ADEQ
Arizona Department of Environmental Quality
Janice K. Brewer, Governor
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FACT SHEET

Ambient Groundwater Quality of the Aravaipa Canyon Basin: A 2003 Baseline Study – May 2013

INTRODUCTION

A baseline groundwater quality study of the Aravaipa Canyon basin was conducted in 2003 by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring Program. ADEQ carried out this task pursuant to Arizona Revised Statutes §49-225 that mandates ongoing monitoring of waters of the state including its aquifers. This fact sheet is a synopsis of the ADEQ Open File Report 13-01.[1]

The Aravaipa Canyon groundwater basin covers approximately 517 square miles in southeastern Arizona within Graham and Pinal counties (Map 1). Largely undeveloped, the remote basin has an estimated 135 residents and includes the community of Klondyke.[2] Low-intensity livestock grazing is the predominant land use although there are some irrigated fields and orchards along Aravaipa Creek. Historic mining activity resulted in the creation of the Klondyke Tailings Water Quality Assurance Revolving Fund (WQARF) site in 1998.[3] Groundwater is used for all domestic purposes within the basin as well as most irrigation and stock water supplies. Irrigation uses the most groundwater in the basin.[2]

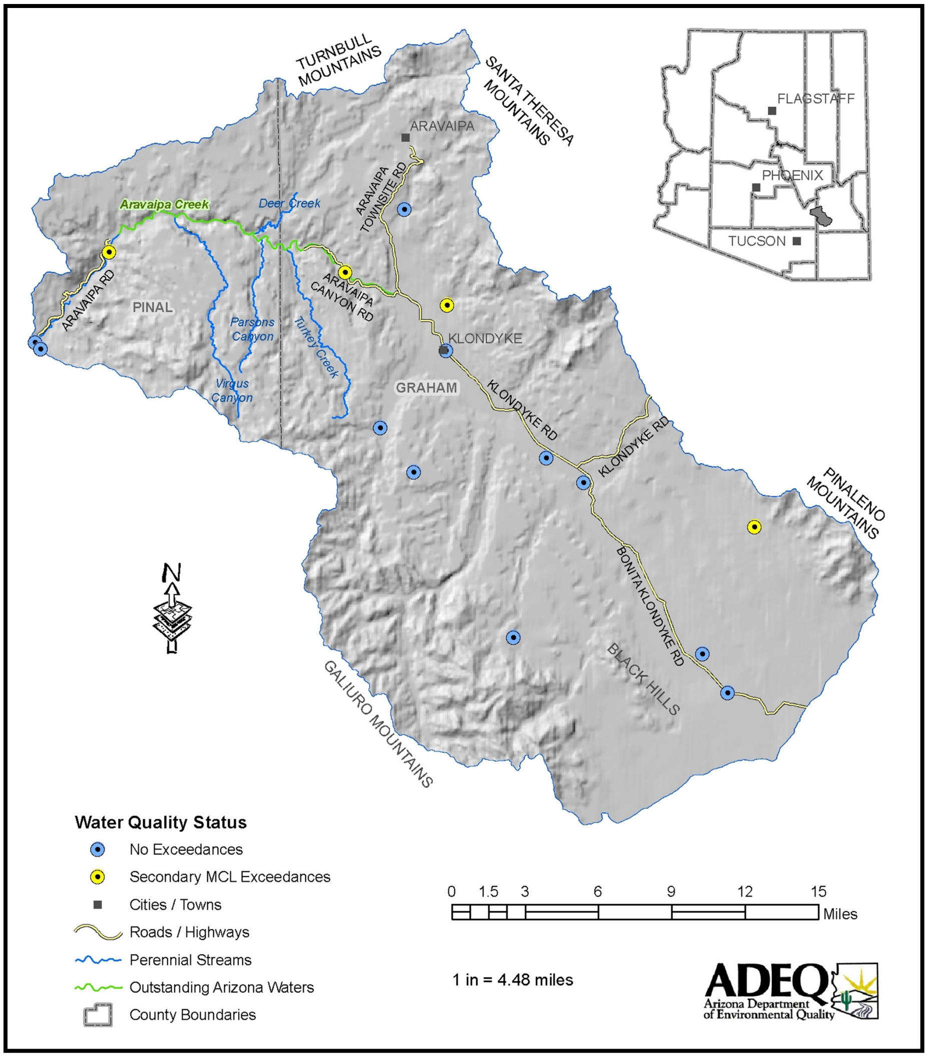
The basin is bounded on the north by the Turnbull Mountains, on the northeast by the Santa Theresa and Pinaleno mountains, and on the southwest by the Galiuro Mountains. To the southeast, a subtle ridge forms the boundary between the Aravaipa Canyon and Willcox groundwater basins. Elevations range from 7,540 feet above mean sea level (amsl) at Kennedy Peak in the Galiuro Mountains to 2,400 feet amsl where Aravaipa Creek flows into the Lower San Pedro groundwater basin. The basin consists of federal land managed by the U.S. Forest Service (26 percent) and Bureau of Land Management (BLM) (21 percent), State Trust lands (38 percent), private land (14 percent) and Native American land (1 percent) of the San Carlos Apache Tribe.[2]

