ARIZONA DEPARTMENT OF WATER RESOURCES

Maps Showing Groundwater Conditions in the Southern Navajo County, Arizona: April - August 2001

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By

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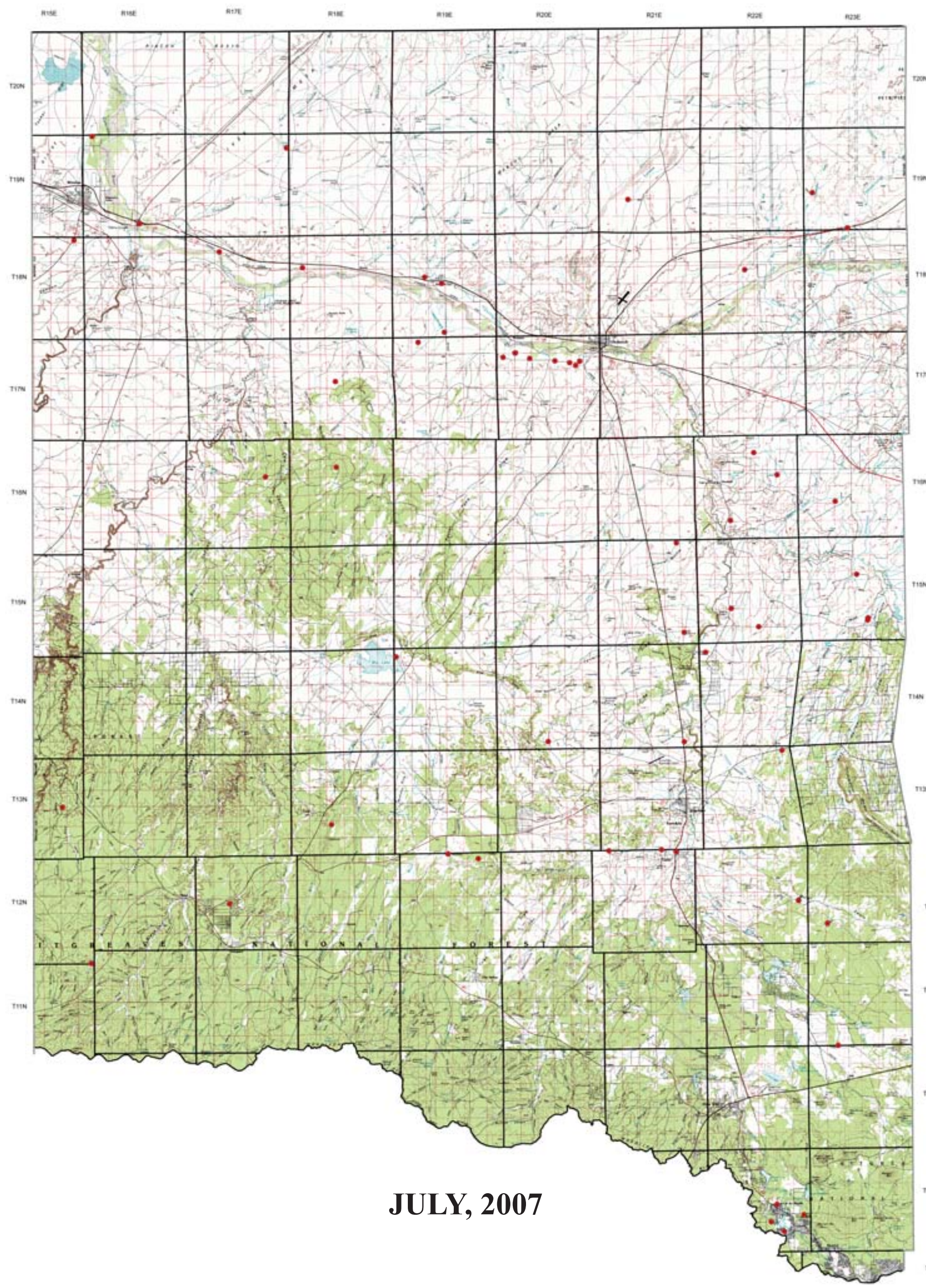

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Introduction

Southern Navajo County is located in the northeastern portion of the state roughly halfway between Flagstaff and New Mexico. It is bounded by Apache County on the east, Coconino County on the west, the Navajo Nation to the north and the Mogollon Rim to the south. It is roughly rectangular in shape measuring about 76 miles north to south by 51 miles east to west with an approximate area of 3,900 square miles and wholly drained by the Little Colorado River and it's tributaries.

Total relief is about 2,500 feet with four distinctive vegetative zones. Alpine forests, principally Ponderosa Pine, crown the highest elevations (7,500 feet) along the Rim. As elevation drops toward the north the landscape transitions to pinion juniper parkland starting around 5,500 to 5,600 feet, followed by highland savanna grasslands and finally high desert at about 5,000 feet. Topography also varies from moderate to steep rugged hills in the south to a more gently rolling landscape in the central part of the county and finally to nearly flat lying plains with wide vistas, promontory buttes and deep narrow canyons of the Little Colorado River valley.

Climate is a function of relief. Precipitation typically ranges from 20 - 30 inches in the Rim country and progressively drops to as little as 8 inches in the north (see Precipitation Map, this sheet). Conversely, average annual temperatures are lower in the south, about 49°F at Heber, and higher in the north, about 56°F at Winslow (Sellers and others, 1985).

Geology

Southern Navajo County lies in the south central portion of the Colorado Plateau physiographic province of the western United States (Hunt, 1967) and is composed of thick sequences of Paleozoic (Permian) marine and eolian sediments. Layers of Triassic and Cretaceous sediments of Mesozoic age overlie these sequences, which are in turn, further overlain by Tertiary sediments and Quaternary volcanic materials. Finally, the drainage channels, which overlay and progressively cut into the preceding layers, are lined with Quaternary alluvium.

The hydrologically significant Permian formations in ascending order are the Supai Group, Coconino Sandstone and Kaibab Formation. These three formations constitute the most important geologic units from a hydrologic standpoint in that they form the basement, host and confining parameters of the regional aquifer. The upper two formations crop out extensively south of the Little Colorado River but are contrasted by composition and thickness. The white chalky limestone member of the Kaibab Formation and its thinness (seldom more than a few tens of feet, except in the Heber area), contrasts easily with the thick and sandy Coconino. As a result, the contact between the Kaibab and the Coconino is quite clear and locally observable. The contact between the Coconino and the Supai is less clear. Both the lower strata of the Coconino and the upper strata of the Supai, the Schnebly Hill Formation, are composed of noncalcareous and petrographically similar sandstones. The contact between these units form a transition zone of gradation and intertonguing marked by subtle changes in stratification style and color (Blakey, 1990). Lower siltstone beds of the Supai Group prevent downward hydrologic drainage (Mann, 1976).

Most of the Mesozoic Era formations consist of soft shale and sandstones and were eroded away in response to the regional uplifting of the Colorado Plateau during the Cenozoic (Cooley and Akers, 1961). The exceptions being along the highlands of the Mogollon Rim where Upper Cretaceous and Tertiary sediments overlay tilted Triassic and Permian beds and north of the Little Colorado River, where the Chinle and Moenkopi Formations overlay the Coconino Sandstone. Only the lower Triassic formations remain and crop out extensively, the Moenkopi south of the Little Colorado River and the Chinle and to a lesser extent the Shinarump Conglomerate to the north (Peirce and others, 1970), (see Geology Map, sheet 2). They are characterized by varying colored bands of sandstones, siltstones, shales, mudstones and conglomerate beds. Additionally, lenses of volcanic ash (bentonite), gypsum and halites give the terraces of the Little Colorado River valley their badlands look, otherwise known as the Painted Desert.

By the early Tertiary, the final and uppermost deposits of the Mogollon Rim, the rim gravels, overlaid the already partially eroded surface of the upper Cretaceous formations. The mid to late Tertiary period was marked by cycles of erosion and deposition in response to the differential on again off again uplifting of the Colorado Plateau (Childes, 1948; Hunt, 1956; Cooley and Akers, 1961). During uplifting phases of the cycle, the ancestral Little Colorado River entrenched itself into the soft Mesozoic materials. As uplifting slowed and ceased these materials were re-deposited to form broad river terraces and plains. When uplift resumed the river system would shift course in response to the altered landscape and begin new entrenchments or resumed canyon cutting in more established drainage features. By the end of the Tertiary the course of Little Colorado River and its tributaries had become established in its present position.

Structural Geology - Several important structural features are present in the study area. They include the Mogollon slope, the Holbrook Anticline, internal drainage sub-basins and solution collapse structures. The Mogollon slope is a regional northeast-trending downwarp structural dip between the crest of the Mogollon Rim and beyond the Little Colorado River. Its saucer like shape extends laterally into the adjoining parts of southern Coconino and Apache Counties and has a pronounced influence on the drainage patterns of both surface and ground water.

The Holbrook Anticline is about half way between the Mogollon Rim and the Little Colorado River (see Geology Map, sheet 2). This asymmetrical flexure interrupts the otherwise nearly flat sloping landscape and runs almost the entire east-west length of the county. It is characterized by a steep south limb and a long, gently sloping north limb. This dramatic asymmetry is easily recognizable along State Route 377 as it ascends the Pink Cliffs just east of Dry Lake. East of Snowflake the anticline becomes almost indistinguishable from the rest of the rolling topography formed by minor warping, buckling and faulting. While the anticline and similar structural features are considered to be about the same age as the Mogollon slope - late Cretaceous to early Tertiary (Akers, 1964), the exact mechanics of the formation of the anticline are a matter of some debate (Martinez and others, 1998; Neal and Johnson, 2001). What is clear, however, is that the displacement of the surface and subsurface has profoundly altered the ancient surface water drainage pattern (Bahr, 1962) and groundwater quality (Peirce, and Gerrard, 1966).

There are two rather large internal drainage features in the study area. They are locally known as Dry Lake and Long Lake internal drainage areas (see Geology Map, sheet 2) and can be divided into 2 classes respectively: 1) solution collapse structures and 2) basalt depressions.

The Dry Lake area is a solution collapse structure resulting from the dissolution of the uppermost members of the Schnebly Hill Formation, which underlies the Coconino Sandstone (Neal and Johnson, 2001). Southern Navajo County is underlain by the very thick (1,200-3,200 feet) limestones and sandstones of the Supai Formation (Conley, 1977), now named and upgraded to the Supai Group (Blakey, 1990). The upper 400 – 500 feet is locally composed of large evaporates assemblages, principally gypsum, halite (rock-salt) and anhydrite (Peirce and Gerrard, 1966). At least since the Late Cenozoic (Pliocene?) these evaporate beds have been undergoing dissolution resulting in the formation of karst features (Neal and Johnson, 2001). The source of the ground water was most likely percolation from lacustrine ponding south of the axis of the Holbrook anticline. Pluvial stages of the Pleistocene Epoch accelerated and intensified the dissolution process. Eventually the weight of the overlying Coconino Sandstone collapsed into the voids created by the dissolution process and formed an internal drainage basin at land surface.

The most prominent topographical feature that developed from this process was the formation of a subsidence trough known as Dry Lake Valley (also known as Zeniff or Dry Lake Syncline). It is located roughly 20 miles west-northwest of Snowflake, is about 12 miles long on the south side of the Holbrook anticline, and has an internal drainage area of some 140 square miles. In and around the Dry Lake area numerous sinkholes pockmark the landscape. These surface sinkholes have been formed in the recent past. Much older sinkholes are filled in with alluvium and lay just beneath the surface. The sinkholes are only partially the result of secondary collapsing of the thin limestone member of the Kaibab Formation onto the previously collapsed Coconino sandstone. Additional ongoing geological processes associated with regional extension appear to be, at least in part, responsible for the continued sinkhole formation (Bahr, 1962; Neal and Johnson, 2001).

The Long Lake area is an internal drainage system composed of numerous but relatively small basalt depressions. It is located in the southeastern corner of the study area where Cretaceous and Tertiary sediments are overlain by Quaternary lava flows of the White Mountain volcanic field. Most of the depressions alternate between dry playas and small ponds or lakes depending on the level of seasonal precipitation. Long Lake is the largest of these features and has a surface area of perhaps as much as a square mile at its greatest extent. The smaller pools have surface areas of only a few acres with a drainage area of a square mile or less (U. S. Geological Survey, 1970, 1971).

Groundwater Occurrence

The Coconino aquifer is the principal source of groundwater in Navajo County and underlies the entire study area. The aquifer gets its name from the host rock, the Coconino sandstone and is now referred to as the C aquifer in this study in keeping with conventional nomenclature (Cooley and others, 1969).

Just below the Mogollon Rim on highways 260 west of Heber and 60 south of Show Low the Coconino Sandstone is mapped at about 500 feet thick (Moore and others, 1960; Wilson and others, 1959; Wilson and others, 1960). Roughly 50 wells drilled through the entire Coconino Sandstone in Navajo County have logs on file at the Arizona Department of Water Resources (ADWR). These logs indicate that the Coconino Sandstone ranges in thickness from less than 100 feet to almost 900 feet (see Geology Map, sheet 2) and is most commonly found in the form of white, medium grained, frosted quartz sand although color varies widely. Strata cohesion varies from un-cemented free flowing sand to tightly cemented layers.

The C aquifer occurs under both confined and unconfined conditions (see map, this sheet). The aquifer is confined – sometimes referred to as under hydrostatic, potentiometric or artesian conditions - where the Coconino sandstone is fully saturated and overlain by an impermeable layer, usually the limestone unit of the Kaibab Formation or tightly cemented sandstone or shales of the Moenkopi Formation. Confining conditions generally occur from just south of the Little Colorado River and northward. It is also confined in the Snowflake – Taylor area from south of the Holbrook anticline and southeast toward the Apache County line.

There are localized exceptions in both confined areas where upward leakage occurs depending on the degree of fracturing or composition of the Kaibab and or Moenkopi Formations. The boundary between the confined and unconfined areas shown on the map (this sheet) is only an approximation. The actual state of the aquifer may vary slightly on either side of the line depending on local geological conditions and the aquifers' seasonal degree of saturation.

The aquifer is unconfined or under water-table conditions, where the upper portion of the Coconino sandstone is not fully saturated or where a confining layer is absent or is highly fractured. It is also unconfined where the Coconino Sandstone crops out or is overlain by non-confining strata. In the Heber area and along the Mogollon Rim (see sheet 2) the Coconino Sandstone is relatively thin and the upper sandstones of the underlying Supai Group are the primary water bearing units. The upper part of the Supai Group is also the primary water-bearing unit just north of the Holbrook Anticline where the upwarped Coconino Sandstone is dry or nearly dry (see Cross-section, sheet 6).

The water-bearing capacity of the aquifer depends on a number of local geologic factors. Among them are regional uplift, nearby volcanic and solution collapse activity, as well as the degree of cementation, minor faulting and low amplitude warping. These processes have contributed to widely varied fracturing and breakage of the Coconino Sandstone (Hart and others, 2002). As a result the degree of permeability - and in turn well yields - varies directly with the degree to which the water-bearing zone is fractured and broken.

There are several localized water-bearing zones in southern Navajo County. The largest and most productive of them is the Pinetop-Lakeside aquifer. Water-bearing zones also occur in the Moenkopi Formation, the Chinle Formation and stream channel alluvium (see sheet 3).

The Pinetop-Lakeside aquifer (see sheet 4) is a small body of groundwater covering an area of a little more than 16 square miles. It is composed of 2 distinctive but closely spaced and hydrologically well-connected water-bearing zones: a primary zone of upper Cretaceous rocks and a smaller, younger zone of Quaternary volcanic rocks. The host material for the primary water-bearing zone is clearly of upper Cretaceous age as is demonstrated by frequent shows of coal seams noted in drillers' logs. Additionally, this water-bearing zone(s) is composed of sand and sandstone perched between layers of coal, shale and clay, mostly in an unconfined condition. The volcanic water-bearing rocks are located on the eastern end of the Pinetop-Lake-side aquifer, cover an area of less than 6 square miles, appear to function as a separate water- bear-ing zone perched on clay lenses and completely under water-table conditions. As the water-bearing zone moves down gradient in a generally westerly direction the volcanic rocks onlap with the Cretaceous rocks in Section 10, Township 8 North, Range 23 East. Further to the west wells encounter both the volcanic and

Cretaceous rocks that are partly to fully saturated, hydraulically connected and function as a single water-bearing zone.

Insufficient water-level data has been collected from a single water-year to develop a complete picture of the Pinetop-Lakeside aquifer. However, water-level data from drillers' logs are sufficient to allow generalized mapping of the spatial extent and depth of the aquifer (sheet 4). The contours represent a composite of water-level data derived from drillers' logs over the last twenty-five years and depict a long-term conceptual image of the groundwater flow system rather than a traditional snapshot in time of water level contours based on a single water-year. More importantly it shows the relationship between the volcanic and Cretaceous water-bearing rocks of the Pinetop-Lakeside aquifer and the deeper C aquifer. For clarity only selected data points are displayed.

Drillers logs also indicate a cluster of wells drilled into water-bearing Cretaceous materials. These wells are shown on the Minor Aquifers Map (sheet 3) and located around the White Mountain Lake area in Township 11 North, Range 22 East. Similarly, wells have been drilled into water-bearing volcanic material east of State Route 77 in the White Mountain Lakes area and eastward toward the Apache County line and southward toward the Pinetop-Lakeside area. (See volcanic well points on the Minor Aquifers Map, sheet 3).

The water-bearing zones of the Moenkopi Formation are not a single body of groundwater but an assemblage of unevenly dispersed small zones of groundwater perched on shale or clay seams within the formation. Informally called 'top water' by local drillers, these perched water-bearing zones were (and still are) an important source of stockwater to ranchers before the advent of more advanced drilling equipment that allowed access to the deeper C aquifer. Currently, ADWR requires drillers to seal off these small zones of groundwater to prevent them from leaking into and degrading the quality of the C aquifer (ADWR, 2003). Water-bearing sandstones of the Chinle Formation consist of a few small zones of perched water. Wells that tap these zones are few in number as the water is poor in quality and yield little water. They are located along the northern part of the study area. They are usually under confined conditions and water levels in these wells rise to less than 100 feet below land surface (Akers, 1964).

North of the Little Colorado River the drainage pattern changes. Unlike the deep canyons in the tributaries south of the Little Colorado River, the tributaries on the north side of the river are wider and only slightly incised into the landscape. This is because the slopes of the drainage channels have a much lesser gradient than those of the Mogollon slope. As a result, water-bearing zones can occur in washes where large quantities of unconsolidated alluvial material have accumulated to a thickness sufficient enough to yield water to wells. These zones occur where fine-grained sediments, that prevent downward leakage, underlie the alluvium. Most of these water-bearing zones are small and seasonally dependent on precipitation runoff. The principal tributaries of the Little Colorado River with wells tapping the alluvial water-bearing zones are the Puerco River, Leroux Wash and Cottonwood Wash.

Recharge and Discharge

Aquifers and water-bearing zones of southern Navajo county are recharged by direct infiltration of precipitation, snowmelt, and runoff, by downward leakage from overlying groundwater-flow systems or by underflow from outside the study area. Precipitation in the study area is slightly greater in the winter than in the summer (Sellers and others, 1985). However, most of the recharge potential occurs in the winter and spring months when evapotranspiration rates are lowest. Discharge of groundwater from the study area occurs as downward leakage and underflow, base stream flow, evapotranspiration and spring flows. Groundwater withdrawal from well pumping also constitutes a means of discharge.

Direct recharge to the groundwater flow systems that overly the C aquifer occurs primarily from precipitation in the form of snowmelt during the winter and spring and intense monsoon thunderstorms in the summer. Direct recharge to the C aquifer from precipitation and runoff occurs in areas such as Fools Hollow and Dry Lake where the Kaibab Formation is extremely fractured and broken or where the formation does not exist. Recharge to the C aquifer also takes place from the overlying groundwater flow systems and the internal drainage areas in the form of downward leakage. Recharge, in the form of underflow, enters the study area from saturated parts of the C aquifer from the east and from the southwest along Chevelon and Clear Creeks (Mann, 1976).

