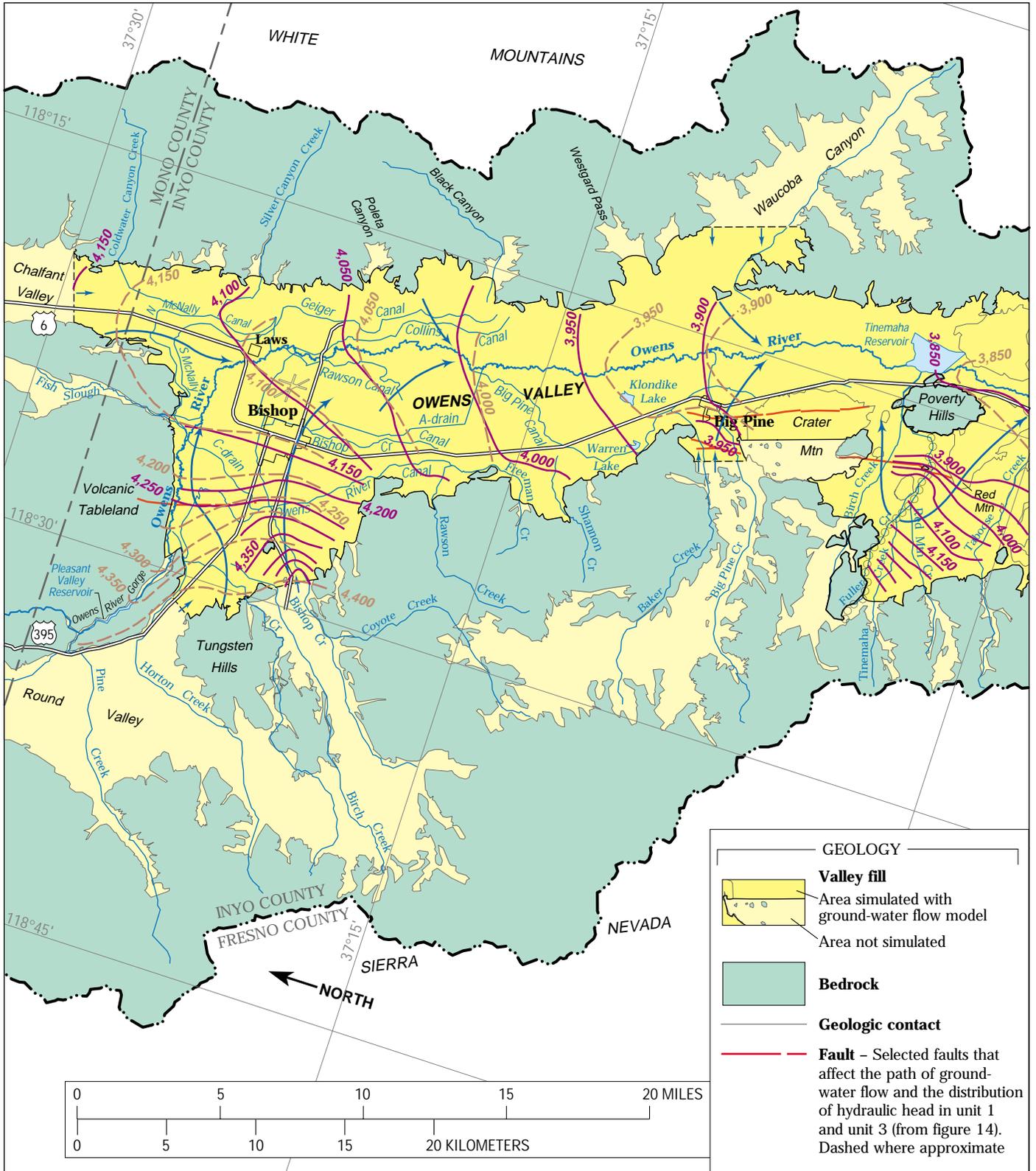


Figure 20. Measured and simulated potentiometric surfaces for hydrogeologic unit 3 (lower model layer) in the Owens Valley, California, spring 1984.

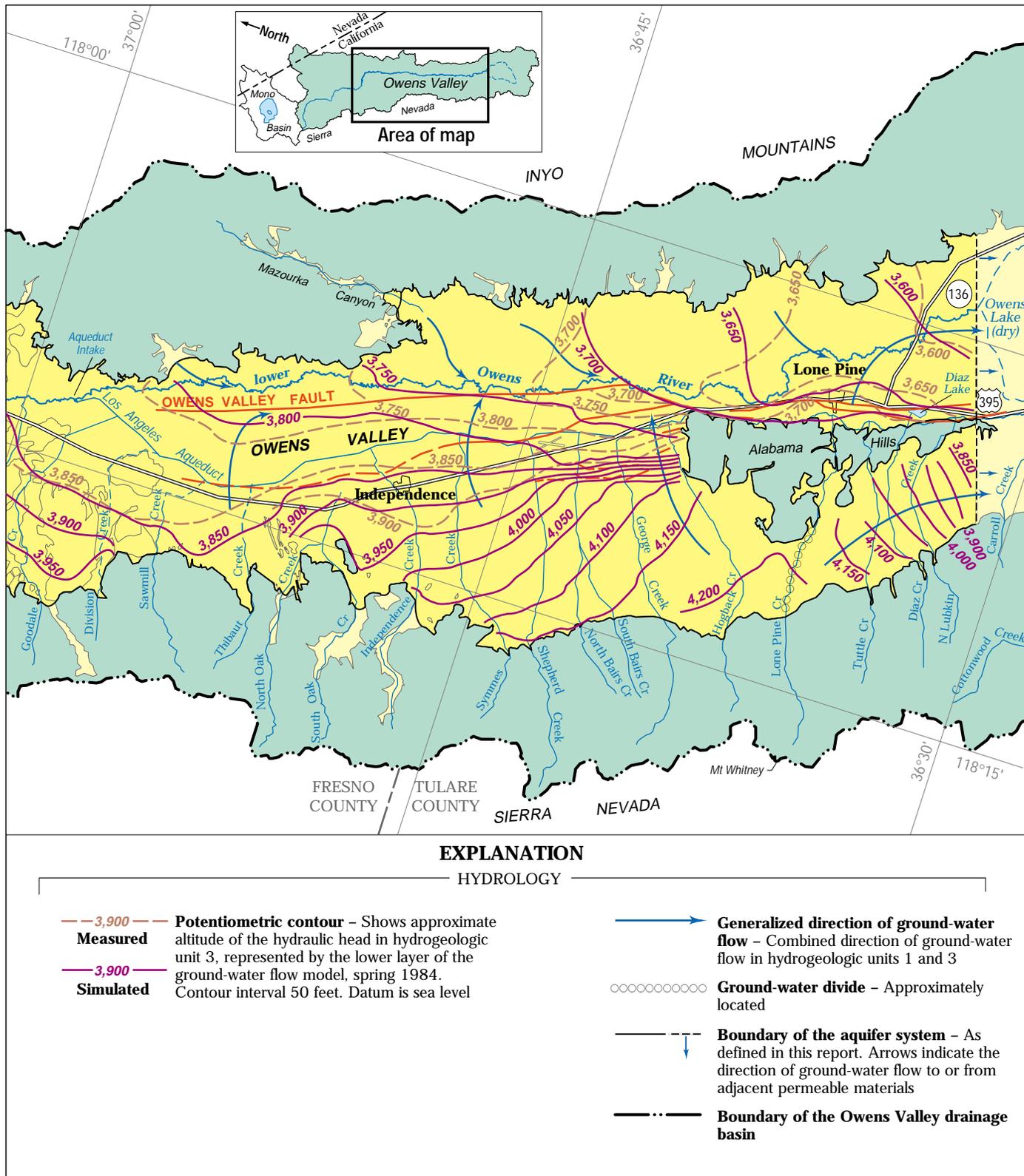


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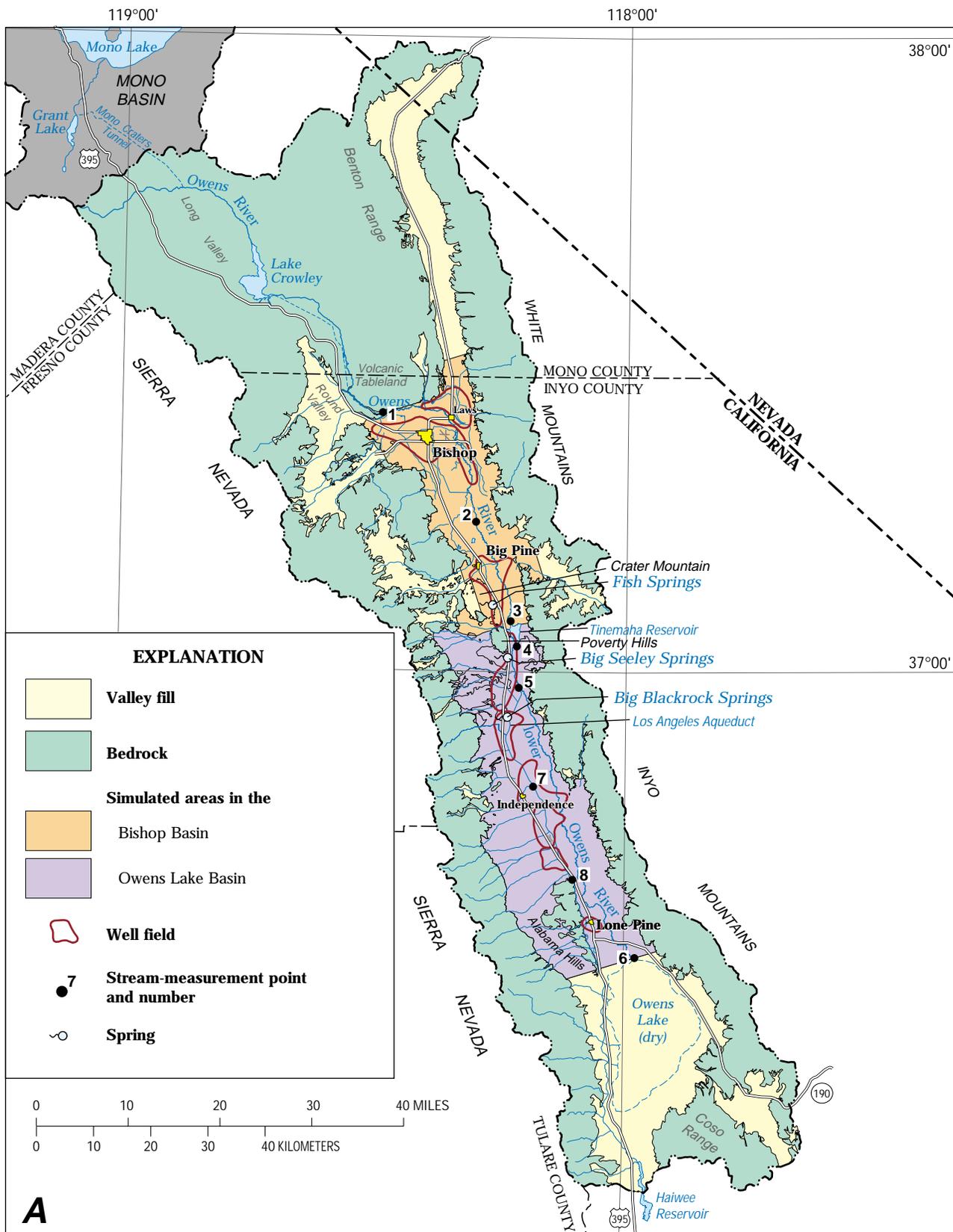


Figure 21. Simulated ground-water recharge and discharge during water years 1963–88 in the Owens Valley, California. Values for each water-budget component are given in table 11.

