ATTACHMENT 1B

(Supplemental Documentation to the: Mogollon Rim Water Resource Management Study Report of Findings)

Evaluation of the Source Water Chemistry from the Major Springs and Select Wells in the Mogollon Rim Water Resources Management Study Area by Hydrosystems Inc., February 2006

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DRAFT

Prepared for:

Town of Payson Water Department

Prepared by:

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Prepared for
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by
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Introduction

To help characterize and constrain the origin(s) of groundwater in the Mogollon Rim Water Resources Management Study (MRWRMS) area, including the Towns of Payson, Pine, Strawberry, and Star Valley, several water samples have been collected from springs, surface waters, and wells for general inorganic chemical analysis. All samples were analyzed for total dissolved solids (TDS) and the major ions of calcium, magnesium, sodium, alkalinity, chloride, fluoride, nitrate, and sulfate. Most were also analyzed for potassium and silica and had field parameters collected for temperature, conductivity, and pH. Some general chemistry data and hydrogeologic descriptions of the study area were also referenced from other sources as part of this investigation, including Kaczmarek (2003) for the Pine-Strawberry area; Southwest Ground-water Consultants, Inc. (2004), and AGRA Earth & Environmental (1999) for the Star Valley area; and Feth, 1954; Bills et al., 2000; Parker et al., 2005; and USGS, 2005 for the Mogollon Rim and Colorado Plateau study area.

The hydrogeologic units that are referred to in this document are summarized briefly here for an explanation of terms. The regional aquifer of the Colorado Plateau, referred to as the C aquifer, occurs within Paleozoic strata, including the Kaibab limestone, Coconino sandstone, Schnebly Hill formation, and upper to middle Supai formation. The C aquifer is separated to some extent from the underlying RMX aquifer by the lower Supai formation. The RMX aquifer is comprised of the Redwall limestone, Martin formations (primarily carbonate rock), and underlying Proterozoic rock (granitoids, intrusive gabbro, metamorphics). The water in this aquifer flows primarily through fractures and dissolution cavities within the host rock, and in some cases there may be little contribution to or from the underlying Proterozoic rocks, particularly in areas of lesser fracturing and faulting. Farther south of the Mogollon Rim, the X aquifer is also a fractured rock aquifer, and refers to similar Proterozoic rock, where the Redwall and Martin formations are absent. Groundwater is also present in smaller aquifers of valley-fill sediment and/or decomposed granitoids, as will be discussed primarily in the context of the Payson area and Star Valley. The Rye basin, located at the southern end of the study area is also discussed and includes both shallow and deep valley fill aquifer systems.

The general chemistry of most groundwater, spring water, and surface water samples in the MRWRMS area is dominated by calcium, magnesium, and bicarbonate, as illustrated in *Figures 1 and 2*. These figures illustrate the chemical variability of the aquifer systems compositionally (*Figure 1*) and spatially (*Figure 2*), and will be discussed throughout this document. Springs and wells tapping regional groundwater sources tend to be higher in solute concentrations due to longer exposure time of the groundwater with the surrounding rock and aquifer materials and larger source areas which have allowed the water to evolve along its travel path. Conversely, springs and wells that tap shallow groundwater and surface runoff tend to be significantly more dilute compared to regional sources. Exceptions occur, predominantly when land-use practices alter the shallow aquifer system, including reclaimed water use for irrigation, septic tank leach fields, and solvent leaks, as have occurred in the Payson area. This investigation will take a closer look at the general chemistry of five major springs in the MRWRMS area, as well as nearby groundwater and surface water samples collected within their hydrologic basins. By analyzing the general chemistry of these samples in the context of the local and regional hydrogeology, we can better understand the sources of water contributing to the major springs and wells of interest.

Spring Water Chemistry

Fossil Springs

Fossil Springs is the source of the Fossil Creek drainage system and the largest set of springs in the study area. It has the highest total dissolved solids (TDS) concentration of all the measured springs in this study (380 to 420 mg/L). Given discharge from the Naco formation, the source of this spring is likely to be dominated by the C aquifer. This is supported by the high TDS and high, stable flow rates, which are indicative of long residence times and the C aquifer's large discharge area. Previous investigations have suggested there is significant contribution from the Redwall limestone through fractures and dissolution cavities of the Redwall and Naco (Kaczmarek, 2003; Parker et al., 2005). On the basis of several samples collected from Fossil Springs (at three locations and from 1952-2004; *Table 1*), the calcium, magnesium bicarbonate chemistry is fairly consistent and indicative of C aquifer groundwater (*Figure 1*).

Also of interest, Fossil Springs is surrounded by large travertine deposits, both as extensive older terraces and as lesser active deposits. The formation of travertine requires supersaturation of calcium bicarbonate typically associated with a drop from high to low pressure and large supplies of carbon dioxide and calcium bicarbonate. Early research (Feth et al., 1954) suggested that these conditions were met in the Mogollon Rim area through deep-seated limestone aquifers. More recently, Crossey et al. (2006) showed that travertine formation at springs in the Grand Canyon results from active upper mantle degassing contributing large amounts of carbon dioxide to the aquifer system. The extensive volcanic deposition over the Fossil Springs area suggests a similar scenario may be possible for the travertine formation there.

Tonto Natural Bridge Spring

Heading east from Fossil Springs, Tonto Natural Bridge Spring is the next large spring in the MRWRMS area, and is located within the Diamond Rim Basin (*Figure 2*). It discharges water of a similar chemistry, though more dilute (TDS = 320 mg/L), to that of Fossil Springs.