Discharge occurs as underflow out of the study area across the northern boundary line into the Navajo Nation. Discharge also occurs as downward leakage through fractures in the lower Supai basement rocks and ultimately discharges at Blue Springs, located about 13 miles upstream from the mouth of the Little Colorado River. Stream flow discharge occurs where down cutting near the mouths of Clear Creek, Chevelon Canyon Creek and Silver Creek has intersected with the top of the water table (Harrel and Eckel, 1939; Hart and others, 2002).

Potentiometric pressure, in the form of upward leakage, discharges water through fractures in the confining Moenkopi formation along the Little Colorado River near Holbrook and along Silver Creek near Snowflake (ADWR, 1989, a and b). Evapotransporation from phreatophytes constitutes another means of discharge where the water table is at or near the land surface along stream channels.

The Silver Springs complex near the headwaters of Silver Creek is the most significant spring discharge in the Mogollon Rim area from volcanic water bearing rocks. The Mogollon Rim is an approximate groundwater divide. Springs on the south slope of the rim below about 6,100 feet elevation, and 6,400 feet south of the rim in the Heber area, probably discharge from the C aquifer while springs above those altitudes probably discharge from the Pinetop-Lakeside aquifer.

Groundwater Movement

The contour lines on the Map Showing Groundwater Conditions in the C aquifer (this sheet) show the approximate altitude of the top of the C aquifer above mean sea level where the aquifer is under water table conditions (unconfined) and the top of the potentiometric surface where the aquifer is confined. The arrows indicate the direction of flow of the aquifer. Groundwater movement is generally from south to north and reflects the overall surface gradient of the Mogollon slope. From Range 21 East to the eastern county line groundwater flows in a north-northwesterly direction. As it approaches the Little Colorado River the direction of flow changes to the west beginning at the lower end of Township 15 North. This is the result of a small structural trough, named the St. Johns Sag by Cooley and others (1969), that extends roughly from west of St. Johns, in Apache County and across the county line toward Holbrook (Akers, 1964; Mann, 1977; Conley, 1977).

West of Range 21 East groundwater flows in a north-northeasterly direction. As the groundwater passes beneath the Holbrook Anticline in the vicinity of Dry Lake its direction is modified slightly into a radial configuration before returning to a northward trend just south of the Little Colorado River. As the flow of the aquifer passes under the river it moves to a north-northwesterly direction along the entire width of the county. It is of interest to note that groundwater from the C aquifer and groundwater in alluvium of the Little Colorado River flow perpendicular to each other between Holbrook and Winslow. Groundwater from the C aquifer flows northward as it passes under the Little Colorado River, while groundwater in the Alluvium of the river moves from east to west. A thin wedge of the Moenkopi formation separates the two bodies of water.

Cooley and Akers (1961) indicate that the top of the water table may be as much as 100 feet higher than it was at the end of the Pleistocene. This infers that the total amount of water in storage fluctuates in response to long-term geological processes.

Water Levels and Changes

ADWR staff collected over 400 water levels in the spring and summer of 2001, with over 300 from the C aquifer, a few dozen in the Pinetop-Lakeside aquifer and the water-bearing streambed alluvium and a handful from the water-bearing zones of the Moenkopi Formation. Water levels for the C aquifer are shown on sheet 1. This map shows water levels in the C aquifer range from near zero along the Winslow – Holbrook corridor where many wells were previously flowing artesian wells, to over 1,000 feet below land surface (bls) in Pinetop.

Water levels along the Mogollon Rim area vary between communities. Water levels in the Heber – Overgaard area are 500 to 600 feet bls and in the outlying Heber area range from 400 to near 900 feet bls. In the

Linden area water levels range from just over 100 feet to just over 300 feet bls and in the Show Low area water levels range from just over 400 to near 600 feet bls. Potentiometric water levels in wells range from less than 100 feet to just over 200 feet bls in the Snowflake – Taylor and Hay Hollow areas. Around Dry Lake, water levels range from 400 feet bls to about 550 feet bls. To the west of Dry Lake water levels are even deeper, ranging from the mid 600's to over 900 feet bls.

About 100 of the wells where water level data was collected in 2001 have multiple water levels. The US Geological Survey (USGS) originally measured these wells between the early 1950's and 1970's. These wells and the change in water level in feet are shown on sheet 5.

Wells with a water level decline are shown in red, while wells where the water level has risen are shown in blue. These wells are also listed in table form to the right of the map. The Rate of Change in water levels is achieved by dividing total feet of change by time in years. This allows all the wells on the table to be grouped and compared on an equal basis in terms of how much the water level in any given well has risen or fallen on average per year over a long period of time.

The water levels in wells are also categorized by similar rates of water level rise or fall. For purposes of comparison wells with a rate of change of 3″ (0.25′) or less are considered to have a negligible rate of change. Well rates of change between 3″ (0.25′) and 9″ (0.75′) per year or less are categorized as low. Well rates of change between 9″ (0.75′) and 1′-3″ (1.25′) per year are labeled medium and rates of change greater than 1′-3″ are considered high.

About a dozen wells have an almost continuous annual water level measurement record. These water levels are shown in the form of hydrographs and are also shown on sheet 5. A similar table summarizing the average long-term rate of change for the hydrographs is shown.

In summary, 25 wells showed a negligible decline while 17 showed a negligible rise; 21 showed a low rate of decline while 11 showed a low rate of rise; 13 showed a moderate rate of decline while 2 showed a moderate rate of rise and finally, 2 wells showed a high rate of decline while 1 showed a high rate of rise. In total, 61 wells had water level declines and 31 wells had a rise in water levels.

Water Quality

Beginning in 1992 ADWR started collecting groundwater quality samples from wells in southern Navajo County. A total of 57 detailed analyses were obtained from these samples. These analyses are displayed in the form of Stiff diagrams on sheet 6. Stiff diagrams represent the ionic content of the samples and are used to compare and contrast groundwater water quality from place to place. The left side of the Stiff diagram represents the cationic values (+) for sodium, calcium and magnesium while the right side represents the anionic values (-) for chloride, bicarbonate (expressed as total alkalinity) and sulfate. The Stiff diagram well points are also color coded to identify the geologic formation from which the sample was obtained. Specific conductance and fluoride values are also displayed next to the well point. Water samples from some wells were tested for conductance values only.

Specific conductance is an indirect way of measuring the amount of dissolved solids in water. Dissolved solids can be approximated by multiplying specific conductance values by 0.66, which is the approximate ratio of dissolved solids in mg/l (milligrams per liter) to specific conductance in microsiemens per centimeter (μS/cm) at 25 °C. The Environmental Protection Agency (1988) has established a secondary maximum contaminate level (SMCL) for dissolved solids at 500mg/l, which is the approximate equivalent to a specific conductance value of 833 µS/cm. Secondary levels are based on aesthetic qualities such as taste, odor and color and are only guidelines, not enforceable standards.

Specific conductance levels ranged from a very low 168 µS/cm to 339 µS/cm in the volcanic member of the Pinetop-Lakeside aquifer. The specific conductance value from the Cretaceous unit was 301 µS/cm. Values between Pinetop and Show Low in the C aquifer ranged from 220 – 550 µS/cm. Similar values were found in the Heber area, eastward toward Silver Creek and down gradient towards Snowflake. North of Snowflake and from the Hay Hollow area down into the Little Colorado River valley, conductance values increased above the 833 µS/cm level. This area is mostly where the aquifer is confined. Akers (1964)suggests that the higher conductance values are the result of upward leakage via hydrostatic pressure from the highly mineralized water of the underlying Supai Group.

Conductance values above 833 µS/cm were also found along the front of and the back slope of the Holbrook Anticline. Here the highly mineralized Supai Group is situated at or near the top of the water table (Cross-section A-A'). The aquifer is unconfined in this area and the upwarping of the anticline has displaced both the Coconino Sandstone and the Supai Group on the backside or northern limb of the anticline such that the top of the water table is near the contact between the bottom of the Coconino and the top of the Supai (Hunt, 1956). Conductance values along the front of the anticline probably fluctuate in response to the cycle of ponding and drainage events associated with the dissolution processes of the collapse structures there.

Fluoride levels in all the aquifers of southern Navajo County were well below the maximum contaminant level of 4 mg/l as set by the Arizona Department of Environmental Quality, (1991) with the highest level measured at a spring issuing from the Chinle Formation at 2.1 mg/l.

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Legal Description of Well Location

The terms *cadastral location* and *legal description* both refer to a method of locating land according to a rectangular coordinate system commonly known as the Public Lands Survey. Much of Arizona has been mapped according to this system. The initial point of reference was arbitrarily chosen as the confluence of the Gila and Salt Rivers. From this initial point, a north-south *meridian*, and an east-west *baseline,* divide the state into four unequal **quadrants** (A, B, C, D). (Baseline Road in Phoenix is named for our state's baseline. See the map below.)

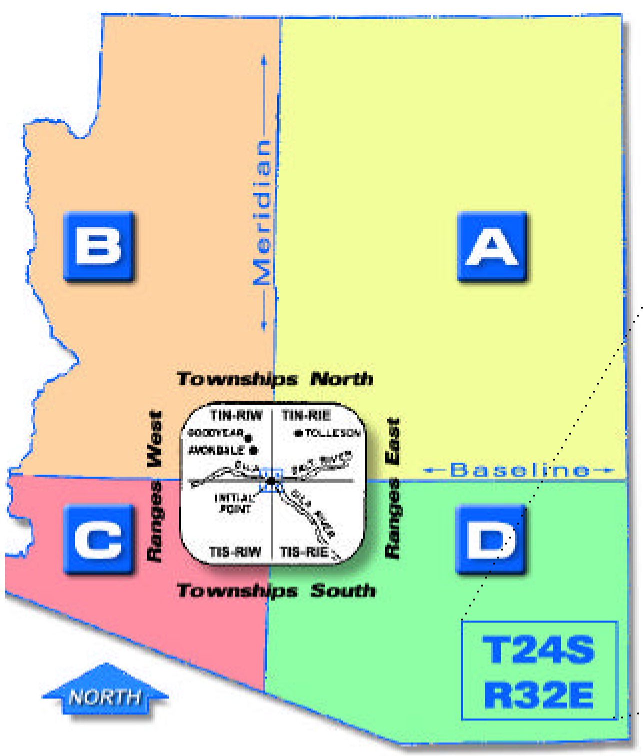
Each quadrant was surveyed and subdivided into congressional *townships*, with each square-shaped township typically six miles on each side, or 36 square miles in all. (Not all townships are exactly the same size due to landform variations and the curvature of the earth.) Beginning at the initial point and the number 1, each township is designated as being so many six-mile units – called **Townships** (capital T) – north or south of the baseline, and so many six-mile units – called **Ranges** – east or west of the meridian. The Township and Range together define a particular township.

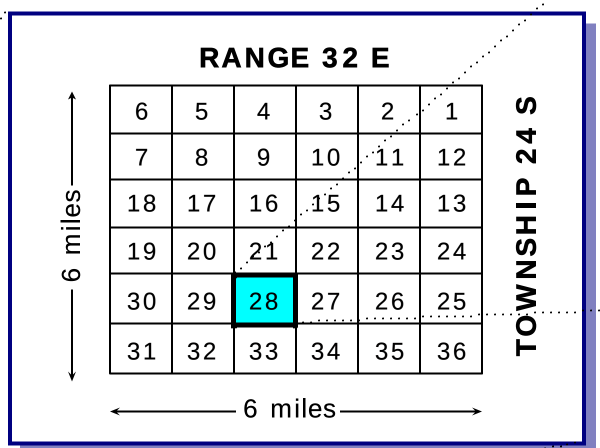
Each township is divided into 36 equal parts called **sections.** Each section is approximately one square mile, about 640 acres. Each 640-acre section can be subdivided into four 160-acre quarters. Each 160-acre quarter is further subdivided into four 40-acre quarters, and each 40-acre quarter is further subdivided into four 10-acre quarters. Each 160-, 40- and 10-acre quarter is designated as the northeast, northwest, southwest, or southeast quarter (a, b, c, d respectively).

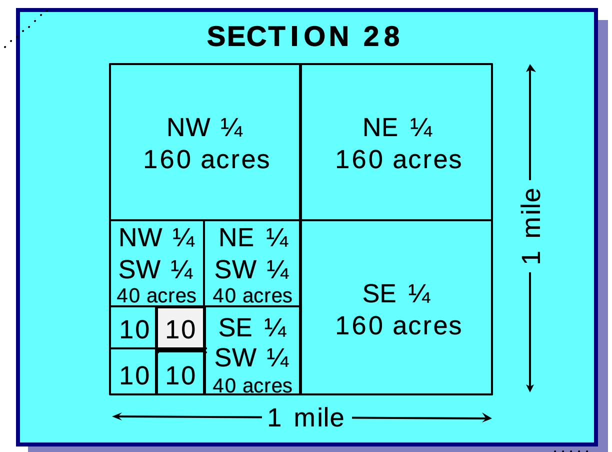
In the example here, the property for a well is in the southeastern-most township in the state, 24 townships south of the baseline, and 32 ranges east of the meridian, i.e., **T24S, R32E**. Within this township, the property lies in Section 28. The 10-acre white area where the well is located is in the southwest 160-acre quarter, then the southwest 40-acre quarter, and finally, the northeast 10-acre quarter. The legal description would be written as follows:

TOWNSHIP (N/S)	RANGE (E/W)	SECTION	160 ACRE	40 ACRE	10 ACRE
24S	32E	28	SW ¼	SW ¼	NE ¼

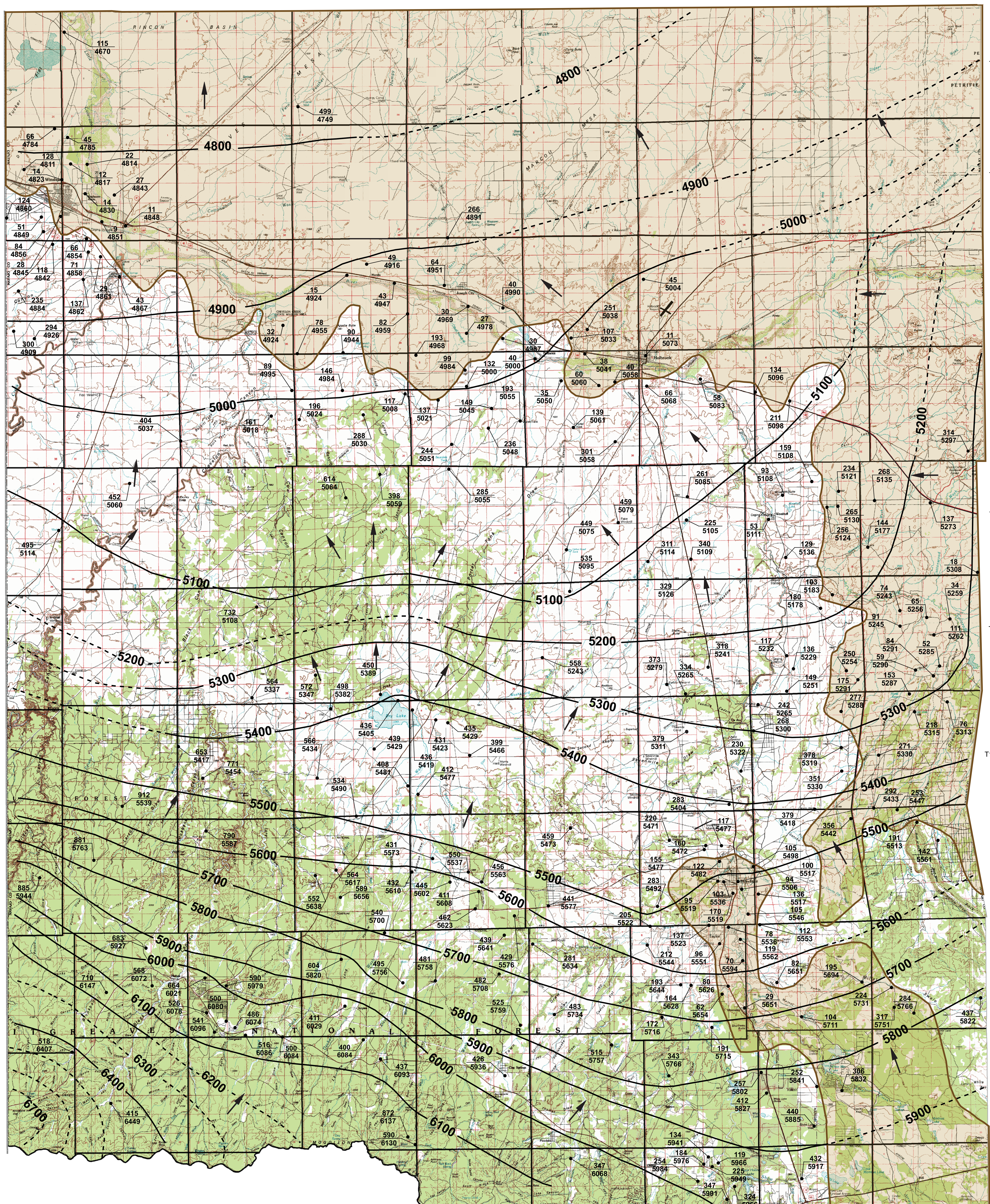
The cadastral location would be written as follows: **D (24-32) 28 cca**







Township and Range data can be found on U.S. Geological Survey maps, and many metropolitan street atlases.



Introduction

Southern Navajo County is located in the northeastern portion of the state roughly halfway between Flagstaff and New Mexico. It is bounded by Apache County on the east, Coconino County on the west, the Navajo Nation to the north and the Mogollon Rim to the south. It is roughly rectangular in shape measuring about 76 miles north to south by 51 miles east to west with an approximate area of 3,900 square miles and wholly drained by the Little Colorado River and it's tributaries.

Total relief is about 2,500 feet with four distinctive vegetative zones. Alpine forests, principally Ponderosa Pine, crown the highest elevations (7,500 feet) along the Rim. As elevation drops toward the north the landscape transitions to pinion juniper parkland starting around 5,500 to 5,600 feet, followed by highland savanna grasslands and finally high desert at about 5,000 feet. Topography also varies from moderate to steep rugged hills in the south to a more gently rolling landscape in the central part of the county and finally to nearly flat lying plains with wide vistas, promontory buttes and deep narrow canyons of the Little Colorado River valley.

Climate is a function of relief. Precipitation typically ranges from 20 - 30 inches in the Rim country and progressively drops to as little as 8 inches in the north (see Precipitation Map, this sheet). Conversely, average annual temperatures are lower in the south, about 49°F at Heber, and higher in the north, about 56°F at Winslow (Sellers and others, 1985).

Geology

Southern Navajo County lies in the south central portion of the Colorado Plateau physiographic province of the western United States (Hunt, 1967) and is composed of thick sequences of Paleozoic (Permian) marine and eolian sediments. Layers of Triassic and Cretaceous sediments of Mesozoic age overlie these sequences, which are in turn, further overlain by Tertiary sediments and Quaternary volcanic materials. Finally, the drainage channels, which overlay and progressively cut into the preceding layers, are lined with Quaternary alluvium.

The hydrologically significant Permian formations in ascending order are the Supai Group, Coconino Sandstone and Kaibab Formation. These three formations constitute the most important geologic units from a hydrologic standpoint in that they form the basement, host and confining parameters of the regional aquifer. The upper two formations crop out extensively south of the Little Colorado River but are contrasted by composition and thickness. The white chalky limestone member of the Kaibab Formation and its thinness (seldom more than a few tens of feet, except in the Heber area), contrasts easily with the thick and sandy Coconino. As a result, the contact between the Kaibab and the Coconino is quite clear and locally observable. The contact between the Coconino and the Supai is less clear. Both the lower strata of the Coconino and the upper strata of the Supai, the Schnebly Hill Formation, are composed of noncalcareous and petrographically similar sandstones. The contact between these units form a transition zone of gradation and intertonguing marked by subtle changes in stratification style and color (Blakey, 1990). Lower siltstone beds of the Supai Group prevent downward hydrologic drainage (Mann, 1976).