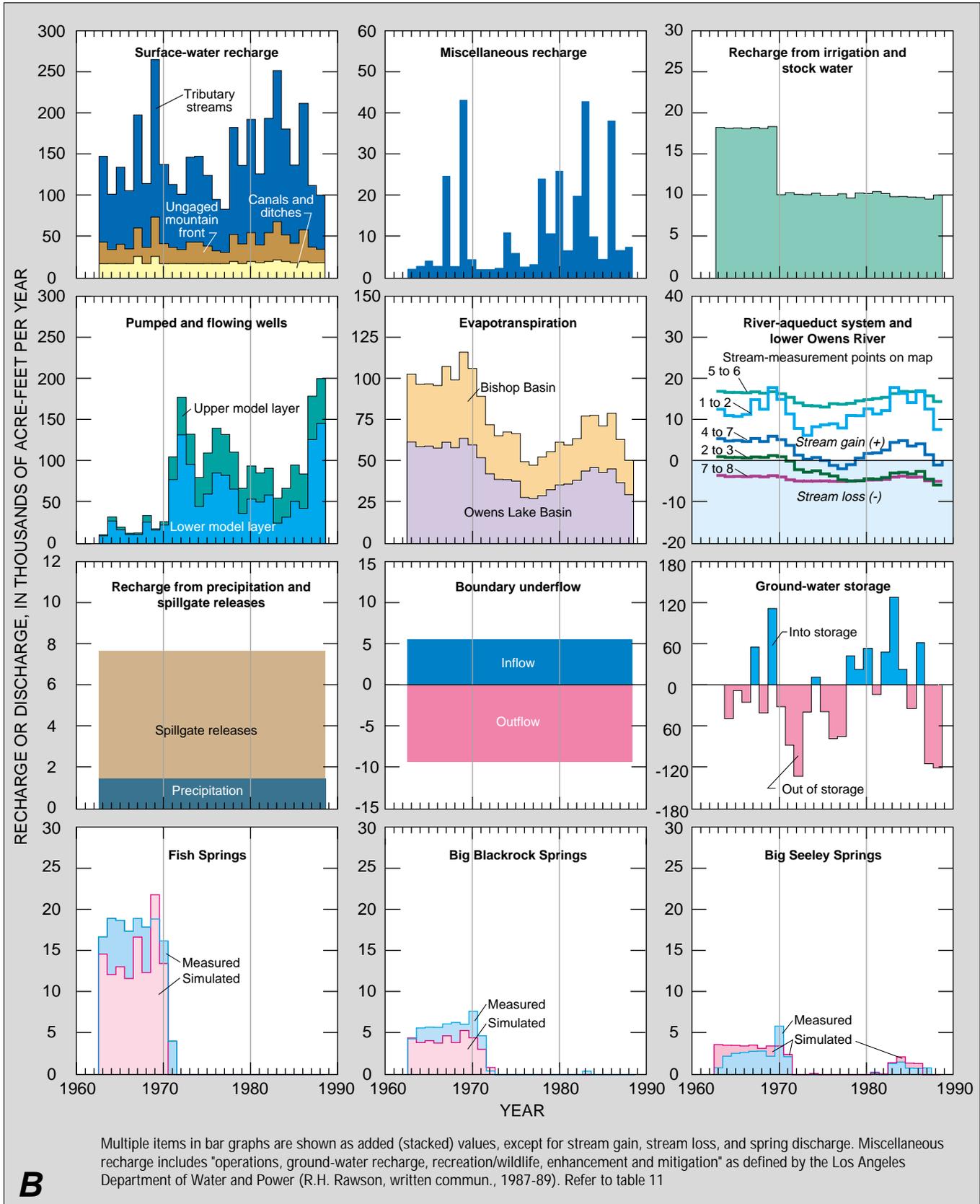
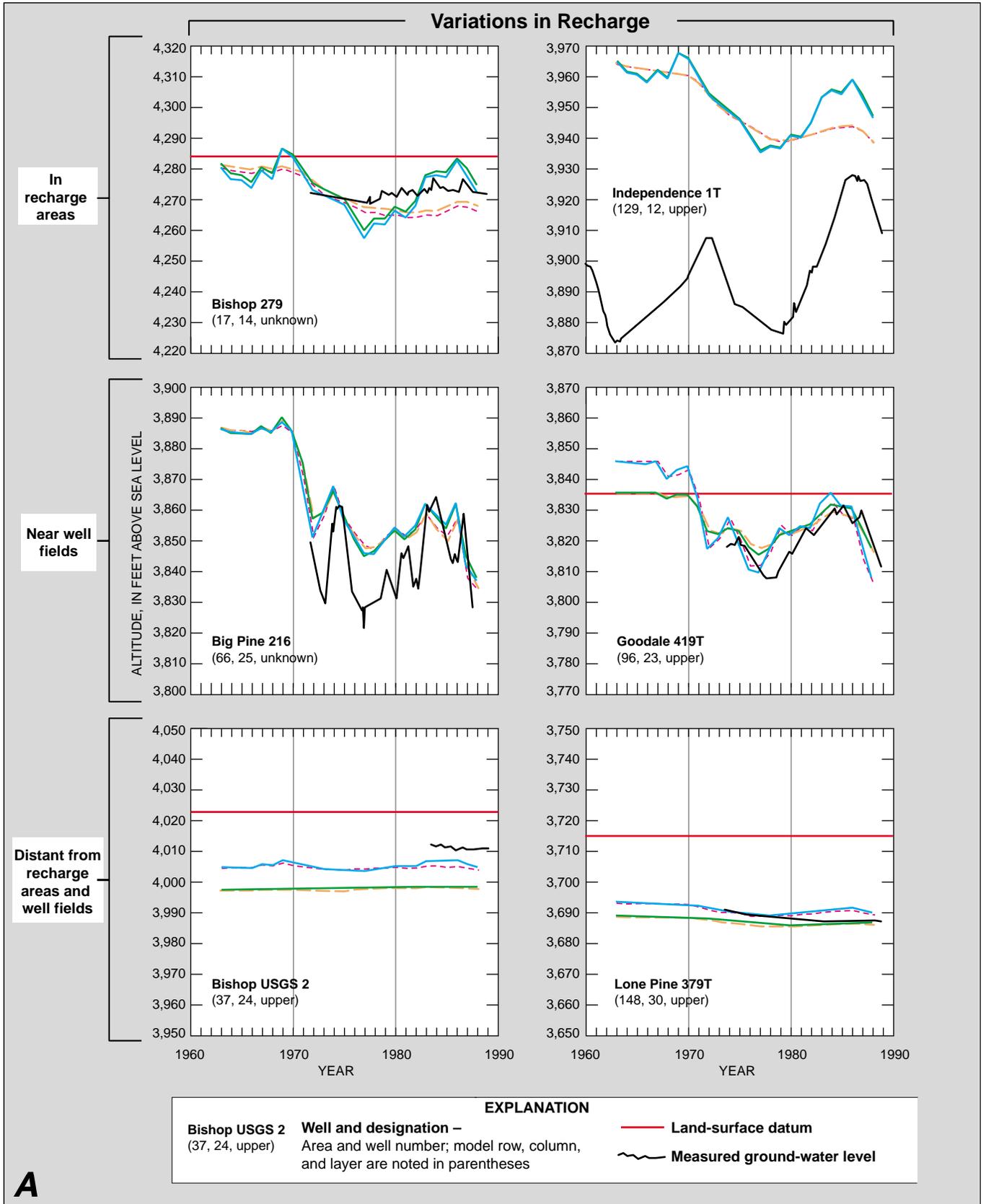


Figure 21. Continued.



**Figure 22.** Sensitivity of simulated hydraulic heads in the Owens Valley, California, to variations in recharge (**A**) and pumpage (**B**) at wells in recharge areas, near well fields, and distant from both. Method of variation is described in text. Well locations are shown on plate 1.