Our interpretation of the geology indicates the discharge of the spring is from the Martin formation (regional RMX aquifer), although others (Feth and Hem, 1963; Parker et al., 2005) have suggested it is from the Tapeats sandstone. Discerning the Martin from the Tapeats has been discussed by Teichert (1965) and Hereford (1977). Although some portion of the C aquifer is contributing to the regional RMX aquifer directly and through re-infiltration of spring discharges along the rim, the RMX aquifer is also diluted by local recharge through large fractures and dissolution caverns. This helps to explain the similar but diluted chemistry of Tonto Natural Bridge Spring compared to Fossil Springs. Tonto Natural Bridge Spring is likely receiving a direct contribution from local recharge, as shown by a relatively higher silica concentration (19 mg/L) that might be attributed to the adjacent cliffs, capped with Rim Gravels and basalt (Parker et al., 2005). Like at Fossil Springs, the volcanics here may be indicative of upwelling carbon dioxide gas being related to the active deposition of travertine (Crossey et al., 2006). The natural bridge itself is an older travertine terrace that spans Pine Creek about 180 feet above creek level (Feth, 1954).

Webber Spring

Continuing east along the Diamond Rim Fault area, the next large spring is Webber Spring, which is located in the East Verde River drainage basin (*Figure 2*). This spring also discharges from the Martin formation, and continues to show similar calcium, magnesium bicarbonate chemistry that is consistent with the RMX aquifer, but even further diluted than Tonto Natural Bridge Spring. The TDS ranged between 220 and 280 mg/L between August and October of 2004. Its water temperature was as low as 14°C, which is 5 degrees warmer than Tonto Natural Bridge Spring. This suggests that Webber Spring has a larger component of local recharge that has rapidly infiltrated the fractured rock and had little water-rock interaction time to pick up dissolved constituents.

Cold Spring

Cold Spring is on the upthrown side of the Diamond Rim Fault, less than 5 miles east of Webber Spring (*Figure 2*). It discharges from the RMX aquifer with a variable flow rate that upon first glance would indicate low storage and most of its contribution from local recharge. However, the TDS concentration of Cold Spring is 350 to 370 mg/L, which is greater than that of Webber Spring, having greater concentrations of calcium and bicarbonate. It is quite comparable to the chemistry of Indian Gardens Spring (Parker et al., 2005), which is on the same side of the Diamond Rim Fault, but in the Tonto Creek watershed. The chemistry from both of these springs is chemically more evolved and indicates longer travel times and water-rock interaction times than springs discharging from the rim face (Parker et al., 2005) or discharge waters that are dominated by local recharge. Also, when comparing the two samples collected from Cold Spring in April and August 2004, there is only minor dilution of the April sample in dissolved constituents during the wetter winter/spring season. The water temperature from Cold Spring is slightly lower (13°C) than Webber Spring (14 - 21°C), but apparently more stable. Given this chemical evidence and isotopic evidence (C. Eastoe, this report) for a significant contribution of regional RMX groundwater to Cold Spring, and its generally large volume of discharge, the suggestion of a large local recharge contribution to this spring is in question. However, due to the lack of historical data collected from Cold

Spring, additional seasonal sampling and flow monitoring is necessary to determine if the chemical data presented here are consistent over time and support a significant regional aquifer contribution, or if the water chemistry shows to vary with discharge volume and climatic changes.

For additional comparison, in October of 2004 a water sample was also collected from Ellison Creek Well, nearly 4 miles east of Cold Spring, but presumably on the same fault. This well is drilled to 560 feet and withdrawals water from the Martin formation and underlying fractured granite. The chemistry of the groundwater is similar to Cold Spring but slightly more diluted, having a TDS of 290 mg/L. The similar but diluted chemistry to Cold Spring suggests more local recharge is being received by the well than by the neighboring spring. This reflects the local variations in fractures, dissolution channels, and related hydrogeologic properties of the RMX aquifer that affect the influence of local recharge and groundwater flow.

Tonto Hatchery Spring

Tonto Hatchery Spring is located at the head of Tonto Creek, near the rim face on the eastern side of the MRWRMS area (*Figure 2*). It has a comparatively low TDS of 60 to 104 mg/L which is interpreted to result from discharging a blend of local recharge and C aquifer water from the Colorado Plateau. In comparison to Fossil Springs, this water has had minimal water-rock interaction due to the short distance from its regional source in clean Coconino sandstone and rapid travel time allotted by the fractured rock. Feth (1954) believed that the Coconino sandstone was so pure in this area because it had been partly leached of soluble matter by active groundwater circulation along the rim. Although Tonto Hatchery Spring discharges a dominantly calcium, magnesium bicarbonate water, it differs from the waters that have interacted with the limestone aquifer by having a greater molar calcium-magnesium ratio (> 2), which supports the concept that this water originated in and flowed through clastic rocks such as the Coconino sandstone and Schnebly Hill formation (Parker et al., 2005). Likewise, the low temperature (9°C) and low silica concentration (6.8 mg/L) of Tonto Hatchery Spring water suggests little chemical evolution and rapid infiltration of recharge through the fractured rock system. Also in comparison to Fossil Springs, not only is the chemistry from Tonto Hatchery Spring significantly diluted, it is also more variable. The observed variations are based on a similar time span (from 1952-2004; *Table 1*), and are illustrated in the expanded view of the trilinear diagram in *Figure 1*.

Well Water Chemistry

Strawberry – Pine Area

The Strawberry – Pine area, located on the crest of the Mogollon Rim in the northwestern part of the MRWRMS area, has been characterized has having local aquifers in the Schnebly Hill formation and Supai formation that share a common restricted recharge zone (Parker et al., 2005). Kaczmarek (2003) indicates that the Schnebly Hill formation with its greater primary permeability and storage allows wells in Strawberry to be generally more productive and less prone to climate changes than wells in Pine which are drilled in the Supai formation with tighter siltstones and very fine sandstones. Deeper wells have also been successfully constructed down into the Redwall-Martin, which offer additional water supply from the regional RMX aquifer.

The groundwater chemistry sampled from wells in the Pine-Strawberry area is generally indicative of the RMX or C aquifers, which are difficult to distinguish using only general chemistry parameters (*Table 2; Figures 1 and 2*). Of the wells that have been sampled in and around the Towns of Strawberry and Pine as part of this and previous investigations (Kaczmarec, 2003; Ploughe, 2005), only one differs significantly in water chemistry. That well is the shallow Strawberry Hollow well, SH-2 (55-579973), located in northwest Pine. This shallow well is screened in the Lower C aquifer and is located next to the Strawberry Hollow Fault. The water chemistry is higher in TDS, notably in calcium, magnesium, bicarbonate and sulfate, but its composition is similar to surface water samples collected in the area that are lower in TDS. Therefore its composition is interpreted to be a blend of regional C aquifer and local recharge.

