Upper Verde River Watershed Protection Coalition Watershed Taskforce

Watershed Restoration and Management Project Plan

Prepared for:

UPPER VERDE RIVER WATERSHED PROTECTION COALITION

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

Prepared by:

Upper Verde River Watershed Protection Coalition Watershed Taskforce

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Executive Summary

The Upper Verde River Watershed Protection Coalition (UVRWPC or Coalition) is an intergovernmental partnership comprised of representation from the City of Prescott, Towns of Prescott Valley and Chino Valley, Yavapai County and the Yavapai-Prescott Indian Tribe. Established in 2006, the Coalition has a mission to protect the base flows of the Upper Verde River and reach safe yield in the Prescott Active Management Area while balancing the reasonable water needs of residents who live and businesses that operate within watershed boundaries.

In March of 2012, a Watershed Taskforce was established by Coalition leadership with the directive to develop a plan that will guide future watershed restoration and management efforts. The resulting collaboration of natural resource managers, engineers, scientists, planners, business owners and private citizens worked in service of a common goal to ensure the long-term vitality and health of the Upper Verde River Watershed and its supporting ecosystems. A grant from the United States Bureau of Reclamation, awarded in September 2012, augmented this comprehensive project-based planning effort.

Critical watershed issues identified by taskforce members include:

1. Water supply security;
2. Forest health;
3. Increase in catastrophic wildfires; and,
4. Proliferation of invasive species.

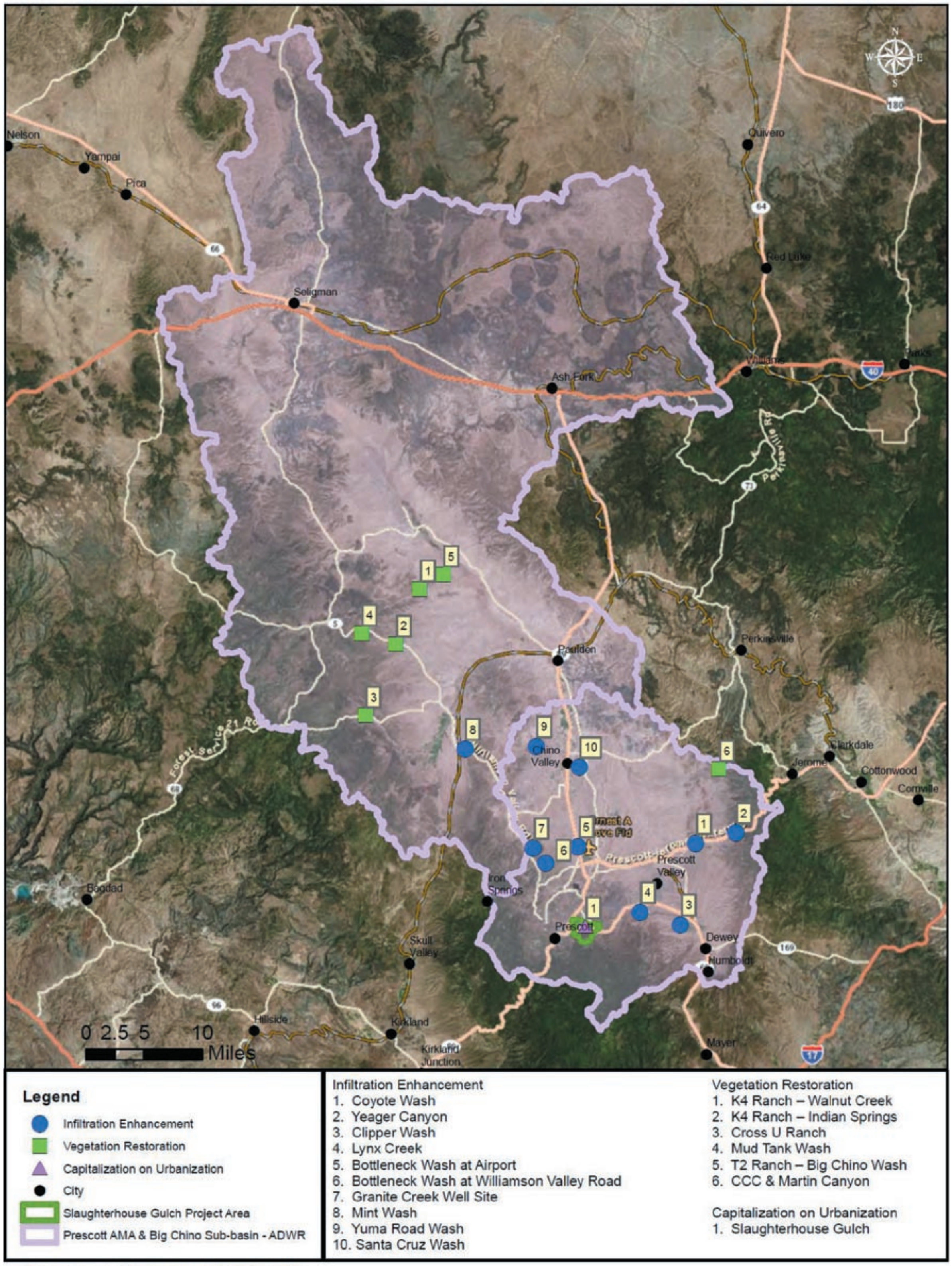
Project concepts developed to address critical issues span four areas also took into account historical and desired watershed conditions, as well as goals and objectives of the multi-stakeholder taskforce. Focus areas include:

1. Vegetation Management
2. Recharge Enhancement
3. Capitalization on Urbanization
4. Land Use Management, Water Conservation and Aquifer Protection

Taskforce members methodically analyzed the watershed using Geographic Information Systems (GIS), hydrologic and geologic characteristics, land ownership and field work to select project locations. Project types and locations are illustrated on Map 1 on the next page. Multi-faceted projects, including cost estimates, were designed to achieve maximum benefit to the watershed and associated ecosystems. They have the potential to locally enhance recharge while mitigating the risk of catastrophic wildfire through vegetation thinning; reduce unhealthy sediment loads in bodies of water and improve the water quality of runoff; enhance recharge through installation of retention structures (gabions); and restore riparian and wildlife habitat. Scenario planning was incorporated to further define project parameters, as well as identify the needs for and threats to implementation.

Several themes emerged throughout the process. There is a clear and critical need to engage policy makers, incorporate the private sector as a major partner, and garner public support through increased education and dissemination of information.

Map 1 – Project Locations by Type



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BURGESS & NIPLE

1.0 Acknowledgements

This report and its findings involved collaboration among numerous stakeholders acting in their capacity as watershed stewards and stakeholders. Upper Verde River Watershed Taskforce members found common ground to guide the watershed restoration and management effort. To that end, partners in the Upper Verde River Watershed Protection Coalition would like to acknowledge the following taskforce members for their participation, and support:

- Abra Water Company – Kevan Larson
- Arizona Game and Fish Department – David Weedman, Wade Albrecht, and Trevor Buhr
- Arizona State Land Department – John Bodenchuk
- Bureau of Reclamation – Vivian Gonzales
- City of Cottonwood – Tom Whitmer
- City of Prescott – Leslie Graser
- The Nature Conservancy – Steve Olson and David Gann
- Prescott National Forest – Jim Gilsdorf
- Town of Prescott Valley – John Munderloh and Gary Marks
- Yavapai County – John Rasmussen and Kevin Blake
- Yavapai-Prescott Indian Tribe – Peter Bourgois, Amber Tyson, and John Sterling
- USDA Natural Resource Conservation Service – Bob Adams and Marques Munis, and Kresta Faaborg
- Private Citizens – Mike Flannery, Larry Geare, Dava Hoffman and Bill Remick

2.0 Introduction

Water supply security continues to be a major, and often controversial and polarizing issue impacting the communities within the Upper Verde River Watershed. The region has been identified by the United States Bureau of Reclamation as having a "high likelihood" of conflict over water issues by 2025.

The UVRWPC, as a regional partnership, has the collective resources to successfully:

1. Conduct outreach to expand the current watershed group;
2. Research, investigate, and plan;
3. Implement and manage projects;
4. Make policy and project recommendations to decision-making bodies that have authority with respect to the watershed; and,
5. Promote water conservation and sustainable use of limited water resources.

A directive by the Coalition's Executive Board in the spring of 2012 launched the watershed initiative and subsequent two-year effort culminating with completion of this project-based plan. The Watershed Taskforce, operating under the Coalition financial and operational umbrella included representation from the Coalition, agencies with responsibility for addressing watershed issues, and business owners and private citizens who live and work within watershed boundaries. The grant awarded by the United States Bureau of Reclamation defined the process and steps that guided the planning effort and included:

Year 1

1. Expansion of the watershed group
2. Development of vision, mission and goals
3. Identify critical watershed needs
4. Select project concepts based on critical needs
5. Conduct GIS mapping across the watershed

Year 2

1. Develop and refine projects
2. Conduct scenario planning process
3. Write watershed plan

Water rights and water supply were a primary consideration throughout the process. Water rights fall into four categories.

1. Groundwater rights – access controlled by Arizona Department of Water Resources;
2. Surface water rights – governed by the Doctrine of Prior Appropriation;
3. Reclaimed water (effluent) – governed primarily by Arizona Supreme Court cases Long vs. APS and Long vs. City of Phoenix and partially administered by the Arizona Groundwater Code; and
4. Rainwater or sheet flow – not an appropriable source of water as long as it is collected prior to entering a defined stream channel.

Current sources of water supply include:

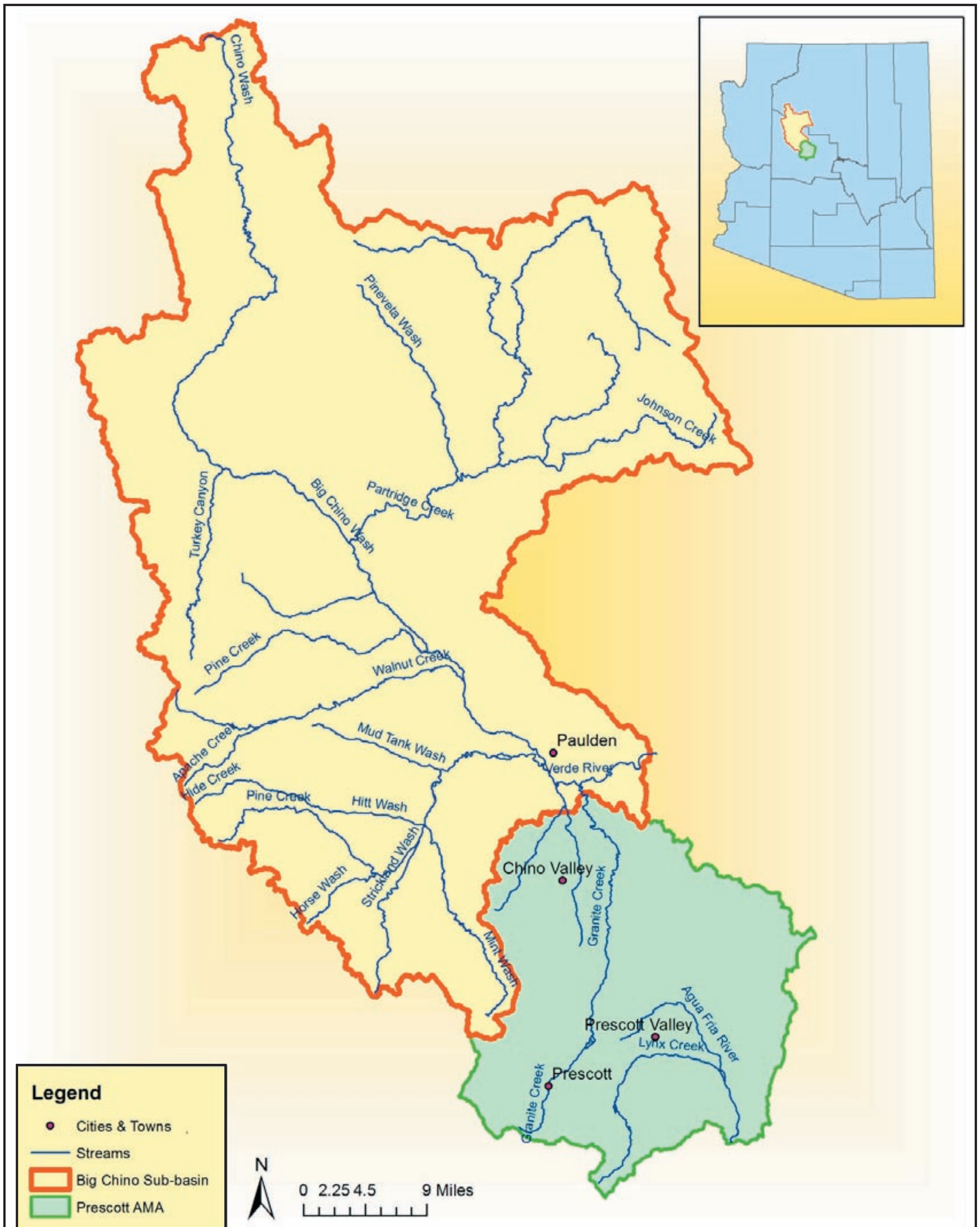
1. Groundwater from the Little Chino and Upper Agua Fria Sub-basins within the PrAMA and managed by ADWR through the 1980 Groundwater Management Act
2. Groundwater within the Big Chino sub-basin
3. Surface water in the PrAMA – Watson and Willow Reservoirs, Lynx Lake
4. Reclaimed water (effluent) – City of Prescott, Towns of Prescott Valley and Chino Valley

This report documents the watershed taskforce efforts, findings, and next steps toward implementation.

3.0 Plan Development Process

The planning area totals 2,235 square miles and encompasses the Big Chino Sub-basin (1,850 square miles) and the Prescott Active Management Area (PrAMA, 485 square miles). Most of the planning area, or 2,060 square miles, forms the Upper Verde River Watershed. The eastern portion of the PrAMA forms the Upper Agua Fria River Watershed.

Map 2 – Prescott AMA and Big Chino Sub-Basin



Watershed Management Task Force members were the driving force behind plan development. They met every six weeks over the two-year project period to find common ground; develop a mission, vision and goals; assess the watershed; establish project evaluation criteria; identify and develop potential projects; participate in scenario planning; research funding opportunities; define next steps; and assist with plan writing. Key concepts for discussion and inclusion in the plan were selected by the group early in the process, with enough flexibility to allow the plan to evolve as it was developed.

Planning also took into consideration ongoing efforts within the watershed to lessen the possibility of duplication of effort and identify valuable resources. The Taskforce Committee included representation from all of the agencies mentioned below: Ongoing efforts include:

- Monitoring and modeling efforts conducted by the City of Prescott, Town of Prescott Valley and Salt River Project in the Big Chino Sub-basin with assistance from the. Arizona Department of Water Resources (ADWR) and US Geological Survey (USGS).

- Monitoring and planning efforts throughout the Upper and Middle Verde watersheds conducted by the Yavapai County Water Advisory Committee (WAC) – now defunct. This included the Central Yavapai Highlands Water Resource Management Study (CYWHRMS) conducted in partnership with the United States Bureau of Reclamation (BOR), ADWR and USGS

- Water management planning by ADWR to develop the PrAMA 4th Management Plan with support from the PrAMA Groundwater User's Advisory Council (GUAC).

- Hydrologic Modeling in the Prescott AMA. ADWR recently released the fourth-generation Prescott AMA model (Prescott AMA Groundwater Flow Model Update Report – 2014 (Modeling Report 25).

- Range and grassland management efforts ongoing in the Big Chino sub-basin by various private land owners, the Arizona State Land Department (ASLD), the US Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), and Arizona Game and Fish Department (AZGFD).

- Oversight of state and federal public policy that governs water providers by the Northern Arizona Municipal Water Users Association (NAMWUA).

- Efforts of individual water providers and users to conserve water and enhance recharge (i.e. cities and towns, agricultural users, etc.)

- National Environmental Policy Act (NEPA) work completed by the Prescott National Forest (PNF) to obtain necessary environmental clearances and funding to facilitate reduction of woody plant density and decrease fire intensity on forest lands.

- Efforts by the (PNF) to develop and implement a forest management plan.

4.0 Development of Mission Statement, Vision, and Goals

4.1. Common Ground

Identification and recognition of individual participant agency goals and objectives forwarded the realization of common ground on which to build. Individual agency goals pertinent to the plan are listed below:

Coalition

1. Balancing reasonable water needs of residents
2. Protecting base flow of the Upper Verde
3. Safe yield in the PrAMA

US Department of Agriculture - Forest Service

1. Multi-use (lands) with restrictions
2. Protect water source quality, including habitat management
3. Vegetation control for fire, habitat, and forest health

Arizona State Land Department

1. Maintain or increase the value of State Trust lands by protecting or augmenting the available water supplies associated with those lands
2. Evaluation of the existing water supplies associated with State Trust lands as well as the potential to increase those supplies
3. Cooperate with UVRWPC partners, making Department resources available to the extent possible
4. Assist and advise UVRWPC relative to use of and access to State Trust lands, including but not limited to: rights of way, easements, leases, placement of improvements, and land treatments

Arizona Game and Fish Department

1. Protect base stream flows and functionality of riparian system
2. Recharge to aquifers is important, balance with wildlife needs

USDA Natural Resource Conservation Service

1. Equip program – irrigation efficiency (cropland and rangeland)
2. Amount and type of vegetation
3. Healthy watershed
4. Ecological site descriptions
5. National, state, and local concerns

Private Property Owner

1. Evaluate existing knowledge base

4.2. Goal Comparison

A matrix was used to identify matching, coincidentally aligned, conflicting, and neutral goals. Results are presented in Table 1.

TABLE 1 – AGENCY GOAL COMPARISON

Matching Goals	Coincidentally Aligned Goals	Conflicting Goals	Neutral Goals
PROTECT STREAM FLOWS - Protecting base flow of the Upper Verde (UVRWPC) - Protect base stream flows and functionality of riparian system (AZGFD) **HEALTHY WATERSHED** - Healthy watershed (NRCS) - Protect water source quality, including habitat management (FS)	**CONCERN FOR AMA** - Safe yield in the AMA (UVRWPC) - Recharge to AMA is important, balance with wildlife needs (AZGFD) - Healthy watershed (NRCS) - Maintain or increase the value of State Trust lands by protecting or augmenting the available water supplies associated with those lands (ASLD) - Evaluation of the existing water supplies associated with State Trust lands as well as the potential to increase these supplies (ASLD) - Equip program – irrigation efficiency (NRCS) **VEGETATION CONTROL** - Vegetation control for fire, habitat, and forest health (FS) - Amount and type of vegetation (NRCS)	None	- Balancing reasonable water needs of residents (UVRWPC) - Multi-use (lands) with restrictions (FS) - Cooperate with UVRWPC partners, making Department resources available to the extent possible (ASLD) - Assist and advise UVRWPC relative to use of and access to State Trust lands, including but not limited to: rights of way, easements, leases, placement of improvements, and land treatments (ASLD) - Ecological site descriptions (NRCS) - National, state and local concerns (NRCS) - Evaluate existing body of knowledge – (Private Property Owner)

4.3. Group Objectives

A facilitated workshop was held early in year 1 to establish the task force mission, vision, and goals.

1. Mission Statement

   Utilization of a project based approach to watershed planning and management that results in healthy ecosystems while optimizing regional water supplies.

2. Vision Statement

   Realization of healthy ecosystems that optimize regional water supplies.

3. Group Characteristics and Goals

Task Force members established goals, as well as desired group characteristics that resulted in a more productive process. Goals and characteristics are listed below.

- Open mindedness
- Common goals
- Working together among various agencies; barriers are broken down = collaboration
- Obtain public input and support
- Heightened public awareness; increased public education; public buy-in
- Timeline
- Data sets and maps
- Big document of maps and historical perspective
- Determine problems and needs within the watershed
- Process for large assessment and narrowed to project(s)
- Focused geographic area
- Completion of reclamation grant (both first and second phase)
- Develop a cooperative watershed plan with fully developed project(s)
- $1.5 million in funding for first round projects
- Implementation of projects
- On the ground improvement

5.0 Assessment of Watershed

Much has changed within the watershed since the Arizona Territory was established here over 150 years ago. The earliest settlers and explorers mentioned the old growth Ponderosa forests around Prescott, the valley grasslands and abundant water supplies. In 1864, the year Prescott was founded, the man often referred to as the "Father of Arizona" Tom Poston described the area:

"The granite mountains, covered with great pine forests, give a grandeur and beauty to the country which I have not seen elsewhere. The atmosphere is the perfection of temperature, seldom varying from 75 during my visit. The water is pure, cool, and refreshing, and abounds in every direction."

Wood and grassland resources, along with gold, provided the economic stimulus for the development of the new Arizona Territory. During these early years, Prescott was known as the "City of Stulls" (mine timbers) as the Ponderosa forests were exploited to support the development of mines and railroads. These early "cut and run" harvesting methods left watersheds in poor condition. In 1898, the Prescott City Council asked the General Land Office to protect the watershed upstream of the City's water supply from cut and run harvesting. Similarly, the vast grasslands were overstocked and overgrazed during the late 1800's. In the ensuing years, a policy of suppressing fires on forested land and grasslands led to an over-dense forest area and, combined with past grazing practices, allowed woody plants, such as juniper trees, to expand into historic grasslands.

It is unclear how changes to watersheds have impacted the area's water supplies, either in terms of surface runoff or groundwater recharge. Ranchers and land managers point out that many small springs have declined or dried up. The USGS water budget for the Big Chino sub-basin and PrAMA groundwater basin show that about 2 percent of the average annual precipitation recharges the aquifers, while the recharge from precipitation in the neighboring Verde Valley basin is twice that rate (USGS 2006).

5.1. Historical Conditions

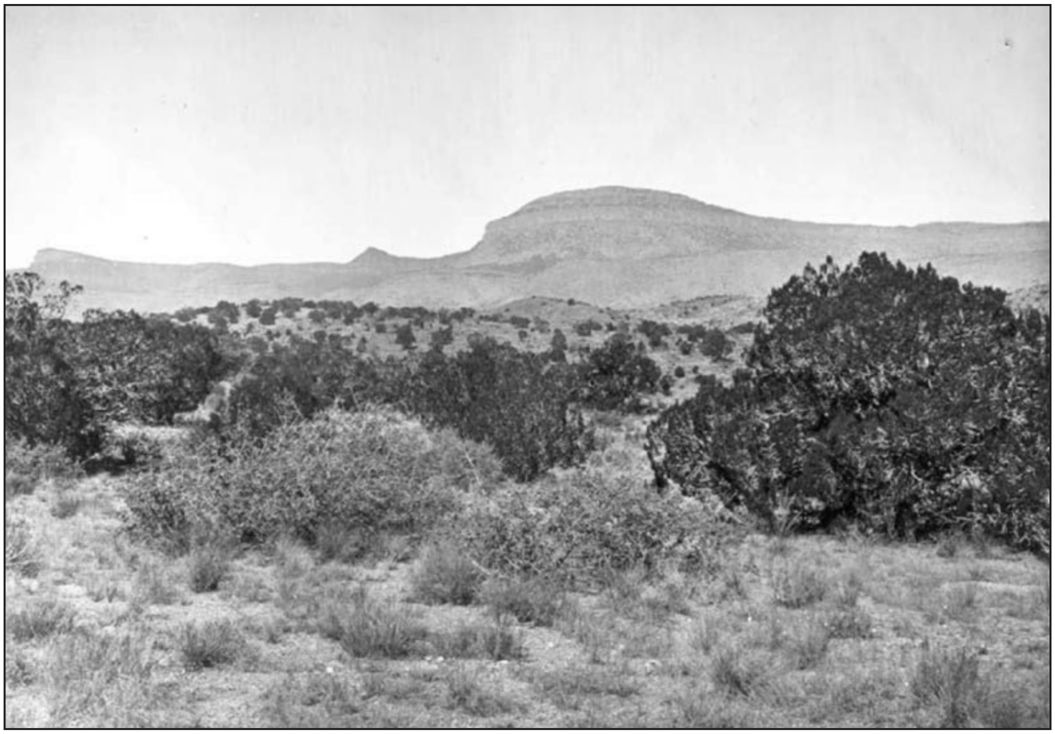
Understanding historical watershed conditions provides insight into how the watershed functioned prior to human landscape-altering activities, such as wildfire suppression, grazing and development. However, because many modern changes to the watershed have become permanent features (e.g. people), restoring historical conditions may not be practical or desirable. Woody vegetation density has increased in forested areas and encroached on former open grasslands throughout much of the watershed.

A photographical exploration of historic conditions over the last 150 years was prepared by Harley Shaw(1). Shaw retraced the steps of several expeditions that traversed the upper Verde River watershed in the mid-1800s from the mid-1900s. His work illustrates that areas of woody vegetation did exist prior to modern settlement; however, the woody vegetation density of many of these areas has increased. Refer to Shaw's repeat photographs included in the upcoming pages to illustrate the increase in woody vegetation density that has occurred throughout the watershed[1].