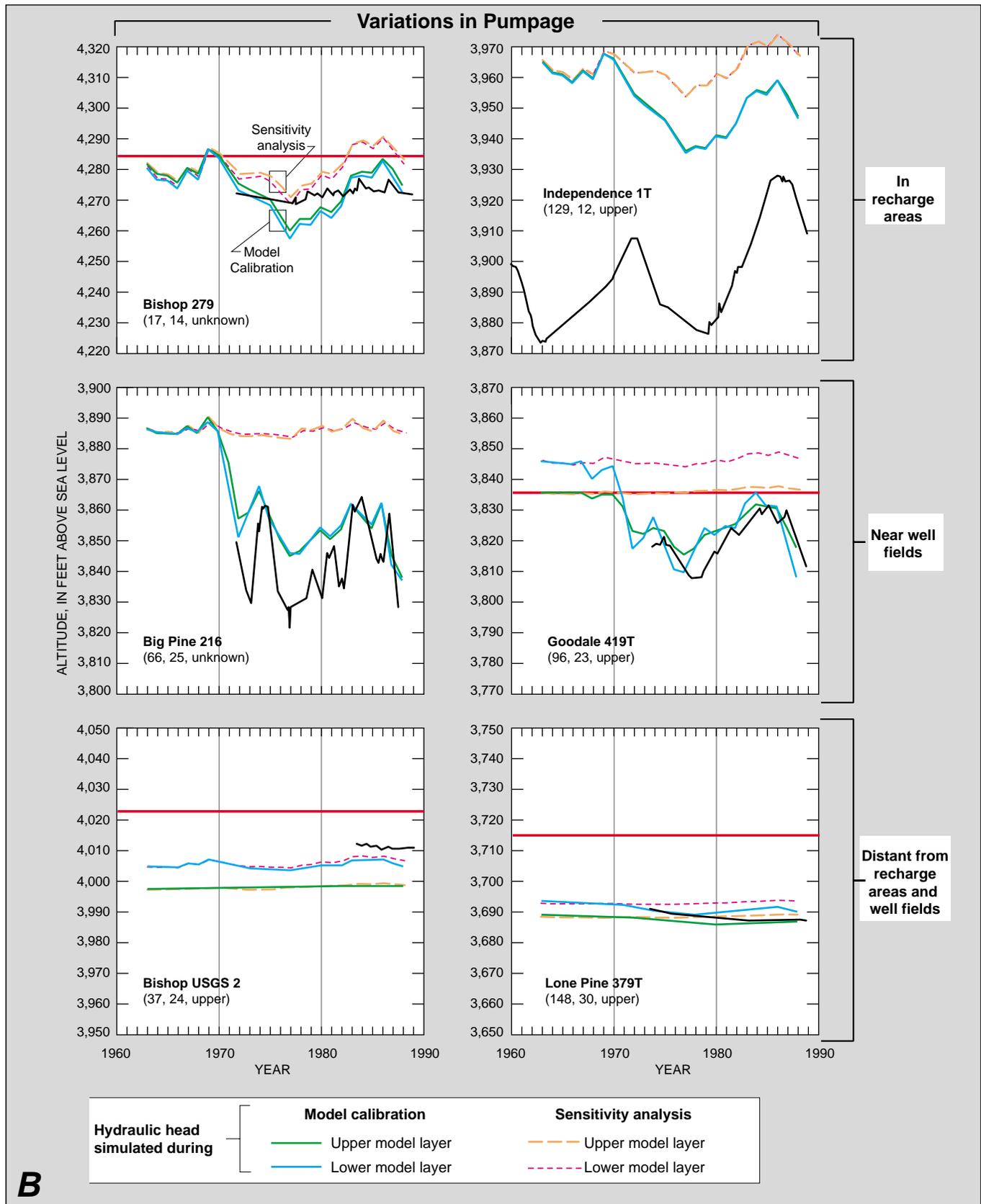


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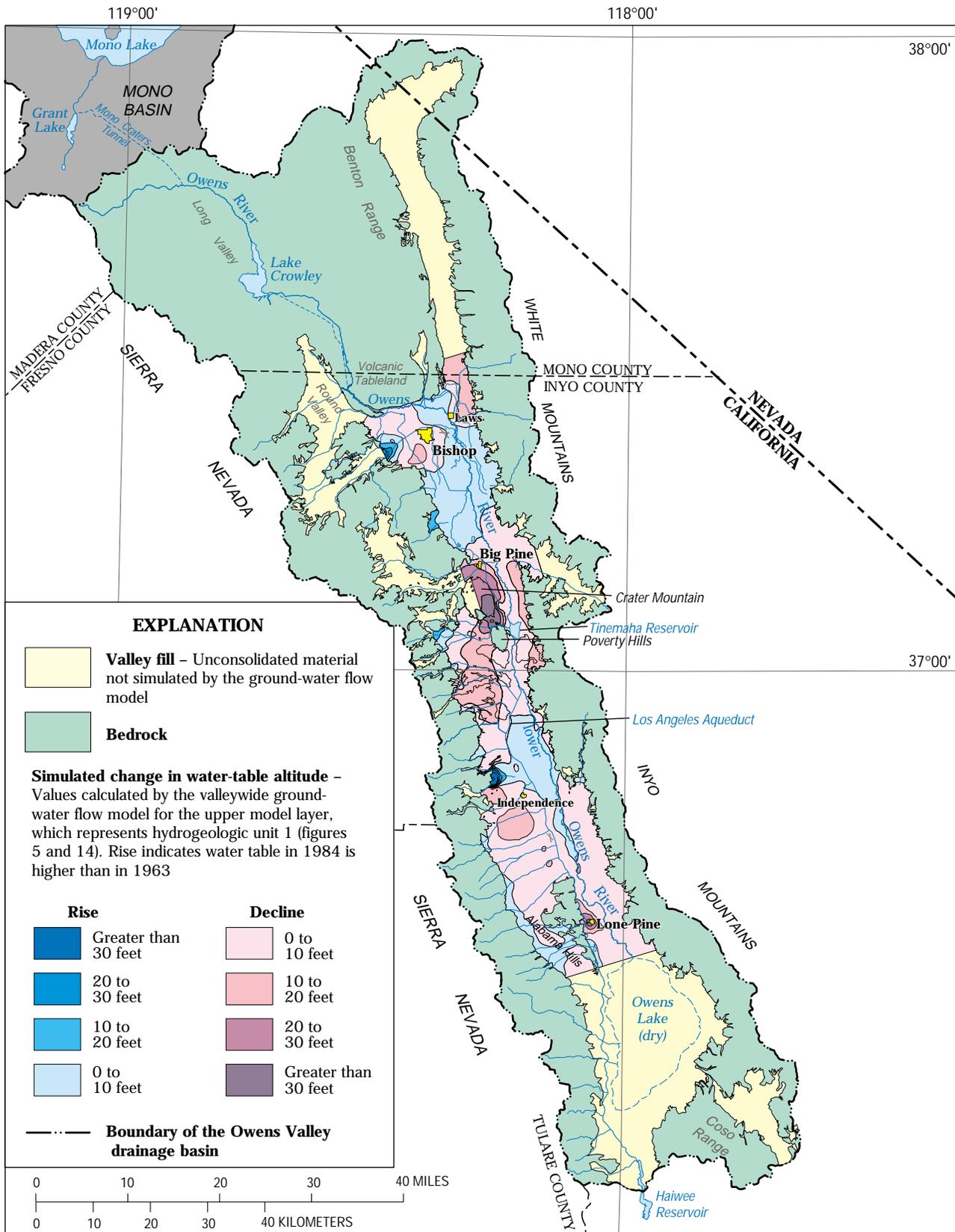
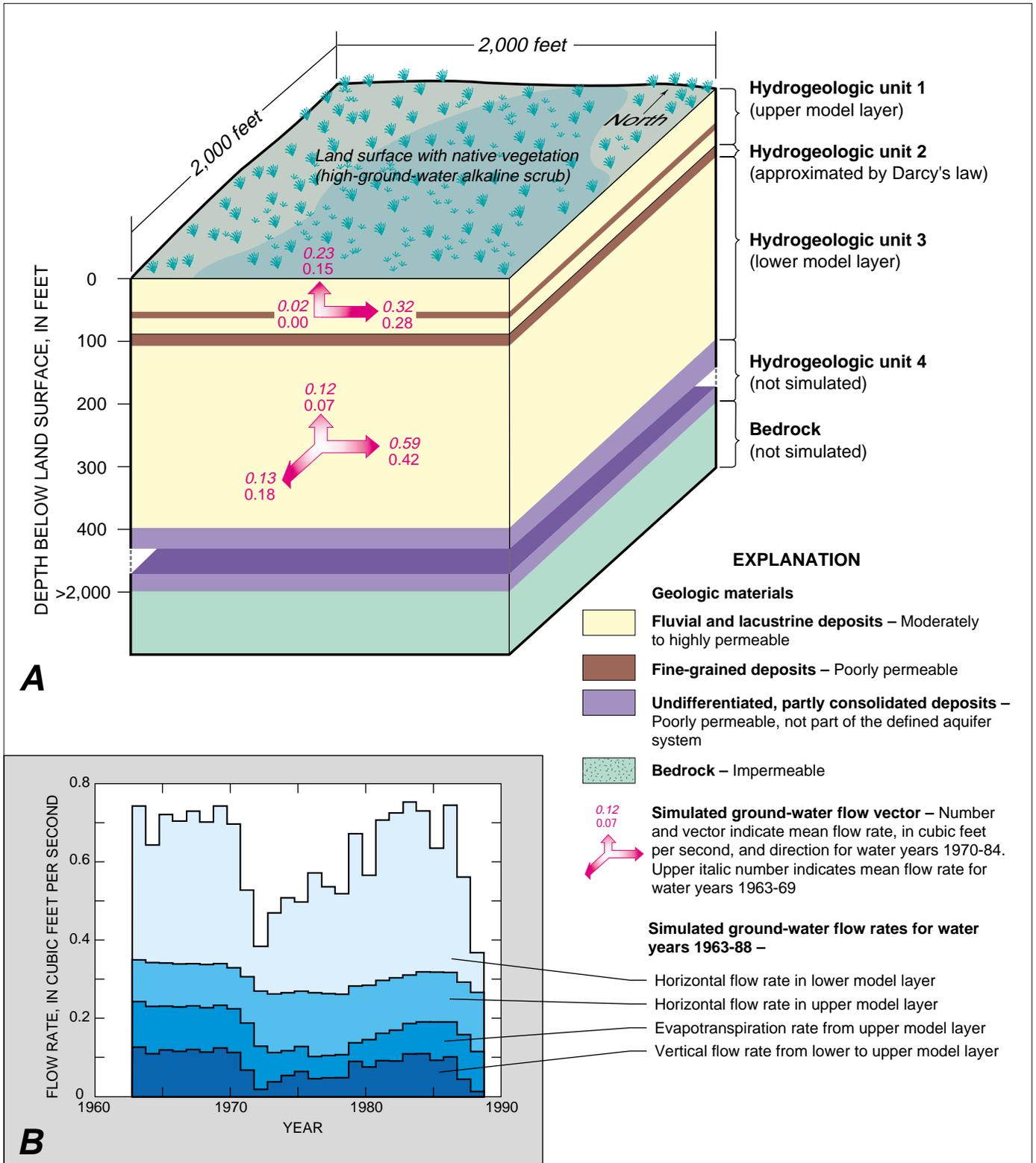
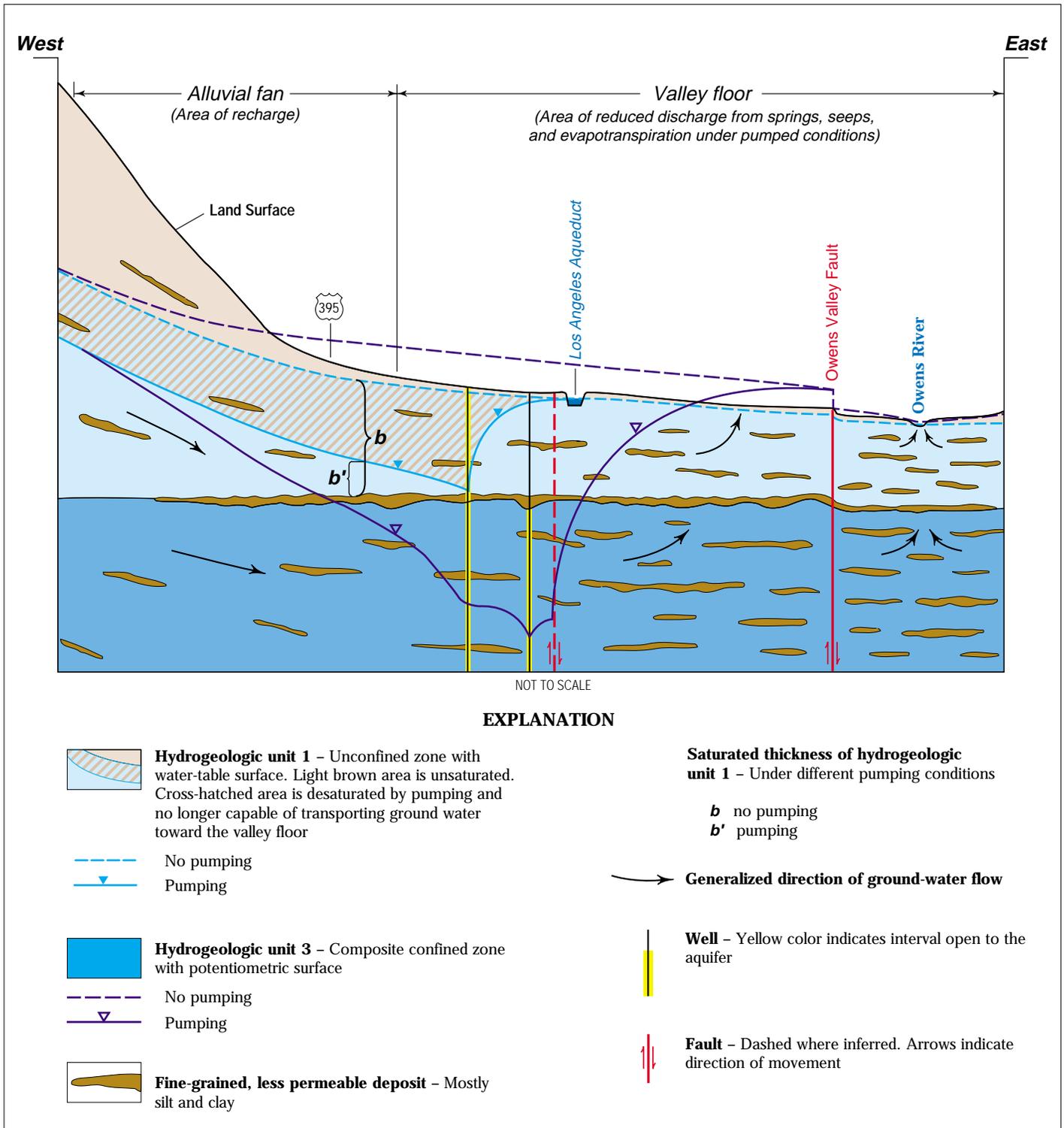