Most of the Mesozoic Era formations consist of soft shale and sandstones and were eroded away in response to the regional uplifting of the Colorado Plateau during the Cenozoic (Cooley and Akers, 1961). The exceptions being along the highlands of the Mogollon Rim where Upper Cretaceous and Tertiary sediments overlay tilted Triassic and Permian beds and north of the Little Colorado River, where the Chinle and Moenkopi Formations overlay the Coconino Sandstone. Only the lower Triassic formations remain and crop out extensively, the Moenkopi south of the Little Colorado River and the Chinle and to a lesser extent the Shinarump Conglomerate to the north (Peirce and others, 1970), (see Geology Map, sheet 2). They are characterized by varying colored bands of sandstones, siltstones, shales, mudstones and conglomerate beds. Additionally, lenses of volcanic ash (bentonite), gypsum and halites give the terraces of the Little Colorado River valley their badlands look, otherwise known as the Painted Desert.

By the early Tertiary, the final and uppermost deposits of the Mogollon Rim, the rim gravels, overlaid the already partially eroded surface of the upper Cretaceous formations. The mid to late Tertiary period was marked by cycles of erosion and deposition in response to the differential on again off again uplifting of the Colorado Plateau (Childes, 1948; Hunt, 1956; Cooley and Akers, 1961). During uplifting phases of the cycle, the ancestral Little Colorado River entrenched itself into the soft Mesozoic materials. As uplifting slowed and ceased these materials were re-deposited to form broad river terraces and plains. When uplift resumed the river system would shift course in response to the altered landscape and begin new entrenchments or resumed canyon cutting in more established drainage features. By the end of the Tertiary the course of Little Colorado River and its tributaries had become established in its present position.

Structural Geology - Several important structural features are present in the study area. They include the Mogollon slope, the Holbrook Anticline, internal drainage sub-basins and solution collapse structures. The Mogollon slope is a regional northeast-trending downwarp structural dip between the crest of the Mogollon Rim and beyond the Little Colorado River. Its saucer like shape extends laterally into the adjoining parts of southern Coconino and Apache Counties and has a pronounced influence on the drainage patterns of both surface and ground water.

The Holbrook Anticline is about half way between the Mogollon Rim and the Little Colorado River (see Geology Map, sheet 2). This asymmetrical flexure interrupts the otherwise nearly flat sloping landscape and runs almost the entire east-west length of the county. It is characterized by a steep south limb and a long, gently sloping north limb. This dramatic asymmetry is easily recognizable along State Route 377 as it ascends the Pink Cliffs just east of Dry Lake. East of Snowflake the anticline becomes almost indistinguishable from the rest of the rolling topography formed by minor warping, buckling and faulting. While the anticline and similar structural features are considered to be about the same age as the Mogollon slope - late Cretaceous to early Tertiary (Akers, 1964), the exact mechanics of the formation of the anticline are a matter of some debate (Martinez and others, 1998; Neal and Johnson, 2001). What is clear, however, is that the displacement of the surface and subsurface has profoundly altered the ancient surface water drainage pattern (Bahr, 1962) and groundwater quality (Peirce, and Gerrard, 1966).

There are two rather large internal drainage features in the study area. They are locally known as Dry Lake and Long Lake internal drainage areas (see Geology Map, sheet 2) and can be divided into 2 classes respectively: 1) solution collapse structures and 2) basalt depressions.

The Dry Lake area is a solution collapse structure resulting from the dissolution of the uppermost members of the Schnebly Hill Formation, which underlies the Coconino Sandstone (Neal and Johnson, 2001). Southern Navajo County is underlain by the very thick (1,200-3,200 feet) limestones and sandstones of the Supai Formation (Conley, 1977), now named and upgraded to the Supai Group (Blakey, 1990). The upper 400 – 500 feet is locally composed of large evaporaite assemblages, principally gypsum, halite (rock-salt) and anhydrite (Peirce and Gerrard, 1966). At least since the Late Cenozoic (Pliocene?) these evaporaite beds have been undergoing dissolution resulting in the formation of karst features (Neal and Johnson, 2001). The source of the ground water was most likely percolation from lacustrine ponding south of the axis of the Holbrook anticline. Pluvial stages of the Pleistocene Epoch accelerated and intensified the dissolution process. Eventually the weight of the overlying Coconino Sandstone collapsed into the voids created by the dissolution process and formed an internal drainage basin at land surface.

The most prominent topographical feature that developed from this process was the formation of a subsidence trough known as Dry Lake Valley (also known as Zeniff or Dry Lake Syncline). It is located roughly 20 miles west-northwest of Snowflake, is about 12 miles long on the south side of the Holbrook anticline, and has an internal drainage area of some 140 square miles. In and around the Dry Lake area numerous sinkholes pockmark the landscape. These surface sinkholes have been formed in the recent past. Much older sinkholes are filled in with alluvium and lay just beneath the surface. The sinkholes are only partially the result of secondary collapsing of the thin limestone member of the Kaibab Formation onto the previously collapsed Coconino sandstone. Additional ongoing geological processes associated with regional extension appear to be, at least in part, responsible for the continued sinkhole formation (Bahr, 1962; Neal and Johnson, 2001).

The Long Lake area is an internal drainage system composed of numerous but relatively small basalt depressions. It is located in the southeastern corner of the study area where Cretaceous and Tertiary sediments are overlain by Quaternary lava flows of the White Mountain volcanic field. Most of the depressions alternate between dry playas and small ponds or lakes depending on the level of seasonal precipitation. Long Lake is the largest of these features and has a surface area of perhaps as much as a square mile at its greatest extent. The smaller pools have surface areas of only a few acres with a drainage area of a square mile or less (U. S. Geological Survey, 1970, 1971).

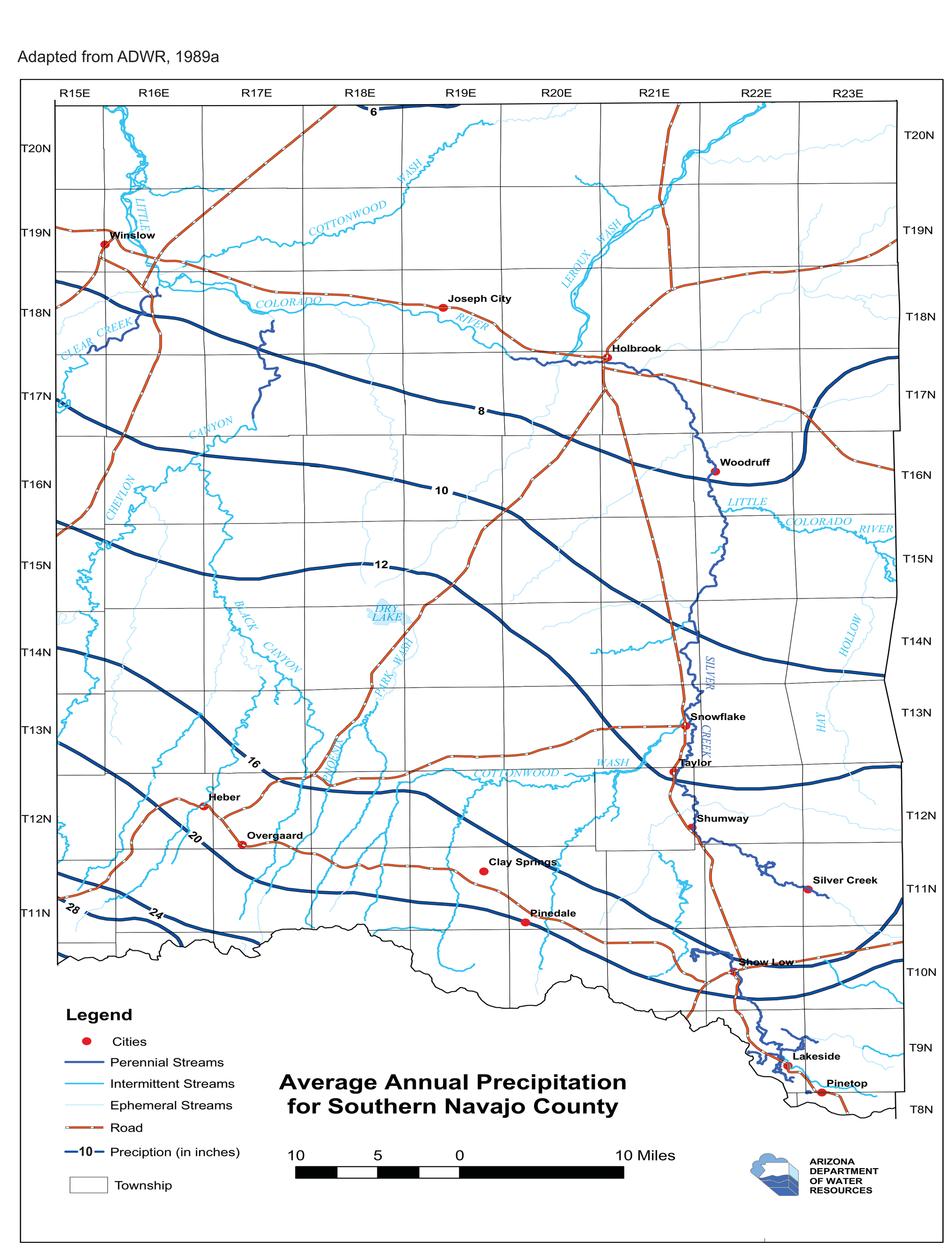
Groundwater Occurrence

Recharge and Discharge

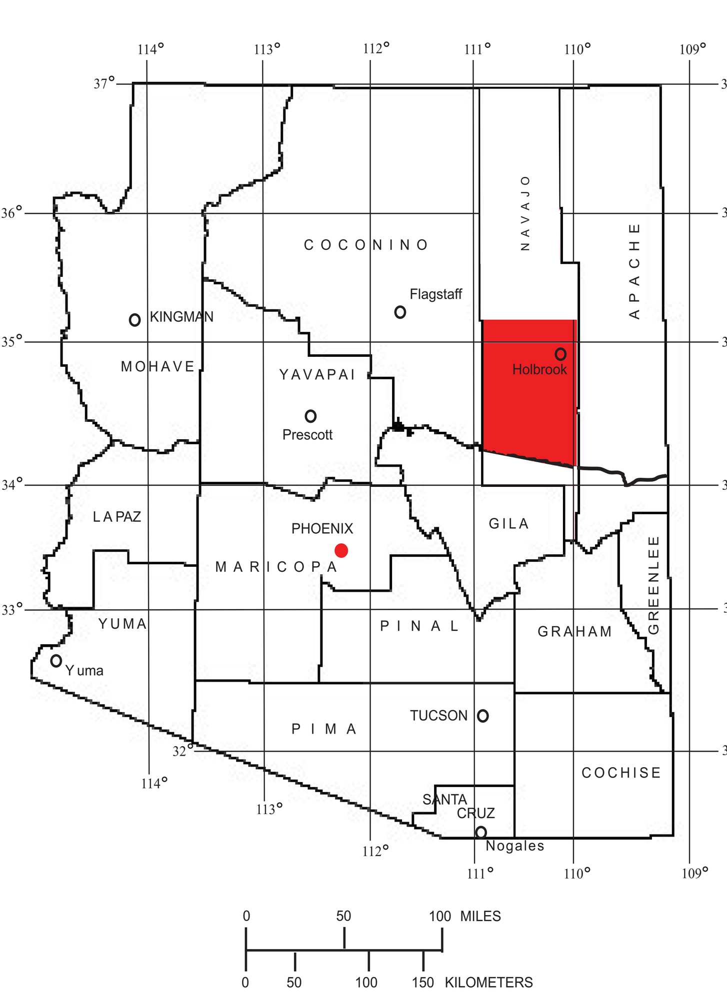
Groundwater Movement

Water Levels and Changes

Text continues on sheet 6


Adapted from ADWR, 1989a

Average Annual Precipitation for Southern Navajo County


INDEX MAP SHOWING AREA OF REPORT (SHADED)

EXPLANATION

415 / 6449 — WELL IN WHICH DEPTH TO WATER WAS MEASURED IN 2001. UPPER NUMBER 415, IS DEPTH TO WATER IN FEET BELOW LAND SURFACE. LOWER NUMBER 6449, IS THE ALTITUDE OF THE WATER LEVEL IN FEET ABOVE MEAN SEA LEVEL.

6400 — WATER LEVEL CONTOUR - SHOWS THE APPROXIMATE ALTITUDE OF THE WATER LEVEL. THE NUMBER 6400 REPRESENTS 6400 FEET ABOVE MEAN SEA LEVEL. DASHED WHERE INFERRED.

SHADED AREA SHOWS APPROXIMATE AREA WHERE THE COCONINO AQUIFER IS IN A CONFINED CONDITION.

GROUNDWATER FLOW DIRECTION

FOR READERS WHO PREFER TO USE METRIC UNITS RATHER THAN INCH-FEET UNITS, THE CONVERSION FACTORS FOR THE TERMS USED IN THIS REPORT ARE LISTED BELOW:

ENGLISH UNITS			METRIC UNITS
1	INCH	25.4	MILLIMETERS
1	FOOT	0.3048	METERS
1	MILE	1.609	KILOMETERS
1	SQUARE MILE	2.59	SQUARE KILOMETERS
1	ACRE-FEET	0.001233	CUBIC HECTOMETERS

SCALE BARS

Map reference: adapted from USGS 1:100,000 Topographic maps for Show Low , Holbrook, St. Johns and Springerville

ADWR BOOKSTORE
Phone: (602) 771-8638
Fax: (602) 771-8690
WEBSITE: www.azwater.gov

MAP SHOWING GROUNDWATER CONDITIONS IN THE COCONINO AQUIFER IN SOUTHERN NAVAJO COUNTY, ARIZONA: APRIL - AUGUST 2001

BY

A. E. OVERBY

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE, 602 771-8638

Southern Navajo Water Level Data

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-08-23 01DCB2	340649109515701	604577.48	3775138.6	6,542	5/16/2001	788	
A-08-23 08ABA	340644109555601	598354.64	3774794.3	6,163	5/1/2001	912	
A-08-23 10BAD2	340629109541501	601073.77	3774515.1	6,107	5/1/2001	1078.1	
A-09-21 01BAC2	341235110041501	585624.28	3785574.5	5,979	5/1/2001	560.9	
A-09-22 04CAD	341213110010101	590569.57	3784974	6,021	7/10/2001	574.3	
A-09-22 05DDC	341155110013801	589627.93	3784410.5	6,029	5/4/2001	611.4	
A-09-22 09DBC	341121110005001	590866.58	3783375	6,045	5/4/2001	555.5	
A-09-22 10BCC	341134110002001	591630.59	3783782.9	6,044	7/11/2001	557.2	
A-09-22 14ADA	341045109582601	594640.23	3782334.1	6,062	5/4/2001	668.5	
A-09-22 15DCB1	341017109594801	592473.61	3781357.6	6,043	4/23/2001	597.1	
A-09-22 25ACC2	340856109574001	595775.55	3778957.2	6,082	5/1/2001	736.4	
A-09-22 26CDA3	340835109585101	593963.73	3778292	6,096	5/1/2001	634.3	
A-09-22 36CCA2	340739109580501	595159.28	3776579	6,099	5/1/2001	661	
A-10-20 04CBB	341733110135701	570635.48	3794659.7	6,068	4/23/2001	347.5	
A-10-21 03CCC	341714110063801	581889.41	3794166.1	5,976	5/1/2001	184.1	
A-10-21 03DDB	341717110054801	583115.82	3794269.4	5,966	4/24/2001	118.6	
A-10-21 10BAA	341706110061001	582607.2	3793956.8	5,949	5/1/2001	225.7	
A-10-21 14CAC	341537110052101	583859.27	3791195.6	5,991	4/23/2001	347.5	
A-10-22 09CBD	341631110011301	590185.69	3792948.6	5,917	4/24/2001	432.3	
A-10-22 20DAD	341445110013401	589731.4	3789648.2	5,978	5/1/2001	421.6	
A-10-22 30ABA	341429110025201	587664.04	3789135.8	5,989	10/17/2000	530.7	
A-10-22 32ACB	341324110015801	589064.43	3787146.7	5,998	5/1/2001	516.7	
A-11-16 20ADB2	342013110392201	531709.1	3799313.4	6,449	5/7/2001	415.8	
A-11-18 11BBC	342210110242501	554530.75	3803084.1	6,093	5/11/2001	437	
A-11-18 36ACB	341835110225501	556844.24	3796475.5	6,137	5/21/2001	872.6	
A-11-18 36DAD	341813110223201	557461.65	3795832.4	6,130	5/11/2001	590.3	
A-11-19 14ABD	342123110173301	565064.26	3801673.1	5,936	10/16/2000	428.6	
A-11-20 02AAD	342244110113901	574087.51	3804266.2	5,757	4/26/2001	515	
A-11-21 17BAC	342118110083001	578936.83	3801656.9	5,766	4/24/2001	343.5	
A-11-22 15ADB	342118109593301	592681.62	3801721.6	5,884	7/12/2001	123.8	
A-11-22 15CCC	342045110002001	591464.71	3800754.6	5,841	7/16/2001	252.6	
A-11-22 18BBD	342126110032201	586752.12	3801941.8	5,802	4/24/2001	257	
A-11-22 19BAD	342028110030701	587202.8	3800190.2	5,827	4/24/2001	412.6	
A-11-22 23BAD	342036109585801	593589.05	3800406	5,832	7/12/2001	306.1	
A-11-22 33AAA	341855111003001	591241.99	3797394.7	5,885	4/24/2001	440.9	

Southern Navajo Water Level Data

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-12-15 36DDC	342231110412801	528425.3	3803645.7	6,407	5/11/2001	518.2	
A-12-16 10ADB	342716110371801	534675.21	3812476	5,927	4/23/2001	683.2	
A-12-16 20DBA	342516110393201	531319.83	3808706.4	6,147	4/26/2001	710.8	
A-12-16 23BCB	342534110370101	535197.63	3809274.6	6,072	5/2/2001	568.4	
A-12-17 18DDB	342554110340501	539661.61	3809939.4	6,021	4/23/2001	664.6	
A-12-17 21BCB	342533110325501	541476.72	3809269.7	5,979	4/27/2001	590.7	
A-12-17 30DAD	342419110340101	539801.86	3806983.1	6,078	4/27/2001	526.9	
A-12-17 32AAD	342356110325601	541464.49	3806281.9	6,080	4/27/2001	500.1	
A-12-17 32CAD	342327110333201	540472.74	3805353.5	6,096	4/23/2001	541.4	
A-12-17 33BDD	342342110322401	542207.45	3805730.8	6,074	4/27/2001	486.3	
A-12-17 34CCC	342317110315201	543104.13	3805088.1	6,086	4/27/2001	516.2	
A-12-19 02DCA	342748110173101	565006.81	3813562.6	5,641	5/8/2001	439.2	
A-12-19 14CDA	342601110174901	564570.44	3810263.7	5,708	5/8/2001	482.2	
A-12-19 20BBB	342545110212001	559163.03	3809704.1	5,758	5/8/2001	481.6	
A-12-19 36CAA	342310110164101	566362.41	3805933	5,759	5/8/2001	525.8	
A-12-20 07ADB	342722110155901	567410.65	3812809.7	5,634	5/10/2001	281.2	
A-12-20 29DDD	342410110144801	569241.16	3806847.3	5,734	5/8/2001	483.2	
A-12-21 01BBB	342805110050801	583984.18	3814238.4	5,536	4/26/2001	78.3	
A-12-21 01DCA	342731110042901	584988.73	3813200.1	5,562	5/3/2001	119.9	
A-12-21 02DCC	342720110053801	583231.21	3812845.4	5,551	4/26/2001	96.6	
A-12-21 06AAA	342809110092801	577349.96	3814304	5,522	4/25/2001	205.9	
A-12-21 06DDC1	342718110093801	577107.86	3812731	5,544	4/25/2001	212.1	
A-12-21 12DDC	342633110042101	585183.7	3811415.2	5,594	4/26/2001	70.6	
A-12-21 21ABB	342528110074901	579943.74	3809366.5	5,644	4/25/2001	193.7	
A-12-21 22BBC	342526110071301	580812.15	3809312.3	5,628	4/26/2001	164.2	
A-12-21 23DBA	342501110053101	583448.2	3808565.5	5,654	5/3/2001	62.1	
A-12-21 24BBC	342523110051101	583952.65	3809247.7	5,626	7/11/2001	80.5	
A-12-21 25ADA	342422110041701	585347.99	3807412.1	5,651	7/16/2001	29	
A-12-21 29DCB	342400110085101	578358.69	3806611.4	5,716	4/26/2001	172.6	
A-12-21 35BCA	342330110060601	582579.56	3805754.5	5,715	5/3/2001	191.1	
A-12-22 24BDD1	342533109574701	595283.78	3809603.2	5,694	5/2/2001	195.7	
A-12-22 33BDB	342357110010801	590181.14	3806656.7	5,711	4/26/2001	104.4	
A-12-22E06BCD	342811110032401	586635.75	3814447.5	5,553	5/3/2001	112.8	
A-12-22E19ADD	342532110022901	588085.26	3809563.1	5,651	10/17/2000	82.3	
A-12-23 20CCB	342515109560901	597790.48	3809136.3	5,731	5/2/2001	224.2	