Otherwise, the chemistry of the Strawberry and Pine wells are fairly indistinguishable from each other and the nearby Dripping Springs. Parker et al. (2005) distinguishes Dripping Springs from other springs along the rim based on its higher silica concentration, to which they attribute volcanics that cap the rim at Milk Ranch Point. Silica concentrations in the well water samples range from 8.9 to 34 mg/L, suggesting varying influences from the volcanic rocks and/or contributions from local recharge.

Payson Area

Several wells have been sampled within and around the Town of Payson between 1998 and 2005 that are considered in this investigation (*Table 2*). Most of the wells in this area are drilled entirely in fractured and decomposed Payson granite of Proterozoic age, whereas others are drilled in other Proterozoic igneous and metamorphic rocks that are also fractured and offer little primary capacity. *Figure 1* demonstrates that chemical distinctions can be made between these waters from the X aquifer and the upgradient RMX aquifer, depending on the size of the fracture system and length of time the groundwater has had to interact with the host rock. Similarly, there are chemical differences between the wells that discharge locally recharged groundwater and the wells that primarily discharge groundwater from the regional aquifer system. In the Payson area, the regional groundwater flows through fractured granite and other igneous and metamorphic rocks, but the predominant calcium, magnesium bicarbonate signature can ultimately be tied to upgradient sources in the RMX and C aquifers.

Regional Aquifer

The geology of the X aquifer in the Payson area is primarily comprised of fractured Payson granite and Gibson diorite/gabbro. Some of the faults and fractures are of limited extent and result in relatively isolated systems that are sometimes more dependent on local recharge, whereas others are deeper more extensive fault and fracture systems supplying larger reliable water volumes to multiple wells. The water chemistry of groundwater in the regional aquifer north and northwest of Payson is more evolved than local recharge, having higher concentrations of dissolved solids, primarily as calcium, magnesium, bicarbonate, and silica. The Skypark (55- 568624), Summit (55-576872), NP-2 (55-577329), and Goat Camp #1 (55-565426) wells are all examples of this type of groundwater, as shown in *Figure 3*. Their measured TDS concentrations range from 220 to 400 mg/L. Slight variations in the chemical composition are likely attributed to variations in the flow path and geological conditions. For example, the Skypark well produces water from the Birch Mesa Fault which is in contact with Payson granite and older gneissic granite; Summit well produces water from Gibson diorite and gabbro, with some influence from the down-dropped Martin formation via the Summit Mine Fault; and NP-2 and Goat Camp #1 produce water from Payson and gneissic granite in an area of northeast Tertiary and northwest Precambrian faults.

There is some chemical evidence to support mixing of groundwater in the regional system, between different but connected fault and fracture systems. In a hypothetical mixing scenario, the water chemistry of Skypark well resembles a 2:1 mixture of water from NP-2 and Summit well, respectively. Spatially in support of this, Skypark well is also located between these two wells (*Figure 3*). The exception to this mixing scenario is chloride, which is greater in Skypark well than either NP-2 or Summit well. In the absence of contamination, increasing chloride concentrations in groundwater may be an indication of dissolution of chloride from the rocks through which the groundwater is moving and may be attributed to a longer residence time of water in the aquifer.

The Payson Pines 4 well (55-564016), also sampled north of Payson, has aquifer testing and isotope results that suggest little local recharge, yet a short residence time for its groundwater derived from the regional aquifer (M. Ploughe, personal communication; C. Eastoe, this report). Water chemistry results indicate it is more dilute than neighboring wells (*Figure 3*), which could be indicative of the influence of local recharge. However, given the other test results, the reduced TDS may be indicative of the short residence time and rapid flow that minimizes water-rock interaction and dissolution of minerals. It may also be indicative of more open and less mineralized fractures.

Local Recharge

In the Payson area, the chemical evidence for groundwater influenced by local recharge appears in two different ways. One way that local recharge can be confirmed chemically is through dilution, as seen in the springs and wells in other parts of the MRWRMS area. At least three wells that are centrally located in Payson have shallow to deep screened intervals and exhibit generally similar water chemistry types to deeper regional wells; however, they are relatively diluted in TDS, primarily through reductions in calcium and bicarbonate. These include the Beeline (55-620867), Woodland #1 (55-503323), and McKamey (55-509870) wells. In comparison to the northern Payson wells that primarily discharge X aquifer groundwater, this blend of local and regional groundwater has measured TDS concentrations that are lower, ranging from 190 to 230 mg/L, and plots at a higher sodium, chloride and sulfate position on the trilinear diagram in *Figure 1*.

The other way that shallow recharge is recognized is through surficial contamination or land-use impacts such as that caused by shallow recharge and irrigation with reclaimed wastewater. Reclaimed wastewater from the Gila County Sanitary District is slightly elevated in TDS (440 mg/L), primarily as added sodium and chloride. Because sodium and chloride are naturally low in the regional groundwater system, addition of these constituents as artificial recharge and irrigation can be traced in samples from nearby wells. Specifically, Country Club Well #3 (55-565297), Lake Drive Well (55-558391), and Mt. View Well (55-512759), which are all shallow screened wells located in southern Payson near the recharge facility and exhibit elevated sodium, chloride, and TDS concentrations. These wells also plot separately from the regional and shallow aquifer wells on the trilinear diagram in *Figure 1*. Well CPN-13 (55-544348), located near a golf course receiving reclaimed irrigation water in eastern Payson, is also proportionally higher in sodium and chloride (*Figure 1*), but has a lower TDS of 250 mg/L.

Other sources of contamination that indicate local recharge include septic leach fields, as shown by elevated nitrate concentrations in the Luke Well (55-575304), northwest of Payson, and PCE contamination in southern Payson as monitored by TOP Well 19 (55-519459).