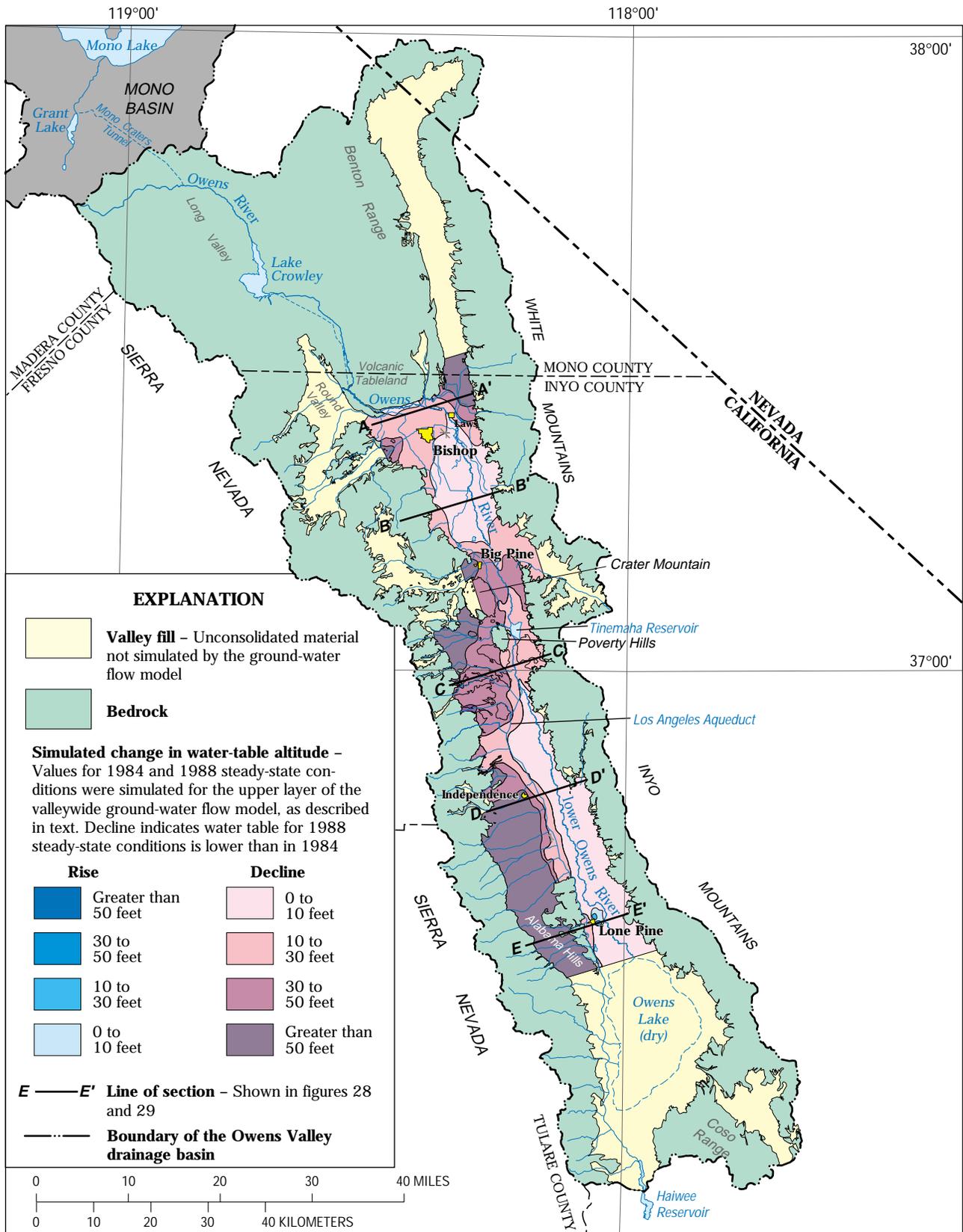
Figure 23. Simulated change in water-table altitude in the Owens Valley, California, between water years 1963 and 1984.



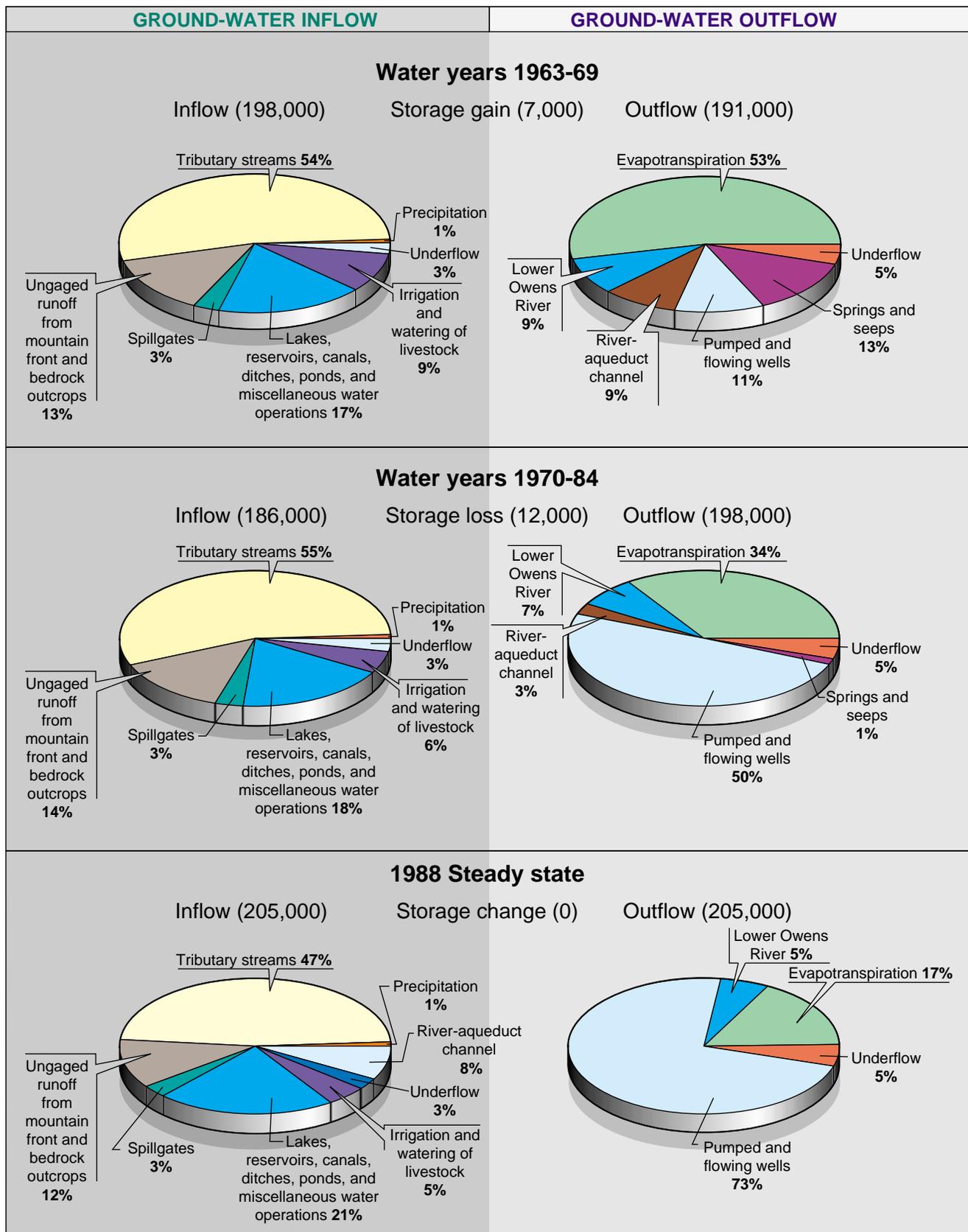
**Figure 24.** Simulated ground-water flow rates near the fast-drawdown site at Independence, California (figure 2, site K; table 1). **A**, average flow vectors for water years 1963–69 and 1970–84 for the ground-water model cell (row 128, column 23) that represents the area surrounding site K. Also refer to section C–C (figure 5). **B**, annual flow rates for water years 1963–88.



