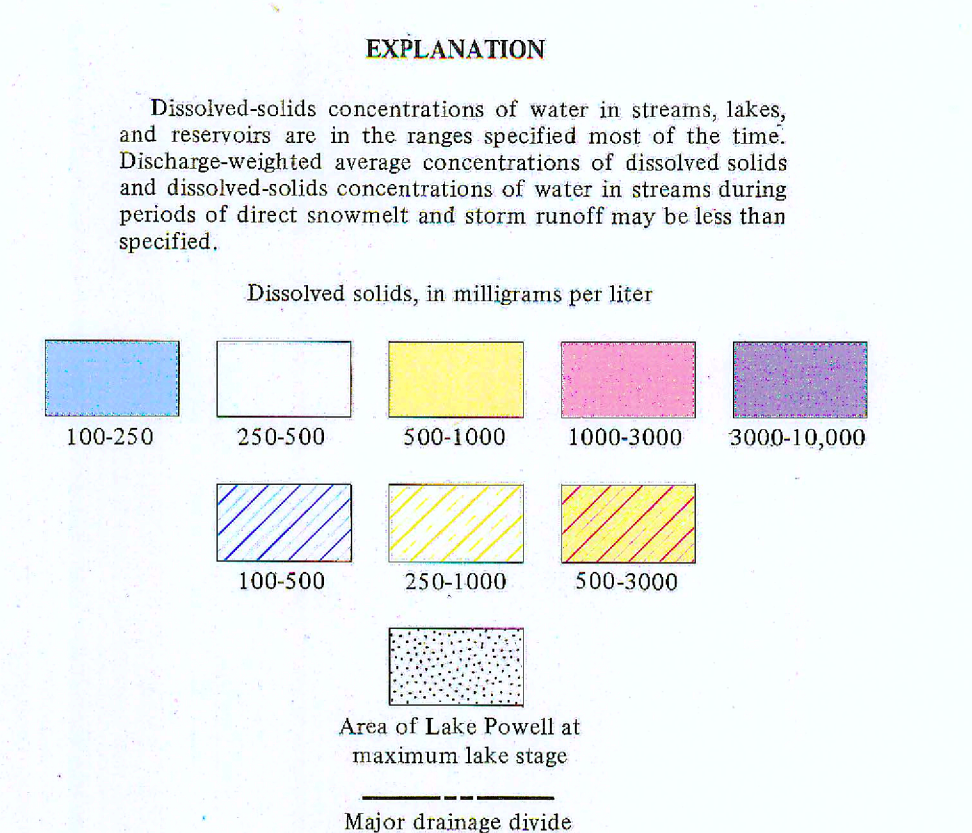
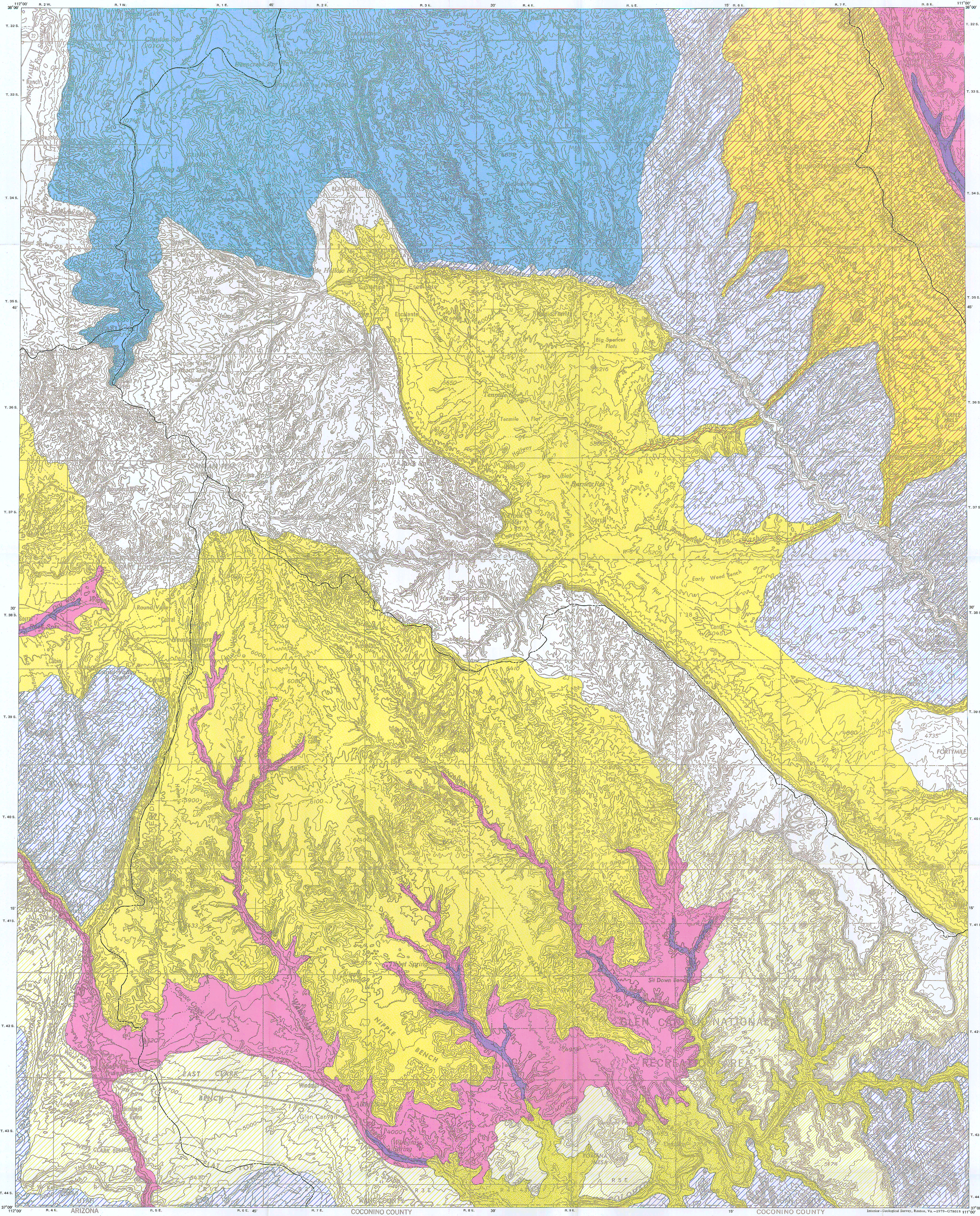