"1867 photograph by Alexander Gardner taken west of present Ash Fork, Arizona. Picacho Mountain is in the distance. Courtesy of Boston Public Library. (1)"

"1995. Repeat... A few junipers have invaded and a low shrub, possibly winterfat, is less abundant. Otherwise, the site is still a relatively open grassland. Photograph by R. M. Turner. (1)"

"Timothy O'Sullivan photograph of Music Mountains taken in 1871 near present Truxton, Arizona. It represents the juniper/grassland interface prior to the time that heavy permanent grazing had occurred in the area. It is possible that livestock had been herded through the area by the time this photograph was taken." (1)



"August, 1995 repeat... Woodland has grown denser 124 years since the first photograph was taken. Pinyon, not visible at all in 1871, has become a major component of the woodland. While some evidence of woodcutting is apparent in the area, it does not appear to have undergone any major juniper eradication. Note that the three turbinella oaks in the foreground may be the same shrubs that were present in 1871. Photograph by Raymond M. Turner."

6.0 Need to Enhance Recharge

Total average annual precipitation received in the Big Chino and Little Chino portion of the PrAMA is calculated to be 2,084,430 acre-feet (USGS SIR 2005-5198). Of this total, 2,019,550 acre-feet (97 percent) is lost to evaporation and transpiration. Precipitation leaves the watershed(s) as runoff and approximately 2 percent recharges aquifers. The Upper Agua Fria portion of the PrAMA follows this same trend, although precipitation water budgets were not computed for this watershed by the USGS.

Groundwater recharge occurs primarily along mountain fronts and within stream channels. Higher elevation mountains create orographic uplift increasing precipitation in the Juniper, Santa Maria, Bradshaw, Sierra Prieta, Granite, and Bill Williams Mountains. Runoff originating in these mountains accumulates in streams and eventually recharges the aquifer, if there are sufficient, sustained flows. Streams inducing recharge in the planning area include Granite and Lynx Creek in the PrAMA, and Big Chino Wash, Pine Creek, Walnut Creek and Williamson Valley Wash in the Big Chino sub-basin. The long-term average Verde River base flow near the headwaters at Paulden has been declining since the mid-1990s, likely due to continuing drought. A decline in groundwater storage levels over the same timeframe is attributed to groundwater pumping and a reduction in stream bed recharge caused by drought. (2)

Though not fully understood, mountain front and mountain block recharge plays a key role in the recharge component of the area water balance. (3) Recharge rates are not directly measured; recharge is the derivative from calculating the better-known components of a water budget, such as stream discharge and groundwater pumping. Groundwater models coupled with on-the ground monitoring will allow for a better understanding of recharge rates within the system.

Watershed-scale groundwater recharge remains difficult to quantify. In addition to mountain front/mountain block recharge, it is essential to have a better understanding of impacts on recharge due to storm events, and evapotranspiration.

Previous studies found through-flow rates increased dramatically during larger storm events, which may lead to increased recharge. It is hypothesized this is due to bedrock void saturation. Further, there is little information available regarding recharge rates associated with melting snowfall. (3)

Evapotranspiration rates may also impact recharge rates. Multiple studies have been completed that suggest different plant species and densities impact evapotranspiration rates, which may impact recharge rates. There is still significant opportunity for research in this arena. (3)

The feasibility and effectiveness of recharge enhancement projects will be impacted by local conditions. Projects designed to increase recharge across the watershed will not be practical. Enhancing recharge in localized areas has the potential to positively impact groundwater levels.

Design of vegetation management projects must also take into consideration the impact on plant and animal species. For example, juniper removal will likely lead to the return of grasslands and increased groundwater recharge. Grasslands are good for antelope and other species that require large, open areas; however, this change may adversely impact species that require cover to thrive, such as deer. Restoration efforts will be guided by historical conditions and consultation with experts who are well-versed about natural watershed characteristics.

7.0 Mapping

A comprehensive GIS effort, conducted early in year 1 of the project period, was pivotal to the planning process. Taskforce members identified mapping information necessary for project-site selection. GIS layers were combined in various ways to develop a set of theme-based maps. Key data sets included vegetation, geology, land ownership and use, topography and aerial imagery, hydrology, and soil.

Maps were also essential for the selection of landscape areas appropriate for project development, as well as areas to avoid. A substantial geo-database was constructed using available GIS layers from multiple sources. Examples of maps created to support the planning effort are included at Appendix A.

The Yavapai County GIS Department compiled and houses the data sets used to construct maps for the Watershed task force. Table 2 contains a list of the data sets considered during this planning process.

Table 2 - GIS Data compiled for potential project site(s) analysis

GIS LAYER	SOURCE ORGANIZATION
Parcels	Yavapai County
Roads	Yavapai County
STR	Yavapai County
Land Ownership	Yavapai County
Contours (20'; & 2' Limited areas)	Yavapai County
Population Density	Yavapai County, Census
Soils	USDA, ALRIS
Vegetation	Forest, ALRIS
Watersheds	ADWR
Basins, Sub-Watersheds	ADWR
Wells	ADWR
Prescott AMA	Yavapai County
Hydrology	YC, ALRIS, USGS
Lakes	ALRIS
Springs	ALRIS
Reaches	USEPA
Mining Claims	Yavapai County
Geology	ALRIS
Wildfire Analysis	USFS
HUCS	USGS
Dams	USEPA
EPA Ecoregions	USEPA
Minerals	ALRIS
Rainfall	NOAA
Cooling Degree Days	NOAA
Heating Degree Days	NOAA
Precipitation	NOAA
Relative Humidity	NOAA
Snow	NOAA
Temperature	NOAA
2010 Color & CIR NAIP Imagery	State, NAIP, YC
2010 Flood Control (Limited Area)	Yavapai County
2009 Aerials Express	Yavapai County
2011 Bing Imagery	ESRI, Bing

8.0 Desired Conditions

The objective of this plan is to guide a process for achievement of desired conditions to support restoration of the Upper Verde River Watershed to a healthy state with known historical conditions and site-specific evaluations serving as a baseline. Desired conditions are aligned with conditions that should naturally occur at any given location.

Characteristics of a healthy functioning Upper Verde River Watershed include:

- Soil erosion control with respect to vegetation management
- Naturally supported vegetation structure for a given location
- Balance of watershed structure and function, including aquifer protection
- Minimal, if any, impact on wildlife

A key component of a healthy watershed and a desired condition is increased recharge due to a) reducing evapotranspiration rates, b) increasing runoff to areas of high infiltration, c) increasing the period of runoff to areas with high infiltration, and all without increasing sediment loads.

Infiltration rates in the watershed are low when compared to the amount of precipitation falling in the planning area. The majority of the precipitation (about 97 percent) is lost to evaporation and transpiration from plants. About 1 percent is runoff and 2 percent is recharged. A primary cause of the water loss is attributed to an overabundance of plant cover.

Water absorbed past 6 to 12 inches of topsoil generally requires uptake through plant roots, rather than evaporation, to bring it back to the surface. Without influence by plants, water that permeates the soil will gradually continue downward or remain bound in soil pore spaces. Precipitation cannot always be absorbed into the soil if it is already saturated or has a lower infiltration rate than the rate of rainfall. In densely wooded areas, the cover canopy and leaf litter can prevent a substantial percentage of annual precipitation from reaching the soil. Instead of providing benefit to plants and aquifers, this intercepted precipitation is evaporated. A study in Texas found that "as a result of interception loss via the canopy and litter, only 20.3%, 34.0% and 53.9% of annual rainfall reaches mineral soil under the canopy of ashe juniper, redberry juniper and live oak, respectively. This is compared to the 81.9% and 89.2% of annual precipitation that reaches the soil under bunchgrass and shortgrass cover, respectively." (5)

Rainfall that impacts the ground with a high rate of intensity dislodges soil particles. Water also travels across the soil, picking up sediment as it travels. Aside from reductions in water quality due to increased sediment in lakes, washes, and streams, the loss of soil profile degrades the watershed's ability to sustain native plants. It is theorized that reduction of invasive species will encourage the reestablishment of a healthy vegetative state and return of native grasses. Native grasses transpire less water than local invasive species, reduce sediment transport in rainfall events, and slow the rate of runoff.

The desired future condition of vegetation in the Big Chino sub basin is characterized by a return to a natural vegetative state in terms of type, composition and distribution, and occurrence of a healthy fire regime in relation to frequency and severity. Former grassland will be restored and naturally forested areas will be thinned with reduced with more grass in the interspaces between trees. Vegetation changes will occur and be sustained across the watershed on private, municipal, state, tribal, and federal (USFS, BLM) land.

Planning of cross-jurisdictional projects included specific jurisdictional management objectives and associated silvicultural prescriptions from each land owner. Permitting and approval requirements are also specific to each land owner and range from a "Consent Agreement" with a private rancher to a "Stewardship Agreement" with the USFS. Environmental and cultural requirements vary significantly based upon land ownership. The coordinated modification of vegetation at this level is operational in nature; namely, harvesting and transportation systems.

9.0 Realizing Desired Conditions

Realizing desired conditions across the watershed is a complex, long-term process. Taskforce members and stakeholders identified desired conditions and restoration efforts in the form of project concepts with associated developed projects that can lead to the realization of desired conditions. Efforts at watershed restoration and management previously have not been undertaken across the entire planning area. Planning has occurred in sections of the watershed (i.e. Prescott National Forest Plan), but this is the first effort that encompasses federal, state, municipal, tribal and private land.

Taskforce members came to common ground with agreement that addressing identified critical needs will improve overall watershed health resulting in opportunities for increased recharge and optimization of water supplies.

In order to optimize regional water supplies, it is necessary to recharge or augment the groundwater supply. The taskforce determined that, in order to enhance recharge and improve overall watershed health, a variety of on-the-ground projects, along with additional water conservation activities and land use management policies, should be implemented and enacted. Four project concepts were identified: vegetation restoration, infiltration enhancement, capitalization on urbanization, and land use management/conservation. On the ground projects include scientific monitoring to gauge effectiveness and gather needed data to determine impact on recharge.

9.1. Existing Recharge Facilities

There are three permitted recharge sites in the Prescott AMA. These facilities, their permit numbers, permitted recharge volumes, recharge volumes, and other key attributes are summarized below in Table 3.

Table 3 - ADWR Underground Storage Facilities in the Prescott AMA*

Facility Name	Facility No.	Permittee Name	Facility Type	Permitted AF/Year	Recharged AF/Year(2013)**	Water Source
Old Home Manor Recharge Project	71-595206	Town of Chino Valley	Constructed	1,120	242.1	Effluent
Prescott Recharge Facility	71-519567	City of Prescott	Constructed	7,200	4,124.2	Effluent & Surface Water
Upper Agua Fria Recharge Facility***	71-220048	Town of Prescott Valley	Constructed	3,600	2,057.5	Effluent

*as of July 8, 2014
**Total credited effluent (after losses) per ADWR Annual Report
***Prescott Valley operates both a Constructed in-channel facility and a Constructed off-channel basin facility under this permit.

9.2. Enhanced Runoff and Recharge

As previously described, approximately two percent out of over 2 million acre-feet per year of the estimated average annual precipitation is recharged into the aquifer; the remainder is lost to evapotranspiration or otherwise leaves the watershed. Even a small increase in the percentage recharged would create a meaningful change in the aquifer. The taskforce explored various ways to increase runoff and recharge rates within the watershed, including constructed improvements, policies, and changes to vegetation. Project plans with the goal of increasing runoff to optimize recharge must take into account the potential for soil erosion from runoff, wildlife needs, aesthetics, existing vegetation, land ownership, and costs. A focus on large storm events and seasonal events (e.g. winter storms) will be important since large winter events tend to be the primary sources of recharge. A project may focus on increasing the length of time water flows in stream beds, which would likely lead to increasing recharge amounts.

9.3. Silvicultural Prescriptions

Silviculture is the art and science of manipulating vegetation to accomplish the objectives of the land owner. The prescriptive use of thinning and burning is unique to each area and is specified accordingly.

9.4. Possible Effects of Juniper Removal on Water Balance

In the previously mentioned study in Texas, junipers have been shown to have a profound effect on hydrology and water balance. Those effects include:

- Interception of precipitation: juniper canopies and the leaf litter they produce have been shown to intercept up to 80 percent of the total annual precipitation where it quickly evaporates. Grasslands only intercept about 10 percent of the total annual precipitation.
- Infiltration and runoff: juniper leaf litter increases infiltration rates (what amount is not first intercepted in the canopy) under the tree canopy, however, because junipers also diminish the grass cover outside of the canopy, increased runoff and erosion is created in the space outside of the tree's dripline.
- Herbaceous Production: Juniper has extensive lateral and deep roots and physiological adaptations that enable it to extract water from very dry soil. It also has a dense mat of fibrous roots at the soil surface. These traits allow juniper to outcompete grass for water and nutrients.
- Evapotranspiraton: Aside from intercepting and evaporating water before it reaches the soil surface, junipers are evergreens and have the capability to transpire water yearlong, including times when grasses have gone into a temperature or drought-induced dormancy.
- Runoff: Juniper leaf litter and the increases to infiltration rate caused by the root system allow the tree to intercept and infiltrate runoff flowing from interspaces between trees. However, when the tree is cut and removed, the modified soil structure remains for many years and improves deep infiltration and reduces runoff.
- Recharge: Junipers affect deep drainage on rangelands because of the effects on the water balance including 1) a large percentage of total rainfall never reaching the soil and 2) junipers extract most of the water that does enter the soil to meet its transpiration requirements. Invasion of juniper on areas that were primarily grassland has strong implications for recharge of aquifers.

9.5. Fire Regime and Condition Class

The Big Chino sub basin area is characterized by vegetation types evolved and maintained by fire. The Yavapai Communities Wildfire Protection Plan (YCWPP) area is characterized by vegetation types evolved and maintained by fire. Fire started by lightning and native people was an integral part of the local ecosystems. This ecological setting was likely diverse and productive with a built-in resistance to large scale, devastating fires. Fire regime and condition class are significant because of this history. Fire events are inevitable, but their affect is manageable through prevention; namely, removing and reducing density of vegetation.

The effect fire has on vegetation types within the area is highly variable and complex. Ecological processes, such as intermediate stage development, nutrient cycling, fuel accumulation, and water availability are all influenced by fire, as well as vegetative characteristics such as fuel composition, plant health/vigor, age/size class distribution, and species composition.

Vegetation types may be classified by fire regime. The area includes several natural fire regimes because of the diversity in soil, elevation, aspect, precipitation, and vegetation type. The natural fire regime is the total pattern of fires within the vegetation type that is characteristic of that portion of the area. Factors that make up the natural fire regime include source of ignition, behavior and intensity, size, return interval, and effects. Fire regimes may be described by intensity, effect on vegetation, and frequency.

The Condition Class of a vegetation type for a particular area may be used to define its departure from the natural fire regime. This departure from historical fire frequencies and the level of change from the natural regime are considered along with the likelihood of losing key ecological components to determine the current Condition Class.

- Condition Class 1: Fire regimes are within an historical range and the risk of losing key ecosystem components is low.
- Condition Class 2: Fire regimes have been moderately altered from their historic range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals.
- Condition Class 3: Fire regimes have been significantly altered from their historic range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals.

During the last century natural fire return intervals have been interrupted across most of the PrAMA and Big Chino sub-basin. The current fire environment can be characterized by an overgrown complex fuel profile, moderate to steep terrain, poor ground access, increasing percentage of dead standing and downed trees, increasing percent dead in understory bushes, an extended drought climate and an expanding wildland/urban interface.

The longer the return interval of fire, the more severe and larger the fire event. Also, the more acres burned by fire through time affects the movement towards restoration of the natural fire regime at the landscape level.

Primary vegetation types within the study area are affected by fire, and affect fire behavior in different ways:

Ponderosa Pine. In this vegetation type, Ponderosa pine (*Pinus ponderosa*) is the predominant tree species throughout although other species such as White fir (*Abies concolor*) and Douglas fir (*Pseudotsuga menziesi*) may be found in association at the higher elevations, while Gambel oak (*Quercus gambelii*), pinyon pine (*Pinus* *californiarum var. fallax*), shaggy bark juniper (*Juniperus osteosperma*), Alligator juniper (*Juniperus deppeana*) and chaparral species are intermixed to varying degrees. Many Ponderosa pine stands are currently stocked at moderately high levels with an age class composition characterized as mostly immature with very little in the young and mature components.

The natural fire regime within this vegetation type was probably typical of other western Ponderosa pine forests. This regime can be described as having frequent light surface fires with return intervals of from one to twenty-five years (Covington, 1992; Dieterich, 1988). These fires maintained open and park-like conditions with a grass and forb understory. Burning released nutrients from accumulated woody debris and leaf and needle litter.

Fire suppression, timber harvesting, and historical grazing practices have disrupted the natural fire regime to the extent that current tree stocking is relatively high and associated forest fuels are more continuous. Understory grass and forb stocking is correspondingly low. The absence of fire has allowed the conversion to shade-tolerant species at the higher elevations. These understory species have become ladder fuels, allowing fire to climb from the surface fuels up into the Ponderosa pine overstory, causing more severe and destructive fires. Some of the Ponderosa pine vegetation type is currently in Condition Class 3 which means that fire frequencies have departed from historical frequencies by multiple return intervals. In these areas, fire regimes have been significantly altered from the natural range and the risk of losing key ecosystem components is high.

<u>Pinyon-Juniper</u>. The species that make up this vegetation type include pinyon pine, and numerous junipers (*Juniperus deppeanna, J. monosperma, and J. osteosperma*). In some cases chaparral may be found intermixed, and in others grasses are interspersed through the vegetation type. Ponderosa pine and riparian vegetation including Arizona walnut and willow may be found in some drainage bottoms as well. Pinyon-juniper and pure juniper stands are represented by a range of stocking levels with general ages being greater than 50 years with many old age trees in the hundreds of years. These woodland stands typically have little understory vegetation and ground cover. They can also be characterized by extensive levels of sheet and gully erosion. Areas previously chained, sheared, or fire wooded with no follow-on prescribed fire are now restocked with moderate to high levels of regeneration by juniper and/or chaparral species. Extensive areas of natural grassland are currently being encroached upon by constantly expanding juniper(*J. osteosperma*). Trees of various ages, including relatively young trees, produce seeds which are carried by water down slope into the grasslands.

The natural fire regime within this vegetation type was likely one characterized by infrequent and severe surface fires with return intervals of more than 25 years (Hollenshead, 2001). However, the natural range was probably more confined than today with much having been grassland with a significantly different fire regime. The natural range was probably more limited to sites that were relatively protected from frequent fire, such as rock outcrops. When these stands burned under this fire regime there were likely sporadic and isolated crown fires that killed many trees but did not replace the stand (Hollenshead, 2001).

Fire suppression combined with certain historical grazing practices has significantly disrupted the natural fire regime of natural grassland areas. Many of these areas are now occupied by the pinyon-juniper vegetation type with correspondingly sparse to nonexistent understory vegetation and surface fuels. This current vegetation and fuels condition will not carry the frequent low-intensity surface fires that occurred naturally. Significant loss of the grassland component on these acres has already occurred, and the current risk of losing key ecosystem components to a fire event is relatively low.

<u>Chaparral</u>. Predominant species include mountain mahogany (*Cercocarpus montanus*), manzanita (*Arctostaphylos pungens*), silk tassel (*Garrya wrightii*), scrub oak (*Q. turbinella*), emory oak (*Q. emoryi*), and Arizona white oak

(*Q. arizonica*). The post-fire resprouting shrubs associated with this vegetation type may include Gambel oak, manzanita, mountain mahogany, scrub oak, and silk tassel. This vegetation type is arranged as large, continuous stands of chaparral in addition to being interspersed with pine and juniper. A range of stocking levels is represented in this vegetation type with an approximate age class composition as mostly mature, some young, and very little immature. Mature chaparral stands tend to have little in the way of understory vegetation and associated ground cover. Extensive levels of sheet and gully erosion of the soils can occur in these stands.

The natural fire regime within this vegetation type was characterized as severe surface fires combined with crown fires. The return interval was approximately 35 to 40 years (Floyd-Hanna, 1997). These fires served as replacement events in mature stands of chaparral and likely resulted in a mosaic of age classes across the landscape.

Fire suppression has moderately altered the natural fire regime in the chaparral vegetation type. Relatively large and continuous stands with little age class or structural diversity now make up much of the chaparral. Most of this type has burned at least once in the last century, which represents a departure by at least one fire return interval. This places much of the chaparral in Condition Class 2. Fire regimes have been moderately altered from their historic range, and the risk of losing key ecosystem components is considered moderate.

Grassland. Grassland in the study area has been altered to varying degrees by overgrazing and invasion of woody species. The natural fire regime within this vegetation type was characterized as low-intensity surface fires with a return interval of from one to twenty-five years (Hollenshead, 2001). Frequency and nature of these fires likely maintained the grass composition and prevented the establishment of woody vegetation.

Fire suppression combined with historical grazing practices has significantly disrupted the natural fire regime on some natural grasslands. Many of these areas have evolved into chaparral stands or woodlands and now may have a completely different fire regime. Existing grasslands have probably not burned as frequently as in the past. However, fire events have occurred and have helped to promote and maintain the grass component. Departure from the natural fire regime is difficult to determine. The risk of losing key ecosystem components may be low. On those portions of the watershed in a vegetation condition class of two or three, the reduction in woody biomass along with the reintroduction of fire is expected to reduce soil erosion, improve soil hydrology, increase grass stocking and enhance tree growth.

9.6. Capitalization on Urbanization

Different development patterns impact the watershed both positively and negatively. Recognizing that development will continue to occur, projects will focus on mitigating impacts from existing development and/or minimize impacts of future development.

Urbanized areas increase the amount of impermeable surfaces (paved areas and rooftops), increasing runoff rates and volumes. Current development codes require that the peak runoff rate not be higher than the runoff rates for the property prior to development. Mitigation measures such as detention basins are common in the commercial areas of the PrAMA. However, the total runoff volume after a rain event is often larger than the pre-development conditions due to the reduction of on-site infiltration into the soil. Because there is an additional volume of water that is created due to urbanization, opportunities exist to utilize the increased runoff to enhance recharge.

The City of Prescott currently has a system in place to take advantage of much of the urbanized runoff. Two reservoirs, Watson and Willow Lakes, are downstream of much of the city's urbanized areas and capture the additional runoff. However, historic water rights owned by the city to the water in the reservoirs remain unchanged. There may be an opportunity to capture the amount of additional runoff due to urbanization, store in reservoirs and put that water to beneficial use.

There are water right issues to be aware of when looking at a system to utilize urban runoff. Downstream, senior water right owners will have a basis of claim for the pre-development water runoff. Proving how much water is "new" water from urbanization will take effort.

9.7. Land Use Management, Conservation and Aquifer Protection

Land use management will involve water providers and residential, commercial, and agricultural land users. In addition to large scale recharge enhancement projects, smaller scale conservation and rainwater harvesting projects were investigated. Land use management and conservation projects and policies address landscape considerations, range management, and reducing consumer water use.

Aquifer protection projects must address growth impacts to the groundwater supplies. Within the PrAMA portion of the watershed, the 1980 Groundwater Management Act and subsequent policies and laws have resulted in a moratorium on new groundwater-supplied irrigated agriculture, prevent new subdivisions to be constructed using existing groundwater supplies, established water rights, require implementation of conservation practices and establish well spacing guidelines.

Within the Big Chino sub-basin portion of the watershed, only the Big Chino Water Ranch property purchased as a water supply by the City of Prescott carries any such protection. Outside of this, there are as many as 500,000 acres of private and State Trust Land within the sub-basin that may be developed. Aquifer protection programs for this sub-basin will require a significant amount of political will to enact. Some of the aquifer protections that have been enacted in other areas that may replicable in the Big Chino sub-basin include:

- Purchase of development rights (conservation easements)
- Arizona State Trust Land reform
- Low or no-Impact developments employing wastewater and rainwater collection and recharge
- Establishment of water rights and prohibition on new uses

Because these are largely policy-related programs, the Watershed Task Force did not create a project. Next steps toward implementation will be through direction from the Coalition Executive Board and other stakeholders.

10.0 Project Evaluation Criteria

Evaluation criteria were established for each project concept, and used to screen potential projects prior to full development.

10.1. Vegetation Management

Projects target pinion-juniper and chaparral removal, with the intent of restoring grassland conditions, reducing evapotranspiration and ultimately increasing recharge. They include prescribed burns and removal of exotic vegetation species. Projects will incorporate monitoring to demonstrate the effectiveness of the prescription. Screening criteria are included in Table 4.

Table 4 – Vegetation Restoration Project Criteria

Evaluation Criteria	Consideration/Required Value
Vegetation type/density	Pinion juniper or chaparral
Slope/aspect/elevation	Site specific
Size	40 acre minimum (control and project site)
Ownership	Cooperative ownership Excludes small private parcels
Soil type/geology	Conducive to runoff and recharge
Recharge/runoff potential	Site specific; proximity to basin boundaries
Measurable conditions	Site specific – instrumentation/ stream levels and other measurement methods acceptable
Close proximity of sites	Prefer adjacent/close
Consistent with management plan(s)	Taskforce Watershed Plan; PNF Plan; PrAMA 4th Management Plan, etc.
Potential Natural Vegetation Type	Consistency with NRCS recommended vegetation Long term viability
Secondary benefits	Habitat; fire control; grazing; water quality; flood control
Accessibility	Must be reasonable treatment and monitoring Must have legal access
Precipitation/weather	Site specific; day-to-day conditions for access and monitoring
Representative of watershed	Must be able to replicate or ability to upscale

10.2. Infiltration Enhancement

Infiltration enhancement projects will typically involve constructing gabions to slow runoff flow during rain events in washes, increasing detention time in the channel, and expanding the wetted perimeter to increase recharge. Gabion design will meet all flood control requirements and will adhere to conventions honoring down-stream appropriative water rights. Screening criteria for infiltration enhancement projects are included in Table 5.

