FACT SHEET

Ambient Groundwater Quality of the Ranegras Plain Basin: A 2008-2011 Baseline Study – June 2012

INTRODUCTION

A baseline groundwater quality study of the Ranegras Plain basin was conducted from 2008 through 2011 by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring Program. ADEQ carried out this task pursuant to Arizona Revised Statutes §49-225 which mandates ongoing monitoring of waters of the state including its aquifers. This fact sheet is a synopsis of the ADEQ Open File Report 11-07.[1]

The Ranegras Plain groundwater basin covers approximately 912 square miles in western Arizona within La Paz County (Map 1).[2] Interstate 10 and U.S. Highway 60 cross the basin east to west and the Central Arizona Project aqueduct crosses the basin in a northwest-southeast direction. Although lightly populated, the basin includes the communities of Bouse, Brenda, Hope, Vicksburg, and Vicksburg Junction. Many residents are seasonal visitors who live in the north-central portion of the basin.

The Ranegras Plain is at the center of the basin and is bordered by the New Water, Kofa, and Plomosa Mountains in the west, Little Horn Mountains in the south, the Eagletail, Little Harquahola and Granite Wash Mountains to the east, and the Bouse Hills to the north. Elevations range from 2,805 feet in the New Water Mountains to 930 feet near the community of Bouse.[2] The basin consists predominantly of federal land managed by the Bureau of Land Management (66 percent) and the U.S. Fish and Wildlife (16 percent) which administers the Kofa National Wildlife Refuge in the southwest portion of the basin. Private lands (11 percent) and State Trust lands (7 percent) are generally found in the center of the basin.[3]

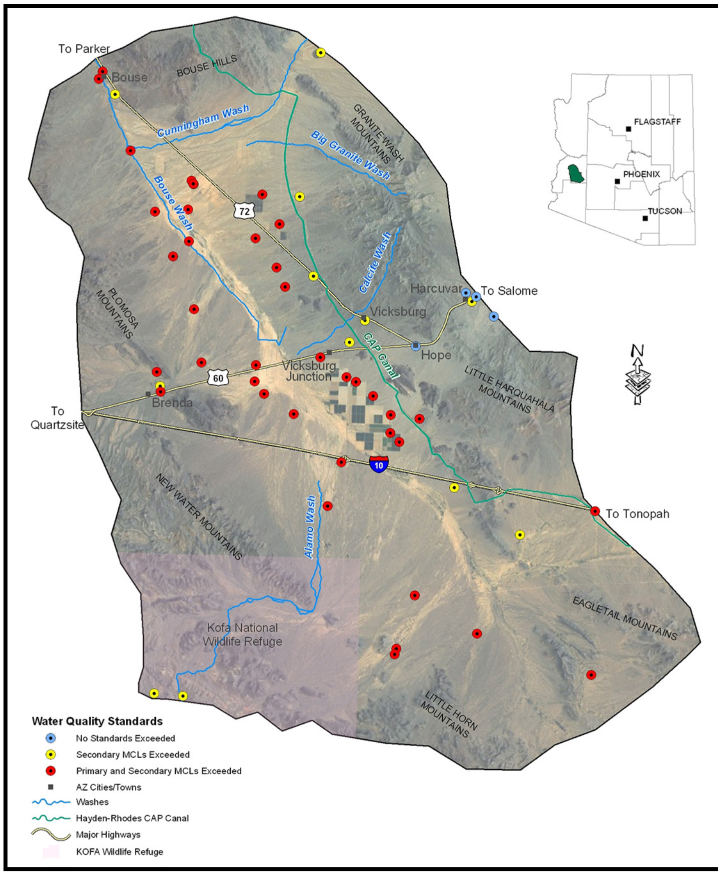
Figure 1 – With Coyote Peak in the background, ADEQ's Susan Determann collects a sample from Spreaders House Well located south of Interstate 10. The well, used for stock watering, had nitrate concentrations four times the drinking water quality standard.