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-12-23 25ACD2	342444109511401	605331.83	3808263.5	5,822	5/15/2001	437.9	
A-12-23 29CCB UNS	342413109560401	598012.52	3807444.3	5,751	5/2/2001	317.1	
A-12-23 33BBC UNSRV	342404109545601	599677.36	3806969.1	5,766	5/2/2001	284.3	
A-13-15 14DCA	343033110431701	525677.3	3818422.3	5,944	4/25/2001	885.6	
A-13-16 17ABC	343120110401301	530262.28	3819914.6	5,763	4/25/2001	881.8	
A-13-17 05CAA	343239110340001	539761.46	3822383.8	5,587	4/24/2001	790	C
A-13-18 16CCB	343050110264901	550765.31	3819080	5,617	5/1/2001	564.1	
A-13-18 20BBB	343034110275701	549008.41	3818608.6	5,638	5/1/2001	552	
A-13-18 28BAC	342934110263501	551135	3816771.9	5,656	4/26/2001	589	
A-13-19 17BCB	343119110212801	558944.22	3820052.5	5,573	5/9/2001	431.2	
A-13-19 18CCC	343043110223701	557166.57	3818901.6	5,610	4/26/2001	432	
A-13-19 21AAA	343041110192901	561960.48	3818901.6	5,537	5/9/2001	550.6	
A-13-19 21CBB	343015110203101	560410.48	3818059.7	5,602	5/9/2001	445.7	
A-13-19 22DBA	343015110184601	563088.07	3818077.5	5,563	5/10/2001	456.6	
A-13-19 27BAA	342948110185601	562838.69	3817244.1	5,608	5/9/2001	411.1	
A-13-19 27CDC	342901110190801	562542.4	3815794.4	5,623	5/10/2001	462.5	
A-13-19 36BDA	342840110165801	565862.7	3815201.3	5,576	5/10/2001	429.4	
A-13-20 04CDB	343241110135001	570602.13	3822629	5,473	5/1/2001	459.3	
A-13-20 29CCA	342906110150701	568739.05	3816053.8	5,577	5/10/2001	441.3	
A-13-21 08DBB	343205110082301	578971.89	3821587.5	5,471	5/1/2001	220.1	
A-13-21 10CDA	343150110063001	582060.51	3821152.3	5,472	10/17/2000	160.2	
A-13-21 11CDB	343149110052901	583386.44	3821133.3	5,477	5/2/2001	117.9	
A-13-21 13DDD2	343051110034301	586105.32	3819371.4	5,498	5/2/2001	105.73	
A-13-21 14CBD2	343106110053502	583219.87	3819807.2	5,482	5/2/2001	122.4	
A-13-21 15BAB	343140110062601	581936.04	3820812.3	5,477	5/2/2001	155.48	
A-13-21 23CAC	343010110052201	583592.36	3818085.4	5,536	5/2/2001	103.71	
A-13-21 23CBC2	343011110054201	583081.77	3818142.5	5,519	5/2/2001	95.33	
A-13-21 24CCB	343009110043501	584790.94	3818096.3	5,517	10/17/2000	100.75	
A-13-21 25BAB	342950110042301	585102.89	3817452.3	5,506	4/26/2001	94	
A-13-21 26ADB1	342940110045201	584366.37	3817106.7	5,519	4/26/2001	170.8	
A-13-21 30DDD	342901110090301	577973.54	3816003.5	5,492	7/10/2001	283.3	
A-13-21 34DCC1	342812110061201	582324.24	3814408.3	5,523	4/26/2001	137	
A-13-21 36ACC	342841110040301	585632.27	3815362.4	5,546	5/3/2001	105.5	
A-13-22 01ADC	343300109581801	594351.91	3823425.6	5,442	5/4/2001	356.73	
A-13-22 02BBB	343326110001701	591285.2	3824226.7	5,418	5/1/2001	379.3	

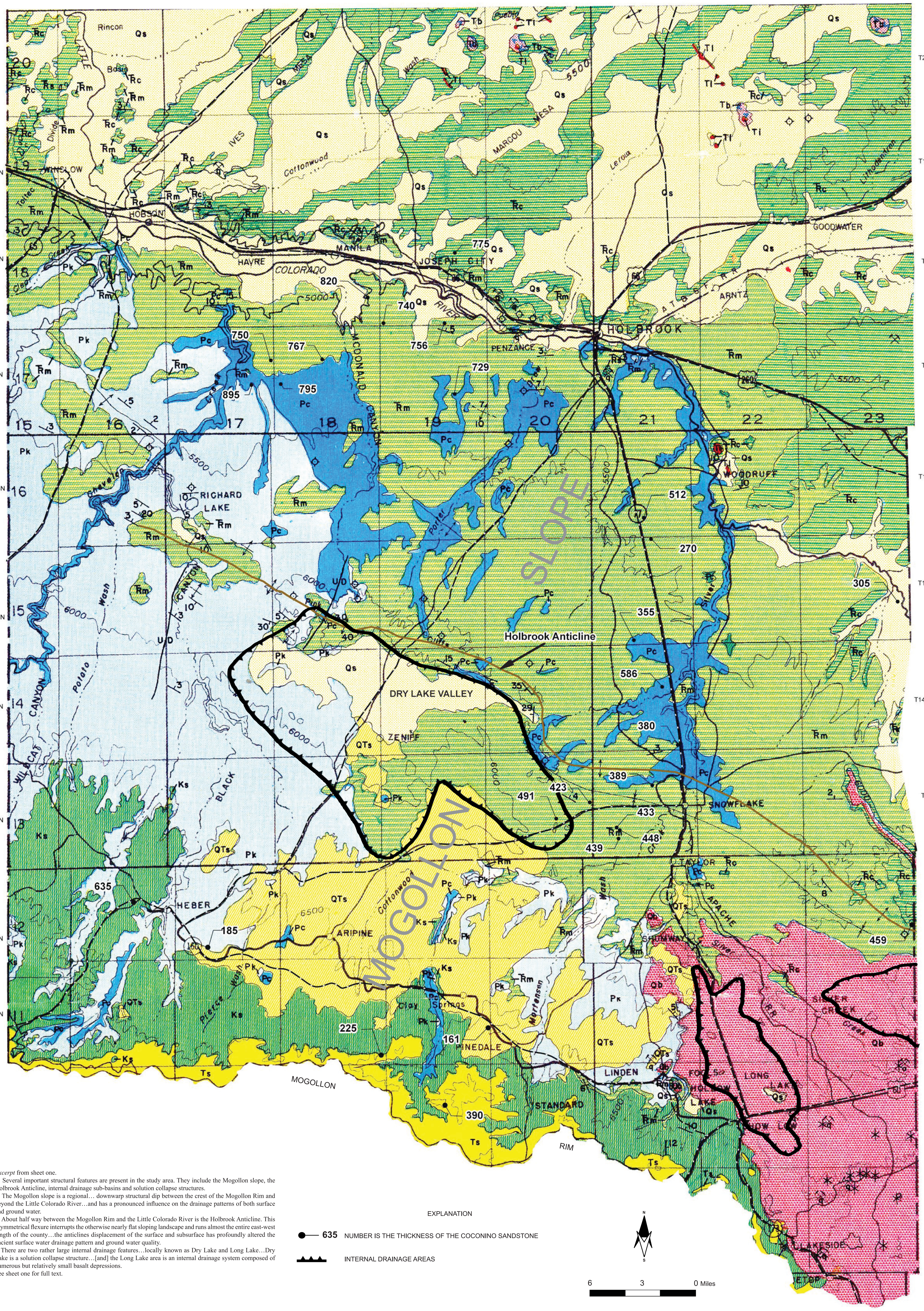
Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-13-22 30BCD	342935110032801	586509.61	3817034	5,517	4/25/2001	136.8	
A-13-23 03CDB	343247109543201	599937.73	3823114.5	5,513	5/4/2001	191.93	
A-13-23 04BBA	343324109554901	598269.52	3824174.9	5,447	5/4/2001	253.5	
A-13-23 11CCA	343158109533001	601713.36	3821593.4	5,561	5/4/2001	142.8	
A-14-16 34BCB	343350110383801	532668.23	3824481.4	5,539	4/24/2001	912.9	
A-14-17 18BBB	343640110353001	537413.14	3829520.2	5,417	4/24/2001	653.3	
A-14-17 20CDB	343504110341001	539487.53	3826849	5,454	4/24/2001	771	
A-14-18 05ADC2	343809110270401	550309.33	3832600	5,382	5/1/2001	498	
A-14-18 14CBB	343622110244001	553994.89	3829324.9	5,429	5/1/2001	439.6	
A-14-18 20CCD	343503110275001	549168.6	3826864.5	5,434	5/1/2001	566.5	
A-14-18 25ADC	343440110224901	556841.31	3826200	5,481	4/26/2001	408	
A-14-18 34CCD	343316110254001	552473.36	3823648.4	5,490	5/1/2001	534.6	
A-14-19 06BCC	343809110223201	557234.6	3832640.3	5,419	5/9/2001	436.1	
A-14-19 08ADA	343733110203501	560220.72	3831550.4	5,429	5/9/2001	435.7	
A-14-19 08BAB	343741110211501	559200.59	3831790.2	5,423	5/9/2001	431.6	
A-14-19 15CCC	343603110192301	562072.71	3828790.3	5,466	5/10/2001	399.3	
A-14-19 18ACA	343637110215201	558270.88	3829812.9	5,491	5/9/2001	354	
A-14-19 30CDD	343416110221501	557711.99	3825496.9	5,477	5/9/2001	412.8	
A-14-21 09DCB	343704110072101	580446.85	3830810.9	5,311	5/3/2001	379.8	
A-14-21 24CDD	343514110042201	585036.53	3827463.4	5,322	5/3/2001	230.9	
A-14-21 35DBD	343342110050301	584042.92	3824651	5,404	5/3/2001	283.8	
A-14-22 02DDB	343755109584701	593520.9	3832505.1	5,288	7/7/2004	277.2	
A-14-22 06BDD	343816110105401	586487.17	3833083.5	5,265	5/1/2001	242.12	
A-14-22 07CCC	343704110033901	586100.46	3830861.9	5,300	5/3/2001	268.9	
A-14-22 13CBC	343616110584801	593526.28	3829455.3	5,298	4/27/2001	399.05	
A-14-22 24CCD	343511109584701	593571.99	3827453.3	5,330	4/27/2001	351.5	
A-14-23 02CBA	343818109525401	602501.41	3833308.9	5,313	4/26/2001	76.7	
A-14-23 03BBB	343844109540801	600608.58	3834089.1	5,307	4/26/2001	171.4	
A-14-23 03DAA	343816109531001	602094.72	3833242.8	5,316	4/26/2001	73.79	
A-14-23 09ABB	343817109544201	599734.81	3832477.6	5,315	4/26/2001	218.5	
A-14-23 19AAD	343610109560701	596691.78	3828810.1	5,330	4/27/2001	271.5	
A-14-23 32CCD	343329109570201	596279.7	3824338.8	5,433	4/27/2001	292	
A-15-17 02CCC	344255110310801	544055.05	3841347	5,108	10/18/2000	732.2	
A-15-18 29CBB	343946110275401	549020.45	3835581	5,347	5/2/2001	572.1	
A-15-18 35CAD	343852110241801	554527.96	3833948.5	5,389	5/9/2001	450.8	

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-15-18 36CDC	343835110232001	556007.63	3833433.7	5,405	5/9/2001	436.2	
A-15-20 04BDD	344332110134601	570550.8	3842682.4	5,095	7/8/2004	535.1	
A-15-20 19DDD	344030110151901	568226.98	3837058.4	5,243	5/3/2001	558.7	
A-15-21 27DAB	343950110061201	582257.62	3836248.7	5,241	7/10/2001	318.8	
A-15-21 32ACB	343914110082601	578757.38	3834801.1	5,279	5/2/2001	373.9	
A-15-21 33DCB2	343848110072401	580342.59	3834013.8	5,265	7/10/2001	334.9	
A-15-22 02CDD	344316110591201	592784.82	3842386.7	5,183	7/12/2001	103.95	
A-15-22 10DAB	344239109595701	591778.76	3841236.7	5,178	4/25/2001	180.4	C
A-15-22 20DDD	344030110014601	588917.1	3837234.6	5,232	7/10/2001	117.55	
A-15-22 26 DDA	343947109582801	593969.57	3835960	5,254	7/12/2001	250.95	
A-15-22 28CAD	343954110012401	589487.74	3836131.1	5,229	7/10/2001	136.3	
A-15-22 32DDA	343852110014801	588920.72	3834215.6	5,251	5/1/2001	149.81	
A-15-22 36ACB	343923109575001	594944.72	3835199.8	5,291	4/25/2001	175.7	
A-15-23 08DDA	344230109552801	598497.52	3841028.8	5,243	4/25/2001	74.9	
A-15-23 14BDA	344207109374101	602728.72	3840335.6	5,259	7/12/2001	34.99	
A-15-23 15BCB	344211109535901	600768.03	3840468	5,256	4/25/2001	65.2	
A-15-23 16AAC	344213109542901	599953.58	3840490	5,232	4/25/2001	73.16	
A-15-23 17DAB	344150109552601	598511.34	3839735.1	5,245	4/25/2001	91.05	
A-15-23 22ABB	344124109533601	601369.44	3838995.9	5,262	4/25/2001	111.88	
A-15-23 27DAC	344003109532401	601856.7	3836351.8	5,285	4/26/2001	52.33	
A-15-23 28DCC1	343950109544001	599823.83	3836021.5	5,297	10/17/2000	54.9	
A-15-23 28DCC2	343950109544002	599823.83	3836021.5	5,290	4/26/2001	59.88	
A-15-23 34AAD2	343938109531501	601939.52	3835767.3	5,294	4/26/2001	56.7	
A-15-23 34ABC	343930109533901	601331.33	3835514.2	5,291	4/26/2001	84.5	
A-16-15 13DAB	344627110420601	527298.66	3847843.1	5,114	8/3/2004	495.9	
A-16-16S03BDD	344835110381001	533282.99	3851805.6	5,060	8/5/2004	452.5	
A-16-18 09ACC1	344757110261201	551583.37	3850596.4	5,064	7/15/2004	614.5	
A-16-18S02BAD	344856110241601	554468.51	3852584.6	5,059	7/15/2004	398.6	
A-16-19 04BBC	344908110202901	560309.13	3853021.5	5,055	5/3/2001	285	
A-16-20 14DDD	344638110110301	574649.45	3848506.1	5,079	7/14/2004	459.8	
A-16-20 28BDB	344527110135501	570269.65	3846192	5,075	7/14/2004	449.3	
A-16-21 09DAD	344749110071201	580502.28	3850681.2	5,085	7/11/2001	261.4	
A-16-21 16DDD	344645110071601	580417.89	3848708.8	5,105	4/23/2001	225.26	
A-16-21 17ABD	344723110083401	578451.56	3849770	5,106	5/3/2001	299.3	
A-16-21 27CCC1	344457110065001	580802.96	3845385.1	5,109	4/30/2001	340.6	

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-16-21 31ABB	344452110092501	577168.28	3845199.9	5,114	7/10/2001	311.5	
A-16-21 33DDD	344403110143501	580741.28	3843721.1	5,126	4/24/2001	329.3	
A-16-22 03CDD	344828110001701	591036.32	3851981	5,108	7/11/2001	159.3	
A-16-22 09CAA	344757110012101	587894.78	3850995.4	5,108	4/24/2001	93.1	
A-16-22 10ADB2	344810109595901	591499.2	3851431.1	5,099	5/2/2001	270.7	
A-16-22 11DAA1	344759109584401	593306.47	3851141.2	5,121	5/2/2001	234	
A-16-22 14ADB	344720109585001	593243.05	3849877.5	5,130	5/2/2001	265	
A-16-22 14BDB	344717109592701	592328.74	3849806.6	5,124	5/2/2001	256.1	
A-16-22 17CBD	344700110023901	580515.51	3849171.8	5,119	4/24/2001	51	
A-16-22 17CCD	344644110024201	587382.24	3848772.4	5,111	10/17/2000	53.7	
A-16-22 28CCC	344457110092101	588836.86	3845551.6	5,136	5/1/2001	129.11	
A-16-23 15BAD	344723109533901	601068.45	3850175.9	5,273	5/2/2001	137.4	
A-16-23 18ABB	344734109564901	596338.81	3850371.5	5,135	5/2/2001	268.1	
A-16-23 30BCD	344526109571301	595769.96	3846422.2	5,177	7/10/2001	144.1	
A-17-16 25DAA	345031110351901	537612.93	3855395.5	5,037	7/16/2001	404.8	
A-17-17 12DDC	345248110290801	547013.48	3859689.9	4,995	4/26/2001	89.6	
A-17-17 23ACA	345139110301701	545272.54	3857524.8	5,018	4/26/2001	161.6	
A-17-18 09CDD	345248110261901	551303.8	3859682.1	4,984	4/26/2001	146.5	
A-17-18 09DCD	345248110260501	551659.2	3859684.1	4,983	4/26/2001	150.7	
A-17-18 13ABD	345238110225001	556611.32	3859405.4	5,008	4/25/2001	117.3	
A-17-18 19BCC	345129110284301	547660.94	3857228.9	5,024	4/26/2001	196	
A-17-18 22ABC	345141110251001	553067.37	3857628.3	5,030	4/25/2001	288.9	
A-17-19 01ADA	345411110161601	566592.82	3862337.4	4,966	4/24/2001	78	
A-17-19 03ACB	345413110184401	562836.34	3862372.5	4,955	4/24/2001	107.3	
A-17-19 04DDC	345340110193001	561675.36	3861409.6	4,984	4/24/2001	99	
A-17-19 06BAB	345424110221301	557530.09	3862676.4	4,968	4/23/2001	193.6	
A-17-19 09DDA	345256110192401	561811.63	3860024.3	5,000	4/24/2001	132.6	
A-17-19 11DDC	345247110172301	564885.19	3859768.3	5,016	4/24/2001	106.6	
A-17-19 14CDC	345154110180101	563931.71	3858159.7	5,045	5/3/2001	149.6	
A-17-19 17BDD	345219110210001	559407.44	3858868.6	5,021	4/25/2001	137.4	
A-17-19 23CCC	345102110181301	563663.97	3856494.4	5,048	4/24/2001	236.1	
A-17-19 24DBA	345117110162601	566351.6	3857098.7	5,055	5/3/2001	193.9	
A-17-19 28CCB	345011110201101	560549.35	3855117.9	5,051	5/3/2001	244.5	
A-17-20 03BBC	345424110125101	571817.73	3862777.4	5,041	4/23/2001	38.9	
A-17-20 05CDD	345340110144101	569036.63	3861369.8	5,039	4/23/2001	9	

