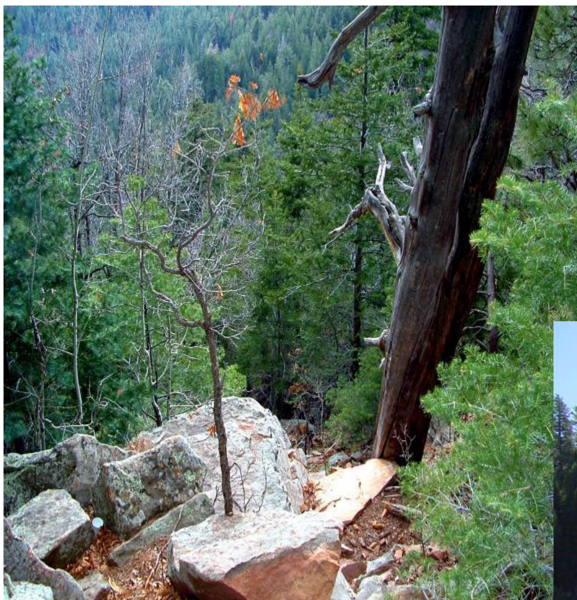
RECLAMATION

Managing Water in the West

Mogollon Rim Water Resources

Management Study
Report of Findings



U.S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office

April 2008

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Executive Summary

There are 44 communities located within the Mogollon Rim Water Resources Management Study (Study) area. The communities are comprised of Towns and unincorporated communities with water services from municipal systems, private water companies, domestic water improvement districts, cooperatives and homeowners associations. The population projected for build out in the Study area of Northern Gila County, AZ is more than triple the present population. Most communities are already experiencing chronic water shortages due to increased seasonal water use, drought conditions, and reliability issues. The primary goal of this study is develop regional alternatives with the potential of resolving the urgent and compelling need throughout the Study area for long term reliable water supplies.

Study Purpose

The Study is a regional effort intended to:

- Identify present population and water use within the Study area.
- Project future population and water demands to the year 2040.
- Determine if there is a need to supplement existing water resources to meet future needs.
- If additional water is needed, develop a comprehensive range of alternatives that will take full advantage of opportunities, as well as take into consideration any constraints, that are identified in the course of the Study.
- Evaluate the alternatives based on criteria developed by the Study stakeholders to determine if there is at least one alternative that can meet the identified water demands.
- If there is at least one alternative capable of meeting the identified water demands, determine whether there is a Federal interest in carrying that alternative forward to a feasibility study.

Study Team

The Study partners are the town of Payson, Gila County, and the Bureau of Reclamation. Gila County represents the unincorporated communities within the Study area. Other participating agencies include the Arizona Department of Water Resources, the U.S. Forest Service, the Salt River Project, the Tonto Apache Tribe, and Brooke Utilities (a private water company in the Study area).

Tasks Performed

A Demand Analysis was performed to establish present and future population and present and future water supply needs.

	Present (2002) Population	Present (2002) Demand (af/yr)	Future (2040) Population	Future (2040) Demand (af/yr)
Town of Payson	14,500	1,805	40,000	5,350
Pine and Strawberry	3,043	298	14,487	1,947
Town of Star Valley	1,774	105	3,785	509
Other Gila County Communities	3,062	401	11,320	1,524
Total	22,379	2,609	69,592	9,330

Projected demands were compared to available resources to estimate projected unmet demands. Because of the volatility of available supplies due to persistent drought conditions, extreme seasonal water use, and unreliability of developed groundwater sources, alternatives were developed to meet all of the projected future water supply needs. The two main sources of supply for the alternatives are groundwater and surface water.

Groundwater is the most relied up source of water in the Study area. And due to the unreliability of the fractured granite shallow aquifer currently used for water supply, the study partners recognized the need to collect more refined data pertaining to the location and movement of water throughout both the shallow and deep aquifer systems in the Study area. Therefore, a Hydrogeologic Framework was developed for the study. The Hydrogeologic Framework provides a conceptual groundwater model aimed at identifying areas of high potential development of reliable groundwater sources.

The passage of the 2004 Arizona Water Rights Settlement Act resulted in allocation of 3,500 ac/ft of annual surface water supply from C.C. Cragin reservoir to northern Gila County. The Act designates 3,000 ac/ft annually for the Town of Payson and 500 ac/ft annually for other northern Gila County communities. Additional C.C. Cragin water supply may be available to the Tonto Apache Tribe and the Pine Water Company by exchange with the Salt River Project for valid CAP allocations. The availability of this renewable surface water source to the communities within the Study area is a key component to solving the long term supply and reliability issues in the region.

Six groundwater alternatives, nine surface water alternatives, one effluent alternative, and three water resource and operational management alternatives were formulated, analyzed and evaluated in the study process. There is either one alternative or a combination of alternatives that can meet the water supply needs of each of the communities in the Study area.

There are many issues with respect to a Federal interest for any of the alternatives. These would include, but not be limited to the following:

- Recognition and respect for Federal landownership and management programs.
- Honoring of existing National Forest's plans.
- Existing Federal environmental programs.
- Contractual and other administrative relationships between Reclamation, and the two Arizona Federal water projects (CAP and SRP).
- Arizona Water Settlement Act of 2004 – Implementation of Indian water settlements
- Anticipated environmental disturbance to Federal lands caused by construction.
- Potential opportunities to improve public use of Federal lands for recreation and other reasonable public access purposes.
- Archeological and ecological locations to identify, protect, and mitigate on Federal lands.
- Potential for entry into Tonto National Forest for purposes of groundwater development.

Conclusions

- There is a need for up to 9,330 af/yr to supplement existing water resources in the Study area.
- There are groundwater (local and regional), surface water (regional, including CAP exchange options) and combinations of both alternatives that will meet the water demands for all of the communities in the Study area.
- Of the nineteen alternatives developed for this study two groundwater and four surface water alternatives were deemed to be viable and are, therefore, recommended for futher feasibility level study.

- Implementing a project which would beneficial use the 3,500 acre-feet of water from the C.C. Cragin Reservoir which was allocated to the Town of Payson and Northern Gila County by the 2004 Arizona Water Rights Settlement Act would be the most effective method of meeting the future water demands of the majority of the citizens living in the Study area.

- There are Federal interests that are vital to a regional plan that justify Reclamation's future involvement in a feasibility study of the viable alternatives.

I. Introduction

I.A Background

The Mogollon Rim Water Resources Management Study (Study) has been conducted to provide a regional assessment of current water supplies and identify potential alternatives for providing adequate water to Arizona communities located in the northwesterly corner of Gila County (see Figure I-1).

The geographic area of focus for this Study is located entirely within northern Gila County, about 100 miles north of the Phoenix metropolitan area, Arizona (see Figure I-2). Gila County is a relatively small county in terms of population (53,000) but quite large in terms of land mass (4,796 square miles). Approximately 96 percent of the County consists of national forests, state, Federal, and tribal lands, leaving only 3.7 percent private lands. One-half of the private land consists of mining properties. The historical county seat (Globe), a major copper producing area, was at one time the Capital of the Arizona Territory, prior to statehood. The Study area (see Figure I-1) is bordered to the west by the Gila County boundary and to the north again by the Gila County boundary along the Mogollon Rim, about 15 miles north of Payson, Arizona. The Mogollon Rim, an escarpment, extends over 100 miles and defines the southern edge of the Colorado Plateau. The eastern boundary of the Study area is Christopher Creek and Tonto Creek; and the southern boundary is about 4 miles south of Payson, at or near Latitude N 34˚09. The Study area encompasses approximately 632 square miles, all of which are located within the Tonto National Forest. The main sources of surface water in the Study area are the East Verde River, a tributary to the Verde River, and Tonto Creek, a tributary to the Salt River.

The Study partners include the Bureau of Reclamation (Reclamation), Gila County (County), and the Town of Payson (Payson). The County represents the unincorporated communities within the Study area, including water improvement districts. Payson represents its citizens, which make up about 68 percent of the total population within the Study area; its town limits occupy about 1 percent of the land mass of the Study area.

Other agencies participating in the Study include: United States Forest Service (FS), both Coconino National Forest (CNF) and Tonto National Forest (TNF); Arizona Department of Water Resources (ADWR); Salt River Project (SRP) - a major supplier of water to the Phoenix metropolitan area; and regulated water utilities in the Study area (mainly Brooke Utilities, Inc.). The Tonto Apache Tribe, the only Native American community within the Study area, has formally requested not to be included as a participant in the Study.

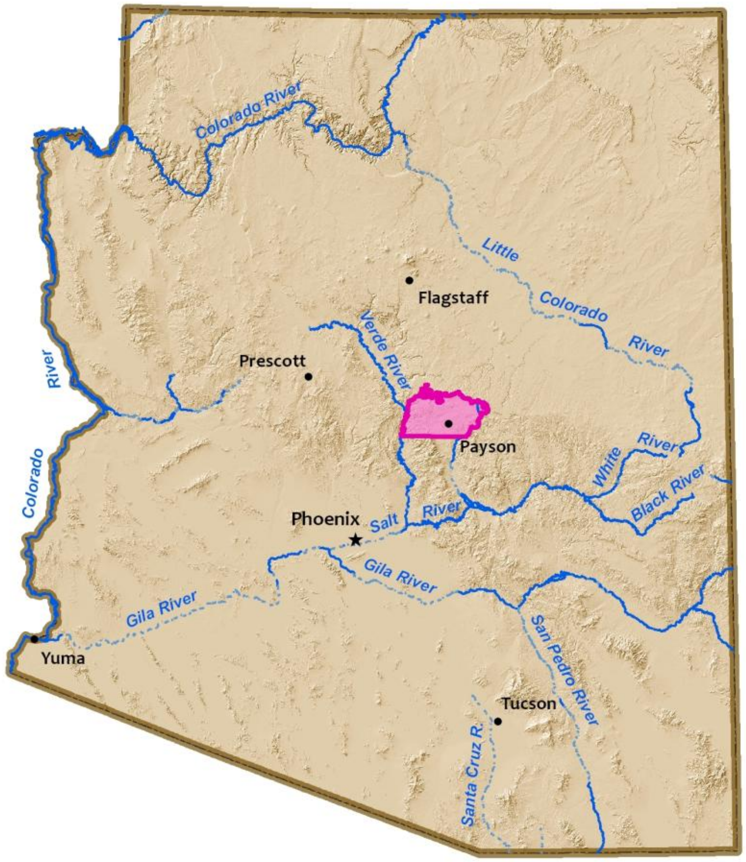

Figure I-1. – General Vicinity Map

I.B Need for and Purpose of the Study

I.B.1 Need for the Study

In the past, water providers and users within the Study area have sought to develop their own water supplies. While most area water resources have been managed with diligence within the Study area, especially in Payson, the ability to meet existing water demands with the available water supply has been seriously compromised by the current drought, in its 10th year as of 2007. The existing developed water resources are inadequate to reliably support future water supply needs of the Study partners.

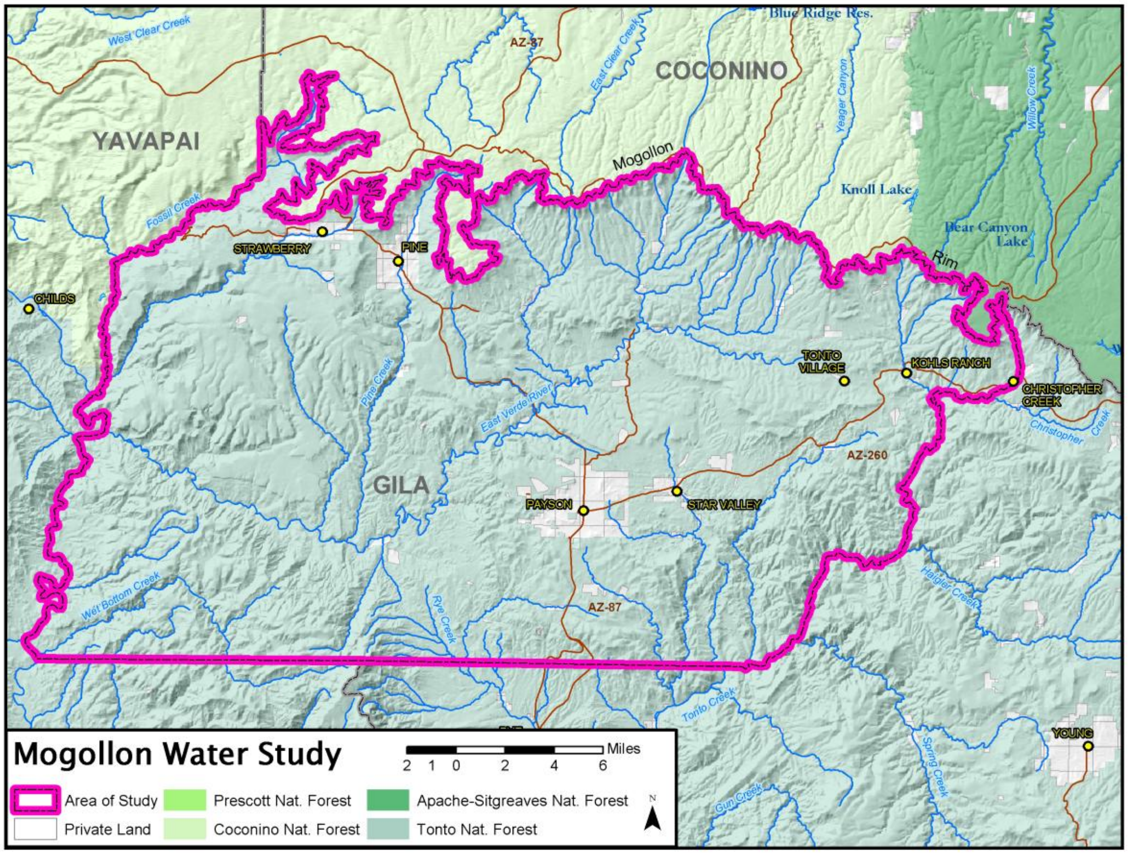

Figure I-2. – Map of the Study area

The Study area's conflict between its growing population and diminishing water supply availability and/or poor reliability has posed significant water resource management problems for the water service providers within the Study area. Almost all of the communities in the Study area are experiencing one or more of the following:

- Water shortages for daily needs;
- Exhausting existing supplies during periods of drought;
- Placing residents under severe water use restrictions; and
- Experiencing inadequate water supplies to sustain the increased growth in the area.

Over the last few years, the Study partners have found it neither possible nor practicable to develop water supply projects independent of each other, and they are concerned about developing and/or maintaining sustainable and renewable water supplies for their communities over the next 35 years. The Study partners are seeking to develop suitable regional alternatives that will allow each partner to contribute both its energies and resources in developing a regional solution to solve their individual water supply needs.

In addition to entities that are a formal part of the Study, there are numerous other water providers and users which could either be directly or indirectly impacted by any proposed regional solution. These entities are located throughout the Study area and include private water companies, rural subdivisions, home owner associations (HOAs), domestic water improvement districts (DWIDs), and private well owners (see section III.A, Types of Water Supply Providers).

As discussed in more detail later in this Study, the projected water demand for the growing population in the Study area is estimated to exceed 10,000 acre-feet per year (af/yr) by 2040, compared to an existing supply and conservation-driven demand of 2,600 af/yr. Nearly all the water currently provided in the Study area comes from shallow well fields that are either fully developed or annually exhausted, many of which may be at risk of contamination due to proximity to local septic systems.

I.B.2 Purpose of the Study

The purpose of the Study is to identify and describe the long-term water supply and demand issues for the communities within the Study area.

The Study expects to accomplish the following:

- Identify present population and water use within the Study area.
- Project future population and water demands to the year 2040.
- Determine if there is a need to supplement existing water resources to meet future needs.
- If additional water is needed, develop a comprehensive range of alternatives that will take full advantage of opportunities, as well as take into consideration any constraints, that are identified in the course of the Study.
- Evaluate the alternatives based on criteria developed by the Study stakeholders to determine if there is at least one alternative that can meet the identified water demands.
- If there is at least one alternative capable of meeting the identified water demands, determine whether there is a Federal interest in carrying that alternative forward to a feasibility study.

An overall objective of the Study is to supply sound technical information (including regional groundwater mapping) that can be used by all of the Study participants and other Study area communities to assist in locating and developing water supplies.

The planning period for the Study is 2005 to 2040. The base data were collected as of the 2002 calendar period. For purposes of this Study it is assumed that "build-out" of all Study area communities will occur by the year 2040. Such build-out projections are anticipated because of the tremendous growth trends expected to occur in the Phoenix area, with many of its residents seeking summer or second homes in the Study area, and in-migration of retirees moving full-time to the Rim County from many states.

I.C Roles of the Study Participants

The Partners, participating agencies, and other water providers in the Study area (not represented by the County) each share a common goal in the development and use of adequate, reliable, renewable, and sustainable water resources for the Mogollon Rim area, and in the preservation and protection of historic water rights. Following is a brief description of the roles and responsibilities of each participant.

I.C.1 Study Partners

Bureau of Reclamation
Reclamation is a Federal agency within the United States Department of the Interior, and is charged with developing and assisting in the development of water resources in the western United States. Besides Reclamation's ownership of dams, canals, and other water resource assets, such as C.C. Cragin Dam and Reservoir (formerly known as Blue Ridge Dam and Reservoir), Reclamation's responsibilities in the Study include funding and coordinating the Study, supplying and analyzing data, and ensuring Federal interests in the Study area are protected and/or addressed.

Gila Country
Gila County represents the interests of the unincorporated communities in the Study area, including facilitating and coordinating their involvement in the Study. The County assisted in the collection of population and water use data from all communities outside of Payson. Additionally, it assisted in the development and analysis of alternative solutions that would help give unincorporated areas access to adequate, sustainable, and renewable supplies of water through the year of 2040 and beyond.

Town of Payson
Payson represents the interest of the town of Payson. Payson provided leadership and political support to locate new water resources for the region. It also provided extensive direction to the Study's Technical Committee; supplied contacts and vendors to assist with consulting and engineering support required

during the Study; and shared existing data and information related to prior regional groundwater mapping and modeling efforts.

I.C.2 Other Participating Agencies

FS, Tonto National Forest
All communities within the Study area are entirely surrounded by the TNF. The TNF has management responsibility over all lands within the TNF, and must ensure any proposed activity that would require a FS permit is consistent with the Forest Plan.

FS, Coconino National Forest
The CNF lies in north-central Arizona. The existing facilities associated with C. C. Cragin Dam[1] are located within the CNF, with the exception of the pipeline on the downslope face of the Mogollon Rim that pumps water from the reservoir to the Verde River, and the hydroelectric generation plant that supplies the primary energy to operate the C.C. Cragin pumping plant. Similar to the TNF, the CNF has management responsibility over all lands within the CNF, and must ensure any proposed activity that would require a FS permit is consistent with the Forest Plan.

Salt River Project
SRP holds most of the water rights to flows of the East Verde River and Tonto Creek, which are stored in reservoirs on both the Verde and Salt rivers. This includes nearly all of the surface water runoff from the Study area.[2] This water is ultimately delivered to and used in the Phoenix metropolitan area. SRP participated in data collection and alternatives development related to this Study.

Arizona Department of Water Resources
ADWR provided guidance to all parties involved in the Study related to Arizona water law, which basically provides for title to all natural groundwater to be vested in the state of Arizona, but makes it available to landowners under which the water lies, for reasonable use at no charge. ADWR also coordinated and shared statistics and technical data related to water development efforts and uses

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[1] Note: C.C. Cragin Dam and Reservoir, and much of its associated transmission system, are located outside the Study area, within the boundaries of the CNF. In addition, a portion of the large regional groundwater aquifer, C aquifer, underlies and is adjacent to the Reservoir. Typically, most of the water captured by the Reservoir is pumped south, over the Mogollon Rim into the East Verde River. In the future it is anticipated that a portion of the diversion may be diverted into a proposed water transmission pipeline to Payson and possibly to other communities. A majority of the water is expected to continue its flow down the river and enter the Salt River Project's reservoir system (subject to SRP requirements and operational needs). While the CNF was not created to protect the watershed for the SRP, it still is required to protect the watershed on behalf of all citizens of the United States.

[2] A limited amount of surface water is used by smaller communities in the Study area that have established water claims pursuant to Arizona's Surface Water Code (see Table II.6, Surface Water Claims on the East Verde River (1984)).

within the Study area. It also provided input related to alternative solutions that may solve water resource problems within the Mogollon Rim area of Arizona.

Water Service Providers and Domestic Water Improvement Districts
Many of the water service providers and domestic water improvement districts within the Study area provided statistical and technical data, as well as considerations and feedback regarding alternatives that may provide solutions to water supply issues they face on a day-to-day basis.

I.D. Development and Use of Technical Data

Hydrologic and geologic data and information are exceptionally lacking for the Study area. Conducting an appraisal-level study using only currently available data would have resulted in a report that provided little more than what is already known about the Study area. Therefore, several key investigations were identified and undertaken as preliminary steps in conducting this Study. These were considered to be essential to identify viable alternatives for meeting the Study area's future water supply needs. These investigations included the following:

- "Hydrogeologic Framework and Review of Alternative Water Solutions for the Mogollon Rim Water Resources Management Study area" by HydroSystems, Inc., April 2008 (Attachment 1);

- "Geology and Structural Controls of Groundwater, Mogollon Rim Water Resources Management Study" by Gaeaorama, Inc., July 2006 (Attachment 1A);

- "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 (Attachment 1B); and

- "Report on an Isotope Study of Groundwater from the Mogollon Highlands Area and Adjacent Mogollon Rim, Gila County, Arizona" by Chris Eastoe, Ph.D., University of Arizona, October 2007 (Attachment 1C).

The results of these studies were extremely helpful in substantiating previously held assumptions and hypotheses regarding groundwater conditions within the Study area.

The Study does not evaluate (in depth) issues of local distribution system infrastructure, wastewater treatment systems, sewerage collection systems, or other operational management tools available to system operators, that are not part of the transmission system bringing water from water supply sources to the water service provider's service area. While these issues are mentioned in the discussion of alternatives, each of these elements require additional study, both technically and economically, so that each interested entity or group can evaluate and assess the total cost of acquiring and using any water source described in this Study.

II. Current Conditions of the Study area

This section includes a brief discussion about the climate, topography, geology, surface water hydrology, and hydrogeology of the Study area, as background information for the discussion concerning the communities within the Study area, their current water supplies, projected water needs, and potential future water resources. Other areas such as environmental, socioeconomic, legal, and institutional considerations and constraints also are briefly addressed, as appropriate.

II.A Climate

Precipitation in the Study area is seasonal; during the winter, storms associated with frontal systems bringing moisture from the Pacific Ocean travel from west to east, generally from late October through April. Precipitation often occurs as rain at the lower elevations near Payson and as snow at higher elevations along the Mogollon Rim, and on the Plateau. Winter storms have been the cause of many of the major floods in this area, particularly when warm rain falls on snow. The highest runoff during the year commonly occurs in March and April as a result of snowmelt. High flows are less common in May and early June, between the winter and summer storm seasons, than during any other part of the year. The second precipitation season is during the summer when moist tropical air sweeps in from the south. Precipitation at this time of year often occurs as short-duration, locally intense thunderstorms that are common from late June through early October and often cause local flash flooding.

Annual precipitation ranges from 18 to 26 inches near the Rim and in the Plateau uplands, with the highest values occurring along the Rim. National Weather Service records indicate Payson receives approximately 22 inches of precipitation a year, at an elevation of 4,900 feet above mean sea level (amsl).

II.B Topography

The Study area is located within both the Verde River and Salt River watersheds, and contains mid-elevation mountain ranges and valleys. Areas of higher elevation exist along the north-central boundary of the Study area. Vegetation includes semi-desert grasslands, Sonoran desert scrub, chaparral, highland, and woodland conifer forests (ADWR 2007). Most of the Study area is comprised of scrub oak, juniper, and conifer forest-type cover.

The elevation within the Study area ranges from more than 7,500 feet amsl at the top of the Mogollon Rim, to about 4,500 feet amsl at Fossil Springs, and 3,400 feet amsl at the Study boundary intersecting Tonto Creek. In most portions of the Study area, the cliffs and hills are thickly forested. The most prominent topographic feature in the Study area is the Mogollon Rim, which forms the boundary between the Colorado Plateau uplands province to the north and the Central Highlands province to the south. It is a steeply sloping cliff that rises from 1,000 to 2,000 feet above Payson to altitudes of 5,500 to 7,500 feet amsl at its upper edge. Topography along the Rim area is notably rugged, with steep cliffs and hills. The topography south of the Mogollon Rim also is rugged, but with less topographic relief. Slopes are generally north-to-south from the Rim, and range from flat in valley sections to nearly vertical at the Rim.

II.C Geology

The Study area is geologically and structurally complex, with a full range of sedimentary, igneous, and metamorphic rock formations, coupled with a high degree of structural discontinuity. Geological formations exposed at the surface range from Precambrian crystalline and metamorphic basement rocks in the south, to a suite of Paleozoic limestone, shale, and siltstones toward the north. The cross-section in Figure II-1, below, represents a generalized view of the geology and associated aquifers across the Study area, from top to bottom and north to south (as left to right).

Geologic structures, mainly faults, of three distinct ages are present in the Study area: Proterozoic, Laramide, and Tertiary structures. There are numerous Proterozoic and Tertiary faults; however, very few Laramide faults and monoclines are evident and are mentioned only incidentally in this Report.

The Proterozoic faults are about 1.65 million years old. They trend north to northeast, and tend to be located in the southerly parts of the Study area. Hydrothermal solutions moving along the faults in both Proterozoic and Tertiary times extensively cemented these faults, largely with silica; thus, to a large extent they are sealed. They have little porosity and permeability and generally do not provide much passageway for groundwater movement. There has been, however, re-activation on several Proterozoic faults, likely of the Tertiary age. This can result in creation of open space in fault breccia, which result in formation of fractured bedrock aquifers.

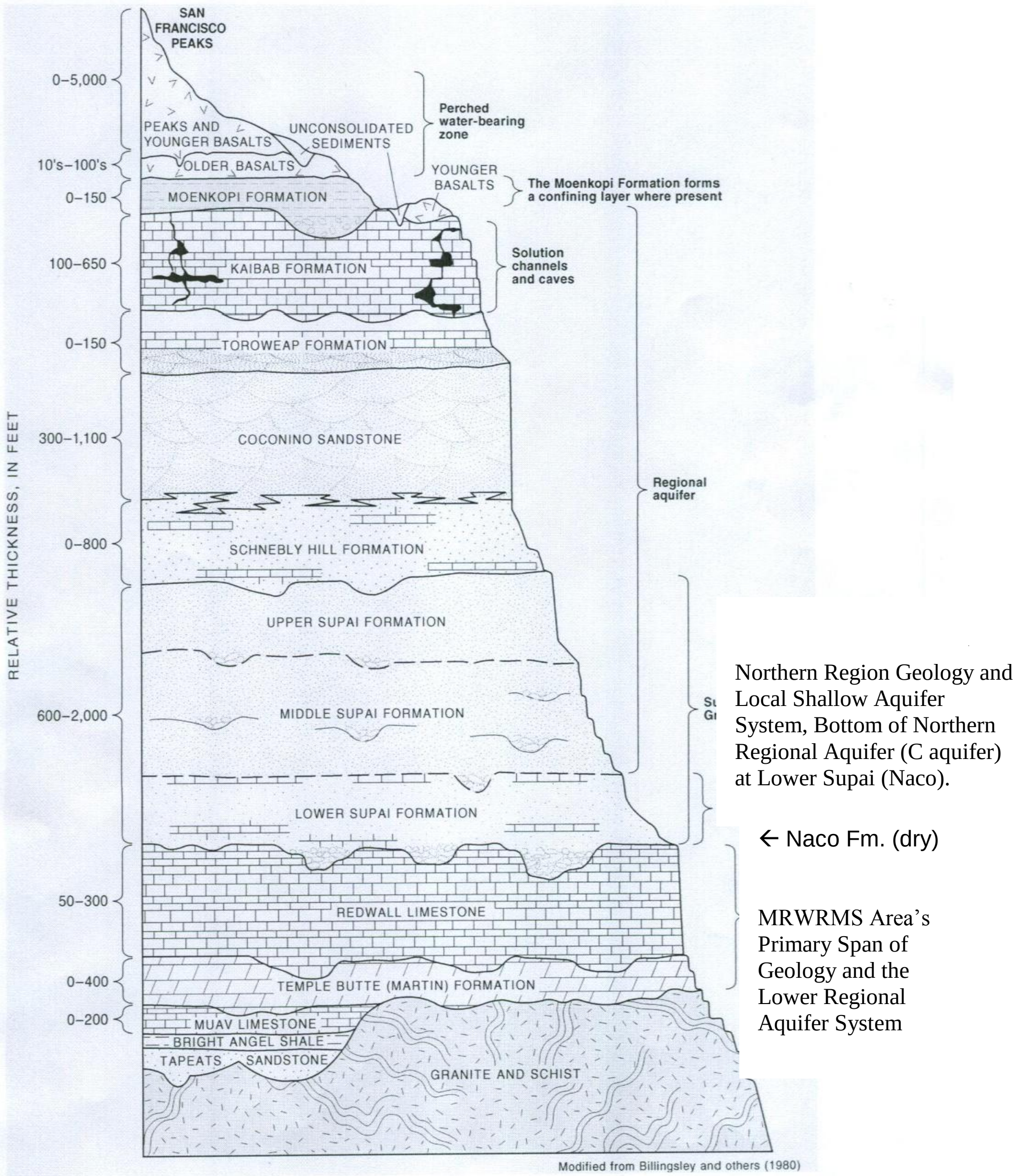

Figure 11. Generalized stratigraphic section of rock units, Flagstaff, Arizona.

24 Hydrogeology of the Regional Aquifer near Flagstaff, Arizona, 1994–97

Figure II-1. – Composite, Generalized Stratigraphic Section for the Study area.

Note: Modified from Figure 11 of USGS Doc. 00-4122, Bills and Others

There are three fundamental Tertiary fault systems: an east- to northeast-trending system; a north-trending system; and one that is generally northwest-trending but has locally north-trending faults. These systems likely developed under tensional tectonic conditions ("pull-apart faults") resulting, at least locally, in areas of broken ground and open spaces. Pull-apart faults are ideal for secondary porosity and secondary permeability, which means there is enhanced porosity and permeability beyond what is provided in normal pore space between grains in sandstones and between crystals in limestones. This is important for development of high production wells.

Not all Tertiary faults result in enhanced permeability and porosity, however. Some may have little or no permeability and porosity due to veins that have filled the fault, or the presence of soft rocks such as shales, shaly and silty sandstones. Some faults can have compressional characteristics that yield minimal open space, while chemical decomposition of fault wallrock may also result in impermeable fault zones. For example, basalt, which is common in the Study area, would readily form clay and calcite.

Overall, areas where younger fault systems intersect older faults systems are found to exhibit higher degrees of both weathering and fracturing, which relates to correspondingly higher well yields.

The Study area, being at the northern boundary of the basin and range province, is commonly referred to as the "Central Arizona Geologic Transition Zone." With minor exceptions, there is a noticeable lack of major young alluvial filled basins that form traditional aquifers in other locations within the basin and range province, such as Phoenix and Tucson. Because of the "broken" nature of the geology immediately south of the Mogollon Rim, there are no regionally extensive and hydrologically confining units present in the Study area. However, the complex relationship of faults and fracture systems and localized presence of isolated confining units do occasionally result in confined to semi-confined aquifer conditions. In addition, a wide range of fractured bedrock geologies in the region host both locally relevant and regionally extensive fractured aquifer systems.

Because of the diversity and complexity of the region's hydrogeology, the "Hydrogeologic Framework and Review of Alternative Water Solutions for the Mogollon Rim Water Resources Management Study area" (Attachment 1; HydroSystems 2008) divided the Study area into four Sub-Regions, based upon hydrogeologic characteristics and complexities. This Study has adopted this approach and utilizes the same sub-basin geographic boundaries in discussing the various communities and water providers within the Study area (Figure II-2).

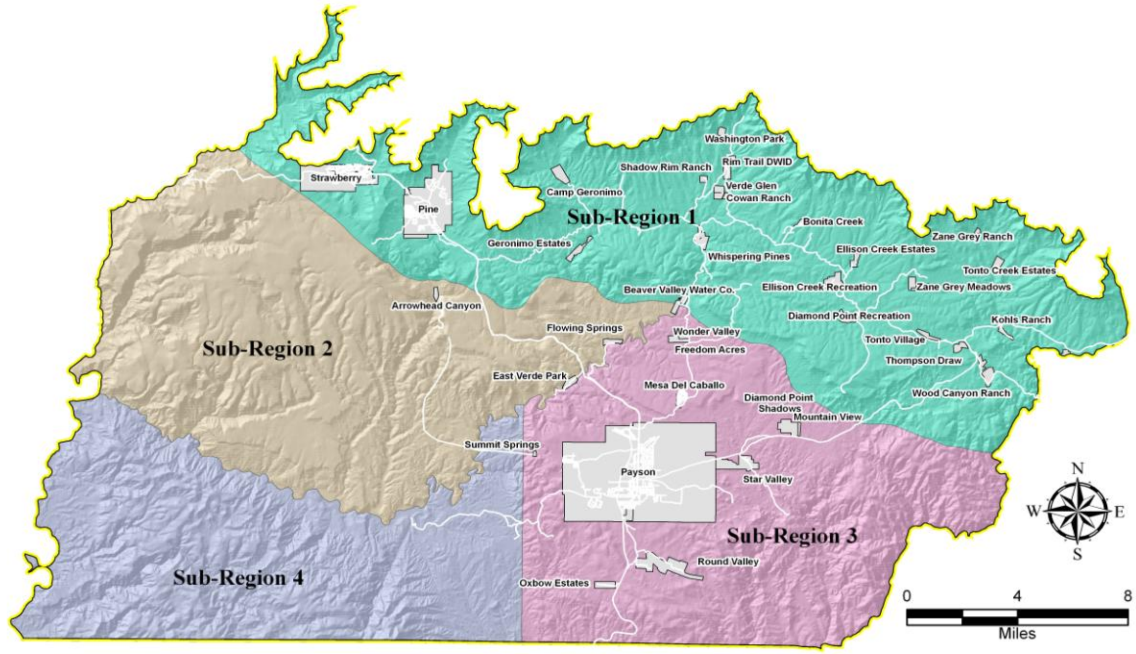

Figure II-2. – Four Sub-Regions within the Study area (HydroSystems 2008)

II.C.1 Geologic Sub-Region 1

Sub-Region 1 encompasses the area south of the Mogollon Rim (along the southern perimeter of the Colorado Plateau) and north of the Diamond Rim Fault. North of the Diamond Rim fault, the Study area consists of increasingly thicker deposits of Paleozoic strata, and it is ultimately dominated in the north by the Permian formations of the Upper Supai and Coconino Sandstone, which cap the Mogollon Rim. At the base of the Supai group, the Naco Formation is considered to be a locally confining sequence of alternating shale and limestone layers, which eventually pinches out a number of miles north of the Study area, beneath the Colorado Plateau. Faults in this Sub-Region are small but numerous enough to locally create aquifers. They ultimately circumvent the confining ability of the Naco Formation, and result in groundwater draining from the C aquifer down into the limestone, dolomite, sandstone, and eventually the Precambrian basement aquifer below.

Characteristic of this Sub-Region is the exposure of substantial portions of Paleozoic sedimentary rock units of the Colorado Plateau. Although not in the Study area, the Colorado Plateau is very influential because it is the primary recharge zone for the regional groundwater systems that exist both north and south of the Mogollon Rim. The gradient of groundwater moving south of the Mogollon Rim's crest is steep and groundwater flow is generally southward from the Rim. This groundwater makes up the primary groundwater inflow into the Study area, coming from precipitation events that infiltrate along the southern fringe of the C aquifer system through the Coconino Sandstone and layers of the Upper Supai Formation down to the Lower Supai Formation. The fractures and faults through these units appear to act as sub-vertical drains for local recharge. This facilitates leakage from the C aquifer, transmitting groundwater from along and beneath the Colorado Plateau into the lower section of Paleozoic strata through this Sub-Region, and ultimately into the Precambrian rocks below.

II.C.2 Geologic Sub-Region 2

Sub-Region 2, which is sparsely population, is located south of the Diamond Rim fault, and north/west of the East Verde River. Much of this Sub-Region is covered by Tertiary basalt units which can have a thickness of more than 1,500 feet. The basalt and other Tertiary units overlay some of the same Paleozoic units exposed along the Mogollon Rim, which have been vertically offset by the Diamond Rim Fault.

The Diamond Rim fault represents the physical break that defines the structural edge of the Colorado Plateau, resulting in the "Little Diamond Rim," a prominent ridge just a few miles south of the edge of the much larger Mogollon Rim. The Diamond Rim fault system has resulted in the displacement of large blocks of Paleozoic strata down towards the south in the areas of Fossil Springs, Hardscrabble Mesa, Tonto Natural Bridge, and south of Beaver Valley. This regionally extensive fault system literally cuts across most of central Arizona with normal (southerly side down) displacements locally greater than 1,000 feet. This regionally significant structural feature has a major influence on the region's hydrogeology, particularly with regard to Fossil Springs at the extreme northwest boundary of the Study area. The offset along the Diamond Rim fault in the vicinity of Fossil Springs is estimated to be 2,000 feet down to the south. The fault is likely acting locally as a boundary to groundwater flow across it, but acting as a conduit along the northern side of its strike. Interaction of the Diamond Rim fault with the Fossil Springs fault likely resulted in the formation and evolution of Fossil Springs.

There are only 53 registered wells within Sub-Region 2, most of which are located along its periphery. The direction and magnitude of groundwater flow through the Sub-Region is uncertain. Springs discharging along the outside edge of the basalt indicate groundwater recharge in the area; however, the basalt may conceal faults and fractures in the underlying sedimentary units that could be transmitting unknown quantities of groundwater elsewhere in the Study area.