Table 5 – Infiltration Enhancement Project Evaluation Criteria

Evaluation Criteria	Consideration/Required Value
Slope/aspect/elevation	Gentle slope
Location	Systems not in place already; proximity to location with recharge potential; proximity to location as alternate source
Size	Large enough to have "control" portion of site
Ownership	Cooperative ownership
Vegetation	Conducive to filtration and water quality
Soil type/geology	Acceptable permeability; transmissivity to recharge aquifer; sheet flow occurring
Measurable conditions	Site specific; baseline data available
Representative of watershed as a whole	Must be able to replicate or upscale
Environmental	Grazing; habitat; flood control; etc. Investigations complete
Accessibility	For treatment and monitoring Must be reasonable and legal access
Precipitation/weather	Site specific; day-to-day conditions for access and monitoring

10.3. Capitalization on Urbanization Project Concept

Capitalization on urbanization projects are designed to mitigate the impacts of development on the watershed. Project components will be site specific and likely include vegetation restoration within the project boundary, rainwater harvesting, flood water management, enhancements to improve downstream water quality, or other unique measures to enhance recharge, improve water quality, habitat and esthetics. They may be located be on public or private lands, as opportunity dictates. General and site specific applications will be investigated and considered. Screening criteria are included in Table 6.

Table 6 – Capitalization on Urbanization Project Evaluation Criteria

Evaluation Criteria	Consideration/Required Value
Existing vs. New	Existing – already permeable; New – ordinance based
Slope/aspect/elevation	Site-specific
Location	Systems not in place already; proximity to location with recharge potential; proximity to location as alternate source
Ownership	Cooperative ownership
Soil type/geology	Appropriate on-site and at recharge site
Measurable conditions	Site specific
Representative of watershed	Must be able to replicate or upscale
Accessibility	For treatment and monitoring Must be reasonable and legal access
Precipitation/weather	Site specific; day-to-day conditions for access and monitoring

10.4. Land Use Management, Conservation and Aquifer Protection Project Concept

The last project concept focuses on resource management. Implementation may be in the form of public education, conservation incentives, and/or policy changes regarding land and water use. Physical project implementation or policy revisions may be completed by others and/or individuals. Screening criteria for this concept are included in Table 7.

Table 7 – Land Use Management/Conservation Project Concept

Evaluation Criteria	Consideration/Required Value
Location	Proximity to other water-using sites
Vegetation	Appropriate
Species	Type and number
Recharge	Natural recharge already occurring
Measurable conditions	Site specific; baseline data available
Environmental	Grazing; habitat; flood control; etc.
Accessibility	For treatment and monitoring; Must be reasonable and legal access
Secondary benefits	Habitat; Fire control; Grazing; Water quality; Flood control
Precipitation/weather	Site specific; day-to-day conditions for access and monitoring

11.0 Project Development

11.1. Vegetation Restoration

Vegetation management addresses the concept of increasing watershed recharge by removing woody vegetation from native grassland or reducing the density of woody vegetation and increasing grass density. Eventual reintroduction of fire is a desired maintenance element. All project concepts will incorporate some type of hydrologic, meteorlogic and vegetation monitoring to determine project effectiveness in meeting goals.

A range of vegetative types are found within the central portion of the Big Chino sub-basin and are generally associated with elevation. On the west side of Big Chino Wash grasslands at 4,500 feet elevation above sea level transition through pure shaggy bark juniper stands, increasing amounts of chaparral and cacti species as elevation rises, mixed with pinyon pine around 5000 feet. Grass composition and stocking varies, but is always representative of full site potential.

The effect of slope aspect on micro site conditions and resulting species composition is evident and translates into many exceptions to this general association within a very narrow elevation range. Higher elevation plants are found on cooler, moister sites (facing north and east) at lower elevations, and lower elevation plants are found on hotter, dryer sites (facing south and west) at higher elevations.

Evidence of previous tree removal activities are common on some private ranch properties and span decades since the pushing, pulling, shearing, or firewood cutting first took place. Generally speaking, there is little evidence of fire across this part of the landscape. The response by woody vegetation has been to fully occupy the site either as sprouted chaparral brush or natural regeneration of juniper and pinyon trees. Grass stocking is typically less under moderate to heavy brush and juniper stands with more stocking in openings and throughout lighter stocked stands of trees and brush.The desired condition is a fully stocked woodland forest dominated by grass and maintained with frequent fire. This condition will minimize soil erosion, enable soil building, promote wildlife habitat, and improve soil moisture.

It is anticipated that rubber-tired machines will be used to harvest and transport trees to a staging area. Expected products include firewood and woody biomass. A bio baler may be used to harvest and bale brush. The exact vegetation removal methodology and treatment will be determined on a case by case basis as projects are implemented. Each project sheet includes project costs based upon "lop and drop" and harvesting and forwarding methods. Lop and drop is the cutting of trees and leaving them in place; harvesting and forwarding involves cutting the trees, concentrating the woody biomass, and forwarding it to an area convenient to pick up for commercial reuse.

In order to use rubber-tired machines and utilize removed trees and brush, ground conditions must have operating slopes less than 45 percent with minimal rock outcrops. When possible, thinned trees and brush will be removed from the treatment area and linked into a transportation system. Access to these treatment areas is available on existing roads. Primary routes include Williamson Valley Road, Camp Wood Road, and Big Chino Road. Secondary road segments are across private ranch property. Harvest and transportation design on ASLD and NFS lands will be according to their respective specifications and permit requirements.

Project sites that require further environmental investigation and/or cultural surveys will be implemented after these investigations are completed by the responsible agency (i.e. NEPA requirements completed by the U.S. Forest Service on Prescott National Forest land). Monitoring duration will typically span 5 years. At the end of five years and based on the project results, project maintenance without monitoring may continue. No requirement for maintenance is anticipated within the monitoring period (five years). Timeframe for implementation for each project is variable.

The use of fire is recommended to maintain restored vegetation. In many instances fire will be difficult to implement. Private lands owners may not have the necessary insurance and will likely need to obtain a burn permit. A regionalized burn plan will expedite burn approval, and require a multi-stakeholder and agency approach. If approval to burn is not obtained, maintenance activities will include mowing and bailing re-growth.

Successful commercialization of woody biomass removal will play a key role in long-term and wide-spread implementation of vegetation restoration and management. Based upon available funding, site location and configuration, projects may include biomass determination per acre, or how much woody biomass is generated by clearing an acre of junipers and other invasive species. This knowledge is critical to commercialization of the harvested woody materials as an alternative fuel source or as a raw material for manufacturing. Biomass determination per acre is key in learning:

1) whether there is enough local biomass for sustained commercial use;
2) the cost effectiveness of woody biomass harvesting for commercial use; and
3) whether market(s) will develop for the use of woody biomass.

The Coalition is a member of Arizona's Woody Biomass Team established to assist organizations with conversion to wood energy, investigate the feasibility of wood energy conversions, and forward establishment of markets for use of woody biomass.

Public awareness, education, and acceptance will also be critical to long-term success. Vegetation restoration projects may not initially be well received because of the tree removal requirement. Projects should include an educational component to communicate the importance of removing invasive species and the resulting reduced wildfire risk.

Cost estimates for each project are included in Appendix B with several exclusions. A permitting mechanism for widespread vegetation removal on forest service lands does not currently exist; therefore, these permit costs have been excluded from the cost estimates. In addition, permit costs are not available for ASLD lands, and costs will be variable on private lands. Again, due to uncertainty, permitting costs were excluded.

11.1.1. Hydrologic Monitoring Plan for Vegetation Restoration Projects

Hydrologic monitoring is necessary to determine the impact of vegetation restoration on hydrologic conditions. Past studies of vegetation treatments only monitored surface water runoff from a given site, and the element of recharge or deep percolation was omitted.

Within this planning area, the recharge component of the water budget is possibly the most significant element. Much of the planning area lies either on top of or near an alluvial aquifer that forms the primary water supply for water users, as well as for notable springs, such as the Upper Verde Springs. Direct measurement of recharge is difficult and expensive, which is likely why it has not previously been attempted. Chemical analysis is possible, such as a chloride mass balance study, but a collection reservoir buried below the plant root zone is still required to collect water samples. For monitoring proposed in this report, an inexpensive direct water collection lysimeter will be employed. These inexpensive "passive wick" lysimeters are a relatively recent development for use in groundwater hydrology but have been well-tested in the agricultural arena to monitor deep drainage and transport of constituents by percolating water. Passive wick lysimeters use a slight negative atmospheric pressure to collect percolating water from a soil column and collect that water in a tube where it can be weighted and tested. The rate of water percolating past the root zone (and therefore into the aquifer) can be directly converted from the weight of the water in the collection tube. Additional analysis, such as a chloride mass balance, can also be completed.

It is important to note that although these lysimeters are relatively cheap, we still cannot install enough of them to develop a statistically valid quantitative value of recharge. However, these lysimeters are used in a comparison study, not in a quantitative analysis. In other words, the study examines the changes caused by vegetation restoration, while the other part of the study is established as a control without any vegetated changes, somewhat like a trial for approval of a new drug. The collected data is compared to the control sample to determine if improvements to recharge were observed or not.

Three lysimeters will be installed in each small paired watershed project area, one below the active stream channel near the outlet of the watershed, one within the floodplain and one in a representative vegetated area. Each watershed within the pair will mirror each other to the extent possible. A year of data collection prior to any vegetation treatment is proposed in order to compare and normalize the data between the watershed pair without the added influence of vegetation treatment.

In addition to recharge rates, surface water outflow and meteorological conditions will be measured. Surface water outflow completes the water budget and meteorological data can be used to calculate evapotranspiration (ET) from the study area for a given vegetation class. Vegetation transects will also be conducted to determine the success of native grass recruitment and reestablishment of the removed vegetation.

Project Name:
K4 Ranch – Walnut Creek

Location:
Limestone Peak Quad
T18N R4W S 3 & 4

Project type:
Vegetation Restoration

Project size:
240 acres
(multiple possibilities)

Treatment:
- Juniper Removal Grassland Restoration
- Groundwater monitoring

Cost to Implement:
Lop and drop:
$94,000

Harvest and Forward:
$170,000

Anticipated Annual Monitoring Expense:
$25,000

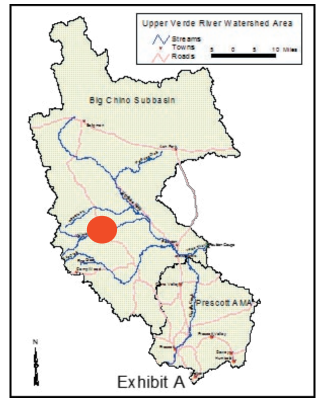
Timeframe for implementation:
3 months – 1 year

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Lop and drop:
$241,000

Harvest and Forward:
$317,000

K4 Paired Watershed



Project site description: The approximate 240 acre paired watershed is characterized by distinct drainages oriented northwest to southeast with all aspects and slopes ranging from 5-25 percent. Areas of high erosion are evident. No evidence of fire is apparent. The site has not previously been treated. There is a local limestone outcrop that could impact recharge by creating a "bowl" that captures water.

Ownership: Ownership is private.

Existing Vegetation: The site is moderately stocked by shaggy bark juniper and pinyon pine (150 trees/acre) and lightly occupied by scrub oak brush. Tree heights range from 5' - 20'. Understory grasses are well stocked in some places and typically less stocked on mid and upper slopes where less mineral soil is present. Juniper tree relics are common across the site

Topography: Variable slopes (large areas of gentle slopes are present). Distinct surface drainage channels are present

Soils: Gravelly, cobbly or stony soils that are dominantly sandy loam or nearly level to steep fans, plains, and valley side slopes

Geology: Tertiary sedimentary rocks and terrace gravels

Hydrology: Tributary drainages to eastern portion of Walnut Creek. Washes are sandy bottomed and presumed to be a major recharge source to the Big Chino sub-basin. Depth to water in nearby wells is approximately 130-400 feet.

Hydrologic Monitoring: Nearby wells on K4 ranch.

Project description: Paired watershed, Juniper clearing (and potential utilization), surface water and groundwater monitoring, ecological monitoring. The silvicultural prescription will include thinning from below of all species and an overstory stand improvement by retaining better vigor and form trees. Fire may be reintroduced. Expected products include firewood and biomass. Many areas nearby were previously treated (20-25 years ago) and could be used for comparison.

Site Access: Access to the site is from the Big Chino Road across the T2 and K4 ranches or from Williamson Valley Road across the K4 ranch.

Permitting: K4 will likely require an update to their ranch management plan to incorporate treated and control areas. Burn permits obtained for vegetation maintenance can be obtained from the Arizona Department of Environmental Quality (ADEQ). Permitting costs have been excluded from the project cost estimate.

Site Photos - K4 Ranch at Walnut Creek

Project Name:
K4 Ranch – Indian Springs

Location:
Limestone Peak Quad
T18N R4W S 31 & 32

Project type:
Vegetation Restoration

Project size:
100 (multiple possibilities)

Treatment:
- Juniper Removal Grassland Restoration
- Groundwater monitoring

Cost to Implement:
Lop and drop:
$76,000

Harvest and Forward:
$111,000

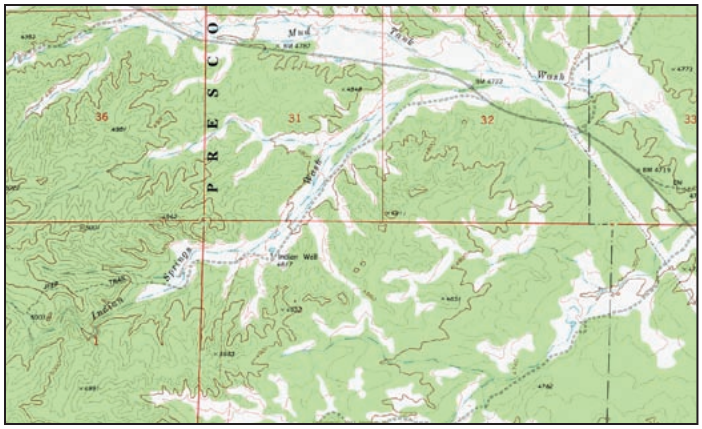
Anticipated Annual Monitoring Expense:
$25,000

Timeframe for implementation:
3 months – 1 year

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Lop and drop:
$223,000

Harvest and Forward:
$258,000



Project site description: The approximate 100 acre paired watershed is characterized by distinct drainages oriented northwest to southeast with all aspects and slopes ranging from 5-25 percent. No evidence of fire is apparent. The site has previously been treated by fire wood cutting of juniper trees.

Ownership: Ownership is private.

Existing Vegetation: The site is moderately to heavily stocked with pinyon pine and shaggy bark juniper trees (100 trees per acre) and moderately to heavily stocked with scrub oak brush (200 plants per acre). Tree heights range from 15'-30'. Understory grasses are well stocked in places not occupied by brush. Juniper tree relics are found where fire wood cutting did not occur.

Topography: Gentle slopes on east side of Santa Maria Mountains. Distinct surface drainage channels.

Soils: Gravelly, cobbly or stony soils that are dominantly sandy loam or nearly level to steep fans, plains, and valley side slopes

Geology: Tertiary sedimentary rocks and terrace gravels. Some young alluvium

Hydrology: Indian springs and Mud Tank washes; presumed to be a potential recharge source to the Big Chino sub-basin. Depth to water in the vicinity in nearby wells is approximately 150-350 feet based on data available from ADWR's database.

Project description: Juniper clearing (and potential utilization), groundwater monitoring, ecological monitoring. The silvicultural prescription will include a thin from below of all species including bushes and an overstory stand improvement by retaining better vigor and formed pinyon pine trees. Larger stemmed oaks will also be retained. Fire may be reintroduced. Expected products include fire wood and biomass.

Site Access: Access to the site is from Williamson Valley Road across K4 property.

Permitting: K4 will likely require an update to their ranch management plan to incorporate treated and control areas. Burn permits for maintenance can be obtained through ADEQ. Permitting costs have been excluded from the project cost estimate.

Site Photos - K4 Ranch at Indian Springs

Project Name:
Cross U Ranch

Location:
6.5 miles west of Williamson Valley
Road on Camp Wood Road
N 34° 48' 50"
W 112° 45' 36"

Project type:
Vegetation Restoration

Project size:
200 acres

Treatment:
- Juniper removal
- Groundwater/Surface water monitoring, ecological monitoring

Cost to Implement:
Lop and drop:
$93,000

Harvest and Forward:
$162,000

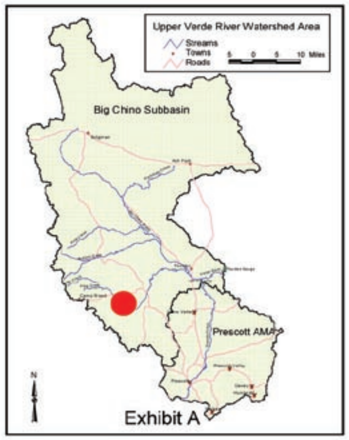
Anticipated Annual Monitoring Expense:
$25,000

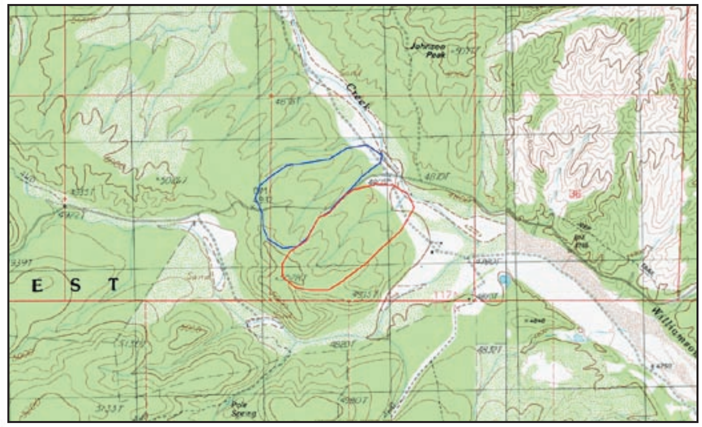
Timeframe for implementation:
3 months – 1 year

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Lop and drop:
$240,000

Harvest and Forward:
$290,000





Project site description: The approximate 200 acre paired watershed is characterized by distinct drainages oriented southwest to northeast and slopes ranging from 5-30%. No evidence of fire is apparent. The site has been previously treated by chaining of juniper trees.

Ownership: Majority ownership is US Forest Service with private on the lower slope.

Existing Vegetation: The site is moderate to heavily stocked with pinyon pine and shaggy bark juniper trees (250 trees per acre) and moderate to heavily stocked with chaparral brush (150 plants per acre) including manazanita and scrub oak. Tree heights range from 15-30 feet. Understory grasses are moderately stocked in the few openings across the site. Juniper tree relics are found where chaining did not occur; typically the upper slopes and drainages.

Topography: Level to steep, shallow-sloped project areas do exist

Soils: Deep and shallow, gravelly, cobbly or stony soils that are dominantly sandy loam or nearly level to steep fans, plains, and valley side slopes

Geology: Mixed Sedimentary Rocks (siltstone, sandstone, and minor conglomerate).

Hydrology: Tributary drainages to upper portion of Williamson Valley Wash. Wash is sandy bottomed and presumed to be a major recharge source to the Big Chino sub-basin. Depth to water in the vicinity from one GWSI well in 2013 was 17 feet bls.

Hydrologic Monitoring: GWSI well B-17-04-34-DBA. A stream gage approximately 1 mile downstream on Williamson Valley Wash has been installed and operated by City of Prescott and SRP.

Project description: Paired watershed, juniper clearing, surface water, groundwater monitoring and ecological monitoring. The silvicultural prescription will include thinning from below of all species and a stand improvement in the overstory by retaining trees of good form and vigor. Understory and mid story pinyon pine trees will also be retained. If possible, fire will be reintroduced. Expected products include firewood and biomass.

Site Access: Site access is from Camp Wood Road across the Cross U ranch property.

Permitting: The Forest Service expects to complete NEPA permitting for this site in 2015. Project implementation will be deferred until those efforts are complete. Permitting costs have been excluded from the project cost estimate.

Site Photos - Cross U Ranch

Project Name:
Mud Tank Wash

Location:
North of Mud Tank Wash and South of County Road 5 (Williamson Valley Road). T18N R5W Sec 26 and 27

Project type:
Vegetation Restoration

Project size:
200 acres

Treatment:
- Juniper/brush removal
- Groundwater/Surface water monitoring, ecological monitoring

Cost to Implement:
Lop and drop:
Not developed

Harvest and Forward:
$160,000

Anticipated Annual Monitoring Expense:
$25,000

Timeframe for implementation:
3 months – 1 year

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Lop and drop:
Not developed

Harvest and Forward:
$309,000

Mud Tanks Wash Paired Watershed

Project site description: Approximate 200 acre paired watershed. No evidence of fire is apparent. Based on forest service K4 allotment mapping, the subject watersheds are located within an area of forest with significant departure from Prescott National Forest (PNF) defined desired conditions. The area has been identified by the PNF for planned "spot mechanical thinning and or prescribed fire." Additional project information is included in Appendix C.

Ownership: Ownership is US Forest Service

Existing Vegetation: The site is moderately to heavily stocked with pinyon pine and shaggy bark juniper trees (100 trees per acre) and moderately to heavily stocked with scrub oak brush (200 plants per acre). Tree heights range from 15'-30'. Understory grasses are well stocked in places not occupied by brush. Juniper tree relics are found where fire wood cutting did not occur.

Topography: Watersheds drain into Mud Tank Wash, which drains about 2 miles southeast to its confluence with Indian Springs Wash. Elevation of the paired watershed ranges from approximately 4950 - 5150 feet.

Soils: Soil types will be investigated during project implementation.

Geology: Geology will be investigated during project implementation.

Hydrology: Watersheds drain into Mud Tank Wash, which drains about 2 miles southeast to its confluence with Indian Springs Wash.

Hydrologic Monitoring: Hydrological parameters, including soil moisture and surface runoff, as well as sedimentary and soil characteristics will be monitored using standard monitoring techniques. A temporary weir will be established in each watershed outlet and fitted with a data logger.

Project description: Paired watershed, juniper clearing, surface water, groundwater monitoring and ecological monitoring. The silvicultural prescription will include thinning from below of all species including bushes and an overstory stand improvement by retaining better vigor and formed pinyon pine trees. Larger stemmed oaks may also be thinned.

Site Access: Access to the site is from Williamson Valley Road across K4 property.

Permitting: This project is consistent with US Forest Service plans for the area. Permitting costs have been excluded from the project cost estimate.

Project Name:
T2 Ranch – Big Chino Wash

Location:
Limestone Peak Quad
T19N R4W S 35 & 36

Project type:
Vegetation Restoration

Project size:
100-200 acres
(multiple possibilities)

Treatment:
- Juniper Removal
  Grassland Restoration
- Groundwater monitoring

Cost to Implement:
Lop and drop:
$79,000-$94,000

Harvest and Forward:
$111,000-$157,000

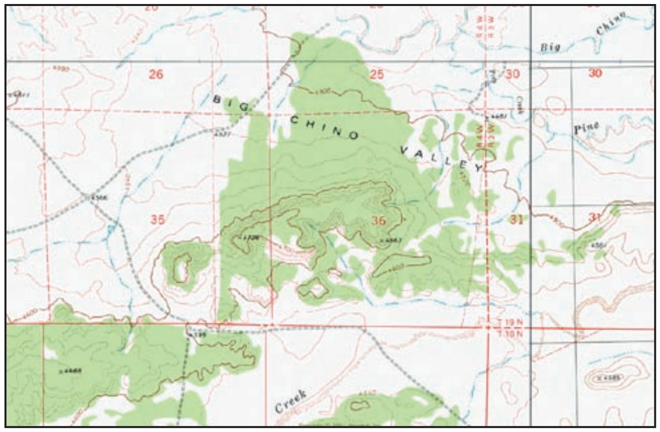
Anticipated Annual Monitoring Expense:
$25,000

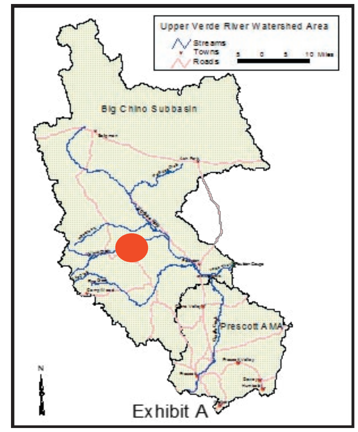
Timeframe for Implementation:
3 months – 1 year

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Lop and drop:
$226,000-$241,000

Harvest and Forward:
$258,000-$304,000





Project site description: The approximate 100 acre T2 Ranch Big Chino Wash sub-watershed is characterized by a north aspect slope ranging from 1-15 percent. No distinct drainage is evident. A highly eroded band extends across much of the site. No evidence of fire is apparent. The site has not previously been treated.

Ownership: Ownership includes the private T2 Ranch and Arizona State Land Department. The rancher has no priority area.