Shallow aquifers thought to be dominated by local recharge have been sampled in neighboring communities of Payson, including Star Valley to the east. The Star Valley wells, Milky Way (55-605247), Sky Run (PW-1), and Landfill (MW-1) are of relatively shallow depths (120 to 300 feet) that penetrate thin alluvium and fractured granite, and have shallow water levels that tend to fluctuate significantly with respect to local recharge. The isotope results for Milky Way (oxygen-18, deuterium, and tritium) also support local recharge as a primary source. The water chemistry results from these shallow aquifer systems are more difficult to differentiate from regional groundwater for the following reasons: 1. The water chemistry from shallow wells is similar to northern Payson wells that are interpreted to discharge water primarily from the regional X aquifer (*Figures 1 and 3*); 2. Water chemistry data available from a deeper well (Sky Run PW-2, 1,000 feet) are incomplete for major ions and were collected prior to deepening the well (407 feet); 3. Water chemistry data available from the shallow wells represent one point in time for each well and cannot demonstrate if there are seasonal changes. Therefore, at this time little can be interpreted from the water chemistry data from Star Valley other than the shallow aquifer system here may be chemically similar to the deeper X aquifer.

The shallow aquifer systems of Round Valley, south of Payson, and Doll Baby Ranch, east of Payson, have a similar chemistry to the blended local and regional groundwater in central Payson (*Figure 1*), but are higher in TDS (320 to 400 mg/L). Of possible significance, both of these aquifer systems overlie fractured Gibson diorite/gabbro, though in the case of Doll Baby Ranch, the deeper Gibson diorite/gabbro aquifer appears to be confined from the shallow aquifer that is composed of Tertiary gravels. This confined aquifer is of significantly different quality than the regional system, having a large component of sodium sulfate not seen in any other wells in this study. Feth (1954) hypothesized sources of significant sodium sulfate in the southwestern part of the Verde Basin, including deep-water basins having a continuous influx of salty waters, the relict part of a desiccating lake, as well as leaching of igneous and metamorphic rocks with copper mineralization. This deeper water source may also be connected to the deep groundwater found in the Rye Basin, near the southern end of the MRWRMS area. The groundwater in Rye is much more saline due to potential connate sources within the Tertiary gravels and clay rich sediments which underlie that location.

Conclusions

1. Groundwater in the C and RMX aquifers is generally similar in chemical composition within the study area, comprised primarily of calcium, magnesium, and bicarbonate and suggesting that the RMX aquifer is fed by downward leakage and re-infiltration of spring waters from the C aquifer.
2. The relative contribution of local recharge to springs along the Mogollon Rim has been interpreted based on the following criteria: 1. TDS, where a higher TDS is indicative of longer residence times and water-rock interaction and lower TDS is attributed to rapid local recharge through vertical fractures and minimal water-rock interaction. 2. Water temperature, where lower temperature may be indicative of more local recharge, but variation in temperatures is also a consideration. 3. Silica concentration, where silica concentrations may be higher in local recharge if volcanics or gravels are present above the spring discharge area. Silica may also be significantly low in local recharge water that has undergone rapid infiltration. Using these criteria, Webber Spring and Tonto Hatchery Spring are thought to have significant contributions from local recharge. Cold Spring also receives local recharge, but its evolved chemistry seems to indicate perhaps less than originally thought.
3. Wells located north and northwest of Payson are producing groundwater that is dominantly from the regional X aquifer. This groundwater likely originated from the RMX and C aquifers along the Mogollon Rim based on a similar but evolved chemistry and the extensive faults and fractures that appear to connect them.
4. Groundwater in central Payson is a blend of local recharge and regional X aquifer groundwater. This water is more dilute and chemically distinct from regional groundwater that has not been significantly influenced by local recharge.
5. Wells located south of Payson show the impact of local recharge through chemical mixing of reclaimed water (artificially recharged) and groundwater. Other chemical tracers have also been used to identify contributions from local recharge, including elevated nitrate associated with septic leach fields and PCE contamination.
6. Groundwater in the Proterozoic rock beneath Doll Baby Ranch and in the deep alluvium of the Rye Basin is chemically distinct from the regional X aquifer in the Payson area, being significantly higher in sodium, chloride, and sulfate.

Recommendations

1. The water chemistry data provided for this report primarily offer one or two points in time, which limits the ability to make inferences on the stability or variability of water chemistry over time and with changes in season. Collection of water samples

on a seasonal (quarterly) basis for a few years would be worthwhile to observe whether or not there are seasonal or other temporal trends in water chemistry data.

2. More water chemistry data is needed from the Star Valley area, particularly from deeper wells to better differentiate regional versus local groundwater contributions.
3. C-14 testing of the Payson Pines 4 well north of Payson suggested short flow times (decades) for water reaching the X aquifer from the regional C and RMX aquifers (C. Eastoe, this report). However, this well was slightly anomalous in chemical composition, being comparatively dilute from other wells in the area that discharge regional groundwater from the X aquifer. If higher TDS is indicative of longer water-rock interaction times, then additional C-14 testing of some of these other wells (Skypark, Summit, Goat Camp 1) should indicate longer flow times.