GL0131-0001

DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY

UNIVERSITY OF UTAH  
RESEARCH INSTITUTE  
EARTH SCIENCE LAB.

MISCELLANEOUS INVESTIGATIONS SERIES  
MAP I-1033-F



**INTRODUCTION**

This is one of a series of maps that describes the geology and related natural resources of the Kaiparowits coal-basin area, Utah. Published sources of water-quality data used in the preparation of this map included Jones, Hembree, Phoenix, and Oakland (1964), Good (1966, 1969), U.S. Bureau of Land Management (1976), and U.S. Geological Survey (1977). Sources of unpublished data included the U.S. Bureau of Reclamation and the Southeastern Utah Association of Geologists. Some of the unpublished data was provided by Vaughn Hansen Associates of Salt Lake City, Utah, whose assistance is gratefully acknowledged.

**RUNOFF**

As noted by Price (1977), runoff in the Kaiparowits coal-basin area—except parts of the Escalante River basin—is intermittent or ephemeral. Shown on this map are the ranges of dissolved-solids concentrations that can be expected most of the time in runoff (including streams, small lakes, and reservoirs) when present. Dissolved-solids concentrations in direct storm and snowmelt runoff generally are lower than the ranges shown here, as are the discharge-weighted average dissolved-solids concentrations in runoff from the area (Price and Wadell, 1973, about 2). The ranges shown on this map are chiefly on (1) chemical analyses of about 130 water samples collected at about 40 sites throughout the basin during low runoff periods from 1972 to 1975 and (2) the local geology (Blackburn and Wyatt, 1973) and general chemical quality of ground water (Price, 1977)—both of which significantly influence the chemical quality of runoff. Other factors taken into consideration while compiling the map included mean altitude of individual drainage basins, normal annual precipitation, mean annual runoff, surface-water use, and reprecipitation along water courses. Of the surface-water sites sampled, 12 are along the main stem and headwater tributaries of the Escalante River; 14 are in the Wahwapee, Warm, and Lost Chance Creek drainage basins; 2 are in the Four River drainage area; and 1 is in the East Fork Sevier River. The rest are in miscellaneous streams, most of which drain directly into Lake Powell. The expanded ranges of dissolved-solids concentrations (100-200, 250-500, and 500-1000) shown on this map are for those areas where there were insufficient data for better definition of the surface-water quality.