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-17-20 06ACB	345414110153601	567607.75	3862375.7	5,000	10/18/2000	40	
A-17-20 08BBB	345336110150101	568504.31	3861273.3	5,028	4/23/2001	34.8	
A-17-20 08DAA	345311110140901	569830.04	3860513.2	5,050	5/3/2001	35.4	
A-17-20 10DDB	345257110120401	573006.49	3860106.7	5,060	4/30/2001	60.5	
A-17-20 11CBD	345304110113601	573665.77	3860204.4	5,037	4/30/2001	40.6	
A-17-20 21CDD	345101110132901	570850.75	3856547.1	5,061	7/12/2001	139.4	
A-17-20 26DBC	345023110111401	574390.67	3855342.9	5,058	3/28/2000	301.8	
A-17-21 06BDB	345418110092701	576971	3862634.5	5,073	4/26/2001	11.5	
A-17-21 07CDC	345254110092401	577068.93	3860047.6	5,068	4/26/2001	66.9	
A-17-21 07DAA	345307110084601	578030.17	3860456.2	5,072	5/2/2001	28	
A-17-21 08DAD	345301110074701	579529.47	3860284.3	5,087	4/26/2001	37.8	
A-17-21 10CBA	345310110062501	581608.03	3860641.5	5,083	2/21/2000	58.1	
A-17-22 17DDB	345212110012901	589165.78	3858801.9	5,098	4/24/2001	211.39	
A-17-22 18BCB	345235110032201	586264.1	3859544.3	5,096	4/26/2001	134.3	
A-18-15 01BAD	345932110422401	526770.25	3872053.1	4,842	5/1/2001	118.2	
A-18-15 11CDC	345759110432801	525155.79	3869152.9	4,883	5/1/2001	227.2	
A-18-15 15DBB	345724110441801	523890.59	3868102.2	4,884	4/30/2001	235.7	
A-18-15 27CAC	345534110443501	523468.15	3864712.7	4,909	5/2/2001	300.9	
A-18-15 35BAA	345514110432501	525220.53	3864070.4	4,926	5/2/2001	294	
A-18-16 05CAB	345912110402401	529789.1	3871415.5	4,858	5/1/2001	71.6	
A-18-16 05DDA	345858110394401	530829.9	3871018.5	4,861	5/1/2001	29.3	
A-18-16 09DDD	345802110384001	532433.32	3869299.1	4,867	5/1/2001	43	
A-18-16 17BBB	345756110404101	529365.64	3869073	4,862	5/1/2001	137.7	
A-18-17 25BDD	345548110293601	546274.78	3865200.1	4,924	4/25/2001	32.8	
A-18-18 09DDC	345805110260201	551680.12	3869449.4	4,924	5/2/2001	15.1	
A-18-18 10ADA	345833110244901	553348.39	3870383.1	4,916	5/2/2001	49.2	
A-18-18 24DDD	345618110224001	556823.07	3866183.8	4,959	5/2/2001	82.3	
A-18-18 31CCD	345430110284901	547479.66	3862803.6	4,955	4/25/2001	78.4	
A-18-18 33DCC	345432110261601	551361.98	3862886.1	4,944	4/25/2001	90.5	
A-18-19 17ADC	345736110204201	559927.74	3868575.6	4,951	10/18/2000	64.2	
A-18-19 22CBB	345637110191901	561943.4	3866802.4	4,969	4/30/2001	30.8	
A-18-19 23DBD	345635110173801	564886.98	3866668.8	4,990	10/18/2000	40.3	
A-18-19 28DDD	345525110192501	561806.62	3864521.8	4,978	4/30/2001	27.2	
A-18-19 35ADB	345509110172901	564879.99	3864081	4,987	4/27/2001	30.3	
A-18-20 27CDC	345531110124101	572029.87	3864843.1	5,038	5/1/2001	251.9	

Cadastral	Site Id	UTM East	UTM North	Altitude	Date	Depth to Water	Remark
A-18-20 33BDA	345508110133501	570665.26	3864123.9	5,033	5/1/2001	107	
A-18-21 18BCA	345748110093301	576789.73	3869102.4	5,004	4/24/2001	45.9	
A-19-15 01ABB	340451110421601	526944.04	3881849.3	4,784	7/18/2001	66.5	
A-19-15 13DDA	350231110415301	527539.54	3877538.5	4,823	7/19/2001	14.1	
A-19-15 14AAA	350308110430201	525864.86	3878426.9	4,816	4/26/2001	53.6	
A-19-15 14BBC	350302110435701	524344.97	3878391.9	4,811	4/23/2001	128.9	
A-19-15 25DAD	350050110415701	527447.57	3874427	4,845	5/2/2001	28.9	
A-19-15 26DAD	350050110425601	525825.73	3874360.6	4,849	4/24/2001	51.3	
A-19-15 27CCB	350046110445701	522885.95	3874291.2	4,860	5/3/2001	124.7	
A-19-15 35DAA	350008110425401	526006.65	3873129	4,856	5/1/2001	84.3	
A-19-15 36ACA	350016110420301	527298.65	3873379.2	4,841	7/17/2001	67.7	
A-19-16 06CAB	350425110413001	528035.23	3881113.3	4,785	4/23/2001	45.1	
A-19-16 07CDD	350314110412301	528295.48	3878865.4	4,817	5/2/2001	12.7	
A-19-16 08CDC	350313110402701	529688.83	3878839	4,814	7/10/2001	22.5	
A-19-16 18CAA	350245110412401	528272.93	3877972	4,812	7/10/2001	24.6	
A-19-16 20CBA	350152110403501	529519.6	3876343.3	4,830	5/3/2001	14.8	
A-19-16 21DAB	350148110385701	532003.24	3876228.5	4,843	7/10/2001	27	
A-19-16 28CCC	350038110393801	530946.63	3873976.1	4,851	4/30/2001	9.1	
A-19-16 30DDB	350043110405901	528917.73	3874369.9	4,842	4/25/2001	12.6	
A-19-16 32CCD	345948110403101	529633.38	3872524	4,854	5/2/2001	66.1	
A-19-16 33BBA	350032110393201	531124.37	3873884.3	4,846	4/30/2001	6	
A-19-16 34BAC	350023110382001	532950.26	3873613.5	4,848	5/3/2001	11.5	
A-19-19 33CCC	345946110202501	560205.44	3872613	4,891	5/1/2001	266.6	
A-20-18 30CDA	350601110283201	547799.3	3884091.5	4,749	7/10/2001	499	



EXPLANATION

QUATERNARY

Qs — **Sand, silt, and gravel**

Qb — **Basalt** *Locally includes tuff and agglomerate.*

Qi — **Dikes and plugs** *Mainly basaltic in composition.*

QTs — **Sand, silt, gravel, and conglomerate**

QTb — **Basalt** *Locally includes tuff and agglomerate.*

TERTIARY

Ts — **Sandstone, shale, and conglomerate**

Ta — **Andesite** *Flows, tuff, and agglomerate*

Tb — **Basalt** *Flows, tuff, and agglomerate*

Ti — **Dikes, plugs, and sills** *Intermediate to basaltic in composition.*

CRETACEOUS

CRETACEOUS UNDIVIDED — Ks — **Limestone, shale, and sandstone**

TRIASSIC

Rc — **Chinle formation** *Including Shinarump conglomerate south of lat. 35° 15'*

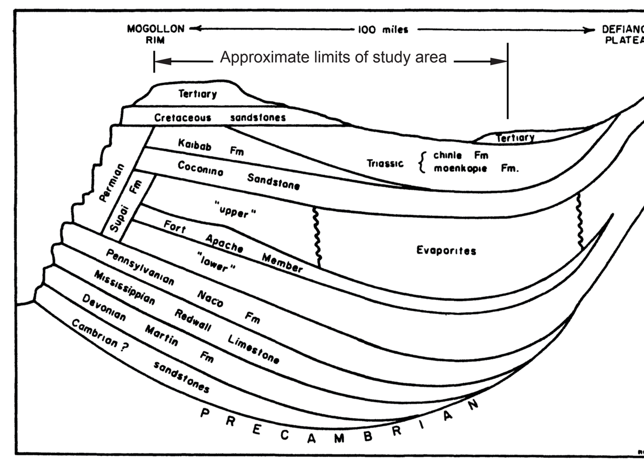
Rs — **Shinarump conglomerate** *Including Moenkopi formation at southern end of Defiance uplift.*

Rm — **Moenkopi formation**

PERMIAN

Pk — **Kaibab limestone** *Includes Toroweap formation*

Pc — **Coconino sandstone** *Including De Chelly sandstone in Defiance Plateau and Monument Valley areas.*



Diagrammatic geologic section along SW-NE direction from Mogollon Rim to Defiance Plateau.

SYMBOLS

Contact

Fault — *Dashed where approximately located* U, *upthrown side;* D, *downthrown side*

Axis of anticline showing direction of plunge

Axis of syncline showing direction of plunge

Axis of monocline

DESCRIPTION OF MAP UNITS

A thin veneer of surficial material, which is not of sufficient thickness to be mapped, caps most of the units in the area. The surficial material may include alluvium, eolian sand, and soil and other residual-weathering products

Adapted from Mann, 1976 (see references, sheet, 6)

Era	System	Formation or member		Approximate thickness, feet	Lithologic description	Water - bearing characteristics
CENOZOIC	QUATERNARY	ALLUVIUM		0- 150 +	Unconsolidated poorly sorted sand, silt, gravel, and clay.	Most wells that tap this unit yield less than 50 gal/min of water, however, irrigation and public-supply wells along the Puerco River generally yield from 300 to 600 gal/min, and one well near Winslow is reported to yield 1,700 gal/min
		Basaltic rocks		0 - 1,000+	Mainly basalt flows, cinder cones, and cinder beds, in places the basalt flows are separated by clay lenses.	Upper unit of the Pinetop-Lakeside aquifer. The unit contains ground water in fractures or cinder beds where underlain by relatively impermeable strata, the unit gererally is in hydraulic connection with the rim gravel where present; wells yield from about 10 to 350 gal/min of water, about 2,200 gal/min of water issues to Silver Springs from this unit, and as much as 1,100 gal/min issues to springs in the Pinetop-Lakeside area. (See pl. 4.)
	QUATERNARY AND TERTIARY	Rim gravel		0 - 200(?)	Unconsolidated to semiconsolidated bouldery gravel, coarse-grained sand and sandstone, silt, and mudstone. Mudstone, olive-gray to reddish-brown. Sand grains are composed of feldspar, quartz, chert, and clay. Locally well cemented by calcite.	Middle unit of the Pinetop-Lakeside aquifer. The unit is not saturated in outcrop is most of the area but generally is saturated where present in the sub-surface, yields small amounts of water to domestic and live-stock wells in places near the Mogollon Rim. (See pl. 4.)
	TERTIARY	Dikes and plugs		-------------	Mainly andesitic to basaltic dikes and plugs.	No known water-bearing potential.
MESOZOIC	CRETACEOUS	Upper Cretaceous sedimentary rocks		0 - 650	Sandstone, shale, and limestone. Sandstone, feldspathic. Fine-to coarse-grained, pale yellowish-gray to yellowish-brown and pale red, crossbedded, conglomeratic at base. Shale, dark-to medium-gray and olive-brown to reddish-brown shaly coal beds a few inches to 6 feet thick at 20 to 85 feet above base. Limesone, silty, olive-gray to green, discontinuous.	Lower unit of the Pinetop-Lakeside. Groundwater occurs mainly in the sandstone beds where underlain by the less permeable shale beds; sandstone beds in upper 100 to 250 feet generally are hydrauically connected with the rim gravel or the basaltic rocks, especially in the Pinetop-Lakeside area. The rocks generally yield less than 50 gal/min of water to wells but in places yield as much as 250 gal/min. (See pl. 4.)
	TRIASSIC	Chinle Formation		0 - 1,450	Mainly siltstone and mudstone, grayish-red to grayish--red -purple and reddish-brown. Shinarump Member at base is a 20-to 60-foot thick. fine-to coarse-grained, yellowish-orange to pale-orange sandstone and conglomerate. Sonsela Sandstone Bed of Petrified Forest Member near middle is a 20-to 40 foot thick. fine-to coarse-grained, light-gray to pal-orange sandstone and conglomerate.	Most wells that tap this unit yield 5 to 10 gal/min of water. Locally wells yield as much as 50 a gal/min of water; water is used mainly for livestock and domestic supplies.
		Moenkopi Formation		0 - 300	Mainly siltstone and mudstone, reddish-brown to purplish-blue; contains very fine coarse-grained reddish-brown to pale-yellowish-brown sandstone beds 30 to 50 feet thick near the top and base, includes gypsum beds and stringers a few inches thick.	Most wells that tap this unit yields 5 to 40 gal/min of water. Locally wells yields as much as 100 gal/min; used mainly for livestock and domestic supplies. The Moenkopi confines the water in the underlying Coconino aquifer.
PALEOZOIC	PERMIAN	Kaibab Linestone		0 - 200	Limestone and sandstone. Limestone, commonly silty, dolomitic, and cherty, light-gray to light-yellow-gray and pale-olive-gray, beds are generally 1 to 4 feet thick. Sandstone, fine to very fine grained, light-yellowish gray to light-yellowish-brown, thin bedded to massive; locally contains small-scale crossbeds.	Upper unit of the Coconino aquifer; may yield water to wells in the north-central and eastern parts of the area. Readily accepts and transmits recharge to the Coconino Sandstone in the southern and western parts of the area.
		Coconino Sandstone		250 - 850	Sandstone, fine-to medium-grained, light-yellowish gray to pale-orange. Local reddish-brown beds as much as 50 feet thick; weakly to well cemented by quartz, iron oxide, and calcite. Large-scale cross-beds are common in the upper part, but the beds probably are massive and flat in the lower part. Sandstone thickens toward the northwest.	Middle unit of the Coconino aquifer, wells generally yield from 500 to 2,000 gal/min of water, a few wells near Joseph City, Shumway, and Taylor yield from 2,500 to 2,800 gal/min, water discharged from the Coconino Sandstone maintains the base flow of most of the perennial streams in the study area. In the southern part of area the water is of acceptable chemical quality for most uses, in the northern part of the area, however, the water is of poor chemical quality.
		Supai Formation	Upper part of upper member	450 - 1,300	Siltstone, sandstone, halite, gypsum, and anhydrite. Siltstone and sandstone, very fine grained, pale-red to pale-reddish-brown. Thinly laminated to massive, calcareous. Halite, gypsum, and anhydrite; the aggregate thickness of the halite, gypsum, and anhydrite and northern parts of the area; the beds are from 0 to 200 feet below the top of the unit. The unit thickens toward the north-central part of the area near Holbrook.	Lower unit of the Coconino aquifer, sandstone beds in the upper 200± feet of this unit are in hydraulic connection with the Coconino Sandstone. The underlying siltstone, halite, gypsum, and anhydrite beds may prevent ground water in the Coconino aquifer from moving downward into the underlying strata. The sandstone and siltstone beds contain water of poor chemical quality in the central and northern part of the area.

Excerpt from sheet one.

Several important structural features are present in the study area. They include the Mogollon slope, the Holbrook Anticline, internal drainage sub-basins and solution collapse structures.

The Mogollon slope is a regional… downwarp structural dip between the crest of the Mogollon Rim and beyond the Little Colorado River…and has a pronounced influence on the drainage patterns of both surface and ground water.

About half way between the Mogollon Rim and the Little Colorado River is the Holbrook Anticline. This asymmetrical flexure interrupts the otherwise nearly flat sloping landscape and runs almost the entire east-west length of the county…the anticlines displacement of the surface and subsurface has profoundly altered the ancient surface water drainage pattern and ground water quality.

There are two rather large internal drainage features…locally known as Dry Lake and Long Lake…Dry Lake is a solution collapse structure…[and] the Long Lake area is an internal drainage system composed of numerous but relatively small basalt depressions.

See sheet one for full text.

EXPLANATION

635 NUMBER IS THE THICKNESS OF THE COCONINO SANDSTONE

INTERNAL DRAINAGE AREAS

6 3 0 Miles

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MAP SHOWING THE GENERALIZED SURFACE GEOLOGY MAP OF SOUTHERN NAVAJO COUNTY, ARIZONA ADAPTED FROM WILSON AND OTHERS, 1960 (SEE REFERENCES, SHEET 1)

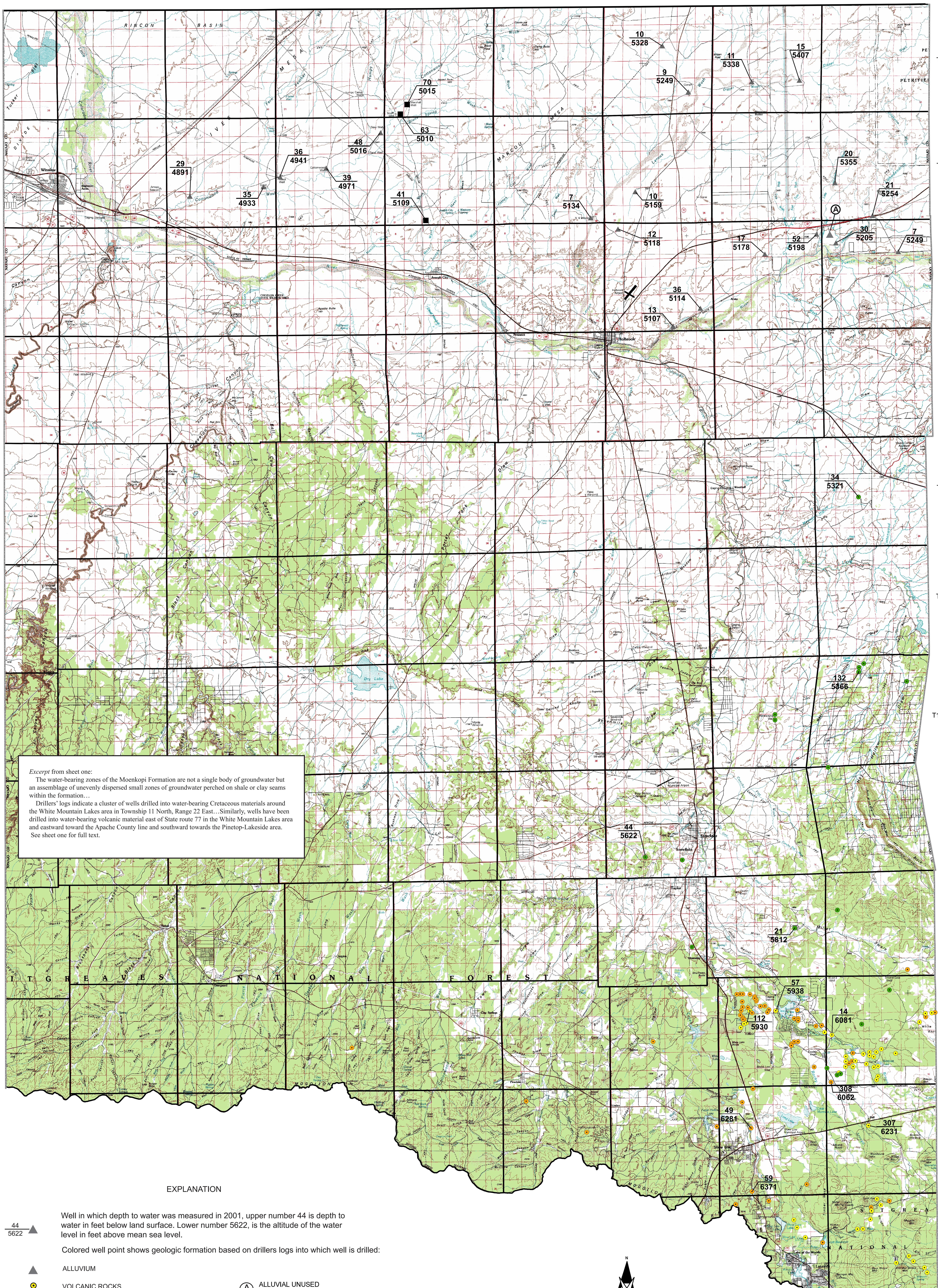
BY

A. E. OVERBY

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE. 602 771-8638

PREPARED IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

THE ARIZONA DEPARTMENT OF WATER RESOURCES



Excerpt from sheet one:

The water-bearing zones of the Moenkopi Formation are not a single body of groundwater but an assemblage of unevenly dispersed small zones of groundwater perched on shale or clay seams within the formation…

Drillers' logs indicate a cluster of wells drilled into water-bearing Cretaceous materials around the White Mountain Lakes area in Township 11 North, Range 22 East…Similarly, wells have been drilled into water-bearing volcanic material east of State route 77 in the White Mountain Lakes area and eastward toward the Apache County line and southward towards the Pinetop-Lakeside area.

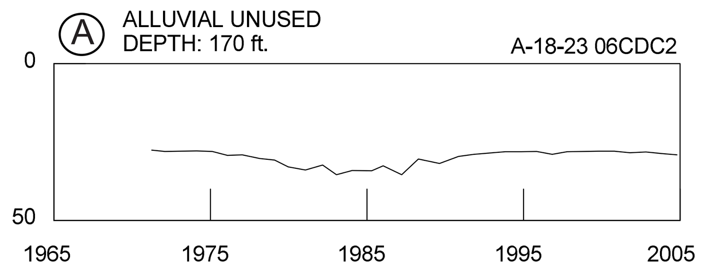
See sheet one for full text.