Existing Vegetation: Site is moderately stocked (150 tpa) by relatively young shaggy bark juniper ranging in height from 5-15 feet. Understory grasses are well stocked in places. Evidence of tree relics are found on the upper slope and do not extend down slope.

Topography: Gentle north-slope. No distinct surface drainage channels.

Soils: Gravel, cobbly or stony soils that are dominantly sandy loam are nearly level to steep fans, plains, and valley side slopes. Soil composition varies widely.

Geology: Tertiary sedimentary rocks and terrace gravels.

Hydrology: Near Big Chino Wash and presumed to a potential recharge source to the Big Chino sub-basin. Depth to water nearly wells is 15-350 feet based on data available from ADWR's database.

Site Access: Access no the site is from the Big Chino Road across T2 ranch property.

Project description: Juniper clearing (and utilization), groundwater monitoring, ecological monitoring. The silvicultural prescription will include the removal of encroached juniper, retention of old age juniper and pinyon trees, and reintroduction of fire.

Permitting: Private lands will likely require an update to their ranch management plan to incorporate treated and control areas. State lands will require a cultural survey. Additional environmental investigation may be required, dependent upon results of the cultural survey. Project work on state lands will be deferred until cultural surveys are completed by the state land department. Permitting costs have been excluded from the project cost estimate.

Site Photos - Big Chino Wash at T2 Ranch

11.2. Infiltration Enhancement

Potential projects include flood detention measures such as in-channel gabion structures, modification to channel morphology and induced recharge projects.

11.2.1. Flood Detention

Flood detention measures will take the form of open graded rock gabions with filter fabric beneath in existing wash beds. The intent is to increase recharge by slowing water flow through the channel during storm events. Gabions will be spaced based upon existing channel slopes. Due to the fact that favorable soil conditions have been visually observed in washes with significant drainage areas, the intent is to utilize the effectiveness of gabions during smaller rainfall and runoff events, and design them to fail during larger events, such as the 50 year 24 hour storm and 100 year 24 hour storm. This will be accomplished by sizing the rock (rip-rap) size to disperse upon exposure to wash flows associated with these events. Gabions will be constructed as a 'leaky' rock structures so surface water is not retained and appropriative rights are not impacted.

Ten sites were reviewed and considered. Each site had surface evidence of permeable soils, a long, supercritical wash reach, and relatively close proximity to existing wells. Most sites are also located within designated floodplains. Hydraulic modeling and/or rip-rap sizing will be conducted prior to construction to assure channel water levels do not experience a net rise during design storm runoff events. Map 3 showing the locations of infiltration enhancement projects is included on the next page. Project data sheets follow and indicate the site number next to the project title. A conceptual detail for construction of gabions is included as *Figure 2*.

Although gabions are utilized for sediment control as a Best Management Practice, monitoring will occur to gauge the impact on recharge. Two system arrays will be installed, one will serve as a control where no water detention occurs. Additional information on hydrologic monitoring for gabion projects is included in Section 11.1.3. Monitoring is expected to occur for a minimum of five years.

Maintenance included in the project cost estimates reflect the probable need for reconstruction of the gabion arrays every five years due to flows associated with larger storm/runoff events. Cost estimates for each project are included in *Appendix D.*

11.2.2. Hydrologic Monitoring Plan for Gabion Projects

Similar to the vegetation restoration projects discussed earlier, the effectiveness of gabions in inducing recharge will be determined with lysimeters (section 10.1.1) that directly measure recharge rates.

In the case of gabions, two lysimeters will be installed within the area of influence of the gabion and two lysimeters outside of predicted influence of the gabion, preferably upstream of the wetted influence. Each site will locate a lysimeter under the active flow channel and another just outside of the flow channel, on the edge of the new wetted perimeter caused by the gabion. These locations and distances will be mirrored upstream, away from the gabion's influence with another pair of lysimeters.

In addition to measuring recharge rates, flow stage (depth of flow) and time of flow will also be measured and recorded. This will be accomplished with a pressure transducer within the active flow channel in a straight and well defined area of the channel.

Map 3 - Location of infiltration enhancement projects

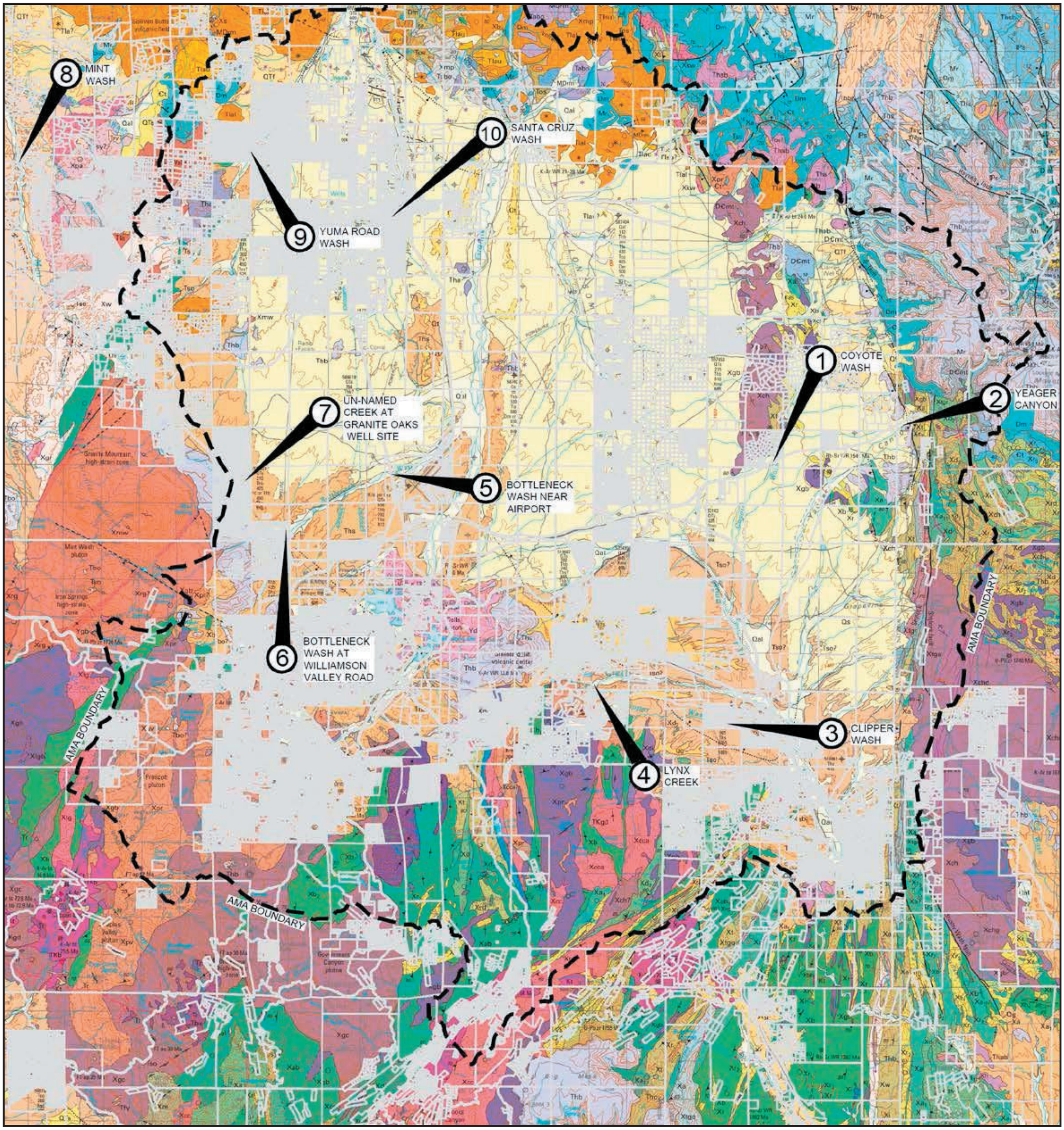
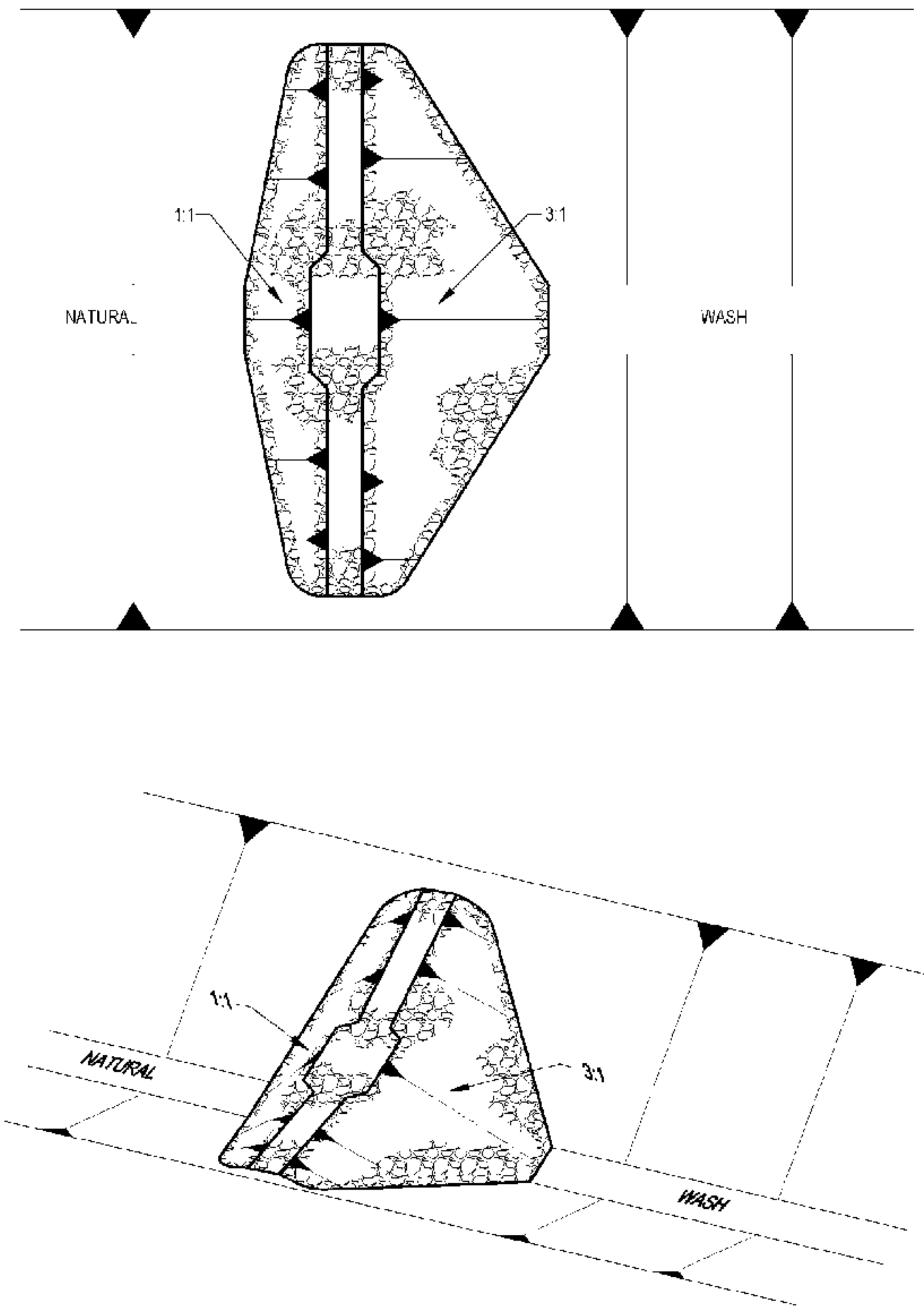


Figure 1 - Gabion Conceptual Details



Project Name:
Coyote Wash (1)

Location:
3.6 miles east of Fain Road
on State Route 89A
in Prescott Valley
N 34° 39' 32"
W 112° 15' 33"

Project type:
Infiltration Enhancement

Project size:
Less than 0.10 Acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to implement:
$51,000

Anticipated Annualized Maintenance and Monitoring Expense:
$20,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$151,000

Project site description: Coyote Wash is a tributary to the Agua Fria River. The site is on private property located just south of State Route 89A approximately 3.6 miles east of Fain Road. It has legal access from SR89A, a publicly dedicated right-of-way, however, may be access controlled by ADOT.

Ownership: Ownership is Private (Rancher ownership)

Channel description: Fairly well incised, approximately 60 feet wide

Longitudinal Slope: Approximately 1.8 percent (north to south)
Soils: SuB (Springerville-Lonti Association – Undulating) Gravelly Loam and Gravelly Clay – Yavapai County AZ - Western Part

Geology: Qs – Sediment (Holocene and Pleistocene) (USGS Geologic Mapping Resource)

Hydrology: Coyote Wash near SR89A receives runoff from approximately 10 square mile drainage basin draining generally from north to south.

Project description: Approximately 900 foot long array, medium diameter rip-rap, approximate spacing of gabions: 150 feet, 7 gabions in this array.
Site Access: Access to the site is from State Route 89A.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from private land owner, flood control permit, design plans and hydraulic calculations.

Project Name:
Yeager Canyon (2)

Location:
8.3 miles east of Fain Road on State Route 89A,
N 34° 40' 38"
W 112° 10' 40"

Project type:
Infiltration Enhancement

Project size:
0.50 acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to implement:
$97,000

Anticipated Annualized Maintenance and Monitoring Expense:
$28,000

Timeframe for implementation:
2 years

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$237,000

Project site description: Yeager Canyon is a tributary to the Agua Fria River. The site is on U.S. Forest Service property located just south of State Route 89A approximately 8.3 miles east of Fain Road. It has legal access from SR89A, a publicly dedicated right-of-way, however, may be access controlled by ADOT.

Ownership: Federal

Channel description: Well incised, approximately 20 feet wide

Longitudinal Slope: Approximately 3.7 percent (east to west)

Soils: No soil data available, visually appears to be sandy cobbly soil

Geology: Qs – Sediment (Holocene and Pleistocene) (USGS Geologic Mapping Resource)

Hydrology: Yeager Wash near SR89A receives runoff from approximately 6.2 square mile drainage basin draining generally from east to west.

Project description: Approximately 5,300 foot long array, medium diameter rip-rap, approximate spacing of gabions: 130 feet, 40 gabions in this array.

Site Access: Access to the site is from SR 89A.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, NEPA approval, other federal permitting, flood control permit, design plans and hydraulic calculations.

Project Name:
Clipper Wash (3)

Location:
On Manzanita Trail, approximately 1.5 miles west of the intersection of SR 69 and Fain Road
N 34° 33' 35"
W 112° 17' 01"

Project type:
Infiltration Enhancement

Project size:
Approximately 0.2 acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to implement:
$72,000

Anticipated Annualized Maintenance and Monitoring Expense:
$25,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$197,000

Project site description: Clipper Wash drains to the Agua Fria River just north of Bradshaw Mountain Road and east of SR 69 in Prescott Valley. This site on Clipper Wash is on Yavapai County Flood Control District property located south of and parallel to Manzanita Trail primarily west of Durham Road, in a community called Prescott Country Club. Access is off of Manzanita trail and Durham Road, both, publicly dedicated rights-of-way.

Ownership: Yavapai County

Channel description: Fairly incised, approximately 60 feet wide

Longitudinal Slope: Approximately 1.4 percent (west to east)

Soils: Ly2 (Lynx soils - eroded) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: Tso – Sedimentary Rocks (USGS Geologic Mapping Resource)

Hydrology: Clipper Wash near Williamson Valley Road receives runoff from approximately 6.5 square mile drainage basin draining generally from west to east.

Project description: Approximately 2,500 foot long array, large diameter rip-rap, approximate spacing of gabions: 200 feet, 12 gabions in this array.

Site Access: Access to the site is off of Manzanita trail and Durham Road, publicly dedicated rights-of-way.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, flood control permit, design plans and hydraulic calculations.

Project Name:
Lynx Creek (4)

Location:
0.2 miles west of the Fain Lake Parking Lot, off of 5th Street in Prescott Valley
N 34° 34' 26"
W 112° 21' 16"

Project type:
Infiltration Enhancement

Project size:
Less than 0.20 Acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

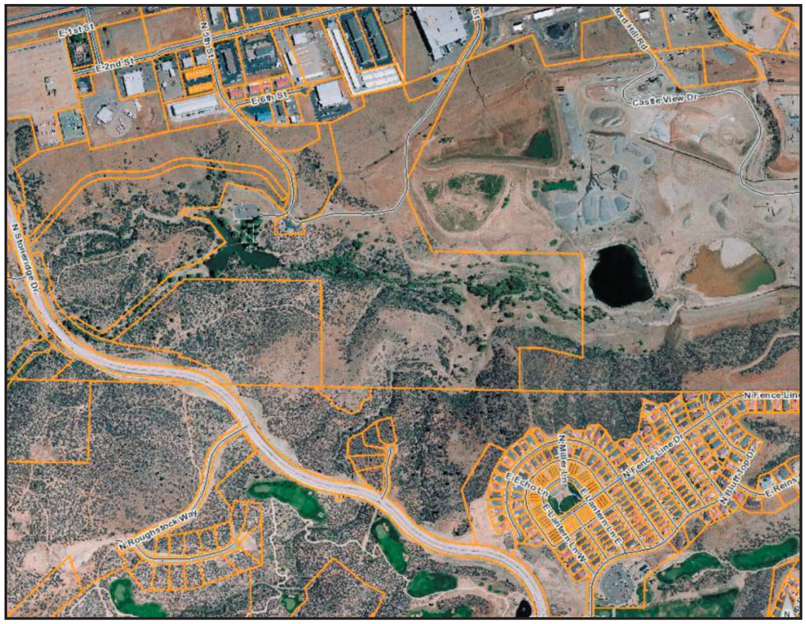
Cost to implement:
$65,000

Anticipated Annualized Maintenance and Monitoring Expense:
$23,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$180,000



Project site description: Lynx Creek is a tributary to the Agua Fria River. The site is on Town of Prescott Valley owned property located approximately 1/4 mile southwest of the intersection of SR 69 and 5th Street in Prescott Valley, upstream of Fain Lake and east of Stoneridge Drive. It has access via 5th Street, a publicly dedicated right-of-way.

Ownership: Ownership is Town of Prescott Valley.

Channel description: Fairly well incised, approximately 50 feet wide.

Longitudinal Slope: Approximately 2.7 percent (west to east)

Soils: AwE, Arp very rocky clay loam, cobbly clay loam, clay, weathered bedrock

Geology: Xpr – Prescott Granodiorite (USGS Geologic Mapping Resource)

Hydrology: Lynx Creek at this location receives runoff from approximately 28 square mile drainage basin draining generally from west to east.

Project description: Approximately 1,100 foot long array, medium to large diameter rip-rap, approximate spacing of gabions: 100 feet, 12 gabions in this array.

Site Access: Access to the site is from 5th Street, across Town property, alternate legal access is off of Stoneridge Drive, a publicly dedicated right-of-way, south of SR 69.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, flood control permit, design plans and hydraulic calculations.

Project Name:
Bottleneck Wash at Airport (5)

Location:
1/4 mile east of US89,
just north of Ruger Road,
Prescott
N 34° 39' 18"
W 112° 25' 36"

Project type:
Infiltration Enhancement

Less than 0.10 Acres

Treatment:
- Constructed gabbions
- Soil moisture monitoring

Cost to Implement:
$32,000

Anticipated Annualized Maintenance and Monitoring Expense:
$17,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$117,000

Project site description: The Bottleneck Wash site is on private property located just north of Ruger Road, near the Prescott Airport, in Prescott. It is a tributary to Granite Creek. It has access from Ruger Road, a publicly dedicated right-of-way.

Ownership: Ownership is City of Prescott.

Channel description: Fairly well incised, approximately 30 feet wide

Longitudinal Slope: Approximately 1.0 percent (southwest to northeast)

Soils: Ly (Lynx) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: Qal – alluvium (Holocene) (USGS Geologic Mapping Resource)

Hydrology: Bottleneck Wash near Ruger Road receives runoff from approximately 10 square mile drainage basin draining generally from southwest to northeast.

Project description: Approximately 800 foot long array, medium to large diameter rip-rap, approximate spacing of gabions: 200 feet, 5 gabions in this array.

Site Access: Access to the site is from Ruger Road

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from land owner (City of Prescott), flood control permit, design plans and hydraulic calculations.

Project Name:
Bottleneck Wash at Williamson Valley Road (6)

Location:
0.5 miles east of the intersection of Bailey Avenue and O'Neal Road, east of Williamson Valley Road, Prescott
N 34° 38' 06"
W 112° 28' 51"

Project type:
Infiltration Enhancement

Project size:
Less than 0.20 acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to implement:
$62,000

Anticipated Annualized Maintenance and Monitoring Expense:
$23,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$177,000

Project site description: This Bottleneck Wash site is on private property located just east of Bailey Avenue and O'Neal Road in Prescott. It is a tributary to Granite Creek. It traverses section 33, township 15 North, range 2 West, Gila and Salt River Base and Meridian. Access is unknown as this section is surrounded by other sectionalized property with no apparent dedicated right-of-way.

Ownership: Ownership is private.

Channel description: Fairly well incised, approximately 30 feet wide

Longitudinal Slope: Approximately 4 percent (southwest to northeast)

Soils: Ly (Lynx) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: Qal – alluvium (Holocene) (USGS Geologic Mapping Resource)

Hydrology: Bottleneck Wash near Baily Avenue receives runoff from approximately 5 square mile drainage basin draining generally from southwest to northeast.

Project description: Approximately 1,700 foot long array, medium to large diameter rip-rap, approximate spacing of gabions: 100 feet, 18 gabions in this array.

Site Access: Access to the site is unknown

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from land owner, flood control permit, design plans and hydraulic calculations.

Project Name:
Unnamed Wash at Granite Oaks Well (7)

Location:
0.75 miles east of Williamson Valley Road on Glenshandra Drive
N 34° 39' 02"
W 112° 30' 15"

Project type:
Infiltration Enhancement

Project size:
Less than 0.10 acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

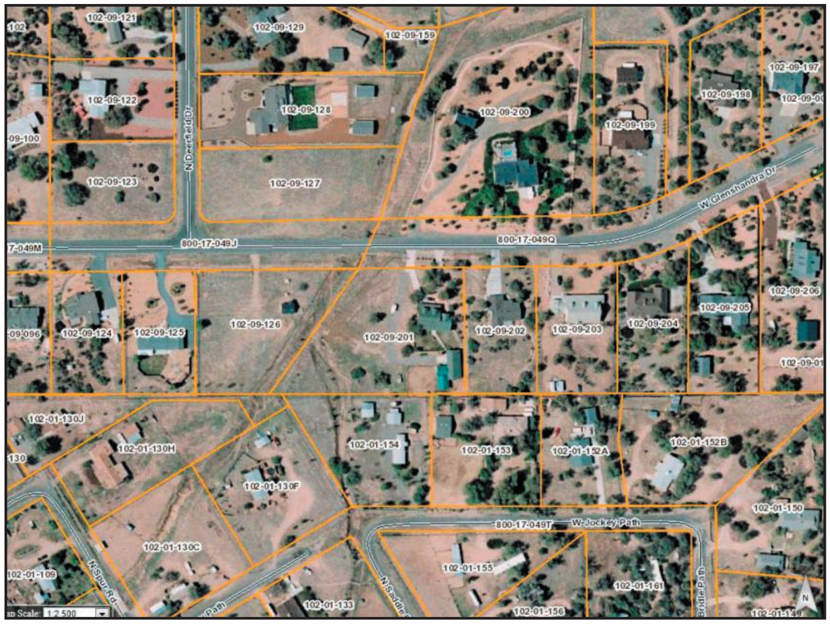
Cost to implement:
$31,000

Anticipated Annualized Maintenance and Monitoring Expense:
$16,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$111,000



Project site description: This unnamed wash site is on private property located about 1/2 of a mile east of Williamson Valley Road on Glenshandra Drive in the Granite Oaks subdivision. It is a tributary to Granite Creek. Access is from Glenshandra Drive, a publicly dedicated right-of-way.

Ownership: Private (multiple residences)

Channel description: Fairly well incised, approximately 15 feet wide

Longitudinal Slope: Approximately 1.6 percent (southwest to northeast)

Soils: Ly (Lynx) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: ThS – Sedimentary Rocks (USGS Geologic Mapping Resource)

Hydrology: This unnamed wash on Glenshandra Drive receives runoff from approximately 1.1 square mile drainage basin draining generally from southwest to northeast.

Project description: Approximately 1,100 foot long array, small diameter rip-rap, approximate spacing of gabions: 150 feet, 8 gabions in this array.

Site Access: Access to the site is from Glenshandra Drive, a publicly dedicated right-of-way.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from land owners, flood control permit, design plans and hydraulic calculations.

Project Name:
Mint Wash (8)

Location:
On Williamson Valley Road,
7.56 miles north of Outer
Loop Road
N 34° 46' 40"
W 112° 36' 35"

Project type:
Infiltration Enhancement

Project size:
Approximately 0.2 acres

Treatment:
- Constructed gabbions
- Soil moisture monitoring

Cost to implement:
$60,000

Anticipated Annualized Maintenance and Monitoring Expense:
$22,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$170,000

Project site description: Mint Wash drains to Williamson Valley Wash which is a tributary to the Verde River. This site on Mint Wash is on private property located at its crossing with Williamson Valley Road, approximately 7.6 miles north of Outer Loop Road. It traverses section 8, township 16 North, range 3 West, Gila and Salt River Base and Meridian. Access is through private properties served by Williamson Valley Road, a publicly dedicated right-of-way.