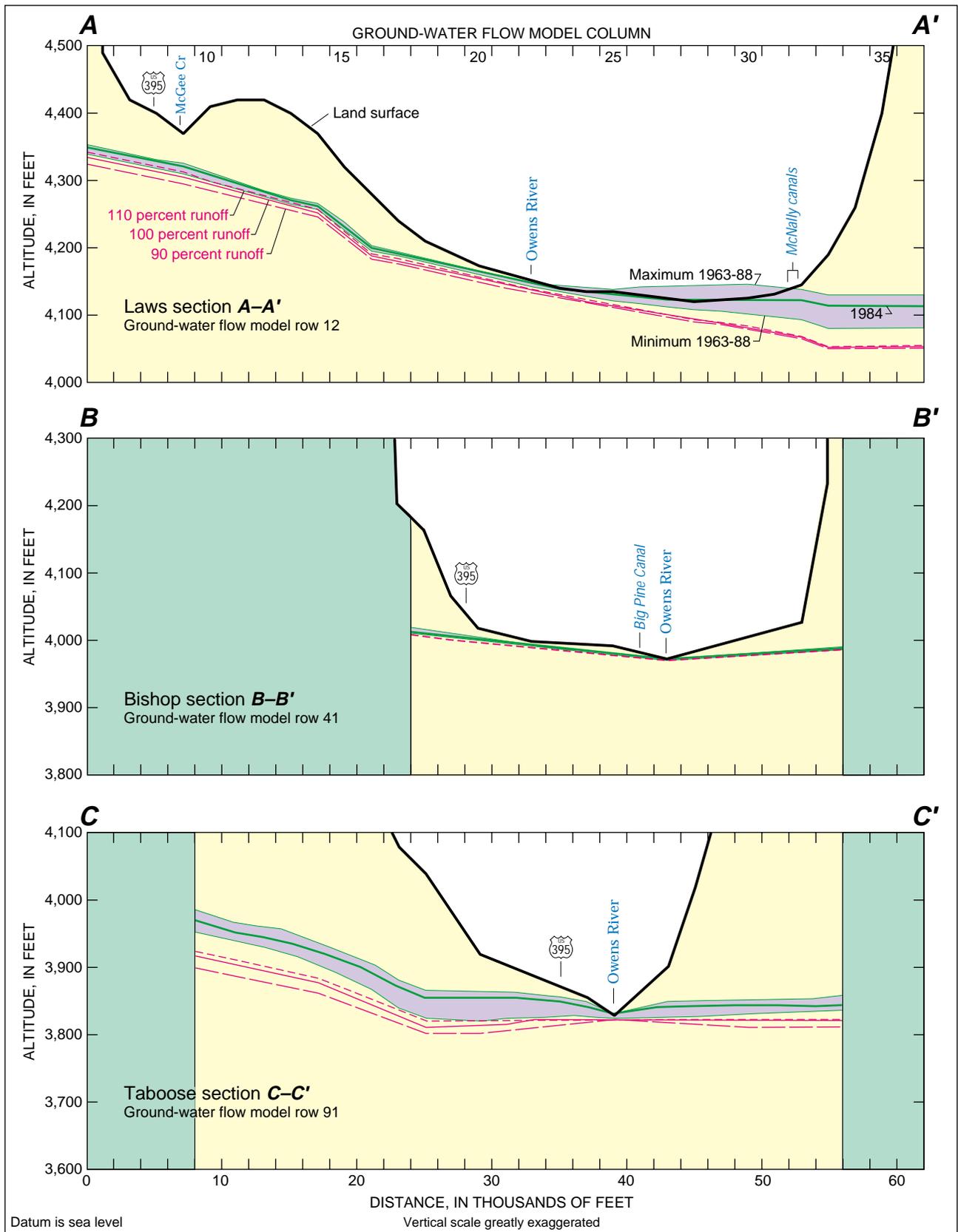
**Figure 25.** Schematic section across the Owens Valley near Independence, California, showing ground-water flow under different pumping conditions. Saturated thickness of hydrogeologic unit 1 beneath the alluvial fans may decrease markedly (from *b* to *b'*) during pumping and result in significantly less ground-water flow toward the valley floor.



**Figure 26.** Simulated change in water-table altitude in the Owens Valley, California, between water year 1984 conditions and 1988 steady-state conditions.



**Figure 27.** Simulated ground-water budgets for the aquifer system of the Owens Valley, California, for water years 1963–69, water years 1970–84, and 1988 steady-state conditions. Average inflow, outflow, and change in storage are expressed in acre-feet per year. Refer to text for model assumptions and to table 11 for precise values.



**Figure 28.** Sections showing the simulated water table in the Owens Valley, California, for 1998 steady-state conditions with different quantities of runoff. Line of sections shown in figure 26.

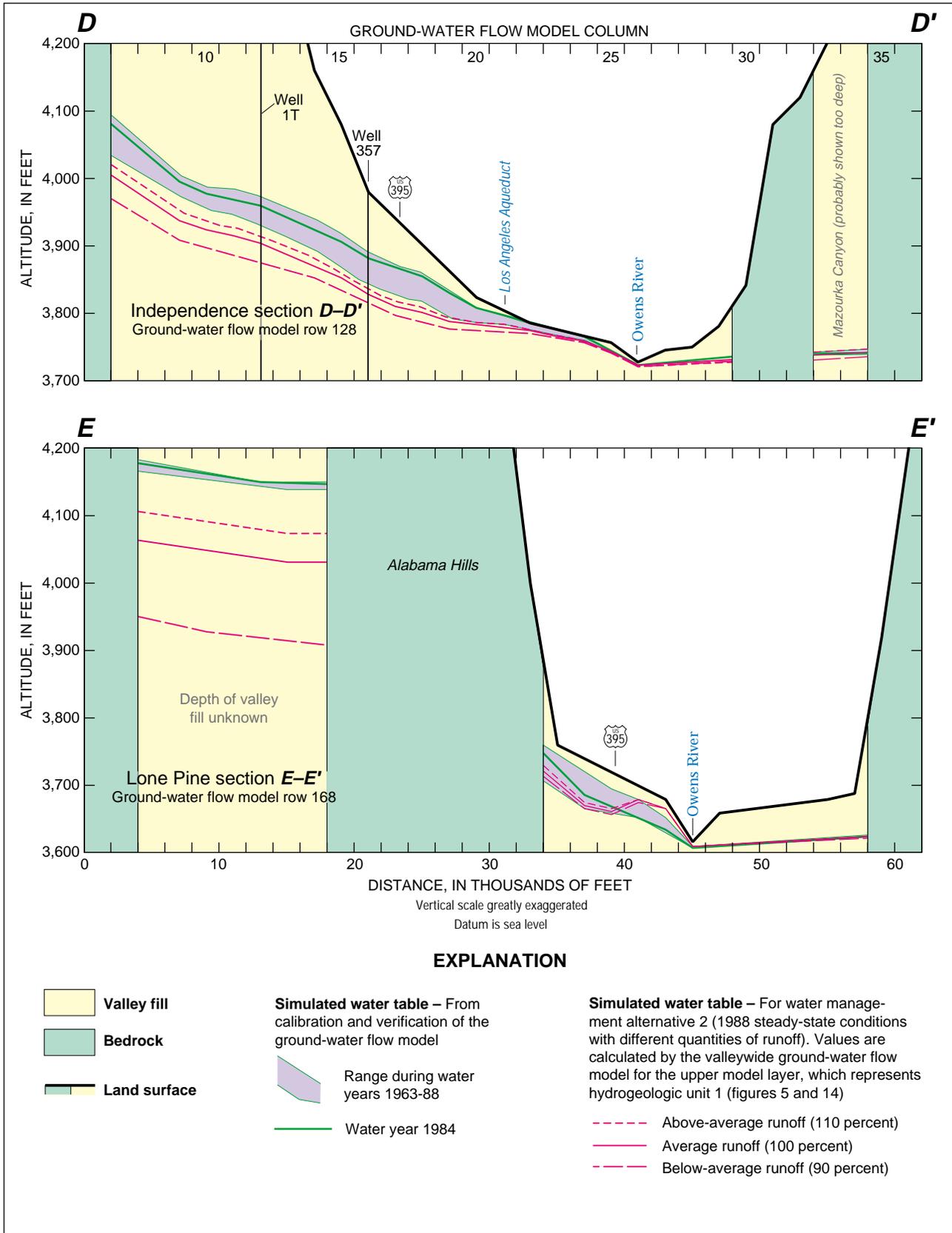
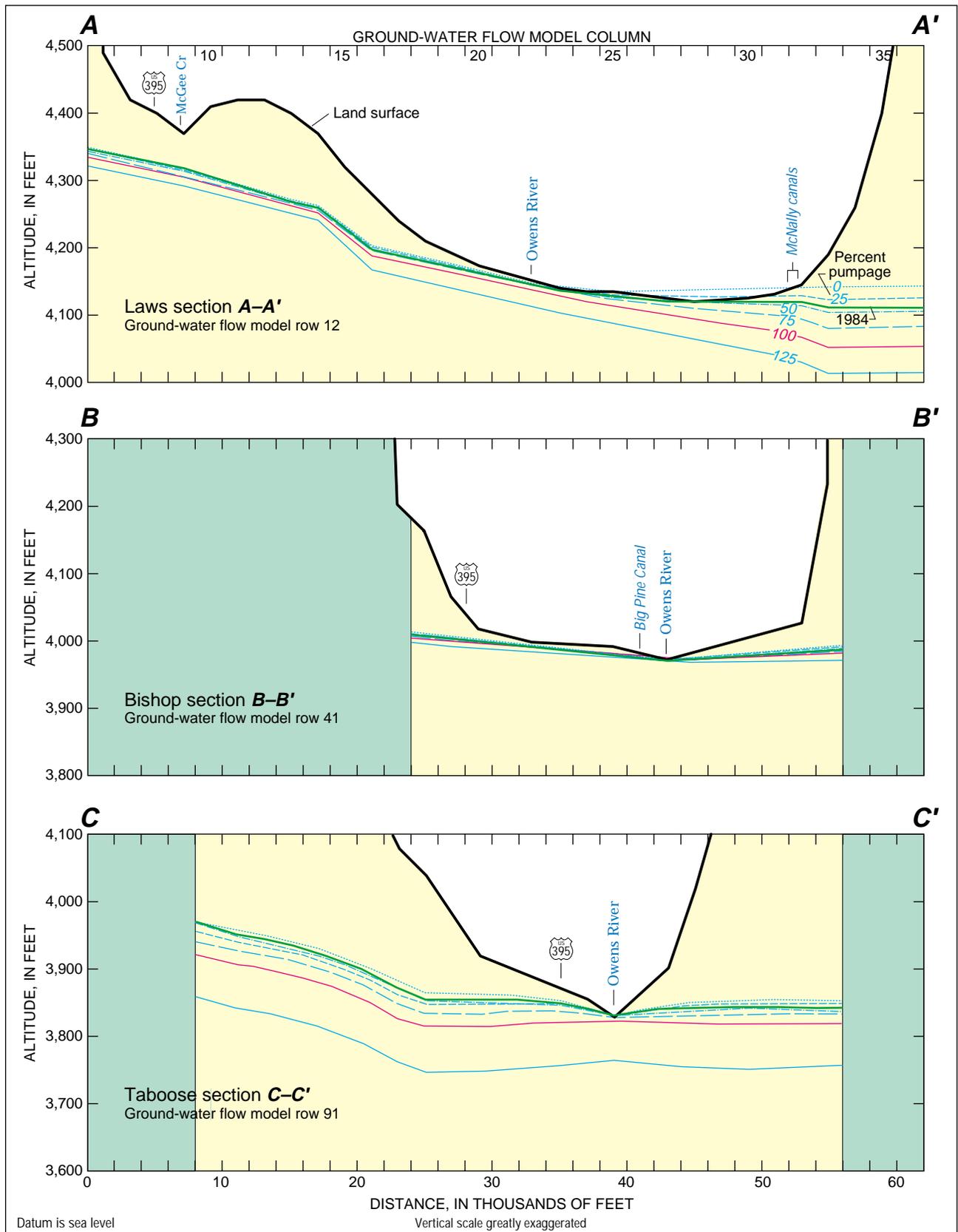