II.C.3 Geologic Sub-Region 3

Sub-Region 3 falls within the southeast portion of the Study area, within which the majority of the Study area's population is located, including the communities of Payson and Star Valley. Most of the studies to date, which have been conducted related to geology and hydrogeology of the region, cover this portion of the Study area.

The geology of this Sub-Region consists predominately of Proterozoic rock units, which are exposed at the surface in most populated areas; however, in the northwestern portion, the Proterozoic rocks are covered by remnants of the lower Paleozoic sedimentary units. Around Payson, a thin veneer of Cambrian Tapeats sandstone commonly caps some of the granite hills around Payson. The contact between the Tapeats and the Precambrian basement is commonly referred to as "The Great Unconformity" where there is a gap in the geologic record of about 1.2 billion years between the time the granites were weathered at the surface, and the deposition of the sandstone approximately 530 million years ago. Because the Precambrian basement has been exposed to surface weathering and faulting repeatedly in its geologic history, the result is a deeply chemically weathered surface, rather than physical erosion. This chemically weathered surface can, however, vary greatly in thickness. The uppermost sections of the Payson granite, in particular, can have as much as 200 feet or more of this weathered-in-place rock or "decomposed granite" immediately adjacent to "hard ribs" of solid granite. The presence of this decomposed horizon is one reason for the Precambrian basement's unexpected performance as a reliable aquifer in the area and points to the likelihood of such aquifers being present in Precambrian host rocks to the north both beneath and adjacent to the Mogollon Rim. The remnants of Tapeats sandstone and their obvious displacements across the south-central portion of the Study area indicate the high degree of faulting in the region, as well as the role the faults played to fracture and further weather the Precambrian basement rocks, thereby forming the fractured bedrock aquifers which support many community water needs.

The nature of the fracturing in the crystalline basement rocks was found to be variable both laterally and with depth, and in concert with the host rocks' mineralogy, the age and interaction of the faults, and degree of weathering in a given area of consideration. Storage is inherently low thus making the aquifers vulnerable to over-pumping and drought. Wells installed within tens of feet of each other can have highly different yields, as is typical for fracture aquifer systems. Overall, where younger fault systems intersect older fault systems, these areas are found to exhibit higher degrees of both weathering and fracturing and relate to correspondingly higher well yields. Within the context of fractured crystalline bedrock, high groundwater yields (200 to 1,000 gpm) in the Payson area have been identified at depths approaching 1,000 feet into Precambrian basement rocks where faults intersect and deep weathering is present. This lower canvas of broken and displaced basement rock geology, with its localized high yield groundwater potential and both regionally and locally sourced aquifers, continues towards the north and constitutes the base of the regional aquifer system of the entire Study area.

Because the Paleozoic sequence was not deposited and/or was previously eroded in areas further south and east of Payson and Star Valley (due in part to a Precambrian - Cambrian bedrock high in this area), there are few if any locations in eastern portions of the Study area with Paleozoic strata preserved south of the Diamond Rim fault. This major fault is entirely within Precambrian basement rocks as it bifurcates and exits the east side of the Study area into the Hells Gate Wilderness.

Aquifers within this region constitute potential "mixing zones" of groundwater flowing southerly through the deep Precambrian fractured aquifer and locally recharged or perched aquifers within structurally bound blocks of dropped down Paleozoic and Tertiary strata. A few communities that lie within this extremely complicated hydrogeologic region are Mesa Dell, Wonder Valley, Freedom Acres, Beaver Valley, and northern Diamond Point Shadows.

II.C.4 Geologic Sub-Region 4

Sub-Region 4 is located in the southwest corner of the Study area, south of the East Verde River. It includes a portion of the Mazatzal Wilderness in the western portion of the Sub-Region, and a portion of Rye Creek Valley along Cypress Thicket. The portion of the Mazatzal Wilderness within the Study area comprises the northernmost end of the Mazatzal Mountains, for which there is very limited hydrogeologic information. The rugged terrain and its classification as a Wilderness Area greatly restrict efforts to obtain any data for this area. Only two registered wells exist in the Mazatzal Wilderness, one of which is abandoned. Both wells were drilled into Proterozoic rock units; groundwater movement is likely restricted to fractures and faults. Due to the area's higher elevation, it likely is a source of recharge to surrounding alluvial valleys. There also may be some groundwater contribution to streamflow of the East Verde River to the north.

Groundwater from Sub-Region 3 flows west into the eastern portion of this Sub-Region, separating near the Verde River and Tonto Creek watershed divide. A portion of the flow continues moving west along the East Verde River, while the other portion moves southward through the Rye Creek Valley, primarily through the Tertiary sedimentary deposits of the Valley. Springs discharging along the eastern edge of Sub-Region 4 all appear to be associated with mapped faults; their discharge is likely derived from recharge occurring in Sub-Region 3 as well as more distant sources.

II.D Water Resources

II.D.1 Surface Water Hydrology

The hydrologic system of the Study area is characterized by a surface network of short, steep stream channels that drain the upland regions and flow southerly into the Salt and Verde River watersheds. The Study area encompasses about 632 square miles, all of which is located within the TNF; only 2.4 percent of the land within the Study area is privately owned. The primary rivers or creeks flowing from the area include Fossil Creek, East Verde River, and Tonto Creek. All of these originate on the face of the Mogollon Rim and then flow southwestward in the Verde River into Horseshoe and Bartlett Reservoirs, or southeastward in Tonto Creek and into Theodore Roosevelt Lake and the remaining Salt River reservoirs.

Records for major streams that flow out of the Mogollon Rim indicate that base flow discharge increases downstream under most conditions although that flow may not continue without loss all the way to the mouth of the stream. During most flow conditions, the East Verde River and Tonto Creek are gaining in their downstream reaches. In the uppermost reaches above major springs, flow typically occurs only during periods of runoff; flashy runoff in the generally bedrock stream channels is typical. Below these springs, base flow may be maintained year-round for variable stretches. Of the streams originating in the Study area, the U.S. Geological Survey (USGS) has operated continuous-recording streamflow gaging stations on Tonto Creek, Fossil Creek, and the lowermost segment of the East Verde River. Peak flows within the largest perennial streams occur most often in winter or spring as a result of regional frontal storms. Runoff during such storms is augmented by snowmelt. Winter storms account for most of the annual floods above the median peak discharge on all gaged perennial streams draining the Mogollon Rim.

Fossil Creek

Fossil Creek is a major perennial tributary of the Verde River, draining southwest off the Mogollon Rim between the major sub-basins of East Verde River to the south and West Clear Creek to the north. Virtually the entire Fossil Creek drainage area is on land administered by the FS. Rainfall and snowmelt contribute to intermittent streamflow between the upper basin and Fossil Springs. Average annual precipitation is approximately 18 to 20 inches as recorded by Arizona Public Service (APS) at the Childs and Irving hydroelectric power plants, respectively. Precipitation varies considerably on a monthly and yearly basis. Generally, precipitation is distributed bi-modally over the year, occurring during the winter months as a result of storms originating in the north Pacific Ocean, and during the summer monsoon season as a result of convective thunderstorms which form from moisture drawn into the region from the Gulf of Mexico and Gulf of California.

Perennial flow occurs from Fossil Springs at an elevation of 4,280 feet amsl, approximately 14.3 miles upstream from the Verde River. There are several small springs above and below the Irving hydroelectric plant that produce minor additional flows. Fossil Springs represents the largest concentration of spring water discharge in the Mogollon Rim region. Spring flows emerge over an estimated 1,000-foot reach of Fossil Creek and are relatively constant at nearly 46 cubic feet per second (cfs). The Springs provide approximately 74 percent of the average annual basin yield above the Fossil Springs Diversion Dam. Various flow measurements taken during the past 50 years indicate that these springs maintain a flow of about 20,000 gallons per minute (gpm) that has varied little with respect to time.

In general the only flow measurements on Fossil Creek have been taken at the point of diversion for power plant use at the APS hydroelectric plant near Childs, Arizona. Since there is a general lack of data for Fossil Creek, it has been modeled to estimate its annual flows. Based upon a 2-year recurrence interval, the flow has been estimated to be about 32,230 af/yr. Years in which a 5-year flood occurred would result in flows of about 68,510 af/yr.

Generally, Fossil Creek is gaining flow in its downstream reaches. In the uppermost reaches, above major springs, flow typically occurs only during periods of runoff, but below Fossil Springs a base-flow is maintained year round.

Storm runoff and snowmelt from surrounding mountains contribute to flows in excess of base flow. Intense but brief and localized monsoonal storms produce large volumes of runoff within the watershed that generates flashy flows and flooding. Significant flows that overflow the low flow channel and transport substantial quantities of sediment occur about every other year. Floods in excess of a 5-year recurrence interval have high peak flow velocities capable of transporting cobbles, small boulders, and considerable debris. Under current watershed conditions, the estimated peak flow of the 100-year flood event is approximately 13,530 cfs.

For over 100 years, the surface water in Fossil Creek had been subject to power generation permits (issued by the Federal Energy Regulation Commission [FERC] to APS), which allowed for diversion from the Creek for power generation at Childs and Irving power generation facilities. No water consumption was allowed. In 1992, APS filed an application for a new license for the powerplants. APS then entered into discussions with the FS, U.S. Fish and Wildlife Service (FWS), environmental interveners (American Rivers, Arizona Riparian Council, Center for Biological Diversity, Northern Arizona Audubon Society, Arizona Chapter of the Nature Conservancy, and Yavapai-Apache Tribe). In 2000, APS and the other parties filed an Offer of Settlement (Settlement Agreement) requesting that FERC approve the surrender of the license to operate the hydroelectric facility and proposed to remove facilities and restore the area. The Settlement Agreement stated that APS would cease power generation and restore full flows to Fossil Creek no later than December 31, 2004, and complete site restoration by December 31, 2009.

As part of the agreement, APS submitted a surrender application to FERC in April 2003. FERC permits were surrendered in October 2004, and on June 18, 2005, APS restored full flow to 14 miles of the Fossil Creek wetland ecosystem, returning the area to a “natural and scenic” waterway.

II.D.1.1 Tonto Creek

Long-term records of flow from Tonto Spring show little fluctuation in base flow over a 20-year period. Stability of flow in Tonto Spring results from its location about 300 feet below the crest of the groundwater mound. A two-year record of flow in Pine Creek below Tonto Natural Bridge Spring shows little change in base flow, most of which is supplied by the spring.

The FS has measured the flow of Tonto Creek below the Mogollon Rim, and the amount of base flow was nearly equivalent to the combined discharge of springs in upper Tonto Creek and its tributaries, indicating there is no significant groundwater contribution to the channel from either the C or limestone aquifer other than spring flow. This base flow is approximately 24 percent of the Creek's total flow volume. Stream base flow, spring discharge, evapotranspiration, and runoff account for the greatest components of outflow

II.D.1.2 East Verde River

The base flow for the East Verde River is approximately 36 percent of the River's total flow volume. There are no data to determine the extent to which flow of the East Verde River is maintained by the C aquifer beyond spring discharge, and all base flow in excess of spring discharge is assumed to come from the limestone aquifer. Based upon data developed by USGS, the C aquifer is considered to be the source of most flow that discharges from the underlying limestone aquifer.

Since 1964, a significant additional source of flow into the headwaters of the East Verde River has been water diverted by pipeline from C.C. Cragin Reservoir. This is explained in more detail below.

II.D.1.3 C.C. Cragin Dam and Reservoir

Although they are not located within the Study area, C.C. Cragin Dam and Reservoir have historically impounded water that flowed in the upper portions of Clear Creek, a tributary to the Little Colorado River, which was then diverted into the East Verde River headwaters within the Study area through an exchange agreement between Phelps Dodge Corporation (Phelps Dodge) and SRP. Under this agreement, Phelps Dodge, former owner and operator of C.C. Cragin Dam and Reservoir, stored water from the Little Colorado River watershed at the reservoir and transferred it by diverting the water into the East Verde River for delivery by SRP to the metropolitan Phoenix area. In return, SRP water from the Salt River watershed was used at Phelps Dodge's Morenci mine facility. C.C. Cragin Reservoir has a storage capacity of 15,000 af. From 1964 until January 2002, Phelps Dodge diverted an average of 9,680 af/yr to the East Verde River, to satisfy the requirements of the exchange agreement.

With implementation of the Black River/Central Arizona Project Exchange Agreement in 2002 and passage of the Arizona Water Settlements Act in 2004, Phelps Dodge gave up ownership and ceased its operations of the C. C. Cragin

Dam and Reservoir system. The facilities were transferred to the U.S. Government with Reclamation as the primary Federal agency having direct oversight. SRP became responsible for the operation and maintenance of this system. At the time of this report, SRP, in collaboration with Reclamation, is performing studies and other efforts to determine operational plans for the newly acquired facilities. Pursuant to agreements with Reclamation, SRP may divert up to an average of 11,000 af/yr into the East Verde River, a portion of which may be acquired for use by entities in northern Gila County.

The drainage area above the C.C. Cragin Dam is 71.1 square miles. The watershed is divided into two sub-areas. The longer less steeply sloping sub-area is drained by East Clear Creek. The shorter more steeply sloping sub-area is drained by Miller and Bear Canyons. The major drainages into the reservoir are East Clear Creek, Miller Canyon, and Bear Canyon. Elevations in the watershed range from about 6,720 feet amsl at the Dam to about 7,800 feet amsl along the north ridge of the watershed, to 8,077 feet amsl at Baker Butte. The average elevation of the watershed is about 7,200 feet amsl. The watershed consists almost entirely of dense conifer and pine forest. Soils in the watershed are described as deep cobbly and gravelly fines, sandy loam, and deep cobbly loam.

C.C. Cragin Reservoir has experienced many cycles of deep drawdown (up to 80 feet) and refilling during its 40-year history. The reservoir normally fills during spring run-off and typically is at the full supply level (El. 6,720 feet amsl) in late spring. Withdrawals have typically been made in the summer and fall with the reservoir reaching minimum pool level (El. 6,640 feet amsl) in late fall. Since January 2002, withdrawals by Phelps Dodge are no longer being made and, as a result, reservoir drawdown is limited and occurs as a result of spillway discharges, seepage, and evaporation. Annual losses due to seepage and evaporation at C.C. Cragin Reservoir have been estimated to be 843 af/yr.

The system has eight pumps that are available to lift water from the Reservoir to a 2-million gallon priming reservoir. The water then drains by gravity through a pipeline south over the Mogollon Rim (and into the TNF, Gila County) to a hydropower plant. Up to 6 of the pumps can operate simultaneously to produce a maximum flow of about 33 cfs. The power generated at the plant adjacent to the East Verde River is only used to pump water associated with the project.

II.D.1.4 Other Springs

Other springs in the Study area that produce annual volumes of discharge are detailed below, and are summarized in Table II.1. They include the following:

- Tonto Natural Bridge Spring
- Webber Springs
- Cold Springs
- Tonto Spring
- Horton Spring

- R-C Spring

Table II.1. – Springs Producing Annual Volumes of Discharge Greater than 1,000 af/yr

East Verde River Drainage System (> 1,000 af/yr)	Discharge (gpm)	Annual Volumetric Discharge (af/yr)
Tonto Natural Bridge Spring	841	1,357
Webber Springs	996	1,608
Cold Springs	1,060	1,711
Total	**11,797**	**19,025**
Tonto Creek Drainage System (> 1,000 af/yr)		
Tonto Spring	1,291	2,084
Horton Spring	1,100	1,776
R-C Spring	800	1,291
See Springs	1,088	1,757
Total	**4,279**	**6,908**

These springs, as well as the lesser springs (those under 1,000 af/yr flow volume), contribute to the streamflow (base flow) of their respective drainage system. [***Note: many springs are subject to a high degree of seasonal flow variability and may not be adequately gaged.*****]**

II.D.2 Hydrogeology

Groundwater flow in the Study area is generally from northeast to southwest. Although recharge to groundwater occurs throughout the Study area, it occurs predominantly along the Colorado Plateau and Mogollon Rim. Recharge contributions are from both regional precipitation and snow melt during the winter, and more localized precipitation events in the summer, which is typical throughout most of Arizona. As precipitation is a function of elevation, so also is recharge. The higher elevations in the Study area along the Mogollon Rim and northward along the Colorado Plateau tend to have greater rainfall and snow totals. This, in turn, provides greater volumes of recharge to the regional groundwater systems both north and south of the Mogollon Rim.

As recharge water moves through the more permeable sedimentary units of the C aquifer and reaches saturated portions, it begins to move with the groundwater gradient. The groundwater gradient north of the Mogollon Rim tends to be shallow through the more conductive Coconino Sandstone and upper Supai Sandstone units. Moving south of the Mogollon Rim, the groundwater encounters the fine-grained units of the Lower Supai and Naco Formations. The gradient becomes very steep as a result of the typically low hydraulic conductivities associated with fine-grained shale and limestone and the nature of topographic relief near the Rim. Near vertical flow through these less permeable units is facilitated by abundant faults and fractures, which provide conduits for groundwater flow.

The locations and discharge rates of springs are affected by both lithologic and structural controls. Faults and fractures intercepting the groundwater provide conduits to the land surface and result in the formation of seeps and springs along the Mogollon Rim. Also, as permeable layers (typically coarse grained intervals bounded by shale rich layers) intercept the land surface, these too may result in the formation of springs and seeps. Many of the monitored and sampled springs in the area indicate highly variable discharge rates individually, and reflect contributions from both local and far removed sources (based on the water's isotopic and ionic composition; see Attachments 1A and 1C). In some locations, spring discharge increases substantially after precipitation events, while in other locations, springs show a more tempered response depending upon local hydrogeologic constraints. The increase in discharge may be the result of recharging precipitation increasing head pressures. As recharge occurs from an even greater distance, newly recharged groundwater will "push" older groundwater out of the system ahead of the recharge front.

As groundwater moves down through the Naco Formation (where breached) and into the limestone units of the Redwall and Martin Formation, fractures and solution channels become the dominant mechanism for flow. The surface exposures of these units north of the Diamond Rim Fault are recharged by precipitation events as well as by the capture of stream flow, which is often fed from above by spring discharge along the Mogollon Rim.

The Diamond Rim Fault zone potentially represents the most influential structural feature with regard to groundwater flow in the Study area; however, due to the limited amount of data available for this area, the true relationship between the fault and groundwater flow is uncertain. Nevertheless, some reasonable inferences can be made. The location and discharge rate of Fossil Springs appear to be controlled to a great degree by the Diamond Rim Fault. Other springs in the Study area appear to be both directly and indirectly related to the presence of this fault. Locally, this fault may act as a barrier or a conduit to groundwater flow--likely both as a conduit along its strike and barrier across it in the case of Fossil Springs.

South of the Diamond Rim Fault zone, groundwater exits the Paleozoic sedimentary units and flows down into the Proterozoic igneous and metamorphic units below. The area beneath Hardscrabble Mesa may be an exception to this general statement in that there may be a saturated sequence of Paleozoic sedimentary units (primarily the Redwall Limestone and Martin Formation) preserved below the Tertiary basalt and conglomerate cover.

Groundwater flow through the Proterozoic units (like much of the Paleozoic units) relies primarily upon the secondary porosity and permeability of faults and fractures. As mentioned above, the faults and fractures provide avenues for localized precipitation to recharge the aquifer in addition to providing pathways for regional groundwater through flow. The uppermost portions of the Proterozoic units tend to have greater hydraulic connections relative to deeper fractured areas. Water levels observed in wells penetrating these units exhibit strong variability associated with localized recharge events. The presence of springs and gaining reaches in the East Verde River and Tonto Creek along the periphery of the Sub-Region 3 appears indicative of groundwater discharging from the regional aquifer system.

II.D.3 Groundwater Budget Estimates

Understanding the groundwater systems within the Study area is complicated by significant variability in the host aquifers, which makes consideration of aquifer storage extremely difficult. In addition, variables such as highly variable slope, vegetation, and soil types make surface water calculations an approximation at best. Nevertheless, in a simplified way, a regional water budget can be roughly estimated by assuming the aquifer systems are collectively recharged by both local and regional sources and adjusting for generally accepted surface water runoff and evapotranspiration rates. In the case of groundwater (a primary focus of the investigation), utilizing two primary assumptions and a suite of other simplifying assumptions (see Attachment 1), it is possible to estimate the flow of groundwater through the system. First, it is conservatively estimated that 31,800 af/yr enters the system by direct leakage through the Mogollon Rim from the C aquifer into the lower regional aquifer strata (USGS 2005). Additionally it is considered that direct recharge from local precipitation can be estimated at 4 to 5 percent overall (although locally it can be as much as 10 to 16 percent). This low range of values is utilized to account for highly variable slopes, soil types, and vegetative cover observed throughout the region. The annual groundwater recharge from precipitation is then estimated to be 30,700 to 38,300 af/yr. In combining these estimates, the total regional groundwater in-flow to the system is assumed to be 62,500 to 70,100 af/yr.

Groundwater inflow manifests itself as outflow in the form of spring discharges, stream base-flow, and groundwater underflow. As a matter of balance, it is then assumed that approximately 42,700 af/yr discharges as spring flow (the majority of C aquifer input discharges at Fossil Springs) and 18,000 af/yr discharges in the form of stream base-flow. The remaining 1,800 to 9,400 af/yr is groundwater underflow or “flux” through the system. The above values are rough estimates.

Ultimately, the groundwater within the Study area is an interconnected aquifer system flowing through several different geologic units. Locally, a groundwater system may behave as an isolated component to the regional system, but ultimately plays a role in a much larger long-term regional perspective. Continuity of groundwater flow is disrupted by recharge zones, faults, fractures, and by the lithologic variability of the sedimentary units in the area. However, connection between and through these various units is facilitated by the broken and fractured nature of the Study area’s geology. Viewing the Study area as a regional groundwater system appears to be supported by water levels observed in wells, spring elevations, and by water chemistry data. This regional aquifer system provides a large canvas that communities and water resource managers can draw upon to plan and develop water resources for the area.

II.D.4 Water Quality

Water quality within the Study area is variable. A limited sampling of water quality data is represented in Table II.2, which provides values for selected water chemistry properties in the Mogollon Highlands. (Source - USGS). A number of springs and wells throughout the Study area also were sampled in support of this Study, to develop basic data for water chemistry and isotope analyses. Theses data generally indicate comparable water chemistry throughout the Study area to that shown in Table II.2; however some differences are observed in key constituents that relate to source waters, recharge mechanism, and age. These concepts were considered in depth for the development of the conceptual hydrogeologic framework of the region. Please see Attachments 1, 1B, and 1C for full details.

Table II.2. – Selected Water Chemistry Property Values of Surface Water Sources Located in the Mogollon Highlands, Arizona

Water\Source	pH		Dissolved Solids (mg/L)	
	Range	Mean/Median	Range	Mean/Median
Stream-flow - Tonto Creek above Gun Creek	7.2-8.9	8.2/8.2	0.23--620	58/19
Stream-flow - East Verde River near Childs	7.8-8.6	8.4/8.4	.05--250	23/11
Spring Flow - East Verde River Drainage	6.9-7.5	7.3/7.4	158 -- 350	253/267
Spring Flow - Tonto Creek Drainage	7.1-7.7	7.3/7.3	90 -- 319	185/169
Groundwater*	6.5-7.5	6.5	170 -- 400	250

*Representative of Payson groundwater sources only.[3]

ADEQ, in compliance with the Clean Water Act of 1977 and supplements thereto, established designated uses for various surface waters within the state of Arizona, including those within the Study area. ADEQ also has performed assessments to determine whether or not the designated uses are being met. Table II.3 presents a

[3] Payson performs an annual Water Quality Survey of it drinking water sources – groundwater, as required by ADEQ. Payson's drinking water is in full compliance with all drinking water standards established by EPA and ADEQ, i.e., primary and secondary drinking water quality standards. Similarly, other water service providers in the Study area are required to provide their customers with an annual Consumer Confidence Report that provides similar water quality information as found in Payson’s Annual Water Quality Survey. It is assumed the water quality of Payson’s groundwater is similar to the groundwater quality throughout the Study area since most groundwater sources are taken from the same geologic formations. (See also Attachments 1, 1B, and 1C.)

summarization of ADEQ's determinations regarding its assessment of the Designated Uses for the listed rivers and creeks within the Study area.

Table II.3. – Designated Uses for Surface Water Quality Standards at Specific Locations - the East Verde River and Tonto Creek

Location	A&Ww	FBC	DWS	FC	AgI	AgL
East Verde River--Below confluence with Ellison Creek	Y	Y	Y	Y	Y	Y
Fossil Springs	Y	Y	Y	Y	N	N
Tonto Creek—Headwaters below confluence with an unnamed tributary	Y	Y	N	Y	Y	Y

Note: Numeric water quality criteria to maintain and protect water quality for designated uses are prescribed in Arizona Administrative Code: Appendix A, R18-11-109, R18-11-110, and R18-11-112. Narrative water quality standards to protect all surface waters is prescribed in R18-11-108. The terms used in this table are as follows: "AgI" -- agricultural irrigation; "AgL" – agricultural & livestock watering; "A&Ww" -- aquatic & wildlife (warm water); "DWS" – domestic water source; "FBC" – full-body contact; and "FC" – fish consumption.

Additionally, ADEQ, acting on the behalf of EPA, has prepared a Source Water Assessment for all public and private water service providers within the Study area. ADEQ has determined that, in general, all groundwater supplies are at a high to moderate risk for being impaired by another water source of unacceptable water quality with respect to the Safe Drinking Water Act of 1974 due to source aquifer types (fractured bedrock formations). The Tonto Village, Christopher Creek, and Kohl's Ranch communities are under evaluation by ADEQ to determine the extent of mitigation effort that should occur.

A potential water quality issue may exist for smaller communities whose wastewater is processed by septic systems, or which use a similar type of wastewater treatment and disposal system. This is especially true for communities that utilized wastewater treatment system specifications under pre-1974 ADEQ rules (Bulletin 12). These rules related to small lot subdivisions that were not required to reserve space for adequate septic/water system separation. There also could be a potential for water supply impairment from human waste entering the local water supply as a result of installation procedure requirements in place prior to 1990. These procedures were replaced by more rigorous requirements in 2001 when the aquifer protection permit rules were adopted as part of the Arizona Administrative code.

Additionally, there is some concern about arsenic contamination (20 to 30 times the maximum contaminant limit) on the lower portions of the East Verde River from its American Gulch confluence to its confluence with the Verde River.

II.E Environmental and Social Resources Considerations and Constraints

II.E.1 Biological Resources

II.E.1.1 Vegetation

The project area encompasses three major vegetative communities: Great basin conifer woodland, interior chaparral, and the interior riparian deciduous forest and woodland (Brown 1994).

The Great Basin conifer woodland is a cold-adapted community characterized by the presence of two evergreen conifers--juniper (*Juniperus*) and pinyon pine (*Pinus*). Junipers have invaded large areas of former grasslands and tend to be found at lower elevations than pinyons, on deeper soils below 2,000 meters in elevation. At higher elevations, important plant associations include Gambel oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus*), and skunkbush sumac (*Rhus trilobata*). Other important shrubs are cliffrose (*Cowania mexicana*), Apache plume (*Fallugia paradoxa*), and fourwing saltbush (*Atriplex canescens*) (Brown 1994).

Only a few vertebrate species are closely tied to the Great Basin conifer woodland, e.g. pinyon mouse (*Peromyscus truei*) and pinyon jay (*Gymnorhinus cyanocephalus*) (Brown 1994). However, the community is seasonally of great importance as winter range for elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*).

Interior chaparral is a drier-adapted community than the conifer woodlands. The dominant plant species will change depending upon elevation, slope, aspect, and soils. In Arizona, shrub live oak (*Quercus turbinella*) is the most widespread and dominant species. Most chaparral species form dense, compact stands that quickly regenerate after burning. Very little herbaceous cover may be present. An occasional juniper, oak, or pinyon pine is often present and any of these species may form an open, scattered overstory. Arizona smooth-bark cypress (*Cupressus glabra*) may occupy north facing slopes, canyons, and canyon bottoms (Brown 1994). The drier, rockier sites often support representatives of the Sonoran desert and semidesert communities, such as catclaw (*Acacia greggii*), jojoba (*Simmondsia chinensis*), and crucifixion thorn (*Canotia holacantha*) (Brown 1994). Brown (1994) lists bird, mammal, and reptile species that can be found in the interior chaparral community, most of which are scrub-adapted species or species that range widely over several vegetation communities.

Riparian vegetation has been defined as that which occurs in or adjacent to drainage ways and/or their floodplains, and which differs in species and/or life forms from that of the immediately surrounding vegetation (Szaro 1989, p. 71). Within the Study area, the Sonoran riparian deciduous forest and woodlands would typically be found along drainages such as Tonto Creek, Christopher

Creek, and the Verde River. Signature tree species such as Fremont cottonwood (*Populus fremontii*) and Goodding's willow (*Salix gooddingii*) are found along the immediate floodplain, and mesquite (*Prosopis*) on drier, upper terraces. Other trees of note include Arizona sycamore (*Platanus wrightii*), velvet ash (*Fraxinus velutina*), and the non native saltcedar (*Tamarix*). Vegetation diversity is high and structure more complex than adjacent uplands.

While covering less than one percent of the land area in the southwestern United States, riparian forests support some of the highest species richness and abundance totals of terrestrial vertebrates in North America (Stromberg and Tellman 2009, p. 152). Approximately 75 percent of the breeding birds in the southwest are classified as facultative riparian and over 50 percent as obligate riparian species (Johnson et al. 1977).

II.E.1.2 Threatened and Endangered Species

There are several species listed as threatened and endangered pursuant to the Endangered Species Act (ESA) located in Gila County. While no attempt has been made to establish the exact location of these particular species relative to the Study area, it is important to note that threatened and endangered species must be given proper attention with all alternatives, including the Future Without Alternative. This includes ongoing research, continued protection, and mitigation of potential impacts.

There are four status levels of threatened and endangered species within Gila County: threatened, endangered, candidate, and conservation agreement. It is useful to define the status levels that are identified for threatened and endangered species within Gila County. Threatened (species) means that a species is likely to become endangered if it is not protected. Endangered (species) means that a species is in immediate danger of becoming extinct and needs protection to survive. Candidate (species) means listing of the species is warranted but precluded as a distinct vertebrate population segment in the western United States on July 25, 2001. (Candidate) Conservation Agreement is a formal agreement between the FWS and one or more parties to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened. Table II.4 provides a summary of the status of threatened and endangered species that are known to exist in Gila County.

Table II.4. – Status of Federally Listed Threatened and Endangered Species, Gila County, Arizona

Common Name	Scientific Name	Status	Elevation (ft)
Apache (Arizona) Trout	*Oncorhynchus apache*	Threatened	>5000
Arizona agave	*Agave arizonica*	Endangered	3,000-6,000
Arizona hedgehog	*Echinocereous triglochidiatus var. arizonicus*	Endangered	3,700-5,200
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Varies
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	Endangered	<4,000
California Brown pelican	*Pelecanus occidentalis californicus*	Endangered	Varies
Chiricahua leopard frog	*Rana chiricahuensis*	Threatened	3,300-8,900
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered	<4,000
Gila chub	*Gila intermedia*	Endangered	2,000-5,500
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	Endangered	<4,500
Gila trout	*Oncorhynchus gilae*	Endangered	5,000-10,000
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Endangered	<6,000
Loach minnow	*Tiaroga cobitis*	Threatened	<8,000
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	4,100-9,000
Razorback sucker	*Xyrauchen texaanus*	Endangered	<6,000
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	<8,500
Spikedace	*Meda fulgida*	Threatened	<6,000
Yuma clapper rail	*Rallus longirostris yumanensis*	Endangered	<4,500
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate	<6,500
Arizona bugbane	*Cimicifuga arizonica*	Conservation Agreement	5,300-7,000

II.E.2 Cultural Resources

There has been intense archaeological and historical interest about the cultural history of the TNF since the turn-of-the-century. The lands now contained within the TNF's boundaries appear to have been among the earliest and longest occupied areas of Arizona. There is evidence that the variety of settlements, cultural traditions, lifestyles, and subsistence patterns can provide a rich source of information about the history of the entire central region of the state. The lands supported part of the Hohokam population, a prehistoric culture. The Study area also was the center of another prehistoric cultural group--the Salado. The region shows evidence of contact and interaction with many other ethnic groups of prehistoric Arizona, including the Anasazi, Mogollon, Sinagua, and Tucson Basin Hohokam.

The Payson-Pine Area was used during the Archaic period (7500 B.C to A.D. 200). There is evidence of earlier exploitation of the area during the Paleoindian period (Clovis; ca. 9000 to 8000 B.C.). The area was used regularly for subsistence activities. Notable archaeological sites in the Payson-Pine area include Shoofly Village and a Hohokam-style pithouse near Payson.

Other heritage resources within the TNF include historic period sites related to early ranching and homesteading, mining, and military use; cultural landscapes; and spiritual places. The TNF Heritage Program is charged with preserving the many archeological and historic sites on the TNF and protecting them from development, vandalism, and looting. Carrying out this effort requires close relationships between the TNF and many other peoples and groups, for example the State Historic Preservation Office (SHPO), the Arizona Site Stewards Volunteer Organization, and several Indian tribes. In addition to protecting archeological sites, the TNF also works with the tribes to ensure that traditional Native American economic and religious activities can continue to be practiced on what are now public lands. A similar heritage program exists for the CNF.

Cultural resources issues are expected to exist for each alternative presented in this report. Careful research and field investigation would be required prior to the implementation of any alternative presented in this report.

II.E.3 Recreational Resources

Recreational activities abound within the Study area. The TNF is heavily visited due to its proximity to the Phoenix metropolitan area. A variety of outdoor recreational activities are scattered throughout the Study area including hiking, camping, fishing, hunting, biking, picnicking, golfing, recreational shooting, rock-hounding and prospecting, sightseeing, off-highway vehicle use, and water sports. Winter snow makes possible cross-country skiing, snowmobiling, and cross-country snowshoe racing.

Portions of two designated TNF wilderness areas fall within the Study area. Hellsgate Wilderness is located east of Payson and south of State Route 260, in the southeastern portion of the Study area. Part of the Mazatzal Wilderness falls within the southwestern portion of the Study area. In addition, the Fossil Creek Wilderness, which is located in Coconino County, lies just north of the Mazatzal Wilderness and just beyond the northwestern boundary of the Study area.

II.E.4 Socioeconomics of the Study area

Gila County, covering 4,796 square miles, had a population of 51,335 in 2000, representing about 1 percent of the state's population. The Study area, which consists of about 13 percent of the County's land mass, is home to about 44 percent of the County's population. The proportion of individuals below the poverty level within the Study area (10 percent) is lower than that of either the county or state (17 and 14 percent, respectively) (Table II.5).

Table II.5. – Population and Selected Socioeconomic Comparisons for the Study area, Gila County, and State of Arizona

	ARIZONA			GILA COUNTY			STUDY AREA		
	Number	% of:		Number	% of:		Number	% of:	
Total population (2000)	5,130,632			51,335	1%	AZ	22,754	44%	Co.
Average household size	2.64			2.50			2.23		
Median household income (1999)	40,558			30,917			35,412		
Individuals below poverty level	698,669	14%	Co.	8,752	17%	Co.	2,354	10%	SA
Families below poverty level	128,318			1,785			467		
Estimated poverty threshold (2002)*	$15,574			$14,989			$13,896		
*calculated as 5780+(3080 x avg. family size)									

U.S. Census data

Gila County's major industries include ranching, tourism, recreation, and copper production. Areas of employment within Gila County include public administration, retail trade, health care and social assistance, accommodation and food services, educational services, construction, arts, entertainment, and recreation, manufacturing, transportation, public utilities, mining, waste services, and other undefined areas of employment. Government provides the most employment of any sector in Study area. Another significant area of employment is the construction industry. There has been some emphasis on attracting manufacturing businesses, but most growth has occurred in the service sector.

The economy of the Study area is mainly associated with tourism, in-migrating retirees, and seasonal residents. For Payson in particular, the local economy is dominated by tourism, retirement, and construction industries, with a growing emphasis on manufacturing and service firms. The community also encourages light industry which is compatible with the community's "High Quality of Life." The Tonto Apache Reservation is in an excellent position to take advantage of the high tourism volume around Payson.

Pine and Strawberry are generally described as vacation and retirement centers. The commercial sectors of both communities rely heavily on weekend tourists and second-home residents. With the growth in the area, light industry manufacturing is being encouraged. Some residents travel to Payson for employment; however, most non-tourist-related income comes from construction and service-related businesses.

II.F Other Considerations and Constraints

II.F.1 Drought

Arizona's climate is characterized by a high degree of year-to-year and decade-to-decade variability, i.e. the amount of precipitation between successive wet and dry years fluctuates greatly. Year-to-year fluctuations are indicative of the climatic conditions in Arizona, which are rarely average (normal) over space and time. However, due to persistence in Pacific Ocean sea surface temperature conditions, which have a strong influence over the path of storms entering the Southwest, year-to-year fluctuations in climate can be embedded within multi-year periods during which the duration and intensity of dry or wet conditions remain above or below average. Droughts (multi-year dry periods) are a normal and expected phenomenon.

Arizona, including the Study area, is susceptible to periods of unusually low precipitation or drought, which places a strain on the state's water resources. Snowfall, rather than rainfall, is the critical source of Arizona's water supply. Recharge from snowmelt in spring helps to replenish groundwater aquifers. The water from snowmelt also provides natural vegetation with critical moisture for spring growth. Finally, the runoff from snowmelt augments rivers and streams with water that eventually collects in reservoirs for delivery to arid and high-demand areas.

Arizona streams technically are under drought conditions 60 to 80 percent of the time, and individual droughts commonly last as long as 5 years. Drought is defined, at least for this Study, as an extended period of less than average streamflow. Arizona streams have short periods of large discharge and long periods of small discharge, which make "average streamflow" larger than the rates that are ordinarily available to water users.