Ownership: Private.

Channel description: Well incised, approximately 60 feet wide

Longitudinal Slope: Approximately 0.5 percent (south to north)

Soils: Ly (Lynx) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: Qal – alluvium (Holocene) (USGS Geologic Mapping Resource)

Hydrology: Mint Wash near Williamson Valley Road receives runoff from approximately 37.5 square mile drainage basin draining generally from south to north.

Project description: Approximately 4,000 foot long array, large diameter riprap, approximate spacing of gabions: 500 feet, 9 gabions in this array.

Site Access: Access to the site is from Williamson Valley Road via privately held properties.

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from land owners, flood control permit, design plans and hydraulic calculations.

Project Name:
Yuma Road Wash (9)

Location:
2.5 miles west of US 89
on North Yuma Drive,
N 34° 46' 38"
W 112° 30' 07"

Project type:
Infiltration Enhancement

Less than 0.10 Acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to implement:
$47,000

Anticipated Annualized Maintenance and Monitoring Expense:
$19,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$142,000

Project site description: The Yuma Drive Wash is a tributary to Chino Valley Stream. The site is on private property located on Yuma Drive, Hopi Lane just north of Chaparral Road in Chino Valley. It has access from North Yuma Drive, a publicly dedicated right-of-way.

Ownership: Private (10 residential parcels)

Channel description: Fairly well incised, approximately 60 feet wide

Longitudinal Slope: Approximately 1.25 percent (southwest to northeast)

Soils: Alc (Abra-Balon Association – Rolling) Gravelly Sandy Clay Loam – Yavapai County AZ - Western Part

Geology: Qal – alluvium (Holocene) (USGS Geologic Mapping Resource)

Hydrology: Yuma Drive Wash near Ruger Road receives runoff from approximately 6.7 square mile drainage basin draining generally from southwest to northeast.

Project description: Approximately 1,100 foot long array, medium diameter rip-rap, approximate spacing of gabions: 200 feet, 6 gabions in this array.

Site Access: Access to the site is from North Yuma Drive

Required Permits/permission/design: Possible need for Section 404 pre-construction notification, permission from multiple private land owners, flood control permit, design plans and hydraulic calculations.

Project Name:
Santa Cruz Wash (10)

Location:
1,900 feet east of Road 1 East, just south of Center Street, Chino Valley
N 34° 44' 42"
W 112° 26' 28"

Project type:
Infiltration Enhancement

Project size:
Less than 0.10 Acres

Treatment:
- Constructed gabions
- Soil moisture monitoring

Cost to Implement:
$42,000

Anticipated Annualized Maintenance and Monitoring Expense:
$19,000

Timeframe for implementation:
6 months

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
$137,000

Project site description: The Santa Cruz Wash site is on private property located south of Center Street, approximately 1,900 feet east of Road 1 East in the Town of Chino Valley. It is a tributary to Granite Creek. Access is from Center Street, a publicly dedicated right-of-way.

Ownership: Private

Channel description: Well incised, approximately 50 feet wide

Longitudinal Slope: Approximately 1.3 percent (south to north)

Soils: Ly (Lynx) Loam, Clay Loam – Yavapai County AZ - Western Part

Geology: Qal – alluvium (Holocene) (USGS Geologic Mapping Resource)

Hydrology: Santa Cruz Wash at Center Street receives runoff from approximately 9.8 square mile drainage basin draining generally from south to north.

Project description: Approximately 1,000 foot long array, medium to large diameter rip-rap, approximate spacing of gabions: 200 feet, 6 gabions in this array.

Site Access: Access to the site is from Center Street.

Required Permits/permission/design: Possible need for Section 404 Pre-construction notification, permission from land owner, flood control permit, design plans and hydraulic calculations.

Project Name:
Railroad Wash

Location:
4.0 miles east of SR 89 on Perkinsville Rd, then 5 miles east on old railroad grade.
N 34° 44' 45"
W 112° 15' 55"

Project type:
Infiltration Enhancement

Project size:
300 acres, upstream watershed = 8-10K acres

Treatment:
- Channel morphology
- Gabions
- Groundwater/Surface water monitoring, ecological monitoring

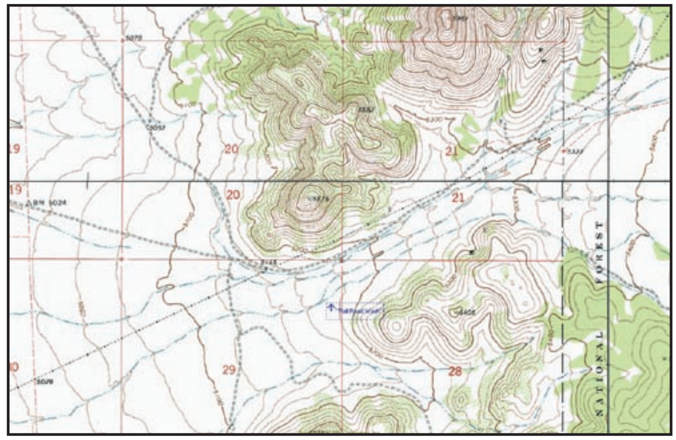
Cost to Implement:
Not determined

Anticipated Annualized Maintenance and Monitoring Expense:
Not determined

Timeframe for implementation:
Not determined

Anticipated Monitoring Duration:
5 years

Total 5 Year Estimated Cost:
Not determined



Project site description: Channel morphology restoration

Topography: Gently sloping

Soils: Deep to shallow soil that is predominantly loam and gravelly sandy loam on nearly level to moderately steep fans, plains and side slopes.

Hydrology: 'Railroad wash' tributary drainage to Lonesome Valley/Chino Valley. Flow channel appears to have become channelized and straightened by work on now abandoned railroad grade. Runoff appears to collect in a channel then spread out as sheetflow east of Granite Creek. Little if any runoff ends up in Granite Creek, instead it is consumed by a 500 acre area of grasslands.

Existing Hydrologic Monitoring: GWSI well B-16-01-23ACA located 3 miles downgradient (West) (DTW = 362 ft). GWSI well B-16-10-25DDA located 1.8 miles downgradient (DTW = 438 ft)

Project description: Modify channel morphology to slow flow rate, include gabions and erosion control structures. Include surface water, groundwater and ecological monitoring.

Site Access: Access to the site is from Perkinsville Road, at 5.3 miles east of Highway 89, continue east on old railroad grade.

Required Permits/Design: Not determined.

Site photos:

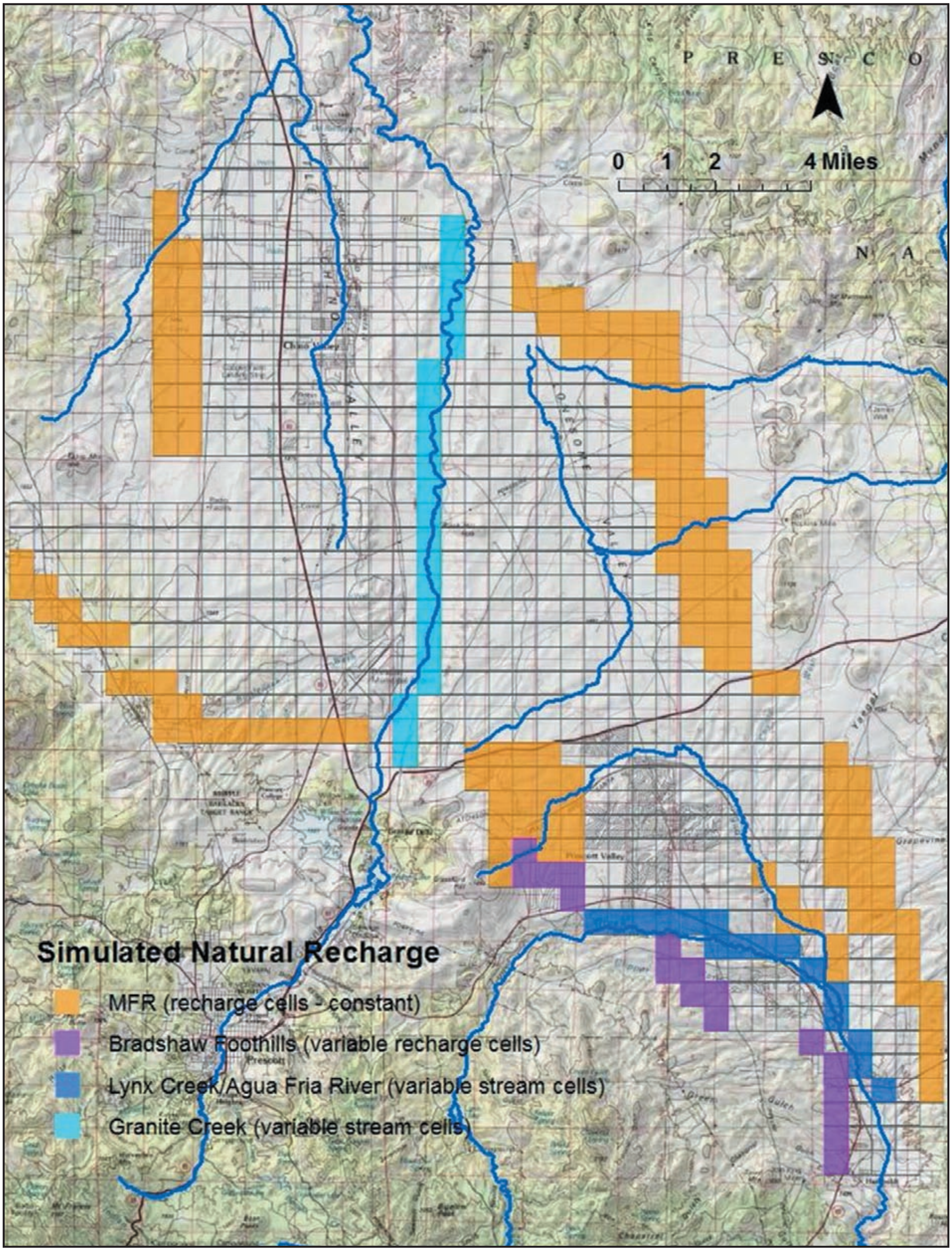
11.3 Induced Recharge

Induced recharge takes advantage of naturally occurring recharge within certain ephemeral stream-aquifer systems. Some ephemeral stream-aquifer systems consist of high groundwater levels and cannot accept additional recharge during runoff events. It is possible to induce more recharge by pumping these aquifer systems and reducing groundwater levels. For decades, the City of Nogales in southern Arizona has induced recharge at their Potrero Wellfield. This ephemeral stream-aquifer system is recharged during summer monsoon precipitation events and pumped throughout the year. If the system were not pumped, potential recharge during monsoon events would simply runoff since the aquifer would have little or no storage space.

This concept can be implemented in the Big Chino and PrAMA at locations with high water levels (e.g. within 50 feet of the stream bottom) near stream recharge systems. In particular, Williamson Valley Wash several miles upstream of its confluence with Big Chino Wash has a water table that is 5 feet below land surface in some locations and the Upper Big Chino valley along Big Chino Wash has water tables that are 20 to 50 feet below the bottom of the channel. During wet winters, the Big Chino water levels increase to fill the available space in the aquifer and create a situation where much of the potential recharge is forced to run off. This is where the City of Prescott's Big Chino Water Ranch is located as a planned future groundwater source for Prescott and Prescott Valley.

Within the PrAMA, two stream systems are currently being examined for potential future well pumping to increase recharge. Granite Creek below the Granite Dells and Lynx Creek below Fain Lake are the primary sources of stream recharge in the PrAMA. Groundwater users may locate wells closer to these recharge sources to create void space in the aquifer near these recharge source stream. Map 5 from ADWR Modeling Report 25 (Nelson and Yunker, 2014) shows the areas within the PrAMA flow model where natural recharge was simulated, in particular along Granite and Lynx Creeks.

Map 4 – Areas of simulated natural recharge within the PrAMA



11.4. Capitalization on Urbanization

Capitalization on Urbanization projects may include a combination of various treatments and techniques to improve recharge or meet other water resource or water quality goals. Objectives include design of project(s) that are replicable, improve recharge, and lead to better land management. They may also address flood control problems, improve aesthetics, enhance and or re-establish riparian areas, promote water reuse, improve channel morphology and downstream conditions, and promote installation of permeable pavement for improved localized recharge.

Slaughterhouse Gulch in Prescott, within the Slaughterhouse Gulch sub-watershed on land owned by the Yavapai-Prescott Indian Tribe (YPIT), emerged as the broadest reaching capitalization on urbanization project. Several issues were created with the large, high visibility hillside cut on ASLD lands that made way for construction of a Lowe's Home Warehouse. Full-scale project implementation will address existing issues and provide multiple stakeholder benefits. Goals include improving downstream conditions, optimization of local recharge, reduction in runoff velocities and improving water quality in a tributary to Watson Woods Riparian Preserve along Granite Creek above Watson Lake. A partnered approach that includes developing a riparian area along Slaughterhouse Gulch downstream has also been integrated, which is expected to improve water quality at Watson Lake. Slaughterhouse Gulch joins Granite Creek upstream from Watson Woods and Watson Lake.

This project is replicable. Other potential improvement sites that can incorporate similar concepts include:

- Walmart
- Costco
- Home Depot
- Sam's Club
- Car dealership
- Other large 'box' stores and commercial development
- Fain Lake in Prescott Valley where development has resulted in significant sediment loading

11.4.1. Slaughterhouse Gulch Watershed

11.4.1.1. Project Concept

To reduce intensity of storm runoff, create a riparian environment on Yavapai-Prescott Indian Tribe (YPIT) land, optimize localized recharge, improve water quality downstream, promote water conservation and address tribal flood control issues.

11.4.1.2. Background Information

The Slaughterhouse Gulch sub-watershed is a tributary to Granite Creek, joining Granite Creek within the Yavapai-Prescott Indian Tribe upstream of the City of Prescott Watson Woods Preserve. It originates at an elevation of about 6,400 feet on the east side of Badger Mountain ('P' Hill) within the Ranch at Prescott subdivision. Urban runoff into the main channel also originates from the Gateway Mall, Lowe's Home Improvement, SR 69 and a variety of businesses and private residences. Slaughterhouse Gulch is joined by an unnamed tributary from the west side of Badger Mountain at a location 0.4 miles north of the Yavpe Connector and SR 69 intersection on the Yavapai-Prescott Indian Tribe. This unnamed wash incorporates runoff from private residences in Government Canyon and the majority of runoff from Frontier Village Mall. A spring is located in this channel just north of SR 69 that seems to support about 0.1 stream miles of grasses, aquatic plants and a variety of phreatophytes.

Figure 2: Aerial view of the highly urbanized portion of Slaughterhouse Gulch.

11.4.1.3. Project Description

The main focus is to slow down flow velocity during storm events so that the water remains in place longer to both support a planned riparian environment and natural improvements to water quality. Other opportunities incorporated into the project concept include:

1. Construct detention basins within the terraces on Lowe's Hill to support native vegetation and slow runoff
2. Improve at least one large detention basin that does not appear to be detaining storm water. Other basins throughout the watershed are likely to need improvements or repairs.
3. Install energy dissipating structures in some channels, specifically the rip-rap lined channel in the unnamed wash north of SR 69.
4. Consider installing pervious pavement at the planned new casino on tribal land to improve recharge and reduce runoff. The casino is planned for the intersection of SR 69 and Yavpe Connector. Water that infiltrates here will slowly make its way to Slaughterhouse Gulch downstream.
5. Slaughterhouse Gulch will require changes to its morphology to capture sediments and slow down storm water flows. The channel through tribal land is very straight and narrow, possibly influenced by past gravel mining activities. Changes to the channel may include reducing slope with energy dissipating structures and creating backwater pools.

11.4.1.4. Project Cost

The next step in this process is a full complete a site assessment and feasibility study of the Slaughterhouse Gulch watershed. A concept design for the Slaughterhouse Gulch Channel has been conducted by YPIT.

11.5. Land Use Management, Conservation and Aquifer Protection

Land Use Management/Conservation projects focus on resource management. Priorities include public education and outreach, policy development and recommendations to support watershed health, water conservation, and aquifer protection.

Potential projects/strategies include:

- Land/Resource Management Policy Changes:

- Range management
    - o Timing and stocking of cattle on forest service lands for wet year grass consumption. There may be no long term hydrological benefit, but there could be benefits associated with fire management.
    - o ASLD adjust cattle grazing allowance based on rainfall.
- Forest Service and ASLD - changes to woodcutting and harvesting regulations that will favor invasive species removal.
- Fire Management Plan

Dead and down trees lying on ASLD land

City/Town Initiatives:

- Collect evapotranspiration information and utilize 'smart' irrigation technology coupled with Supervisory Control and Data Acquisition (SCADA) technology at public parks to reduce the amount of water used for irrigation. This has been demonstrated in Prescott Valley.
- Consider artificial turf rather than grass at additional parks.
- Provide areas of 'community grass.' Often, having access to grass at a park deters residents from planting their own grass. This has been demonstrated in Prescott Valley.
- Provide WaterSmart and other landscape/irrigation specific outreach to new residents.
- Continue to develop and distribute WaterSmart literature to promote water conservation and education.
- Establish low impact development guidelines
- Utilize low impact development methods and private owner/developer incentives listed below for public facility construction
- Outreach to water providers to assist with tiered water rate structures, targeting lost and unaccounted for water, rate studies, system studies, and vertical rainwater harvesting to enhance conservation.
- Potential for rainwater harvesting ordinance, including requirements for rain gutters for large buildings.
- Develop a Virtual Rainwater Harvesting website to create an interactive, web-based and personalized rainwater harvesting design center.

Private owner/developer incentives:

- Drywells/French drains to recharge rainwater captured from rooftops (see Section 11.4.1), individually or in groups.
- Rainwater harvesting incentives.

Aquifer Protection projects that address growth impacts to the groundwater supplies should be more completely addressed. Within the PrAMA portion of the watershed, the 1980 Groundwater Management Act and subsequent policies and laws have resulted in a moratorium on new groundwater-supplied irrigated agriculture, established water rights, conservation practices and well spacing rules, and prevent new subdivisions from accessing PrAMA groundwater supplies.

Within the Big Chino sub-basin portion of the watershed, only the Big Chino Water Ranch property purchased as a water supply by the City of Prescott carries any such protection. Outside of this, there are as many as 500,000 acres of private and State Trust Land within the sub-basin that can be developed. Aquifer protection programs for this sub-basin will require a significant amount of political will to enact. Some of the aquifer protections that have been enacted in other areas that may be replicable in the Big Chino sub-basin include:

- Purchase of Development Rights (Conservation Easements)
- State Trust Land Reform
- Low or No-Impact Developments employing wastewater and rainwater collection and recharge
- Establish water rights and prohibit certain new uses

11.5.1. Well Owner's Rainwater Harvesting and Recharge System

11.5.1.1. Background

Typical rainwater harvesting systems capture rainwater from rooftops and store the rainwater in a reservoir or cistern. Stored water is then used during the dry season(s) for application on outdoor landscaping to reduce demand for potable water. Typical rainwater harvesting system characteristics:

1. An efficient system is expensive. A large reservoir is required to maximize use of the available rainwater. For Central Yavapai County, rainwater collected during the (typically) wet months such as January through March would be used to meet landscaping water needs in May and June. A 2008 water conservation study conducted by the Coalition (Regional Water Conservation Program Development and Recommended Implementation Plan by Larson and Associates, September 2008), concluded that a 2,875 gallon storage tank with a pumping and filtration system would cost $7,500.
2. Much of the potentially available rainwater is lost due to lack of storage capacity. In the example above (using a 2,500 square-foot roof area and 5 inches of seasonal precipitation), approximately 7,800 gallons of rainwater could be captured. However, the 2,875 gallon storage system is capable of storing only 37 percent of the available supply.
3. Typical rainwater harvesting systems may create an incentive for owners to install additional plants in their landscaping because of the 'free' water. This may actually drive up demand for potable water during times when the rainwater harvesting system runs dry.
4. Typical rainwater harvesting systems are often complex, incorporating pumps, filtration systems and backflow prevention devices – effectively creating a separate water system that must be maintained.
5. Water storage tanks are a potential breeding ground for mosquitoes and must be managed for algae growth.

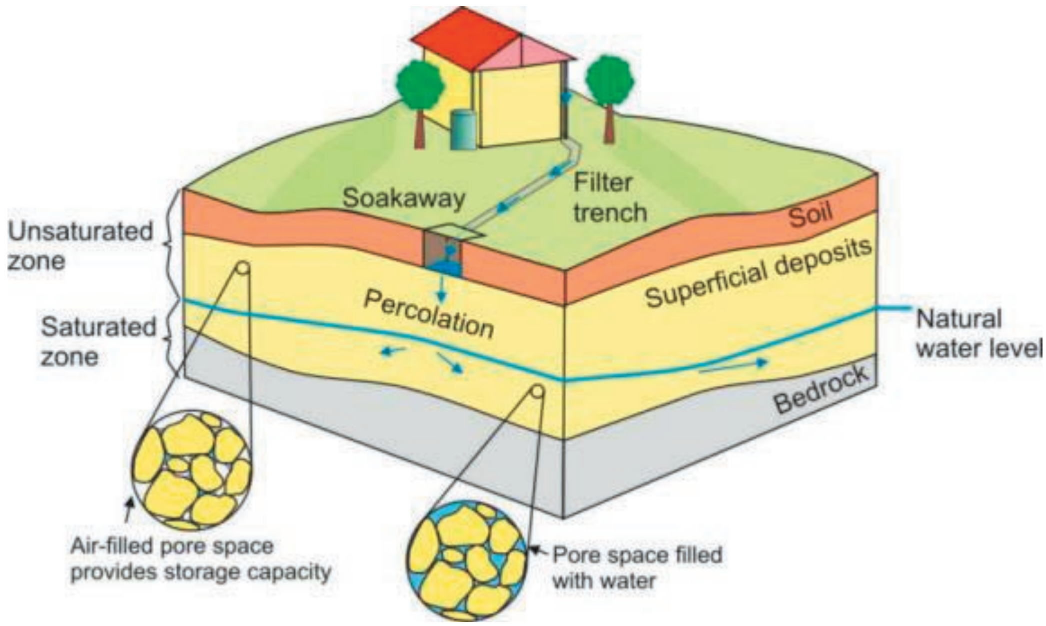
Another alternative that is less expensive and more efficient at collecting rainwater: recharge the rainwater into the aquifer rather than use for landscape watering. Primarily aimed at private well owners, this concept may also extend the usable life of a well. The concept requires installation of a simple French drain or drywell directly plumbed to the rooftop gutter system. There are several advantages to this type of system:

1. Storage capacity of the system can be much smaller than the typical rainwater harvesting system since it is designed to drain collected rainwater into lower stratum between precipitation events.
2. Costs are about 1/3 of the typical system with a large storage tank.
3. Less operational knowledge is required and maintenance costs are minimal.
4. All of the harvested rainwater recharges the aquifer to benefit the well. The harvested yield is much higher than for most rainwater harvesting systems.
5. This concept does not incentivize installation of additional plants; the primary household water source for the landscaping still comes from the well. The landowner operates one water system.
6. No opportunity for mosquito breeding since the system drains within a day or two.
7. Once installed, property above the drains can be used for parking, etc.

11.5.1.2. Policy/Institutional Issues

1. Registration of the system with ADEQ is likely required under the dry well registration program. Registration fees are $100.00.
2. Under the dry well registration program, there appears to be a setback requirement from groundwater wells of 100-feet. This requirement may limit the application and effectiveness of these systems.
3. An Aquifer Protection Permit will not be required unless other storm water sources were introduced.
4. Systems may not be applicable in all areas, such as locations with impermeable strata, or small properties.
5. Deep rooted plants must be located a significant distance away from the system.

Figure 3 – Conceptual Residential Rainwater Harvesting and Recharge System



11.5.1.3. Cost Estimate for a Small Scale French Drain for Rainwater Harvesting and Aquifer Recharge

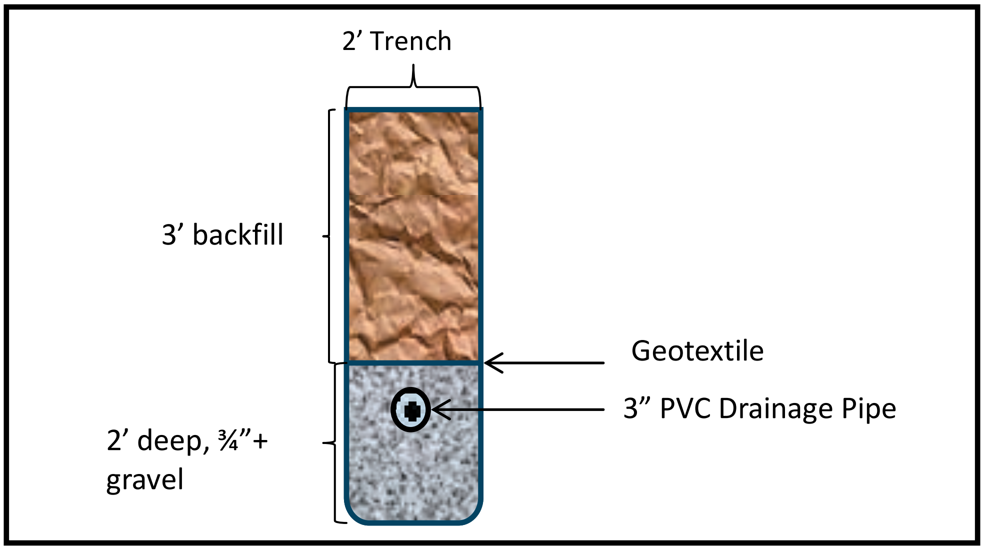
Design Criteria: Capture, store and recharge rainwater.

