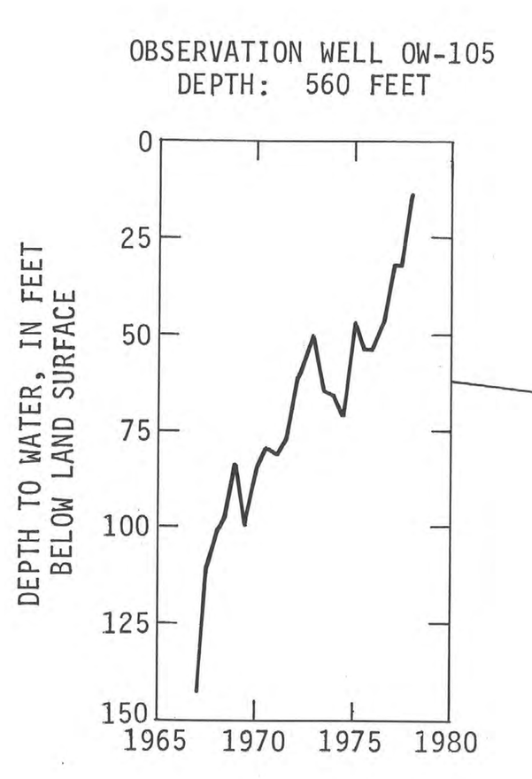
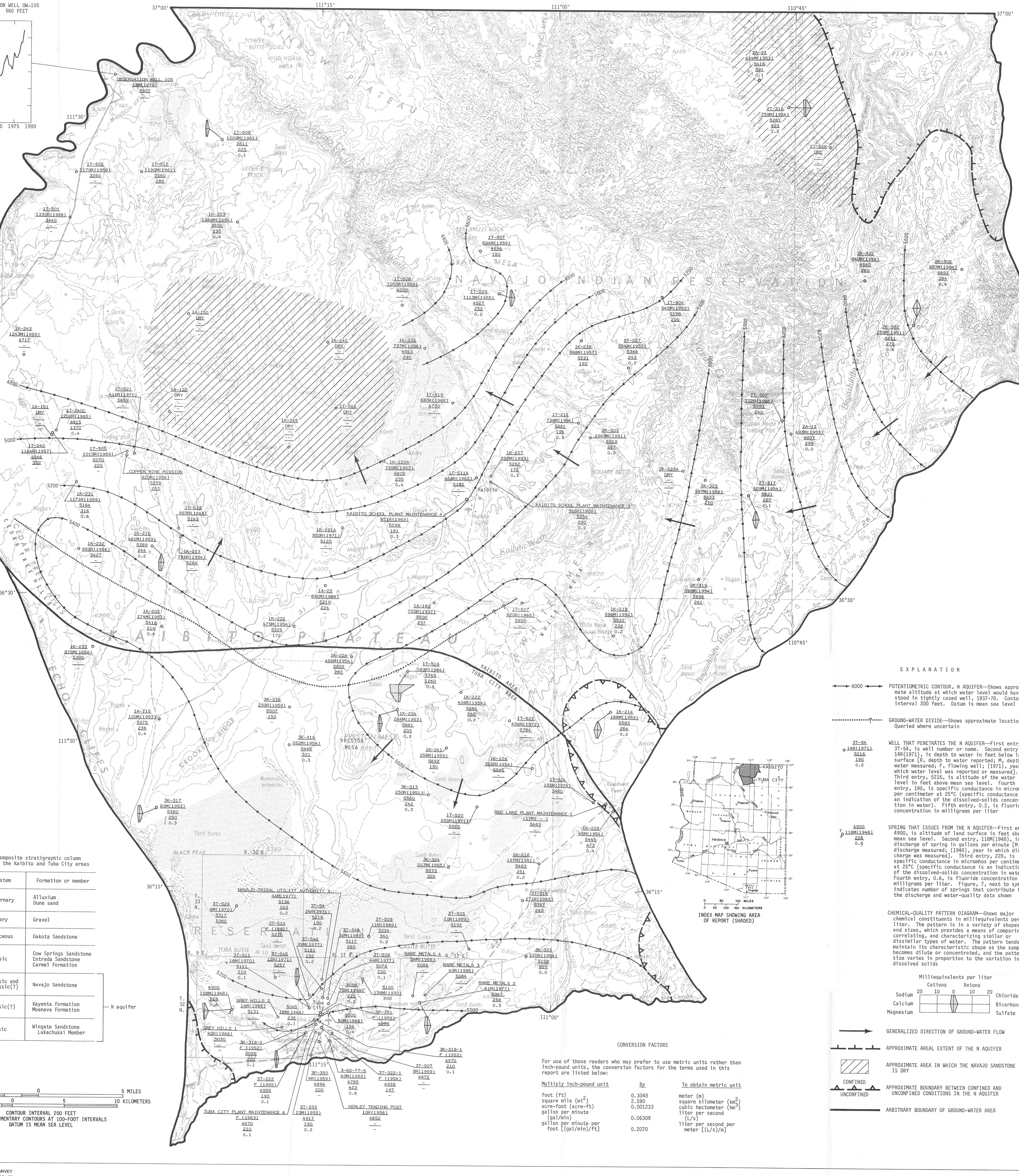
PREPARED IN COOPERATION WITH THE
ARIZONA WATER COMMISSION