HYDROLOGY

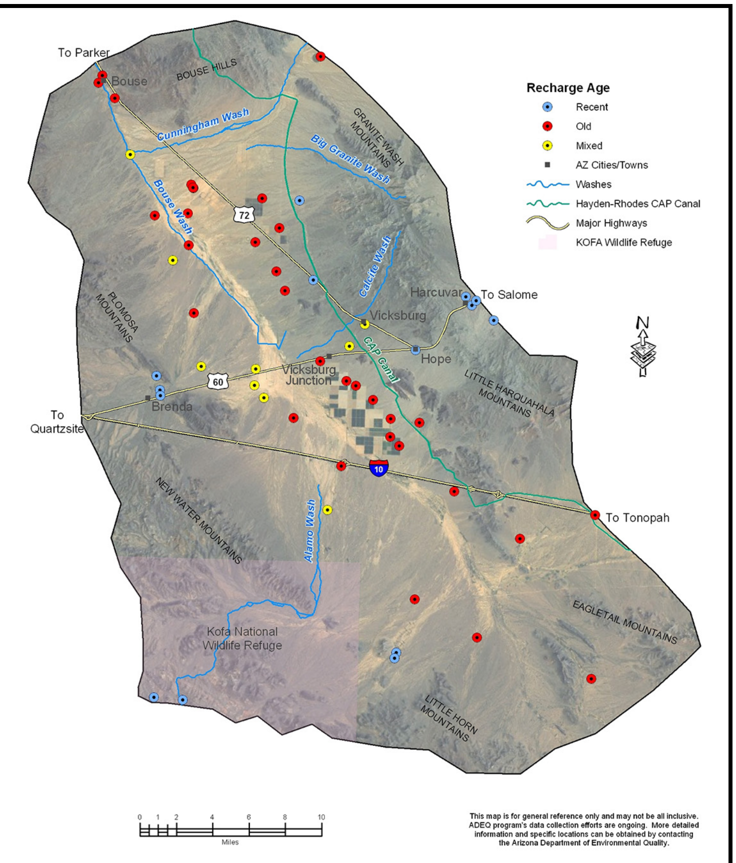
The basin's main drainage is the ephemeral Bouse Wash which heads in the southeast portion and exits the basin to the northwest near Bouse. There are no perennial or intermittent streams or lakes within the basin.[3] Groundwater is the sole source for all domestic, public, and irrigation purposes and most stock uses in the basin.[3]

The basin's main aquifer is the lower basin fill which is composed of clay, sand, gravel, volcanics, and conglomerate.[2] The lower basin fill is overlain by a fine-grained unit that contains evaporates in its lower part.[4] Well yields vary widely though most wells have low to moderate production rates because of the high clay content of the basin fill.[2] The surrounding mountain areas sometimes produce small quantities of groundwater.[4] Groundwater levels vary from approximately 450 feet below ground in the eastern part of the basin near the mountain fronts to 30 feet below ground near Bouse.[2] There is an estimated 21.7 million acre-feet of water available in the basin to a depth of 1,200 feet.[3]

Surface flow moves from the surrounding mountains toward the central axis of the basin and follows the Bouse Wash to the northwest. In general, groundwater movement follows surface flow except where a cone of depression caused by irrigation pumping has occurred south of Vicksburg Junction.[2]



Map 1 – Sample sites in the Ranegras Plain basin are color-coded according to their water quality status.



Map 2 – Sample sites in the Ranegras Plain basin are color-coded according to their recharge age.

METHODS OF INVESTIGATION

To characterize regional groundwater quality, samples were collected from 55 sites consisting of 53 wells and 2 springs. The wells produced water for livestock (20), residence (16), irrigation (10), and semi-public supply (7) uses and the springs for wildlife purposes. Most samples were collected from sites located in the center and north-central parts of the basin as there were few wells available for sampling in undeveloped areas along the basin's margins and south of Interstate 10.

Inorganic constituents and oxygen and deuterium isotopes were collected at all 55 sites. Other samples collected include radon at 33 sites, radionuclide at 18 sites, and nitrogen isotopes at 10 sites. Sampling protocol followed the *ADEQ Quality Assurance Project Plan* (www.azdeq.gov/function/programs/lab/). The effects of sampling equipment and procedures were not found to be significant based on seven quality assurance/quality control tests.

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] Of the 55 sites sampled, 39 sites (71 percent) had constituent concentrations that exceeded Primary MCLs. Constituents exceeding Primary MCLs include arsenic (35 sites), chromium (4 sites), fluoride (28 sites), and nitrate (12 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 55 sites sampled, 51 (93 percent) had constituent concentrations that exceeded Secondary MCLs. Constituents above Secondary MCLs include chloride (16 sites), fluoride (40 sites), manganese (1 site), pH (4 sites), sulfate (25 sites), and total dissolved solids or TDS (44 sites).