Figure 1 - A perennial reach of Aravaipa Creek created by groundwater being brought to the surface by bedrock in Aravaipa Canyon. This stream segment was named one of Arizona's Heritage Waters in 2007 based on its cultural, historical, political, scientific and social significance. [4]

SURFACE WATER HYDROLOGY

The basin is drained by Aravaipa Creek, a tributary to the San Pedro River. The creek flows from the southeast to the northwest. The creek is intermittent in its upper reach but has perennial flow where bedrock brings groundwater to the surface at Araviapa Spring. Perennial flow typically lasts for 17 miles until surface water infiltrates into streambed alluvium about five miles above its confluence with the San Pedro River. [2]

The perennial segment of Aravaipa Creek was named an Arizona Heritage Water based on its cultural, historical, political, scientific, and social significance.[4] This stretch is partially located within the 19,700-acre Aravaipa Canyon Wilderness Area, administered by the BLM, and the 9,000-acre Aravaipa Canyon Preserve managed by the Nature Conservancy. Both entities have instream-flow rights that are used to maintain base flows for conservation purposes.[4]



Map 1 – Sample sites in the Aravaipa Canyon basin are color-coded according to their water quality status: No Water Quality Exceedences and Secondary MCLs Exceedences.

GROUND WATER HYDROLOGY

Groundwater occurs primarily in two aquifers: stream alluvium and basin-fill alluvium. The main aquifer is stream alluvium which varies in width from 0.5 to 1 mile following Araviapa Creek and some of its major tributaries. Streambed alluvium is very productive, yielding up to 1,500 gallons per minute. Fine-grained lake bed sediments separate the stream alluvium from the basin-fill alluvium, causing confined conditions in the latter aquifer. Well yields in the basin-fill aquifer are variable but tend to be much less than the streambed alluvium aquifer. Minor amounts of groundwater are found in the surrounding bedrock, especially along faults, fracture zones, and/or localized perched aquifers.[2]

Groundwater flow direction is from the surrounding mountains to the valley floor and then northwest towards Aravaipa Canyon. Total recharge in the basin is estimated to range from 7,000 to 16,700 acre feet per year. Streambed infiltration of runoff is the primary source of recharge for the streambed aquifer and mountain-front recharge replenishes the basin-fill aquifer.[2]

METHODS OF INVESTIGATION

To characterize the basin's regional groundwater quality, samples were collected from 15 sites (13 wells and two springs). None of the samples appeared to be water from the confined, basin-fill aquifer. Field data indicated none of the wells were flowing and drill logs were not available for most wells.

Inorganic constituents, radon, and isotopes (oxygen and deuterium) were collected from each site. Sampling protocol followed the ADEQ Quality Assurance Project Plan (see www.azdeq.gov/function/programs/lab/). The effects of sampling equipment and procedures were found to be not significant based on quality assurance/quality control evaluations.