- 2,500 square-foot roof, 1 inch rainfall in 1 hour.
- Total Water Capture = 208 ft3 or 1,558 gallons
- Assume pore space of 1/2 gravel is 38% by volume
- Need 140 feet of trench, 2 feet wide filled with 2 feet of gravel to store 208 ft3 of water
- Install 3-inch PVC corrugated drainage pipe in top 6 inches of gravel with 3 inches of cover and geotextile
- Back fill top 3 feet with excavated material (3-foot depth will locate gravel and drain below typical rooting depth of grasses. Trees and shrubs should be kept away.)
- Drains should be at least 10 feet away from foundations
- Drains should not compete with leach fields
- Drains in soils with poor drainage characteristics may need to be upsized

Table 1 - Cost Estimate for Rooftop Rainwater Harvesting/Recharge (2.500 ft^2 Roof captures 1 inch rain in 1 hour)

Description	Quantity	Units	Unit Cost	Cost
Excavation	52	Cu Yards	$ 15.75	$ 819
Haul Off-site	21	Cu Yards	$ 20.00	$ 420
3/4 Gravel Delivered	21	Cu Yards	$ 30.00	$ 630
Back fill 3/4+ Gravel	21	Cu Yards	$ 7.00	$ 147
Back fill excavated material	31	Cu Yards	$ 7.00	$ 217
3" PVC drainage pipe	180	Feet	$ 0.62	$ 112
Geotextile	32	Sq Yards	$ 0.26	$ 8
NDS Catch Basin	2	Each	$ 51.36	$ 103
Labor	8	Hours	$ 15.00	$ 120
Total				$2,576

Figure 4 – Conceptual Trench Detail



12.0 Implementation/Next Steps

There are four primary next steps and objectives that have emerged from this plan 1) project implementation; 2) develop policy recommendations that will improve watershed health; 3) continue with the Watershed Taskforce and maintain stakeholder communication and partnerships that were established during plan development; and, 4) expand the effort to promote markets for use of woody biomass. Successful plan implementation will require a significant investment by Coalition partners, additional funding from private/public grant makers and other partners, as well as dedicated technical assistance from members of the Coalition Technical Advisory Committee and Watershed Taskforce. The Coalition has separately developed a funding plan that will be used to support plan implementation.

12.1. Partnerships and grant applications underway

12.1.1 U.S. Forest Service Wood to Energy Grant

The Coalition partnered with the Arizona State Forester to submit a grant to the U.S. Forest Service for funding to form a statewide Wood Energy Team with the purpose of supporting businesses, other governments, schools, hospitals, and others convert to wood energy systems. Goals of the program are to reduce risk of catastrophic wildfire, improve watershed health, and promote development of markets for use of woody biomass. Grant funding was awarded to the Arizona State Forester and a multi-disciplinary State Woody Biomass Team was established, of which the Coalition is member.

12.1.2. USDA Natural Resource Conservation Service, Resource Conservation Partnership Program (RCPP)

This grant was developed in partnership with the Arizona Game and Fish Department and will provide funding for five years to support vegetation restoration within the watershed.

12.1.3. ASLD Woody Biomass Harvesting and Valuation

The Coalition is working ASLD staff to develop a project to allow valuation and subsequent removal of trees and brush from ASLD lands, which is currently not allowed in ASLD policy without substantial additional expense making many of these cost prohibitive.

12.1.4. Arizona Water Protection Fund

The taskforce is working in partnership with the Yavapai-Prescott Indian Tribe to apply to the Arizona Water Protection Fund for financial assistance of at least $500,000 to support implementation of the Slaughterhouse Gulch Capitalization on Urbanization Project.

12.1.5. National Resource Conservation District (NRCD) Partnership

The Coalition and taskforce is partnering with the regional NRCD Education Center to research and submit joint funding applications that will support implementation of the watershed plan and NRCD goals.

12.1.6. U.S. BOR, Water and Energy Efficiency Grant

A grant of up to $300,000 is being requested from the BOR to support implementation of infiltration enhancement projects involving construction of gabions to optimize recharge, improvements in channel morphology, and monitoring to report water benefits.

13.0 Conclusion

13.1. Opportunities

Taskforce members do not consider completion of this plan an end, but instead a beginning. It outlines steps and projects to begin the long-term process of restoration and management of the Upper Verde River Watershed. The process has resulted in the development of numerous partnerships and working relationships that may not otherwise have been possible.

Prior to completion of this plan, benefits were already being realized. The AZGFD collaboration, numerous funding partners, and project development allowed application to be made to the USDA-NRCS for implementation of vegetation restoration. Without the taskforce and relationships established, such support would not have occurred. Participation on the Arizona State Woody Team was a direct result of planning, as well as the readiness to quickly apply for grant funding to implement infiltration enhancement and capitalization on urbanization projects.

Planning has highlighted areas of need and participating agencies have the tools they need to make and promote policy change recommendations to support watershed health. Common ground was identified and will continue to support joint projects for benefit of the watershed. The plan is a working document – a guide or a tool – to facilitate watershed restoration and management. It will be reviewed on a regular basis and revised, as needed. Results will be shared; replication will be encouraged and scientific knowledge will be expanded.

13.2. Constraints

The planning process and overall results are positive. However, constraints due exist to full-scale implementation including:

- Legal constraints prohibit the physical retention of water..
- Current water use is not sustainable (not operating at safe yield).
- Science supporting the connection between vegetation restoration, infiltration enhancement, and other project concepts and their impact on recharge is not readily available. Impact on runoff, not recharge, has been the focus of earlier studies. Developing data about vegetation impacts on recharge will take time.
- Current land management practices do not optimize recharge potential. New policies could be introduced, but their acceptance may be difficult or take significant time to be adopted.
- Animal populations may be impacted by return to a natural vegetative state.
- Deteriorating/poor water quality currently adversely affects the watershed.
- Sufficient funding to implement projects

13.3. Needs

The following watershed and environmental needs should be addressed as part of plan implementation.

- Decrease evaporation and evapotranspiration
- Increase stream flows
- Wildfire control and reduction
- Demonstrate and quantify recharge (water savings benefits)
- Identify Best Management Plan for the watershed
- Create a project information clearing house for project coordination (form, website, etc.). There is a federal site in progress.
- Protect wildlife habitat and incorporate wildlife considerations
- Determine rainfall threshold on effectiveness of different management strategies
- Increase public education
- Understanding among policy makers and grant makers of the critical need to fund scientific monitoring and the value of scientific data on recharge characteristics in arid and semi-arid regions

14.0 References

(1) Shaw, Harley G. 2006. Wood plenty, grass good, water none: Vegetation changes in Arizona's upper Verde River watershed from 1850 to 1997. Gen. Tech. Rep. RMRSGTR-177. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 50 p.

(2) Blasch, K.W., Hoffmann, J.P., Graser, L.F., Bryson, J.R., and Flint, A.L., 2006, Hydrogeology of the upper and middle Verde River watersheds, central Arizona: U.S. Geological Survey Scientific Investigations Report 2005–5198, 102 p., 3 plates.

(3) Montgomery & Associates. 2011. Mountain Front Recharge Review in Support of Upper Verde River Watershed Protection Coalition Application for NSF Grant NSF 11-551, 18 p.

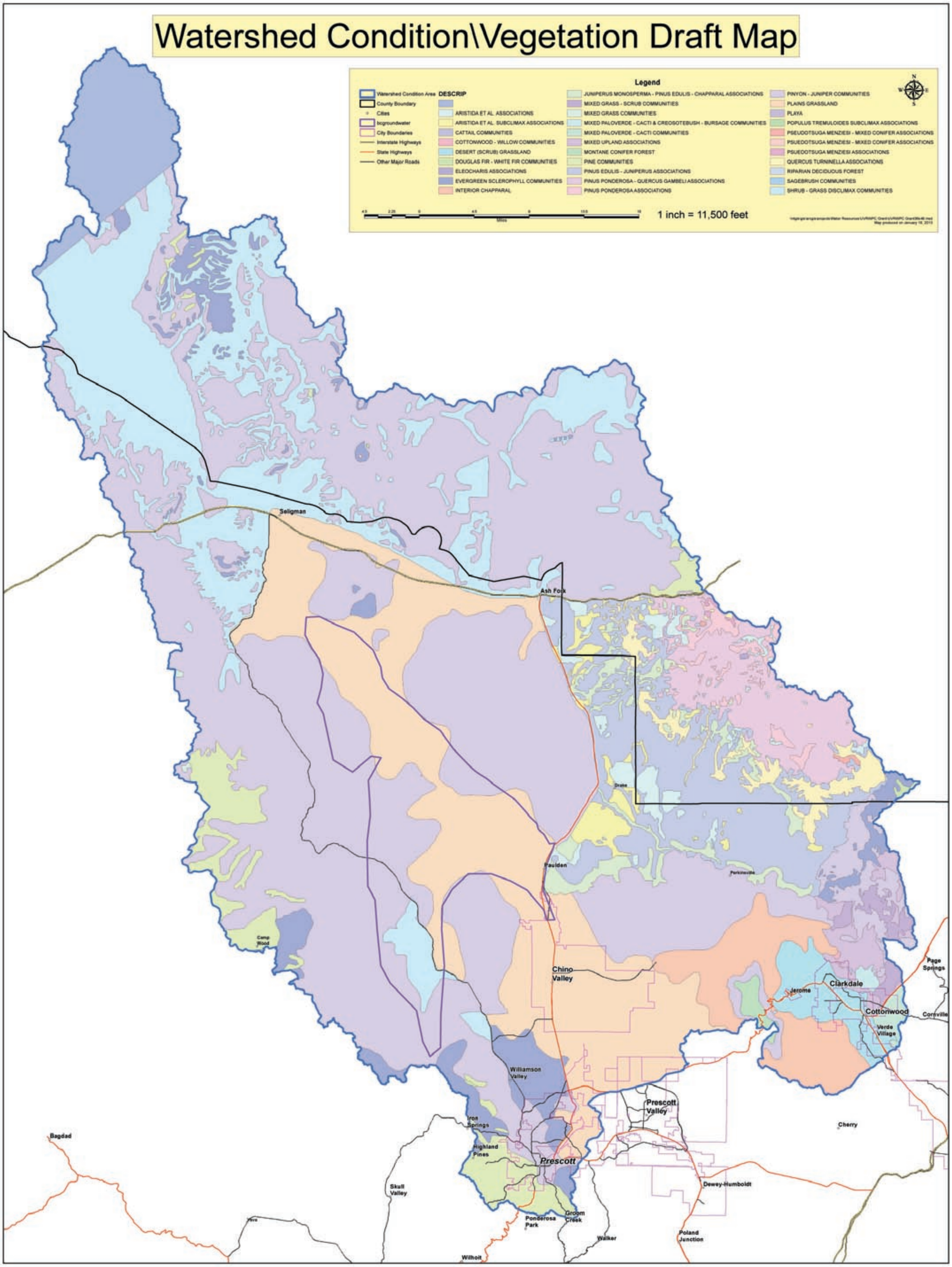
(4) DeWitt, Ed, Langenheim, Victoria, Force, Eric, Vance, R.K., Lindberg, P.A., and Driscoll, R.L., 2008, Geologic map of the Prescott National Forest and the headwaters of the Verde River, Yavapai and Coconino Counties, Arizona: U.S. Geological Survey Scientific Investigations Map 2996, scale 1:100,000, 100-p. pamphlet.

(5) Thomas L. Thurow and Justin W. Hester, Texas A&M Natural Resource Server Website http://texnat.tamu.edu/library/symposia/juniper-ecology-and-management/how-an-increase-or-reduction-in-juniper-cover-alters-rangeland-hydrology/ How an increase or reduction in juniper cover alters rangeland hydrology

(6) Keith Nelson and Diane Yunker, Groundwater Flow Model Update Report for the Prescott Active Management Area, Arizona Department of Water Resources, March 2014, MODELING REPORT NO. 25

APPENDIX A

GIS Mapping


Watershed Condition\Vegetation Draft Map
Legend
Watershed Condition Area
County Boundary
Cities
bcgroundwater
City Boundaries
Interstate Highways
State Highways
Other Major Roads
DESCRIP
ARISTIDA ET AL. ASSOCIATIONS
ARISTIDA ET AL. SUBCLIMAX ASSOCIATIONS
CATTAIL COMMUNITIES
COTTONWOOD - WILLOW COMMUNITIES
DESERT (SCRUB) GRASSLAND
DOUGLAS FIR - WHITE FIR COMMUNITIES
ELEOCHARIS ASSOCIATIONS
EVERGREEN SCLEROPHYLL COMMUNITIES
INTERIOR CHAPPARAL
JUNIPERUS MONOSPERMA - PINUS EDULIS - CHAPPARAL ASSOCIATIONS
MIXED GRASS - SCRUB COMMUNITIES
MIXED GRASS COMMUNITIES
MIXED PALOVERDE - CACTI & CREOSOTEBUSH - BURSAGE COMMUNITIES
MIXED PALOVERDE - CACTI COMMUNITIES
MIXED UPLAND ASSOCIATIONS
MONTANE CONIFER FOREST
PINE COMMUNITIES
PINUS EDULIS - JUNIPERUS ASSOCIATIONS
PINUS PONDEROSA - QUERCUS GAMBELI ASSOCIATIONS
PINUS PONDEROSA ASSOCIATIONS
PINYON - JUNIPER COMMUNITIES
PLAINS GRASSLAND
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PSUEDOTSUGA MENZIESI ASSOCIATIONS
QUERCUS TURNINELLA ASSOCIATIONS
RIPARIAN DECIDUOUS FOREST
SAGEBRUSH COMMUNITIES
SHRUB - GRASS DISCLIMAX COMMUNITIES
N
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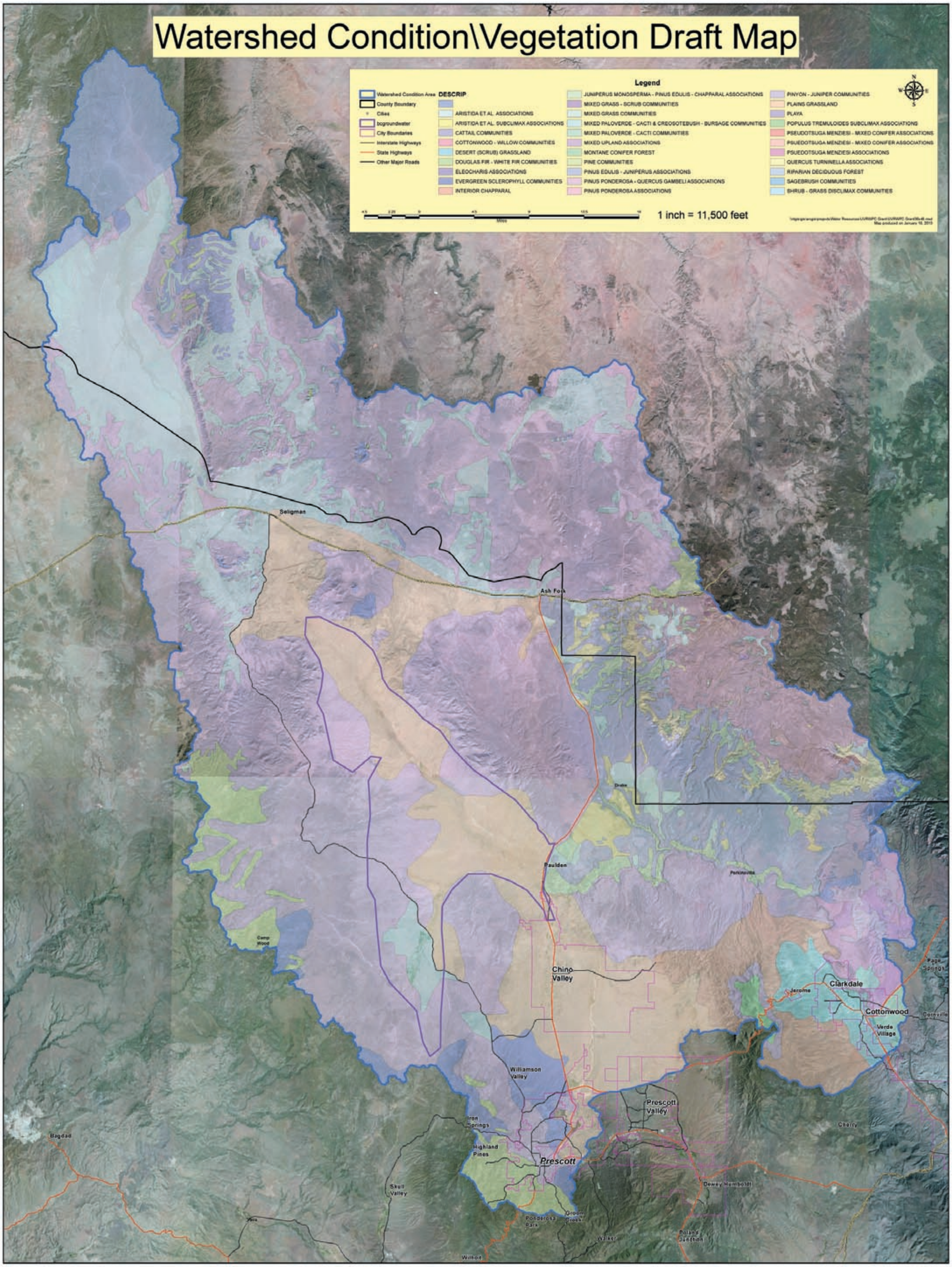
W
E
1 inch = 11,500 feet
Seligman
Ash Fork
Drake
Paulden
Perkinsville
Camp Wood
Chino Valley
Page Springs
Clarkdale
Jerome
Cottonwood
Cornville
Verde Village
Williamson Valley
Prescott Valley
Iron Springs
Bagdad
Cherry
Highland Pines
Prescott
Skull Valley
Dewey-Humboldt
Groom Creek
Ponderosa Park
Walker
Poland Junction
Wilhoit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Legend
Watershed Condition Area
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Cities
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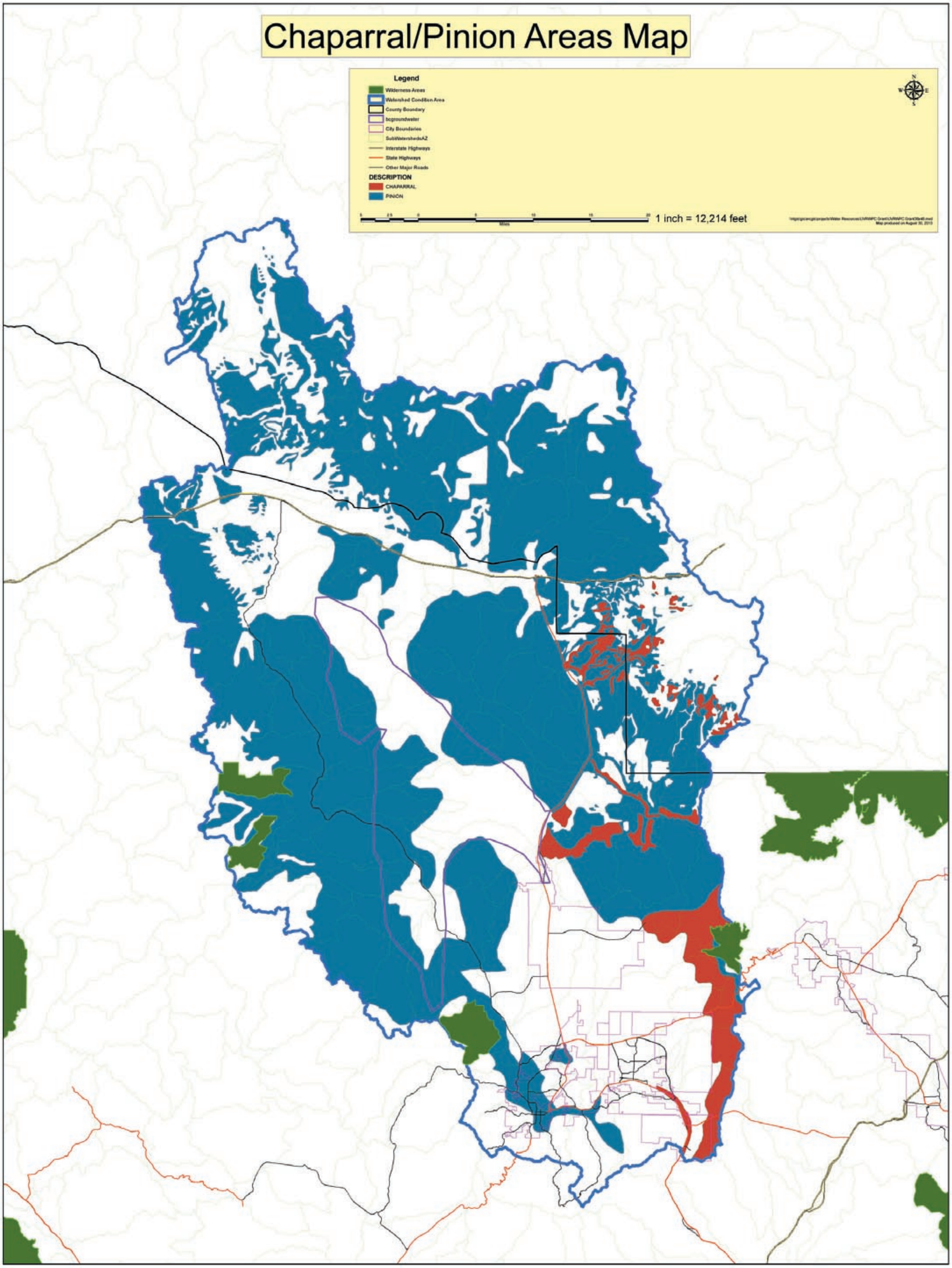
QUERCUS TURNINELLA ASSOCIATIONS
RIPARIAN DECIDUOUS FOREST
SAGEBRUSH COMMUNITIES
SHRUB - GRASS DISCLIMAX COMMUNITIES
1 inch = 11,500 feet
Seligman
Ash Fork
Drake
Paulden
Perkinsville
Camp Wood
Chino Valley
Jerome
Clarkdale
Cottonwood
Verde Village
Cornville
Page Springs
Williamson Valley
Prescott Valley
Iron Springs
Highland Pines
Prescott
Cherry
Dewey Humboldt
Skull Valley
Bagdad
Ponderosa Park
Groom Creek
Walker
Poland Junction
Wilhoit