Figure 28. Continued.



**Figure 29.** Sections showing the simulated water table in the Owens Valley, California, for 1988 steady-state conditions with different quantities of pumpage. Line of sections shown in figure 26.

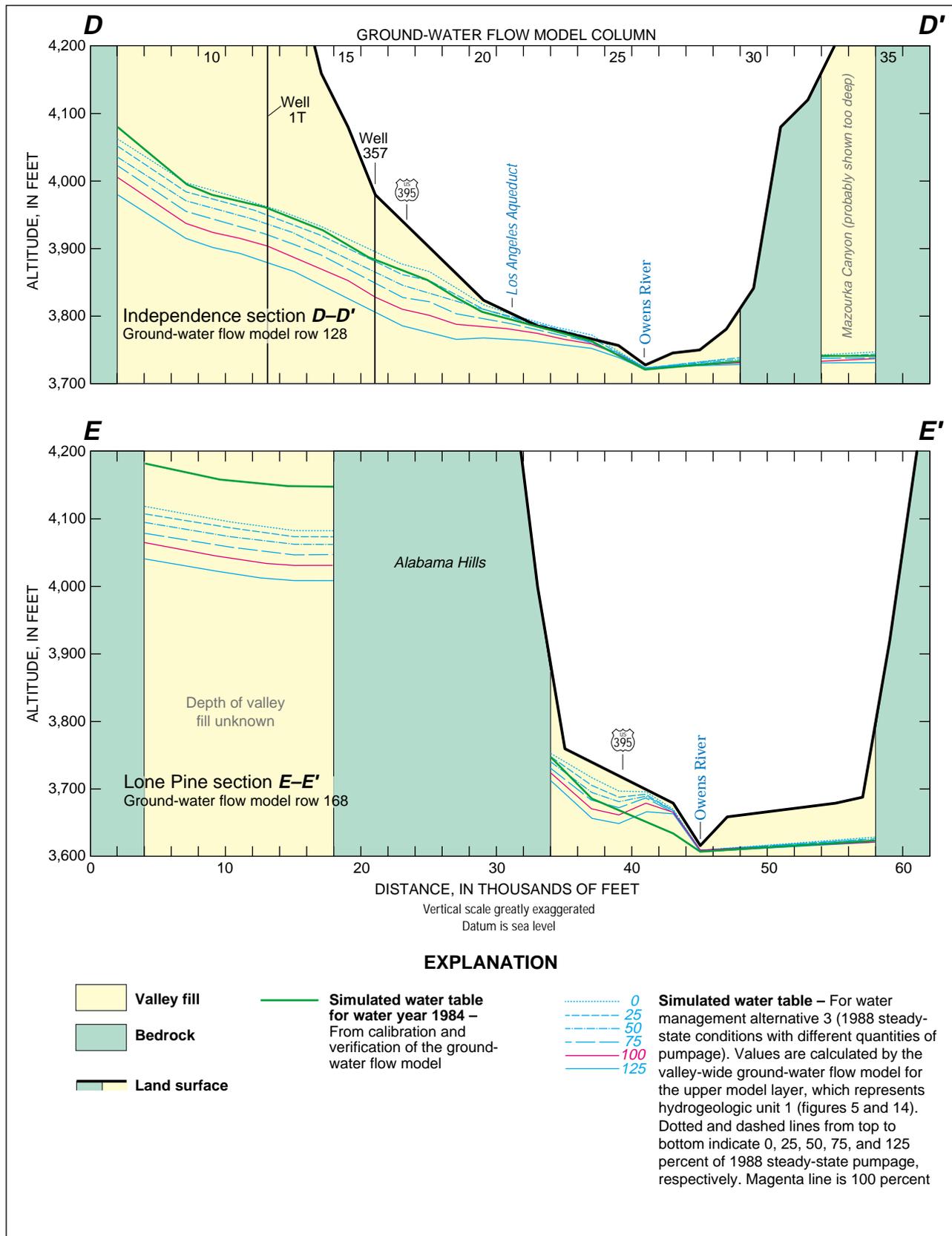
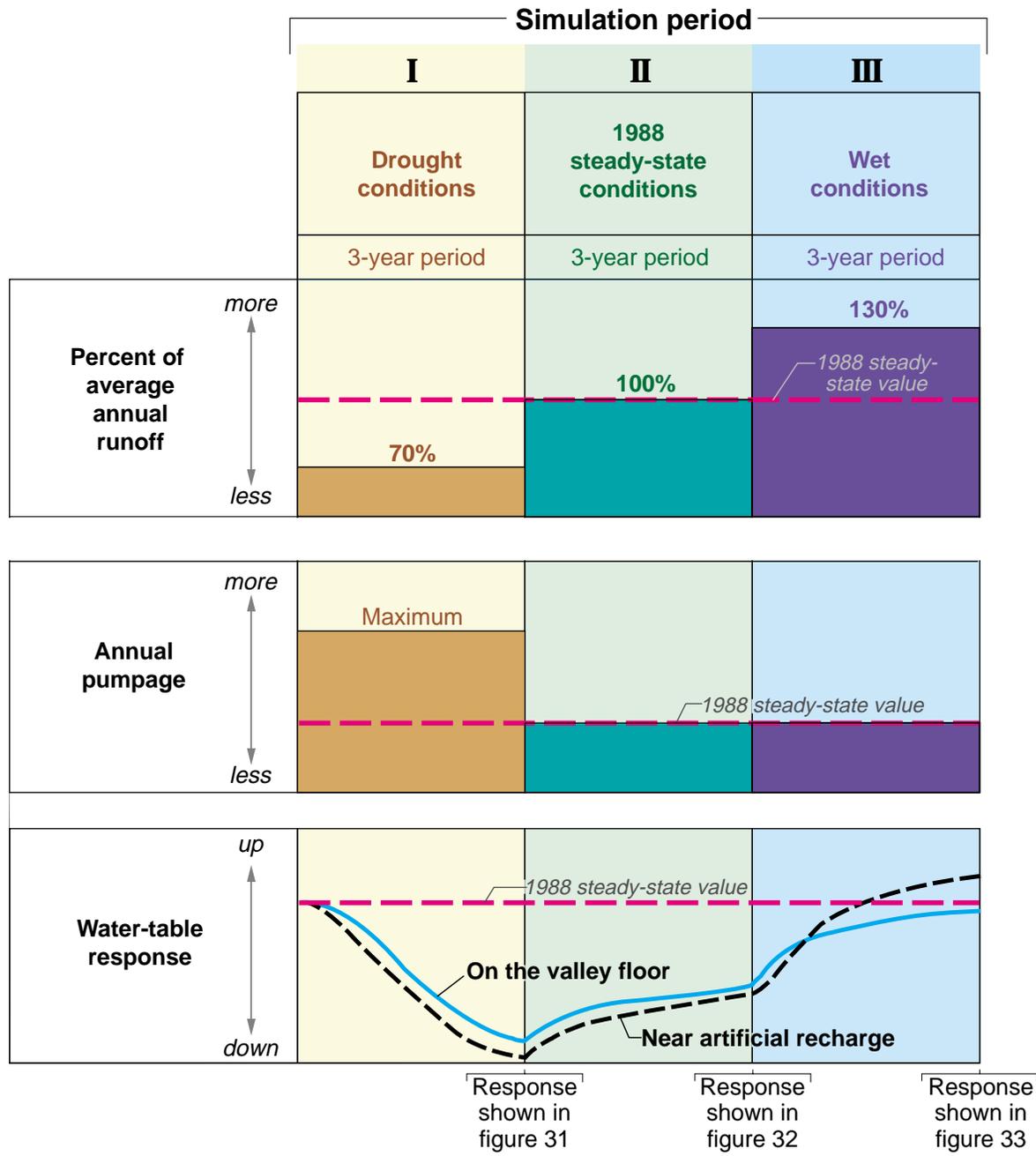
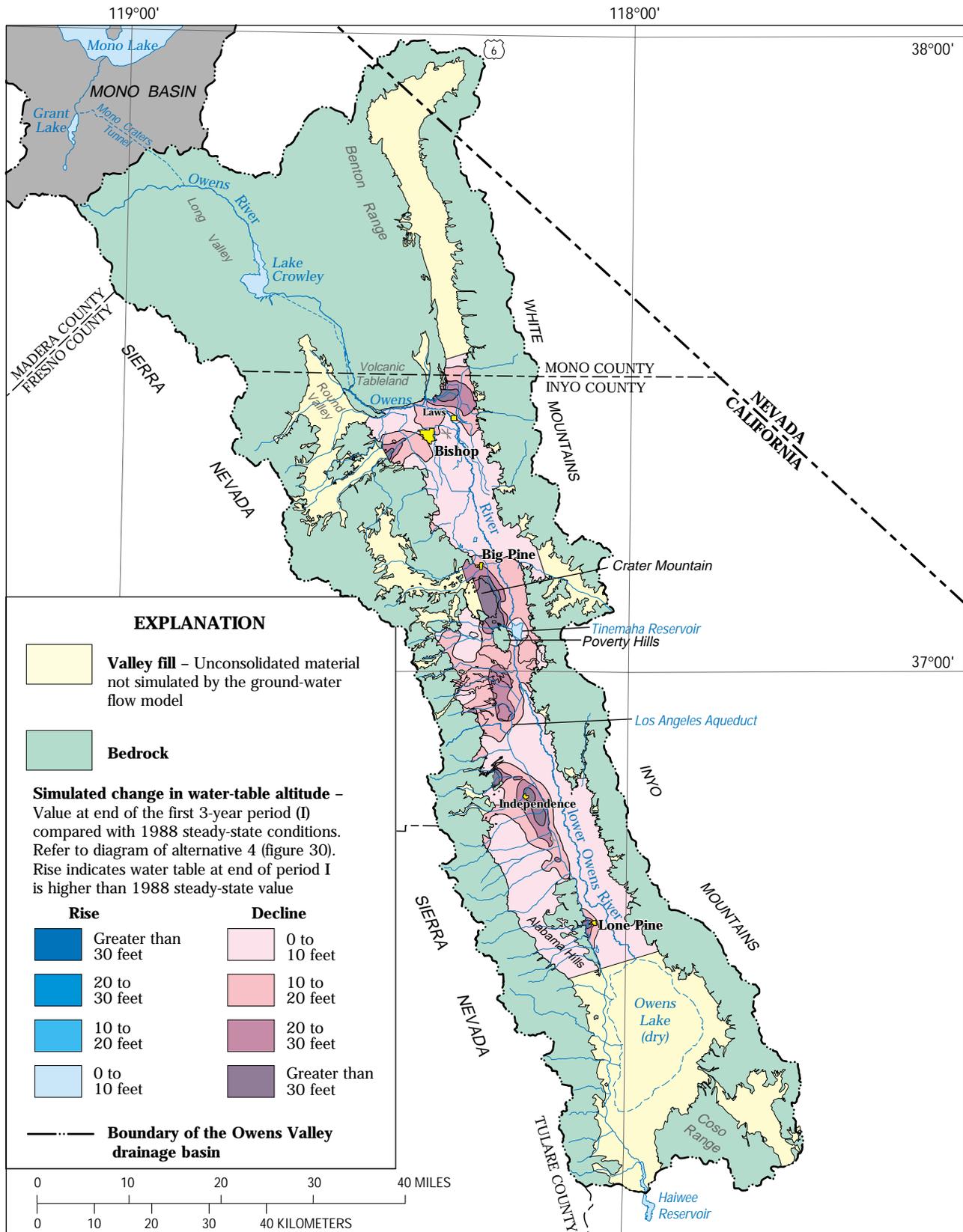