Radon is a naturally occurring, intermediate breakdown product from the radioactive decay of uranium-238 to lead-206. Of the 33 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. Twenty-four (24) sites exceeded the proposed 300 pCi/L standard that would apply if Arizona does not develop a multimedia program.[5]

Figure 2 – ADEQ's Liz Boettcher samples Perry Well used for stock watering west of Vicksburg Junction. Isotope analysis indicated it produced a "mixed recharge" and only exceeded health-based water quality standards for arsenic.

GROUNDWATER COMPOSITION

Groundwater was predominantly of sodium-mixed chemistry that evolved into sodium-chloride or sodium-sulfate chemistry. Levels of pH-field were *slightly alkaline* (above 7 su) at all 55 sites. TDS concentrations were considered *fresh* (below 999 mg/L) at 37 sites, *slightly saline* (1,000 - 3,000 mg/L) at 15 sites, and *moderately saline* (3,000 - 10,000 mg/L) at three sites. Hardness concentrations were soft (below 75 mg/L) at 13 sites, *moderately hard* (75 – 150 mg/L) at 16 sites, hard (150 – 300 mg/L) at 12 sites, *very hard* (300 - 600 mg/L) at six sites and *extremely hard* (> 600 mg/L) at eight sites.

Most trace elements such as antimony, beryllium, cadmium, iron, lead, manganese, mercury, nickel, silver, thallium, and zinc were rarely – if ever - detected. Arsenic, barium, boron, chromium, copper, fluoride, and selenium were detected at more than 20 percent of the sites.

ISOTOPE COMPOSITION

Samples collected at 31 sites had isotope values that do not conform to what would be expected from recharge originating in the plain or surrounding low elevation mountains and are far more depleted than is possible given the basin's elevation (Figure 4). The samples likely consist of paleowater or "old recharge" that was predominantly recharged 8,000-12,000 years ago when the climate was cooler and subject to less evaporation.[6] Sites with "old recharge" were found throughout the basin but particularly in the central portion.

Situated slightly higher on the precipitation trajectory are samples from 10 wells that appear to consist primarily of "old recharge" but appear to also receive more recent recharge (Figure 4). These "mixed recharge" sites are located downgradient from sampled wells and springs that had groundwater consisting of recent recharge.[6]

Fourteen (14) isotope samples collected in the southwest and east-central portions of the basin are higher on the precipitation trajectory and more enriched (Figure 4). Their isotope values that suggest that much of the groundwater at these wells and springs consists of "recent recharge" stemming from precipitation originating in the Kofa, New Water, Plomosa, Granite Wash and Little Harquahala Mountains.

Nitrogen isotope ($\delta^{15}N$) samples were collected at 10 isolated stock wells. Results indicated that natural organic nitrogen was the major source of nitrate in groundwater with only minor inputs of waste associated with livestock lingering in adjacent corrals. Nitrogen isotope samples were not collected from irrigation wells with elevated nitrate concentrations. Nitrogen sources in agricultural areas are likely from fertilizer applications and effluent from dairy operations based on water quality patterns in other Arizona basins.

Figure 3 – After sampling Holly Seep (RAN-28) within the Kofa Wildlife Refuge Wilderness, ADEQ's Susan Determann poses next to the partially frozen water source. Consisting of "recent recharge," the site did not exceed any health-based water quality standards.

GROUNDWATER PATTERNS

Groundwater constituent concentrations appear to be strongly influenced by recharge age. Constituents such as pH-field, specific conductivity (SC), TDS, sodium, chloride, sulfate, arsenic (Figure 5), boron, chromium, and fluoride (Figure 6) had significantly greater concentrations in older recharge than recent recharge; hardness, magnesium, and bicarbonate had the opposite pattern (Kruskal-Wallis test, $p \leq 0.05$).