The USGS studied five major statewide droughts that occurred during the last 350 years. In the last century, periods of significant drought occurred three times between 1932 and 1977. Results are limited due to the fact that these droughts were identified at specific research sites and were not extrapolated to estimate the areal extent of the drought on a statewide basis. Table II.6 briefly summarizes the chronology of major droughts in Arizona from 1721 through 2004.

Table II.6. The Chronology of Major Droughts in Arizona from 1721 – 2004

Date	Area Affected	Recurrence Interval (in years)	Remarks
1721 - 1741	Unknown*	Unknown	Tree Ring Data
1801 - 1823	Unknown*	Unknown	Tree Ring Data
1932 - 1936	Statewide	10 to 20	Effects differed among basins
1942- 1964	Statewide	>100	Second most severe in 350 years, on the basis of tree-growth records
1973 - 1977	Statewide	15 to 35	Most Severe in eastern Arizona
1995 – 2004	Statewide	Unknown**	Unknown**

*Based upon streamflow volumes estimated for as many as 350 years at three sites on the basis of measured rates of tree growth.
** Experts have not yet concluded whether or not this drought has run its full course.

II.F.2 Legal and Institutional Considerations

There are many administrative considerations, both legal and institutional, that place restrictive limitations on water related issues. To the extent possible at this level of study, these limitations will be considered during the development of the various proposed alternative solutions to water problems in the Study area. The legal issues include federal, state, county, and town laws, statutes, and ordinances related to surface water rights, groundwater rights, private property rights, public health and safety, environmental concerns, and resource conservation. Institutional limitations relate to powers and authorities vested within federal and state agencies, counties, and towns. A few key illustrations are discussed below. A summary of these legal and institutional considerations, and how they may apply to the various alternative solutions to water problems in the Study area, are presented in Attachment 4 to this Report, entitled “Legal and Institutional Considerations,” April 2008.

II.F.2.1 Legal Considerations

Arizona water law is based on the doctrine of prior appropriation, and is administered under a system based on surface water being regulated separately from groundwater. Thus, the applicable law is dependent upon a determination of what type of water is being used. Surface water is “all sources flowing in streams, canyons, or ravines or other natural channels, or in definite underground channels (whether perennial or intermittent), floodwaters, wastewaters, or surplus water, and of lakes, ponds, and springs on the surface (Arizona Revised Statutes §45-101). Water law in Arizona is administered by ADWR, with a major division between regulations that apply to Active Management Areas (AMAs) (five AMAs cover major population centers of the State) and non-AMA areas. All of Gila County is within a non-AMA area.

Water rights in Arizona can be held by all types of legal entities such as government agencies, corporations, individuals, groups, etc. Until recently, the law of Arizona prevented county governments from exercising authority to regulate growth of communities because of potential shortages of water; thus, in the past Gila County has not taken an active role in water management or resource development, other than through approval of DWIDs within the Study area. However, Arizona SB 1575, enacted in 2007, gives counties authority to consider water adequacy in the building permit process.

II.F.2.2 Surface Water Laws and Rights

The doctrine of prior appropriation that governs surface water is based on the tenet of "first in time, first in right" which is interpreted to mean the party that first beneficially uses water acquires a right that is superior to those that are later appropriators. Pursuant to Arizona Revised Statutes, Surface Water Laws and Rights (§45-151 and §45-152), a person must obtain a permit in order to appropriate surface water. Point(s) of diversion, place(s) of use, and the ultimate use of the water are key elements of surface water rights. Surface water rights are attached to specific land parcels, and may only be transferred by process of sever and transfer approved by ADWR. Changes in use of the surface water must also be approved by ADWR.

There is limited surface water available for use in the Study area. Approximately 580 af/yr of private surface water rights might be available for evaluation as a renewable water supply (see Table II.7). The remaining volume of surface water is associated with SRP's water rights that have been placed upon the surface water flowing from the Study area's watershed. The TNF has filed for additional in-stream surface water rights within the Study area; however, those rights have yet to be perfected.

Table II.7. – Surface Water Claims on the East Verde River (1984)

Owner's Name/Location	Claim Priority Date	Diversion Claim (af/y)	Cumulative Claims to Water (af/y)
Ewbank Rim Trail	1885	1.5	1.5
Gray Rim Trail	1885	3.0	4.5
Tanner Rim Trail	1875	5.0	9.5
Mueller Rim Trail	1885	1.0	10.5
Carroll Rim Trail	1875	15.0	25.5
Johns Rim Trail	1875	15.0	40.5
Buchanan Rim Trail	1885	2.0	42.5
Barker Trail	1875	50.0	92.5
Johns Rim Trail	1885	1.5	94.0
Knoell, Jr. RimTrail	1909	0.2	94.2
Knoell, Jr. RimTrail	1909	0.1	94.3
Eldean	1900	6.0	100.3
Brintlinger	1909	1.4	101.7
Copen	1909	3.0	104.7
Roper Verde Glen	1909	0.5	105.2
Roper Verde Glen	1909	1.8	107.0
Mayberry Verde Glen	1909	0.9	107.9
Jasper	1909	0.8	108.7
Kerr Verde Glen	1909	3.0	111.7
West Verde Glen	1909	0.6	112.3
Beaver Valley Water	1890	0.0	112.3
Bellows	1906	10.0	122.3
Goodwin	1880	1.5	123.8
Roush Flowing Springs	1915	10.0	133.8
Hudson Flowing Springs	1917	15.0	148.8
Randall Flowing Springs	1890	0.61	149.4
Jones	1880	0.2	149.6
Doll Baby Ranch	1870	310.0	459.6
Jones	1880	0.2	459.8
Tonto National Forest	1879	22.8	482.6
Tonto National Forest	1879	58.0	540.6
Tonto National Forest	1879	7.9	548.5
Tonto National Forest	1879	31.6	580.1

Note: This table is thought to be complete but is subject to as yet unidentified claims and/or water rights adjudication.

C.C. Cragin Dam and Reservoir

A major consideration related to surface water in the Study area involves the rights to surface water impounded behind C.C Cragin Dam, located in Coconino County north of the Study area. Pursuant to the AWSA, Reclamation was given ownership of, and SRP now operates, C.C. Cragin Dam and Reservoir. Also pursuant to the AWSA, the communities in northern Gila County, including the town of Payson, were provided the opportunity to access up to 3,500 af/yr of surface water from the C.C. Cragin Reservoir per calendar year on average, upon agreement with SRP and transfer of water rights in accordance with state law. In May 2008, Payson reached agreement with SRP for the delivery of up to 3,000 acre feet (af) of water from the CC Cragin Reservoir, and subsequently filed for the severance and transfer of water rights on February 17, 2009.

II.F.2.3 Groundwater Laws, Rights, and Policies

ADWR administers the groundwater program throughout Arizona. Generally, within Arizona, groundwater is owned by the public and regulated by ADWR, but is available to property owners who can extract water under their property and put it to a reasonable and beneficial use. There are special rules for AMAs (where overdraft of groundwater has been most severe) and for Irrigation Non-Expansion Areas (INAs). The Study area is located outside any AMA or INA, and groundwater may be withdrawn and used for reasonable and beneficial use. ADWR requires a permit be obtained for a "Notice of Intent" to drill a well. Additionally, well drillers must report initial results of drillings.

Entities other than the FS cannot construct and/or test wells on National Forest lands without FS authorization. The FS must issue a special use permit before water resources exploration or research on Forest land is allowed. Issuance of a special use permit is considered to be a Federal action, for which an assessment of project impacts to the natural and human environment is required under National Environmental Policy Act (NEPA). The FS groundwater policy states that finding groundwater does not ensure its availability for use. If an exploration project is approved, a second, separate NEPA analysis and special use permit would be necessary to address future water production. In the past, TNF has been reluctant to issue special use permits for exploratory drilling and other land-disturbing activities associated with research of groundwater sub-flows. In 2008, the town of Payson and SRP reached an agreement which restricts Payson from installing wells on public lands.

II.F.2.4 Institutional Considerations

Various powers and authorities that affect water in northern Gila County are vested in various Federal and state agencies, county divisions, town departments, and Native American tribes. These are described in more detail in Attachment 4, Legal and Institutional Considerations.

Federal Institutions:

- The Department of Agriculture, Tonto National Forest, Payson Ranger District
- Department of Interior, U.S. Fish and Wildlife Service
- Department of the Interior, Bureau of Indian Affairs
- Department of the Interior, Bureau of Reclamation
- Environmental Protection Agency

State Institutions:

- Arizona Department of Water Resources
- Arizona Department of Environmental Quality
- Arizona Corporation Commission
- Arizona Department of Real Estate
- Arizona Game and Fish Department

County, Municipality, Improvement Districts:

- Gila County Health Department
- Gila County Planning and Zoning
- Northern Gila County Sanitary District
- Payson - Water Department
- Star Valley
- Salt River Project
- Domestic Water Improvement Districts

III. Study Participants' Current Conditions

III.A Types of Water Supply Providers

Within the Study area, potable water is supplied to water users by any of the following five basic provider types: Municipal water system; regulated private water utility or company; DWID; Cooperative/HOA, or private well.

Municipal Water System
Payson is the only community with a municipal water system. The Town of Payson Water Department supplies potable water to the town of Payson. It also delivers potable water to the Tonto Apache Tribe pursuant to a Municipal Services Agreement between the Tribe and Payson. The population served by the Town of Payson Water Department makes up about 68 percent of the Study area's total population.

Domestic Water Improvement Districts
DWIDs are formed by petition at the request of local property owners or developers that receive formal approval from the Gila County Board of Supervisors. The Board of Supervisors has no authority under state law to deny formation of districts because of a lack of adequate water resources. The purposes of DWIDs are to secure long-term water supplies and provide water service directly to consumers within their respective communities. All DWIDs within the Study area have been formed by real estate developers or district residents.

Regulated Private Water Utilities
Eight regulated private water utilities operate within the Study area. Three of these utility companies--Payson Water Company, Pine Water Company, and Strawberry Water Company--are subsidiaries of Brooke Utilities. Brooke Utilities is a California-based unregulated utility holding company. These three regulated subsidiaries together serve nine of the communities within the Study area.

All eight private water utilities fall under jurisdiction of and are regulated by the Utilities Division of the Arizona Corporation Commission (ACC). The ACC's role regarding water utilities is to regulate the pricing and service performance of the private companies that have exclusive rights to distribute water in a given "certificated" geographical service area, designated by a Certificate of Convenience and Necessity (CC&N). The ACC has no authority over municipal water systems (incorporated towns and cities) or over water improvement districts that are formed by property owners and approved by county governments (e.g. DWIDs).

Cooperatives/Home Owners Associations

Approximately half of the communities in the Study area obtain water resources from cooperatives, HOAs, old ranches, community wells, and other loose-knit entities. While these entities are not considered to be towns, DWIDs, or private water companies, they do qualify as water service providers as defined under Arizona State law. In most cases, these smaller, more remote, communities are located on parcels homesteaded in the late 1800s that were ranch or small agricultural properties or land exchange parcels traded with the FS.

Populations for these smaller communities range from none to 300 people, for a total of about 1,300 residents (6 percent of the Study area total population). Thus, while individual community populations are not significant, the total population served is relevant when considering current and potential future water use in the Study area.

Private Wells

Numerous private wells serve many homes and a few commercial businesses in the smaller communities, and even within Payson. Due to incomplete ADWR well records and reluctance of well owners to discuss specifics of their wells, the actual number of wells and exact volumes of water produced cannot be verified. The water produced from the private wells is estimated based upon the calculated number of gallons per capita per day (gpcd). The gcpd rate is derived by actual water system records, discussions with operators, observance of life styles in the community (amount of landscape, horse privileges, etc.), and from ACC annual reports. The total water usage for the population is then estimated by multiplying the number of full-time residents by the gpcd water usage rate.

It is commonly understood that most private wells installed in the hard rock aquifer of the Study area are typically less than 200 feet deep and have low yields, from less than 1 gallon per minute (gpm) to as much as 25 gpm. Only in the areas of Star Valley and Diamond Point are there consistently higher yields from relatively shallow private wells (less than 200 feet deep), with yields observed to range from 35 gpm to over 100 gpm. Correspondingly, these areas consume more groundwater due to the size of properties and higher demand land uses including equestrian, lawns, orchards, and gardens. Private wells in the region have reportedly been subject to loss and/or gains in yield relative to precipitation and variable use. In addition, some loss of well productivity may result from over-pumping of wells and/or from a general lack of conservation during dry spells.

III.B Communities' Existing Conditions and Current Water Use

For each community or entity included in this Study, the existing conditions related to its water supply and use are described (as of 2002), including the estimated 2002 population, current source(s) of water, and estimated water use. The current water use rates for the communities in this Study are quite variable, ranging between 68 and 657 gpcd, with an average water use rate of 168 gpcd for the 41 communities that delivered water in 2002. Any known past and/or present water supply problems associated with each water provider also are noted.

The communities are organized according to the Sub-Regions used in evaluating the hydrologic framework (see Section II.C and Attachment 1).

III.B.1 Sub-Region 1

III.B.1.1 Sub-Region 1, Cluster 1

Cluster 1 includes the water providers for the unincorporated communities of Pine and Strawberry. The area surrounding both Pine and Strawberry has four seasons, but none are severe. Although snow falls in the winter, it usually melts quickly producing little or no runoff and results in limited groundwater recharge. Wells in the area typically are shallow wells that do not have adequate production in early summer months prior to the monsoon rains, which typically arrive in July and August. In addition to limited groundwater recharge, water shortages occur as a result of demand spikes associated with the influx of summer time residents, and visitors on summer holiday weekends, when daily maximum water demand may be two to four times greater than that of a typical summer day. The increase in water demand appears to be exacerbated by a tendency for these same weekenders to engage in discretionary water use activities while visiting, such as washing decks and irrigating lawns, landscaping, and native vegetation. This added demand exhausts the minimum standard water storage and production capabilities within a 2-day period.

A study commissioned by Pine/Strawberry Water Improvement District (PSWID) in 2003 concluded production of groundwater from the relatively shallow Schnebly Hill and Supai Strata is inherently limited by the hydraulic characteristics of groundwater flow through fractures to the pumped wells in the area. The fractures highly constrain the flow to pumped wells such that initial good yields progressively decrease as pumping duration increases and associated non-pumping time for recovery of groundwater levels decreases. Moreover, the potential for competition and hydraulic interference between wells completed in this type of aquifer is high; suggesting that the ability to overcome the problem of constrained well yields by simply drilling more wells into the system is limited due to the potential for interference between wells (Morrison Maierle, Inc. 2003).

To further evaluate the effect of climate on Pine and Strawberry's groundwater supply, Morrison Maierle performed a comparative study of groundwater level hydrograph data and long-term precipitation trends. The study indicated seasonal declines in well yields, caused by inherent hydraulic properties of the aquifer system, are amplified by below-average precipitation conditions; however, historic shortages of water have occurred during extended periods of above-average precipitation trends. The historic water shortages were not the product of drought conditions but, instead, resulted from the demand for water exceeding the production capacity of the wells, as limited by the aquifer hydraulic characteristics. This is particularly true in the Pine area, which offers less favorable aquifer characteristics than the Strawberry area.

Pine
Pine is located about 16 miles northwest of Payson along State Route 260. The community is located at an altitude of 5,448 feet amsl, and in 2002 had approximately 2,000 full-time residents. The community is served by five water providers.

Pine Water Company, Inc., (Brooke Utilities)
The Pine Water Company was established when Brooke Utilities acquired and consolidated several water operations in the late 1990s. It delivers about 87 percent of the potable water used in the community of Pine. The service area is nearly built out; 2,111 out of 2,798 parcels have been developed. Population in the service area in 2002 was 1,889 and the associated water demand supplied by Pine Water Company (Brooke) was estimated to be 159 af/yr. The water use rate is estimated to be 75 gpcd. Pine Water Company's (Brooke) water system consists of 21 production wells that tap into shallow aquifers. There are also 105 private wells which provide water to community residents that are not tied into the system. Currently, existing capacity (all from the shallow aquifers) is estimated to be equal to the current demand of 159 af/yr.

Over many years, Pine Water Company (Brooke) has suffered numerous water outages, water use restrictions, and service complaints. The company has utilized numerous methods to attempt to improve service, including:

- Upgrading the infrastructure of the production and delivery systems;
- Developing water sharing agreements with private well owners;
- Drilling five new wells in Pine and deepening two existing wells where increased water supplies were available;
- Developing a 1.8-mile pipeline from Strawberry Water Company (Brooke) well facilities to deliver water to Pine;[4]
- Adding 100,000 gallons of storage in Pine; and
- Hauling water by truck.

Pine Creek Canyon/Portals IV Domestic Water Improvement District
This District, formed in about 1995, is the newest DWID in the Study area and currently serves about 83 homes in a subdivision of 173 lots. Population in 2002

[4] Until 2007, the water supply for the community of Strawberry consistently provided adequate water to its residents during the same periods of seasonal stressing that occurs in Pine. Brooke Utility determined it could relieve a portion of the water shortages in the Pine community by connecting the Strawberry water supply into Pine's distribution system. To connect the systems between Pine and Strawberry, Brooke Utilities built the Magnolia pipeline that carries water either from Strawberry to Pine or Pine to Strawberry. In 2007, Strawberry suffered shortages and the pipeline was used to take water from Pine up to Strawberry.

was estimated at 20; the associated water demand was estimated to be 8 af/yr. The current water use rate is estimated to be 342 gpcd. Water is supplied by a single 48-gpm production well. The capacity of this well was estimated in a recent study to be about 39 af/yr. The developers of this District were the developers of Portals I, II, and III, all in the Pine Canyon area and all having successful wells that were ultimately developed and later acquired by Pine Water Company (Brooke), or its predecessor firms.

Pine Water Association DWID

Pine Water Association DWID serves 47 out of an estimated 55 parcels in central Pine that have existed over the past 100 years. The population served in 2002 was estimated to be 50; the associated water demand is estimated to be 11 af/yr. The water use rate is estimated to be 192 gpcd. This DWID holds claims to most of the normal surface water in Pine Creek, and has not had conservation restrictions or meter moratoriums in recent years. The DWID has a concern for the viability of long term surface water supply during extended drought periods. Total production capacity from the surface water and well is unknown.

Solitude Trails DWID

This District, formed about 1994, developed two wells in Pine to supply its 78-lot subdivision, of which 34 parcels are developed. The 2002 estimated population was 22 and water demand supplied by this provider was about 4 af/yr. The water use rate is 149 gpcd. The two wells that serve this District are actually located in the Pine Water Company (Brooke) certificated area (CC&N); water is wheeled to the subdivision by water mains belonging to Pine Water Company (Brooke). Today, Solitude Trails DWID sells its excess water, normally about 25 to 37 af/yr, to Pine Water Company (Brooke). This annual volume is generally equal to 14 to 23 percent of the total water served by Pine Water Company.

The subdivision operates its own wastewater treatment plant (WWTP) to help protect the water quality in the relatively shallow aquifers that generally exist in Pine. Long term, this DWID's existing capacity will probably meet future water demand at full build-out; however, establishing back-up alternative water sources would be desirable.

Strawberry Hollow DWID

This District formed in 2000, and has two wells in northwest Pine to supply its 72-lot subdivision, of which 12 parcels have been developed. In 2002 the population was zero but by 2005, this DWID was serving 14 constructed homes with less than 400,000 gallons of water per year. The DWID has completed development of its second well and has been issued a 100-year adequacy certificate by ADWR. The new well is publicly documented to be 1,320 feet deep (three to six times the depth of typical wells in Pine) and penetrates into a different aquifer than the one currently being utilized by many other wells in Pine. Strawberry Hollow DWID has a high quality "alternative" WWTP in operation to help avoid groundwater quality problems in future years. Water production potential available from this provider is estimated to be 25 af/yr.

Strawberry

The unincorporated community of Strawberry is located approximately 2 miles northwest of Pine along State Route 260. The 2002 population of Strawberry was 1,062. Until 2007, the water supply for the community of Strawberry consistently provided adequate water to its residents during the same periods of seasonal stressing experienced in Pine. Strawberry currently has two water providers: Strawberry Water Company, Inc. (Brooke) and the similarly named but separate private water company, Strawberry Water Co. (Hunt Water).

Strawberry Water Company, Inc. (Brooke)

Strawberry Water Company, Inc. (Brooke) was formed around 1996 after acquisition of several water operations within Strawberry. In 2002, it served 1,002 customers, with an associated water demand of about 100 af/yr. The water use rate is 90 gpcd. Strawberry Water Company, Inc. (Brooke) operates nine wells. About 25 private wells that are not tied into this system also provide water to residents. Production capacity is estimated to equal the annual demand, about 100 af/yr.

As noted above in the discussion for Pine Water Company, a 1.8-mile-pipeline (known as the Magnolia pipeline) was constructed to connect the distribution systems of the Pine Water Company (Brooke) and Strawberry Water Company, Inc. (Brooke), initially to relieve water shortages in the Pine community; however, more recently this same pipeline has been used to deliver water from the Pine Water Company (Brooke) to Strawberry Water Company (Brooke) during water shortages in the Strawberry CC&N.

Strawberry Water Company (Hunt Water)

The Strawberry Water Company (Hunt Water) is located in north-central Strawberry. In 2002, the population served was 60, supplying about 14 af/yr using a single well. The water use rate is 200 gpcd. Estimated production capacity of this system is approximately equal to the projected demand of 14 af/yr. This water company has adequate water resources and, while the groundwater quality is good, the quality of the delivered water is reported to have deteriorated due to distribution system problems.

Pine/Strawberry Water Improvement District

The Pine/Strawberry Water Improvement District (PSWID) was formed by property owners of the Pine and Strawberry communities that are not represented by the four existing DWIDs in Pine, or served by the regulated private utility companies in the middle of the Strawberry service area. Under state law, the PSWID is authorized to "wholesale" to water suppliers within the two communities (assuming it can develop water resources to market) and raise capital for asset purchases, or to even condemn the existing water operations if desired (currently underway). The by-laws of PSWID state its purpose is to represent the interests of the communities in securing long-term and reliable sources of water by:

- investigating current and potential sources of water;
- investigating the costs associated with maintaining or expanding present and potential sources of water;
- formulating plans and possible funding for improving present water sources; and
- consulting with county, state, and Federal agencies concerning development of water sources for the communities.

The PSWID commissioned a 2003 study by Morrison and Maierle, which concluded that the groundwater resource in the shallow Schnebly Hill and upper Supai aquifer system has been demonstrably inadequate to support the historic and existing residential water supply demands. This same study further noted the shallow aquifer system does not offer any reasonable potential to support continued population growth in the Pine and Strawberry area. Over the last 5 years, newly developed deep wells in the area have yielded substantial volumes of "new" water that could become available to the communities should agreement on the water's use be reached.

This water provider did not deliver water to any customers in 2002; data on water use since that time have not been included in this Study.

III.B.1.2 Sub-Region 1, Cluster 2

The six communities in this cluster of Sub-Region 1 are located in the central northernmost portion of the Study area, just south of the Mogollon Rim escarpment roughly from the headwaters of the East Verde River southward.

The East Verde River originates from several natural springs about a mile above the northern end of Rim Trail Estates. The water supplies for these six communities consist of both surface water and groundwater; several landowners and/or water suppliers hold surface water claims (see Table II.6 above).

Generally, water supply and quality have not been concerns for these communities; however, a couple entities have experienced some periodic shortage and pressure issues related to the fluctuating number of summer visitors. In addition, the recent extended drought and depletion of East Verde River flows have led to some concerns regarding the adequacy of water supplies in the future. The majority of the six communities are located along Houston Mesa Road (Forest Road (FR) 199), extending from Washington Park south to Whispering Pines. The communities are discussed going south from the Rim.

Washington Park

Washington Park is the northernmost community within the Study area. It is located approximately 11 miles north of Payson and about ½ mile west of where the C. C. Cragin pipeline discharges into the East Verde River. The community consists of 14 small privately-owned cabins on previously leased FS land; these lots were recently removed from the FS' land inventory. All parcels have been developed, but virtually no residence is occupied full time. The 2002 population of Washington Park was estimated to be the equivalent of one full-time resident; the water demand was less than 0.5 af/yr. The water use rate is 100 gpcd.

Washington Park's water source is a capped natural spring that has a volume of about 2-4 gpm. The water is piped into a small storage tank. The spring is estimated to be able to supply about 3 to 4 af/yr.

Rim Trail Estates

Rim Trail Estates is located approximately 10 miles north of Payson, just below Washington Park, and about 150 yards downstream from where the C. C. Cragin pipeline discharges into the East Verde River. This subdivision, which is about 55 years old, is located on the Bulluzzi homestead (old Rim Trail Ranch). The community has 108 parcels developed out of a total of 140. The community extends about a mile downstream along the East Verde River. The population in 2002 was about 44, with an associated water demand of about 11 af/yr. Current water use rate is 218 gpcd.

The Rim Trail DWID is the Estates' water provider. The DWID operates one well; there is another private well which also is used within the Estates that is not connected to the system. The DWID also uses about 7 af/yr of surface water, drawing it from the East Verde River through a pickup station (for potable water). In addition, District residents draw irrigation water from an 1880s-era ditch that was originally established for both domestic use and irrigation of apple and grain crops. The DWID system has an estimated well-water supply of 15 af/yr and a surface water claim by the District of 52 af/yr. The East Verde River has flowed year-round through the neighborhood over Rim Trail Estates' 120+ year history; however, during recent drought years, the river flow appears to be gradually declining. This has created anxiety among the residents. The area also relies on two somewhat adequate wells in the winter months; however, the wells' production is intermittent during summer months.

Shadow Rim Ranch Girl Scout Camp

The Shadow Rim Ranch Girl Scout Camp is located approximately 10 miles north of Payson and a mile west of Houston Mesa Road (FR 199). The camp is operated seasonally and has a population of 300 during the summer months. This is the equivalent of an average full-time population of 48, based upon 300 people occupying the camp for 8 weeks per year, and 2 people occupying the camp for an additional 44 weeks per year. The associated water demand is about 5 af/yr. The water use rate is 96 gpcd. Water is supplied from one well, which is estimated to be able to produce 8 af/yr. In addition, it is estimated about 7 af/yr of surface water is diverted from Chase Creek; however, surface water flow is intermittent. There are no known major water source or quality problems, but inadequate storage may become a problem.

Whispering Pines

Whispering Pines is located approximately 7 miles north of Payson. Out of a total 228 parcels, 171 have been developed. In 2002, the community had a population of 80, with an estimated water demand of 17 af/yr. The water use rate is 195 gpcd. Water is supplied to the community by the Payson Water Company (Brooke) through two wells. The two system wells yield a total of about 26 gpm for an estimated water supply of 32 af/yr. Numerous residents also have their own wells. Storage capacity seems to be an issue during high demand periods. There have been periodic water shortage and pressure issues in Whispering Pines, and water hauling was required in the summers of 2005 and 2006.

Cowan Ranch

Cowan Ranch is an unincorporated community located approximately 9 miles north of Payson off FR 199. Cowan Ranch is essentially built out, with 19 out of 21 parcels having been developed. The estimated population in 2002 for Cowan Ranch was 5; the associated water demand was about 1 af/yr. The water use rate for Cowan Ranch is 164 gpcd. It has a two-well system that is operated by an HOA; the estimated water supply available from this system is 12 af/yr.

Verde Glen

Verde Glen is located adjacent to Cowan Ranch and also is unincorporated. For Verde Glen, the estimated population in 2002 was 16. Water demand met by the Verde Glen Property Owners Association (POA) is about 2 af/yr. The water use rate for Verde Glen is 137 gpcd. Out of 108 total parcels, 66 have been developed. Part of Verde Glen has been adequately served by one well for over 50 years; Verde Glen I-III POA operates a distribution system from the well. The remainder of Verde Glen area is served by five private wells; water demand supplied by the private wells is estimated to be less than 1 af/yr. Total supply for Verde Glen is estimated to be 12 af/yr.

There presently are no problems meeting current demand in this community. Although the Verde Glen POA well has been reliable in the past, it may not be dependable in the future if drought conditions continue. Within Verde Glen, surface water claims between certain land owners and the POA are currently being litigated. Having an alternative water supply would enhance the reliability and sustainability of each community's systems.

III.B.1.3 Sub-Region 1, Cluster 3

Three small communities are included in this cluster; they are located adjacent to each other about 9 miles northeast of Payson. The cluster falls along the dividing line between the Verde River and Salt River watersheds. Secondary permeability may be encountered in faults and fractures within this portion of the Sub-Region. The communities are discussed from their location, west to east.

Zane Grey Meadows

This small community is located approximately 11 miles northeast of Payson, north of FR 64 and just south of Roberts Mesa Road. Five of 20 parcels have been developed. The 2002 population was 4, and the current water demand is about 1 af/yr. The water use rate is 180 gpcd. Water is supplied by five private wells. The existing production capacities of the wells have not been determined.

Collins Ranch

Collins Ranch is located about 11 to 12 miles northeast of Payson, adjacent to and immediately southeast of Zane Grey Meadows. Most lots within this community have been developed (35 out of 38 parcels); however, very few are occupied full time. In 2002, the population of the community was estimated to be 11, with an associated water demand of about 2 af/yr. The water use rate is 199 gpcd. This community is supplied by two system-owned wells, and about six additional wells that are not tied into the system. The available capacity is unknown. The community currently has no major water supply issues.

Mead Ranch

This small community is located adjacent to and directly east of Collins Ranch. Out of 126 parcels, 85 have been developed. In 2002, the population of Mead Ranch was estimated to be 25; the associated water demand was about 3 af/yr. The water use rate of Mead Ranch is 99 gpcd. Payson Water Company (Brooke) supplies potable water to Mead Ranch from a single well yielding 4.1 gpm. Current production capacity of the well has not been verified.

III.B.1.4 Sub-Region 1, Cluster 4

The two small communities that are included in this cluster are located about 10.5 to 11.5 miles northeast of Payson, about a mile apart from each other along Ellison Creek.

Ellison Creek Recreation

This community is located approximately 10.5 miles northeast of Payson, in the northwest corner of the intersection of FR 64 and Ellison Creek. It is so named because it used to be FS leased property that could only be occupied during the summer months; however, about 10 years ago it was sold to the residents for full-time residential use. The area is fully built-out, with 60 developed parcels. In 2002, it had an estimated population of 10, with an associated water demand of about 2 af/yr. The water use rate is 137 gpcd. Two community-owned wells supply potable water. One of these wells is a high yield source, which was the first of its kind to be completely installed through the regional aquifer system. It is 760 feet deep and penetrates into the Precambrian basement aquifer. Together, the total capacity of the wells is greater than 100 gpm (over 160 af/yr). No major issues in terms of water availability or quality were identified during the Study period.

Ellison Creek Estates

Ellison Creek Estates is located about a mile north of Ellison Creek Recreation on FR 430, which runs along Ellison Creek. This community consists of several large parcels on an old homestead off Ellison Creek. Fifty parcels have been developed out of 80 total parcels. Potable water is provided by an unknown number of private wells. In 2002, the estimated population was 30, with an estimated water demand of 4 af/yr. The water use rate is 130 gpcd. Output of the wells is not known.

III.B.1.5 Sub-Region 1, Cluster 5

Cluster 5 in Sub-Region 1 includes four small communities. They are located generally along State Route (SR) 260, about 13 to 15 miles east of Payson.

Thompson Draw I and II

Thompson Draw I and II are two separate areas which make up this one community. One area is located on the east side of SR 260 about 13 miles east of Payson. The other is located about 1 mile north of the first area, on the west side of SR 260. The land was originally leased from the FS, but is now in private ownership. Altogether, the community has 85 parcels and is totally built out. In 2002, the full-time equivalent population of the community was estimated to be 5 people, with an associated water demand of about 4 af/yr. The water use rate is 657 gpcd. Substantial volumes of water apparently are being used by non-permanent residents. Thompson Draw has two community-owned wells that are assumed to meet current needs. Water production capacity is unknown.

Tonto Village

Tonto Village is located approximately ten miles northeast of Payson, about a mile west of the western section of Thompson Draw along FR 64. The Village is almost built out, with 303 developed parcels out of a total of 353. In 2002, the population of Tonto Village was estimated to be 350, with a water demand of about 27 af/yr. The water use rate is 68 gpcd. Tonto Village Water Company, a private regulated water supply utility, provides water to the community using one well. Water production capacity is likely about equal to the demand of 27 af/yr.

Quite a few small lots with septic systems are located near the well within this community. It is surmised that leaky distribution lines have created what may be a long-term water quality issue. Complete nighttime shutdowns of the water system have occurred in recent years due to a reported lack of available resources. The ACC has ordered a new well be drilled every year since 2005. These quantity and quality issues are suspected to be due to the shallow, drought-sensitive wells within the community that have been, on occasion, impacted by septic systems installed in a non-compatible geologic environment (fractured limestone and shales).

Wood Canyon Ranch (previously known as Pine Meadows)
Wood Canyon Ranch is located approximately 13 miles east of Payson, immediately south of the eastern section of Thompson Draw I and II. It is located just north of Little Green Valley Road. Wood Canyon Ranch is completely undeveloped at this time, but 260 subdivision lots are approved. The Ranch reportedly has five adequate wells owned by the developer. Water production capacity is unknown.

III.B.1.6 Sub-Region 1, Cluster 6
There are 10 communities within Cluster 6. These communities are scattered across the entire northeastern quadrant of the Study area, and are interspersed among or adjacent to other communities from Clusters 2, 3, 4, and 5.

Camp Geronimo Boy Scout Camp
This camp is located about 11.5 miles north and just west of Payson, along Webber Creek. The camp is a major facility that serves the Boy Scouts of America Roosevelt Council troops in the greater Phoenix area. It is located on an old ranch site. The camp houses between 600 to 1,000 scouts, leaders, and staff during the summer months but is used year-round for leadership retreats (averaging 5 to 8 people). The water use rate is 96 gpcd. Water is currently supplied by two contained natural springs located on the TNF at the base of the Mogollon Rim (Poison Springs at 80 gpm and Herron Springs at 50 gpm, which together produce about 210 af/yr). The water is piped to storage tanks; substantial overflow goes underground into Webber Creek at the south end of the camp. The camp has a new wastewater treatment facility to help protect the groundwater.

Geronimo Estates
Geronimo Estates is located about 8.5 miles north and just west of Payson. It is about 3 miles downstream of Camp Geronimo along Webber Creek. The 2002 estimated population was 35, with a corresponding water demand of about 6 af/yr. The water use rate is 141 gpcd. There are 109 developed parcels out of a total of 252.

Water is supplied by Payson Water Company (Brooke); the system consists of two wells. There also are 13 private wells that are not connected to the Payson Water Company's (Brooke) system. Because of the apparent low volume of groundwater available and ongoing system operational problems, a full moratorium on new meters and line extensions within the Payson Water Company CC&N has been in effect for 28 years. In 2007, much of the community was completely out of water numerous times, with claims of dry holes, non-working pumps, etc. The lack of adequate storage capacity adds to the water supply problems; only 15,000 gallons of storage capacity are available. The problem of continued inadequate service by Payson Water Company (Brooke) has been brought before the ACC Hearing Division (as of mid-2008).

Bonita Creek
Bonita Creek is in an isolated portion of the Study area approximately 11 miles north and east of Payson. The community is less than a mile north of FR 64. Bonita Creek itself is a perennial stream (reportedly producing a constant 500 gpm for decades); the community straddles the creek for about 1 mile. The community originally consisted of apple orchards and a ranch. In 1990, 55 of 59 homes in this area were burned during the Dude fire, but since then about 30 homes out of a total of 84 lots available have been built within this community. In 2002, the population of the community was estimated at 30, with an associated water demand of just under 4 af/yr. The water use rate is 110 gpcd. Water is supplied from the creek (based on claims dating from 1880s) and groundwater which is distributed by the Bonita Creek Land and HOA Water Company. The number of wells and capacities of both the wells and surface water diversion are unknown. There is some concern related to water claims and availability of surface water diversions. The creek disappears underground about half way through the community.

Diamond Point Recreation
This community is approximately 10 miles northeast of Payson, located just southwest of FR 64. It is so named because it formerly was FS leased property that could only be occupied during the summer months; over the past 10 years or more, the land has been sold for full time residential use. All 45 lots have been developed. In 2002 the population of the community was estimated at 4, with a corresponding water demand estimated to be just under 1 af/yr. The water use rate is 137 gpcd. The capacity of the one well is not known.

Bear Flat
This community is located almost 15 miles east of Payson, about 4 miles south of SR 260 via a relatively rough unpaved road. The 2002 estimated population was 12 full-time residents. The current water demand is estimated to be 3 af/yr. The water use rate is 250 gpcd. There are 61 parcels developed out of a total of 144 parcels in this community. Water is supplied by 20 private wells. Existing total water capacity is unknown.

Kohl's Ranch
Kohl’s Ranch is located approximately 12 miles northeast of Payson just south of SR 260 along Tonto Creek. In 2002, the population of Kohl’s Ranch was estimated to be 270, with a corresponding water demand of about 22 af/yr. The water use rate is 70 gpcd. The primary development in the community is a time-share residential property, although there are many small weekend cabins on relatively small lots on both sides of Tonto Creek. There are 134 developed parcels out of a total of 192 designated parcels within this community.

Tonto Creek Estates
This community is located just over 2 miles north of Kohl’s Ranch, upstream along the Tonto Creek. In 2002, the community had an estimated population of

30, with an estimated water demand of 5 af/yr. The water use rate is 137 gpcd. All 65 lots of the Estates have been developed. Water is supplied to the community by the Tonto Creek Estates Water Company, a private regulated water utility which operates three wells. They apparently have adequate long-term water resources and good water quality. Production capacity information has not been shared.