EXPLANATION

44 / 5622 ▲ Well in which depth to water was measured in 2001, upper number 44 is depth to water in feet below land surface. Lower number 5622, is the altitude of the water level in feet above mean sea level.

Colored well point shows geologic formation based on drillers logs into which well is drilled:

- ALLUVIUM
- VOLCANIC ROCKS
- CRETACEOUS ROCKS
- CHINLE FORMATION
- MOENKOPI FORMATION



N
S

6 3 0 Miles

MAP SHOWING MINOR AQUIFERS IN SOUTHERN NAVAJO COUNTY, ARIZONA: APRIL - AUGUST 2001

BY

A. E. OVERBY

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE. 602 771-8638

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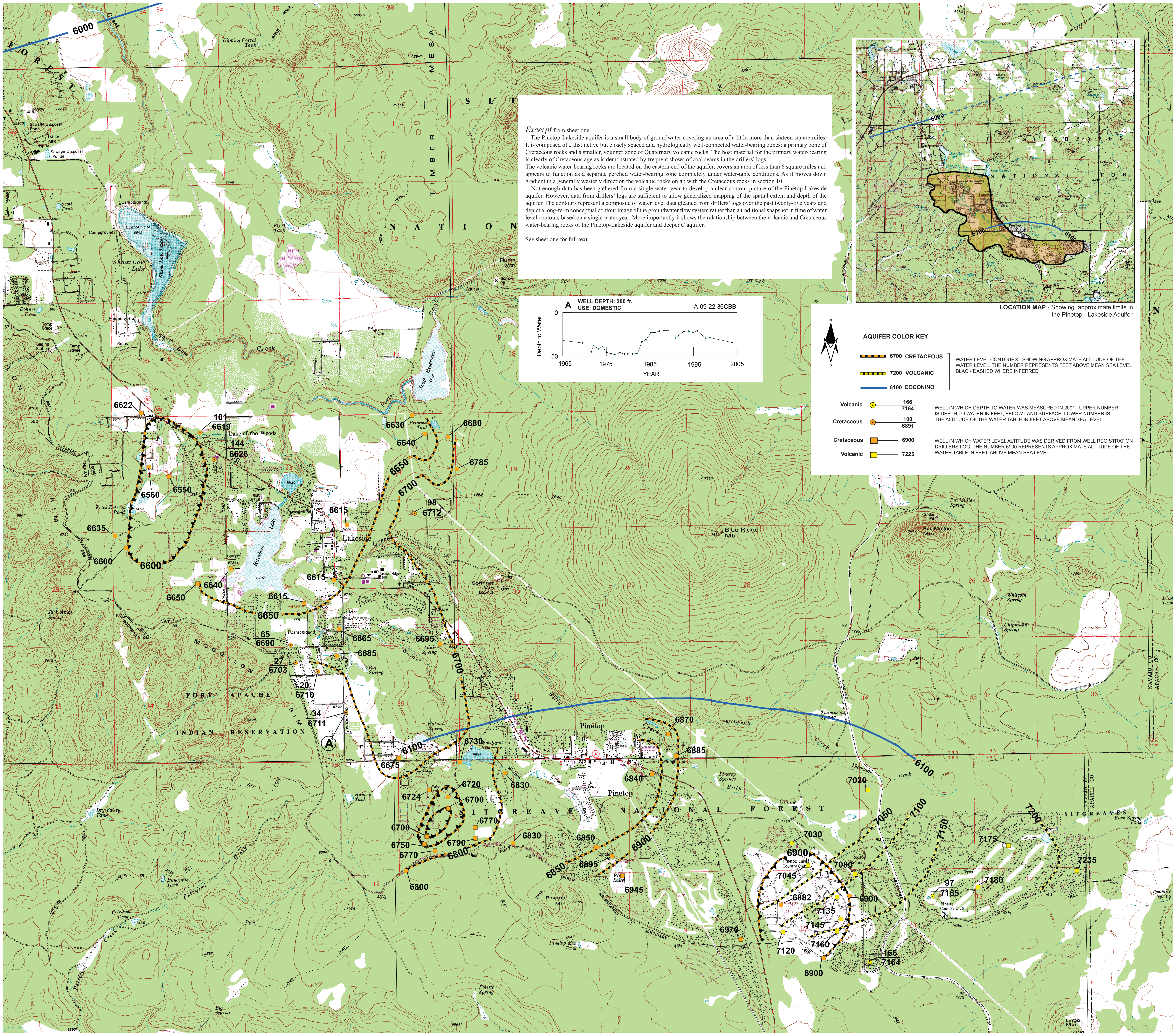
Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude
A-18-23 06CDC2	345901109564001	Unused	5,250	170	596422.19	3871383.7	3/30/1971	27.6	5,222
							2/2/1972	28	5,222
Alluvial							2/14/1974	27.8	5,222
Hydrograph							2/12/1975	28	5,222
							1/30/1976	29.28	5,221
							1/13/1977	29.1	5,221
							2/22/1978	30.26	5,220
							2/7/1979	30.75	5,219
							12/19/1979	32.88	5,217
							1/21/1981	33.92	5,216
							3/4/1982	32.35	5,218
							1/18/1983	35.4	5,215
							1/19/1984	34.12	5,216
							4/18/1985	34.2	5,216
							1/10/1986	32.6	5,217
							3/19/1987	35.4	5,215
							4/11/1988	30.4	5,220
							8/17/1989	31.8	5,218
							11/6/1990	29.6	5,220
							10/28/1991	28.9	5,221
							10/28/1993	28.1	5,222
							11/3/1994	28.1	5,222
							11/1/1995	28.01	5,222
							10/29/1996	28.9	5,221
							10/14/1997	28.1	5,222
							10/19/1999	27.9	5,222
							10/17/2000	27.9	5,222
							10/16/2001	28.4	5,222
							10/23/2002	28.2	5,222
							10/21/2003	28.65	5,221
							10/19/2004	29.1	5,221



Excerpt from sheet one.

The Pinetop-Lakeside aquifer is a small body of groundwater covering an area of a little more than sixteen square miles. It is composed of 2 distinctive but closely spaced and hydrologically well-connected water-bearing zones: a primary zone of Cretaceous rocks and a smaller, younger zone of Quaternary volcanic rocks. The host material for the primary water-bearing is clearly of Cretaceous age as is demonstrated by frequent shows of coal seams in the drillers' logs….

The volcanic water-bearing rocks are located on the eastern end of the aquifer, covers an area of less than 6 square miles and appears to function as a separate perched water-bearing zone completely under water-table conditions. As it moves down gradient in a generally westerly direction the volcanic rocks onlap with the Cretaceous rocks in section 10…

Not enough data has been gathered from a single water-year to develop a clear contour picture of the Pinetop-Lakeside aquifer. However, data from drillers' logs are sufficient to allow generalized mapping of the spatial extent and depth of the aquifer. The contours represent a composite of water level data gleaned from drillers' logs over the past twenty-five years and depict a long-term conceptual contour image of the groundwater flow system rather than a traditional snapshot in time of water level contours based on a single water year. More importantly it shows the relationship between the volcanic and Cretaceous water-bearing rocks of the Pinetop-Lakeside aquifer and deeper C aquifer.

See sheet one for full text.

Map reference: adapted from USGS 1:24,000
Topographic maps for Show Low South, Lakeside and Indian Pines

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MAP SHOWING GROUNDWATER CONDITIONS IN THE PINETOP - LAKESIDE AQUIFER IN SOUTHERN NAVAJO COUNTY, ARIZONA

BY

A. E. OVERBY

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE. 602 771-8638

Cadastral	Site Id	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-09-22 36CBB	340752109581701	6,745	200	594847.86	3776976.3	12/1/1964	32	6,713	
WELL DEPTH: 200ft.						7/1/1969	34.9	6,710	
USE: Domestic						7/13/1971	45.2	6,700	
						1/11/1972	38	6,707	
						3/26/1973	41.7	6,703	
						2/19/1974	38.9	6,706	
						12/18/1974	45.4	6,700	
						1/27/1976	47.4	6,698	
						1/11/1977	48.3	6,697	
						2/23/1978	46.14	6,699	
						2/12/1979	47.66	6,697	
						12/7/1979	47.52	6,697	
						1/20/1981	47.65	6,697	
						3/3/1982	46.8	6,698	
						3/1/1983	33.3	6,712	
						2/13/1984	31.2	6,714	
						4/5/1985	22.8	6,722	
						3/4/1986	23	6,722	
						2/12/1987	21.3	6,724	
						3/15/1988	21	6,724	
						2/2/1989	20.6	6,724	
						11/7/1990	29.1	6,716	R
						10/26/1992	21.6	6,723	
						10/25/1993	21.5	6,724	
						11/3/1994	23.1	6,722	
						10/31/1995	21.2	6,724	
						10/17/1997	29.5	6,716	
						10/19/1998	28.9	6,716	
						10/22/2003	34.39	6,711	

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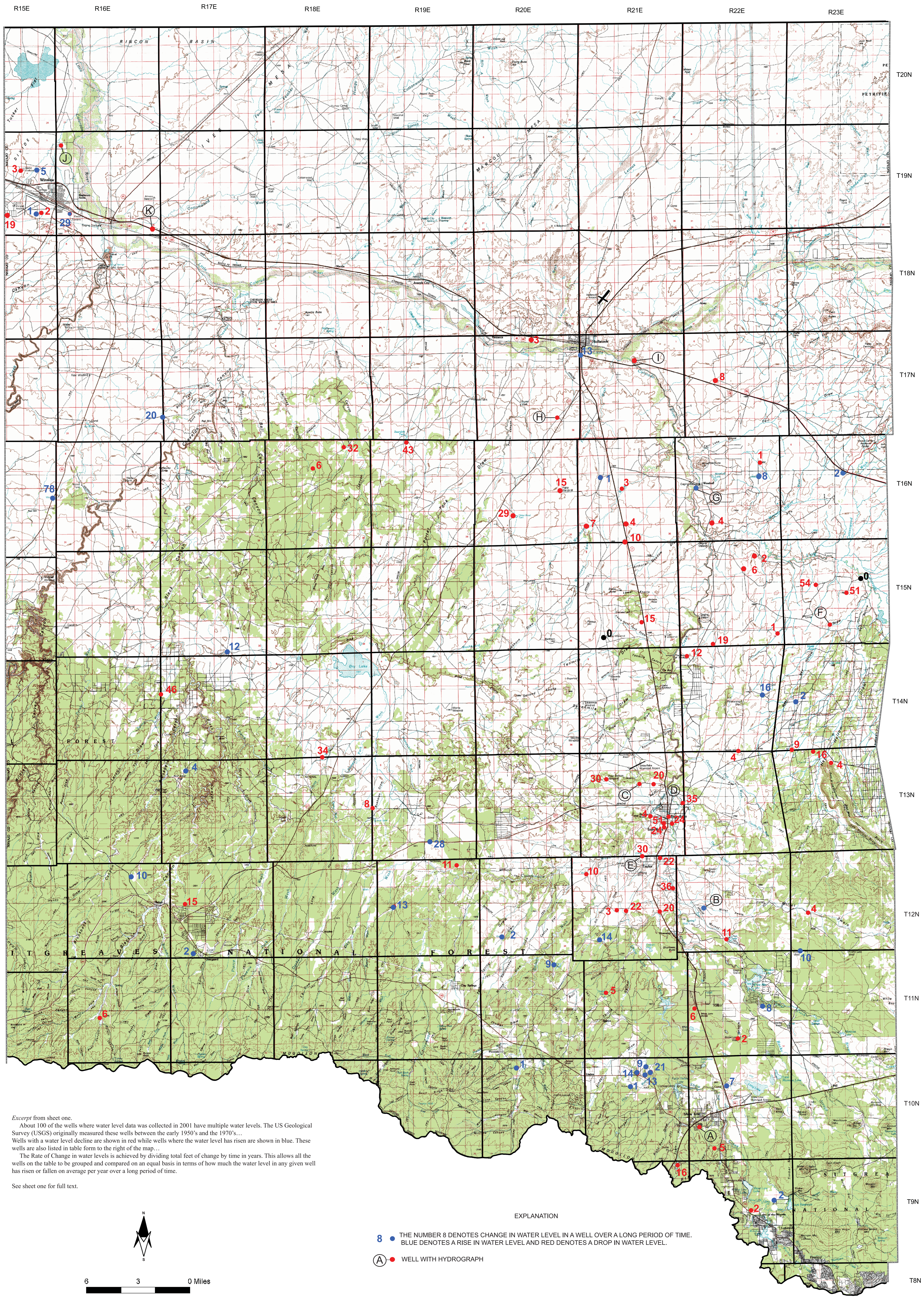

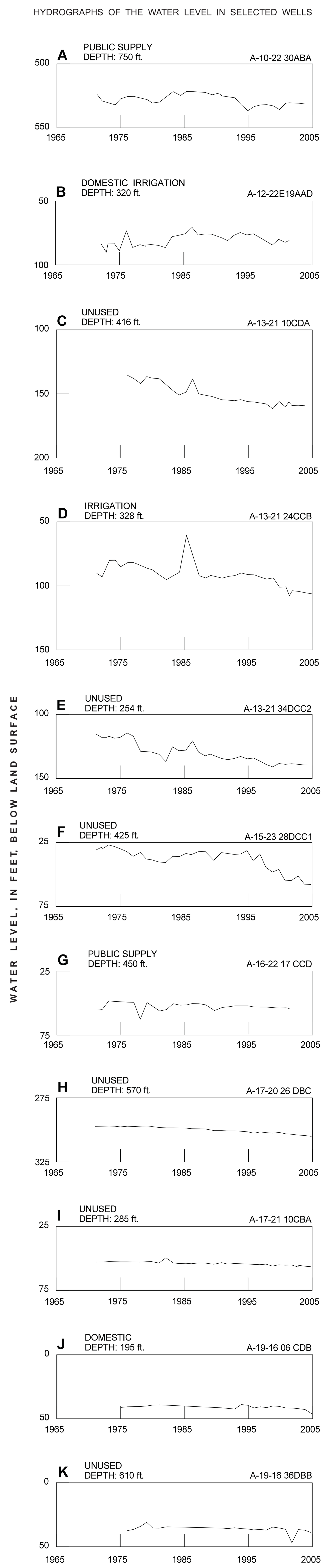

Hydrograph Rate of Change Table

	Hydrograph	Local Id	Date	DTW	WLC	Time in Years	Ft/Yr	Category	Usage/Area
BLUE	G	A-16-22 17CCD	01-APR-71	55.5	+1	30	+0.03	N	Public Supply
			23-APR-01	54.22					Woodruff
BLUE	B	A-12-22E19ADD	23-FEB-72	83.8	+3	29	+0.1	N	Domestic
			26-APR-01	81.2					Millet Swale
RED	J	A-19-16 06CDB	07-APR-71	41.35	-1	30	-0.03	N	Domestic
			23-APR-01	42.7					Winslow
RED	I	A-17-21 10CBA	31-MAR-71	52.88	-3	30	-0.1	N	Unused
			16-MAY-01	55.7					Holbrook
RED	H	A-17-20 26DBC	05-JAN-71	297.22	-6	30	-0.2	N	Unused
			06-NOV-01	303.5					Holbrook
RED	A	A-10-22 30ABA	31-MAR-71	523.58	-7	30	-0.23	N	Public Supply
			01-MAY-01	530.4					Show Low
RED	K	A-19-16 36DBB	10-JUL-72	36	-11	29	-0.38	L	Unused
			17-OCT-01	46.8					Winslow
RED	D	A-13-21 24CCB	01-FEB-72	92.9	-15	29	-0.52	L	Irrigation
			02-MAY-01	107.7					Snowflake
RED	E	A-13-21 34DCC2	07-APR-71	115.5	-23	30	-0.77	M	Unused
			17-OCT-01	138.5					Taylor
RED	C	A-13-21 10CDA	27-JAN-76	135.35	-21	25	-0.84	M	Unused
			02-MAY-01	156.11					Snowflake
RED	F	A-15-23 28DCC1	01-APR-71	30.8	-30	30	-1	M	Unused
			26-APR-01	61.09					Hay Hollow

Explanation of Columns	N: Negligible Rate of Change (0 to 0.25')
DTW: Depth to Water	L: Low Rate of Change (0.26' to 0.75')
WLC: Water Level Change in Feet	M: Medium Rate of Change (0.76' to 1.25')
Ft/Yr: Average Water Level Change in Ft/Yr	H: High Rate of Change (1.26' or Higher)