Chaparral/Pinion Areas Map
Legend
Wilderness Areas
Watershed Condition Area
County Boundary
bcgroundwater
City Boundaries
SubWatershedsAZ
Interstate Highways
State Highways
Other Major Roads
DESCRIPTION
CHAPARRAL
PINION
1 inch = 12,214 feet
N
S
E
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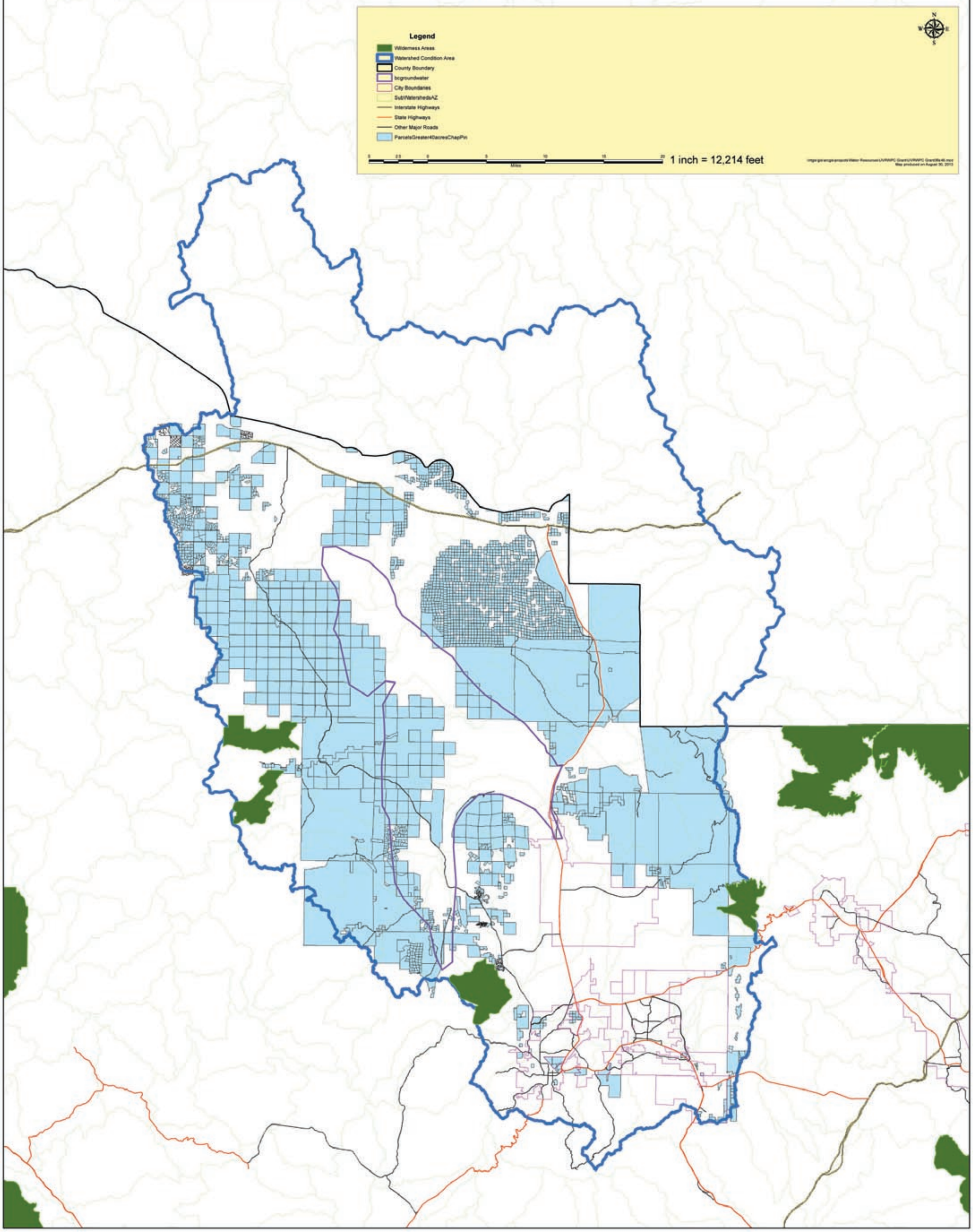
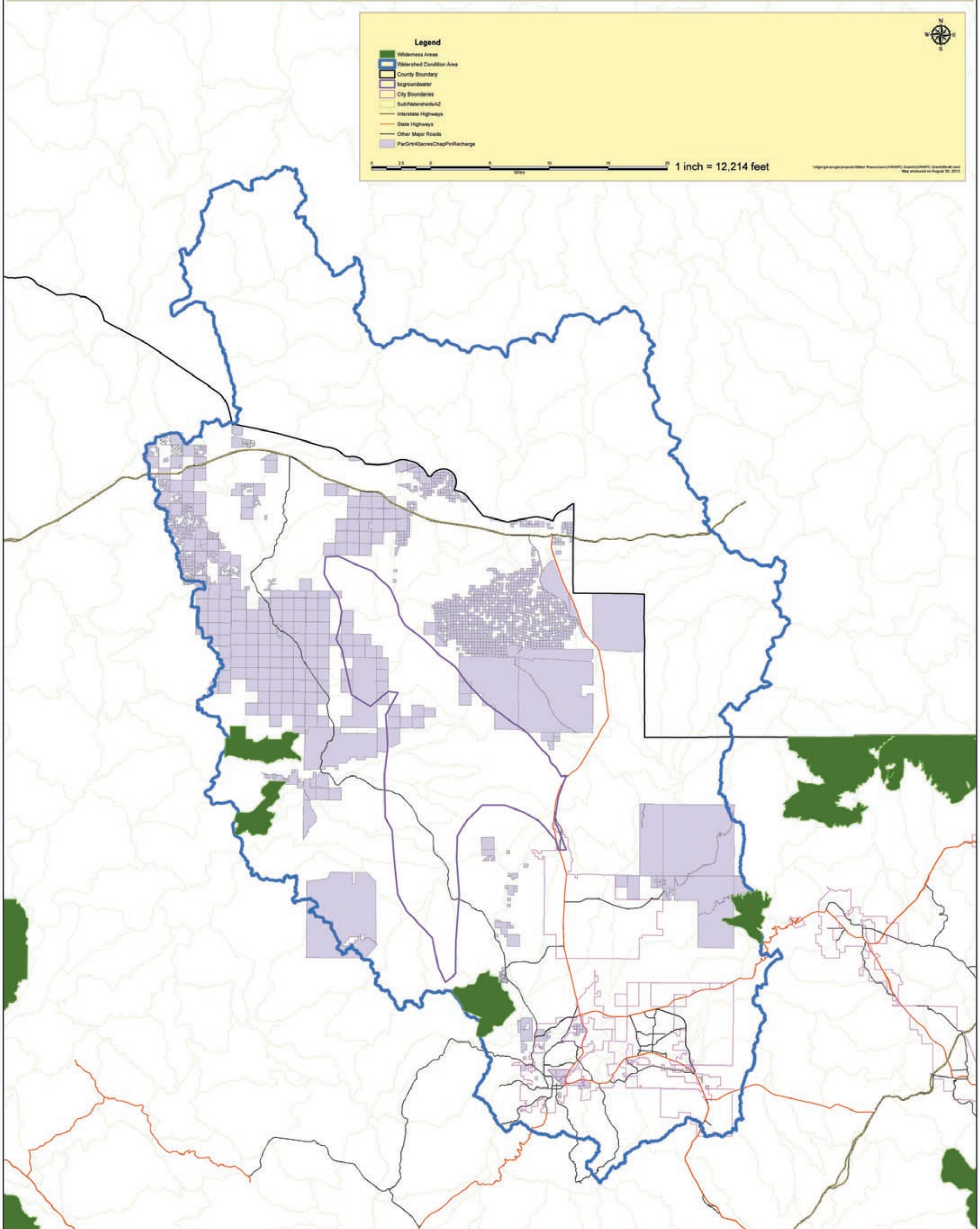
Parcels >40 within Chaparral/Pinion Areas Map



Parcels >40 within Chaparral/Pinion and Recharge Areas Map



APPENDIX B

Vegetation Restoration Project Cost Estimates

UVRWPC: Watershed Management Plan

Vegetation Restoration

T2 Ranch - Big Chino Wash

Engineer's Construction Cost Estimate From Oct. 2014 to Oct. 2019

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Permitting			Excluded	
2	Project Bidding Assistance	L. Sum	1	$ 4,500.00	$ 4,500.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Vegetation Harvesting (lop and drop)	Acre	100	$100.00	$10,000.00
2	Forester Marking and Supervision	Acre	100	$37.50	$3,750.00
3	Monitoring Equipment				
4	Sediment Monitoring (Trap)	Ea.	2	$2,500.00	$5,000.00
5	Climatic Conditions				
6	VP3 Relative Humidity, Temperature and Vapor Pressure Sensor	Ea.	2	$300.00	$600.00
7	EM50 Digital/Analog Data Logger	Ea.	2	$458.00	$916.00
8	SD2 Sonic Anemometer	Ea.	2	$497.00	$994.00
9	Anemometer Mast	Ea.	2	$102.00	$204.00
10	On-site Recharge				
11	Decagon 40525 Watershed Characterization Package G3 Includes: 1) Drain Gauge Model G3, 2)Passive Wick Lysimeter, 3)Em50G Digital Data Logger, 4) 5TM Sensor (qty 3), 5) ECRN-100 Rain Gauge and 6) DataTrac 3 Software - Single Registration	Ea.	2	$3,894.00	$7,788.00
12	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
13	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
14	Soil Moisture Monitoring (additional)				
15	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
16	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
17	Installation	L. Sum	1	$2,281.00	$2,281.00
18	Surface Water Outflow				
19	Stage flow meter, two transducers, datalogger, camera, stage gage, installed	Ea.	2	$12,026.00	$24,052.00
20	Vegetation Removal from Site			Paid by user	
Annual Expenses					
1	Quarterly site visit by staff	L. Sum	4	$1,000.00	$4,000.00
2	Every five year site visit by forester	L. Sum	0.20	$2,000.00	$400.00
3	Data collection, verification, and analysis	L. Sum	1	$25,000.00	$25,000.00
Alternates					
1	Vegetation Harvesting (100 acres harvest and forward) + Forester	Acre	100	$437.50	$43,750.00
2	Vegetation Harvesting (200 acres lop and drop) + Forester	Acre	200	$137.50	$27,500.00
3	Vegetation Harvesting (200 acres harvest and forward) + Forester	Acre	200	$437.50	$87,500.00

Base Subtotal	$69,953.00
Contingency (5%)	$3,497.65
Implementation Cost	**$74,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$221,000.00**

Alternative 2 Subtotal	$83,703.00
Contingency (5%)	$4,185.15
Implementation Cost	**$88,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$235,000.00**

Alternative 1 Subtotal	$99,953.00
Contingency (5%)	$4,997.65
Implementation Cost	**$105,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$252,000.00**

Alternative 3 Subtotal	$143,703.00
Contingency (5%)	$7,185.15
Implementation Cost	**$151,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$298,000.00**

UVRWPC: Watershed Management Plan
Vegetation Restoration
K4 Ranch - Walnut Creek

Engineer's Construction Cost Estimate From Oct. 2014 to Oct. 2019

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Permitting			Excluded	
2	Project Bidding Assistance	L. Sum	1	$ 4,500.00	$ 4,500.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Vegetation Harvesting (lop and drop)	Acre	240	$100.00	$24,000.00
2	Forester Marking and Supervision	Acre	240	$37.50	$9,000.00
3	Monitoring Equipment				
4	Sediment Monitoring (Trap)	Ea.	2	$2,500.00	$5,000.00
5	Climatic Conditions				
6	VP3 Relative Humidity, Temperature and Vapor Pressure Sensor	Ea.	2	$300.00	$600.00
7	EM50 Digital/Analog Data Logger	Ea.	2	$458.00	$916.00
8	SD2 Sonic Anemometer	Ea.	2	$497.00	$994.00
9	Anemometer Mast	Ea.	2	$102.00	$204.00
10	On-site Recharge				
11	Decagon 40525 Watershed Characterization Package G3 Includes: 1) Drain Gauge Model G3, 2)Passive Wick Lysimeter, 3)Em50G Digital Data Logger, 4) 5TM Sensor (qty 3), 5) ECRN-100 Rain Gauge and 6) DataTrac 3 Software - Single Registration	Ea.	2	$3,894.00	$7,788.00
12	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
13	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
14	Soil Moisture Monitoring (additional)				
15	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
16	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
17	Installation		1	$2,281.00	$2,281.00
18	Surface Water Outflow				
19	Stage flow meter, two transducers, datalogger, camera, stage gage, installed	Ea.	2	$12,026.00	$24,052.00
20	Vegetation Removal from Site			Paid by user	
Annual Expenses					
1	Quarterly site visit by staff	L. Sum	4	$1,000.00	$4,000.00
2	Every five year site visit by forester	L. Sum	0.20	$2,000.00	$400.00
3	Data collection, verification, and analysis	L. Sum	1	$25,000.00	$25,000.00
Alternates					
1	Vegetation Harvesting (240 acres harvest and forward) + Forester	Acre	240	$400.00	$96,000.00

Base Subtotal	$89,203.00
Contingency (5%)	$4,460.15
Implementation Cost	**$94,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$241,000.00**

Alternative 1 Subtotal	$161,203.00
Contingency (5%)	$8,060.15
Implementation Cost	**$170,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$317,000.00**

UVRWPC: Watershed Management Plan
Vegetation Restoration
K4 Ranch - Indian Springs

Engineer's Construction Cost Estimate From Oct. 2014 to Oct. 2019

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Permitting			Excluded	
2	Project Bidding Assistance	L. Sum	1	$ 4,500.00	$ 4,500.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Vegetation Harvesting (lop and drop)	Acre	100	$120.00	$12,000.00
2	Forester Marking and Supervision	Acre	100	$37.50	$3,750.00
3	Monitoring Equipment				
4	Sediment Monitoring (Trap)	Ea.	2	$2,500.00	$5,000.00
5	Climatic Conditions				
6	VP3 Relative Humidity, Temperature and Vapor Pressure Sensor	Ea.	2	$300.00	$600.00
7	EM50 Digital/Analog Data Logger	Ea.	2	$458.00	$916.00
8	SD2 Sonic Anemometer	Ea.	2	$497.00	$994.00
9	Anemometer Mast	Ea.	2	$102.00	$204.00
10	On-site Recharge				
11	Decagon 40525 Watershed Characterization Package G3 Includes: 1) Drain Gauge Model G3, 2)Passive Wick Lysimeter, 3)Em50G Digital Data Logger, 4) 5TM Sensor (qty 3), 5) ECRN-100 Rain Gauge and 6) DataTrac 3 Software - Single Registration	Ea.	2	$3,894.00	$7,788.00
12	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
13	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
14	Soil Moisture Monitoring (additional)				
15	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
16	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
17	Installation	L. Sum	1	$2,281.00	$2,281.00
18	Surface Water Outflow				
19	Stage flow meter, two transducers, datalogger, camera, stage gage, installed	Ea.	2	$12,026.00	$24,052.00
20	Vegetation Removal from Site			Paid by user	
Annual Expenses					
1	Quarterly site visit by staff	L. Sum	4	$1,000.00	$4,000.00
2	Every five year site visit by forester	L. Sum	0.20	$2,000.00	$400.00
3	Data collection, verification, and analysis	L. Sum	1	$25,000.00	$25,000.00
Alternates					
1	Vegetation Harvesting (240 acres harvest and forward) + Forester	Acre	100	$450.00	$45,000.00

Base Subtotal	$71,953.00
Contingency (5%)	$3,597.65
Implementation Cost	**$76,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$223,000.00**

Alternative 1 Subtotal	$104,953.00
Contingency (5%)	$5,247.65
Implementation Cost	**$111,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$258,000.00**

UVRWPC: Watershed Management Plan
Vegetation Restoration
Cross U Ranch

Engineer's Construction Cost Estimate From Oct. 2014 to Oct. 2019

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Permitting			Excluded	
2	Project Bidding Assistance	L. Sum	1	$ 4,500.00	$ 4,500.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Vegetation Harvesting (lop and drop)	Acre	200	$120.00	$24,000.00
2	Forester Marking and Supervision	Acre	200	$37.50	$7,500.00
3	Monitoring Equipment				
4	Sediment Monitoring (Trap)	Ea.	2	$2,500.00	$5,000.00
5	Climatic Conditions				
6	VP3 Relative Humidity, Temperature and Vapor Pressure Sensor	Ea.	2	$300.00	$600.00
7	EM50 Digital/Analog Data Logger	Ea.	2	$458.00	$916.00
8	SD2 Sonic Anemometer	Ea.	2	$497.00	$994.00
9	Anemometer Mast	Ea.	2	$102.00	$204.00
10	On-site Recharge				
11	Decagon 40525 Watershed Characterization Package G3 Includes: 1) Drain Gauge Model G3, 2)Passive Wick Lysimeter, 3)Em50G Digital Data Logger, 4) 5TM Sensor (qty 3), 5) ECRN-100 Rain Gauge and 6) DataTrac 3 Software - Single Registration	Ea.	2	$3,894.00	$7,788.00
12	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
13	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
14	Soil Moisture Monitoring (additional)				
15	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
16	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
17	Installation	L. Sum	1	$2,281.00	$2,281.00
18	Surface Water Outflow				
19	Stage flow meter, two transducers, datalogger, camera, stage gage, installed	Ea.	2	$12,026.00	$24,052.00
20	Vegetation Removal from Site			Paid by user	
Annual Expenses					
1	Quarterly site visit by staff	L. Sum	4	$1,000.00	$4,000.00
2	Every five year site visit by forester	L. Sum	0.20	$2,000.00	$400.00
3	Data collection, verification, and analysis	L. Sum	1	$25,000.00	$25,000.00
Alternates					
1	Vegetation Harvesting (240 acres harvest and forward) + Forester	Acre	200	$450.00	$90,000.00

Base Subtotal	$87,703.00
Contingency (5%)	$4,385.15
Implementation Cost	**$93,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$240,000.00**

Alternative 1 Subtotal	$153,703.00
Contingency (5%)	$7,685.15
Implementation Cost	**$162,000.00**
5 Year Operating Cost	$147,000.00
Total 5 Year Estimated Cost	**$309,000.00**

APPENDIX C

Mud Tank Wash
Project Concept Information

UPPER VERDE RIVER WATERSHED
PROTECTION COALITION

Hydrologic Benefits from Vegetation Management
Upper Verde River Watershed Protection Coalition
PROJECT DESCRIPTION

Background Information:

The Upper Verde River Watershed Protection Coalition (Coalition) was established in 2006 through formal intergovernmental agreement with a mission to protect the base flow of the Upper Verde River by balancing the reasonable water needs of residents who live and businesses that operate within watershed boundaries. Its partners include the City of Prescott, Towns of Prescott Valley and Chino Valley, Yavapai County and Yavapai-Prescott Indian Tribe.

A Watershed Restoration and Policy Initiative was implemented in early 2012 through unanimous vote of the Coalition Executive Board. The Watershed Task Force, a multi-jurisdictional, multi-stakeholder committee, began meeting on an ever month to six-week basis in mid 2012. The proposed project is aligned with the task force watershed restoration and management plan.

Key issues include potential risk of fire, loss of habitat, loss of grazing forage, and diminishment of valuable ecological services such as water resources. In combination with potential economic drivers, these issues that have created the necessity to establish partnerships around the western US similar to the coalition's watershed task force.

Project Location:

Location is T18N R5W Sec 26 and 27, which is on the west side of The Big Chino sub basin, north of Mud Tank Wash and South of County Road 5 (Williamson Valley Road).

Work will be performed in paired watersheds of moderate east facing slope. The watersheds drain into Mud Tank Wash, which drains about 2 miles southeast to its confluence with Indian Springs Wash. Elevation of the paired watershed ranges from approximately 4950 - 5150 feet.

No evidence of fire is apparent. The site is moderately to heavily stocked with pinyon pine and shaggy bark juniper trees (100 trees per acre) and moderately to heavily stocked with scrub oak brush (200 plants per acre). Tree heights range from 15'-30'. Understory grasses are well stocked in places not occupied by brush. Juniper tree relics are found where fire wood cutting did not occur.

Paired watersheds, one treated and the other untreated to allow for comparison study, have been selected for their representation of current forest and rangeland conditions in the Big Chino basin, their suitability as a demonstration of techniques that can be replicated and applied to a variety of vegetation types, and their size and location. Each watershed is approximately 100 acres, allowing for sufficient treatment area to demonstrate the methods and landscape results, as well as determine a hydrologic signal. The size is similar to other vegetation treatment studies with similar objectives (Gifford and Shaw 1972; Bosch and Hewlett, 1980; Hibbert et al 1982; Deboodt, et al 2008; 4FRI- Lopez and Springer 2012).

Based on forest service K4 allotment mapping, the subject watersheds are located within an area of forest with significant departure from Prescott National Forest (PNF) defined desired conditions. The area has been identified by the PNF for planned "spot mechanical thinning and or prescribed fire."

Project Methodology:

A paired watershed approach will be used to document the effects of the treatment on vegetation, hydrologic, soil and sedimentary characteristics. The economics of management practices and the amount of material removed will be quantified, as well as the potential for improvement of water yield vegetation management. The proposed two-year project period includes one-year of monitoring; however, the project will be monitored for four additional years beyond the grant period.

The basis of paired watersheds is that there is a quantifiable relationship between paired data for the two watersheds demonstrating the influence of the treatment on measured variables. Prior to treatment, a determination will be made of a significant relationship between the paired watersheds for the parameters of interest, with the intent of illustrating that the differences between the pairs are smaller than the expected effect of the treatment. Relationship significance between paired observations can be tested using analysis of variance and the significance of the treatment can be analyzed by analysis of covariance (EPA, 1993). Regression plots will highlight differences between the watersheds.

Treatment and Monitoring -The treatment will consist of vegetation-thinning and removal using best management practices in one watershed with a second watershed remaining untreated. Both watersheds will be surveyed and monitored pre and post treatment.

Calibration will include a detailed inventory of existing conditions on both watersheds. Primary parameters of interest are vegetative and hydrologic. Vegetative parameters include type and density of all vegetation. Vegetation monitoring will be accomplished with pre and post treatment surveys using standard USFS protocol. A systematic grid will be established made up of 0.1 acre plots around geo-referenced sample point, distributed to allow for a 5% sample. In each plot the vegetation and other conditions (such as surface soil and slope) will be inventoried.

Hydrological parameters, including soil moisture and surface runoff, as well as sedimentary and soil characteristics will be monitored using standard monitoring techniques. A temporary weir will be set up in each watershed outlet and fitted with a data logger.

Physical site conditions such as soil cover, geology, slope and aspect will be mapped. A weather station will be set up at the site in a representative location between the watersheds to measure precipitation (frequency, duration and amount), air temperature, and wind speed and direction.

The silvicultural prescription will include a thin from below all species including bushes and an overstory stand improvement by retaining better vigor and formed pinyon pine trees. Larger stemmed oaks will also be retained as well.

Rubber-tired machines will be used to harvest and forward trees to an upslope staging area to the west. A bio baler will be used to harvest and bale brush. Expected products include fire wood and biomass. Access to the site is from Williamson Valley Road across K4 property.

Desired conditions:

Desired conditions describe how the resources on the PNF should look and function (PNF Revised Forest Plan, 2013). Desired conditions are the focus of the PNF Forest Plan. and the plan is intended to help guide management in areas where the desired condition does not match the current condition. Any activity should be consistent with or help trend toward the desired conditions.

This proposed paired watershed study is consistent the 2013 Prescott National Forest (PNF) Revised Forest Plan. Resource objectives of increased resilience and adaptive capacity of watersheds outlined in the Forest Plan are in complete alignment with this proposed work plan. The project furthers the desired conditions associated with watershed integrity, biological, terrestrial wildlife and scenic value objectives. A silvicutural prescription for the treated watershed will move it towards the PNF desired conditions by bringing it closer to natural conditions and preparing the site for long-term maintenance with fire or other PNF approved methods.

The Forest Service has mapped, at a landscape scale, and described Potential Natural Vegetation Types for the PNF (Map 1 Appendix A, PNF Forest Plan 2012). The concept of potential natural vegetation (PNV) is that the plant community reflects the environmental capability of a land area - a core concept in plant ecology and natural resource management (TNC, 2006).

Potential Natural Vegetation Types: The general area of the proposed study is mapped as “pinon-juniper evergreen shrub” as per PNF Forest Plan, Appendix A - Map 1 Potential natural vegetation types (PNVTs) on the Prescott NF (PNF Revised Forest Plan 2013). Map 1 is a general landscape scale view and specific locations may have other PNVT vegetation types in areas. Sites may transition to other PVNT types depending on conditions such as slope, soils and aspect. Based on site observations, the proposed project site borders a juniper grassland PNVT.

For the pinon-juniper PVNT, the desired conditions at the landscape scale include a mix of trees and shrubs and herbaceous vegetation occurring as discrete groups on the landscape. Trees occur as individuals or in smaller groups with a variety of ages represented. The understory is dominated by low to moderate density shrubs. Native perennial grasses and annual and perennial forbs are present in the interspaces. Old growth generally occurs in small areas as clumps and includes old trees, snags, coarse woody debris and structural diversity. Fires have a range of severity with an average frequency of 35 – 100 years (PNF Forest Plan, 2013)

For the juniper grassland PNVT, desired conditions indicate a tree canopy from 5-20 percent where trees are individuals or in small groups. A continuous herbaceous understory including native grasses and forbs are present, with incidental occurrence of shrubs which support a natural fire regime. Fires occur every 1 to 35 years with low severity favoring regrowth of native grasses and forbs.

The forest service emphasizes that grasslands are important habitat for a variety of species and are essential to maintaining pronghorn populations. Dramatic changes to grasslands over the last 130 years include encroachment by trees, loss of perennial grass cover, los of cool season plant species, and the spread of non-native annual grasses (PNF, 2012). Desired conditions for the grasslands include composition, structure and cover habitat for native animals; a diverse mix of cool and warms season native grasses; and fine fuels to provide for and maintain the desired fire regime.

From a hydrological perspective, desired conditions include appropriate vegetation density and type, to allow natural recharge through direct infiltration and surface runoff to channels where recharge can occur.

In addition to striving for desired ecological and hydrologic conditions, this project will meet PNF scenic integrity objectives by leaving old growth trees and clumps of vegetation.