Christopher Creek
The community of Christopher Creek is approximately 18 miles northeast of Payson and is located just north of SR 260, along Christopher Creek. In 2002, the population of the community was estimated to be 150, with an associated water demand of about 12 af/yr. The water use rate is 73 gpcd. Out of a total of 528 parcels, 342 have been developed. Water is supplied by Christopher Creek Haven Water Company, a private regulated utility, which operates a water system consisting of 4 wells. Total production capacity of the four wells is unknown. No major water production issues are known to exist. Currently this community has a surface water remediation plan in place to mitigate water quality issues within its community and possibly downstream at the R Bar C Boy Scout Camp.

Hunter Creek
Hunter Creek is located approximately 1.5 miles downstream and south of the community of Christopher Creek. Out of a total of 166 lots in this community, 75 have been developed. In 2002, the population of the community was estimated to be 35, with an associated water demand of 22 af/yr. The water use rate is 571 gpcd, which is the second highest water use rate per person in the Study area. A possible reason for this high usage rate is heavy water use for landscaping by part-time residents who are not counted in the population totals. There are two community-owned wells; output capacities of the wells are unknown. The community also operates a wastewater treatment facility. Both the wells and the wastewater treatment facility are located near the edge of the creek.

R-Bar-C Boy Scout Camp
This Boy Scout camp is a smaller seasonal camp than Camp Geronimo. It is located about 16 miles east of Payson, just south of SR 260 along Christopher Creek. The equivalent full-time population in 2002 was estimated to be 20, with a water demand of 2 af/yr. The water use rate is 96 gpcd. There are two wells that serve the camp. Assuming the camp continues to be operated like it has been in the past, the water supply is assumed to be sufficient into the future. Current production capacity of the wells is unknown. County wastewater management personnel and others have expressed a major concern regarding water quality problems in the creek, apparently resulting from upstream septic systems.

III.B.2 Sub-Region 2, Arrowhead Canyon

There is only one community located within this Sub-Region—Arrowhead Canyon. It is a small, unincorporated community located at the northern edge of Sub-Region 2, just below the Diamond Rim fault, approximately 2.5 miles south of Pine. The 2002 population of the community was about 10, with a corresponding water demand of about 1 af/yr. The water use rate is 100 gpcd. There are five private wells that are used; their existing capacities are unknown.

III.B.3 Sub-Region 3

This Sub-Region is located in the southeastern quadrant of the Study area. Twelve communities, mostly located in the western portion, are included within this Sub-Region. This area also approximates the central portion of the entire Study area. It is the most populated of all Sub-Regions, as well as having the single-most populated community in the Study area—the town of Payson, with a 2002 population of 14,500.

Beaver Valley

The Beaver Valley community is the northernmost community within this Sub-Region. It is almost 7 miles north of Payson, along Houston Mesa Road (FR 199). The community is about 66 percent built out, with 231 lots developed out of 351 total available lots. In 2002, an estimated 240 people lived in Beaver Valley, with an associated water demand of 22 af/yr. The water use rate is 82 gpcd. Water is supplied by a one-well system operated by the Beaver Valley Water Company, an ACC regulated private utility. There also are two private wells that are not part of the system. The utility also claims a water right of about 23.75 af/yr on the East Verde River, of which about 22 af/yr are used. Total water supplies available are currently estimated to be 23 af/yr.

Over the last few years, the water system operator has had to move the system's point of diversion intake several hundred yards upstream on the East Verde River. This is because an insufficient volume of water flows down the East Verde River past the community during periods of drought or when the C. C. Cragin pumps are not operating. In the past, water quality has been a concern in this community due to high density septic systems in the service area, and a heavily used FS campground located less than a mile upstream (Water Wheel) which has no sanitation facilities. An old low volume shallow well is now in operation, but without increased flow in the river, the community is in jeopardy of having insufficient potable water during drought periods or if the streamflow is polluted by the upstream campground. These situations all contribute to reliability issues with the existing water delivery system.

Freedom Acres and Wonder Valley

Freedom Acres is about 5.5 miles north of Payson, located along and just west of Houston Mesa Road (FR 199). Freedom Acres is completely built out, with all 21 lots developed. In 2002, Freedom Acres had an estimated population of 29, with an associated water demand of 9 af/yr; the water use rate is 283 gpcd. This community consists mostly of full-time residents living on fully developed large lots; many have horses. Wonder Valley is located just east of Freedom Acres, and is almost completely built out, with 20 lots out of 23 lots developed. In 2002, Wonder Valley had an estimated population of 40, with an associated water demand of about 3 af/yr; the water use rate is 69 gpcd. Similar to Freedom Acres, this community consists mostly of full-time residents.

Freedom Acres owns one well, and Wonder Valley owns two well, which together are operated as one system. In addition, there are 10 privately-owned wells in Freedom Acres and 12 privately-owned wells in Wonder Valley that appear to be meeting current demands; however, these wells are located in shallow aquifers and are subject to reduced output under severe drought conditions. The groundwater supply currently available to Freedom Acres appears to be limited, particularly in extended dry periods. The Wonder Valley community had a well collapse in 2002 during which time Gila County had to haul water to the community. An initial replacement well did not yield significant water; a second replacement well producing nearly 30 gpm was developed to meet current demands. The current water supply in Wonder Valley is estimated to be just under 17 af/yr.

Mesa del Caballo

This community is just over 3 miles north of Payson, and has one of the highest densities within the Study area. It is almost completely built-out, with 409 lots developed out of 455. In 2002 the estimated population of Mesa del Caballo was 640, with an associated water demand of 66 af/yr. The water use rate is 92 gpcd. Water to the community is supplied by Payson Water Company (Brooke). The utility operates a system that consists of seven low volume wells. The 7 wells yield a total of 45to 50 gpm, enough capacity to supply 70 to 80 af/yr. The wells have apparently been operationally stable over the past 6 to 8 years, with only periodic water supply shortages. During 2006-2007, there were short periods of time during which there were inadequate supplies.

Flowing Springs

Flowing Springs is about 5 miles north of Payson, along both sides of the East Verde River. In 2002, the population of Flowing Springs was estimated to be 40, with an associated water demand of about 6 af/yr. The water use rate is 137 gpcd. The community is almost 60 percent built-out, with 42 lots developed out of 73.

Water is provided to Flowing Springs by Payson Water Company (Brooke) using a single low volume well. Some members of this community have surface water claims and they apparently use surface water from the East Verde River for irrigation purposes. Total potable supply available to the community is currently estimated to be 7 af/yr.

East Verde Estates (also known as East Verde Park)

This community is about 4.5 miles north of Payson, just west off SR 87 along the East Verde River. It is about 2 miles downstream of Flowing Springs. In the past it was also referred to as East Verde Park. Out of 246 total lots, 164 have been developed. In 2002 the population of East Verde Estates was estimated to be 180, with a corresponding water demand of 16 af/yr. The water use rate is 79 gpcd. Payson Water Company (Brooke), the water provider, has three low volume wells that make up the water supply system. There are also 11 private wells within the community that are not connected to Payson Water Company's system. This community has experienced significant outages over the years. Large demand spikes sometimes exceed short-term storage capacity, indicating a need for additional storage capacity. Without a new water supply (and likely new storage), the community would be expected to continue to experience significant water shortages.

The three low volume wells total 13 gpm. The system is estimated to have a current supply of 16 af/yr.

Summit Springs
This is a new community that has 27 approved lots, but does not yet have any residences. It is located approximately 3 or 4 miles west of Payson. Summit Springs may have adequate water for full build-out through the use of an existing well; however no information is known about the well's capacity.

Town of Payson
Payson is centrally located in the Study area. It is the largest community in the Study area with an estimated population of 14,500 in 2002. This represents approximately 68 percent of the total Study area population. It also has the highest proportion of full-time residents compared to the rest of the Study area. Out of a total possible 9,747 parcels, 7,254 parcels have been developed, which is about 74 percent of Payson's total planned build-out. The estimated water demand in 2002 was 1,805 af/yr; this represents about 70 percent of the total water used within the Study area. The water use rate is 111 gpcd.

Payson's water supply has historically been produced entirely from groundwater wells within the town limits. From early settlement of Payson in 1882 to the advent of a privately-owned water company in 1950, residents of Payson depended on shallow hand dug wells and cable tool wells. Public water mains were installed in the early 1950s and water was distributed to the original town site area and subsequent subdivisions in central Payson. Water, supplied from several drilled shallow wells, was pressurized in hydro-pneumatic tanks for delivery to area homes. The 1950s and 1960s saw the development of three additional wells within the current Payson town limits, and creation of separate public service water systems to serve new Payson subdivisions. Payson's first large mountaintop water storage tank (500,000-gallon capacity) was constructed in 1967. The four separate water systems serving the Payson community were interconnected in 1976. The town of Payson incorporated in 1980 and founded the Payson Water Department which acquired the four private water companies. The Payson Water Department currently operates 37 water production wells, 11 water storage tanks, and over 200 miles of pipeline to supply water to 7,800 public water system connections. Most of Payson's wells are relatively shallow

(300 to 500 feet below land surface) with some deeper wells approaching 1,000 feet. There also are about 300 private wells that are operated within the town but are not connected to the Payson Water Department system.

Payson originally was allocated 4,995 af/yr of Central Arizona Project (CAP) water. Payson commissioned multiple studies to determine if and how it could receive its CAP allocation; however, the use of a CAP exchange mechanism for local surface water supply could not be developed due to insufficient quantities of local water rights available for exchange, and FWS concerns regarding federally protected species, as well as a general lack of interest by local surface water rights holders. The allocation was sold and the funds from the sale were subsequently used by Payson to help maximize its groundwater resources through exploration programs, safe yield studies, conservation, and also partially fund studies for the construction of a wastewater reclamation and recycling project now known as the Green Valley Park recharge/reuse water reclamation project (1996). In addition to this recharge/reuse project, Payson has created multiple programs to enhance water efficiency and conservation.

Payson manages its groundwater resources, voluntarily by the concept of Safe Yield (Payson is not in a state AMA). Payson's safe yield is currently estimated (2008) at 2,681acre-ft/yr of groundwater, based upon an available water supply of this same amount from a combination of in- and out-of-Town well fields. Water demand is expected to remain below safe yield until a new surface water source comes on line. C.C. Cragin water was made available through the 2004 Arizona Water Settlements Act (AWSA) and the 2008 SRP/Payson water rights agreement. It is anticipated that between 2015 and 2020, facilities may be in place to deliver surface water. At that time Payson intends to manage both surface and groundwater sources conjunctively with a preference for surface water, thereby allowing the groundwater aquifers to recover.

Tonto Apache Tribe

The Tonto Apache Tribe is the only Native American community within the Study area. The Tonto Apache Reservation is located on Arizona SR 87, just south of Payson. The Tonto Apaches were recognized by a Congressional act in October 1972 giving them 85 acres. The Tribe had a population of 132 in 2002; however some members live off the reservation. For Study purposes, the Tribal population living on the reservation is included in the Payson population estimate above.

Tribal membership is increasing and the Tribe recently succeeded at expanding its reservation by acquiring 278 acres from TNF in February 2008. At present, housing on the Reservation can accommodate only about half the residential needs of current tribal members due to the Reservation's limited size. Many houses on the Reservation contain two families and some contain three. The Tribal Chairperson estimates a need for 25 additional houses to accommodate the present need.

The Tribe's current water supply is provided by the Payson Water Department. The reliability of this supply is dependent on the reliability of Payson's groundwater supply and associated infrastructure. This water service is provided through a Municipal Services Agreement between the Tribe and Payson. The Municipal Services Agreement expired in 2001 and was not renewed until 2006; however, Payson has continued to deliver water to the Tribe in the absence of any formal agreement. A water production well is present on the reservation, but it has been dry for several years--a casualty of drought. The Tribe's well is located adjacent to a contaminated groundwater area; thus, deepening the well has not been investigated.

The Tribe has a CAP water allocation of 128 af/yr. To date, however, the Tribe has not utilized its allocation directly due to the distance from the CAP delivery system. The Tribe is also seeking a Water Settlement from the United States Government. The status of that legal action is not known at this time.

The Reservation is in an excellent position to take advantage of the high volume of tourism around Payson, and has prime highway frontage available for economic development. The tribal council has completed several major projects including the 35,000-square-foot Mazatzal Casino, a hotel, and the Tonto Apache Tribal Market.

As noted earlier, the Tribe has formally requested to not be included as a participant in the Study; however, for purposes of this evaluation, the Tribe's population and associated water demand have been incorporated into Payson's.

Town of Star Valley (previously:Star Valley and Diamond Point Shadows)
Star Valley is located adjacent to the eastern edge of the town of Payson, and Diamond Point Shadows is another 1.5 miles east of Star Valley on SR 260. In 2002, the population of both communities was estimated to be 1,774, with 1,634 total in Star Valley (700 in Star Valley A&B service area; an additional 934 in Star Valley get their water from private wells), and 140 in Diamond Point Shadows. The Diamond Point Shadows section of Star Valley is nearly built-out, with 181 parcels developed out of a total of 197. The estimated water demand of Diamond Point Shadows is 39 af/yr, which is met by about 260 private wells. The water use rate is 250 gpcd. This development has large lots, orchards, and small ranches with horses.

Central Star Valley, with an estimated population of 700 in 2002, is served by Payson Water Co. (Brooke). This water service area is referred to as Star Valley A&B. The 2002 estimated water demand was 66 af/yr. The water use rate is 84 gpcd. Star Valley A&B operates two wells. Potable water for the remainder of Star Valley, that is not part of the Payson Water Co. (Brooke) service area, is provided by private wells.

Star Valley and Diamond Point Shadows are located in a relatively water-rich area and generally have the most available groundwater resources of any communities in the Study area. Groundwater is frequently encountered at less than 20 feet below ground surface. Successful development of two new deep wells is indicative of water availability from the local aquifers of the immediate area; these two wells are now owned and operated by Payson Water Department. Two existing wells in central Star Valley, owned by Payson Water Company (Brooke), together yield over 40 gpm (around 60 af/yr), while a recently developed deeper well in The Knolls, a newer subdivision within Star Valley, reportedly yields 140 gpm (over 225 af/yr).

At the start of this Study, Star Valley and Diamond Point Shadows were unincorporated areas within Gila County and were represented by Gila County's participation in the Study. Star Valley and Diamond Point Shadows subsequently became formally incorporated as the Town of Star Valley in November 2005. The Town of Star Valley has elected not to join the other parties in this Study. However, current and future population and related water demand considerations originally included in Gila County's portion of the Demand Analysis (and in 2007 updated discussions) are used in the remainder of this Study.

As historically demonstrated in the region, there is a potential for water quality problems to occur in the Star Valley area. The community's wastewater system consists primarily of private septic tanks. Little or no effluent is expected to be available for reuse within Star Valley due to the lack of central wastewater treatment facilities. There is a concern in the community that the septic tanks could be an eventual contamination source to the groundwater because static water levels in the area are sometimes 20 feet or less below ground surface.

Round Valley

Round Valley is located about 3 miles south of Payson, east of SR 87. It is a small ranch-like community that is mostly built-out, with 178 out of 202 lots developed. The 2002 estimated population was 300, with an estimated water demand of 77 af/yr. The water use rate is 230 gpcd. The entire water supply for the community comes from an unknown number of private wells. The only major grass-landscaped cemetery for northern Gila County is located in Round Valley. The cemetery, located in upper Round Valley, often has to import groundwater from lower Round Valley or other areas to maintain its grounds during extended dry periods. During prolonged periods of drought, well yields have been observed to substantially decline first in the upper Round Valley, followed by wells in lower Round Valley. Concerns about declining wells were observed in the 2001-2002 drought period.

Oxbow Estates

Oxbow Estates is located just under 2 miles southwest of Round Valley, west of SR 87. It is a bedroom community for Payson, which is approximately 4 miles north. It is essentially built out, with 70 out of 75 parcels developed. The 2002 estimated population of Oxbow Estates was 240, and its associated water demand was about 32 af/yr. The water use rate is 120 gpcd. The water for this community is supplied by an unknown number of private shallow wells. The wells are all typically low yield (<10gpm) and drought sensitive.

IV. Alternative Formulation, Analysis and Evaluation

This section identifies the future-without and the future-with project alternatives. Alternatives were developed to meet the future water demands of each water provider in the Study area. All of the alternatives were evaluated based on criteria established for the appraisal-level study and then evaluated for viability.

Estimates of future water needs and a summary of constraints and considerations for each community considered in Section III are presented below. The future water demand for the Study area has been projected from 2002 to 2040. The 2040 water demand is based upon the estimated future population of each community multiplied by a water usage rate in gpcd. For purposes of estimating the 2040 population of each community, the Study assumes all developable land has been built upon and occupied with full-time residents by 2040. The amount of developable land is identified in Attachment 2 – Demand Analysis, as the total number of parcels identified for each community (see Attachment 2, Table 6, which also includes all the data utilized to develop the current and future demands estimates, by water provider type). In order to estimate future population, the total number of developable parcels per community was multiplied by 2.4 (estimated average number of persons per household).

Water demand for 2040 was estimated for both low and high water demand scenarios. Under the low water demand scenario, a water use rate of 120 gpcd was used for all the communities throughout the Study area. For the high demand scenario, a future gpcd rate generally based upon the current water usage was used for each community. The assignment of the water use rate in each community was also influenced by such factors as parcel size, existence of horse privileges, presence of gardens, and the number of trees maintained, life style, etc.

IV.A Communities' Future Conditions, Projected Water Demands, and Future-Without Project

This Future-Without Project looks at population projections, associated water demand, and estimated available existing capacity in order to identify any future unmet demands for each community. Additionally, there is a brief discussion of the most likely actions these entities would or could take to address any shortfalls in water supply and/or system reliability, in the absence of any action resulting from this Study. For all communities included in the Study, it is anticipated some mix of additional conservation, development of local groundwater aquifers through additional wells, water hauling, rainwater harvesting, and growth management would be pursued to some degree should other avenues for developing additional water supplies prove unsuccessful. As with Section III, the communities are organized according to the sub-regions used in evaluating the hydrologic framework in Attachment 1.

IV.A.1 Sub-Region 1

As noted in Section III, water quality generally has not been a concern for most of these communities; however, many entities have experienced periodic shortage and low pressure issues related to the influx of summer visitors. The recent extended drought conditions and depletion of East Verde River flows have resulted in some concerns regarding the adequacy of water supplies in the future. A summary of the current population and water demand, and future annual water demand projections for all the communities in Sub-Region 1 is provided below.

IV.A.1.1 Sub-Region 1, Cluster 1

Table IV.1 provides a summary of the current population and water demands, and future annual water demand projections for all the communities in Sub-Region 1, Cluster 1.

Table IV.1 – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 1

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Pine Water Co. (Brooke)	1,889	159	75	159	8,393	120	1,128	1,128	969	969
Pine Creek Canyon/ Portals 4 (DWID)	20	8	342	8	432	250	58	120	50	112
Pine Water Association DWID	50	11	192	37	132	250	18	37	0	0
Solitude Trails DWID	22	4	149	31	187	150	25	31	0	0
Strawberry Hollow	0	1	0	29	173	150	23	29	0	0
Strawberry Water Co. (Brooke)	1,002	101	90	101	5,002	150	672	840	571	739
Strawberry Water Co. (Hunt)	60	14	200	14	168	200	23	38	9	24

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.

Pine Water Co. (Brooke)

This community is 25 percent built-out. Assuming the remaining lots are developed and full-time residents move in, the projected 2040 population is 8,393, an increase of 6,504. The future water demand would increase by 969 af/yr and reach a total of 1,128 af/yr based on a water use rate of 120 gpcd. The 120 gpcd rate was used for both the high and low scenarios because the current use rate is 92 gpcd and the water company has substantial water conservation requirements in place. Additional water supplies of 969 af/yr would be needed by 2040.

Pine Water Co. (Brooke) has access to 161 af/yr of CAP entitlement. An exchange of this entitlement for wet water could be possible if an exchange agreement can be negotiated with an entity having water rights to both the East Verde River and CAP water. In 2005, under order by ACC, Pine Water Co. (Brooke) identified and analyzed 24 different water supply alternatives. To date, none have been "seriously explored" by the company itself; however, Milk Ranch LLC drilled a deep well that has been thoroughly tested and yields a water supply equal to about 75 percent of all the water currently distributed by Pine Water Co. (Brooke). No agreement has been developed between the well owner and Pine Water Co. (Brooke).

Domestic Water Improvement Districts (Pine Creek Canyon, Pine Water Association, Solitude Trails, and Strawberry Hollow)
By 2040, the four DWIDs located in Pine are expected to grow by 832 persons, bringing the total population to 924. For the low demand scenario, a 120 gpcd use rate was assumed for all four DWIDs; the projected total demand in 2040 is estimated at 124 af/yr (an increase of 100 af/yr). For the high demand scenario, a 150 gpcd water use rate was assumed for Solitude Trails DWID and Strawberry Hollow DWID, while a 250 gpcd water use rate was assumed for Pine Water Association DWID and Pine Creek Canyon DWID. This results in a total estimated 2040 water demand of 218 af/yr (an increase of 194 af/yr).

Pine Creek Canyon/Portals IV DWID
Pine Creek Canyon/Portals IV depends on a single low-volume well for its water needs. This DWID has adequate supplies currently, but this DWID will need additional water supplies if the population forecasts prove to be correct.

Pine Water Association DWID
Pine Water Association has surface water rights to use in the upper reaches of Pine Creek Canyon (100+ years), that are assumed to be sufficient for this DWID's future demand. A more reliable system would result from inter-connection to the other DWID water system systems; however, no plans are being proposed to increase the reliability of the water supply.

Solitude Trails DWID
This DWID has 2 wells that produce about 10 times what is normally needed; however, under a current water-sharing agreement with Pine Water Co., (Brooke), Pine Water Co. (Brooke) will become the water supplier for Solitude Trails when this subdivision has sold its last lot. The wells will then become the property of Pine Water Co. (Brooke).

Strawberry Hollow DWID
This DWID has two wells in different aquifers; one is 1,320 feet deep in an aquifer far below the other wells of Pine. There are no supply or reliability issues.

Strawberry Water Co. (Brooke)
By 2040, the water service area is anticipated to be totally built-out, and population is estimated to increase 400 percent, to 5,002 people. Assuming a low demand scenario water use rate of 120 gpcd and a high demand scenario water use rate of 150 gpcd, total demands are expected to increase to 672 and 840 af/yr, respectively. This would require an additional water supply of between 571 and 739 af/yr.

The aquifers local to the Strawberry community appear to have water development potential similar to those in the nearby community of Pine; however, higher costs of drilling, higher drilling risks, and higher operating costs appear to exist for deep wells in Strawberry. A potential may exist for developing additional wells, particularly in deeper aquifers, although drilling and casing problems have been encountered in the area. Higher production and reliability of the deeper wells seem to be more favorable than for shallow wells.

Strawberry Water Co. (Hunt)
By 2040, the population of the Strawberry Water Company (Hunt Water) service area is estimated to increase by 108 to total 168 persons. Assuming a low demand scenario water use rate of 120 gpcd and a high demand scenario water use rate equal to its current rate of 200 gpcd, the total amount of water needed at build-out would be between 23 and 38 af/yr, respectively. This would require an additional water supply of between 9 and 24 af/yr.

Strawberry Water (Hunt) reportedly has adequate water supplies, but needs to improve the performance of its distribution system.

IV.A.1.2 Sub-Region 1, Cluster 2
Table IV.2 provides a summary of the current population and water demands, and future annual water demand projections for all the communities in Sub-Region 1, Cluster 2.

Table IV.2. – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 2

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Washington Park	1	0	100	3	34	150	5	6	2	3
Rim Trail Estates	44	11	218	67	358	218	48	87	<19>	20
Shadow Rim GS Camp	48	5	96	8	52	120	7	7	0	0
Whispering Pines	80	17	195	32	547	200	74	123	42	91
Cowan Ranch	5	1	164	12	50	164	7	9	0	0
Verde Glen	16	2	137	12	274	175	37	54	25	42

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.

Washington Park

Although all parcels have been developed, there are no full-time residents. Assuming a maximum full-time population at the end of the Study period, there would be a total of 34 full-time residents in 2040. The associated water demand would be 5 af/yr under the low demand scenario. Using a water use rate of 150 gpcd for a high demand scenario, the associated water demand would be 6 af/yr. Assuming a current water supply of 3 af/yr, between 2 and 3 af/yr of additional water would be needed, depending upon the demand scenario.

Assuming the existing spring continues to perform at historical flow rates, this water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios. The community is small but is projected to grow.

Rim Trail Estates

By 2040, the full-time population for the Rim Trail DWID is projected to grow by 314 persons to a total population of 358. Under the low demand scenario, this additional population would result in a total water demand of 48 af/yr. Using a high demand water use rate of 218 gpcd, which is the current water demand, the total water demand in 2040 would be 87 af/yr. This relatively high use rate was assumed because the community is somewhat affluent and the lot sizes are large, with substantial landscaping and horse properties. Assuming a current water supply of 67 af/yr from both ground and surface water, an additional water supply of 20 af/yr would be needed to meet the high demand scenario. The current water supply is impacted by drought conditions and reduced flow of the springs upstream from Rim Trail. Therefore, it is likely additional water supplies would need to be developed to provide reliability under the low demand scenario, as well as provide the additional water supply needed under the high demand scenario.

Assuming the springs feeding the East Verde River continue to flow at 50 percent or more of their historical flows, an adequate amount of surface water should be available for the next 10 or more years as the community steadily moves toward more full-time residents and full build-out by 2040. At this time, the district has no significant water supply issues since it believes it is the oldest in water right claims and highest elevation community on the East Verde River. After 2015, however, water shortages are likely to occur, and a deep well or additional surface water rights may be required to meet demands. The district seeks:

- Better well capacity for improved water quantity should the river stop flowing;
- Well capacity for access to better quality water if the river is polluted from storms or from ash caused by forest fires (about 1,200 acres of the 1,400-acre watershed were burned the last few years with the Dude fire and Pack Rat fire); and
- To move its stream pickup station 200 yards upstream, just above the C.C. Cragin discharge in order to avoid water quality issues from mixing natural stream water and lake water, as well as evaluate the possible location of a filtration plant (on leased Forest land) at the edge of Rim Trail.

Shadow Rim Ranch Girl Scout Camp

The Shadow Rim Girl Scout Camp currently serves an equivalent full-time population of 48 persons. It is expected that the equivalent full-time population will increase to 52 persons by 2040. A future water use rate of 120 gpcd was assumed for both the low and high demand scenarios. By 2040, the annual water demand for this facility will increase by 2 af/yr, for a total of 7 af/yr. Current supplies of 8 af/yr are estimated to marginally exceed estimated future demands of 7 af/yr.

This water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios, assuming the camp continues to operate as it has in the past. Adequate storage may be an issue in the future.

Whispering Pines

Significant population growth is projected to occur in this community, from the 2002 population of 80 to 547 full-time residents in 2040. At a water use rate of 120 gpcd, the total water supply needed would be 74 af/yr. To meet a high demand scenario, in which a water use rate of 200 gpcd has been projected, the total water supply needed would be 123 af/yr. With a current water supply of about 32 af/yr, the low and high demand scenarios would require an additional 42 to 91 af/yr, respectively.

Additional groundwater development will be required. The community will continue to have one of the most tenuous supplies in the Study area. Currently, no known water resource development projects are in either a planning or project implementation phase for this community.

Cowan Ranch

The population of Cowan Ranch is expected to increase from about 5 to 50 full-time residents by 2040. In the low demand scenario, the total water supply needed is expected to be 7 af/yr (an increase of 6 af/yr). In the high demand scenario, a water use rate of 164 gpcd was assumed, which is the same as the current water use rate. This would result in a total water demand of 9 af/yr. Because current supplies are estimated to be 12 af/yr, the community may not need additional supplies for either future use scenario, assuming current well production does not decrease.

This water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios, assuming existing wells remain productive as in the past.

Verde Glen

A significant increase in population is projected by 2040, from 16 residents to 274 in 2040. The water demands in Verde Glen in the low demand scenario are projected to be approximately 37 af/yr, an increase of 35 af/yr over use in 2002. In the high demand scenario, a water use rate of 175 gpcd is assumed, due to the larger sized lots within Verde Glen. This high demand scenario would result in a total water demand of 54 af/yr, an increase of 52 af/yr. With a current water supply of 12 af/yr, an additional water supply of between 25 and 42 af/yr is required for the low and high water demand scenarios, respectively.

Additional groundwater development will be required. Resolution of surface water rights issues remains an important factor. No known water supply supplementation programs are planned for near-future implementation.

IV.A.1.3 Sub-Region 1, Cluster 3

Table IV.3 provides a summary of the current population and water demands, and future annual water demand projections for all the communities in Sub-Region 1, Cluster 3.

Table IV.3. – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 3

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Zane Grey Meadows	4	1	180	1	48	180	6	10	5	9
Collins Ranch	11	2	199	2	84	150	11	14	9	12
Mead Ranch	25	3	99	3	130	130	41	44	38	41

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.

Zane Grey Meadows

The population of Zane Grey Meadows in 2040 is expected to total 48 full-time residents. Under the low demand scenario, a total water supply of 6 af/yr will be needed. Using the current water use rate of 180 gpcd for the future high demand scenario, a total water demand of 10 af/yr is anticipated. Assuming a current water supply of 1 af/yr, an additional 5 af/yr and 9 af/yr will be needed to meet the low and high demand scenarios, respectively.

Additional local groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

Collins Ranch

By 2040, the full-time population is expected to increase from 11 to 84 residents. Under the low water demand scenario of 120 gpcd (reduced from a current rate of 199 gpcd), the total water demand is expected to be 11 af/yr. With a water use rate of 150 gpcd under the high demand scenario, the total demand is expected to increase to 14 af/yr. Assuming the existing system has a minimum capacity of 2 af/yr, this would require an increased water supply of between 9 to 12 af/yr to meet the future low and high water demands of this community, respectively.

Additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

Mead Ranch

Substantial build-out in Mead Ranch is expected to occur, with residents living there year-round by 2040. The population is expected to increase by 277 to 302 residents. Using the 120 gpcd low demand scenario, a total water supply of 41 af/yr is needed. Due to its current water use rate of 99 gpcd, a relatively low water use rate of 130 gpcd is assumed in the high demand estimate; a total water supply of 44 af/yr is needed. Assuming a current water supply of 3 af/yr, an additional 38 af/yr and 41 af/yr would be needed to meet the low and high demand scenarios, respectively.

Additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

IV.A.1.4 Sub-Region 1, Cluster 4

Table IV.4 provides a summary of the current population and water demands, and future annual water demand projections for the two communities in Sub-Region 1, Cluster 4.

Table IV.4. – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 4

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Ellison Creek Recreation	10	2	137	160	144	19	19	23	0	0
Ellison Creek Estates	30	4	130	4	150	26	26	32	22	28

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.

Ellison Creek Recreation

This community is already fully built-out, but the number of full-time residents is projected to increase from 10 in 2002, to 144 by 2040. In the low demand scenario, total water usage is projected to be 19 af/yr in 2040. For the high demand scenario, only a minor increase was made to the current water rate, from 137 gpcd to 140 gpcd. This results in a total water demand of 23 af/yr. With the recently developed deep well, there appears to be an adequate supply to meet future water demands of this community.

Ellison Creek Estates

As the remainder of the 30 parcels is developed and more residents begin living here on a full-time basis, the population of this community is expected to reach 192 by 2040. Under the low demand scenario, the total water demand in 2040 would be 26 af/yr. Increasing the current water rate for the high demand scenario, from 130 gpcd to 150 gpcd, would result in a total water demand of 32 af/yr in 2040. Assuming a current water supply of 4 af/yr, this would require an increased water supply of between 22 af/yr and 28 af/yr to meet the low and high demand scenarios, respectively.

Additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

IV.A.1.5 Sub-Region 1, Cluster 5

Table IV.5 provides a summary of the current population and water demands, and future annual water demand projections for the three communities in Sub-Region 1, Cluster 5.

Table IV.5. – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 5

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Thompson Draw I & II	5	4	656	4	204	200	27	46	23	42
Tonto Village	350	27	68	27	847	120	114	114	87	87
Wood Canyon(3)	0	0	0	105	624	150	84	105	0	0

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.
(3) Formerly Pine Meadows

Thompson Draw I and II

By 2040, it is anticipated the number of full-time residents will increase from 5 to 204 persons. In the low demand scenario, total water usage would increase from 4 af/yr to 27 af/yr. Because the current water use rate is exceptionally high, the 200 gpcd use rate for the high demand scenario assumes a significant increase in water use efficiency will be achieved by 2040. The total amount of water needed under the high demand scenario is 46 af/yr. Current water production capacity is unknown. Assuming the existing capacity is at least as much as the current water demand, the amount of additional water needed to meet the low and high demand scenarios would be between 23 and 42 af/yr, respectively.

Additional water supply will be required from either new or deeper wells or possible exchanges for use of some of the Tonto Creek water currently being used by Arizona Department of Transportation (ADOT) to construct new highway. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Tonto Village

The projected 2040 population is estimated to be 847. Due to the existing low water use rate, 120 gpcd was used for both the low and high demand future scenarios. This results in a total future demand of 114 af/yr, an increase of 87 af/yr over the current water demand.

Additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Wood Canyon Ranch (Pine Meadows)
Currently none of the lots have been developed in this subdivision. At full build-out in 2040, 624 full-time residents are expected to live here. Under the low demand scenario, the total water demand is expected to be 84 af/yr. Using a water use rate of 150 gpcd for the high demand scenario, which is considered to be a reasonable rate for an outlying community with average sized parcels, the total water supply needed would be 105 af/yr. The property reportedly has five adequate wells owned by the developer; however, water production totals are not known.

This water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios. This is a new community, but it is expected that Wood Canyon Ranch may not need additional resources in the long-run due to the wells already in place.

IV.A.1.6 Sub-Region 1, Cluster 6

Table IV.6 provides a summary of the current population and water demands, and future annual water demand projections for all the communities in Sub-Region 1, Cluster 6.

Table IV.6. – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 1, Cluster 6

Community/Water Service Provider	Population (2002)	2002 Water Demand		Estimated capacity(2) (af/yr) (2002)	Projected population (2040)	Projected High(1) Water Demand (gpcd)	Projected Water Demand (af/yr)		Additional water supply needed(2) (af/yr)	
		(af/yr)	gpcd				low	high	low	high
Camp Geronimo	128	14	96	19	140	120	19	19	0	0
Geronimo Estates	35	6	141	6	624	150	84	105	78	99
Bonita Creek	30	4	110	4	202	150	27	34	23	30
Diamond Pt. Recreation	4	1	137	1	108	150	15	18	14	17
Bear Flat	12	3	250	3	346	200	46	77	43	74
Kohl's Ranch	270	21	70	80	461	120	62	62	18	18
Tonto Creek Estates	30	5	137	26	156	150	21	26	0	0
Christopher Creek	150	12	73	12	1,363	120	183	183	171	171
Hunter Creek	35	22	571	22	398	300	54	134	32	112
R-Bar-C BS Camp	20	2	96	3	23	120	3	3	0	0

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand

Camp Geronimo Boy Scout Camp

By 2040, it is expected the full-time resident equivalent will equal an annual average of 140 persons. Because the current water use rate is 96 gpcd, a water use rate of 120 gpcd was used for both the low and high demand scenarios; the associated total water demand would be 19 af/yr, an increase of 5 af/yr over current water use of 14 af/yr.

This water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios. The Camp has water rights recognized by TNF and SRP; however, the amounts and defensibility of such ownership rights is not known. Substantial overflows from the storage tanks end up underground in Webber Creek at the south end of the camp. Notwithstanding legal and economic feasibility issues, there may be sufficient excess water to serve Geronimo Estates located 2 miles downstream on Webber Creek; however, water rights and point of use concerns may restrict any transfer of surface water use to other communities.

Geronimo Estates

The population is projected to increase significantly from 35 residents in 2002, to 624 in 2040. Water demand under the low demand scenario would require a total of 84 af/yr. Under the high demand scenario, a water use rate of 150 gpcd was used, which represents a minor increase over the current water use of 141 gpcd. The total water demand under this high water demand scenario is 105 af/yr. An addition 78 af/yr and 99 af/yr would be needed to meet the low and high demand scenarios, respectively.

In addition to problems associated with the existing low volume wells and system operations, the lack of storage (only 15,000 gallons of storage is available) may add greatly to the water supply and delivery problems that have resulted in a moratorium on new meters and line extensions that has been in effect within this water service area.

As discussed above, supplemental supplies may be possible from surpluses at Camp Geronimo Boy Scout Camp. Otherwise, additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community. Additional storage to meet peak demand spikes will help produce a more reliable supply.

Bonita Creek

The population in 2040 is expected to increase from 30 to a total of 202 residents. Under the low demand scenario, this results in a total water supply need of 27 af/yr. A moderate increase over the current use rate, from 110 gpcd to 150 gpcd, is assumed for the high demand scenario, which results in a water demand of 34 af/yr. The volumes of available surface and well water are not known; however, some residents think the surface water from Bonita Creek provides a steady 500 gpm.

Because of issues related to surface water claims, additional groundwater development may be required. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Diamond Point Recreation

Although this community is already fully built-out, the number of full-time residents is projected to increase from 4 to 108 by 2040 for purposes of this study. In the low demand scenario, total water usage would be 15 af/yr in 2040. The current water use rate was increased somewhat for the high demand scenario, from 137 gpcd to 150 gpcd. Under the high demand scenario, the amount of water needed would be 18 af/yr.

One well serves this community; its capacity is unknown. Additional groundwater development is assumed to be required to meet the 2040 water demand. No known water resource development projects are in either a planning or project implementation phase for this community.

Bear Flat

Significant build-out is expected to occur in Bear Flat since less than half the total available parcels have been developed. The 2040 population is expected to increase by 334 to a total of 346 residents. A total water supply need of 46 af/yr is expected under the low demand scenario, which is an increase of 43 af/yr over current use. Assuming a water use rate of 200 gpcd under a high demand scenario (a reduction from the current use of 250 gpcd), 77 af/yr would be required to meet the total water demand in 2040, representing an increase of 74 af/yr over the current demand met by the existing system.