Figure 29. Continued.



**Figure 30.** Diagram of water-management alternative 4 for the Owens Valley, California. Shown are changes in percent of average annual runoff, annual pumpage, and water-table response at typical locations in the valley during the 9-year simulation period. Results at the end of each 3-year period are displayed in figures 31–33.



**Figure 31.** Simulated change in water-table altitude in the Owens Valley, California, for water-management alternative 4 at the end of period I, representing 3 years of drought.

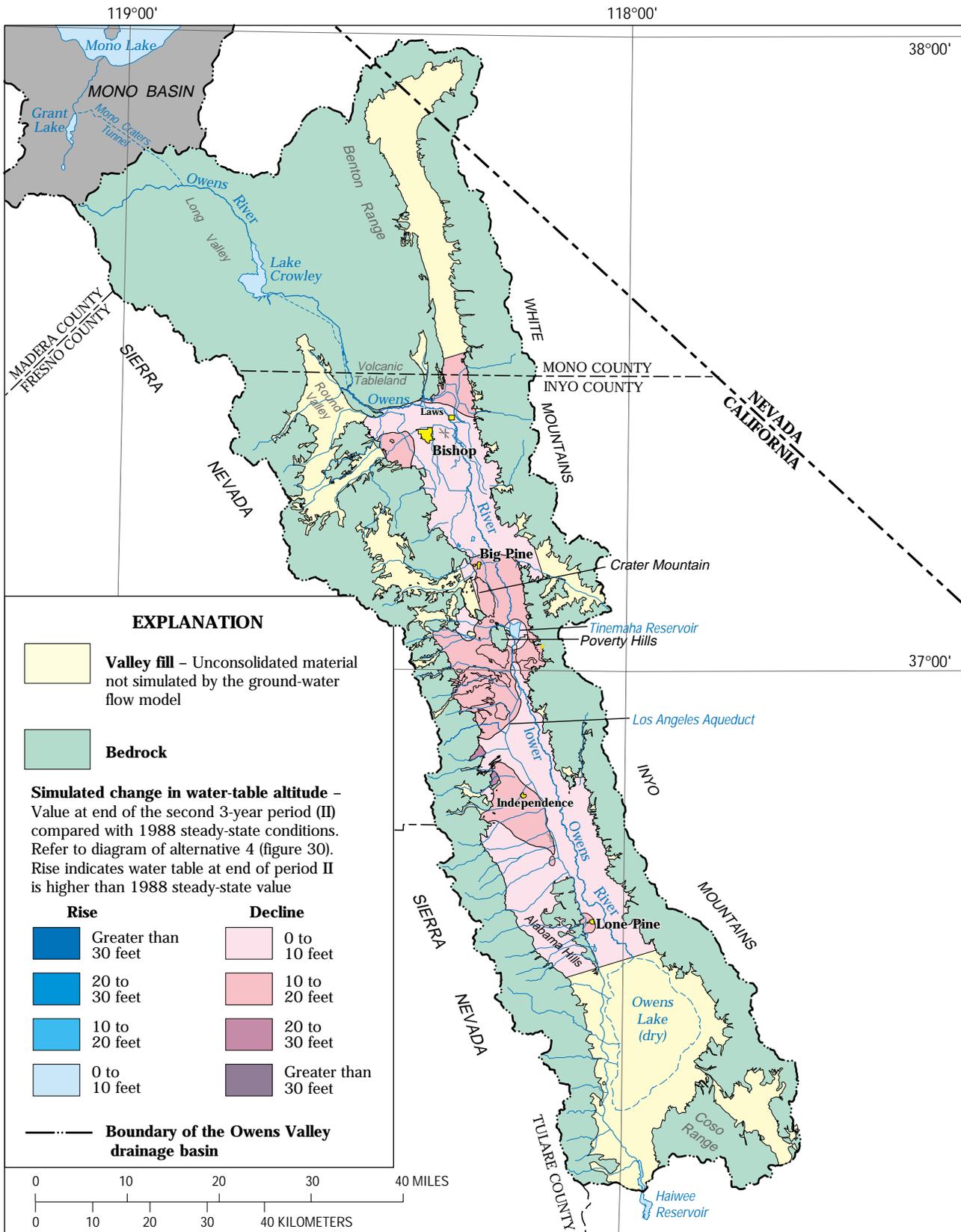
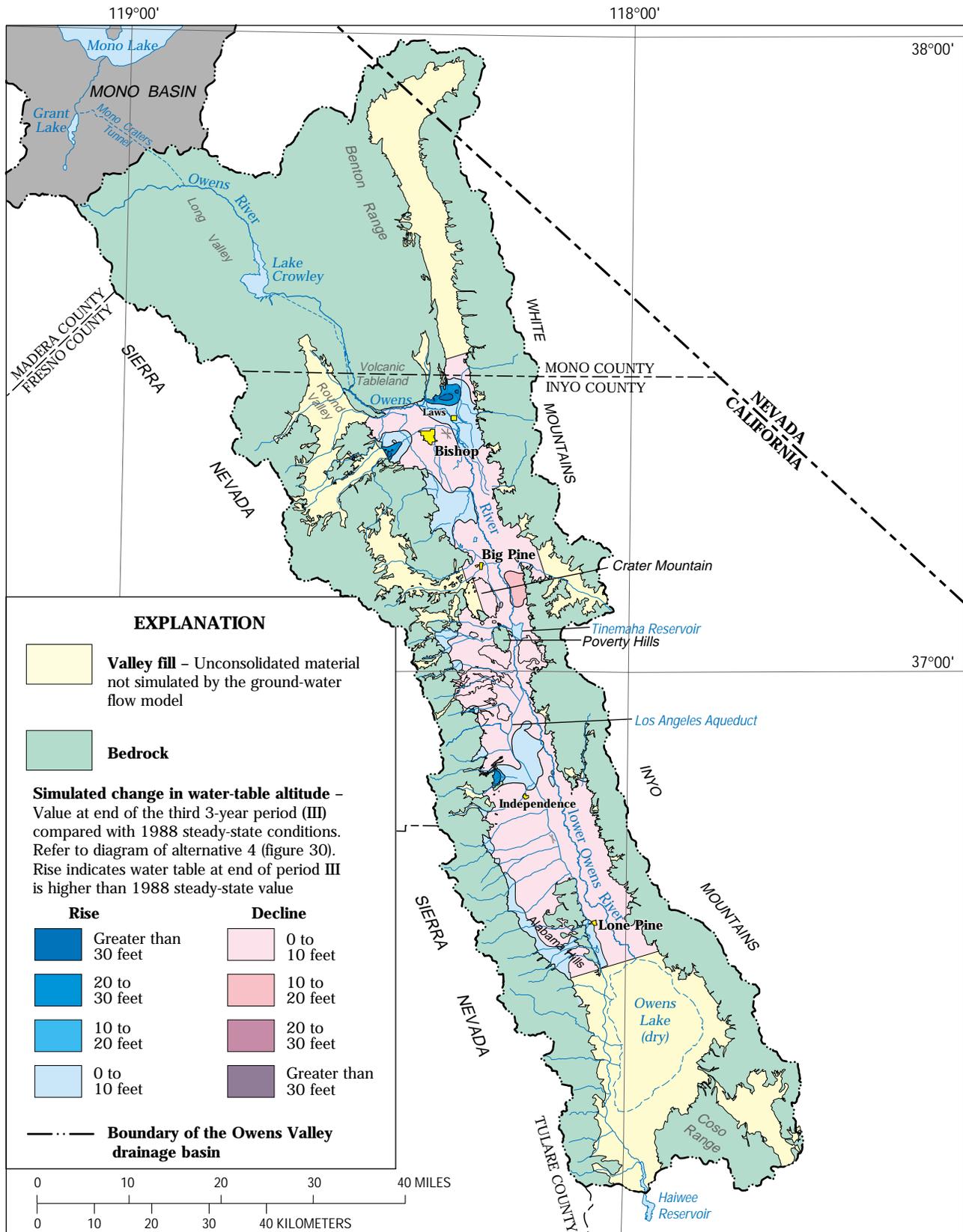
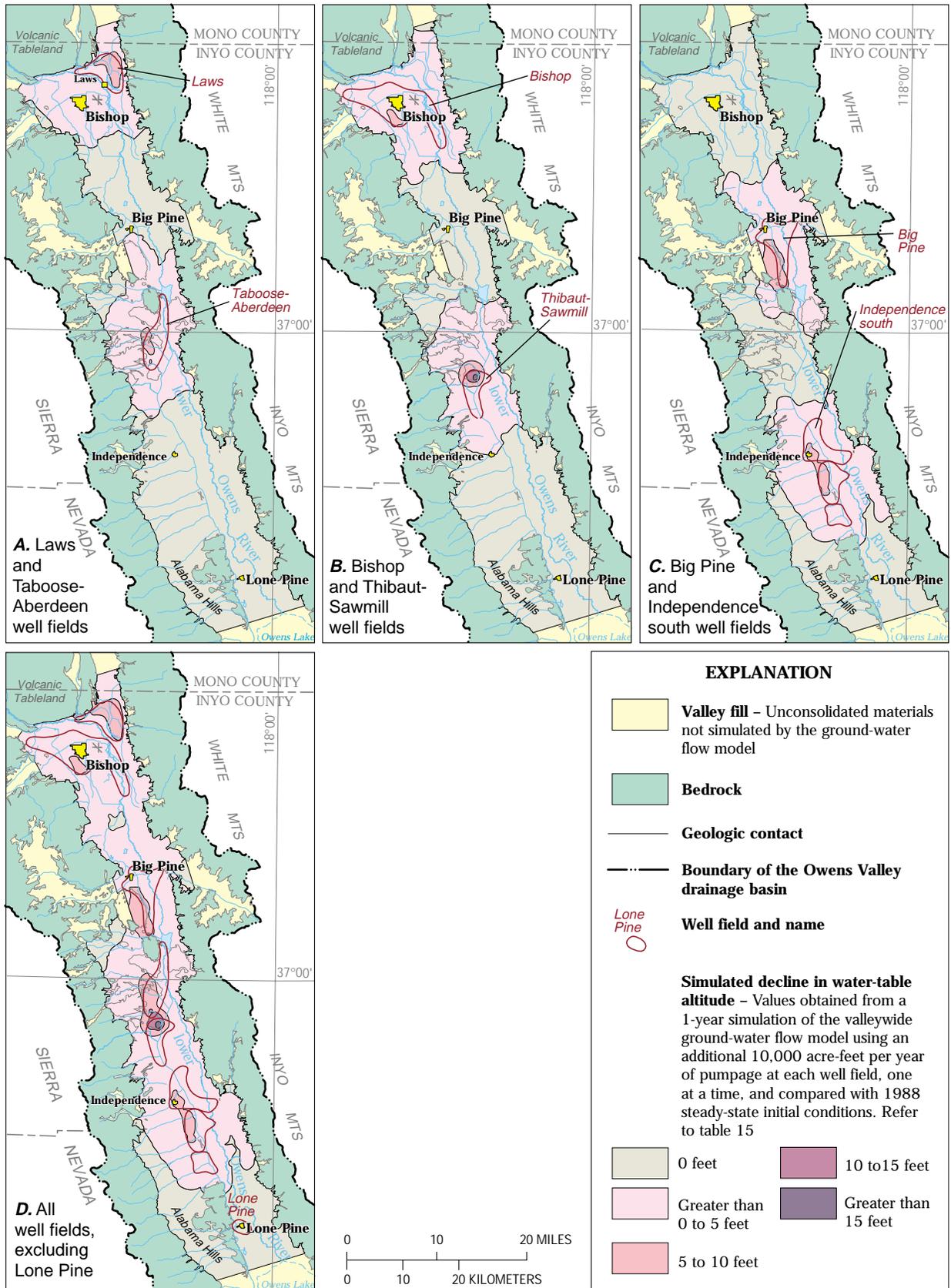