WATER QUALITY SAMPLING RESULTS

Groundwater sample results were compared with the Safe Drinking Water Act (SDWA) water quality standards. Public drinking water systems must meet these enforceable, health-based, water quality standards, called Primary Maximum Contaminant Levels (MCLs), when supplying water to their customers. Primary MCLs are based on a daily lifetime (70 years) consumption of two liters of water.[5] Primary MCLs were not exceeded at any of the 15 sites.

Groundwater sample results were also compared with SDWA water quality guidelines. Public drinking water systems are encouraged by the SDWA to meet these unenforceable, aesthetics-based water quality guidelines, called Secondary MCLs, when supplying water to their customers. Water exceeding Secondary MCLs may be unpleasant to drink and/or create unwanted cosmetic or laundry effects but is not considered a health concern.[5] Of the 15 sites sampled, four (27 percent) had constituent concentrations that exceeded Secondary MCLs. Constituents above Secondary MCLs include fluoride (three sites) and manganese (one site).

Radon is a naturally occurring, intermediate breakdown product from the radioactive decay of uranium-238 to lead-206. Of the 15 sites sampled for radon, none exceeded the proposed 4,000 picocuries per liter (pCi/L) standard that would apply if Arizona establishes a multimedia program to address the health risks from radon in indoor air. Seven sites (47 percent) exceeded the proposed 300 pCi/L standard that would apply if Arizona does not develop a multimedia program.[5]

Figure 2 – A domestic well drilled in the floodplain down-gradient of the Aravaipa Canyon Wilderness Area.

GROUNDWATER COMPOSITION

Groundwater chemistry in the basin is most commonly calcium-bicarbonate. Levels of pH measured in the field were *alkaline* (above seven standard units) at all 15 sites and three sites exceeded eight standard units. Total dissolved solids (TDS) concentrations were considered *fresh* (below 999 mg/L) at all 15 sites. Hardness concentrations were *soft* (below 75 mg/L) at one site, *moderately hard* (75 - 150 mg/L) at six sites, and *hard* (150 - 300 mg/L) at eight sites. Nitrate (as nitrogen) concentrations do not appear to have been influenced by human activities, being divided into *natural background* (three sites at <0.2 mg/L) and *may or may not indicate human influence* (12 sites at 0.2 – 3.0 mg/L).[6] Most trace elements such as aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc were rarely detected. Only fluoride was detected at more than one third of the sites.

Oxygen and deuterium isotope values at most sites appeared to consist of recently recharged winter precipitation. Two sites with more enriched isotope values appeared to consist of recently recharged summer precipitation.[7]

GROUNDWATER PATTERNS

Some groundwater constituent concentrations appear to be influenced by recharge source and geology. Constituents such as temperature, specific conductivity (SC), TDS, bicarbonate, oxygen-18, and deuterium had significantly greater concentrations in recent summer precipitation than in recent winter precipitation. Constituents such as SC, TDS, calcium, bicarbonate, chloride, and oxygen-18 had significantly greater concentrations in sites located in consolidated rock than in unconsolidated sediment (Kruskal-Wallis test, $p \leq 0.05$).

DISCUSSION

Groundwater in the basin is suitable for drinking water use based on the results of this ADEQ ambient study. This conclusion is supported by a number of other factors including limited development in the basin, the results of other ADEQ ambient groundwater studies in the region, and limited data from prior studies in the basin conducted by the U.S. Geological Survey in 1975 and ADEQ's WQARF program in 2001. In the latter study, 15 wells sampled in the vicinity of the Klondyke WQARF site by ADEQ had "very good groundwater quality." [3]

Secondary MCL exceedances for fluoride may be the result of hydroxyl ion exchange or sorption-desorption reactions. These have been cited as providing controls on lower (< 5 mg/L) levels of fluoride. As pH values increase downgradient, greater levels of hydroxyl ions may affect an exchange of hydroxyl for fluoride ions thereby increasing the levels of fluoride in solution.[8] The pH level of only one of the three exceedances however, appears to follow this pattern so there may be yet other influences causing the elevated fluoride concentrations.