Composite stratigraphic column
for the Kaibito and Tuba City areas

System	Formation or member	
Quaternary	Alluvium Dune sand	
Tertiary	Gravel	
Cretaceous	Dakota Sandstone	
Jurassic	Cow Springs Sandstone Entrada Sandstone Carmel Formation	
Jurassic and Triassic(?)	Navajo Sandstone	N aquifer
Triassic(?)	Kayenta Formation Moenave Formation	N aquifer
Triassic	Wingate Sandstone Lukachukai Member	N aquifer

5 0 5 MILES
5 0 5 10 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL

CONVERSION FACTORS

For use of those readers who may prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]

E X P L A N A T I O N

6000 — POTENTIOMETRIC CONTOUR, N AQUIFER—Shows approximate altitude at which water level would have stood in tightly cased well, 1937-78. Contour interval 200 feet. Datum is mean sea level

GROUND-WATER DIVIDE—Shows approximate location. Queried where uncertain

3T-54 / 14R(1971) / 5216 / 190 / 0.2 — WELL THAT PENETRATES THE N AQUIFER—First entry, 3T-54, is well number or name. Second entry, 14R(1971), is depth to water in feet below land surface [R, depth to water reported; M, depth to water measured; F, flowing well; (1971), year in which water level was reported or measured]. Third entry, 5216, is altitude of the water level in feet above mean sea level. Fourth entry, 190, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Fifth entry, 0.2, is fluoride concentration in milligrams per liter

7 4900 / 118M(1948) / 228 / 0.6 — SPRING THAT ISSUES FROM THE N AQUIFER—First entry, 4900, is altitude of land surface in feet above mean sea level. Second entry, 118M(1948), is discharge of spring in gallons per minute [M, discharge measured; (1948), year in which discharge was measured]. Third entry, 228, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Fourth entry, 0.6, is fluoride concentration in milligrams per liter. Figure, 7, next to symbol indicates number of springs that contribute to the discharge and water-quality data shown

CHEMICAL-QUALITY PATTERN DIAGRAM—Shows major chemical constituents in milliequivalents per liter. The pattern is in a variety of shapes and sizes, which provides a means of comparing, correlating, and characterizing similar or dissimilar types of water. The pattern tends to maintain its characteristic shape as the sample becomes dilute or concentrated, and the pattern size varies in proportion to the variation in dissolved solids

Milliequivalents per liter
Cations Anions
20 10 0 10 20
Sodium — Chloride
Calcium — Bicarbonate
Magnesium — Sulfate

GENERALIZED DIRECTION OF GROUND-WATER FLOW

APPROXIMATE AREAL EXTENT OF THE N AQUIFER

APPROXIMATE AREA IN WHICH THE NAVAJO SANDSTONE IS DRY

CONFINED / UNCONFINED — APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS IN THE N AQUIFER

ARBITRARY BOUNDARY OF GROUND-WATER AREA

INTRODUCTION

The Kaibito and Tuba City areas include about 2,500 mi^2 in the Navajo Indian Reservation in north-central Arizona. The main source of ground water is the Navajo Sandstone. (See the composite stratigraphic column.) Ground-water development has been slight in the Kaibito and Tuba City areas, and the water is used mainly for public supply; small amounts of ground water are used for domestic and livestock supplies, and an estimated 5 percent of the total consumption is used for irrigation. In 1977 estimated ground-water withdrawals were about 350 acre-ft in the Kaibito area and 650 acre-ft in the Tuba City area. Except near Lake Powell, water levels probably have not changed greatly during 1937-78. Near Lake Powell, water levels have risen in several wells in response to the rising water level of the lake; the water level in well OW-105 rose from 143 ft below the land surface in 1967 to 13 ft in 1978 (see hydrograph). Although numerous springs are present in the areas, only the springs having a measured discharge of more than 10 gal/min are shown on the map, and only selected wells are shown in areas of high well density.

The hydrologic data on which the map is based are available, for the most part, in computer-printout form for consultation at the Arizona Water Commission, 222 North Central Avenue, Suite 800, Phoenix, and at U.S. Geological Survey offices in: Federal Building, 301 West Congress Street, Tucson; Valley Center, Suite 1880, Phoenix; and 2255 North Gemini Drive, Building 3, Flagstaff. Material from which copies can be made at private expense is available at the Tucson, Phoenix, and Flagstaff offices of the U.S. Geological Survey.