Rate of Change Table

	Local-Id	Date	DTW	WLC Less than	Time in Yrs	Ft/Yr	Category	Usage/Area
	A-15-21 32ACB	11-JUN-58	373.33	0	43	0	N	Unused
		02-MAY-01	373.9					Flattop Hill
	A-15-23 14BDA	20-MAR-72	35.3	0	29	0	N	Unused
		12-JUL-01	34.99					Hay Hollow
RED	A-15-22 36ACB	22-MAR-72	174.3	-1	29	-0.03	N	Stock
		25-APR-01	175.7					Hay Hollow
RED	A-11-22 33AAA	22-NOV-53	438.5	-2	48	-0.04	N	Stock
		24-APR-01	440.9					Show Low
RED	A-19-15 25CBC	20-DEC-53	48	-2	48	-0.04	N	Domestic
		25-APR-01	50.2					Winslow
RED	A-09-22 15DCB1	03-AUG-71	595	-2	30	-0.07	N	Irrigation
		23-APR-01	597.1					Lakeside
RED	A-12-21 21ABB	05-APR-72	191.2	-2	29	-0.07	N	Unused
		25-APR-01	193.7					West of Taylor
RED	A-15-22 02CDD	21-MAR-72	101.5	-2	29	-0.07	N	Unused
		12-JUL-01	103.95					Little Colorado
RED	A-13-22 02BBB	23-OCT-53	375	-4	48	-0.08	N	Stock
		01-MAY-01	379.3					Concho Flat
RED	A-17-20 03BBC	20-NOV-72	36.3	-3	29	-0.1	N	Irrigation
		23-APR-01	38.9					Holbrook
RED	A-11-21 17BAC	01-AUG-63	338	-5	38	-0.13	N	Stock
		24-APR-01	343.5					Pinedale
RED	A-16-21 16DDD	22-NOV-71	221.7	-4	30	-0.13	N	Stock
		23-APR-01	225.26					Washboard Wash
RED	A-16-22 28CCC	23-NOV-71	124.6	-4	30	-0.13	N	Stock
		01-MAY-01	129.11					Woodruff
RED	A-13-21 23CBC2	21-MAR-73	91.5	-4	28	-0.14	N	Irrigation
		02-MAY-01	95.33					Snowflake
RED	A-19-15 14BBC	08-FEB-79	126	-3	22	-0.14	N	Domestic
		23-APR-01	128.9					Winslow
RED	A-13-23 03CDB	28-AUG-74	188	-4	27	-0.15	N	Domestic
		04-MAY-01	191.93					Point of the Mtn
RED	A-16-21 27CCC1	01-JAN-74	336.8	-4	27	-0.15	N	Unused
		30-APR-01	340.6					Washboard Wash
RED	A-10-22 32ACB	14-SEP-70	512	-5	31	-0.16	N	Public Supply
		01-MAY-01	516.7					Show Low
RED	A-16-21 31ABB	11-JUN-58	304.19	-7	43	-0.16	N	Unused
		10-JUL-01	311.5					Washboard Wash
RED	A-11-22 19BAD	19-APR-72	407.1	-5	29	-0.17	N	Stock
		24-APR-01	412.6					White Lake
RED	A-13-19 18CCC	05-FEB-55	423.82	-8	46	-0.17	N	Stock
		26-APR-01	432					Bushman Draw
RED	A-14-23 32CCD	25-OCT-53	283	-9	48	-0.19	N	Stock
		27-APR-01	292					Hay Hollow
RED	A-16-18 09ACC1	01-SEP-72	608	-6	32	-0.19	N	Stock
		15-JUL-04	614.5					Chimney Canyon
RED	A-15-22 10DAB	23-NOV-71	174.6	-6	30	-0.2	N	Stock
		25-APR-01	180.4					Woodruff
RED	A-11-16 20ADB2	01-JUN-73	410	-6	28	-0.21	N	Domestic
		07-MAY-01	415.8					Heber
RED	A-17-22 17DDB	21-DEC-71	202.9	-8	30	-0.27	L	Stock
		24-APR-01	211.39					Woodruff
RED	A-16-21 33DDD	14-OCT-71	319	-10	30	-0.33	L	Stock
		24-APR-01	329.3					Washboard Wash
RED	A-12-21 06DDC1	24-FEB-72	202.5	-10	29	-0.34	L	Irrigation
		25-APR-01	212.1					West of Taylor
RED	A-16-22 11DAA1	01-FEB-72	223	-11	29	-0.38	L	Stock
		02-MAY-01	234					Woodruff
RED	A-12-22 33BDB	23-FEB-72	93.5	-11	29	-0.38	L	Irrigation
		26-APR-01	104.4					Love Lake
RED	A-12-19 02DCA	28-JUN-73	428.5	-11	28	-0.39	L	Stock
		08-MAY-01	439.2					Day Wash
RED	A-14-22 06BDD	23-NOV-71	230.1	-12	30	-0.4	L	Stock
		01-MAY-01	242.12					Lower Silver Creek
RED	A-15-22 32DDA	27-OCT-53	130.64	-19	48	-0.4	L	Stock
		01-MAY-01	149.81					Lower Silver Creek
RED	A-16-20 14DDD	09-MAY-69	444.6	-15	35	-0.43	L	Stock
		14-JUL-04	459.8					Flake Windmill
RED	A-12-17 18DDB	03-MAR-71	650	-15	30	-0.5	L	Stock
		23-APR-01	664.6					Heber
RED	A-09-21 01BAC2	01-AUG-71	545	-16	30	-0.53	L	Public Supply
		01-MAY-01	560.9					Summer Pines
RED	A-15-21 27DAB	01-MAR-74	304	-15	27	-0.55	L	Stock
		10-JUL-01	318.8					Lower Knolls
RED	A-12-21 22BBC	01-NOV-62	142.34	-22	39	-0.56	L	Stock
		26-APR-01	164.2					Schoens Crossing
	A-13-23 04BBA	28-AUG-74	237.5	-16	27	-0.59	L	Domestic
		04-MAY-01	253.5					Point of the Mtn
RED	A-16-20 28BDB	08-FEB-55	420	-29	49	-0.59	L	Stock
		14-JUL-04	449.3					Heber Road Tank
RED	A-12-21 24BBC	25-FEB-72	60.9	-20	29	-0.69	L	Irrigation
		11-JUL-01	80.5					Shumway
RED	A-13-21 11CDB	23-FEB-72	98.1	-20	29	-0.69	L	Unused
		02-MAY-01	117.9					Snowflake
RED	A-12-21 12DDC	24-AUG-50	34.25	-36	51	-0.71	L	Irrigation
		26-APR-01	70.6					Taylor
RED	A-13-21 26ADB1	14-JAN-69	147.2	-24	32	-0.75	L	Public Supply
		26-APR-01	170.8					Taylor
RED	A-12-21 01BBB	12-JAN-72	56.3	-22	29	-0.76	M	Irrigation
		26-APR-01	78.3					Taylor
RED	A-13-21 25BAB	07-MAR-72	70.3	-24	29	-0.83	M	Irrigation
		26-APR-01	94					Snowflake
RED	A-13-21 13DDD2	16-NOV-61	71	-35	40	-0.87	M	Irrigation
		02-MAY-01	105.73					Snowflake
RED	A-16-18S02BAD	23-Apr-68	366.2	-32	36	-0.89	M	Stock
		15-Jul-04	398.6					Lard Bucket Draw
RED	A-13-21 34DCC1	10-MAR-69	106.7	-30	32	-0.94	M	Irrigation
		26-APR-01	137					Taylor
RED	A-13-21 26AAB	14-SEP-50	118.2	-51	51	-1	M	Public Supply
		26-APR-01	169.2					Snowflake
RED	A-13-21 08DBB	21-Sep-72	190.1	-30	29	-1.03	M	Unused
		1-May-01	220.1					Snowflake
RED	A-15-23 17DAB	27-OCT-53	37.46	-54	48	-1.1	M	Stock
		25-APR-01	91.05					Hay Hollow
RED	A-14-18 34CCD	21-SEP-72	500.4	-34	29	-1.17	M	Stock
		01-MAY-01	534.6					Dry Lake Valley
RED	A-16-19 04BBC	23-Apr-68	241.6	-43	33	-1.23	M	Stock
		3-May-01	285					Saunders Tank
RED	A-14-17 18BBB	20-JUN-72	607.4	-46	29	-1.59	H	Public Supply
		24-APR-01	653.3					Deer Run
RED	A-15-23 22ABB	20-MAR-72	60.9	-51	29	-1.76	H	Stock
		25-APR-01	111.88					Hay Holow
BLUE	A-16-21 17ABD	04-MAR-53	300.69	+1	48	+0.02	N	Unused
		03-MAY-01	299.3					Washboard Wash
BLUE	A-10-20 04CBB	08-JUN-72	348.6	+1	29	+0.03	N	Domestic
		23-APR-01	347.5					Pinedale
BLUE	A-10-21 09DBD	11-MAY-72	254.7	+1	29	+0.03	N	Domestic
		23-APR-01	254					Show Low
BLUE	A-14-23 19AAD	25-OCT-53	273	+2	48	+0.04	N	Stock
		27-APR-01	271.5					Hay Hollow
BLUE	A-19-15 26DAD	15-APR-77	52	+1	24	+0.04	N	Domestic
		24-APR-01	51.3					Winslow
BLUE	A-12-17 32CAD	02-OCT-69	543.5	+2	32	+0.06	N	Public Supply
		23-APR-01	541.4					Heber
BLUE	A-09-22 14ADA	01-SEP-72	670	+2	29	+0.07	N	Public Supply
		04-MAY-01	668.5					Lakeside
BLUE	A-12-20 29DDD	05-JUN-72	485.2	+2	29	+0.07	N	Stock
		08-MAY-01	483.2					W of Cactus Flat
BLUE	A-16-23 15BAD	22-DEC-71	139.8	+2	30	+0.07	N	Stock
		02-MAY-01	137.4					Petrified Forest
BLUE	A-13-17 05CAA	15-MAR-64	794.5	+4	37	+0.11	N	Stock
		24-APR-01	790					Red Knoll Flat
BLUE	A-11-23 06ABB	20-NOV-53	231.6	+10	48	+0.21	N	Stock
		11-JUL-01	222					Guy's Well
BLUE	A-17-21 07BBC	01-JUN-44	40	+13	57	+0.23	N	Industrial
		11-JUL-01	26.7					Holbrook
BLUE	A-19-15 14AAA	20-FEB-79	59	+5	22	+0.23	N	Domestic
		26-APR-01	53.6					Winslow
BLUE	A-10-22 09CBD	04-APR-72	439.4	+7	29	+0.24	N	Stock
		24-APR-01	432.3					Long Lake
BLUE	A-15-17 34DAC	07-FEB-55	576.42	+12	49	+0.24	N	Stock
		04-AUG-04	564.1					Richard's Camp Well
BLUE	A-11-22 23BAD	25-MAY-72	314.1	+8	29	+0.28	L	Public Supply
		12-JUL-01	306.1					Show Low Well
BLUE	A-16-22 14ADB	12-SEP-72	272.7	+8	29	+0.28	L	Unused
		02-MAY-01	265					Woodruff
BLUE	A-10-21 03DBB1	10-MAY-72	143.3	+9	29	+0.31	L	Domestic
		01-MAY-01	133.9					Pinedale
BLUE	A-11-20 02AAD	05-APR-72	524.4	+9	29	+0.31	L	Stock
		26-APR-01	515					East Well
BLUE	A-12-16 10ADB	05-JUN-72	693.6	+10	29	+0.34	L	Irrigation
		23-APR-01	683.2					Heber
BLUE	A-12-19 20BBB	01-AUG-64	495	+13	37	+0.35	L	Stock
		08-MAY-01	481.6					Long Hollow Tank
BLUE	A-10-21 10BAA	30-APR-69	239	+13	32	+0.41	L	Public Supply
		01-MAY-01	225.7					Pinedale
BLUE	A-10-21 03CCC	29-AUG-68	198.6	+14	33	+0.47	L	Public Supply
		01-MAY-01	184.1					Pinedale
BLUE	A-12-21 29DCB	05-APR-72	186.3	+14	29	+0.48	L	Stock
		26-APR-01	172.6					Linden Well
BLUE	A-14-22 13CBC	06-SEP-72	394.3	+16	32	+0.5	L	Stock
		07-JUL-04	377.8					Hay Hollow
BLUE	A-17-16 25DAA	1-SEP-72	425	+20	29	+0.69	L	Stock
		16-JUL-01	404.8					South of Windslow
BLUE	A-10-21 03DDB	29-MAY-74	140	+21	27	+0.78	M	Domestic
		24-APR-01	118.6					Pinedale
BLUE	A-13-19 27CDC	23-JUN-72	490.7	+28	29	+0.96	M	Public Supply
		01-MAY-01	462.5					Day Wash
BLUE	A-16-15 13DAB	16-AUG-66	573.9	+78	38	+2.05	H	Unused
		3-AUG-04	495.9					Red Hill

Explanation of Columns	N: Negligibale Rate of Change (0 to 0.25')
DTW: Depth to Water	L: Low Rate of Change (0.26' to 0.75')
WLC: Water Level Change in Feet	M: Medium Rate of Change (0.76' to 1.25')
Ft/Yr: Average Water Level Change in Ft/Yr	H: High Rate of Change (1.26' or Higher)

Excerpt from sheet one.

About 100 of the wells where water level data was collected in 2001 have multiple water levels. The US Geological Survey (USGS) originally measured these wells between the early 1950's and the 1970's…

Wells with a water level decline are shown in red while wells where the water level has risen are shown in blue. These wells are also listed in table form to the right of the map…

The Rate of Change in water levels is achieved by dividing total feet of change by time in years. This allows all the wells on the table to be grouped and compared on an equal basis in terms of how much the water level in any given well has risen or fallen on average per year over a long period of time.

See sheet one for full text.

EXPLANATION

8 ● THE NUMBER 8 DENOTES CHANGE IN WATER LEVEL IN A WELL OVER A LONG PERIOD OF TIME. BLUE DENOTES A RISE IN WATER LEVEL AND RED DENOTES A DROP IN WATER LEVEL.

(A) ● WELL WITH HYDROGRAPH

6 3 0 Miles

MAP SHOWING WATER LEVEL CHANGES IN THE COCONINO AQUIFER IN SOUTHERN NAVAJO COUNTY, ARIZONA

BY

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WEBSITE: www.azwater.gov

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE. 602 771-8638

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude
A-10-22 30ABA	341429110025201	P S	6,520	750	587664.04	3789135.8	3/31/1971	523.58	5,996
							2/7/1972	529	5,991
Hydrograph A							2/13/1974	532	5,988
Public Supply							12/19/1974	527.3	5,993
							1/27/1976	525.5	5,995
							1/11/1977	525.4	5,995
							2/12/1979	527.95	5,992
							12/7/1979	530.6	5,989
							1/20/1981	529.8	5,990
							3/1/1983	521.7	5,998
							5/2/1984	524.7	5,995
							4/4/1985	521.6	5,998
							4/4/1986	521.65	5,998
							3/15/1988	522.3	5,998
							4/10/1989	524.2	5,996
							4/3/1990	522.9	5,997
							11/7/1990	525.1	5,995
							10/26/1992	526.5	5,994
							10/29/1993	532	5,988
							11/3/1994	536.6	5,983
							10/31/1995	533.3	5,987
							10/29/1996	532.1	5,988
							10/17/1997	531.8	5,988
							10/22/1998	532.8	5,987
							10/19/1999	535.7	5,984
							10/17/2000	530.7	5,989
							5/1/2001	530.4	5,990
							10/24/2002	530.79	5,989
							10/23/2003	531.3	5,989

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-12-22E19ADD	342532110022901	H I	5,733	320	588085.3	3809563.1	2/23/1972	83.8	5,649	
							12/7/1972	90.1	5,643	
Hydrograph B							3/21/1973	82.9	5,650	
Domestic							2/20/1974	83	5,650	
Irrigation							12/19/1974	88.9	5,644	
							1/27/1976	73.3	5,660	
							1/13/1977	86.3	5,647	
							3/8/1978	84.2	5,649	
							1/28/1979	85.4	5,648	
							2/15/1979	83.58	5,649	
							1/23/1981	84.76	5,648	
							2/16/1982	86.45	5,647	
							3/2/1983	77.9	5,655	R
							3/1/1984	76.9	5,656	R
							4/5/1985	75.6	5,657	
							4/17/1986	70.7	5,662	
							4/3/1987	76.6	5,656	
							4/13/1988	75.8	5,657	
							4/19/1989	75.9	5,657	
							11/7/1990	78.7	5,654	
							10/28/1991	81	5,652	
							10/26/1992	76.9	5,656	
							10/25/1993	74.7	5,658	
							10/31/1994	76.6	5,656	
							11/1/1995	75.7	5,657	
							10/28/1996	78.5	5,655	
							10/22/1998	84.4	5,649	
							10/18/1999	80	5,653	
							10/17/2000	82.3	5,651	
							4/26/2001	81.2	5,652	
							10/17/2001	81.3	5,652	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-13-21 10CDA	343150110063001	U	5,632	416	582060.51	3821152.3	1/27/1976	135.35	5,497	
							1/13/1977	137.8	5,494	
Hydrograph C							3/8/1978	142	5,490	
Unused							2/15/1979	136.46	5,496	
							11/28/1979	137.65	5,494	
							1/23/1981	138.2	5,494	
							4/5/1983	147.58	5,484	
							3/1/1984	150.9	5,481	R
							4/5/1985	148.7	5,483	
							4/17/1986	138.3	5,494	
							4/3/1987	150	5,482	
							4/14/1988	151.1	5,481	
							4/19/1989	152	5,480	
							11/6/1990	154.6	5,477	
							10/28/1991	154.9	5,477	
							10/27/1992	155.3	5,477	
							10/25/1993	154.5	5,478	
							10/31/1994	156	5,476	
							10/30/1995	156.3	5,476	
							10/28/1996	157.1	5,475	
							10/13/1997	157.8	5,474	
							10/22/1998	161.6	5,470	
							10/18/1999	155.9	5,476	
							10/17/2000	160.2	5,472	
							5/2/2001	156.31	5,476	
							10/17/2001	159.1	5,473	
							10/24/2002	158.89	5,473	
							10/22/2003	159.26	5,473	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-13-21 24CCB	343009110043501	I	5,618	328	584790.94	3818096.3	3/31/1971	90.27	5,528	
							2/1/1972	92.9	5,525	
Hydrograph D							3/21/1973	80.05	5,538	
Irrigation							2/19/1974	80	5,538	
							12/19/1974	85.1	5,533	
							1/27/1976	81.8	5,536	
							1/13/1977	81.85	5,536	
							3/8/1978	84.25	5,534	
							2/15/1979	86.25	5,532	
							11/28/1979	87.4	5,531	
							1/23/1981	91.6	5,526	
							2/16/1982	95.11	5,523	
							3/1/1984	89.3	5,529	
							4/5/1985	60.6	5,557	
							4/3/1987	92.1	5,526	
							4/13/1988	93.8	5,524	
							1/19/1989	91.8	5,526	
							11/6/1990	93.9	5,524	
							10/28/1991	92.55	5,525	
							10/27/1992	91.95	5,526	
							10/25/1993	89.95	5,528	
							10/31/1994	91.15	5,527	
							10/30/1995	91.35	5,527	
							10/29/1996	93.15	5,525	
							10/13/1997	94.65	5,523	
							10/22/1998	93.75	5,524	
							10/18/1999	101	5,517	
							10/17/2000	100.75	5,517	
							5/2/2001	107.7	5,510	
							10/17/2001	103.75	5,514	
							10/24/2002	104.35	5,514	
							10/22/2003	105.35	5,513	
							10/28/2004	106.15	5,512	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-13-21 34DCC2	342811110061201	U	5,658	254	582324.2	3814408.3	4/7/1971	115.5	5,543	
							2/7/1972	117.9	5,540	
Hydrograph E							11/23/1972	117.9	5,540	
Unused							3/21/1973	117.1	5,541	
							2/19/1974	118.6	5,539	
							12/19/1974	118	5,540	
							1/27/1976	114.5	5,544	
							1/13/1977	116.9	5,541	
							3/8/1978	128.8	5,529	
							2/15/1979	129.1	5,529	
							11/28/1979	129.45	5,529	
							1/23/1981	131.2	5,527	
							2/16/1982	136.8	5,521	
							3/2/1983	125.3	5,533	
							3/1/1984	128.3	5,530	
							4/5/1985	127.9	5,530	
							4/17/1986	120.7	5,537	
							4/3/1987	129.5	5,529	
							4/13/1988	132.3	5,526	
							1/19/1989	131	5,527	
							11/7/1990	134.4	5,524	
							10/28/1991	135.3	5,523	
							10/26/1992	134.4	5,524	
							10/25/1993	132.8	5,525	
							10/31/1994	134.7	5,523	
							11/1/1995	134.1	5,524	
							10/28/1996	136.4	5,522	
							10/13/1997	139.1	5,519	
							10/22/1998	140.9	5,517	
							10/18/1999	138.3	5,520	
							10/17/2000	139	5,519	
							10/17/2001	138.5	5,520	
							10/24/2002	139	5,519	
							10/22/2003	139.5	5,519	
							10/28/2004	139.6	5,518	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-15-23 28DCC1	343950109544001	U	5,352	425	599823.8	3836021.5	4/1/1971	30.8	5,321	
							1/31/1972	28.8	5,323	
Hydrograph F							3/20/1972	30	5,322	
Unused							3/20/1973	26.9	5,325	
							1/28/1974	28.1	5,324	
							2/12/1975	30.06	5,322	
							1/26/1976	32.13	5,320	
							1/13/1977	35.86	5,316	
							3/8/1978	32.8	5,319	
							2/6/1979	37.95	5,314	
							11/29/1979	38.48	5,314	
							1/23/1981	40.26	5,312	
							2/16/1982	40.64	5,311	
							3/10/1983	35.8	5,316	
							4/10/1984	36	5,316	
							4/18/1985	33.6	5,318	
							2/14/1986	34.5	5,318	
							3/25/1987	32.2	5,320	
							4/13/1988	31.9	5,320	
							8/17/1989	38.9	5,313	
							11/6/1990	32.9	5,319	
							10/27/1992	34.3	5,318	
							10/27/1993	34	5,318	
							11/2/1994	31.3	5,321	
							10/31/1995	39.5	5,313	
							10/30/1996	33.8	5,318	
							10/13/1997	44.4	5,308	
							10/20/1998	48.1	5,304	
							10/19/1999	46.1	5,306	
							10/17/2000	54.9	5,297	
							10/16/2001	54.6	5,297	
							10/22/2002	51.29	5,301	
							10/21/2003	57.6	5,294	
							10/19/2004	57.75	5,294	