Additional groundwater will be required; only private wells are currently used to provide water to the residents of this community. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Kohl’s Ranch

The projected population in this community is expected to increase from 270 in 2002, to 461 in 2040. Because the current water use rate is only 70 gpcd, 120 gpcd was used for both the low and high water demand scenarios. Therefore, the future water supply needs under either scenario would be 62 af/yr, or an increase of 41 af/yr over current conditions. The current water supply of 80 af/yr from Indian Garden Springs is sufficient; however, these springs may be affected by drought conditions.

No known water resource development projects are in either a planning or project implementation phase for any of this community.

Tonto Creek Estates
Build-out in Tonto Creek Estates has occurred with all 65 parcels currently developed. As more residents become full-time, the population is expected to increase by 126 to 156. The 2040 population will require 21 af/yr in the low demand scenario. For the high demand scenario, the current water use rate was increased somewhat, from 137 gpcd, to 150 gpcd, resulting in a 2040 water demand of 26 af/yr under the high demand scenario. Production capacity of the water system has not been disclosed; however, assuming the current water supply is at least equal to the current water demand of 5 af/yr, the additional water needed to meet the projected 2040 population is 16 to 21 af/yr.

This water provider is expected to have adequate resources to meet the projected 2040 water demands for both the low and high demand scenarios. The community is nearly built-out and has adequate long-term water resources and quality. Should the expected resources for the above communities not support the future demands it is expected that the community would be able to meet demand through some mix of additional conservation, development of local groundwater aquifers through additional wells, water hauling, rainwater harvesting, and growth management.

Christopher Creek
The full-time population of this community is expected to increase from 150 in 2002, to 1,363 in 2040. For the low and high demand scenario, the water use rate was assumed to increase from the current level of 73 gpcd to 120 gpcd. Water demand is therefore projected to increase from 12 af/yr currently, to 183 af/yr in 2040 for both the low and high demand scenarios. Total production capacity of the four existing wells is unknown.

Additional water supplies may be required from either new or deeper wells, or possible exchanges for C.C. Cragin water for water diverted from Christopher Creek. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Hunter Creek
With less than 50 percent of the available lots developed, substantial future growth is assumed for this community. The 2040 population is expected to reach 398 full-time residents, from a population of 35 in 2002. In the low demand scenario, this would result in a total water demand of 54 af/yr. Hunter Creek's current water use rate is 571 gpcd. For the high demand scenario, it was assumed that better water efficiency will reduce the water use rate to 300 gpcd. This results in an expected total water demand of 134 af/yr in 2040. Output capacities of the system wells have not been disclosed.

Additional water supplies are anticipated to result from increased water use efficiency, new or deeper wells, or direct use of surface water based on an exchange of waters from Hunter Creek for CAP, ADOT, or C.C. Cragin water. No known water resource development projects are in either a planning or project implementation phase for any of this community.

R-Bar-C Boy Scout Camp

The Study assumes there is an increase in staffing needs that will result in a full-time equivalent population of 23 in 2040. Both the low and high demand scenarios assume a water use rate of 120 gpcd, resulting in a 1-af/yr increase in water demand, for a total water demand of 3 af/yr in 2040. Current production capacities of the two wells is unknown, however, if the camp is operated like it has in the past, the water operator feels the current system is adequate for all future operations. Should the expected resources not support the future demands, the future-without project for this entity would be expected to be some mix of additional conservation, development of local groundwater aquifers through additional wells, water hauling, rainwater harvesting, and growth management.

IV.A.2 Sub-Region 2

Arrowhead Canyon

This is the only community within Sub-Region 2. By 2040 this community's population is expected to nearly double, to 19 full-time residents. The associated water demand would be 3 af/yr in the low demand scenario. With a projected future high demand water use rate of 140 gpcd, the associated 2040 water demand would also be 3 af/yr. This would require an additional water supply of 2 af/yr under either the low or high demand scenario.

Additional groundwater development will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

IV.A.3 Sub-Region 3

As indicated in Section III, this sub-region is the most populated of all sub-regions, as well as having the single-most populated community in the Study area—the Town of Payson, with a 2002 population of 14,500. Should the expected resources identified below for the communities in Sub-Region 3 not support the future demands, the future-without project for these communities would be expected to be some mix of additional conservation, development of local groundwater aquifers through additional wells, water hauling, rainwater harvesting, and growth management.

Table IV.7 provides a summary of the current population and water demands, and future annual water demand projections for all the communities in Sub-Region 3.

Table IV.7 – Summary of population projections and future low/high annual water demands for the communities in Sub-Region 3

Community/Water Service Provider	Population (2002)	2002 Water Demand (af/yr)	2002 Water Demand gpcd	Estimated capacity (2) (af/yr) (2002)	Projected population (2040)	Projected High (1) Water Demand (gpcd)	Projected Water Demand (af/yr) low	Projected Water Demand (af/yr) high	Additional water supply needed(2) (af/yr) low	Additional water supply needed(2) (af/yr) high
Beaver Valley	240	22	82	23	842	150	113	142	90	119
Freedom Acres	29	9	283	9	50	283	7	16	0	7
Wonder Valley	40	3	69	17	58	225	8	15	0	0
Mesa del Caballo	640	66	92	70	1,092	130	147	159	77	89
Flowing Springs	40	6	137	6	192	150	26	32	20	26
East Verde Estates	180	16	79	16	590	130	79	86	63	70
Summit Springs	0	0	n/a	11	65	150	9	11	0285	0
Payson	14,500	1,805	111	2,681(3)	40,000	120	5,350	5,350	2,669	2,669
Tonto Apache Tribe (4)										
Star Valley A&B	700	66	84	285	3,785	120	509	509	185	185
Star Valley – Private Wells	934									
Diamond Pt. Shadows	140	39	250	39						
Round Valley	300	77	230	77	581	230	78	150	1	73
Oxbow Estates	240	32	120	32	250	150	34	42	2	10

(1) Project low demand used for all communities is 120 gpcd.
(2) When the 2002 system capacity is unknown, for purposes of estimating additional supplies needed by 2040, the system capacity is assumed to be equal to the 2002 water demand.
(3) Payson recently developed a new well in Star Valley that supplies about 876 af/yr, thus increasing the 2002 estimated capacity of 1805 af/yr to 2681 af/yr.
(4) Tonto Apache Tribe's population and associated water demands are included in Town of Payson estimates.

Beaver Valley

The population of this community is projected to increase significantly from 240 to 842 full-time residents in 2040. Assuming the current water use rate has been artificially held down due to the drought, low flows in the river, and problems with the infrastructure, future water demand is projected to increase even in the low demand scenario, to 120 gpcd. This would result in a total water demand of 113 af/yr, in increase of 90 af/yr by 2040. Under a high demand scenario, a water use rate of 150 gpcd is assumed. This would result in a total water demand of 142 af/yr, an increase of 119 af/yr. Both scenarios greatly exceed the current estimated supply to the community of 23 af/yr.

The existing community supply will remain in jeopardy during drought periods or if the streamflow is polluted by the upstream campground. Additional local groundwater is required since the current well is old, low producing and shallow. Any new well may need to be deeper to provide a reliable supply; because Beaver Valley is built directly across the Diamond Rim fault system, there should be opportunities for drilling and developing a new deep groundwater source. No water resource development projects are in either a planning or project implementation phase for this community.

Freedom Acres and Wonder Valley

The 2040 projected build-out population for Freedom Acres is 50 persons, an increase of 21 persons over the current population. In the low demand scenario, estimated at 120 gpcd, this future population is expected to require a water supply of 7 af/yr. The high demand scenario assumes a water use rate that is the same as the current rate of 283 gpcd, with a total water supply need of 16 af/yr. As current supplies are estimated at 9 af/yr, no additional water supply is likely needed for the community in the low demand scenario; 7 af/yr would be needed in the high demand scenario.

Wonder Valley is estimated to increase from 40 in 2002, to 58 full-time residents by 2040. Assuming a future low demand water use rate of 120 gpcd, Wonder Valley would need a total water supply of 8 af/yr. Although the current use rate is 69 gpcd, a use rate of 225 gpcd is being used for the high demand use rate. This is based on the assumption there will be a significant increase in water use resulting from replacement of many existing wells of marginal quality with a better quality community well, causing a higher water use rate. Thus, under the high demand scenario, the water supply needed will be 15 af/yr, an increase of 12 af/yr over the current use rate of 3 af/yr. Current supplies are estimated at 17 af/yr, so the community may not need additional supplies under either demand scenario; however, the area is underlain by generally poor aquifers, including the deep aquifer, subjecting the community to a higher than normal risk of inadequate well production.

Because the existing wells are subject to reduced output under severe drought conditions and are of marginal quality, their replacement with more reliable and deeper wells will likely be needed for both communities. Data from Payson Diamond Rim studies indicate poor conditions at depth (hard unfractured rock implied by geophysical studies). No water resource development projects are in either a planning or project implementation phase for this community.

Mesa del Caballo

This community is expected to grow to a built-out population of 1,092 persons, an increase of 452 people over the current population. As noted in Section III.B.3, current supplies in the community are estimated to be 70 to 80 af/yr. In the low demand scenario, the total 2040 water demand would be 147 af/yr. Using a high demand water use rate of 130 gpcd, the 2040 water supply needed for this community is expected to be 159 af/yr. Assuming the current capacity of the system is 70 af/yr, this would require an additional water supply of between 77 and 89 af/yr for the low and high demand scenarios, respectively.

Additional local groundwater will be required to meet the future water demand. The existing shallow wells are subject to drought conditions, so either deeper wells or alternate sources of water supply are needed. No known additional water supply programs are planned by the community.

Flowing Springs

The Flowing Springs water service area is expected to grow from a population of 40 in 2002, to 192 full-time residents by 2040. With the low demand scenario, there would be a water demand of 26 af/yr. Using a water use rate of 150 gpcd for the high demand water use rate, the total demand would be 32 af/yr in 2040. This would require additional water supplies of between 20 and 26 af/yr, for the low and high demand scenarios, respectively.

Additional local groundwater will be required. No known water resource development projects are in either a planning or project implementation phase for this community.

East Verde Estates (East Verde Park)

The projected population in 2040 is 590, an increase of 410 over the estimated population of 180 in 2002. For the low demand scenario, this population increase represents an expected total demand of 79 af/yr. Using a high demand water use rate of 130 gpcd, the total water demand would be 86 af/yr. This would require an additional water supply of between 63 and 70 af/yr, for the low and high water demand scenarios, respectively.

Storage capacity is needed to address large demand spikes; additional groundwater will be required to meet future water demand. No water resource development projects are in either a planning or project implementation phase for this community.

Summit Springs

There are currently no residents in Summit Springs, but an estimated 65 residents are expected to reside in the community by 2040. In the low demand scenario, the total water supply demand would be 9 af/yr. A water use rate of 150 gpcd is used for the high demand scenario, which is considered to be a reasonable rate for an outlying community with average sized parcels; this results in a total water supply requirement of 11 af/yr. Total water supplies for this community are unknown.

The future-without project would be expected to be a mix of development of local groundwater aquifers through additional wells, water hauling, rainwater harvesting, and growth management.

Town of Payson

At total build-out, Payson's population is projected to be 44,600, an increase of 30,100 over the estimated population of 14,500 in 2002. For purposes of this study, Payson chose to use a 2040 water use rate of 120 gpcd for both the low and high demand scenarios. Using a water use rate of 120 gpcd, the total water demand in 2040 would be 6,000 af/yr. With an existing water supply of 2,681 af/yr, the unmet demand for Payson in 2040 would be 3,319 af/yr. Payson anticipates, however, that build-out densities may not realize a population of more than 40,000, which would equate toa maximum water demand of about 5,350 af/yr. This would result in a more realistic projected unmet demand of 2,669 af/yr.

There currently appears to be sufficient groundwater available to meet short-term needs in Payson (Southwest Ground-Water Consultants 1998; Clear Creek Associates 2007). To meet the future long-term water demands of Payson as projected in this study, the existing groundwater supplies will need to be augmented.

Effluent is not expected to be a major alternative water supply for Payson. The current and future production of effluent is and will be expected to be contracted, stored, and delivered for the purpose of irrigating public properties (cemeteries, school grounds, and sports fields) and public and private golf courses. The use of effluent for these purposes takes the direct impact off Payson’s limited groundwater supplies. Assuming 35 percent capture, the expected total volume of effluent available from full build-out conditions in 2040 would be 2,100 af/yr. It is expected this water will still be contracted for irrigation and recharge purposes by 2040; expansion of irrigation uses are unlikely due to the limited land area and existing users.

Tonto Apache Tribe

The future water demands of the Tonto Apache Tribe are included in the demands identified above for Payson. Water needed for potential development of the Tribe’s proposed expansion property would fall into two categories, residential and commercial.

- Residential water needs: The amount of additional water needed for residential purposes would not be significant. The Reservation population has increased from 85 to 130 individuals over the past 29 years, or an average growth rate of about one and half persons per year. The Tribe currently estimates that 25 additional new houses are needed in order to accommodate the existing population. There are very few lawns at existing Reservation homes. The Tribe has stated that members might like to have gardens and some ornamental plantings.

- Commercial water needs: Out of 278 acres that make up the Federal parcel being exchanged to the Tribe, there are approximate 28 acres suitable for commercial development. That acreage includes 19 acres that are located west of Highway 87 and south of Payson's Event Center and in a narrow strip (241 feet wide) along the southern edge of the existing Reservation boundary. Water demands associated with potential commercial lands are as yet unknown.

If the Tribe acquires the expansion property, an opportunity would exist for the Tribe to replace 34 existing homes on the Reservation by moving or rebuilding them on the acquired Federal parcel. There also are 5 acres within the highway easement that are not usable. This would free up an additional 35 acres of the existing Reservation, where homes now sit, that could potentially be made available for commercial development.

It is the intent of the Tonto Apache Tribe to develop a water supply independent of Payson. For purposes of this Study, however, it is anticipated a future Tribal water supply would utilize Payson's WTP and pipeline for treatment and delivery of the Tribe's water resources to the Reservation under a joint powers service agreement with Payson. The Tonto Apache Tribe has a CAP allocation of 128 af/yr that could be used should a physical water supply become available for use, e.g., through an exchange for C.C. Cragin surface water.

Star Valley and Diamond Point Shadows (Town of Star Valley)
Based upon a projected build-out population in 2040 of 3,785 (which includes an existing population of 1,774 plus an additional 2,011 new residents in Star Valley A&B and Diamond Point Shadows), the Town of Star Valley's (Star Valley and Diamond Point Shadows) total associated water demand for all segments would be 509 af/yr, using 120 gpcd for both the low and high water demand scenarios. Assuming all future water use would be served by a water provider (i.e., 934 residents currently using private wells would be served by a water provider in the future), an additional 404 af/yr would be needed to meet the expected water demand for the entire Town of Star Valley, including Diamond Point Shadows, in 2040.

There currently appears to be a sufficient supply of groundwater available to meet short term needs within the Star Valley area watershed (Clear Creek Associates 2007). It is expected this area will probably continue to have some of the most reliable water supplies over time due to the favorable hydrogeologic conditions in the immediate area.

The 2040 low/high water demand should be readily met by local groundwater, assuming no extreme changes are observed in land uses, commercial and industrial activities, and population density.

Round Valley
As the community builds out and more full-time residents move in, the population is projected to increase by 281 residents to a total of 581 in 2040. Under the low water demand scenario, the current water use rate of 230 gpcd would be reduced to 120 gpcd; thus, even though the population would increase, the water demand would be 78 af/yr--almost the same as the current demand of 77 af/yr. For the high water demand scenario, its current rate of 230 gpcd was used. This would result in a total water demand of 150 af/yr. This relatively high use rate was assumed due to the larger lot size in this community compared

to the average lot size in the Study area. Thus in 2040, between 1 and 73 af/yr of additional water would be needed.

Because the existing wells are affected by drought conditions, additional groundwater will be required even under the low water demand scenario. No known water resource development projects are in either a planning or project implementation phase for any of this community.

Oxbow Estates

Oxbow Estates is nearly built-out and only a slight increase in population is expected by 2040 (an increase of 10 individuals, for a total population of 250). Increased water demands would be small. The additional water demand in the low water demand scenario would be 2 af/yr. Under the high water demand scenario, a water use rate of 150 gpcd was assumed, resulting in an additional water demand of 10 af/yr. Assuming a current water supply of about 32 af/yr, between 2 and 10 af/yr of additional water would be needed by 2040 for the low and high demand scenarios, respectively.

Because this community depends upon private shallow wells that are typically low yield (<10gpm) and drought sensitive, additional groundwater will be required from deeper or larger wells. No known water resource development projects are in either a planning or project implementation phase for any of this community.

IV.A.4 Summary – Future Without Plan

Under the Future Without a regional plan, the various communities, domestic water improvement districts, private water companies, and private individuals with wells would continue to pursue solutions to their specific issues, which include not only securing adequate water supplies, but assuring adequate quality and reliability as well. The overall water supply available for use within the Study area is limited due to the area's underlying complex hydrogeological conditions and because of restrictions on well development due to the vast majority of the Study area being in public ownership. Without access to reliable water supplies that can be developed, treated (if necessary), and delivered at an affordable cost, there will need to be significant changes made to the current development and lifestyle trends, and/or there will be substantial changes to the economic conditions within the Study area. The status of the water supply conditions for communities within the Study area are briefly summarized in Table IV.8.

Table IV.8 – Summary – Future Without Project

Summary – Future Without Project								
	2002			2040				
Community/Water Service Provider	Population	Water Demand (af/yr)	Estimated capacity (af/yr)	Population	(Low) Water Demand (af/yr)	Unmet Demand	Alternative Required (Yes/No)	Comments
Pine Water Co. (Brooke)	1,889	159	159	8,393	1,128	969	Yes	
Pine Creek Canyon/ Portals 4 (DWID)	20	8	8	432	58	50	Yes	Needs system reliability also
Pine Water Association DWID	50	11	37	132	18	0	No	System reliability desirable
Solitude Trails DWID	22	4	31	187	25	0	No	Brooke gets wells at full build-out
Strawberry Hollow	0	1	29	173	23	0	No	
Strawberry Water Co. (Brooke)	1,002	101	101	5,002	672	571	Yes	
Strawberry Water Co. (Hunt)	60	14	14	168	23	9	Yes	
SR1 – CL1 Total	**3,043**	**298**	**379**	**14,487**	**1,947**	**1,599**		
Washington Park	1	0	3	34	5	2	Yes	Drought susceptible
Rim Trail Estates	44	11	67	358	48	0	Yes	Drought Susceptible
Shadow Rim GS Camp	48	5	8	52	7	0	No	Storage capacity
Whispering Pines	80	17	32	547	74	42	Yes	
Cowan Ranch	5	1	12	50	7	0	No	
Verde Glen	16	2	12	274	37	25	Yes	
SR1 – CL2 Total	**194**	**36**	**137**	**1,315**	**178**	**69**		
Zane Grey Meadows	4	1	1	48	6	5	Yes	
Collins Ranch	11	2	2	84	11	9	Yes	
Mead Ranch	25	3	3	302	41	38	Yes	
SR1 – CL3 Total	**40**	**6**	**6**	**434**	**58**	**52**		
Ellison Creek Recreation	10	2	160	144	0	0	No	Drought susceptible
Ellison Creek Estates	30	4	4	192	26	22	Yes	
SR1 – CL4 Total	**40**	**6**	**6**	**336**	**45**	**39**		
Thompson Draw I & II	5	4	4	204	27	23	Yes	
Tonto Village	350	27	27	847	114	87	Yes	
Wood Canyon(3)	0	0	105	624	84	0	No	
SR1 – CL5 Total	**355**	**31**	**136**	**1675**	**225**	**110**		
Camp Geronimo	128	14	19	140	19	0	No	
Geronimo Estates	35	6	6	624	84	78	Yes	

Summary – Future Without Project								
	2002			2040				
Community/Water Service Provider	Population	Water Demand (af/yr)	Estimated capacity (af/yr)	Population	(Low) Water Demand (af/yr)	Unmet Demand	Alternative Required (Yes/No)	Comments
Bonita Creek	30	4	4	202	27	23	Yes	
Diamond Pt. Recreation	4	1	1	108	15	14	Yes	
Bear Flat	12	3	3	346	46	43	Yes	
Kohl's Ranch	270	21	80	461	62	0	No	Drought susceptible
Tonto Creek Estates	30	5	26	156	21	0	No	
Christopher Creek	150	12	12	1,363	183	171	Yes	Capacity of existing wells Unknown
Hunter Creek	35	22	22	398	54	32	Yes	Assumes substantial reduction in GPCD
R-Bar-C BS Camp	20	2	3	23	3	0	No	
SR1 – CL6 Total	**714**	**90**	**176**	**3821**	**514**	**361**		
Total Sub-Region 1	**4,386**	**467**	**840**	**22,068**	**2,967**	**2,230**		
Arrowhead Canyon	10	1	1	19	3	2	Yes	
Total Sub-Region 2	**10**	**1**	**1**	**19**	**3**	**2**		
Beaver Valley	240	22	23	842	113	90	Yes	
Freedom Acres	29	9	9	50	7	0	No	
Wonder Valley	40	3	17	58	8	0	No	Drought susceptible
SR3 – G7	**309**	**34**	**49**	**950**	**128**	**90**		
Mesa del Caballo	640	66	70	1,092	147	77	Yes	
Flowing Springs	40	6	6	192	26	201	Yes	
East Verde Estates	180	16	16	590	79	63	Yes	
Summit Springs	0	0	11	65	9	0	No	
Payson	14,500	1,805	2,681	40,000	5,350	2,669	Yes	
Star Valley A&B	700	66	105	3,785	509	404	Yes	
Star Valley – Private Wells	934							
Diamond Pt. Shadows	140	39						
SR3 - IC	**17,134**	**1,998**	**2,889**	**45,724**	**6,120**	**3,414**		
Round Valley	300	77	77	581	78	1	Yes	
Oxbow Estates	240	32	32	250	34	2	Yes	
SR3 – G8	**540**	**109**	**109**	**831**	**112**	**3**		
Total Sub-Region 3	**17,983**	**2,141**	**3,047**	**47,505**	**6,360**	**3,507**		
Total Study area	**22,379**	**2,609**	**3,888**	**69,592**	**9,330**	**5,737**		

Reevaluation of Social Values, Increased Water Use Restrictions, and Conflicts

Groundwater has always been the primary water supply source for the Study area. However, this resource is susceptible to long-term drought conditions as a result of limited aquifer storage. As the aquifer is depleted and recharge and aquifer recovery fail to provide for an adequate water supply for the growing population of the Study area, conflicts among water service providers, water users, and communities will increase. The Study area is not located within a state-mandated AMA and, therefore, those within the Study area are not required to achieve "Safe Yield" in which groundwater withdrawals must not exceed natural and artificial recharge of the aquifer by a date certain. Without a state-imposed "Safe Yield" requirement, each community is allowed to grow as it desires, so long as local planning, zoning, and permitting requirements are met. Also, restrictions on water use during periods of limited water supply availability are not applied uniformly within the Study area. Currently, heated discussions take place related to denial of personal property rights and restrictions on water use, pitting neighbor against neighbor. Full-time residents and part-time residents do not agree on water use over weekends. Without development of additional water supplies to meet current and future unmet demands, there could be increased imposition of restrictive water conservation measures, including policing water use for non-essential uses such as irrigating landscapes, washing cars or driveways, etc. Reduction in available water supplies for fire protection could occur. Other areas where water use could be restricted or eliminated may include cultural resources preservation and protection, and recreation facilities.

Each community will need to determine when and how it will address its own "Safe Yield" limitation issues. As drought conditions persist and water reliability and quality issues increase, scrutiny over how limited supplies are used will intensify. There could be perceived inequality among the various communities as to how much responsibility each community accepts for protecting and ensuring the long-term viability of the aquifer, and at what cost. For the Study area as a whole, any or all of these constraints and restrictions would impact the social values and quality of life and may make the area less attractive for locating a second home or as a vacation destination.

Perceptions of Inequity

The costs of water provider services and water supply development, and their effects on socioeconomic status, ethnicity, age, gender, and seniority of those living and/or wanting to live within the Study area require additional study. For example, the cost to haul and deliver water to a community as a result of insufficient water production and storage capacity is a significant issue in several communities. Concerns over water use and cost inequities among communities may become more passionate.

Recognition of Institutional Constraints on Water Use

As noted throughout this Report, surface water rights in the Study area can generally be regarded as held by SRP, with a small number of water rights claims held by private land owners and local water companies.

Land ownership is both a legal and institutional constraint in a geographic area that is made up primarily of federal and tribal lands (96 percent). There are few state lands of consequence in the region other than state parks. Individuals and corporations own less than four percent of the land in Gila County. Hence, very little private land is available for developing well sites and other water system infrastructure needed for a water supply distribution system, particularly groundwater wells and associated pipelines.

Special use permits for groundwater exploration and development in the TNF have been difficult for Payson to acquire. It is expected that acquisition of special use permits by others will be equally difficult now and in the future.

Institutional Formation

There are state laws that may be used to form multi-jurisdictional water facilities, districts, or other water service type organizations, e.g. intergovernmental agreements. The formation of an institutional arrangement may be appropriate for and between Payson and the Tonto Apache Tribe. The purpose of this agreement would be to form an alliance between the Tribe and Payson for the development of supplemental water supplies to serve both the Tribe and Payson. This agreement would be an extension of previous water supply and service agreements between Payson and the Tribe.

IV.B Future-With Regional, Sub-Regional, and local Alternatives

As discussed in Section IV.A, in the absence of regional, sub-regional, and local projects, many communities are anticipated to have inadequate water supplies to meet the projected future demands. Section IV.A identifies several communities that have adequate supplies to meet their future demands; however, sensitivity to drought conditions, system reliability issues, and other concerns may affect their ability to develop and deliver suitable potable water in the future. In order to be inclusive, alternatives have been developed and evaluated in this Future-With section for all communities regardless of their perceived future need.

Potential regional, sub-regional, and local project alternatives are identified and evaluated that may provide additional water supplies to meet the 2040 projected water demands for the Study area. In general, the Study considered water supply options in the following broad categories: (a) those that would increase groundwater supplies; (b) those that would increase surface water supplies, including CAP and other surface water exchanges; (c) those that would reclaim more wastewater effluent; and (d) those utilizing both surface and groundwater supplies that, in combination, would meet water demand goals.

Study participants identified the following potential water supply alternatives to be investigated in this Study:

- Groundwater
  - Regional groundwater system
  - Sub-regional groundwater systems
  - Local groundwater development systems
  - Arizona Department of Transportation recharge system – Highway 260 projects
  - Installation of wells in the C aquifer near C.C. Cragin, utilizing current C.C Cragin infrastructure to deliver both groundwater and C.C. Cragin surface water
  - Slant drilling (directional drilling) into the Mogollon Rim (Coconino/Supai or Redwall/Martin or X aquifers)

- Surface Water
  - C.C. Cragin Reservoir
  - Central Arizona Project allocation/exchange
  - Fossil Creek/Fossil Springs
  - Regional and/or local off-stream storm water runoff collection and storage (may include or exclude reclaimed waters)

- Effluent
  - Passive recharge
  - Reuse
  - Fire suppression/protection

- Water Resource and Operational Management Options
  - Demand management and water conservation
  - Conjunctive water resource management

Alternative Analysis
The following issues are addressed in the analysis of each alternative:

Environmental Issues
Environmental concerns that are considered include biological and cultural resources, threatened and endangered species, and water quality impacts.

Legal and Institutional Issues
Legal and institutional issues outlined in Attachment 4 are assessed for each alternative.

Cost
In an appraisal level study, the Field Cost is considered to provide sufficient cost data upon which cost comparisons among alternatives and their options can be

made. Field and subsequent annual costs were estimated using the following economic considerations:

- Federal Project Evaluation and Formulation Rate (2008) = 4-7/8 percent
- Expected Project Life = 20 years
- Capital Recovery Factor = 0.07939
- Most costs, and all historic costs developed by others, were adjusted to the 1st quarter, 2008 Reclamation Construction Cost Trends. Only in one instance was there an attempt to do a cost adjustment based upon feature-by-feature costs adjustments using specific Reclamation Construction Cost Trends, i.e., the CAP/Roosevelt Lake Diversion and Delivery project.
- In general, the annual operation and maintenance cost of an alternative is assumed to be 8 percent of its Field Cost.
- The baseline used for the initial population and water demand analyses is 2002. All future population and water use estimates have been projected to the year 2040. All developable lots are assumed to be "built out" by 2040.
- To develop a range for potential water use, low and high demand water use rates (gpcd) were assumed for each community (towns, unincorporated communities, DWIDs, and water companies). The 2040 projected low and high water demands for each community are shown in Table 6 of Attachment 2.
- The cost of each alternative was evaluated based on the costs associated with the 2040 low water demand (120 gpcd). This provides a baseline cost for each alternative since the higher water demand scenario would either have the same or, in most cases, greater project cost.
- The field cost of an alternative is made up of the contract cost plus contingencies, which are calculated as follows:
  - The initial cost of an alternative is based upon the alternative's estimated quantities (at the appraisal design level);
  - The mobilization costs for an alternative are assumed to be five percent of the initial cost;
  - Unlisted items are estimated to be 15 percent of the sum of the initial cost and the mobilization costs (this component is meant to adjust for the imprecise nature of an initial cost based upon an appraisal level design. Contingency costs are estimated to be 25 percent of the contract cost (which is the sum of the initial cost plus costs for mobilization and unlisted items)

Alternative Evaluation
Based on the information generated in the analysis phase, the Study partners, in accordance with the Federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&Gs), evaluated the viability of each alternative. Originally established as guidance for conducting studies in 1983, Reclamation has traditionally applied the "four tests of viability" as a screening tool to identify alternatives that are appropriate for further study. These four tests include the following:

Acceptability
The workability and viability of the alternative with respect to acceptance by state and local entities and the public, and compatibility with existing laws, regulations, and public policies.

Effectiveness
The extent to which an alternative plan solves the specified problems and achieves the specified opportunities as stated in the Study purpose and need.

Efficiency
The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

Completeness
The extent to which the alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require linking the plan to other public or private plans if the other plans are crucial to realizing the objective. Each alternative is analyzed to assess whether it would respond to the Study purpose and objectives as a stand-alone project, without further investments or implementation of other plans not assumed to already be in place.

Note: Some conceptual alternatives had limited information available to consider during their evaluation in the Study and, as a result, failed the test of completeness and were not considered further as a potential alternative.

IV.B.1 Groundwater Alternatives

This Study considered three approaches in formulating alternatives that develop groundwater as a water supply:

- Developing a regional system;
- Developing additional and/or more reliable groundwater supplies, with associated combined sub-regional water delivery systems that serve two or more communities/water service areas, based upon geographic proximity; and

- Developing additional and/or more reliable water supplies on an entity-by-entity basis.

IV.B.1.1 Regional Groundwater Alternative

Under this alternative, a groundwater supply would be developed that is sufficient to meet the projected regional demand of all the communities within the Study area. In addition, the associated infrastructure system needed to serve the entire Study area would be constructed. As indicated in Section II, much of the groundwater within the Study area comes from fractured rock aquifers, making it difficult to estimate the volume of groundwater in storage. Due to the fractured nature of the rock aquifers, production wells large enough to supply the entire projected regional demands may need to be drilled a great distance from where the water would be used. Therefore, wells would need to be located where sufficient fracturing occurs, which may be on public lands.

Analysis

Environmental Issues

The quality of the groundwater encountered within the Study area is generally good and requires little or no treatment other than disinfection, and possibly localized radon and/or arsenic removal.

Due to the fractured nature of the rock aquifers, production wells large enough to supply the entire projected regional demands may need to be located on public lands. The public land sites pose challenges because of the various permits required for water extraction and because of citizens' and Forest Service concerns regarding the impacts upon their groundwater supplies.

Development of groundwater supplies on a large scale may impact the flow of springs and streams in the area.

Legal and Institutional Issues

Known restrictions include, but probably are not limited to, the following: public acceptance; geographic scale; land ownership and permitting issues on federal or tribal lands; potential impacts to existing surface water rights; relocations and other physical disruptions of private and public service; the current nonexistence of regional water resource management institutions and taxing authorities; financial limitations; and legal challenges (including water rights and federal, state, and local laws).

Cost

Expanding groundwater development programs may require a significant capital expenditure to drill wells and build pipelines to deliver water to where it is needed. Based on the need for connection among sub-regional systems, the cost of this alternative would exceed the sum of the costs of each of the sub-regional groundwater systems.

Note: It must be understood that these Field Costs do not include transmission and distribution pipe systems, energy sources and power systems, power (demand and energy), water treatment (where required), land, environmental, and other non-contract cost.

Evaluation

Acceptability - No
This alternative does not meet the acceptability criterion because of the many legal and institutional issues involved.

Effectiveness - No
There is insufficient existing data to determine the effectiveness of this alternative. Additionally, based upon the analysis of the sub-regional alternative, it appears the sub-regional alternative would likely be as effective as the regional alternative, at a lower cost.

Efficiency - No
Not all of the communities in the Study area require additional water. This system would be redundant and not necessarily efficient for several communities.

Completeness - No
There is no institutional mechanism in place to allow for the development of funds to construct this alternative, and no entity is available to operate and maintain the facilities. This alternative is not complete.

Findings

The Study found there are too many restricting factors to allow for the development of any regional alternative that would be acceptable to all project participants and receive acceptance and approval by those institutions which must give approval to implement such a project (FS special-use permits and other required approvals). This alternative might meet the test for effectiveness if additional data were available for analysis. It does not satisfy the tests for acceptability, efficiency, and completeness. This alternative is not considered viable. The regional groundwater alternative was considered but eliminated from further evaluation.

IV.B.1.2 Sub-Regional Groundwater Alternative

The Sub-Regional Groundwater Alternative considers options for developing joint water service delivery systems (joint water systems) which would serve two or more communities that are located within close proximity to one another. These potential joint water systems would transport groundwater developed by one of the drilling alternatives (if applicable) that also are described below. Although Section IV.A identifies several communities that have adequate supplies to meet their future demands, sensitivity to drought conditions, system reliability, and other issues may affect their ability to develop and deliver suitable potable water in the future.

At least one alternative involving development of a groundwater supply is considered for each community. Where practicable, communities are combined to form a joint water system within a Sub-Region Cluster. A joint water system would consist of a groundwater supply sufficient to serve the low water demand of two or more communities for the common benefit, based upon geographic proximity, and would include a delivery system that would be constructed to serve all the participants. In order to be inclusive, alternatives were developed and evaluated in this Future-With section for all communities, except those few communities for which a joint water system is not practicable. It is assumed these isolated communities would develop individual well systems.

The development of potential joint water systems is generally based upon the organization of communities into the four Sub-Regions, established in Attachment 1, and used in Sections III.B and IV.A; however, some joint water systems are proposed solely due to geographic proximity. There are no communities within Sub-Region 4; therefore, no alternatives are considered for this sub-region.

Analysis

The following elements have been considered in this Study's analysis; however, the Study recognizes there are many considerations and decisions each community must weigh prior to deciding whether or not to participate in a joint water system, which are outside the scope of this Study.

Environmental Issues
The quality of the groundwater encountered within the Study area is generally good and requires little or no treatment other than disinfection, and possibly localized radon and/or arsenic removal.

Due to the fractured nature of the rock aquifers, production wells large enough to supply the entire projected regional demands may need to be located public lands. The public land sites pose challenges because of the various permits required for water extraction and because of citizens' and Forest Service concerns regarding the impacts upon their groundwater supplies.

Development of groundwater supplies on a large scale may impact the flow of springs and streams in the area.

Legal and Institutional Issues
In general, most of the land in the four Sub-Regions is Federal land that is managed by the TNF Payson Ranger District. There are small amounts of private land scattered throughout the four Sub-Regions. Several groups of

communities/water service areas were identified that could join together to develop a groundwater supply and joint water system, and provide for their management.

Cost

To establish a capital cost for production wells, the following considerations were established:

- The 2040 low water demand was assumed to meet the needs of a full-time resident population.
- The 2040 low water demand was used for the total annual water requirement for each community, without regard to current water supply availability (with the exception of Payson).

In general, the production rate of a low volume well is assumed to be ≤ 20 gpm; if the daily production rate is less than or equal to 150 gpm, then a well or group of wells that could produce 20 gpm each was selected to meet the daily water demands of that community. The probable field cost for a low volume production well (20 gpm) is estimated to be $38,400. If a community's 2040 low water demand rate is greater than 20 gpm but less than or equal to 180 gpm, it is assumed that the lower production rate wells (20 gpm), would be used to meet daily demands. However, when the daily production exceeds 180 gpm, then a 150-gpm production well was selected over using nine wells capable of producing 20 gpm to meet the daily demand. This decision was made based upon the fact that the cost of nine low water volume production wells (20 gpm), are essentially equivalent to the cost of one high water volume production well. The field cost for nine wells is estimated to be $345,600, or $350,000.

If the required total daily well production rate is equal to or exceeds 180 gpm then the well production rate is expected to require one or more well(s) with a production rate of 150 gpm. Additional wells would be added, as required, to meet the daily well production demand. The probable field cost for a high volume production of 150 gpm could be expected to be $350,000.

Well locations for either an individual community, or a joint water system for a group of communities, have not been determined. Hence, details for developing supporting infrastructure costs were not determined for any cluster. Only a probable estimate of the well cost is being offered to give some idea of the cost for establishing a sub-regional groundwater alternative for a joint water system, or the costs for individual communities that are not expected to be part of a joint water system (see Table IV.9).

Note: It must be understood that these Field Costs do not include transmission and distribution pipe systems, energy sources and power systems, power (demand and energy), water treatment (where required), land, environmental, and other non-contract cost.