GROUND WATER

In the Kaibito and Tuba City areas ground water is obtained from the N aquifer and from the alluvium. The N aquifer consists of the Navajo Sandstone, Kayenta Formation, Moenave Formation, and the Lukachukai Member of the Wingate Sandstone. The aquifer is present everywhere except where erosion has removed it in small areas in the northeastern corner of the Kaibito area and the southwestern part of the Tuba City area (Cooley and others, 1969, pl. 1). Northward from the southwestern part of the Tuba City area, the boundary of the N aquifer is coincident with the boundary of the Tuba City area. The N aquifer is composed of an alternating sequence of fine-grained sandstone and siltstone and is from a few feet to more than 1,300 ft thick. The Navajo Sandstone is the principal water-bearing unit tapped by wells in the areas, although two wells in the northeastern part of the Kaibito area obtain water from the Wingate Sandstone.

A ground-water divide extends west from White Mesa through the north edge of Preston Mesa and then northwest to Cedar Tree Hills, as indicated by the movement of ground water south and northwest away from the divide. Ground water is under unconfined conditions except where the N aquifer is overlain by confining beds in the Entrada Sandstone and Carmel Formation. Ground water is under confined conditions in the extreme southern part of the Kaibito area and along the eastern edge of the Tuba City area. Water also is under confined conditions in a small undelineated area near Tuba City, where tongues of the Navajo Sandstone interfinger with siltstone beds of the Kayenta Formation. The tongues are hydraulically connected with the main body of the Navajo Sandstone; the tongues are more than 125 ft thick in places but thin or pinch out to the southeast (Harshbarger and others, 1957). The static head is sufficient to cause water to flow at the land surface in some wells that penetrate the tongues of the Navajo Sandstone.

In the Kaibito and Tuba City areas wells range from 100 to 1,500 ft deep, and water levels range from flowing at the land surface to 1,360 ft below the land surface. In the Tuba City area wells are less than 1,000 ft deep and generally are less than 500 ft deep near Tuba City. Well depths tend to be greatest in the western and central parts of the Kaibito area.

Wells that tap the Navajo Sandstone yield from less than 5 to more than 300 gal/min of water. Wells near Tuba City generally yield more than 100 gal/min, and the specific capacity ranges from 0.2 to 7.9 (gal/min)/ft. Near Tuba City, flowing wells yield as much as 44 gal/min. In the southern part of the Kaibito area and near Kaibito, wells yield as much as 50 gal/min. Elsewhere in the Kaibito area, wells generally yield less than 30 gal/min. Northwest of Kaibito, at least five dry holes have been drilled in the Navajo Sandstone; the holes are from 902 to 1,420 ft deep. Faulting and folding apparently have created an area where the Navajo Sandstone is above the zone of saturation, but water probably occurs in the lower units of the N aquifer. The Navajo Sandstone also is dry in the northeastern part of the Kaibito area near the erosional boundary of the N aquifer. In this area two wells obtain water from the underlying Lukachukai Member of the Wingate Sandstone. The wells are 733 and 858 ft deep, and the water levels are 624 and 759 ft below the land surface. Bail tests indicate that the wells yield 3 and 7 gal/min, respectively.

The chemical quality of the water in the N aquifer does not vary greatly in the two areas. Dissolved-solids concentrations in the water range from 101 to 822 mg/L (milligrams per liter) but generally are less than 300 mg/L. The Kayenta Formation probably contributes water to well 1T-516 in the northern part of the Tuba City area. The water from the well has a higher dissolved-solids concentration than that from other wells in the areas. The water contains more than 500 mg/L of dissolved solids, which is the proposed secondary maximum contaminant level for dissolved solids in public water supplies (U.S. Environmental Protection Agency, 1977, p. 17146). The specific conductance varies with the concentration of ions in solution and is an indication of the dissolved-solids concentration in the water. The dissolved-solids values may be estimated by multiplying the specific conductance by 0.6, which is the average ratio of dissolved solids to specific conductance in the areas. Calcium and bicarbonate are the dominant ions in water in the N aquifer; sodium and chloride are the dominant ions in the water from the well that probably obtains some water from the Kayenta Formation. The fluoride concentration in water from the N aquifer ranges from 0 to 0.6 mg/L. The maximum contaminant level for fluoride in public water supplies differs according to the annual average maximum daily air temperature (Bureau of Water Quality Control, 1978, p. 6). In the Kaibito and Tuba City areas the annual average maximum daily air temperature is about 69°F, and the maximum contaminant level for fluoride is 1.8 mg/L.

Along some of the valleys in the Kaibito and Tuba City areas, the alluvium yields water to many shallow dug wells. Most of the dug wells are less than 20 ft deep, and water levels generally range from 5 to 15 ft below the land surface. Water levels in the dug wells fluctuate seasonally, and the wells often go dry during part of the year. Dissolved-solids concentrations in water from the alluvium usually are less than 600 mg/L, and calcium and bicarbonate are the dominant ions.

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BASE FROM U.S. GEOLOGICAL SURVEY
MARBLE CANYON 1:250,000, 1956-63

MAP SHOWING GROUND-WATER CONDITIONS IN THE KAIBITO AND TUBA CITY AREAS, COCONINO AND NAVAJO COUNTIES, ARIZONA—1978

By
C. D. Farrar