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Figure 1. Piper Diagram Indicating Water Chemistry Differences between Regional Groundwater Aquifers and Local Recharge

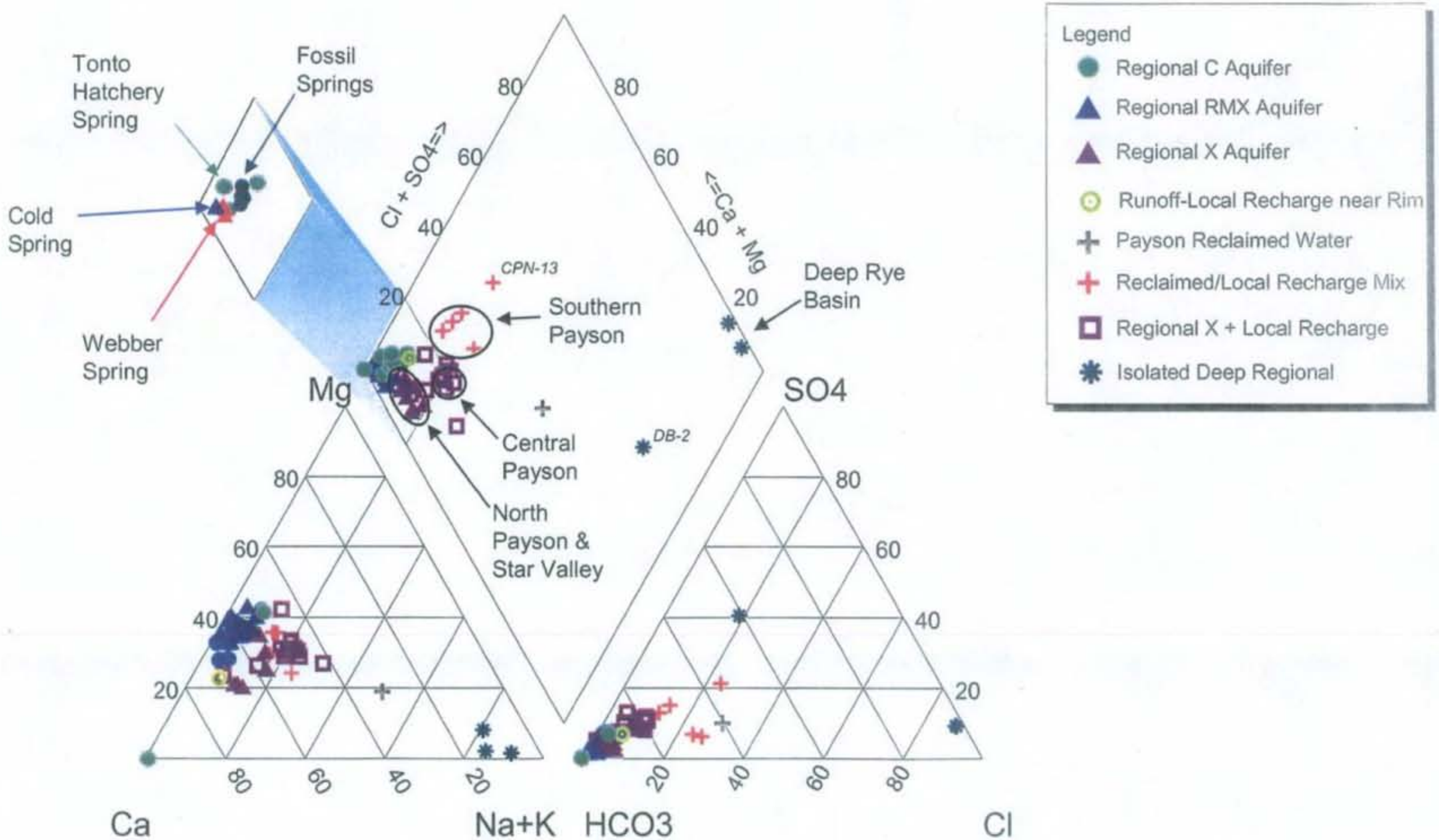

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Figure 2. Chemical Variability of Spring, Surface and Well Waters as Shown by Stiff Diagrams
(Colors indicate regional aquifer contribution and shapes generally vary according to amount of local recharge)