Sub-Region 1

Sub-Region 1 has the greatest potential for developing joint water systems to serve unincorporated communities within a defined hydrogeologic area. The following water providers within Sub-Region 1 could develop groundwater supplies and supporting delivery infrastructure to serve several communities, generally consistent with the Clusters identified in Attachment 1, and used in Sections III.B and IV.A.

- Cluster 1: Pine Water Company, Pine Creek Canyon, Pine Water Association, Solitude Trails, Strawberry Hollow, Strawberry Water Company (Brooke), and Strawberry Water Company (Hunt);
- Cluster 2: Washington Park, Rim Trail Estates, Shadow Rim Ranch, Whispering Pines, Cowan Ranch, and Verde Glen;
- Cluster 3: Zane Grey Meadows, Collins Ranch, and Mead Ranch;
- Cluster 4: Ellison Creek Recreation and Ellison Creek Estates;
- Cluster 5: Thompson Draw I & II, Tonto Village and Wood Canyon Ranch; and
- Cluster 6: Bear Flat , Christopher Creek, Hunter Creek and R Bar C Boy Scout Camp

It would be unlikely for the following Cluster 6 communities to be included in a joint water system due to the distance involved: Camp Geronimo, Geronimo Estates, Bonita Creek, Diamond Point Recreation, Kohl’s Ranch, and Tonto Creek Estates. Table IV.9 presents the annual costs for a well development program where these outlying communities within Cluster 6 would independently develop individual groundwater supplies.

Table IV.9 – Probable Well Field Cost to Meet 2040 Low Water Demand, Communities not Participating in a Joint Water System, Sub-Region 1 (225 af/yr)

Water Service Provider	Low Water Demand (gpm)	Number of 20 gpm wells	Annual Amortization ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/af)	Annual Cost ($/Kgal)
Camp Geronimo	11.8	1	3,000	3,100	6,100	322	0.99
Geronimo Estates	52.1	3	9,100	9,200	18,400	219	0.67
Bonita Creek	16.7	1	3,000	3,100	6,100	227	0.70
Diamond Point Recreation	9.3	1	3,000	3,100	6,100	408	1.25
Kohl's Ranch	38.4	2	6,100	6,100	12,200	197	0.61
Tonto Creek Estates	13.0	1	3,000	3,100	6,100	291	0.89

Sub-Region 1 – Cluster 1

The existing distribution systems within the Pine area are not interconnected; additional construction would be required to connect each of the systems into a combined infrastructure system

There is a transmission pipeline between the communities of Strawberry and Pine – Magnolia pipeline, which currently connects the Pine Water Company and Strawberry Water Company facilities (both are owned by Brooke Utilities). This pipeline can deliver flows in both directions, i.e. from Strawberry to Pine or from Pine to Strawberry. If the water source is groundwater only, no treatment other than disinfection would be required by this delivery system. To develop a joint water system, additional infrastructure may be required by each entity in this cluster. That decision would need to be determined by each cluster member if and when it decides to join into this or another groundwater supply project.

Based on the projected demands identified in Attachment 2 and Section IV.A, if all of the water service providers within this cluster were to participate in a joint water system project, a total supply of 1,947 af/yr would need to be developed to meet the 2040 low demand scenario. This project would serve an additional population of 11,444 persons by 2040. Table IV.10 presents the probable well field cost for a groundwater supply, including a summary of the number of wells required and associated field costs. Probable costs are shown for each individual community and then collectively for the entire cluster as a joint water system.

Table IV.10 – Probable Well Field Cost to Meet 2040 Low Water Demand, Sub-Region 1, Cluster 1 – Individual Community and Joint Water System (1947 af/yr)

Sub-Region 1, Cluster 1 Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Combined Number)	Well Field Costs ($)
Pine Water Co. (Brooke)	699.4>180	4.7*	9	1,592,000
Pine Creek Canyon DWID	180>36.0>20	1.8	2	76,800
Pine Water Association	11.0<20	0.31	1	38,400
Solitude Trails DWID	15.6<20	0.45	1	38,400
Strawberry Hollow DWID	14.1<20	0.41	1	38,400
Strawberry Water Company (Brooke)	416.8>180	2.77	3	1,050,000
Strawberry Water Company (Hunt)	14.0<20	0.40	1	38,400
Total Individual		--	18	2,872,400
Cluster 1	***1,207.2>180***	***8.04[2]***	***9***	***2,838,400***

*While the number of wells shown indicate that 4.7 wells with a production rate of 150 gpm wells are needed for this groundwater system, the system can be configured, more economically, as follows: The reconfigured well system would include four production wells able to produce 150 gpm each plus five production wells capable of producing 20 gpm each for a total of nine production wells. This configuration would produce a net savings in overall capital cost of $72,400, i.e., ($1,400,000 for four 150 gpm wells plus $192,000 for five production wells producing 20 gpm.)

Table IV.11 presents the comparison between annual costs for a well development program where each community within Cluster 1 independently develops its own groundwater supply versus the expected annual cost for all communities if they elect to develop a joint water system

Table IV.11 – Sub-Region 1, Cluster 1 Annual Cost – by Individual Community and Joint Water System (1947 af/yr)

Water Service Providers	Cluster 1 Ungrouped 7 Communities (23 Wells)			Cluster 1 – Joint Water System 7 Communities (9 Wells)		
	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)
Pine Water Co. (Brooke)	253,700	225	0.69	262,099		
Pine Creek Canyon DWID	12,200	211	0.65	13,477		
Pine Water Association	6,100	340	1.04	4,182		
Solitude Trails DWID	6,100	245	0.75	5,809		
Strawberry Hollow DWID	6,100	266	0.82	5,344		
Strawberry Water Company (Brooke)	167,400	249	0.76	156,144		
Strawberry Water Company (Hunt)	6,100	266	0.82	5,345		
Total						
Cluster 1	***457,800***	***---***	***---***	***452,400***	***232***	***0.71***

If the Sub-Region 1, Cluster 1 communities were to develop a joint water system, it appears that it would be slightly less costly than the sum of the individual systems. Infrastructure costs and associated annual costs of a regional system would decrease the cost of the overall system.

A joint water system for the Cluster 1 communities potentially could meet the tests of acceptability, effectiveness but would fail the test for efficiency in meeting the 2040 low water demand for each community. A final analysis regarding the viability of this alternative could be completed when all project costs are estimated, which would provide each community with a sense of the potential cost for participating in a sub-regional joint-use groundwater system alternative.

Sub-Region 1 - Cluster 2

As noted in Sections III and IV.A, this Cluster includes a mix of private and community wells, a DWID, and a private water company. The communities in this cluster are physically close enough to one another to make a joint water system a viable alternative. A shared distribution system may add to the overall reliability and sustainability for each of the communities. While the physical infrastructure needed for this alternative is fairly straightforward, bringing together each of these parties into an organizational structure for the purposes of financing, constructing, and operating a groundwater system may be difficult to achieve.

Based on the projected demands identified in Attachment 2 and Section IV.A, if all of the water service providers listed for this cluster were to participate in a joint water system, a total groundwater supply of 178 af/yr would be needed for this cluster to serve an additional population of 1,121 persons by 2040. Table IV.12 presents the probable well field cost for a groundwater supply, including a summary of the number of wells required and associated field costs.

Table IV.12 – Probable Well Cost to Meet 2040 Low Water Demand, Sub-Region 1, Cluster 2 – Individual Community and Joint Water System (178 af/yr)

Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Number)	Well Costs ($)
Washington Park	2.9<20	0.1	1	38,400
Rim Trail Estates	180>29.8>20	1.5	2	76,800
Shadow Rim Ranch	4.3<20	0.2	1	38,400
Whispering Pines	180>45.6>20	2.3	3	115,200
Cowan Ranch	4.2<20	0.2	1	38,400
Verde Glen	180>22.8>20	1.1	2	76,800
Total Individual			10	384,000
Cluster 2	***180>106.4***	***5.3***	***6***	***230,400***

Table IV.13 presents the annual cost comparison between an individual community developing its own groundwater system and a joint water system that serves the entire Cluster.

Table IV.13 – Sub-Region 1, Cluster 2 Annual Costs – by Individual Community and as a Joint Water System (178 af/yr)

Sub-Region 1, Cluster 2 Water Service Providers	Cluster 2 Ungrouped 6 Communities (10 Wells)			Cluster 2 Joint Water System (6 Wells)		
	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)
Washington Park	6,100	1,224	3.76	1,031		
Rim Trail DWID	12,200	255	0.78	9,897		
Shadow Rim Ranch	6,100	874	2.68	1,443		
Whispering Pines	18,400	248	0.76	15,257		
Cowan Ranch	6,100	874	2.68	1,443		
Verde Glen	12,200	331	1.02	7,629		
Total						
Cluster 2	***61,100***	***---***	***---***	***36,700***	***206***	***0.63***

It appears that if all communities were to join together the "economies of scale" could be used to reduce each community's annual capital and operation and maintenance cost. The addition of other infrastructure costs to develop the full groundwater supply system may determine its viability based upon efficiency (cost).

This alternative has the potential to effectively and efficiently provide the 2040 low water demand for each community. A final analysis of the viability of this alternative could be made when all project costs are estimated, which would give each community a sense of the potential cost for participating in a sub-regional groundwater alternative.

Sub-Region 1 – Cluster 3
This cluster includes the communities of Zane Grey Meadows, Collins Ranch, and Mead Ranch. The communities in this cluster are physically close enough to one another to make a joint water system a viable alternative. A shared distribution system may add to the overall reliability and sustainability for each of the communities. While the physical infrastructure needed for this alternative is fairly straightforward, bringing together each of these parties into an organizational structure for the purposes of financing, constructing, and operating a groundwater system may be difficult to achieve.

Based on the projected demands identified in Attachment 2 and Section IV.A, if all of the water service providers listed for this cluster were to participate in a joint water system, a total groundwater supply of 58 af/yr would be needed for this cluster to serve an additional population of 394 persons by 2040. Table IV.14 presents the probable well field cost for a groundwater supply, including a summary of the number of wells required and associated field costs.

Table IV.14 – Probable Well Cost to Meet 2040 Low Water Demand, Sub-Region 1, Cluster 3 – Individual Community and Joint Water System (58 af/yr)

Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Number)	Well Costs ($)
Zane Grey Meadows	3.7<20	0.2	1	38,400
Collins Ranch	6.8<20	0.3	1	38,400
Mead Ranch	25.4>20	1.3	2	76,800
Total Individual			4	153,600
Cluster 2	***35.9>20***	***1.8***	***2***	***76,800***

Table IV.15 presents the annual cost comparison between an individual community developing its own groundwater system and a joint water system that serves the entire Cluster.

Table IV.15 – Sub-Region 1, Cluster 3 Annual Costs – by Individual Community and as a Joint Water System (58 af/yr)

Sub-Region 1, Cluster 3 Water Service Providers	Cluster 3 Ungrouped 3 Communities (4 Wells)			Cluster 3 Joint Water System (2 Wells)		
	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)
Zane Grey Meadows	6,100	1,020	3.13	1,262		
Collins Ranch	6,100	556	1.71	2,314		
Mead Ranch	12,200	299	0.92	8,624		
Total						
Cluster 2	***24,400***	***---***	***---***	***12,200***	***211***	***0.65***

It appears that if all communities were to join together the "economies of scale" could be used to reduce each community's annual capital and operation and maintenance cost. The addition of other infrastructure costs to develop the full groundwater supply system may determine its viability based upon efficiency (cost).

This alternative has the potential to effectively and efficiently provide the 2040 low water demand for each community. A final analysis of the viability of this alternative could be made when all project costs are estimated, which would give each community a sense of the potential cost for participating in a sub-regional groundwater alternative.

Sub-Region 1 - Clusters 4 through 6

Communities located in Sub-Region 1, Clusters 4, 5, and 6 are evaluated with respect to two options. Under the first option, each community within a cluster would establish its own groundwater system independent of the other communities within that Cluster. The second option is that all communities within a cluster would utilize a common groundwater supply with associated well(s) and infrastructure. It is assumed that either approach would be viable due to the expected size of either system. Table IV.16 presents the probable annual well cost to meet each community's 2040 low water demand separately and jointly.

Based on the projected demands identified in Attachment 2 and Section IV.A, if all of the water service providers in Cluster 4 were to participate in a joint water system, the total groundwater supply needed for this cluster would be 45 af/yr. This project would serve an additional population of 296 persons by 2040. If all of the water service providers in Cluster 5 were to participate in a joint water system, the total groundwater supply needed for this cluster would be 225 af/yr. This project would serve an additional population of 1,320 persons by 2040. And, if all of the remaining water service providers in Cluster 6 were to participate in a joint water system, the total groundwater supply for this cluster would be 286 af/yr. This project would serve an additional population of 1,913 persons by

2040. Table IV.16 presents the probable well field cost for a groundwater supply, including a summary of the number of wells required and associated field costs for Clusters 4 through 6.

Table IV.16 – Probable Well Cost to Meet 2040 Low Water Demand, Sub-Region 1, Clusters 4 – 6 Individual Community and Joint Water Systems (559 af/yr)

Sub-Region 1, Cluster & Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Number)	Well Costs ($)
Cluster 4				
Ellison Creek Recreation	11.8<20	0.6	1	38,400
Ellison Creek Estates	16.1<20	0.8	1	38,400
Total Individual			2	76,800
Cluster 4	***180>27.9>20***	***1.4***	***2***	***76,800***
Cluster 5				
Thompson Draw I & II	16.7<20	0.8	1	38,400
Tonto Village	180>70.7>20	3.5	4	153,600
Wood Canyon Ranch	180>52.1>20	2.6	3	115,200
Total Individual			8	307,200
Cluster 5	***180>139.6>20***	***7.0***	***7***	***268,800***
Cluster 6				
Bear Flat	180>28.5>20	1.4	2	76,800
Christopher Creek	113.4>180	5.7	6	230,400
Hunter Creek	180>33.5>20	1.7	2	76,800
R Bar C Boy Scout Camp	1.9<20	0.1	1	38,400
Total Individual			11	422,400
Cluster 6	***177.3>180***	***8.9***	***9***	***345,600***

Table IV.17 presents an annual cost comparison between each community continuing to rely on its individual system and developing a joint water system for all the communities within a given Cluster. The annual costs presented are limited to the probable costs of the wells only.

Table IV.17 – Sub-Region 1, Clusters 4 – 6, Annual Costs by Individual Community and by Joint Water System (559 af/yr)

Sub-Region 1, Cluster & Water Service Providers	Ungrouped Communities within a Cluster			Grouped Communities within a Cluster		
	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)
Cluster 4						
Ellison Creek Recreation	6,100	321	0.99	5,151		
Ellison Creek Estates	6,100	235	0.72	7,049		
Total Individual	12,200					
Cluster 4				***12,200***	***272***	***0.83***
Cluster 5						
Thompson I & II	6,100	227	0.70	5,136		
Tonto Village	24,500	215	0.66	21,685		
Wood Canyon Ranch	18,400	219	0.67	15,979		
Total Individual	49,000					
Cluster 5				***42,800***	***190***	***0.58***
Cluster 6						
Bear Flat	12,200	266	0.82	8,862		
Christopher Creek	36,700	201	0.62	35,256		
Hunter Creek	12,200	227	0.70	10,404		
R Bar C Boy Scout Camp	6,100	2,040	6.26	578		
Total Individual	67,200					
Cluster 6				***55,100***	***193***	***0.59***

Not every community in a Cluster may realize an advantage in joining with another community to obtain capital and operational cost savings. Each community should assess and evaluate all project costs prior to seeking a joint-use situation with other communities in a given cluster. Infrastructure costs would also be a factor in determining whether or not it is cost effective to develop a joint-use groundwater system within a Cluster. This alternative has the potential to effectively and efficiently provide the 2040 low water demand for each community.

Sub-Region 2

There is only one local community within this sub-region, Arrowhead Canyon; therefore, no sub-regional alternative has been developed in Sub-Region 2. Based upon the 2040 low water demand (3 af/yr), this community is expected to need only one low water volume production well. This water system is expected to be viable. Field and annual costs for a single well are listed in the Alternative’s Summary Table IV.18.

Table IV.18 – Sub-Region 2 (Arrowhead Canyon) – Field and Annual Cost Summary (3 af/yr)

Description	Cost ($)
Probable Field Cost	38,400
Annual Amortization Cost	3,000
Annual Operation & Maintenance Costs	3,100
Total Annual Cost	6,100
Annual Cost per Acre-Foot	2,040
Annual Cost per 1,000 Gallons	6.26

Sub-Region 3

Due to the distance between the communities, it is unlikely that Mesa del Caballo, Summit Springs, Flowing Springs, East Verde Estates, or Star Valley would benefit from being part of a joint water system. Additionally, it is unlikely that Payson would participate in a joint water system. This is because the 2008 SRP/Town of Payson Water Rights Transfer and Water Delivery and Use Agreement limits Payson's groundwater pumping to 2,520 af/yr; therefore, any supplemental water supply for Payson must come from sources other than groundwater.

Flowing Springs and East Verde Estates could decide to develop a joint water system since both communities are currently being served by Brooke Utilities. For purposes of this Report it was decided that each community would remain independent of the other.

Table IV.19 provides a summary of the total number of wells needed to meet the 2040 low water demand of these individual water system communities. Payson is not included in this table, since it is anticipated the Town will not be pursuing any further groundwater development.

Table IV.19 – Probable Well Cost to Meet 2040 Low Water Demand, Sub-Region 3 - Individual Community (261 af/yr)

Sub-Region 3 Individual Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Number)	Well Costs ($)
Mesa del Caballo	180>91.1>20	4.6	5	192,000
Flowing Springs	16.1<20	0.8	1	38,400
East Verde Estates	180>49.0>20	2.4	3	115,200
Summit Springs	5.6<20	0.3	1	38,400
Star Valley (Including Star Valley A&B/ Diamond Point Shadows)	315.6>180	2.78	3	738,400

Table IV.20 provides a summary of the annual costs to meet 2040 low water demands for each non-cluster communities, Sub-Region 3.

Table IV.20 – Annual Cost to Meet 2040 Low Water Demand, Sub-Region 3, Non-Cluster Communities (261 af/yr)

Water Service Provider	Annual Amortization ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Mesa del Caballo	15,200	15,400	30,600	208	0.64
Flowing Springs	3,000	3,100	6,100	235	0.72
East Verde Estates	9,100	9,200	18,400	232	0.71
Summit Springs	3,000	3,100	6,100	680	2.09
Star Valley (Including Star Valley A&B/ Diamond Point Shadows)	58,600	59,100	117,700	231	0.71

The following water providers within Sub-Region 3 could develop groundwater systems and supporting infrastructure that would be operated to serve several communities with a joint delivery system.

- Group 7: Beaver Valley, Freedom Acres and Wonder Valley
- Group 8: Round Valley and Oxbow Estates

Sub-Region 3 – Group 7

The three unincorporated communities of Beaver Valley, Freedom Acres, and Wonder Valley could comprise a joint water system. If all of the water service providers in this group were to participate, the total groundwater supply needed would be 128 af/yr. This project would serve an additional 641 people by 2040.

Sub-Region 3 – Group 8

At the southern end of the Study area lie the two communities of Round Valley and Oxbow Estates. Currently their water supplies come from groundwater. These two communities are in close proximity to each other and could choose to develop a joint water system and expand their local water supplies to collectively increase the size of their two well fields. Alternately, they could approach Payson about participating in the C.C. Cragin raw water pipeline project. Their combined 2040 low water demand is 112 af/yr. This project would serve an additional 291 people by 2040.

Table IV.21 presents the probable well field cost to meet 2040 low water demand, and Table IV.22 presents a cost summary of annual costs for the Sub-Region 3 well projects, by individual community and joint water systems for Groups 7, 8, and 9.

Table IV.21 – Probable Well Field Cost to Meet 2040 Low Water Demand, Sub-Region 3, Groups 7 and 8, Individual Community and Joint Water Systems (749 af/yr)

Sub-Region 3, Grouped and Individual Water Service Providers	2040 Low Water Demand (gpm)	Number of Wells @ 20 gpm and/or 150 gpm	Required Wells (Number)	Well Costs ($)
Group 7				
Beaver Valley	180>70.1>20	3.5	4	153,600
Freedom Acres	4.3<20	0.2	1	38,400
Wonder Valley	5.0<20	0.2	1	38,400
Total Individual			6	230,400
Group 7	***180>79.2>20***	***4.0***	***4***	***153,600***
Group 8				
Round Valley	180>48.4>20	2.4	3	115,200
Oxbow Estates	20.8≈20	1.0	1	38,400
Total Individual			4	153,600
Group 8	***180>69.2>20***	***3.5***	***4***	***153,600***

Table IV.22 – Sub-Region 3, Groups 7 and 8, Summary of Annual Costs by Individual Community and by Joint Water System Group (749 af/yr)

Sub-Region 3 Grouped and Individual Water Service Providers	Individual Communities by Group			Group Joint Water Systems		
	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/KGal)
Group 7						
Beaver Valley	24,500	217	0.66	21,629		
Freedom Acres	6,100	874	2.68	1,340		
Wonder Valley	6,100	765	2.35	1,531		
Total Individual	36,700					
Group 7				***24,500***	***191***	***0.59***
Group 8						
Round Valley	18,400	235	0.72	17,063		
Oxbow Estates	6,100	182	0.56	7,437		
Total Individual	24,500					
Group 8				***24,500***	***219***	***0.67***

Sub-Region 4

There are no communities located within this Sub-Region of the Study area; therefore, no alternatives were considered or developed for this Sub-Region.

2040 Water Demand by Sub-Region Cluster/Group

Table IV.23 is a summary of the increase in population from 2002 to 2040. In addition, the estimated total water supply demand (2040) associated with this projected future population is also provided.

Table IV.23 – 2040 Population Increase and Water Demands over Current Populations and Water Supply, By Sub-Region Cluster/Group

Cluster/Group	Population Change (2002 – 2040)	2040 Water Demand (Low) (af/yr)
Sub-Region 1, Cluster 1	11,444	1,947
Sub-Region 1, Cluster 2	1,121	178
Sub-Region 1, Cluster 3	394	58
Sub-Region 1, Cluster 4	296	45
Sub-Region 1, Cluster 5	1,320	225
Sub-Region 1, Cluster 6	3,107	514
Sub-Region 2	9	3
Sub-Region 3, Individual Communities	28,590	6,120
Sub-Region 3, Group 7	641	128
Sub-Region 3, Group 8	291	112
Total Study area	**47,213**	**9,330**

Note: The numbers in this table differ slightly from Attachment 1, Table 6, due to some modifications to assumptions for Payson, See Section IV.A.3 – Town of Payson.

There are potential opportunities in which participation in a joint water system would provide for "economies of scale" for two or more communities. The technical components of the sub-regional alternatives would be similar in all instances.

Prior to the planning, design, construction, and operation and maintenance of a groundwater supply system, it is assumed that groundwater supplies could be located and subsequently collected and delivered through appropriate infrastructure to the point of use. The development of any sub-regional infrastructure would need to include consideration of the following elements:

- Groundwater system
    - Locating the well site
    - Drilling and equipping
    - Appurtenances
- Supporting infrastructure system
    - Transmission pipeline
    - Well-head treatment (if required)
    - Disinfection system
    - Power
    - Potable water storage
    - Distribution system
    - Appurtenances (all infrastructure systems)
- Operating and maintenance program

Table IV.24 is a summary of the field and annual costs for all water providers, by Sub-Region and Cluster or Group, as applicable.

Table IV.24 – Field and Annual Costs, Groundwater Systems for Sub-Region 1, Clusters 1 through 6; Sub-Region 2; Sub-Region 3, Groups 7 and 8; and Sub-Region 4

Sub-Regions	Field Cost Low Volume Production Wells (20 gpm)	Field Cost High Volume Production Wells (150 gpm)	Total Field Cost ($)	Annual Amortization Cost ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Sub-Region 1 – Non-Cluster								
Camp Geronimo	38,400	0	38,400	3,000	3,100	6,100	322	0.99
Geronimo Estates	115,200	0	115,200	9,100	9,200	18,400	219	0.67
Bonita Creek	38,400	0	38,400	3,000	3,100	6,100	227	0.70
Diamond Point Recreation	38,400	0	38,400	3,000	3,100	6,100	408	1.25
Kohl's Ranch	76,800	0	76,800	6,100	6,100	12,200	197	0.61
Tonto Creek Estates	38,400	0	38,400	3,000	3,100	6,100	291	0.89
Sub-Region 1 – Cluster 1								
Pine Water Company	192,000	1,400,000	1,592,000	126,400	127,400	253,700	225	0.69
Pine Creek Canyon	76,800		76,800	6,100	6,100	12,200	211	0.65
Pine Water Association	38,400		38,400	3,000	3,100	6,100	340	1.04
Solitude Trails DWID	38,400		38,400	3,000	3,100	6,100	245	0.75
Strawberry Hollow DWID	38,400		38,400	3,000	3,100	6,100	266	0.82
Strawberry Water Co. (Brooke)	0	1,050,000	1,050,000	83,400	84,000	167,400	249	0.76
Strawberry Water Co. (Hunt)	38,400	0	38,400	3,000	3,100	6,100	266	0.82
Sub-Region 1, Cluster 1 Joint Water System	38,400	2,800,000	2,838,400	225,300	227,100	452,400	232	0.71
Sub-Region 1 – Cluster 2								
Washington Park	38,400	0	38,400	3,000	3,100	6,100	1,224	3.76
Rim Trail Estates	76,800	0	76,800	6,100	6,100	12,200	255	0.78
Shadow Rim	38,400	0	38,400	3,000	3,100	6,100	874	2.68

Sub-Regions	Field Cost Low Volume Production Wells (20 gpm)	Field Cost High Volume Production Wells (150 gpm)	Total Field Cost ($)	Annual Amortization Cost ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Ranch								
Whispering Pines	115,200	0	115,200	9,100	9,200	18,400	248	0.76
Cowan Ranch	38,400	0	38,400	3,000	3,100	6,100	874	2.68
Verde Glen	76,800	0	76,800	6,100	6,100	12,200	331	1.02
Sub-Region 1 – Cluster 2 Joint Water System	230,400	0	230,400	18,300	18,400	36,700	206	0.63
Sub-Region 1, Cluster 3								
Zane Grey Meadows	38,400	0	38,400	3,100	3,100	6,100	1020	3.13
Collins Ranch	38,400	0	38,400	3,100	3,100	6,100	556	1.71
Mead Ranch	76,800	0	76,800	6,100	6,100	12,200	299	0.92
Sub-Region 1, Cluster 3 Joint Water System	76,800	0	76,800	6,100	6,100	12,200	211	0.65
Sub-Region 1, Cluster 4								
Ellison Creek Recreation	38,400	0	38,400	3,000	3,100	6,100	322	0.99
Ellison Creek Estates	38,400	0	38,400	3,000	3,100	6,100	235	0.72
Sub-Region 1, Cluster 4 Joint Water System	76,800	0	76,800	6,100	6,100	12,200	272	0.83
Sub-Region 1, Cluster 5								
Thompson Draw I & II	38,400	0	38,400	3,000	3,100	6,100	227	0.70
Tonto Village	153,600	0	153,600	12,200	12,300	24,500	215	0.66
Wood Canyon Ranch	115,200	0	115,200	9,100	9,200	18,400	219	0.67
Sub-Region 1,	268,800	0	268,800	21,300	21,500	42,800	190	0.58

Sub-Regions	Field Cost Low Volume Production Wells (20 gpm)	Field Cost High Volume Production Wells (150 gpm)	Total Field Cost ($)	Annual Amortization Cost ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Cluster 5 Joint Water System								
Sub-Region 1, Cluster 6								
Bear Flat	76,800	0	76,800	6,100	6,100	12,200	266	0.82
Christopher Creek	230,400	0	230,400	18,300	18,400	36,700	201	0.62
Hunter Creek	76,800	0	76,800	6,100	6,100	12,200	227	0.70
R Bar C Boy Scout Camp	38,400	0	38,400	3,000	3,100	6,100	2,040	6.26
Sub-Region 1, Cluster 6 Joint Water System	345,600	0	345,600	27,400	27,700	55,100	193	0.59
Sub-Region 2: Non-Cluster								
Arrowhead Canyon	38,400	0	38,400	3,000	3,100	6,100	2,040	6.26
Sub-Region 3, Non-Groups								
Mesa del Caballo	192,000	0	192,000	15,200	15,400	30,600	208	0.64
Flowing Springs	38,400	0	38,400	3,000	3,100	6,100	235	0.72
East Verde Estates	115,200	0	115,200	9,100	9,200	18,400	232	0.71
Summit Springs	38,400	0	38,400	3,000	3,100	6,100	680	2.09
Town of Payson	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Star Valley	38,400	700,000	738,400	58,600	59,100	117,700	231	0.71
Sub-Region 3, Group 7								
Beaver Valley	153,600	0	153,600	12,200	12,300	24,500	217	0.66
Freedom Acres	38,400	0	38,400	3,000	3,100	6,100	874	2.68
Wonder Valley	8,400	0	38,400	3,000	3,100	6,100	765	2.35
Sub-Region 3, Group 7 Joint Water System	153,600	0	153,600	12,200	12,300	24,500	191	0.59

Sub-Regions	Field Cost Low Volume Production Wells (20 gpm)	Field Cost High Volume Production Wells (150 gpm)	Total Field Cost ($)	Annual Amortization Cost ($)	Annual Operation & Maintenance Cost ($)	Total Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Sub-Region 3, Group 8								
Round Valley	115,200	0	115,200	9,200	9,200	18,400	235	0.72
Oxbow Estates	38,400	0	38,400	3,000	3,100	6,100	182	0.56
Sub-Region 3, Cluster 8 Joint Water System	153,600	0	153,600	12,200	12,300	24,500	219	0.67
Sub-Region 4 – None								

Evaluation

Acceptability - Yes
This alternative is compatible with existing laws, regulations, and public policies.

Effectiveness - Yes
Problems are solved on a sub-regional basis is in accordance with study objective.

Efficiency - Yes
This is the most cost effective groundwater alternative.

Completeness - Yes
Assuming agreements can be arranged for joint use systems, this alternative meets the completeness criteria.

Findings

Based on information provided in the Hydrogeologic Framework (Attachment 1) and the discussion presented above, a sub-regional groundwater alternative with the potential of developing joint water systems is considered to be viable. However, in order to implement this alternative, it will be necessary for respective communities to enter into agreements for the development, implementation, management, and operation of the system.

IV.B.1.3 Local Groundwater Alternative
One groundwater alternative that is highly plausible is for each community to provide their own water service independently for their respective community. Well systems would consist of one of following three groundwater systems: 20 gpm, 150 gpm, or a combination of using both types of production wells in some combination of low and high production wells to achieve the needed low water demand for 2040.

Analysis

Environmental Issues
The quality of the groundwater encountered within the Study area is generally good and requires little or no treatment other than disinfection and possibly localized radon and/or arsenic removal.

Due to the fractured nature of the rock aquifers, to have enough production wells to supply the entire projected regional demands, some of them may need to be located on public lands. The public land sites pose challenges because of the various permits required for water extraction and because of citizens' and Forest Service concerns regarding the impacts upon the groundwater.

Development of groundwater supplies on a large scale may impact the flow of springs and streams in the area.

Legal and Institutional Issues
Known restrictions include, but probably are not limited to, the following: public acceptance; geographic scale; land ownership and permitting issues on Federal or Tribal lands; potential impacts to existing surface water rights; relocations and other physical disruptions of private and public service; the current nonexistence of regional water resource management institutions, taxing authorities and financial limitations; and legal challenges (including water rights and Federal, state, and local laws).

Cost
The Field Cost for the 20 gpm wells has been estimated to be $38,400. The Field Cost for the 150 gpm well has been estimated to be $350,000. Subsequent refinements to these field and annual costs will use these base Field Cost figures to estimate the overall field and annual cost.

Note: It must be understood that these Field Costs do not include transmission and distribution pipe systems, energy sources and power systems, power (demand and energy), water treatment (where required), land, environmental, and other non-contract cost.

Evaluation

Acceptability – Yes
This alternative is compatible with existing laws, regulations, and public policies.

Effectiveness – Yes
Problems are solved on a local basis in accordance with the Study objectives.

Efficiency – Yes
Each community will have to assess the cost effectiveness of developing groundwater; however, this is likely to be one of the lowest cost methods of developing a larger and/or more reliable water supply.

Completeness – Yes
This alternative meets all of the criteria for completeness.

Findings

Groundwater development on a local level may be an acceptable alternative in many communities, particularly for those isolated from surface water sources or for communities that cannot or do not want to take advantage of economies of scale and increase reliability by developing a joint water system with other communities.

Local community-based groundwater alternatives are considered as part of this Study to offer an idea of what the probable cost of a local well(s) might be if a community chooses to use additional groundwater to supply its 2040 low water demand. Although the alternative meets the tests of acceptability, effectiveness, efficiency, and completeness, the decision for implementing a local community's groundwater alternative is expected to remain with the community itself.

IV.B.1.4 Arizona Department of Transportation (ADOT) – Highway 260 – Surface Water Diversion and Groundwater Storage and Recovery

This alternative would consist of the continuation and expansion of an existing water system that is currently owned and operated by ADOT. ADOT built this system in 1999 and is using it to supply construction water for a 21-mile divided highway project on SR 260, between Star Valley and Christopher Creek. The system operates under a water exchange agreement between ADOT and SRP, which holds Tonto Creek surface water rights. The agreement allows ADOT to divert water from Tonto Creek; in exchange, water from an ADOT well located in Phoenix, is delivered into the SRP irrigation system.

ADOT diverts Tonto Creek water at Kohl's Ranch from December to March each winter. The system transports the water through a temporary 6-mile pipeline to two 1-million gallon holding reservoirs. The water is treated to potable standards and is then injected into a well field located about 2 miles east of Diamond Point Estates. ADOT recovers the recharged water from wells located in this same well field, and then uses it for construction purposes. Groundwater levels beneath the well field are monitored; pumping must be discontinued when water levels exceed specified levels. Diversions from Tonto Creek also are restricted if certain flow conditions in the Creek are not met. The current agreement stipulates that upon completion of the ADOT project, the system will be dismantled, the wells sealed, and the stream diversion, pipeline routes, and well field returned to a natural condition.

In order to develop water under this alternative, an entity would need to enter into an exchange agreement that is similar to the existing agreement between ADOT and SRP. Special use permits would need to be obtained from the TNF to operate the system on a long-term basis. With some expansion of the existing system, it may provide a supplemental water supply to several communities located on the eastern end of the ADOT project, in the general vicinity of the intersection of SR 260 and FR 64 (Tonto Village, Thompson Draw I and II, Wood Canyon Ranch, Bear Flat, and Kohl's Ranch), as well as to Star Valley located on the western end of the ADOT project.

The natural storage capacity of this system may be limited. During 2004, the production recovery wells supplied 53.5 af for construction purposes. That same year, the well-field water levels remained at the same static levels after only 35.6 af of Tonto Creek water were injected into the well field, indicating about 18 af of natural recovery during 2004.

Analysis

Environmental Issues

It is likely that the long-term diversion of water from Tonto Creek may initiate impacts to the aquatic environment. Additionally, fluctuating groundwater levels at the alternative site may impact streams and springs in the area.

Legal and Institutional Issues

ADOT has an exchange water supply for SRP. It is not known whether any of the potential parties that could participate in this alternative (e.g., Tonto Village Water Company, Kohl's Ranch, Bear Flats, Thompson Draw I and II, and Wood Canyon Ranch) have access to a source of water for exchange with SRP. Additionally, both TNF and SRP may have issues related to continued allowance of storage and pumping of waters from TNF lands. Historically, SRP and water users in Star Valley have opposed water development projects in the TNF.

Cost
Table IV.25 presents a summary of preliminary field/annual cost for the described Highway 260 groundwater alternative

Table IV.25 – Highway 260 Groundwater Alternative – Preliminary Field Cost and Annual Cost Summary (100 af/yr)

Description	Cost ($)
Probable Field Cost	9,582,900
Annual Amortization Cost	760,800
Annual Operation & Maintenance Costs	766,600
Total Annual Cost	1,527,400
Annual Cost per Acre-Foot	15,274
Annual Cost per 1,000 Gallons	46.87

Evaluation

Acceptability - No
As noted above, there are many legal and institutional barriers associated with this alternative.

Effectiveness - No
The long-term reliability of this alternative has not been established. However, since this system is dependent on a specific water level in Tonto Creek and season of the year, it may be considered unreliable most of the time.

Efficiency – No
At a cost of more than $15,000 per af this alternative is not efficient.

Completeness - No
There are many issues that remain to be addressed in order for this project to be deemed viable: (a) there would need to be an exchange agreement between SRP and some existing downstream surface water rights holder; (b) SRP, TNF, and a future system operator (other than ADOT) would need to agree on operational procedures for the system; (c) the FS would need to issue a special-use permit for construction and operation of a network of permanent source pipelines, filtration systems, storage tanks, and distribution mains; and (d) the communities that would be served by this system would need to develop an agreement and form some type of water provider organization.

Findings

The project is required to be kept in hydrologic balance over time; there is little or no system flexibility. The intricacies of the project and the required mitigation (e.g., preservation of the aquifer, protection of downstream water right holders, environmental protection, special use permit requirements, etc.) would demand continuous and costly maintenance and administrative activities. The very high cost for this alternative compared to the potential water volume available causes this alternative to fail the efficiency test. With the uncertainty associated with all aspects of this alternative, it is considered non-viable.

IV.B.1.5 Installation of Wells in the Coconino Aquifer near C.C. Cragin Reservoir, Utilizing Current Infrastructure to Deliver Both Groundwater and Surface Water

Geologists believe that a portion of the surface water stored within C.C. Cragin Reservoir is flowing away from the Reservoir and into the regional aquifer or into bank storage. This alternative proposes placing recovery wells in selected locations along the Reservoir's perimeter to capture this out-flow of reservoir waters. Currently, there are no conclusive data to support this theory, and additional investigative work would be required to validate or deny this concept.