Runoff in the Kaiparowits coal-basin area generally ranges from fresh to moderately saline according to the following classification commonly used by the U.S. Geological Survey. (See Hem, 1970, p. 219.)

Dissolved-solids concentration (milligrams per liter)

Class	Less than 1,000
Fresh	1,000 to 3,000
Slightly saline	3,000 to 10,000
Moderately saline	10,000 to 35,000
Very saline	More than 35,000

The maximum concentration of dissolved solids recommended by the U.S. Public Health Service (1962, p. 7) for drinking water is 500 mg/L. However, waters containing more than 1,000 mg/L are used for this purpose in some areas where fresher water is unavailable.

Runoff is highest in the headwaters of the Escalante River, which have dissolved-solids concentrations of generally less than 250 mg/L, even during low-flow periods; runoff is most abundant along the lower reaches of Wahwapee, Warm, and Lost Chance Creeks, which have dissolved-solids concentrations of generally more than 2,000 mg/L. Although not shown on the map, there may be local pools of very saline to briny water in these and other lower stream reaches, as well as concentrations of dissolved solids by evapotranspiration.

The principal factors contributing to the salinity of the runoff in the Kaiparowits coal-basin area are irrigation return flows from the Permian and Escalante Rivers, seepage of saline ground water to streams (especially as it downstems from outcrops of the Mancos and Tropic Shales), and reprecipitation along water courses. Sulfate, a phytotoxin that can cause more than 7 feet (2 m) of water per year under 100 percent volume density and ideal growing conditions (Robinson, 1958, p. 75), is well established along the Permian River, lower Wahwapee Creek, Abney Wash, and other streams in the area. Concentrations of sulfate in these streams significantly concentrate the salts in the remaining flows. During periods of very low runoff, salt deposits are left on the beds and banks of such streams as the Permian River and Wahwapee, Warm, and Lost Chance Creeks by deposited runoff and effluent ground water. These salts are readily redissolved in the initial stages of subsequent periods of runoff and increase the salinity of that runoff.

Runoff in the headwaters of the Escalante River and most other areas where dissolved-solids concentrations are generally less than 500 mg/L is of a calcium bicarbonate type. Runoff from other areas is generally of a calcium sulfate or sodium sulfate type.

**LAKE POWELL**

Although considerable quality-of-water data have been collected in Lake Powell since it began filling in 1963, only general information about the chemical quality of the water in the lake is given here. The reader is referred to Blinn, Stewart, and Wilke (1973), Standford, Potter, and Kidd (1973), and Reynolds and Johnson (1974) for more detailed information about the chemical quality and major-element geochemistry of the lake.

As shown on this map, dissolved-solids concentrations of the lake water are in the range of from 500 to 1,000 mg/L (1976 salinity level). During 1965-70 the U.S. Bureau of Reclamation collected and analyzed 64 near-bottom and 54 near-surface samples from the lake at a site in the Wahwapee Creek bay. Dissolved-solids concentrations of these near-surface samples ranged from 291 to 759 mg/L and averaged 554 mg/L. Dissolved-solids concentrations of the near-bottom samples ranged from 417 to 973 mg/L and averaged 815 mg/L. According to Reynolds and Johnson (1974), Lake Powell has an overall average salinity of about 500 mg/L. The lake water has a mixed chemical character with calcium and sodium the dominant cations and sulfate the dominant anion.

Although Wahwapee, Warm, and Lost Chance Creeks discharge moderately saline water into Lake Powell, the total annual salt load contributed to the lake by these streams is relatively small. For example, the total annual salt discharged by these streams into Lake Powell is about 24,500 tons (22,235 t) assuming the streams have a total mean annual runoff of 6,000 acre-feet (7.4 m<sup>3</sup>). U.S. Bureau of Land Management, 1976, p. 13-15 (H-157) and a discharge-weighted average dissolved-solids concentration of 3,800 mg/L. This is only 0.3 percent of the total estimated salt load added to the lake by the Colorado and San Juan Rivers under 1974 conditions (modified) (U.S. Dept. Interior, 1977, p. 65).