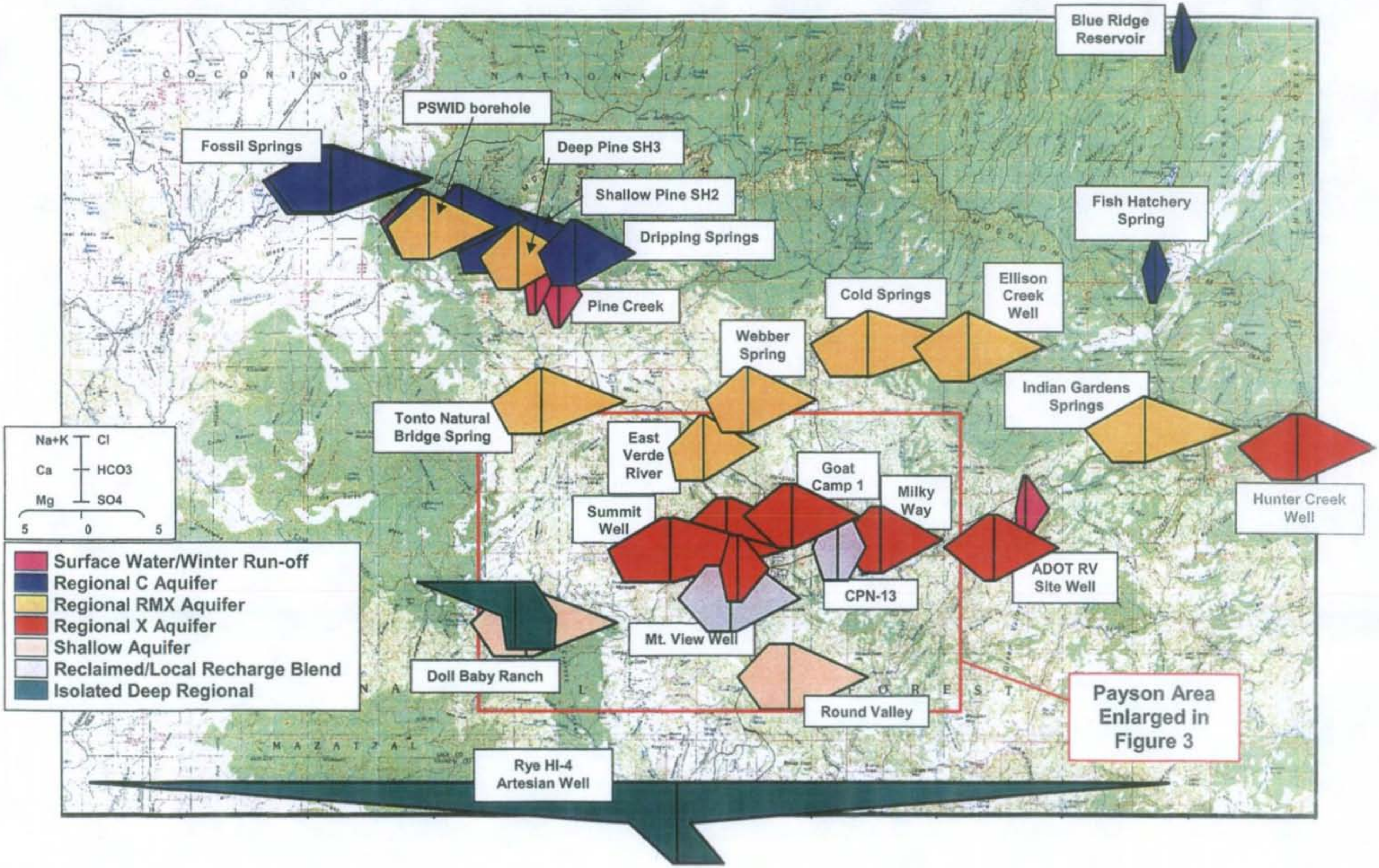

Figure 3. Variations in Payson Area Surface and Groundwater Chemistry due to Local Recharge, Regional Aquifer Contributions and Reclaimed Wastewater Recharge/Reuse