A proposed well-field configuration for the C.C. Cragin groundwater alternative would include six (6) wells scattered around the outer edge of the C.C. Cragin reservoir. It has been assumed the annual production volume of this groundwater alternative is 3,500 acre-feet.

The possible beneficiaries of this water supply alternative would be the communities that could partner in a C.C. Cragin Reservoir pipeline project. Such a pipeline alternative is discussed in the Surface Water Alternative section in this report.

Analysis

Environmental Issues

The quality of the groundwater near the Reservoir will likely have the characteristics of the surface water in C.C. Cragin Reservoir and may require more extensive treatment that other groundwater sources in the Study area.

Development of C aquifer groundwater supplies on a large scale may impact bank storage return flow to the Reservoir and the flow of springs and streams in the area causing potential impacts to federally protected fish species and to riparian habitat.

Legal and Institutional Issues

This alternative poses significant legal issues, including Arizona's prohibition of the development and transfer of groundwater between sub-basins. Additionally, much of the Federal land near the Reservoir is administered and managed by the CNF and would require coordination for special use permits.

Cost

The probable cost for each well located in this field is expected to be around $500,000. The total Field Cost for the well field would be $3,000,000. No costs have been estimated for the costs associated with such items as well completion (pumps, motors, electrical, control panels, etc.), power service, power operational costs, transmission and collection systems, treatment and disinfection, SRP operation and maintenance and other related contractual items, and for all other non-project requirements and costs – including ADWR permits – not previously noted. Table IV.26 presents a summary of preliminary well costs for the described C.C. Cragin groundwater alternative.

Table IV.26 – C.C. Cragin C-Aquifer Groundwater Alternative – Preliminary Field Cost and Annual Cost Summary (3,500 af/yr)

Description	Cost ($)
Probable Field Cost	3,000,000
Annual Amortization Cost	238,200
Annual Operation & Maintenance Cost	240,000
Total Annual Cost	478,200
Annual Cost per Acre-Foot	137
Annual Cost per 1,000 Gallons	0.42

Evaluation

Acceptability – No
Developing and transporting groundwater supplies between basins is not allowed by Arizona law.

Effectiveness - No
There are no conclusive data to show that this supply may be developed and remain reliable throughout the project life.

Efficiency - No
Cost associated with the infrastructure to complete this alternative will likely be very high based on the potential reliability of the project.

Completeness – No
There are many unresolved issues associated with this alternative. The lack of important data required to make informed decisions regarding the potential for development of groundwater in this area causes this alternative to fail the completeness test.

Findings

This alternative failed all four tests and is not considered viable.

IV.B.1.6 Directional (Slant) Drilling into the Mogollon Rim -- Coconino/Supai or Redwall/Martin or X Aquifers

In general, wells in the Study area are drilled as vertical wells only. However, one can observe several springs that are exposed at different elevations along the south-face of the Mogollon Rim. The research and investigative work of the USGS and exploratory investigations of Payson's geological consultants have led many to conclude there is a vertical movement of groundwater from the Colorado Plateau down through the different geologic formations of the Mogollon Rim. Fossil Springs is an excellent example of the movement of groundwater from the Colorado Plateau into Fossil Creek. The existence of these springs has encouraged some communities along the Mogollon Rim to consider the possibility of directional drilling for developing a potable water supply. Directional drilling (sometimes known as slant drilling outside the oil industry) is the science and technology of drilling non-vertical wells. Slant drilling is a potential technology for developing groundwater resources in geologically inaccessible locations within the Study area, e.g., Strawberry and Pine.

The opportunity for communities within a given sub-regional area to use directional (slant) drilling as a method to capture a groundwater supply would generally be limited to those entities near the Mogollon Rim. The most likely entities that could consider directional drilling to develop a groundwater supply are those located in Sub-Region 1, Clusters 1, 2, and 3. All other Clusters are not located sufficiently near the Mogollon Rim to consider this alternative as a water supply option.

Analysis

Environmental Issues
Potential environmental issues include effects to springs and subsequent loss of downstream flow; potential impacts to federally protected fish species; and impacts to riparian habitat.

Legal and Institutional Issues
Water rights are always a primary concern and could be a restrictive factor. It is likely that any capture of flows from the Colorado Plateau would intercept groundwater flow to the springs at the face of the Rim. This may impact local streams that are fed from those springs and flow into the East Verde River, Fossil Creek, and/or Tonto Creek. Most of the land along the face of the Mogollon Rim is public land. All directional drilling programs on FS land would require a special use permit. Based on ongoing efforts by Payson to acquire a permit for an exploratory drilling program in the TNF, it is doubtful a special use permit would be issued for the development of a groundwater supply from a slant drilled well. Additionally, there is the legal issue associated with drilling across a great horizontal distance into the strata of a separate property.

Cost
Table IV.27 offers preliminary information regarding the probable costs of this groundwater option. Probable field costs per well are expected to be $1,000,000. The expected production rate from a directional well has been assumed to be at least 600 gpm. This Field Cost value is for example purposes only. There are too many variables in developing an alternative using this technology to obtain a more precise Field Cost estimate. Some examples of the variables involved in establishing a Field Cost for direction drilling include location, length of proposed directional drilling, equipment, power, and many other costs that would be established when a drilling site, well depth and length, and terminus have been established. Similarly, the production rate is taken on a probable low value since the production rate for a directional well may be higher or lower than the value chosen based upon the directional well's contact with the selected aquifer or aquifers.

Table IV.27 – Directional (Slant) Drilling – Joint-Use Water System Opportunities and Probable Drilling and Equipping Cost by Cluster/Group[5] (2,119 af/yr)

Joint Water Service System by Cluster/Group	Opportunity for Directional Drilling	2040 Low Water Demand Supply (acre-feet per year)	Number of Directional Wells @ 600 gpm	Probable Capital Costs ($)
Sub-Region 1				
1	Yes	1,947	2	2,000,000
2	Yes	172	1	1,000,000
3	Yes	59	0	0
4	No	45	0	0
5	No	225	0	0
6	No	286	0	0
Sub-Region 2				
None	No	3	0	0
Sub-Region 3				
7	No	128	0	0
8	No	105	0	0
9	No	112	0	0
Sub-Region 4				
None	No	0	0	0

The annual costs for directional drilling are shown in Table IV.28. Total annual cost is the sum of the annual amortization and the annual cost for operation and maintenance.

Table IV.28 – Direction Drilling Field Cost -- Annual Cost Summary -- Each Cluster/Group (2,119 af/yr)

Joint Water Service System	Annual Amortization Cost ($)	Annual O&M Cost ($)	Total Annual Cost ($)	Cost (AF/YR)	Cost (Kgal/YR)
1	158,800	160,000	318,800	164	0.50
2	79,400	80,000	159,400	927	2.84
All Other Clusters and Groundwater Systems	0	0	0	0	0

<u>Evaluation</u>

Acceptability - No
It is likely that this alternative would interfere with surface water rights and violate inter-basin groundwater regulations.

Effectiveness - No
This groundwater development method has not been tested in the Study area so its reliability is questionable.

Efficiency - No
The cost of this groundwater alternative far exceeds the costs for normal vertical well development. This alternative would only be considered efficient if all conventional methods of development were ruled out.

[5] For a more detailed description/explanation of the entities included in each Cluster/Group, see Section IV.B.1.2.

Completeness - No
There are many unresolved issues associated with this alternative. The lack of the important data required to make informed decisions regarding the potential for success using this drilling method within the Study area causes this alternative to fail the completeness test.

Findings

This alternative failed all four tests and is not considered viable.

IV.B.2 Surface Water Alternatives

IV.B.2.1 C.C. Cragin Reservoir – Town of Payson, Houston Mesa Road (FS 199)
With the passage of the AWSA, up to 3,500 af/yr of the C.C. Cragin Reservoir's water supply were made available to the water service providers in the Study area. Under this alternative, three options were evaluated that would deliver this water to the communities in the Study area. The first option where 3,000 af/yr, which has been designated for Payson, would be delivered and treated by Payson for use within its water service area. Payson has filed for the severance and transfer of water rights through ADWR, and has entered into an agreement with SRP regarding delivery of that water.

As discussed further below, the Study considered two options for distributing the remaining 500 af/yr. One option would deliver the water to communities located near or along Houston Road, which is the proposed route of Payson's proposed pipeline for delivering its C.C. Cragin supply. The other option would deliver the water to the Pine and Strawberry communities to assist with their water supply and reliability problems.

System Infrastructure
There are two major components to this alternative regardless of the option being considered: the existing C.C. Cragin water supply and delivery system, and a new water delivery and treatment system, including a buried pipelineline proposed to be constructed from the outfall of the C.C. Cragin system into the East Verde River to a a surface WTP proposed to be constructed near and connecting to Payson's existing distribution system.

Existing C.C. Cragin System
The C.C. Cragin Dam and Reservoir system lies within both the CNF (Coconino County) and TNF (Gila County) and occupies approximately 434 acres of land. The ownership of the C.C. Cragin Dam and Reservoir system has been transferred to the U.S. Government with Reclamation as the primary Federal agency having direct oversight. SRP is responsible for the operation and maintenance of this system. At this time, SRP has not yet established the final operating procedures and associated operation, maintenance, replacement, and rehabilitation costs for the C.C. Cragin Dam and Reservoir system. A description of the existing system infrastructure is provided in Section II.D.1.4

Town of Payson Pipeline

Payson's proposed C.C. Cragin water supply pipeline (16-inch diameter and 14.5 miles in length) and treatment system would connect to the C.C. Cragin Dam and Reservoir system to deliver 3,000 af to Payson, on average per calendar year. The pipeline would begin just downstream of the point where the C.C. Cragin pipeline ends at the hydropower plant at Washington Park, and would generally follow the Houston Mesa Road alignment (FS 199) south. Near the terminus of the Payson pipeline, a WTP (consisting of a membrane filtration plant with disinfection) would be constructed to treat the raw water to drinking water standards. The treated water would then be delivered into Payson's potable water distribution system.

Payson will take its C.C. Cragin water supply continuously over the 9 months that SRP proposes to deliver its water. During periods of low water demand, Payson expects any excess water would be used to recharge the local aquifer to facilitate operational flexibility.

Analysis

Environmental Issues
There are threatened and endangered species in the area that will require Federal protection. Additionally, there are federally identified archaeological sites scattered throughout the area that also will require protection or would need to be mitigated.

Legal and Institutional Issues
The Town of Payson will construct, own, and operate the pipeline extension and will have sole and absolute discretion regarding all decisions related to use of the pipeline and/or extension to deliver any Gila County allocated water to rural communities adjacent to the pipeline, or near the Town of Payson. Federal interest in this area is significant. Reclamation is the owner of C.C. Cragin Dam and Reservoir and transmission pipeline system. The infrastructure of this system has become a part of the SRP, which is the operating entity for the system, and holds the rights to the water captured and impounded in the reservoir. The C.C. Cragin Reservoir and Dam are located on the CNF, and the proposed water delivery pipeline would be located on the TNF which requires institutional coordination with both entities.

Cost
A preliminary engineering design and cost evaluation for the Payson pipeline system was developed by Black and Veatch for Payson and is provided in the 2006 Black and Veatch report, "Town of Payson: Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant." This report is included as Attachment 5 to this Report.

The summary of field costs for the Payson pipeline system to deliver water from the C.C. Cragin Reservoir to Payson is summarized in Table IV.29. The estimate includes costs for a raw water pipeline, WTP with disinfection and a storage facility, and appurtenances. The delivery pipeline from Washington Park would be a gravity flow system and no pumping stations are included in the estimate. The annual operating and maintenance costs are incorporated directly into the annual cost numbers.

Table IV.29 – C.C. Cragin Reservoir Alternative; C.C. Cragin Reservoir Raw Water Pipeline & Water Treatment Plant: Houston Mesa Road Alignment (3,000 af/yr) -- Construction Cost Summary; 1st Quarter 2008

Field Cost ($)	33,861,900
Annual Amortization Cost ($)	2,688,300
Annual Operation and Maintenance Cost ($)	2,708,900
Total Annual Cost ($)	5,397,200
Annual Cost per Acre-Foot ($/AF)	1,799
Annual Cost per 1,000 Gallons ($/Kgal)	5.52

Evaluation

Acceptability - Yes
Water rights associated with this option were outlined specifically in the AWSA.

Effectiveness - Yes
This alternative, based on its renewable water supply, is one of the few that can adequately address the issue of reliability of water supplies within the Study area.

Efficiency – Yes
Although the cost of this alternative is relatively high in comparison to some of the other alternatives, the fact that it represents a long term renewable and reliable supply makes it efficient.

Completeness – Yes
This alternative meets all of the criteria, including a water supply and infrastructure, capable of meeting long term water needs of Payson.

Findings

The C.C. Cragin Reservoir alternative is an excellent source of renewable water supply for Payson and the Tonto Apache Tribe. This water supply would furnish 3,000 af/yr with a reliability probability approaching 100 percent with respect to time. With this water supply, Payson will achieve the future water demand of 5,350 af/yr associated with a population of 40,000 in 2040. This alternative is considered viable for Payson.

IV.B.2.2 C.C. Cragin Reservoir Alternative – Unincorporated Communities, Houston Mesa Road (FS 199)

Under this option, the additional 500 af/yr of C.C. Cragin water would be used to supplement the water supplies of communities generally located along Houston Mesa Road. Payson's raw water pipeline would primarily follow the alignment of the Houston Mesa Road (FS 199) south to Payson. In order to accommodate the delivery of additional water to communities using Payson's proposed pipeline along its HoustonMesa Road alignment, Gila County as offered financial support to increase the pipeline diameter from 16 inches to 18 inches. There are several communities located along this road that have projected unmet 2040 water demands; because of their proximity to the main raw water line, these communities would have an opportunity to supplement their water supplies at a relatively reasonable cost, through the development of additional infrastructure built in conjunction with the main Payson pipeline. In addition, there are several other communities near Payson which might be able to supplement their existing supplies by tying into the new infrastructure. These opportunities were evaluated in a report for Gila County prepared by TetraTech entitled “Blue Ridge (C.C. Cragin) Reservoir Drinking Water Source Financial Feasibility Study.” That report is Attachment 6 to this Study Report. The following material is derived from that report.

Communities along Houston Mesa Road (FS 199) that TetraTech considered in its evaluations include: Washington Park, Rim Trail Estates, Verde Glen, Cowan Ranch, Shadow Rim Ranch Girl Scout Camp, Whispering Pines, Beaver Valley, Freedom Acres, Wonder Valley, and Mesa del Caballo. Additional communities, close to Payson, that TetraTech estimated could also be served by this option include Flowing Springs, Star Valley, Round Valley, and Oxbow Estates. Of all the above communities, this Study estimates that Shadow Rim Ranch Girl Scout Camp, Wonder Valley, and Cowan Ranch have sufficient existing supplies to meet future water needs in both the low and high demand scenarios.

The communities along Houston Mesa Road would need a total water supply of 453 af/yr to meet the future low demand scenario in 2040. The communities close to Payson that TetraTech also evaluated (Flowing Springs, Star Valley, Round Valley, and Oxbow Estates) would need a total water supply of 647 af/yr.

The additional 500 af/yr of C.C. Cragin water is not sufficient to satisfy the entire 2040 low water demand scenario for all the communities included in TetraTech’s study; however, since the water could potentially be available to any of the communities and to provide for a consistent cost analysis, this Study assumed this option could serve each community that was evaluated.

Analysis

Environmental Issues
There are threatened and endangered species in the area that will require Federal protection. There are federally identified archaeological sites scatter throughout the area that also will require protection or would need to be mitigated.

Legal and Institutional Issues
As the TetraTech report notes, the Town of Payson will construct, own, and operate the pipeline extension and will have sole and absolute discretion regarding all decisions related to use of the pipeline and/or extension to deliver any Gila County allocated water to rural communities adjacent to the pipeline, or near the Town of Payson. Federal interest in this area is significant. Reclamation is the owner of C.C. Cragin Dam and Reservoir and transmission pipeline system. The infrastructure of this system has become a part of the SRP, which is the operating entity for the system, and holds the rights to the water captured and impounded in the reservoir. The C.C. Cragin Reservoir and Dam are located on the CNF, and the proposed water delivery pipeline would be located on the TNF. Communities desiring to obtain rights to use a portion of the 500 af would need to enter into an agreement with SRP to clarify water rights transfer and water delivery and use agreement, and file for severance and transfer of water rights with ADWR.

Cost

Under this option a network of up to 18 relatively short pipelines would deliver water to the various communities identified below. These pipelines and their estimated cost are detailed in Table IV.30. All the costs are based on Tetra Tech Year 2006 construction cost estimates adjusted to 1st Qtr 2008 construction costs and processed through Reclamation's construction cost format and cost estimating methodologies for this Study, described in Section IV.B.

Table IV.30 – Summary of Estimates of Preliminary Cost of the Water Line Extensions – C.C. Cragin Reservoir Alternative – Houston Mesa Road (FS 199) Communities Option (500 af/yr)

Extension	Start	Terminus	Length (feet)	Diameter (inches)	Pump Stations	Segment Cost
Rim Trail DWID	Payson Pipeline	Rim Trail WTP	250	6	0	$ 96,700
Washington Park	Rim Trail WTP	Washington Park	2,500	6	1	$ 305,300
Verde Glen Extension	Rim Trail WTP	Verde Glen	7,800	6	0	$ 638,100
Cowan Ranch Extension	Verde Glen	Cowan Ranch	500	6	1	$ 102,800
Shadow Rim Ranch Extension	Verde Glen Extension	Shadow Rim GS Ranch	2,400	6	0	$ 295,600
Beaver Valley	Payson Pipeline	Beaver Valley	1,200	6	0	$ 185,000
Whispering Pines	Payson Pipeline	Whispering Pines	400	6	0	$ 209,500
Wonder Valley Extension	Payson Pipeline	Wonder Valley	50	6	0	$ 81,000
Sunflower (Mesa) Extension	Wonder Valley	Sunflower Mesa	200	6	0	$ 75,900
Freedom Acres Extension	Sunflower Mesa	Freedom Acres	800	6	0	$ 176,400
Mesa del Caballo	Payson Pipeline	Mesa Del Caballo	200	6		$ 56,900
E. Verde Main Pipeline Extension	Payson WTP	Split to E. Verde & Flowing Springs	14,800	8	0	$1,623,900
East Verde Estates Pipeline	E. Verde Main Pipeline	E. Verde Estates	4,500	6	0	$ 457,100
Flowing Springs Pipeline	E. Verde Main Pipeline	Flowing Springs	5,000	6	1	$ 571,900
Star Valley	Payson 260 Pipeline	Star Valley System	0	8	1	$ 621,600
Round Valley Main Pipeline Extension	Payson 260 Pipeline	Round Valley	9,800	8	1	$1,292,000
Round Valley Pipeline	RV Main Pipeline	Round Valley	4,500	8	1	$ 647,600
Oxbow Estates Pipeline	RV Main Pipeline	Oxbow Estates	6,650	6	1	$ 699,200
Totals			**61,550**			**$8,136,500**

* Source: Blue Ridge (C.C. Cragin) Reservoir Drinking Water Source Financial Feasibility Study, TetraTech, December 2007, 4th Quarter, 2007.

This option would also include a series of five WTPs, each of which would be positioned to serve several communities within close proximity to the plant. The TetraTech study has assumed that these plants would employ microfiltration followed by chlorination. Since water will only be provided to the Payson pipeline for 9 months a year, the finished water would be delivered to newly developed storage tanks located within each community for release into local distribution systems throughout the year. The communities of Star Valley, Round Valley, Oxbow Estates, East Verde Estates, and Flowing Springs are located downstream of the proposed Payson Pipeline terminus and WTP, so the additional water supply necessary to serve these communities would likely be obtained through the Payson WTP. The estimated costs of the five WTPs are detailed in Table IV.31.

Table IV.31 – Summary of Proposed Water Treatment Plants – C.C. Cragin Reservoir Alternative – Houston Mesa Road (FS 199) Communities Option

Plant #	WTP Location	Communities Served	WTP Capacity (kgal/year)	WTP Capacity (gpd)	Field Costs ($)
1	Rim Trail	Rim Trail, Washington Park, Verde Glen, Cowan Ranch, Shadow Rim Ranch	24,400	66,800	$ 250,100
2	Whispering Pines	Whispering Pines	21,600	59,100	$ 221,400
3	Beaver Valley	Beaver Valley	16,900	46,300	$ 173,200
4	Freedom Acres	Freedom Acres, Sunflower Mesa, Wonder Valley	2,100	5,700	$ 21,500
5	Mesa del Caballo	Mesa del Caballo	40,700	111,400	$ 417,200
6*	Payson	Oxbow Estates, Round Valley, East Verde Estates, Flowing Springs, Star Valley	152,237	417,090	$ 974,300
Totals			257,900	706,400	$ 2,058,000

*Additional capacity required for the Payson WTP

TetraTech's Study did not consider any costs related to delivery or connection fees that may be charged by the Town of Payson to Gila County or to other Town-approved users of the pipeline extension. These Town of Payson related charges would be an additional cost to the non-Payson users of the C.C. Cragin water.

Table IV.C.32 – County Communities along Houston Mesa Road – C.C. Cragin Reservoir Alternative Raw Water Pipeline Option – Field and Annual Cost

Water Service Area	Field Cost* ($)	Annual Amortization Cost ($)	Annual O&M Cost ($)	Total Annual Cost ($)	Annual Cost per Acre-Foot ($)	Annual Cost per 1,000 gallons ($)
Washington Park	377,400	30,000	30,200	60,200	12,040	36.95
Rim Trail Estates DWID	378,700	30,100	30,300	60,400	1,258	3.86
Verde Glen	887,300	70,400	71,000	141,400	3822	11.73
Cowan Ranch	124,800	9,900	10,000	19,900	2843	8.72
Shadow Rim Ranch GSA Camp	359,200	28,500	28,700	57,200	8,171	25.08
Whispering Pines	590,500	46,900	47,200	94,100	1,272	3.90
Beaver Valley	489,400	38,800	39,200	78,000	690	2.12
Freedom Acres	168,400	13,400	13,500	26,900	3,843	11.79
Wonder Valley	98,500	7,800	7,900	15,700	1,962	6.02
Mesa del Caballo	702,000	55,700	56,200	111,900	761	2.34
East Verde Estates	765,700	60,800	61,200	122,000	1,544	4.74
Flowing Springs	763,800	60,600	61,100	121,700	4,681	14.36
Town of Payson	33,861,900	2,688,300	2,708,900	5,397,200	1,799	5.52
Town of Star Valley	344,100	27,300	27,500	54,800	108	0.33
Round Valley	2,313,600	183,700	185,200	368,900	4,723	14.50
Oxbow Estates	868,000	68,900	69,400	138,300	4,068	12.48
Total	**43,093,300**	**---**	**---**	**----**		

*Field Costs developed by TetraTech and are adjusted to 1st Qtr 2008

Evaluation

Acceptability - Yes
Water rights associated with this option were outlined specifically in the AWSA.

Effectiveness - Yes
This alternative, based on its renewable water supply, is one of the few that can adequately address the issue of reliability of water supplies within the Study area.

Efficiency – Yes
Although, the cost of this alternative is relatively high in comparison to some of the other alternatives, the fact that the main distribution pipeline is likely to be

built for Payson makes it a more reliable and affordable supply for the surrounding unincorporated communities.

Completeness – Yes
This alternative meets all of the criteria, including a water supply and infrastructure, capable of meeting long-term water needs for the communities in close proximity to the Payson Pipeline alignment.

Findings
Upsizing Payson's pipeline would provide the means to deliver the additional 500 af/yr to communities in close proximity to Payson and along Houston Mesa Road. Currently, Gila County has committed to upsize the pipeline to 18 inches in order to ensure additional capacity is available for County communities.

This alternative appears to be viable for further consideration. It should be considered as a reliable and sustainable project for the development of a water supply for Payson and other communities along the Houston Mesa Road (FS 199).

IV.B.2.3 C.C. Cragin Reservoir – Pine/Strawberry Extension Option
Under this option, the additional 500 af/yr of C.C. Cragin water would be used to supplement the water supplies of communities of Pine and Strawberry via a 15.2-mile pipeline. This pipeline would split off from the main Payson raw water pipeline approximately at the junction of Houston Mesa Road (FS 199) and the Control Road (FS 64); it would then run west along Control Road (FS64) to the intersection of Arizona State Route 87; it would then run northwest along State Route 87, terminating at a new WTP in Pine. The extension pipeline would be 8 inches in diameter and require three pump stations to convey the water from the Payson pipeline to the termination point at the Pine WTP. The WTP would utilize a microfiltration process.

Note: Alternative pipeline routes could be proposed and be the subject of further study. An early Reclamation study concerning a diversion directly from the top of the Mogollon Rim into Pine Canyon could be re-visited in the future. Such pipeline routes to Pine / Strawberry may yield different conclusions.

As previously discussed in Section III.B.1, there are seven water providers within the Pine and Strawberry communities: the Pine Water Company (Brooke) and four DWIDs (Solitude Trails, Strawberry Hollow, Pine Water Association, and Pine Creek Canyon) in Pine; and Strawberry Water Company (Brooke) and Strawberry Water Company (Hunt) in Strawberry. Of these water providers, the Pine Water Company (Brooke) could use the entire new 500 af/yr water supply and still fall short of meeting its projected unmet demands in 2040. As previously noted, under its current water sharing agreement with Pine Water Company, once the last lot is sold by the developer in Solitude Trails, residents in the Solitude Trails community will have their water delivered by the Pine Water

Company and the deep production well will become the property of Pine Water Company (Brooke); therefore, Solitude Trails will not require a future supply.

Analysis

Environmental Issues

There are threatened and endangered species in the area that will require Federal protection. Additionally, there are federally identified archaeological sites scatter throughout the area that also will require protection or would need to be mitigated.

Legal and Institutional Issues

Federal interest in this area is significant. Reclamation is the owner of C.C. Cragin Dam and Reservoir and transmission pipeline system. The infrastructure of this system has become a part of the SRP, which is the operating entity for the system, and holds the rights to the water captured and impounded in the reservoir. The C.C. Cragin Reservoir and Dam are located on the CNF, and the proposed water delivery pipeline would be located on the TNF. In addition, the Tonto Apache Tribe and Pine Water Company could be recipients of exchange waters to provide them with their CAP water allocations. Communities desiring to obtain rights to use a portion of the 500 af would need to enter into an agreement with SRP to clarify water rights transfer and water delivery and use agreement.

Cost

The preliminary engineering design and cost evaluation for the Pine Extension pipeline was developed by Black and Veatch for inclusion in its 2006 report, "Town of Payson: Blue Ridge Reservoir Water Supply Pipeline and Treatment Plant." This report is included as Attachment 5. Table IV.33 presents the field cost summary for the Pine Extension raw water pipeline, WTP, and appurtenances to deliver C.C. Cragin reservoir water to the Pine community.

Table IV.33 – C.C. Cragin Reservoir Alternative -- Annual Cost Summary: Pine Extension Raw Water Pipeline, Water Treatment Plant and Appurtenances; (500 af/yr)

Field Cost ($)	21,663,600
Annual Amortization Cost ($)	1,719,900
Annual Operating Cost ($)	1,733,100
Total Annual Cost ($)	3,453,000
Annual Cost per Acre-Foot ($/AF)	6,906
Annual Cost per 1,000 Gallons ($/Kgal)	21.19

Note: Field costs prepared by Black & Veatch, and are adjusted to 1st Quarter 2008.

Evaluation

Acceptability - Yes

Water rights associated with this option were outlined specifically in the AWSA.

Effectiveness - Yes
This alternative, based on its renewable water supply, is one of the few that can adequately address the issue of reliability of water supplies within the Study area.

Efficiency – Yes
Although, the cost of this alternative is relatively high in comparison to some of the other alternatives, the fact that it provides a renewable and reliable supply for the Pine and Strawberry communities makes this alternative efficient.

Completeness – Yes
This alternative meets all of the criteria, including a water supply and infrastructure, capable of meeting long-term water needs for the Pine and Strawberry communities.

Findings
Although this alternative does not include a joint use pipeline which would help reduce costs, the alternative should be considered to be viable for further consideration. It is capable of providing a reliable and sustainable project for the development of a water supply for the Pine and Strawberry communities.

IV.B.2.4 Central Arizona Project Allocation and Exchange Alternative

CAP water potentially available for use within the Study area includes 161 af/yr transferred from the E&R Water Company to Pine Water Company (Brooke) in 1999, and the Tonto Apache Tribe's CAP allocation of 128 af/yr. Because CAP water is not physically available for delivery to the Study area, the Tonto Apache Tribe and the Pine Water Company would have to execute exchange agreements with parties that hold both water rights within the Study area and are able to receive CAP water deliveries at their facilities, e.g., SRP.

Water delivered by the CAP is considered to be reliable. Both the Pine Water Company (Brooke) and the Tonto Apache Tribe are expected to be included within the highest priority CAP water delivery scheme. The Pine Water Company's (Brooke) 2040 low demand is 1,128 af/yr. The annual CAP water supply would therefore provide slightly over 14 percent of this total water demand. Additionally, the CAP water supply could improve the current Tonto Apache Tribe's water supply situation.

Two options for exchange were investigated for the Tonto Apache Tribe; (1) The Tribe could exchange and import water from Roosevelt Lake and (2) The Tribe could import water through the Payson pipeline from C.C. Cragin Reservoir. Likewise, two options for exchange were investigated for the Pine Water Company; (1) Pine Water Company (Brooke) could import water via a pipeline from C.C. Cragin Reservoir, and (2) The Pine Water Company (Brooke) could divert water from Pine Creek in an exchange with SRP.

In December 1992, Gookin Engineers prepared an estimate for the probable cost of a pipeline to deliver CAP exchanged water to Payson which is located adjacent to the Tonto Apache Reservation. The report gave some detail of the infrastructure expected to be used to deliver wet CAP water to the Payson area. The CAP water delivery system from Roosevelt Lake consisted of an intake facility/well, raw water pipeline, two pump stations, one WTP, a treated water storage tank, powerline construction, operation and maintenance equipment, and a recharge facility. The CAP pipeline would follow the rights-of-way for State Routes 188 and 87.

A C.C. Cragin option could include exchange water from the C.C. Cragin Reservoir project to each of the CAP entitlement holders.[6] The diversion of Pine Water Company's CAP exchanged water from C.C. Cragin Reservoir could come down the East Verde River and be diverted near East Verde Estates and State Route 87. The raw water pipeline would follow in the right-of-way of State Route 260 and terminate near where State Route 260 and the Pine Creek bridge crossing are located. The system would include a diversion structure and pumping plant, one pumping station, and a WTP. The diversion for the Tonto Apache Tribe could be delivered through an upsized Payson Pipeline.

The Pine Creek option would allow the Pine Water Company (Brooke) to divert water directly from Pine Creek in Pine. This option is less reliable than the first three options discussed above. Surface water flow in Pine Creek is ephemeral and unquantified. The flow in this creek is from seasonal snow melt with occasional flows from summer precipitation events. There are little or no long-term hydrologic surface water flow data for this creek so there is uncertainty as to its effectiveness to deliver the Pine Water Company's (Brooke) CAP water supply allocation.

Analysis

Environmental Issues

There are threatened and endangered species and federally identified archeological sites scatter throughout the area that will require protection or would need to be mitigated.

In addition to environmental issues related to impacts within the Study area, any impacts resulting from the exchange agreement (e.g., impacts from diverting water within the Study area and any impacts associated with subsequent reduction in downstream flow) would need to be considered.

Legal and Institutional Issues

Currently, there are no ongoing or pending political activities with respect to this alternative in the Study area. Any proposed exchange must be consistent with the

[6] Refer to the C.C. Cragin Reservoir alternative for a statement of the probable cost to bring water to the Tonto Apache Tribe and the Pine Water Company (Brooke).

laws of the state of Arizona and all appropriate Federal laws, including those for CAP water service contracts/subcontracts. Because SRP holds most of the water rights to flows of the East Verde River and Tonto Creek on both the Verde and Salt Rivers, including nearly all of the surface water runoff from the Study area, SRP would be the probable exchange party with which an exchange agreement would need to be formalized.

If this project were to go forward, the implementing parties would be required to interact with one or more of the following entities: CAP, SRP, Reclamation, FS, FWS, ADOT, ADEQ, ADWR, AZGFD, Gila County, and private land owners.

Cost – Tonto Apache Tribe, CAP - Roosevelt Lake Diversion
In the 1992 Report, 3rd quarter, 1992, Gookin estimated the Field Cost for the Roosevelt pipeline system at nearly $41,000,000. Updating the Field Cost to 1st quarter 2008 Reclamation Construction Cost Trends would result in a new Field Cost that would be greater than $101,000,000.

Table IV.34 – The Tonto Apache Tribe, Central Arizona Project Water – Roosevelt Lake Diversion and Delivery Option; Construction Cost Summary: Raw Water Pipeline, Water Treatment Plant and Appurtenances (128 af/yr)

Central Arizona Project Water Only	Cost ($)
Field Cost	101,581,400
Annual Amortization)	8,064,600
Annual Operation and Maintenance Cost	8,126,500
Total Annual Cost	16,191,100
Annual Cost per Acre-Foot	126,493
Annual Cost per 1,000 gallons	388.19

Evaluation

Acceptability - Yes
Though complicated, the physical exchange of surface water could comply with Arizona laws.

Effectiveness - Yes
This potential project has the capability of delivering a reliable source of water.

Efficiency – No
This alternative is not efficient based on the very high cost in comparison to other sources.

Completeness - Yes
This alternative meets all of the criteria for delivering a long-term reliable supply.

Findings

Based on the very high cost of this alternative, it is not efficient and therefore not viable.

Cost – Tonto Apache Tribe, CAP – C.C. Cragin Reservoir Diversion
The pipeline outlined in IV.B.2.1 the C.C. Cragin Reservoir – Payson is capable of delivering the 128 acre feet of increased capacity for the Tonto Apache Tribe. Infrastructure and annual operation and maintenance costs associated with the delivery of exchange water would need to be negotiated between Payson and the Tribe. Table IV.35 below assumes costs to the Tribe were based strictly on the proportion of water delivered through the system.

Note: This cost allocation method was assumed only for estimating preliminary field costs and may not represent a preferred method for either party.

Table IV.35 – The Tonto Apache Tribe, Central Arizona Project Water – C.C. Cragin Reservoir Diversion and Delivery Option; Construction Cost Summary (128 af/yr)

Central Arizona Project Water Only	Cost ($)
Field Cost	1,385,700
Annual Amortization)	110,000
Annual Operation and Maintenance Cost	110,900
Total Annual Cost	220,900
Annual Cost per Acre-Foot	1,726
Annual Cost per 1,000 gallons	5.30

Evaluation

Acceptability - Yes
The physical exchange of surface water could comply with Arizona laws.

Effectiveness - Yes
This potential project has the capability of delivering a reliable source of water.

Efficiency – Yes
There could be a significant advantage in cost in partnering with another water user in the capital and long term operation and maintenance costs of this system.

Completeness - Yes
This alternative meets all of the criteria for delivering a long term reliable supply.

Findings

This alternative meets all of the evaluation criteria and is, therefore, viable.

Cost – Pine Water Company, CAP – C.C. Cragin Reservoir Diversion

The probable cost for diverting water from C.C. Cragin via the East Verde River has been offered in Table IV. 36 below.

Table IV.36 – Pine Water Company, Central Arizona Project Water – C.C Cragin Reservoir (East Verde River) Diversion and Delivery Option; Construction Cost Summary: Raw Water Pipeline, Water Treatment Plant and Appurtenances (CAP waters and C.C. Cragin Exchange – 661 af/yr)

Description	Field Cost ($)	Annual Amortization Cost ($)	Annual Operation and Maintenance Cost ($)	Annual Cost ($)	Cost ($/AF)	Cost ($/Kgal)
CAP only - 161 af/yr	15,680,200	1,150,000	1,254,400	2,404,400	14,934	45.83
CAP & C.C. Cragin Reservoir - 661af/yr	23,834,700	1,897,245	1,906,800	3,804,000	5,755	17.66

Evaluation

Acceptability - No
Portions of the East Verde River are designated as wild and scenic and there could be significant environmental issues associated with the diversion of water there.

Effectiveness - Yes
This potential project has the capability of delivering a reliable source of water.

Efficiency – No
This alternative is not efficient based on the very high cost in comparison to other sources.

Completeness - Yes
This alternative meets all of the criteria for delivering a long-term reliable supply.

Findings

Based on the very high cost and potential environmental issues, this alternative is not acceptable or efficient and therefore is not viable.

Cost – Pine Water Company, CAP – Pine Creek Diversion
The probable cost for diverting water from Pine Creek has been offered in Table IV.37 below.

Table IV.37 – Pine Water Company, Central Arizona Project Water – Pine Creek Diversion and Delivery Option; Construction Cost Summary: Raw Water Pipeline, Water Treatment Plant and Appurtenances (CAP waters only – 161 and 661 af/yr)

Description	Field Cost ($)	Annual Amortization Cost ($)	Annual Operation and Maintenance Cost ($)	Annual Cost ($)	Annual Cost ($/AF)	Annual Cost ($/Kgal)
CAP only - 161af/yr	2,885,000	229,000	230,800	459,800	2,856	8.76
CAP & C.C. Cragin Reservoir- 661 af/yr	10,156,000	806,300	812,500	1,618,800	2,449	7.52

Evaluation

Acceptability - No
There could be significant environmental issues associated with the diversion from Pine Creek.

Effectiveness – No
There may be long-term issues with reliability of water in Pine Creek.

Efficiency - Yes
Because the point of diversion is in Pine, the cost of this alternative is more reasonable than a pipeline alternative.

Completeness - No
Because the source of water is not reliable, this alternative is not complete.

Findings

With the lack of long-term hydrologic surface water flow data for this creek and potential environmental effects from surface water diversions, this alternative is not acceptable, effective, or complete and, therefore, is not viable.