DISCUSSION

The most important determination impacting water quality in the Ranegras Plain basin is the recharge age of the groundwater. Recent recharge is generally preferred over old recharge as a water source for drinking water uses; however, this source is spatially limited and was found only in some peripheral areas of basin near the higher mountain ranges. Water quality at sites having a mixed recharge was slightly improved compared with

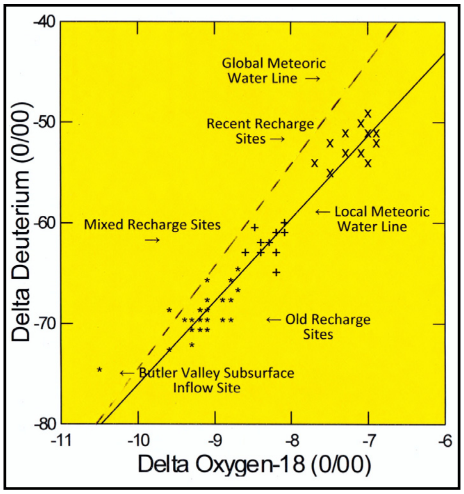


Figure 4 – The isotope samples are plotted according to their oxygen-18 and deuterium values and fall into three groups: recharge from recent precipitation, mixed recharge sites consisting predominately of older recharge, and older recharge from precipitation that occurred roughly 10,000 years ago when the basin's climate was much cooler.

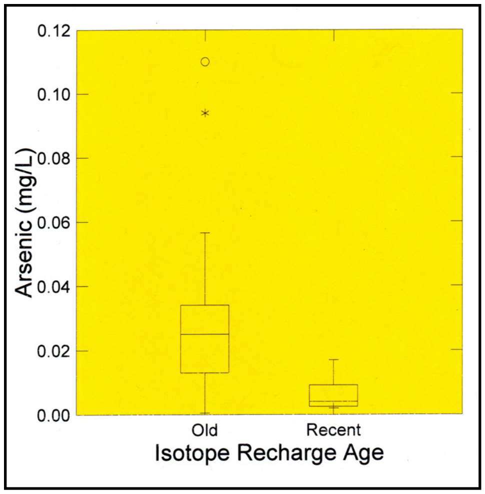


Figure 5 – Sample sites with older recharge have significantly higher arsenic concentrations than sample sites derived from more recent recharge (Kruskal-Wallis, $p \leq 0.01$). Most sample sites having older recharge exceeded the Primary MCL for arsenic while sites with recent recharge were generally below water quality standards. Arsenic concentrations are impacted by aquifer residence time.[4]

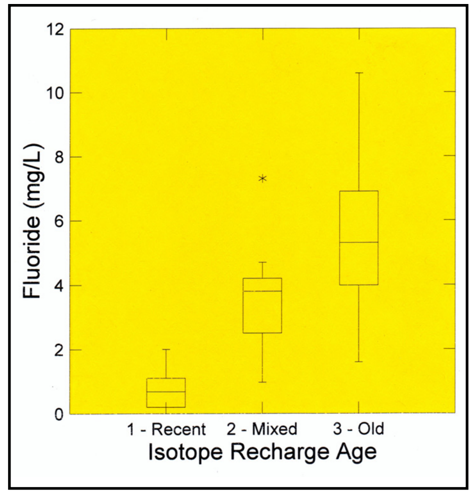


Figure 6. Sample sites with old recharge have significantly higher fluoride concentrations than sample sites derived from recent recharge. Mixed recharge sample sites have fluoride concentrations in between and significantly different from both recent and old recharge (Kruskal-Wallis with Tukey test, $p \leq 0.05$). Generally, fluoride concentrations in recent recharge are below both Primary and Secondary MCLs, fluoride concentrations in mixed recharge exceed the Secondary MCL of 2 mg/L, and fluoride concentrations in old recharge exceed the Primary MCL of 4 mg/L.

sites having old recharge; however, mixed recharge sites were also spatially limited. Old recharge occurs in most areas of the basin and has elevated concentrations of TDS as well as trace elements such as arsenic, chromium, and fluoride. Elevated constituent concentrations appear to be predominantly naturally occurring and have been documented in previous studies.[2,4] Long aquifer residence time of groundwater and evaporite deposits in the basin are major factors in elevating these constituents over water quality standards.[4] Because of the many water quality exceedances in the basin, ADEQ recommends private domestic well owners in the basin have their drinking water tested for contaminants particularly arsenic, chromium, fluoride, and nitrate by a certified laboratory.

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Maps by Jean Ann Rodine

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