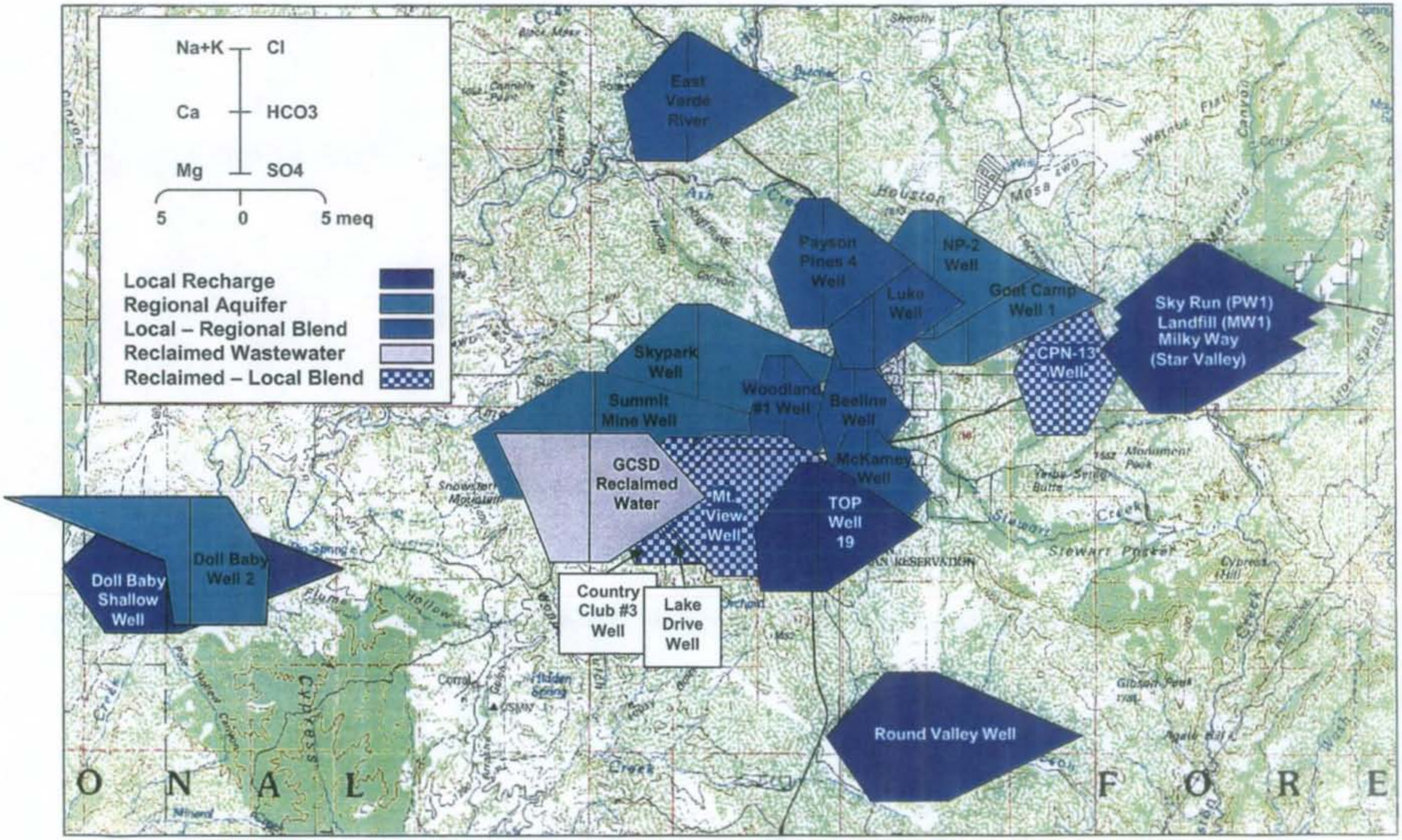

Table 1.
MRWRMS Spring and Surface Water Chemistry Data Summary

Site Name	Site* Type	Aquifer*** Geology	Water Source	Data Source	Sample Date	pH	Cond uS/cm	Temp °C	Alkalinity mg/l	TDS mg/l	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Fe mg/l	F mg/l	Cl mg/l	HCO3 mg/l	NO3 mg/l	SO4 mg/l	SiO2 mg/l
Cold Springs	SP	Redwall-Martin	Regional w/ Minor Local	1	4/21/2004	7.56	610	13	350	370	3.4	<2	83	33	<0.05	<0.4	2.5	427	2.26	5.5	8.9
				1	8/11/2004	7.31	374	13.4	390	350	3.8	<2	93	38	<0.05	<0.4	3.4	475.5	2.17	6.4	9.7
Dripping Springs	SP	Lower C Aquifer/ Volcanics	Blend	4	10/24/2002	6.9	452	13.3	234		8.2	0.7	56	21		0.1	6.3	285		2.2	31
Fish Hatchery Spring	SP	Younger C Aquifer System	Blend	2	10/17/1952		174	9	91	104	0.7	<0.7	26	7.6		0.2	2	111	0.3	3.1	8.7
				4	7/31/1997	7.1	145	9	66		1.32	0.83	18.8	4.51	0.04	<0.1	1.05	80.5	0.53	1.7	7.1
				1	11/17/2004	7	153.9	9.1	66	60	<2	<1	19	4.8	0.08	<0.4	3	66	1.77	3.3	6.8
Fossil Springs (unsurveyed)	SP	Lower C Aquifer	Deep Regional	2	2/16/1952		753	21.5		440	6.9	<6.9	104	40		0.1	9	485	0.5	27	14
				4	8/7/1998	7	720	21	385		10.6	1.85	96.4	34.9		0.2	7.14	469	0.6	22.9	11.9
				5	1/22/2003	6.8	710		399	423	12	2	94	36	<0.03	0.17	8	486	0.62	19	
Fossil Springs Upper	SP	Lower C Aquifer	Deep Regional	1	4/27/2004	7.51	730		380	410	11	<2	96	35	<0.05	<0.4	7.1	463.3	2.52	24	13
				1	10/20/2004				390	420	12	2	97	37	<0.05	0.57	7.5	475.5	2.52	24	13
Lower				1	8/18/2004	6.81	712	21	400	380	12	<2	98	37	<0.05	0.44	7.6	488	2.12	24	13
Indian Garden	SP	Lower Paleozoic	Regional w/ Minor Local	4	7/30/1997	7.1	645	14.5	362		3.23	0.72	92.3	30.5		0.1	3.52	441	0.32	2.7	10.4
Tonto Natural Bridge Spring	SP	Martin	Blend	3	8/19/1997	7.4	620	20	336	350	6.4	0.94	79	32		0.16	6.1	410		3.2	19
				1	10/20/2004	7	580	19.1	330	320	6.3	<2	78	31	<0.05	0.57	6.2	402	3.01	5	19
Webber Spring	SP	Martin/ X (Granite)	Local w/ Minor Regional	4	10/22/2002	7.3	459	21	247		4.2	0.7	62	22		0.2	3.6	301		5.2	10
				1	8/11/2004	7.14	499	14.1	270	220	5.7	<2	67	25	<0.05	<0.4	2.8	329	2.08	5.1	12
				1	10/20/2004	7	489	14.1	270	280	5	<2	68	26	<0.05	0.55	3.3	329	2.52	6.6	11
87 and Cavern	SW	to Redwall	Surface Water	1	4/14/2004				90	110	2.4	<2	27	5.1	<0.05	<0.4	3.2	109.7	<0.8	4.9	20
Pine Creek	SW	to Naco	Surface Water	1	4/14/2004				72	97	2.8	<2	18	6.9	0.12	<0.4	4.1	83	<0.8	4.4	13
Blue Ridge Reservoir	SW	to Upper C	Surface Water	1	10/26/2004	7.62	70	4.3	19.68	47.7	<2	<2	6	2.7	0.21	<0.4	<0.2	24	0.54	3.2	3.1
				1	10/20/2005	7.44	99	6.7	48	52	<2	<2	12	4.8	0.52	<0.4	<2	58.5	<0.8	3.5	5.6

* SP= Spring, SW= Surface Water

** 1 = MRWRMS, 2 = Feth, 1954; 3 = Parker et al., 2005; 4 = USGS NWIS Database, 2005; 5 = Kaczmarek, 2003; 6 = AGRA, 1999 - ADOT Study

*** Any Precambrian Geology Producing Groundwater May be Considered as an "X" Aquifer, For example, Payson Granite is a member of the X aquifer system

HSI HydroSystems, Inc.