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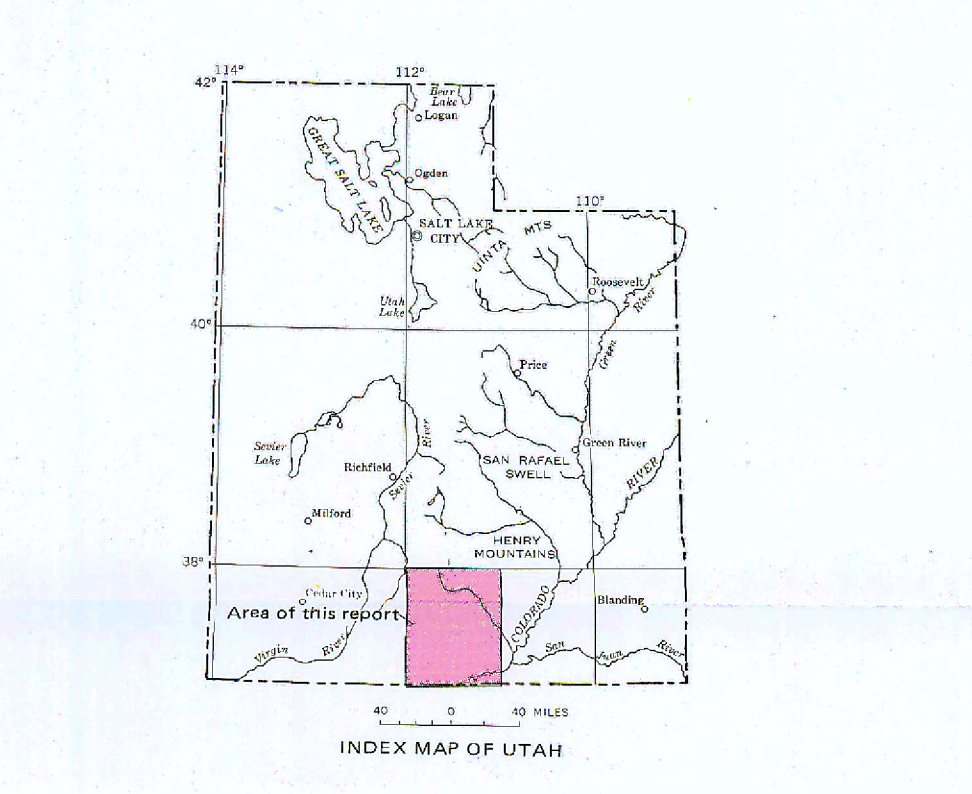
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Base from U.S. Geological Survey 1:250,000 Series Escalante, 1961 (1970 revision)

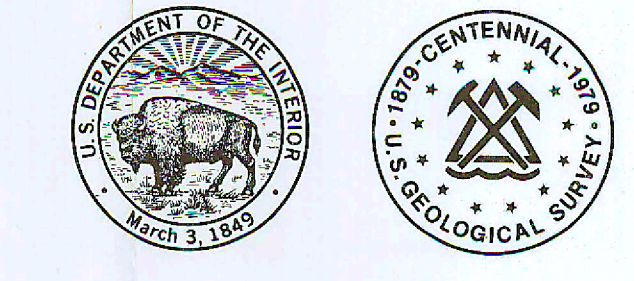
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0 1 2 3 4 5 6 7 8 9 10 MILES

0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

COUNTY INTERVAL 20 FEET  
WITH SUPPLEMENTARY CONTOURS AT 10-FOOT INTERVALS  
TRANSVERSE MERCATOR PROJECTION  
NATIONAL GEODETIC VERTICAL DATUM OF 1929

**MAP SHOWING GENERAL CHEMICAL QUALITY OF SURFACE WATER IN THE KAIPAROWITS COAL-BASIN AREA, UTAH**  
By  
Don Price  
1979



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