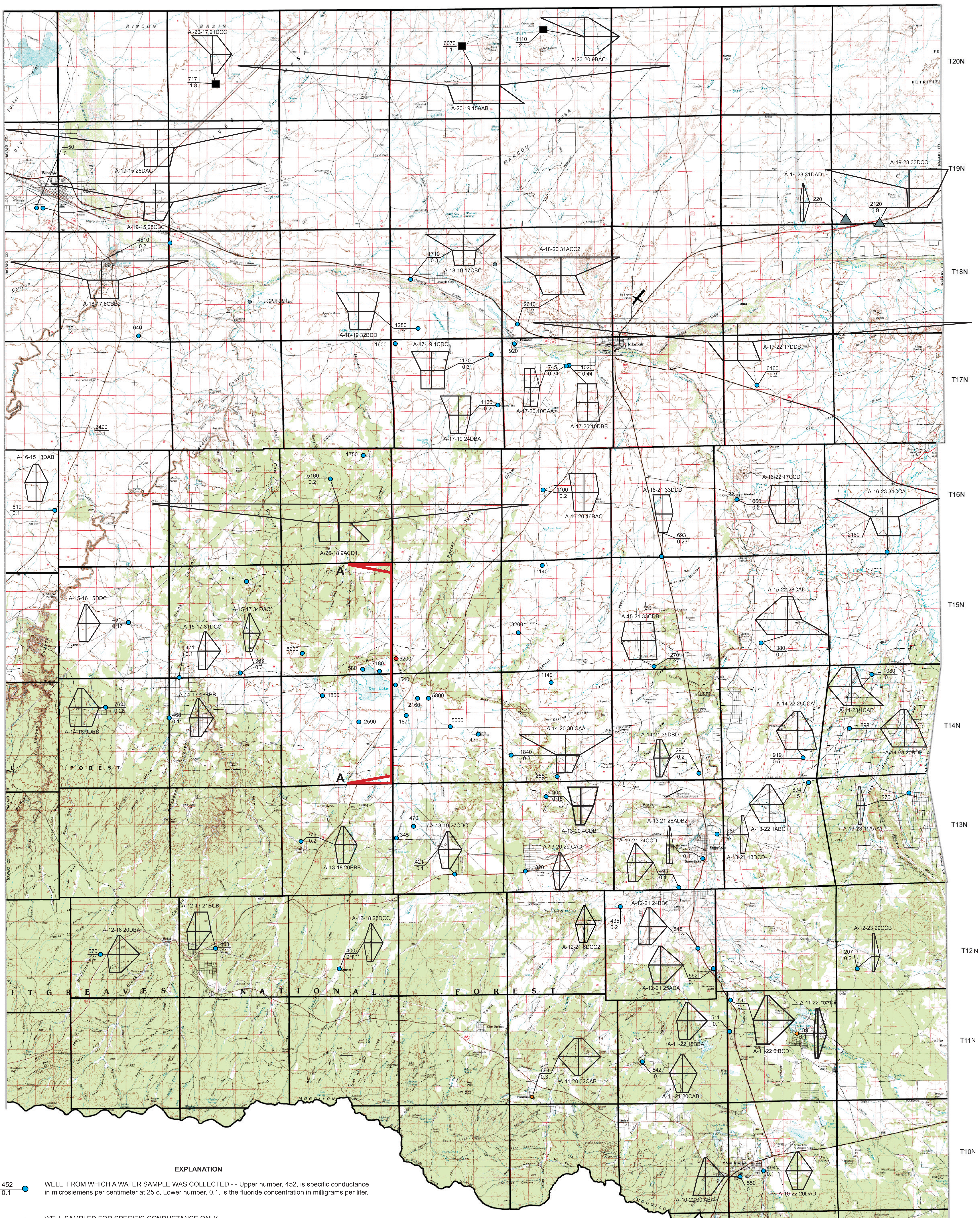
Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-16-22 17CCD	344644110024201	P S	5,165	450	587382.2	3848772.4	4/1/1971	55.5	5,110	
							1/31/1972	55.1	5,110	
Hydrograph G							2/14/1973	48.32	5,117	
Public Supply							2/13/1974	48.72	5,116	
							2/12/1975	49.02	5,116	
							1/26/1976	49.37	5,116	
							1/10/1977	49.45	5,116	
							1/11/1978	62.7	5,102	
							2/6/1979	49.6	5,115	
							1/23/1981	56.15	5,109	
							2/16/1982	55.1	5,110	
							3/10/1983	50.5	5,115	
							4/10/1984	51.7	5,113	
							4/18/1985	51.4	5,114	
							2/13/1986	50.4	5,115	
							3/19/1987	50.5	5,115	
							4/13/1988	51.4	5,114	
							8/17/1989	55.8	5,109	
							11/6/1990	53.4	5,112	
							10/28/1991	52.9	5,112	
							10/27/1992	52.2	5,113	
							11/2/1994	52.2	5,113	
							10/31/1995	53.1	5,112	
							10/30/1996	53.2	5,112	
							10/15/1997	53.2	5,112	
							10/19/1999	53.9	5,111	
							10/17/2000	53.7	5,111	
							4/23/2001	54.22	5,111	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-17-20 26DBC	345023110111401	U	5,360	570	574390.7	3855342.9	1/5/1971	297.22	5,063	
							2/22/1972	297.2	5,063	
Hydrograph H							3/19/1973	297.08	5,063	
Unused							2/19/1974	297.14	5,063	
							12/18/1974	297.63	5,062	
							1/26/1976	297.17	5,063	
							1/10/1977	297.37	5,063	
							1/11/1978	297.59	5,062	
							2/20/1979	297.71	5,062	
							11/30/1979	297.4	5,063	
							1/26/1981	298.17	5,062	
							2/22/1982	298.4	5,062	
							4/26/1983	298.4	5,062	
							4/11/1984	298.6	5,061	
							4/19/1985	298.7	5,061	
							2/13/1986	299.1	5,061	
							4/29/1987	299.2	5,061	
							4/14/1988	299.3	5,061	
							8/21/1989	300.6	5,059	
							11/5/1990	300.6	5,059	
							10/28/1991	300.8	5,059	
							10/27/1992	300.8	5,059	
							10/25/1993	301.1	5,059	
							11/2/1994	301.5	5,059	
							10/31/1995	302.6	5,057	
							10/28/1996	301.7	5,058	
							10/13/1997	302.2	5,058	
							10/19/1998	302.6	5,057	
							10/18/1999	302	5,058	
							10/17/2000	303.1	5,057	
							11/6/2001	303.5	5,057	
							10/22/2002	304.1	5,056	
							10/21/2003	304.45	5,056	
							10/19/2004	305.1	5,055	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-17-21 10CBA	345310110062501	U	5,141	285	581608.03	3860641.5	3/31/1971	52.88	5,088	
							2/1/1972	52.8	5,088	
Hydrograph I							4/10/1973	52.5	5,089	
Unused							1/28/1974	52.6	5,088	
							2/11/1975	52.68	5,088	
							1/26/1976	52.7	5,088	
							1/10/1977	52.75	5,088	
							1/11/1978	52.9	5,088	
							2/6/1979	52.58	5,088	
							11/30/1979	52.5	5,089	
							1/21/1981	53.65	5,087	
							2/24/1982	49.5	5,092	
							4/21/1983	53.5	5,088	
							2/16/1984	54	5,087	
							4/19/1985	53.8	5,087	
							2/13/1986	54.2	5,087	
							3/19/1987	53.6	5,087	
							4/14/1988	53.7	5,087	
							8/17/1989	54.6	5,086	
							11/5/1990	53.3	5,088	
							10/28/1991	54.5	5,087	
							10/27/1992	54	5,087	
							10/26/1993	54.2	5,087	
							11/2/1994	54.4	5,087	
							10/31/1995	54.7	5,086	
							10/30/1996	54.9	5,086	
							10/14/1997	54.5	5,087	
							10/20/1998	56	5,085	
							10/19/1999	55	5,086	
							10/17/2000	55.3	5,086	
							10/16/2001	55.2	5,086	
							10/22/2002	56.79	5,084	
							10/26/2002	55.3	5,086	
							10/21/2003	56.05	5,085	
							10/19/2004	56.5	5,085	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-19-16 06CDB	350417110413301	H	4,830	195	528087	3880743.8	2/12/1975	41.2	4,789	
							1/21/1976	40.7	4,789	
Hydrograph J							3/9/1978	40.4	4,790	
Domestic							1/3/1979	40.1	4,790	
							1/13/1980	39.36	4,791	
							1/10/1981	39.2	4,791	
							11/7/1990	41.5	4,789	
							10/28/1991	42	4,788	
							10/28/1992	42.4	4,788	
							10/27/1993	38.9	4,791	
							11/1/1994	39.5	4,791	
							11/2/1995	41.6	4,788	
							10/31/1996	40.7	4,789	
							10/16/1997	41.3	4,789	
							10/21/1998	40	4,790	
							10/20/1999	40.4	4,790	
							10/18/2000	41.6	4,788	
							10/17/2001	41.7	4,788	
							10/24/2002	42.2	4,788	
							10/23/2003	42.85	4,787	
							10/21/2004	46	4,784	

Cadastral	Site Id	Water Use	Well Altitude	Well Depth	UTM East	UTM North	Date	Depth to Water	Altitude	Remark
A-19-16 36DBB	350002110355501	U	4,890	610	536628.1	3872980.6	2/10/1976	37.4	4,853	
							1/14/1977	36.5	4,854	
Hydrograph K							3/14/1978	33.97	4,856	
Unused							2/9/1979	30.89	4,859	
							1/13/1980	35.24	4,855	
							12/29/1980	35.53	4,854	
							4/13/1982	34.45	4,856	
							11/7/1990	35.4	4,855	
							10/29/1991	35.86	4,854	
							10/28/1992	35.2	4,855	
							10/27/1993	35.8	4,854	
							11/1/1994	36.1	4,854	
							11/2/1995	36.8	4,853	
							10/31/1996	36.5	4,854	
							10/16/1997	37	4,853	
							10/21/1998	34.7	4,855	
							10/20/1999	35.3	4,855	
							10/18/2000	36.3	4,854	
							10/17/2001	46.8	4,843	
							10/23/2002	36.61	4,853	
							10/23/2003	37.05	4,853	
							10/20/2004	38.95	4,851	



EXPLANATION

452 / 0.1 — WELL FROM WHICH A WATER SAMPLE WAS COLLECTED - - Upper number, 452, is specific conductance in microsiemens per centimeter at 25 c. Lower number, 0.1, is the fluoride concentration in milligrams per liter.

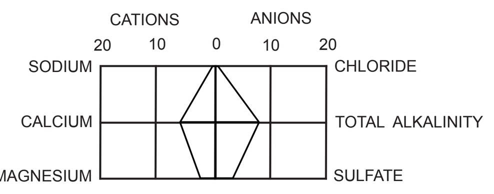
345 — WELL SAMPLED FOR SPECIFIC CONDUCTANCE ONLY

WELL KEY

- WELL COMPLETED IN ALLUVIUM
- WELL COMPLETED IN VOLCANIC ROCKS
- WELL COMPLETED IN CRETACEOUS ROCKS
- WELL COMPLETED IN CHINLE FORMATION
- WELL COMPLETED IN COCONINO SANDSTONE
- WELL COMPLETED IN SUPAI GROUP

Formation source:
Groundwater site inventory (GWSI) and or well registration logs

STIFF DIAGRAM - - Shows major chemical constituents in milliequivalents per liter. The diagrams are in a vareity of shapes and sizes, providing a means of comparing, correlating, and characterizing similar or dissimilar types of water.



N
S

6 3 0 Miles

Water Quality

Beginning in 1992 ADWR started collecting groundwater quality samples from wells in southern Navajo County. A total of 57 detailed analyses were obtained from these samples. These analyses are displayed in the form of Stiff diagrams on sheet 6. Stiff diagrams represent the ionic content of the samples and are used to compare and contrast groundwater water quality from place to place. The left side of the Stiff diagram represents the cationic values (+) for sodium, calcium and magnesium while the right side represents the anionic values (-) for chloride, bicarbonate (expressed as total alkalinity) and sulfate. The Stiff diagram well points are also color coded to identify the geologic formation from which the sample was obtained. Specific conductance and fluoride values are also displayed next to the well point. Water samples from some wells were tested for conductance values only.

Specific conductance is an indirect way of measuring the amount of dissolved solids in water. Dissolved solids can be approximated by multiplying specific conductance values by 0.66, which is the approximate ratio of dissolved solids in mg/l (milligrams per liter) to specific conductance in microsiemens per centimeter (μS/cm) at 25 °C. The Environmental Protection Agency (1988) has established a secondary maximum contaminate level (SMCL) for dissolved solids at 500mg/l, which is the approximate equivalent to a specific conductance value of 833 μS/cm. Secondary levels are based on aesthetic qualities such as taste, odor and color and are only guidelines, not enforceable standards.

Specific conductance levels range from a very low 168 μS/cm to 339 μS/cm in the volcanic member of the Pinetop-Lakeside aquifer. The specific conductance value from the Cretaceous unit was 301 μS/cm. Values between Pinetop and Show Low in the C aquifer range from 220 – 550 μS/cm. Similar values are found in the Heber area, eastward toward Silver Creek and down gradient towards Snowflake. North of Snowflake and from the Hay Hollow area down into the Little Colorado River valley, conductance values increase above the 833 μS/cm level. This area is mostly where the aquifer is confined. Akers (1964) suggests that the higher conductance values are the result of upward leakage via hydrostatic pressure from the highly mineralized water of the underlying Supai Group.

Conductance values above 833 μS/cm are also found along the front of and the back slope of the Holbrook Anticline. Here the highly mineralized Supai Group is situated at or near the top of the water table (Cross-section A-A'). The aquifer is unconfined in this area and the upwarping of the anticline has displaced both the Coconino Sandstone and the Supai Group on the backside or northern limb of the anticline such that the top of the water table is near the contact between the bottom of the Coconino and the top of the Supai (Hunt, 1956). Conductance values along the front of the anticline probably fluctuate in response to the cycle of ponding and drainage events associated with the dissolution processes of the collapse structures there.

Fluoride levels in all the aquifers of southern Navajo County are well below the maximum contaminant level of 4 mg/l as set by the Arizona Department of Environmental Quality, (1991) with the highest level measured at a spring issuing from the Chinle Formation at 2.1 mg/l.

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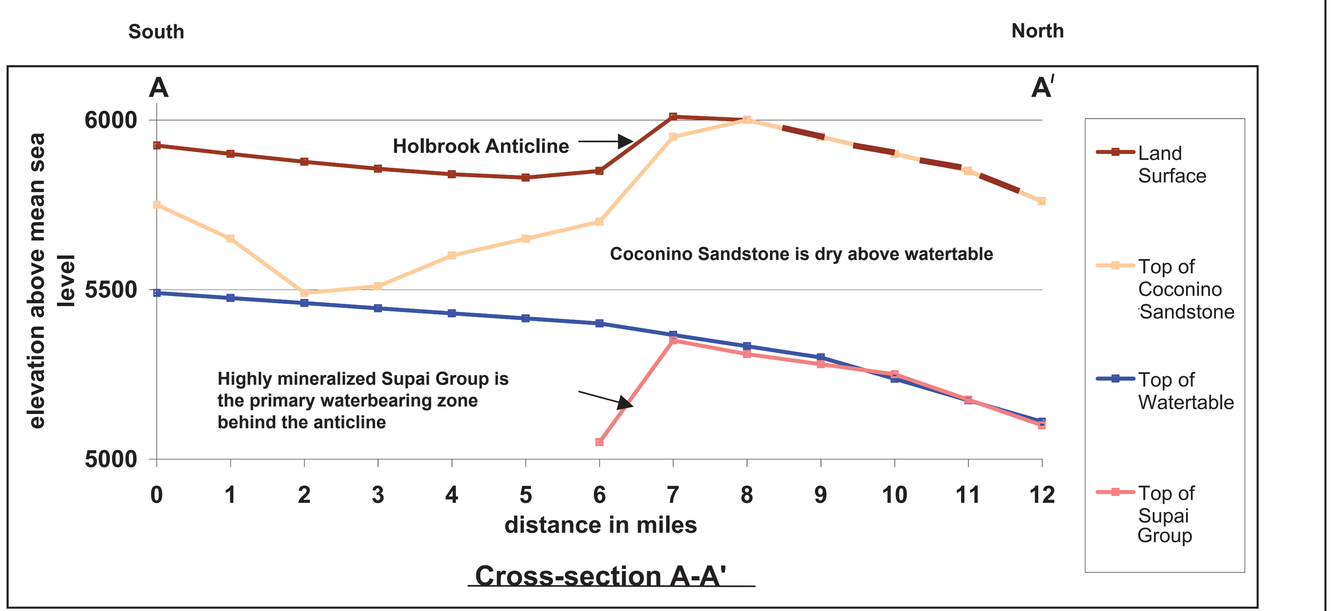

Cross-section A-A'

Sources: Land Surface - adapted from topographical map background, Scale 1:100,000
Top of Coconino Sandstone: Conley, 1977.
Top of Water table from sheet 1.
Top of Supai Group - adapted from well log (A-15-19) 31bbb, 55-526801

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MAP SHOWING WATER QUALITY IN SOUTHERN NAVAJO COUNTY, ARIZONA

BY

A. E. OVERBY

THESE HYDROLOGIC MAPS ARE AVAILABLE UPON REQUEST FROM THE ARIZONA DEPARTMENT OF WATER RESOURCES, INFORMATION CENTRAL, 3550 NORTH CENTRAL AVE, PHOENIX, ARIZONA, 85012. THE HYDROLOGIC DATA ON WHICH THESE MAPS ARE BASED ARE AVAILABLE AT THE ADWR BOOKSTORE. 602 771-8638

navajo qw wells

SITE_WELL_SITE_ID	SITE_UTM_EAST	SITE_UTM_NORTH
A-08-23 04BCC1	598958.868	3775817.268
A-08-23 10BAD1	601099.396	3774515.395
A-08-23 11ABC	602994.745	3774597.531
A-09-22 04DBB	590772.529	3785160.824
A-09-22 26CBC	593218.268	3778561.872
A-09-23 31DAD	598076.941	3776855.397
A-10-22 20DAD	589731.408	3789648.225
A-10-22 30ABA	587664.04	3789135.8
A-11-20 32CAB	569346.031	3796159.44
A-11-21 20CAB	579059.358	3799255.253
A-11-22 06BCD	586828.801	3804684.215
A-11-22 15ADB	592681.626	3801721.626
A-11-22 18BBD	586752.128	3801941.89
A-12-16 20DBA	531319.831	3808706.419
A-12-17 21BCB	541476.729	3809269.739
A-12-18 35ACC	555255.038	3805860.636
A-12-21 06DDC2	577111.698	3812269.011
A-12-21 24BBC	583952.656	3809247.758
A-12-21 25ADA	585347.995	3807412.158
A-12-23 29CCB UNS	598012.524	3807444.341
A-13-18 20BBB	549008.417	3818608.619
A-13-19 27CDC	562542.404	3815794.428
A-13-20 04CDB	570602.131	3822629.042
A-13-20 29CCA	568739.057	3816053.828
A-13-21 13DCD	585646.926	3819305.626
A-13-21 26ADB2	584391.315	3817168.573
A-13-21 32CDD1	578981.153	3814502.61
A-13-22 01ABC	593710.676	3823819.631
A-13-23 11AAA	602590.974	3822927.852
A-14-16 09DBB	531806.775	3830454.114
A-14-17 18BBB	537413.144	3829520.224
A-14-20 30CAA	567517.226	3826210.126
A-14-21 35DBD	584042.926	3824651.075
A-14-22 25CCA	593255.385	3826002.285
A-14-23 04CAB	599318.134	3833335.814
A-14-23 20BDB	597305.407	3828600.922
A-15-16 15DDC	533791.295	3837915.362
A-15-17 31DCC	538264.283	3833096.803
A-15-17 34DAC	543634.344	3833490.241
A-15-21 33CDB	580138.664	3834042.882
A-15-22 28CAD	589487.741	3836131.155
A-16-15 13DAB	527298.665	3847843.129
A-16-18 09ACC1	551583.371	3850596.477
A-16-20 16BAC	570319.762	3849611.834
A-16-21 33DDD	580741.28	3843721.13
A-16-22 17CCD	587382.243	3848772.461
A-16-23 34CCA	600625.877	3844163.483
A-17-19 01CDA	565735.481	3861561.145
A-17-19 24DBA	566351.6	3857098.793
A-17-20 10CAA	572368.699	3860502.184
A-17-20 10DBB	572596.424	3860596.405
A-17-22 17DDB	589165.781	3858801.944
A-18-17 06CBB2	537471.18	3871382.296
A-18-19 17CBC	558662.455	3868136.19
A-18-19 32BDD	559273.562	3863858.197
A-18-19 33DAD2	561789.37	3863320.356
A-18-20 31AAC2	568076.192	3864227.559
A-19-15 25CBC	526256.317	3874454.323
A-19-15 26DAC	525698.749	3874452.733
A-19-23 33DCC	599901.31	3873238.914
A-20-17 21DCC4	541489.021	3885415.914
A-20-20 09BAC	570336.731	3890183.872
A-20-19 15AAB	563085.296	3888682.583