Table 2.
MRWRMS Well Water Chemistry Summary

Site Name	Well Depth	ADWR No.	Aquifer Geology	Water* Source	Data Source	Sampling Date	pH	Cond uS/cm	Temp °C	Alkalin. mg/l	TDS mg/l	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Fe mg/l	F mg/l	Cl mg/l	HCO3 mg/l	NO3 mg/l	SO4 mg/l	SiO2 mg/l
Payson Area Wells																						
Beeline	1004	620867	X Payson Granite	Blend	1	2/9/2004	7.1		18	114	200	17		29	11	<0.01	0.85	10	139	4.43	10	
CC #3 Well	760	565297	X Payson Granite/ Gibson Diorite	Recent	1	1/6/2003	6.27	590	15.7	240	360	22	<2	67	28	0.06	0.41	31	293	5.8	37	30
					1	4/22/2004	7.54	600	16	230	360	24	<2	66	28	1.3	0.44	35	280	7.97	44	24
CPN-13 Well	400	544348	X Granite/ Reclaimed Reuse	Recent	1	4/21/2004	6.88	300	15.8	110	250	18	<2	40	14	0.7	0.8	35	134	2.74	39	38
Goat Camp #1 Well	925	565426	X Gneissic Granite	Deep Regional	1	2/11/2004	7.7			274	300	17		77	14	0.05	0.28	9.5	334	3.5	5.5	
					1	12/18/2001	6.9	529	16.6	270	320	18	<2	81	15	0.18	0.48	12	329	3.5	5.3	27
Lake Drive Well	500	558391	X Granite/ Reclaimed Reuse	Recent	1	1/6/2003	6.13	662	15.3	240	400	28	<2	79	25	0.07	0.4	70	293	1.8	18	29
Luke Well	860	575304	X Payson Granite	Blend	1	1/6/2003	6.26	393	18.7	170	250	21	<2	44	18	<0.05	0.53	14	207	22.6	15	32
					1	12/18/2001	7.1	300	17.5	170	300	23	<2	48	20	1	0.71	18	207	29.7	20	32
McKamey	860	509870	X Payson Granite	Blend	1	1/6/2003	6.15	340	16.3	150	230	18	<2	39	14	<0.05	1.3	15	183	7.1	13	40
					1	3/16/2004	7		18	131	210	18		36	13	0.1	1.3	14	160	5.3	11	
Mt. View Well	280	512759	X Granite/ Reclaimed Recharge	Recent	1	1/6/2003	6.62	691	16.8	270	430	45	<2	81	22	<0.5	0.43	69	329	3.45	22	32
NP-2 Well	1000	577329	X Payson Granite	Deep Regional	1	11/13/2001	7		18	210	240	19	<2	54	14	<0.05	0.64	8.5	256	1.95	3.8	27
					1	10/22/2001	7.6	427	18	240	253	19		50	13		0.6	8.5	293	1.3	3.8	
Payson Pines 4 Well	400	564016	X Payson Granite	Deep Regional	1	4/21/2004	6.9	260	18	180	200	19	<2	42	15	0.39	0.51	9.4	219	2.74	6.8	36
Reclaimed Water			Recharge/ Reuse Golf Courses	Reclaimed	1	1/6/2003	6.22	695	14	230	440	86	17	51	19	0.27	0.56	83	280	3.14	36	35
Skypark Well	815	568624	X Payson Granite	Deep Regional	1	2/12/2004	7.4		18	314	350	19		73	28	3.0	0.44	19	383	3.14	5.9	
Summit Mine Well	970	576872	X Gibson Diorite/ Gabbro	Deep Regional	1	12/18/2001	7.2	400	16.7	380	400	15	<2	85	39	<0.05	0.52	7.3	463	3.4	3.7	31
TOP-19 Well	340	519459	X Payson Granite	Recent	1	1/6/2003	6.15	475	15.4	210	290	16	<2	49	27	0.16	<0.4	18	256	15	18	31
Woodland #1 Well	925	503323	X Payson Granite	Blend	1	4/21/2004	7.3	400	16.5	120	190	16	<2	28	10	<0.05	0.86	11	146	6.6	15	40
Star Valley Area																						
RV Site Well R-2	~500	???	X Payson Granite	Recent	2	10/22/1998				260	320	12	<2	78	10		0.95	12	317	1.24	4.3	35
RV Site Well R-4	~500	???	X Payson Granite	Recent	2	10/26/1998				240	300	14	<2	75	11		0.78	9.3	293	0.62	4.6	38
Landfill MW-1	100	???	X Payson Granite	Recent	1	7/18/2005	6.74	430	15	240	340	9.1	<2	71	14	5.5	<0.4	2.6	293	7.97	10	49
Landfill MW-2	110	???	X Payson Granite	Recent?	1	7/18/2005	6.35	174	18.1	71	130	11	<2	14	5.2	0.27	0.44	3.5	86.6	3.59	7.4	47
Sky Run Well (PW2)	407	???	X Payson Granite	Blend?	3	8/25/2004				230	263	18	<2	64	13		0.5		280	3.54	<5.0	
Sky Run Well (PW1)	300	???	X Payson Granite	Blend?	3	3/23/2004	7.3		18.5	240	270	17	<2	67	12		0.59	8.8	292.6	3.94	5.4	
Milky Way Well	120	605247	X Payson Granite	Recent?	1	11/17/2004	7.7	480	7.4	240	280	19	<2	66	17	<0.01	0.49	8.6	292.6	4.87	8.6	26
Pine / Strawberry Wells																						
Deep Pine SH-3 Well	1320	587628	Martin-X	Blend	1	4/21/2004	7.3	420	11.2	230	320	5.3	<2	60	19	<0.05	<0.4	4.4	280	3.94	6.2	13
Deep Strawberry Well	700	203413	Supai - Lower C	Blend	1	10/25/2004	7.27	470	13.4	250	290	7.8	<2	63	22	0.49	<0.4	4.7	304.8	3.14	6.8	22
PSWID Strawberry	1872	581081	Redwall-Martin	Blend	1	4/11/2005	7.9	470	16.4	270	280	9.6	<2	65	25	<0.05	<0.4	7	329.2	3.1	7	24
Shallow Pine SH-2 Well	240	579973	Supai - Lower C	Blend	1	4/21/2004	7.4	780	11	370	460	16	2.6	84	42	0.06	<0.4	10	451	2.39	26	17
Strawberry Shallow Well	400	588181	Supai - Lower C	Blend	1	10/25/2004	7.38	461	14.3	260	250	9.7	<2	58	23	<0.05	<0.4	5	317	2.7	3.6	23
Other Wells																						
DB-2	992	597574	X Gibson Diorite/ Gabbro (confined)	Deep Regional	1	11/19/2003	7.3	560	22	130	380	140	4.5	17	6.6	0.32	1.8	44	158.5	<0.3	120	26
DB-Shallow	80	???	TG Gravels	Recent	1	11/19/2003	6.9	465	16	290	320	29	<2	70	25	2.1	0.4	14	353.6	4.87	21	26
Ellison Creek Well	560	581836	Martin - X Granite	Blend	1	10/21/2004	7.11	509	13	290	290	2.4	<2	78	24	<0.05	0.5	5.5	353.6	2.43	5.2	8.5
Hunter Creek Well	95	508554	Alluvium - Upper X Quartzite	Recent	1	11/18/2004	7.1	644	9.9	300	330	10	<2	91	24	<0.05	<0.4	21	365.8	2.26	18	10
Round Valley Well	160	???	X Gibson Diorite/ Gabbro	Recent	1	4/15/2004	7.2	450	16.5	310	400	36	<2	79	26	0.91	<0.4	14	378	6.64	43	26
Rye HI-4 Well	840	590440	X Gibson Diorite/ Gabbro	Deep Regional or Connate	1	1/6/2003	7.55	4280	21.1	40	2300	850	19	60	3.1	0.43	5.8	1100	48.8	<0.8	140	23

* 1 = MRWRMS or Town of Payson Publication, 2 = AGRA, 1999 - ADOT Study; 3 = SWGC, 2004