The only other Secondary MCL exceedance was an elevated concentration of manganese. Groundwater in the Aravaipa Canyon basin would normally be expected to be oxidizing and have very low manganese concentrations. The one sample site however, appears to be have a reducing environment, or one in which there is a decrease in the groundwater oxidation state, as evidenced by not only the elevated manganese concentrations but also the basin's only detections of iron and ammonia.[8] Thus, the Secondary MCL for manganese appears to be site specific and not reflective of regional groundwater conditions.

Some aspects of groundwater quality in the Aravaipa Canyon basin remain uncharacterized. Radionuclide samples were not collected at any of the sample sites and these constituents are often elevated by mining activity such as the Klondyke tailings piles. ADEQ's WQARF program also did not collect radionuclide samples at any wells.[3] Radionuclide constituents such as gross alpha and uranium often exceed drinking water standards in Arizona. Also uncharacterized by the study is the confined, basin-fill aquifer. During sample collection, no samples were collected from wells known to be producing water from this aquifer. In nearby basins, samples from confined aquifers often had water quality exceedances for fluoride, arsenic, and TDS.

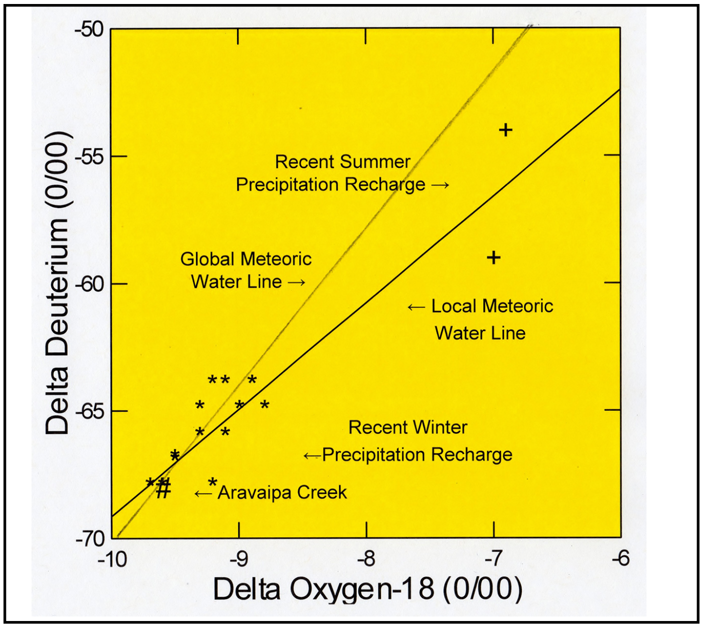


Figure 3 – Isotope samples are plotted according to their oxygen-18 and deuterium values and fall into two groups: recent summer and recent winter precipitation. A surface water sample from Aravaipa Creek consisted of recent winter precipitation.

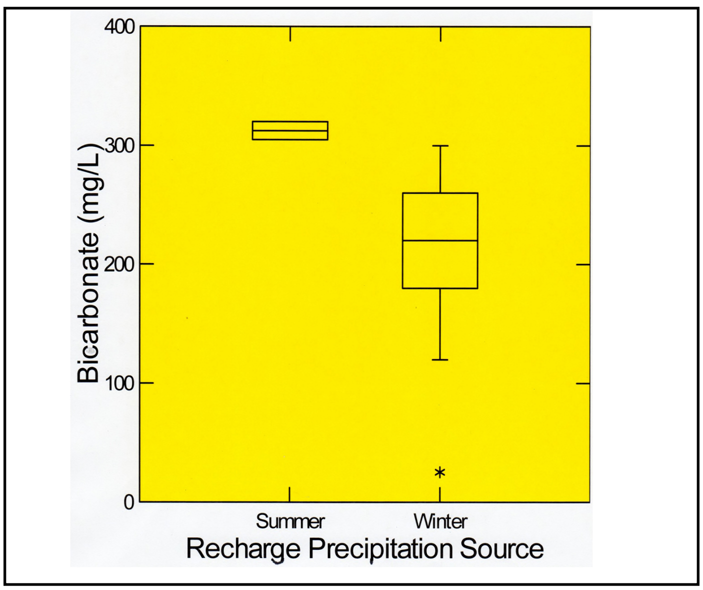


Figure 4 – Sample sites with summer recharge have significantly higher bicarbonate concentrations than sample sites derived from winter recharge (Kruskal-Wallis, $p \leq 0.05$). Elevated bicarbonate concentrations are often associated with recharge areas.