Figure 32. Simulated change in water-table altitude in the Owens Valley, California, for water-management alternative 4 at the end of period II, representing 3 years of recovery.



**Figure 33.** Simulated change in water-table altitude in the Owens Valley, California, for water-management alternative 4 at the end of period III, representing 3 years of wet conditions.



**Figure 34.** Simulated decline in water-table altitude in the Owens Valley, California, resulting from a unit increase in pumpage at each well field.

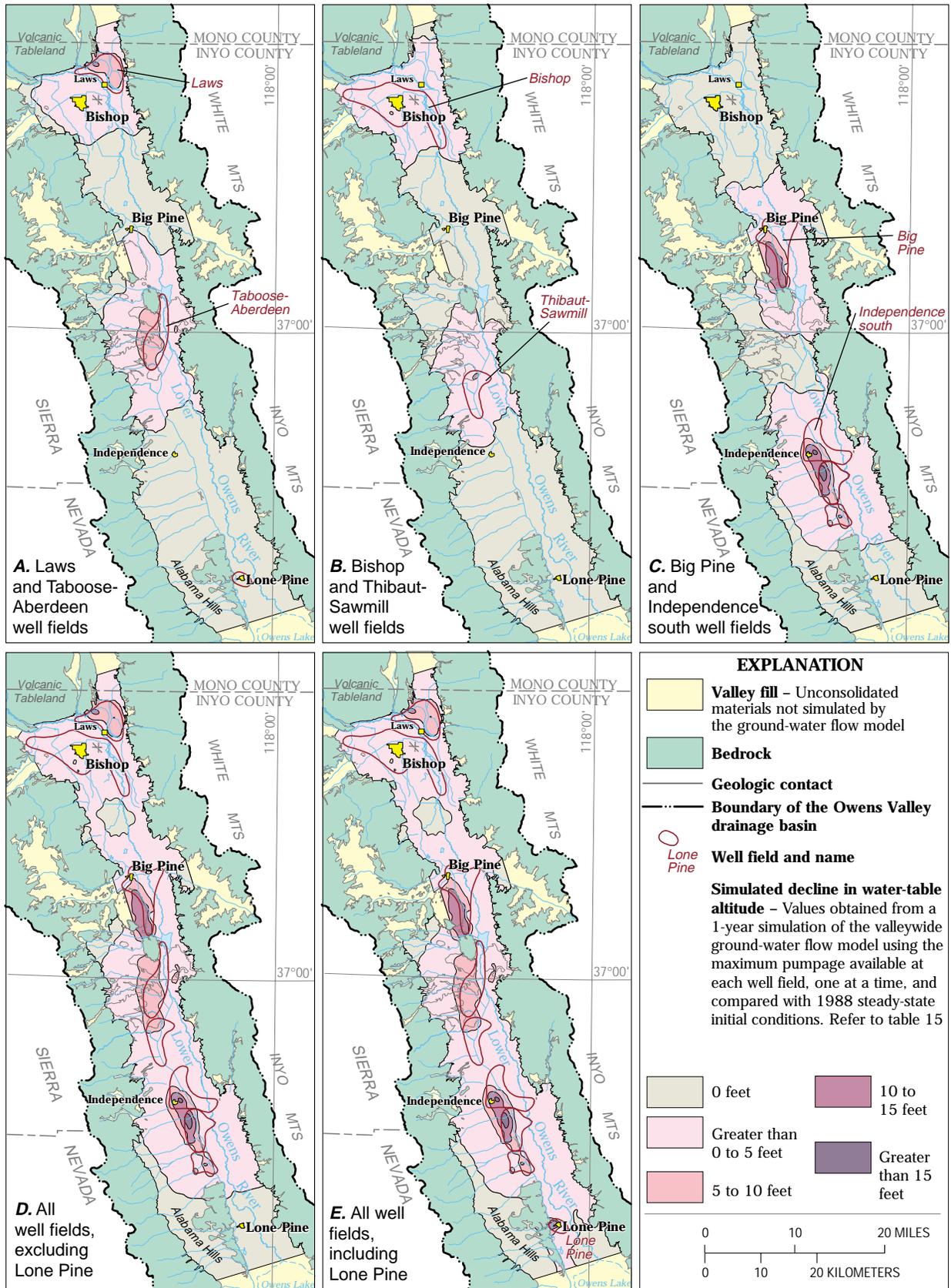


Figure 35. Simulated decline in water-table altitude in the Owens Valley, California, resulting from maximum pumpage at each well field.