IV.B.2.5 Fossil Springs – Regional Alternative

Unlike most alternatives considered in this Study, this alternative has the potential to provide sufficient and reliable water supply to all water service systems within the Study area. For the purposes of designing the delivery infrastructure for this alternative, the Study area was divided into zones: Zone One – along and west of the Houston Mesa Road (FS 199) and Zone Two -- east of the Houston Mesa Road (FS 199) and the east of Star Valley on Highway 260.

Zone One includes the unincorporated communities of Pine and Strawberry, Geronimo Estates, Rim Trail Estates, Verde Glen, Cowan Ranch, Whispering

Pines, Beaver Valley, Wonder Valley, Freedom Acres, and Mesa del Caballo, and the Towns of Payson and Star Valley (including Diamond Point Shadows). While not as economically cost-effective to include in an alternative, Oxbow Estates and Round Valley, located south of Payson could potentially be included in Zone One. Several of the listed communities may be served by a private water company.

Four communities west of Houston Mesa Road (FS 199) were noted to have no relationship with one another or are not in close proximity to the Control Road (FS 64) and were not included in the grouping associated with Zone One. The four communities are Arrowhead Canyon, East Verde Estates, Flowing Springs, and Summit Springs. If additional water supplies are required in the future, it is expected these four communities would continue with or expand either their current groundwater or surface water operations.

Zone Two includes the unincorporated communities of Bear Flat, Bonita Creek Estates, Collins Ranch, Diamond Point Recreation, Ellison Creek Estates, Ellison Creek, Hunter Creek**,** Kohl's Ranch, Mead Ranch, Tonto Creek Estates Water Company, Tonto Village, Christopher Creek Haven Water Company, Thompson Draw I and II, Wood Canyon Ranch, and Zane Grey Meadows.

Fossil Springs System Infrastructure - Location and Alignment

Water for this alternative would be diverted from Fossil Springs at the location of the now decommissioned and partially removed Fossil Springs Diversion Dam.[7] The Fossil Springs raw water pipeline (pipeline) would follow the hiking trail to FS 708; the pipeline would then follow the alignment of FS 708 until it reaches the community of Strawberry. At Strawberry, the pipeline would be located in the right-of-way of Highway 87 until the pipeline could turn easterly and go along Control Road (FS 64) to Houston Mesa Road (FS 199). The flow in the Fossil Springs pipeline, at this junction, could be split into three directions; northward, southward, and eastward. The engineering cost estimate shown below only considers the design cost from Fossil Springs to the junction of the Fossil Springs pipeline with Houston Mesa Road (FS 199). The pipeline cost for this specific section is quite high. As a result, no effort was made to determine the cost of water service extensions from the Houston Mesa Road (FS 199) junction toward the north and east, as the incremental costs for these pipeline extensions are expected to add substantially to the cost already incurred by bringing the pipeline to the Houston Road intersect.

The infrastructure system has been designed to provide water to those parties within Zones One and Two as defined above. While Fossil Springs has more than enough annual flow to provide a source of water to all water service providers in the Study area, no attempt was made to estimate infrastructure cost to the four communities between Pine and Payson that could not efficiently and economically be included into Zone One (Arrowhead Canyon, East Verde Estates, Flowing Springs, and Summit Springs).

[7] Dam removal to be completed by June 30, 2010.

To design the pipeline capacity, the total 2040 low water demand scenario for the Study area, excluding the noted four communities, was used. The total capacity for these communities would need to be 9,722 af/yr, or 13.4 cfs.

The proposed pipeline diameter would be reduced after the deliveries to Pine, Strawberry, Geronimo Estates, and Camp Geronimo. The design flow of the pipeline at the junction of Control Road (FS 64) and Houston Mesa Road (FS 199) was determined to be 98 af/yr or 0.1 cfs to the north (Washington Park, Rim Trail DWID, Shadow Rim Ranch Girl Scout Camp, Verde Glen, and Cowan Ranch), 740 af/yr or 1.0 cfs to the east (Bonita Creek, Ellison Creek Recreation, Ellison Creek Estates, Diamond Point Recreation, Zane Grey Meadows, Collins Ranch, Mead Ranch, Tonto Village Water Company, Thompson Draw I and II, Wood Canyon Ranch, Kohl's Ranch, Tonto Creek Estates Water Company, Bear Flat, R Bar C Boy Scout Camp, Christopher Creek Haven Water Company, and Hunter Creek), and 6,844 af/yr or 9.5 cfs to the south (Whispering Pine, Beaver Valley, Wonder Valley, Freedom Acres, Mesa Del Caballo, Payson, Star Valley [Diamond Point Shadows], Round Valley, Oxbow Estates).

Because the annual volumes to the north and east are small, quantities and cost estimates were not generated. The pipeline estimates, therefore, only include sections from the intake at Fossil Creek through Pine and Strawberry and across Control Road (FS 64) to the junction of FS 64 and Houston Mesa Rd. (FS 199) and then continuing south to the communities described above.

***Note*: For the purpose of consistency in the development of construction cost estimates, design data and cost information that were developed for Payson and the Pine Water Company by Black and Veatch, were either directly used to determine engineering cost or to develop cost adjustments to the engineering cost estimates. In addition, final field cost estimates were made in accordance with Reclamation's appraisal cost-estimating procedures. These cost estimates will vary, but have their basis, from those provided by Black and Veatch in its engineering cost analysis.**

Pumping Plant and Pumping Stations

A Fossil Springs pumping plant with intake structures would withdraw water from Fossil Creek. In addition to the intake structure, six pumping facilities would be required to move water from Fossil Springs to the junction of Control Road (FR 64) and the Houston Mesa Road (FS 199). Field costs for this alternative are provided from Fossil Springs to the system's intersection with Houston Mesa Road and on into the Town of Payson.

Additional pumping stations would be required to move the Fossil Springs water to the north and to the east. Water flowing south would probably be by gravity. No pumping stations were placed in the pipeline going toward Payson.

Water Treatment Plants

As part of this alternative, a regional WTP is proposed to be located in Strawberry to treat the raw water supply coming from Fossil Springs. By placing the WTP in Strawberry, all communities being served by the Fossil Springs raw water pipeline would receive treated water. The regional WTP would be sized to treat 9 mgd.

The plant would be similar to the type of WTP proposed for Payson's WTP which would receive C.C. Cragin reservoir water (as discussed in a subsequent alternative below), using a microfiltration process followed by disinfection. On-site storage also would be included at the WTP as determined by operational considerations.

Analysis

Environmental Issues

Fossil Creek provides outstanding riparian and aquatic habitat for a variety of fish and wildlife. It has one of the few reproducing populations of the sensitive lowland leopard frogs on the CNF and has the highest population density on the Forest. Fossil Creek also provides habitat for five native fish species and a portion of the Creek has been designated as critical habitat for two additional native fish species. Native fish are now found throughout theCreek since a native fish restoration project was conducted during the fall of 2004.[8]

The following federally listed threatened, endangered, proposed, or candidate species may occur in the vicinity of Fossil Creek: bald eagle (threatened), Mexican spotted owl (threatened), southwestern willow flycatcher (endangered), Yuma clapper rail (endangered), yellow-billed cuckoo (candidate), razorback sucker (endangered), Colorado pikeminnow (endangered), loach minnow (threatened), spikedace (threatened), Chiricahua leopard frog (threatened), and Arizona agave (endangered).

There are several special resource areas within the Fossil Creek watershed. Fossil Creek flows through the Fossil Springs Wilderness Area (which is 11,550 acres in size), from the confluence of Sand Tank and Calf Pen Canyons downstream to Fossil Springs. The Fossil Springs Botanical Area is adjacent to the Fossil Springs Wilderness Area. It is a 20-acre site that contains Fossil Springs and an associated riparian deciduous forest. Described as one of the most diverse riparian areas in the state, it provides a striking contrast to the surrounding desert shrub zone, and supports over 30 species of trees and shrubs. The vegetative diversity creates many wildlife niches for deer, javelina, and 100 species of birds. Fossil Creek also flows within the Mazatzal Wilderness from a short distance

[8] During late Fall 2004, a fish renovation project commenced. Reclamation, in cooperation with the FWS, AGFD, and FS, constructed a fish barrier approximately 5 miles upstream from the confluence with the Verde River.

below the confluence with Sally May Wash, until its confluence with the Verde River. The boundary of the Mazatzal Wilderness follows the "thread of Fossil Creek" from near Irving to Sally May Wash.

Fossil Creek has been found to be eligible for designation as a Wild and Scenic River because of its outstanding remarkable values. Fossil Creek enters the boundary of the Verde Wild and Scenic River one-quarter mile east of the Verde River. Legislation has been offered to both houses of Congress (January 2009) to designate Fossil Creek as a Wild and Scenic River (Fossil Creek Wild and Scenic River Act of 2007). The proposed legislation includes the following sections of Fossil Creek:

- Upper Fossil Creek - from the source at Fossil Springs below Sand Rock and Calf Pen Canyons to where the water leaves the Fossil Spring Wilderness Area, as a wild river;

- Middle Fossil Creek - from the border of the Fossil Spring Wilderness Area to the Mazatzal Wilderness Boundary, as a scenic river; and

- A 6.6-mile segment from the Mazatzal Wilderness Boundary down to the confluence with the Verde River, as a wild river.

Ecological Restoration

As noted in Section II.D.1.1, APS entered into a Settlement Agreement with the FS, FWS, and other environmental parties to surrender its FERC license to operate hydroelectric electric facility (Irving/Childs) and remove facilities and restore the area in and near this electric facility. Implementation of that agreement is underway and full flows were returned to Fossil Creek on June 18, 2005.

The key restoration actions for Fossil Creek as a result of Childs-Irving decommissioning are restoration of the 46-cfs baseflow and lowering the crest of the Fossil Springs Diversion Dam by 14 feet. As a direct result of these actions the riparian corridor will be restored, including the restoration of the travertine pool and dam complexes.

Legal and Institutional Issues

Fossil Springs is an excellent source of large quantities of water, but water from the springs is not available as a developable supply. APS' power generation permits from FERC did not allow for water consumption and, as part of the Settlement Agreement, APS must return full flows to Fossil Creek. Under the Settlement Agreement, APS also must transfer its water rights to the FS; however, specifics of Arizona water law may make this transfer difficult.

The return of the previously diverted flows from Fossil Springs back to Fossil Creek is being used to restore and enhance environmental habitat and riparian areas, to preserve instream flows for the benefit of establishing travertine dam and deposits, to enrich a popular recreation area, and to provide sufficient flow conditions for native fish.

In addition to the APS water right for power generation, there are several other water rights and claims within the Fossil Creek watershed. These include water right claims ("38's") for stock ponds, water rights (certificates) for domestic use from springs in the watershed for use at APS' employee housing, and water rights claims ("36's") for instream livestock use by grazing permittees.

There are also downstream water rights that rely on water discharged from Fossil Creek. Fossil Creek is a tributary to the Verde River, which is impounded by Horseshoe Reservoir and Bartlett Lake below the confluence with Fossil Creek for use by downstream water right holders. Downstream appropriators include SRP, Fort McDowell Indian Tribe, and cities within the Phoenix metropolitan area. The Tonto, Coconino, and Prescott National Forests also have an instream flow water right certificate for a reach of the Verde River that extends above and below the confluence with Fossil Creek.

Additionally, the FS applied for an instream flow water right on December 1, 1999, and seeks to acquire rights to a total volume of 33,300 af/yr. The reach included within the instream flow application begins above Fossil Springs, approximately one-half mile above the Fossil Springs Diversion Dam, and extends to the confluence of Fossil Creek with the Verde River. The short reach of Fossil Creek that flows through private property is excluded from the claimed reach.

The Fossil Creek instream flow appropriation sought by the FS would not have a detrimental effect upon valid, existing, senior surface water rights because the appropriation is for an in-situ, non-consumptive use that would not reduce water available to these water right holders.

Cost

The summary of construction cost, Table IV.38, shown below includes one pumping plant, five pumping stations, one regional WTP, a storage facility, and appurtenances. The total annual cost is comprised of the annual amortization and annual operating and maintenance costs. The annual cost per af and 1,000 gallons is based upon the initial total 2040 low water demand of 9,731 af/yr year for all communities in the Study area.

Table IV.38 – Fossil Springs Alternative – Field and Annual Cost Summary (9,731 af/yr)

Description	Cost ($)
Probable Field Cost	99,106,300
Annual Amortization Cost	7,868,000
Annual Operation & Maintenance Costs	7,928,500
Total Annual Cost	15,796,500
Annual Cost per Acre-Foot	1,623
Annual Cost per 1,000 Gallons	4.98

Evaluation

Acceptability - No
Water rights and environmental issues cause this alternative to be unacceptable.

Effectiveness - Yes
Fossil Springs provide a reliable and consistent source of water that could meet the water demands for the entire Study area.

Efficiency - No
Although a design to deliver water to all the potential communities in the entire Study area was not fully developed, the initial costing of the primary trunk line was relatively
expensive when compared to the cost of the C.C. Cragin Reservoir pipeline to Payson.

Completeness – No
Lack of water rights and environmental concerns and constraints on this water supply make this alternative incomplete.

Findings

Based upon the potential for significant conflicts and preexisting constraints; this source of water is not considered to provide a viable solution to the water demand needs of the water service providers in the Study area.

IV.B.2.6 Regional and/or Local Off-Stream Storm Water Runoff Collection and Storage Alternative

In this alternative, storm water runoff would be captured and used to recharge the local aquifer. In 1992, Gookin Engineers evaluated this concept in a report assessing the reliability of Payson's groundwater supply. In its report, Gookin estimated the probable annual volumes of storm water runoff that could be captured as a source of renewable water supply to be nearly 3,000 af in a normal year and 1,300 af in a dry year. This annual storm water runoff was estimated over five sub-watersheds (19.5 square miles) within the corporate boundaries of

Payson. This resource would need to be managed under a prescribed conjunctive water resource management concept, and would only be for the benefit of Payson.

Significant issues associated with this alternative include:

- The lack of a reliable and sustainable source of surface water
- Water rights
- Climate and precipitation variability (e.g., drought)
- Habitat protection issues
- Water quality management issues -- non-point source pollution
- Required water treatment and potentially limited acceptable uses of this water supply
- Location of on-stream and/or off-stream storage sites
- Other required infrastructure systems – pump stations, raw water pipelines, water treatment systems, points of entry and use, distribution systems, and energy systems
- All forms of economic development (e.g., residential subdivisions and commercial building), that would inhibit the runoff from being recharged or creating an increase in off-site pollution
- Environmental and ecological concerns

Analysis

Environmental Issues

Of the above issues, water quality must be given very careful consideration. Water quality associated with urban runoff has been known to carry with it significant contaminants that must be treated and disposed of prior to any form of potential reuse. These are no local data available to define the type, concentration, and impacts of urban runoff water quality constituents at this time. Additional research and data collection should be performed before further development of this alternative could be developed and evaluated.

Legal and Institutional Issues

If this project is to go forward, the implementing parties would be required to either interact or consult with one or more of the following entities: SRP, FS, FWS, ADOT, ADEQ, ADWR, AZGFD, Gila County, and private land owners. Any activities associated with developing and/or implementing this alternative must comply with the laws of both the State of Arizona and United States. Since runoff is generally a surface water condition, it would be expected that surface water right laws would be given the highest consideration regarding this type of water supply. SRP's water rights would have to be protected.

Cost

System components could include runoff storage units, water treatment facilities, pump-back stations, transmission pipeline, and treated water storage. If the water is not treated to potable standards, it may be possible to treat it to some lesser quality so that it can be used for non-potable purposes, such as for irrigation, fire protection, or habitat mitigation. Because there are so many uncertainties associated with this alternative, costs were not evaluated.

Evaluation

Acceptability - No

This alternative does not meet the acceptability criterion because of the many legal and institutional issues involved.

Effectiveness - No

There are insufficient existing data to determine the effectiveness of this alternative.

Efficiency - No

There was insufficient data to adequately evaluate costs.

Completeness - No

Based on potential issues with environmental criteria and water rights, this alternative is not complete.

Findings

At this time this, due to the substantial number of uncertainties and on-site issues as identified above, this alternative fails the completeness test, is considered non-viable, and was not further evaluated in this Study. Should these uncertainties/issues be resolved, this alternative could perhaps be considered a component to a local water supply. However, as noted above, any water supply developed through such an alternative could only be used to help address the needs of Payson. The use of storm water as a water supply is not considered to be a viable alternative.

IV.B.3 Effluent

Because there are very few wastewater treatment plants, effluent is not expected to be a significant alternative water supply for any community in the short-term within the Study area except for the Town of Payson. Payson is served by a sewerage system that delivers its waste water to wastewater treatment facilities owned and operated by the North Gila County Sanitary District. All of the effluent generated from the Town of Payson is treated and owned by the North Gila County Sanitation District. Payson currently receives a portion of the effluent generated by the District's treatment plant (approximately 336 af/yr [including recharge]). That effluent is delivered to an artificial recharge system at the Green Valley Park lakes. With respect to future use of effluent by Payson, the Town has not sought to formally secure portions of the projected future effluent supply (2008). It may choose to do so in the future.

Assuming that, in the future, more entities will develop wastewater treatment facilities, the future production of effluent could be expected to be contracted, stored, and delivered for the purpose of irrigating public properties (cemeteries, school grounds, and sports fields) and public and private golf courses. The use of effluent for these specific purposes reduces the direct impact of water demands on groundwater supplies. The expected total volume of effluent available for Payson from full build-out condition, 2040, (assuming 35 percent recapture) could be somewhere around 2,100 af/yr.

Recharge and reuse system components could include runoff storage units, water treatment facilities, pump-back stations, transmission pipeline, and treated water storage. In 2040, it is expected that effluent will still be contracted out for irrigation and recharge purposes. In addition, effluent may be used to conserve potable supplies through recharge to reinforce drought sensitive groundwater supplies. If the water is not treated to potable standards, it may be possible to treat it to some lesser quality so that it can be used for non-potable purposes, such as for irrigation, fire protection, or habitat mitigation.

Analysis

Environmental Issues

There are a number of environmental issues associated with effluent recharge and reuse. These issues include health and safety hazards and risks, impacts on aquatic ecology, and impacts on groundwater and surface water quality.

Legal and Institutional Issues

Some of the legal and institutional issues associated with this alternative include water rights, wastewater discharge regulations, and issues with public perception.

Cost

In order to develop costs for this alternative it would be necessary to know which communities are planning to develop waste water treatment and reuse systems. Cost would likely vary based on the size of each system and could be largely influenced by the coordination of regional systems. More data are necessary to adequately address costs.

Evaluation

Acceptability - No

This alternative does not meet the acceptability criterion because of the many legal and institutional issues yet to be resolved.

Effectiveness - No
There are insufficient existing data to determine the effectiveness of this alternative.

Efficiency - No
There are insufficient data to adequately evaluate costs.

Completeness - No
Based on potential issues with environmental criteria and water rights, this alternative is not complete.

Findings

Additional study would be required to formulate an alternative that uses effluent as one of its water sources. There are insufficient data available to perform an analysis or to develop a workable alternative and the viability of this type of project cannot be determined without further investigation. This alternative is considered incomplete without being incorporated into an overall regional or local water supply plan.

IV. B.4 Water Resource and Operational Management Alternatives

IV.B.4.1 Rainwater Harvesting

One additional method for capturing water supply was considered by the Study was rainwater harvesting. The Study concluded that it appeared that rainwater harvesting was generally a private property matter and not an opportunity for the local government to develop and implement a specific program to capture rain water.

It was determined that while rainwater harvesting might create some additional water supply for residential purposes, issues with reliability and surface water rights could restrict the implementation of a productive program.

Analysis

Environmental Issues
There may be some issues associated with water quality, but in general, there are few environmental issues associated with rainwater harvesting.

Legal and Institutional Issues
There may be issues with surface water rights for large scale implementation of this program.

Cost

The Texas Water Development Board has presented cost-estimating information for various rainwater collection and storage system. Presented in Table IV.39 are both the rainwater harvesting system components and ranges of cost for the component parts of a rainwater harvesting systems.

Table IV.39 – Cost estimating for rainwater collection and storage system

Rainwater Harvest System Components	Range of Cost	Range of Sizes and Capacities
Storage Tank	0.30 – 4.00 ($/gallon)	55 – 1,000,000 (gallons)
Gutters	3.50 – 6.25 ($/lf)	Varies (lf)
Roof Washers	50 – 800 ($/unit)	30 – 50 gallons
Pumps & Pressure Tanks	200 – 600 ($/unit)	Varies (unit)
Filtering & Disinfection Systems	20 – 3,000 ($/unit)	Varies (unit)

In general, all rainwater harvesting projects within the Study area are expected to originate with private property owners. Hence, all costs for rainwater harvesting projects are expected to lie with those initiating such a project.

Evaluation

Acceptability - No

Potential issues with surface water rights make this alternative unacceptable.

Effectiveness – No

Rainfall in the area is intermittent and there are periods of extended drought which make this supply very unreliable.

Efficiency – No

Costs were not evaluated for large scale systems because it is unlikely that these systems would be developed at the water provider level.

Completeness - No

Issues with reliability and water rights cause this alternative to be incomplete.

Findings

Unless the water right restriction is either overcome or set aside, this option does not pass the completeness test and is considered non-viable; it was not evaluated further in the Study. This alternative was considered but rejected.

IV.B.4.2 Water Conservation and Demand Management

Water conservation is a demand management strategy. As such, no new water supply is developed. Rather, the existing water supply is managed more efficiently to extend its uses and/or the population it serves.

In 2007, only two entities were using water conservation for demand management – Payson and the Pine Water Company (Brooke). Because the communities have a limited supply, they have focused on increasing their efficiency in order to avoid having to develop additional supplies. Payson has used conservation technologies to manage its local groundwater supplies since 1998. Pine Water Company (Brooke) has been directed by the ACC to implement water conservation measures. Prior to 2005, no other community in the Study area was either developing or implementing water conservation programs.

Although water conservation is considered demand management, it has the potential to significantly reduce the projected unmet demand. During the development of the Demand Analysis (Attachment 2) for the study, it was decided that one consistent and conservative gpcd would be used to estimate future water demands (2040 low water demand). This number, 120 gpcd, was used to develop low water demands. Then a higher amount, generally closer to the existing gpcd was used to develop high demands and to provide a range of probable water demands for each community. It may be possible, through the implementation of conservation measures, for all communities in the Study area to meet their supply needs using the lower demand number thus foregoing the difference between the high and low demand, of 812 af/yr.

Analysis

Environmental Issues

Often when water use is more efficient, the intensity of use may cause water quality issues.

Legal and Institutional Issues

On March 20, 2003, Governor Janet Napolitano issued an executive order to establish the Governor's Drought Task Force. The Task Force was to address the drought issues facing all Arizonans. The Task Force made several recommendations, documented in the *Arizona Drought Preparedness Plan*, one of which was that the Governor seeks legislative authority for ADWR to require water systems to develop a drought plan. Based on the group's recommendation, the drought plan would develop mitigation strategies, including a water conservation plan to reduce vulnerability to drought and identify drought response actions. In addition, the Governor's Drought Task Force recommended legislative authorization for ADWR to require that all water systems provide consistent and coordinated water supply information to ADWR.

Recognizing the need for adequate water planning in rural Arizona, the Arizona Legislature passed House Bill 2277 during the 2005 legislative session. House Bill 2277, is now established in the Arizona Revised Statutes – ARS 45-331 – 333. The legislation created the requirement for community water systems to develop and submit a System Water Plan to ADWR.

The development of these plans is an important step toward improving water resource management planning at both the state and local levels. They will enable the state to identify data gaps and gather much needed information. In addition, these plans will allow the state to increase public awareness regarding water supplies, local drought preparedness and response measures, and to promote appropriate statewide (water) conservation practices. The Water Conservation Plan must be designed to increase the community water system's efficiency, reduce waste, and encourage consumer conservation efforts. A good conservation plan is one that encourages a low water use lifestyle and prevents water shortages from occurring. The plan would include both demand and supply management measures, an educational component, and an evaluation component.

Cost
There are a wide range of costs associated with implementing water conservation measures.

Evaluation

Acceptability – Yes
There are many acceptable water conservation practices that may be implemented within the Study area.

Effectiveness – Yes
Although many communities have already imposed strict water conservation criteria and have very low per capita use rates, there are still opportunities available for communities to make water available through the implementation of water conservation.

Efficiency - Yes
Costs were not addressed on a regional or Study-wide scale. Each community must complete their own cost benefit analysis in order to determine the efficiency of implementing an alternative, although, it is likely that implementing water conservation measures is less costly than developing infrastructure and new water sources.

Completeness - Yes
This alternative meets all of the criteria for delivering a long-term reliable supply.

Findings
Water conservation and demand management strategies need to be implemented at the water provider level. This alternative is viable, particularly at the local level.

IV.B.4.3 Conjunctive Water Resource Management

In the early stages of the Study, conjunctive water resource management was considered to have potential for increasing the water supply in the Study area. However as the Study progressed, it was realized that conjunctive water resource management could not physically increase water supplies; rather, it is more effectively used to increase water supply reliability through planned, coordinated management and use of groundwater with a surface water resource. Conjunctive water resource management is not a viable alternative for increasing a water supply. Its impact would be to establish a water management process for improving the reliability of a community's existing water supply by blending available surface and groundwater supplies.

All potential water service providers which expect to use the C.C. Cragin Reservoir surface water or use this new supply conjunctively with the local groundwater supply will have to consider how they will jointly manage these types of water supplies. They will also have to assess and evaluate the challenges of integrating the different water qualities found in both the surface and groundwater sources. Other considerations include the following questions: What types of water treatment will be required? What are the effects of blending the water sources together? What infrastructure considerations are associated with a conjunctive management program? How can the financial and economic concerns be managed to optimize the system's costs? What are the legal and institutional issues that impact the conjunctive use of these water supplies?

Findings

While the previous list is only partially inclusive, the questions point to a few of the management elements that will require additional study prior to the implementation of a conjunctive water resource management program by any community in the Study area. Since conjunctive water resource management is a management option not a water supply alternative, no further discussion will be offered regarding this operational concept.

IV.C Viability of Alternatives Summary

An alternative can only be considered viable if a project can be formulated that satisfies each of the following criteria: completeness, effectiveness, efficiency, and acceptability. If any one of the criteria of formulation is found to be incomplete, limiting, or restrictive, then a NO statement is placed in that cell for that alternative. If each one of the four criteria is found to be acceptable then the entire alternative is considered to be a viable project and a YES is shown in the cell.

Generally, but certainly not in all cases, an alternative may be found to be non-viable due to an inefficiency (efficiency), i.e., the project is not the most cost effective means of resolving the problem or for generating opportunities. An alternative that could not meet the Acceptability criteria is a project having significant legal issues that must be overcome for the project to be implemented. The most frequently encountered legal issues in the Study area will be water rights and special use permits. Logistical and/or cost issues also may be encountered when complying with NEPA and ESA. Administrative issues involving Environmental Justice could arise as well. The actual issues requiring specific consideration will be identified during later studies by project developers.

The viability analysis will only apply to the 2040 low water demand study. Supplemental study would be required to determine the viability of alternatives that could be developed to supply the 2040 high water demand. Table IV.40 presents a summary of project viability for each formulated 2040 low water demand alternative.

Table IV.40 – Summary of Alternatives' Project Viability – 2040 Low Water Demand

Alternatives	Completeness	Effectiveness	Efficiency	Acceptability	Viable
Groundwater (Regional, Sub-Regional, or Local)					
Regional Groundwater Alternative	No	No	No	No	No
Sub-Regional Groundwater Alternative	Yes	Yes	Yes	Yes	Yes
Local Groundwater Alternative	Yes	Yes	Yes	Yes	Yes
ADOT – Highway 260 Surface Water Diversion and Groundwater Storage and Recovery	No	No	No	No	No
Installation of Wells near the C.C. Cragin Reservoir	No	No	No	No	No
Directional (Slant) Drilling in the Mogollon Rim	No	No	No	No	No
Surface Water					
C.C. Cragin Reservoir Alternative - Town of Payson, Houston Mesa Road (FS 199)	Yes	Yes	Yes	Yes	Yes
C.C. Cragin Reservoir Alternative – Unincorporated Communities, Houston Mesa Road (FS 199)	Yes	Yes	Yes	Yes	Yes
Pine/Strawberry Extension Option	Yes	Yes	Yes	Yes	Yes
Tonto Apache Tribe, CAP, Roosevelt Lake Diversion	Yes	Yes	No	Yes	No
Tonto Apache Tribe, CAP, C.C. Cragin Diversion	Yes	Yes	Yes	Yes	Yes
Pine Water Company, CAP, C.C. Cragin Diversion	No	Yes	No	Yes	No
Pine Water Company, CAP, Pine Creek Diversion	No	No	Yes	No	No
Fossil Springs Regional Alternative	No	Yes	No	No	No
Regional and Local Off-Stream Storm Water Runoff Collection and Storage	No	No	No	No	No
EFFLUENT					
Effluent	No	No	No	No	No

Alternatives	Completeness	Effectiveness	Efficiency	Acceptability	Viable
Groundwater (Regional, Sub-Regional, or Local)					
WATER RESOURCE AND OPERATIONAL MANAGEMENT OPTIONS					
Rainwater Harvesting	No	No	No	No	No
Water Conservation and Demand Management	Yes	Yes	Yes	Yes	Yes
Conjunctive Water Resource Management (Reliability)	Yes	Yes	Yes	Yes	Yes

IV.D. Summary of Alternatives' Costs

Project alternatives were developed for both surface water and groundwater supplies. Other alternatives were not formulated due to the lack of sufficient data and other conceptual information upon which reasonable assumptions could be made and alternatives could be formulated. In particular, alternatives associated with effluent and other water resource management methodologies, including demand management, were lacking data. Most of the smaller rural communities do not have central wastewater collection and treatment systems in place at this time; however, in many cases such systems are needed due to potential water quality impacts to source aquifers from existing septic systems.

Each proposed alternative (see Section IV.B Future-With Regional Plan Alternatives) was evaluated with respect to each water service provider's 2040 low water demand. The alternative was developed to provide a water supply solution that served one or more water service providers. It was assumed that the engineering costs of all alternatives, when evaluated for the 2040 high water demand, would either be equal to or greater than the expected low water demand engineering costs for that alternative. Table IV.41 presents a compilation and summary of the 2040 low water demand engineering costs for all alternatives. Each alternative is segregated into the water supply that is expected to satisfy part or all of the specific low water demand.

Table IV.41 – Mogollon Rim Water Resource Management Study -- Future with Project(s) Alternatives -- 2040 Annual Low Water Demand (Acre-Feet per Year)

Alternatives	COST ($)						
	Annual Low Water Demand (Acre-Feet per Year)	Probable Field Cost – Construction ($)	Annual Amortization Cost ($)	Probable Annual Operation & Maintenance Cost ($)	Total Annualized Cost ($)*	Annual Cost ($/AF)	Annual Cost ($/Kgal)
GROUNDWATER (REGIONAL, SUB-REGIONAL, OR LOCAL)							
Sub-Regional Groundwater Alternative							
Sub-Region 1							
Cluster 1	1,947	2,838,400	225,300	227,100	452,400	232	0.71
Cluster 2	178	230,400	18,300	18,400	36,700	214	0.66

Alternatives	COST ($)						
	Annual Low Water Demand (Acre-Feet per Year)	Probable Field Cost – Construction ($)	Annual Amortization Cost ($)	Probable Annual Operation & Maintenance Cost ($)	Total Annualized Cost ($)*	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Cluster 3	58	76,800	3,100	6,100	12,200	207	0.64
Cluster 4	45	76,800	6,100	6,100	12,200	271	0.83
Cluster 5	225	268,800	21,300	21,500	42,800	190	0.58
Cluster 6	514	345,600	27,500	27,600	55,100	193.	0.59
Sub-Region 2							
No Clusters	3	38,400	3,000	3,100	3,100	5,100	15.65
Sub-Region 3							
Group 7	128	153,600	12,200	12,300	24,500	192	0.59
Group 8	509	542,000	43,000	43,400	86,400	225	0.69
Group 9	112	153,600	12,200	12,300	24,500	219	0.67
Sub-Region 4							
No Clusters	0	0	0	0	0	0	0
Arizona Department of Transportation Storage/Recovery System – Highway 260 project	100	9,582,900	760,800	766,600	1,527,400	15,274	46.87
Installation of Wells near the C.C. Cragin Reservoir	3,500	3,000,000	238,200	240,000	478,200	137	0.42
Slant (Directional) Drilling							
Sub-Region 1							
Cluster 1	1947	2,000,000	158,800	160,000	318,800	164	0.50
Cluster 2	178	1,000,000	74,900	80,000	159,400	927	2.84
Cluster 3	58	0	0	0	0	0	0
Cluster 4	45	0	0	0	0	0	0
Cluster 5	225	0	0	0	0	0	0
Cluster 6	514	0	0	0	0	0	0
Sub-Region 2	3	0	0	0	0	0	0
Sub-Region 3							
Group 7	128	0	0	0	0	0	0
Group 8	509	0	0	0	0	0	0
Group 9	112	0	0	0	0	0	0
SURFACE WATER							
C.C. Cragin Reservoir Alternative – Town of Payson, Houston Mesa Road (FS 199)	3,500	33,861,900	2,688,300	2,709,000	5,397,300	1,542	4.73
C.C. Cragin	4,250	44,587,900	3,539,800	3,566,800	7,106,600	1,672	5.13

Alternatives	COST ($)						
	Annual Low Water Demand (Acre-Feet per Year)	Probable Field Cost – Construction ($)	Annual Amortization Cost ($)	Probable Annual Operation & Maintenance Cost ($)	Total Annualized Cost ($)*	Annual Cost ($/AF)	Annual Cost ($/Kgal)
Reservoir Alternative – Unincorporated Communities, Houston Mesa Road (FS 199)							
Pine/Strawberry Extension Option	500	21,663,600	1,719,900	1,733,100	3,453,000	6,906	21.19
Tonto Apache Tribe, CAP, Roosevelt Lake Diversion	661	21,663,600	1,719,900	1,733,100	3,453,000	5,224	16.03
Tonto Apache Tribe, CAP, C.C. Cragin Diversion	661	2,843,800	225,800	227,500	453,300	686	2.10
Pine Water Company, CAP, C.C. Cragin Diversion	661	19,875,300	1,577,900	1,590,000	3,167,900	4,793	14.71
Pine Water Company, CAP, Pine Creek Diversion	661	19,875,300	1,577,900	1,590,000	3,167,900	4,793	14.71
Fossil Springs Regional Alternative	161	2,843,800	225,800	227,500	453,300	2,816	8.64
Regional and Local Off-Stream Storm Water Runoff Collection and Storage	161	12,601,000	1,000,400	1,008,100	2,008,500	12,,475	38.28
EFFLUENT							
Effluent	$Q_{EFF} \leq 0.35*Q_A$	**	**	**	**	**	**
WATER RESOURCE MANAGEMENT							
Rainwater Harvesting	Variable $\approx C*Q_A$	**	**	**	**	**	**
Water Conservation and Demand Management	Variable Q_A	**	**	**	**	**	**
Conjunctive Water Resources Management (Reliability)	$1,500 \leq Q_{SWD} \leq 3,000$	**	**	**	**	**	**

*Federal Interest Rates for Reclamation Projects – 4 -7/8 percent -- Fiscal Year 2008.
**Insufficient data available upon which to make an analysis and cost estimate.

Q_A – Annual Water Demand; Q_{SW} – Annual Surface Water Demand; Q_{GW} – Annual Groundwater Demand; Q_{EFF} -- Annual Effluent Production – Reuse; Q_{SWD} – Annual Surface Water Drainage Volume; and Q_D Annual Water Demand. The water conservation coefficient – C, the expected water conservation percentage (%) expected with respect to a given water conservation management methodology, expected value of C = 8 percent.

Legal, institutional, financial, technical, and other administrative details are in the process of being formalized to ultimately deliver 3,000 af/yr to Payson. Discussions regarding the 500 af/yr for unincorporated communities are ongoing. The Town of Payson and SRP have finalized agreements and are pursuing the severance and transfer of water rights to Payson. The Town of Payson is proceeding with elements of feasibility and has started the permitting process with the FS (TNF) for acquiring the right-of-way necessary for the proposed pipeline. The Town also is pursuing the utilization of a pilot treatment plant to fine tune operations and planning surrounding the application of micro filtration technology.

V. Federal Interest

There are many issues that warrant a Federal interest in further study of the viable alternatives. First, there are Federal Projects, C.C. Cragin Reservoir, and Federal lands, Tonto and Coconino National Forests that are integral pieces of viable long term water supply alternatives. Additionally, there are CAP allocations considered as part of an exchange for both Pine Water Company and the Tonto Apache Tribe. And finally, there are Federal trust responsibilities to the Tonto Apache Tribe associated with the CAP allocations and potential water rights claims.

VI. Findings and Recommendations

Additional water supplies will need to be developed in order to provide the 2040 planned build out water supply (9,330 af/yr) for the Study area. To date, water conservation has been the primary means of meeting present needs with both limited yearly and seasonal supplies. Although a strict conservation ethic will continue to exist in the Study area, many of the most populated communities in the study have imposed such extreme measures and ordinances that it is unlikely that any conservation alternative, on its own, could succeed in meeting future demands.

Recognizing that many non-structural alternatives are already in place, this study developed and evaluated a broad range of surface water, ground water, and other water supply alternatives to meet the projected future demands. In order to establish viability, each alternative was analyzed for legal and institutional issues, environmental issues, and costs. Several alternatives, including the local and sub-regional groundwater alternatives and the C.C. Cragin surface water (including CAP exchange options) were deemed to be viable. The communities may choose one of the options or some combination. In order to further define the alternatives, feasibility level investigations of the viable alternatives is recommended.

Federal lands, projects and trust assets justify the Federal Interest in the Study area. Therefore, there are opportunities for communities in the Study area to continue to work with Federal agencies to develop reliable long-term regional and economical water supplies.