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Maps by Jean Ann Rodine

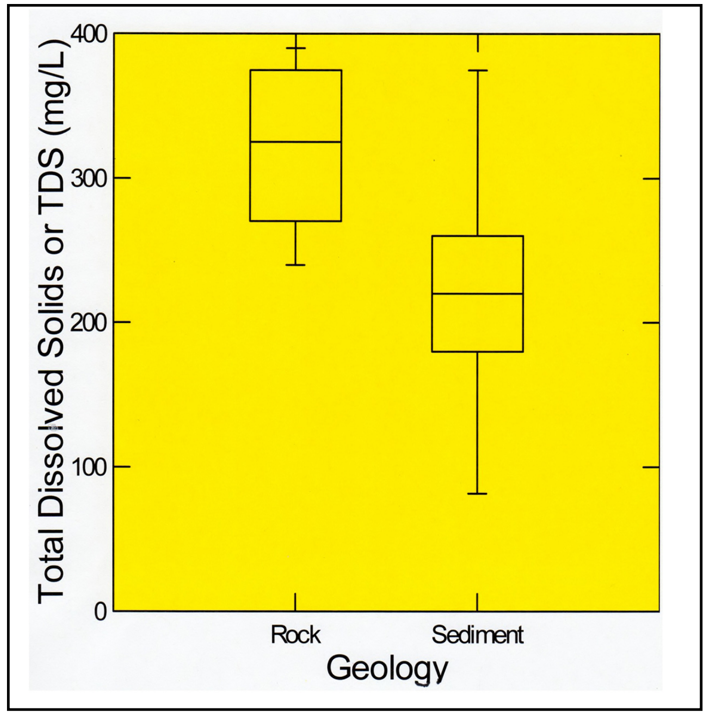

Figure 5 – Sample sites located in consolidated rock have significantly higher hardness concentrations than sample sites located in unconsolidated sediment (Kruskal-Wallis, $p \leq 0.05$). Other groundwater basins in Arizona have also had more mineralized groundwater in hardrock areas than the valley alluvium.

References Cited

1 Towne, D.C., 2013, Ambient groundwater quality of the Aravaipa Canyon basin: A 2003 baseline study: Arizona Department of Environmental Quality Open File Report 13-01, 47 p.

2 Arizona Department of Water Resources Web site, www.azwater.gov/azdwr/default.aspx, accessed 02/4/13.

3 Arizona Department of Environmental Quality, 2009, Klondyke Tailings Water Quality Assurance Revolving Fund (WQARF) Site. ADEQ WQARF program, ADEQ Factsheet 09-16, 2 p.

4 Arizona Heritage Waters website, 2013, http://www.azheritage-waters.nau.edu/loc_aravaipa_creek.html, accessed 01/9/13.

5 U.S. Environmental Protection Agency website, www.epa.gov/waterscience/criteria/humanhealth/, accessed 11/20/12.

6 Madison, R.J., and Brunett, J.O., 1984, Overview of the occurrence of nitrate in ground water of the United States, in National Water Summary 1984-Water Quality Issues: U.S. Geological Survey Water Supply Paper 2275, pp. 93-105.

7 Earman, Sam, et al, 2003, An investigation of the properties of the San Bernardino groundwater basin, Arizona and Sonora, Mexico: Hydrology program, New Mexico Institute of Mining and Technology, 283 p.

8 Robertson, F.N., 1991, Geochemistry of ground water in alluvial basins of Arizona and adjacent parts of Nevada, New Mexico, and California: U.S. Geological Survey Professional Paper 1406-C, 90 p.

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