Project Cost– (Two year project period)

Item	
a. Field Work & Site Surveys	$ 19,000.00
b. NEPA/CEQA	
c. ESA Consultation	
d. Permit Acquisition	$ 1,000.00
e. Project Design & Engineering	$ 15,000.00
f. Contract/Grant Preparation	$ 1,000.00
g. Contract/Grant Administration	$ 750.00
h. Contract/Grant Cost	
i. Salaries	$ 25,024.00
j. Materials & Supplies	$ 40,000.00
k. Monitoring	$ 49,236.00
l. Other – Vegetation Treatment 1. 2, Partner Indirect Cost	$ 54,776.00
m. Project Sub-Total	
n. FS Indirect Costs	$ 3,750.00
Total Cost Estimate	$209,536.00

APPENDIX D

Infiltration Enhancement Project Cost Estimates

UVRWPC: Watershed Management Plan
Gabions - Coyote Wash

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	448	$60.00	$26,880.00
2	Supervision and Inspecton	EA	1	$1,500.00	$1,500.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$5,676.00	$5,676.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$45,726.00**
Contingency (10%)	**$4,572.60**
Total - Permitting/Design & Project Costs	**$51,000.00**

Subtotal - Annual Expenses	**$17,276.00**
Contingency (15%)	**$2,591.40**
Total - Annual Expenses	**$20,000.00**
Total 5 Year Project Cost	**$151,000.00**

K:\URVWPC\Watershed Restoration\Watershed Restoration Plan\Appendix\Infiltration Enhancement Coyote Wash

UVRWPC: Watershed Management Plan
Gabions - Yeager Canyon

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting	LS	1	$10,000.00	$10,000.00
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	960	$60.00	$57,600.00
2	Supervision and Inspecton	EA	1	$2,500.00	$2,500.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$12,020.00	$12,020.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$87,446.00**
Contingency (10%)	**$8,744.60**
Total - Permitting/Design & Project Costs	**$97,000.00**

Subtotal - Annual Expenses	**$23,620.00**
Contingency (15%)	**$3,543.00**
Total - Annual Expenses	**$28,000.00**
Total 5 Year Project Cost	**$237,000.00**

UVRWPC: Watershed Management Plan
Gabions - Clipper Wash

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	768	$60.00	$46,080.00
2	Supervision and Inspecton	EA	1	$2,000.00	$2,000.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$9,616.00	$9,616.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$65,426.00**
Contingency (10%)	**$6,542.60**
Total - Permitting/Design & Project Costs	**$72,000.00**

Subtotal - Annual Expenses	**$21,216.00**
Contingency (15%)	**$3,182.40**
Total - Annual Expenses	**$25,000.00**
Total 5 Year Project Cost	**$197,000.00**

UVRWPC: Watershed Management Plan
Gabions - Lynx Creek

Engineer's Conceptual Construction Cost Estimate

Permitting/Design					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	648	$60.00	$38,880.00
2	Supervision and Inspecton	EA	1	$2,000.00	$2,000.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$8,176.00	$8,176.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$58,226.00**
Contingency (10%)	**$5,822.60**
Total - Permitting/Design & Project Costs	**$65,000.00**

Subtotal - Annual Expenses	**$19,776.00**
Contingency (15%)	**$2,966.40**
Total - Annual Expenses	**$23,000.00**
Total 5 Year Project Cost	**$180,000.00**

UVRWPC: Watershed Management Plan
Gabions - Bottleneck Wash at Airport

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	170	$60.00	$10,200.00
2	Supervision and Inspecton	EA	1	$1,500.00	$1,500.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$2,340.00	$2,340.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$29,046.00**
Contingency (10%)	**$2,904.60**
Total - Permitting/Design & Project Costs	**$32,000.00**

Subtotal - Annual Expenses	**$13,940.00**
Contingency (15%)	**$2,091.00**
Total - Annual Expenses	**$17,000.00**
Total 5 Year Project Cost	**$117,000.00**

UVRWPC: Watershed Management Plan
Gabions - Bottleneck Wash

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	612	$60.00	$36,720.00
2	Supervision and Inspecton	EA	1	$2,000.00	$2,000.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$7,744.00	$7,744.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$56,066.00**
Contingency (10%)	**$5,606.60**
Total - Permitting/Design & Project Costs	**$62,000.00**

Subtotal - Annual Expenses	**$19,344.00**
Contingency (15%)	**$2,901.60**
Total - Annual Expenses	**$23,000.00**
Total 5 Year Project Cost	**$177,000.00**

UVRWPC: Watershed Management Plan
Gabions - Glenshandra (Granite Oaks)

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	136	$60.00	$8,160.00
2	Supervision and Inspecton	EA	1	$2,000.00	$2,000.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$2,032.00	$2,032.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$27,506.00**
Contingency (10%)	**$2,750.60**
Total - Permitting/Design & Project Costs	**$31,000.00**

Subtotal - Annual Expenses	**$13,632.00**
Contingency (15%)	**$2,044.80**
Total - Annual Expenses	**$16,000.00**
Total 5 Year Project Cost	**$111,000.00**

UVRWPC: Watershed Management Plan
Gabions - Mint Wash

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	576	$60.00	$34,560.00
2	Supervision and Inspecton	EA	1	$2,000.00	$2,000.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$7,312.00	$7,312.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$53,906.00**
Contingency (10%)	**$5,390.60**
Total - Permitting/Design & Project Costs	**$60,000.00**

Subtotal - Annual Expenses	**$18,912.00**
Contingency (15%)	**$2,836.80**
Total - Annual Expenses	**$22,000.00**
Total 5 Year Project Cost	**$170,000.00**

UVRWPC: Watershed Management Plan
Gabions - Yuma Drive

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	384	$60.00	$23,040.00
2	Supervision and Inspecton	EA	1	$1,500.00	$1,500.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	6	$440.00	$2,640.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	6	$172.00	$1,032.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$4,908.00	$4,908.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$41,886.00**
Contingency (10%)	**$4,188.60**
Total - Permitting/Design & Project Costs	**$47,000.00**

Subtotal - Annual Expenses	**$16,508.00**
Contingency (15%)	**$2,476.20**
Total - Annual Expenses	**$19,000.00**
Total 5 Year Project Cost	**$142,000.00**

UVRWPC: Watershed Management Plan
Gabions - Santa Cruz Wash

Engineer's Conceptual Construction Cost Estimate

	Description	Unit	Quantity	Unit Cost	Total Cost
Permitting/Design					
1	NEPA Permitting				
2	CWA Section 404 Permitting	LS	1	$500.00	$500.00
3	Flood Control Permitting	LS	1	$500.00	$500.00
4	Project Bidding Assistance	LS	1	$500.00	$500.00
5	Gabion Array Design and Modeling	LS	1	$3,000.00	$3,000.00
6	Monitoring Equipment Design	LS	1	$1,000.00	$1,000.00
Project Costs					
	Description	Unit	Quantity	Unit Cost	Total Cost
1	Gabion Construction	CY	324	$60.00	$19,440.00
2	Supervision and Inspecton	EA	1	$1,500.00	$1,500.00
3	On-site Recharge				
4	Drain Gage model G3 Passive Wick Lysimeter	Ea.	4	$1,300.00	$5,200.00
5	Decagon 20315 Depth sensor for G3 Drain Gauge, 5m 'Cable, Stereo connector for use with Decagon loggers	Ea.	4	$440.00	$1,760.00
6	Soil Moisture Monitoring				
7	EM50 Digital/Analog Data Logger	Ea.	2	$498.00	$996.00
8	5TM Soil Moisture & Temp Sensor	Ea.	8	$172.00	$1,376.00
9	Depth of Flow				
10	CTD Pressure Transducer	Ea.	1	$440.00	$440.00
11	Installation and Incidentals	Ea.	1	$1,538.00	$1,538.00
Annual Expenses					
1	Quarterly site visit by engineer	EA	4	$400.00	$1,600.00
2	Reconstruction (Annualized)	LS	1	$4,188.00	$4,188.00
3	Data collection, verification, and analysis	LS	1	$10,000.00	$10,000.00

Subtotal - Permitting/Design & Project Costs	**$37,750.00**
Contingency (10%)	**$3,775.00**
Total - Permitting/Design & Project Costs	**$42,000.00**

Subtotal - Annual Expenses	**$15,788.00**
Contingency (15%)	**$2,368.20**
Total - Annual Expenses	**$19,000.00**
Total 5 Year Project Cost	**$137,000.00**

	# of Units	Descriptioı	Unit Cost		Total Cost	
Lysimeter Installation Costs (4 units)						
Rental - Skid St	2	Days	$	288	$	576
Rental - 6" auge	2	Days	$	35	$	70
Labor (man hou	32	man hrs	$	20	$	640
T-posts, condui	1	various	$	100	$	100
Fuel	40	gallons	$	4	$	152
Total					$	1,538

K:\URVWPC\Watershed Restoration\Watershed Restoration Plan\Appendix\Infiltration Enhancement Coyote Wash

APPENDIX E

Summary of Scenario Planning Efforts

Exploratory Scenario Planning Process with Upper Verde River Watershed Protection Coalition

Joe Marlow, Hannah Oliver, Ray Quay

12/12/2014

LINCOLN INSTITUTE OF LAND POLICY

SONORAN INSTITUTE *Shaping the Future of the West*

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Introduction

The future of the Upper Verde River Watershed is unlikely to be similar to it's past. Change has and will continue to occur. Some of the region's past factors of change, such as population, economy, and technology, will continue to be important to its future though they will likely manifest themselves in new ways. New factors will also be important, such as climate change. One thing the future will have in common with the past is that the future of the region is highly uncertain. In the past, planners tried to reduce this uncertainty to create predictions of the future, and plan for these futures. But our ability to predict the future has never been very good, more a guess than prediction. When the guesses were right, planning worked well. When the guesses were wrong, planning did not work well. New factors such as climate change, and the volatility of past factors such as the economy and technology making predicting the future even more difficult. Yet planning need not be abandoned as hopeless. A new approach to planning under uncertainty is being used to explore and anticipate an uncertain future, rather than predict and plan for a future.

This approach is based first on envisioning a wide range of futures, good and bad. Then anticipating what these futures mean for the goals of the community or institution, often described as threats and opportunities. Then identifying actions, or adaptations, that may help achieve these goals across the range of possible futures. Finally, over a long period of time, take short term actions as anticipated to respond to the future as it unfolds as one or more of the possible futures. This approach to planning was the process selected to help the Upper Verde River Watershed Protection Coalition explore the implications of uncertainty about the future on the goals and projects with in their plan.

The Upper Verde River Watershed Protection Coalition (Coalition) was selected for a technical assistance grant through a competitive process. Western Land and Communities (WLC), a joint program of the Sonoran Institute and the Lincoln Institute of Land Policy distributed a request for proposals from organizations interested in integrating exploratory scenario planning with their current planning efforts. UVRWPC was provided $10,000 in funding, 500 hours of WLC staff time, along with $5,000 of consulting time from an expert in exploratory scenario planning.

Initial planning for the UVRWPC scenario project began in early April 2014 with discussions with the UVRWPC board to discuss exploratory planning in general and how it could be applied to their project. An initial project scope was developed and the project was initiated in July 2014. The project team included John Munderloh, John Rasmussen, Melody Reifsnyder, Ray Quay, Hannah Oliver and Joe Marlow. The project had four phases: 1) Issue Assessment, 2) Scenario Building, 3) Scenario Assessment, and 4) Strategic Planning Insights.

The first phase established the important stake holders involved in the future of the watershed and their concerns about the future of the watershed. A set of potential stakeholders was identified by the Coalition with input from the WLC staff/consultant. These stakeholders were surveyed with an online survey tool that elicited their perspectives on the planning time span, internal and external trends and factors, reasons why these are important, as well as best and worst cases of the trends and factors. Based on the survey responses and input from the Coalition, stakeholders were organized into groups of common interests and concerns.

The second phase included a scenario workshop, held on July 23, involving key stakeholders to elicit information about the future of the Verde Valley and the important factors that described various possible futures for the Verde Valley. To guide initial discussions of the key change drivers and important uncertainties, the participants were organized into subgroups based on common interest and concerns identified using the survey results. This workshop included exercises to explore the relationships between these factors, identify combinations of these factors that could result in unique futures, and to weight the importance of these factors. Based on this information, six scenarios were constructed that represented the most important factors, relationships, and unique futures.

The third phase included an expert workshop, held on September 18, in which topical experts tested the Watershed Management Plan project concepts and strategies for performance under the conditions of the six future scenarios. Following an in-depth review of each scenario, facilitated discussions focused on how the scenarios could create opportunities and barriers for achieving the goals of the project concepts. Strategies for overcoming the barriers or taking advantage of the opportunities were proposed and discussed. Knowledge gaps and necessary research were also noted.

The fourth phase synthesized the information collected from the online survey, stakeholder workshop, scenario building process, and the expert workshop into a set of strategic observations that can be applied to the Watershed Management Plan. These observations may also be relevant to future planning efforts.

The following provides more detailed results of each phase.

Phase 1: Issue Assessment

In order to envision possible futures, an understanding of the factors of change that may affect the future of the watershed is required. The Coalition members have all been working with the issues of watershed management and each has a deep understanding of different aspects of these issues. To create a comprehensive view of the factors of change for the watershed, a process was used to collect the insights of the Coalition and other stakeholders about what are the important factors related to the future of the watershed. First the Coalition created a list of relevant stakeholders knowledgeable about the issues of watershed use and management (See Table 1). These stakeholders were surveyed as to what factors they though were important and the best and worst case of future conditions related to the important factors that were identified. The survey results of the most important factors (See Table 2), combined with the results of the Sonoran

Institutes Factors of Change in the West project, and were used to create an initial list of factors of change.

Table 1: List of Stakeholders

Abe Springer
Ann DeMarco
Arden Barney
Brenda Smith
Chris Lowman
Craig Brown
Ed Wolfe
Edessa Carr
Greg Fister
Jerry Borgelt
Jim Gilsdorf
John Bodenchuk
John Sterling
John Zambrano
Linda Stitzer
Lora Lee Nye
Marques Munis
Mary Connor
Mary Hoadley
Michael Byrd
Patrick Rappold
Paul Levie
Peter Kroopnick
Rich VanDeMark
Shirley Howell
Tom Whitmer
Wade Albrecht

Table 2: Most Important Internal and External Factors Identified in the Survey

Internal Factors	**Votes**
Land Use Planning	7
Natural Resources Policies	7
Verde River Health	5
Political Climate, Politics	4
An Engaged Public	4
Public Education	3
Residential Growth	3
Development Standards	2
Public Finance	1
Green Infrastructure	1

External Factors	**Votes**
Groundwater Management	5
National, Global Economy	5
Population Growth	5
Climate Change	4
Regional Collaboration	4
Federal, State, County Laws	2
Lack of Control on Development	2
Land Development, Subdivisions	2
Regional Economy and Market	2
State Land, Federal Land, and Large Land Owners	2
Water Supply	2
Surface Hydrology	1
Water Conservation	1
Water Supply Policies	1

Phase 2: Scenario Building

A set of scenarios, each representing a possible future for the watershed, was development from a set of five factors of change, each with two possible future states. These factors of change and their state where developed by stakeholders during a one day workshop.

The scenario workshop activities included:

- Identifying change factors and possible factor states;
- Prioritizing the most important factor/states by voting;
- Identifying relationships among change factors;
- Identifying extraordinary threats or opportunities; and
- Prioritizing the most important threats/opportunities by voting.

The first workshop was convened on July 23, 2014 with 34 stakeholders based on knowledge about the initial list of factors of change. The stakeholders represented a range of interests including ranchers, environmental groups, public land managers, city and county staff, and elected officials. The purpose of this workshop was to identify the key changes factors that may influence the Upper Verde River Watershed's future.

The workshop was structured around several break out groups, organized into areas of general interests. Each stakeholder group was facilitated through a discussion to identify key factors of change and the factors potential impact on the region. Each group then prioritized their factors, and focusing in just two or three, identified what might be the different possible future states for each factor. This discussion created an extensive list. All the stakeholders then voted on discussions during the scenario workshop identified a host of key change factors that were prioritized through voting. The most important factors and the key states of these factors were as follows.

Key Factors of Change for the Upper Verde River Watershed

Public Education and Engagement

- Educated and Engaged
- Uninformed and Less Engaged

This factor is focused on the public's level of knowledge and engagement regarding watershed issues and solutions/strategies/tactics for achieving the goals of the Coalition. Knowledge was described as being more than just awareness of drought and personal water use, but also the different options for water management, and the role the watershed plays in water supplies and the environment. Engagement was described as being participating in activities to plan for water and water shed management, and actively supporting the public decision making process of the Coalition.

The two states of this factor represent opposites – a state of a public that is educated regarding watershed issues and engaged in finding solutions and strategies for achieving the goals of the Coalition, versus a state in which the public is not informed regarding the issues and less engaged in working to achieve the Coalition goals.

Watershed and Land Management

- Healthy Watershed Conditions
- Smart Growth Management

This key factor relates to the full range of watershed and land management strategies employed and activities occurring in the Upper Verde Watershed.

Factor states relate to 1) modes of management yielding watershed conditions with increased recharge, supporting Coalition goals of safe yield and sustained environmental flows in the upper Verde River, and 2) land use management policies in line with low-impact development, energy and water efficiency, local food production, and generally sustainable land use practices.

Economic Trends

- Weak Local Economy
- Strong Local Economy

Perceived by the workshop participants to be an extremely important factor, local economic conditions are seen as critical to the success of the Coalition in achieving their goals.

The states consisted of two opposites – a weak local economy, with low employment, decreased personal and business income and little economic development activity and the reverse of a strong and vibrant local economy, creating jobs, fostering business opportunities and actively growing.

Water Law and Policy

- Science Based Regulation
- Sensible Deregulation

This factor category relates to how water local and state law and policy will impact activities within the watershed including commercial, agricultural, residential, and recreational.

The states of focus for this factor are science-based regulation with more planning, higher efficiency, reduced water usage, improved river flows and overall increased resiliency. The second state in this factor category describes reduced regulation of water related activities based on practical application of science facts that reflects a balance between commercial efficiency and public benefit.

Commercialization of Natural Resources

- Efficient Commercial Utilization
- Inefficient Utilization

This factor is focused on the extent and efficiency of commercial use of natural resources, primarily woody biomass, removed from specific watershed areas due to vegetation restoration activities.

Two states were envisioned for this factor. One state results in the resources being efficiently utilized by commercial interests, producing sustainable energy and improving watershed health and a state with inefficient utilization leading to decreased watershed health.

Scenario Development

As is evident by the large initial list of change factors, uncertainty associated with the future of the Upper Verde River Valley Watershed is quite large. Even in this reduce set of five change factors each with two states represents 36 different possible futures. Trying to analyze such a large set of futures is difficult for groups to do qualitatively. To further narrow the futures to explore, stakeholders engaged in two activities: 1) identification of where two factors may be related (positively and negatively) related to each other; and 2) combinations of factor states that may create significant or unique threats or opportunities to achieve organizational goals. Table 3 presents these relationships and Table 4 presents these unique barriers and opportunities. Both are described with phrases used by the stakeholders in these discussions.

Using the weighting (based on votes) of the factors, the correlations, and unique barriers and opportunities, these possible futures were further narrowed to six scenarios. These scenarios represent the combination of factors, relationships, and threats/opportunities that the stakeholders suggested were the most important, and thus strategic, to explore the possible futures for the watershed.

Table 3: Correlation between Key Change Factors

	Watershed and Land Management	Economic Trends	Water and Law Policy	Commercialization of Natural Resources
Public Education and Engagement	Support funding and need; ecosystem services	Resource awareness and value	Required for compliance; better educated public = better laws and policies (quality of policies and laws)	Understanding values of system and marketplace
Watershed and Land Management		Success generates more activity; communication; sustainability (economic and environmental); quality of life	Creates science based approach; creates need	Enabler
Economic Trends	More use; finance both public and private; drives type of land use; adaptive; inconsistent		Disjointed; drive type of policy; ability to comply; effectiveness of regulation	Investment and market; timing; visibility
Water and Law Policy	Major driver or obstructer or protector; two way street	Rate; nature of policies; market and tourism; change values		Enable or obstruct marketplace (regulate); science
Commercialization of Natural Resources	Financial enabler and driver; prioritization; conflict in some cases (tradeoffs, competing interests)	Broaden tax base; creates new markets; conflicting interests; change in financial structure of infrastructure	Driver or obstructer; creates additional burdens	

Table 4: Unique Threats and Opportunities

		Watershed and Land Management		**Economic Trends**		**Water Law and Policy**		**Commercialization of Natural Resources**	
		Healthy Watershed Conditions	Smart Growth Management	Weak Local Economy	Strong Local Economy	Science Based Regulation	Sensible Deregulation	Efficient Commercial Utilization	Inefficient Utilization
Public Education and Engagement	Educated and Engaged	Funding opportunity	Quality of Life	Private-sector Innovation	Good place to be	Need for broader engagement	Overcome obstacles	Good for Marketplace	
	Uninformed and Less Engaged	Other Funding Sources	Hard to Accomplish	Bad place to be	Threat to long-term sustainability	Very difficult to accomplish	Bad place to be	Harder to develop Marketplace	
Watershed and Land Management	Healthy Watershed Conditions			non-traditional funding	Good place to be	Supportive Relationship	Overcome obstacles	Good place to be	Threats to watershed
	Smart Growth Management			Innovation	Good place to be		Overcome obstacles; unique	Synergy	
Economic Trends	Weak Local Economy					Difficult	Opportunities, but need to be cautious	Resilience; Difficult to have viable economy and ventures	Degradation of resources
	Strong Local Economy					Creates opportunities	Unique in each locality	Better conditions for viable economy and ventures	Difficult to change
Water* Law and Policy	Science Based Regulation							opportunities	Opportunities
	Sensible Deregulation							opportunities	Cautious of threats and opportunities

See the Appendix for notes on the various factors that were discussed during the workshops.

Scenarios

The following describes each of these scenarios and the change factors on which they are based.

Scenario 1: Smart Growth Management, Science Based Regulation, Uninformed and Less Engaged, and Weak Local Economy

The region and local governments are focused on supporting sustainable development and land use planning based on evidence from science and case study research. Much of this is focused on increasing the efficiency of water use. However lack of community support and a weak economy has made this difficult. A disgruntled public has little faith in public official's ability to solve community problems, and there is little public support for water related projects when so many other problems exist. This situation is due in part to a weak local economy that has limited the public and private sectors ability to create opportunities and incentives for resource development and planning.

Scenario 2: Smart Growth Management, Science Based Regulation, Uninformed and Less Engaged, and Weak Local Economy, Climate change

The region and local governments are focused on supporting sustainable development and land use planning based on evidence from science and case study research. Much of this is focused on increasing the efficiency of water use. However lack of community support and a weak economy has made this difficult. A disgruntled public has little faith in public official's ability to solve community problems, and there is little public support for water related projects when so many other problems exist. This situation is due in part to a weak local economy that has limited the public and private sectors ability to create opportunities and incentives for resource development and planning. Across the region there is also less rainfall, but more intense storms and hotter temperatures.

Scenario 3: Smart Growth Management, Science Based Regulation, Efficient Commercial Utilization

The region and local governments are focused on supporting sustainable development and land use planning based on evidence from science and case study research. Much of this is focused on increasing the efficiency of water use. In the region, there is an efficient commercialization of natural resources and in particular wood products. The efficient use of natural resources leads to a better economy, increased fuels management, increased water recharge, and improved water quality.

Scenario 4: Smart Growth Management, Science Based Regulation, Efficient Commercial of Natural Resources, Climate Change

The region and local governments are focused on supporting sustainable development and land use planning based on evidence from science and case study research. Much of this is focused on increasing the efficiency of water use. In the region, there is an efficient commercialization of natural resources and in particular wood products. The efficient use of natural resources leads to a better economy, increased fuels management, increased water recharge, and improved water quality. However, across the region there is also less rainfall, but more intense storms and hotter temperatures.

Scenario 5: Weak Local Economy, Inefficient Commercialization of Natural Resources

A weak local economy has limited the public and private sectors ability to create opportunities and incentives for resource development and planning. As a result natural resources are utilized inefficiently, resulting in a narrowly focused local economy and economic dependence on nearby regions. There is no significant change in policies affecting watershed health resulting in increasing watershed degradation.

Scenario 6: Weak Local Economy, Inefficient Commercialization of Natural Resources, Climate Change

A weak local economy has limited the public and private sectors ability to create opportunities and incentives for resource development and planning. As a result natural resources are utilized inefficiently, resulting in a narrowly focused local economy and economic dependence on nearby regions. There is no significant change in policies affecting watershed health resulting in increasing watershed degradation. The climate has changed to one with less rainfall with more intense storms and hotter temperatures.

Phase 3: Scenario Assessment

The goal of strategic scenario analysis is to help institutions anticipate a wide range of possible futures. Part of this anticipatory approach is to identify a set of strategic insights that can be used to guide current decision making to be better prepared to adapt to different possible futures. Such insights can be:

1) robust in that they identify strategies that work well across a wide range of possible futures;
2) incremental and flexible solutions that can be slowly implemented in stages as one or more possible futures slowly unfolds over time, or be abandoned if they do not;
3) hedge strategies to be prepared for possible worst case futures;
4) trigger points (factors reaching a certain state) that allow strategies requiring significant investments to be planned for but implementation delayed until it is anticipated they are needed;
5) contingency plans that can be prepared for and triggered when certain futures begin to be realized;
6) synergies between normally disparate issues that create unique opportunities or threats under certain possible futures;
7) actions that need to occur early in order to preserve adaptation options for certain possible futures;
8) actions that can be taken now that would be effective in responding to a narrow set of futures, but have secondary benefits so there are no regrets about implementing them even if these futures do not come about; and
9) observations of how different viewpoints about institutional (or community) values may affect success under different possible futures.

This type of analysis requires developing a list of strategies to respond to the range of possible futures and then looking for these insights across this list. In the case of the Upper Verde River Watershed Protection Coalition, the group has identified goals for the institution and a set of project concepts to achieve these goals. To develop strategic insights from the six scenarios, these concepts were reviewed as to what the challenges or opportunities for success there would be if implemented under each of the scenarios and what strategies could be used to increase their chance of success or take advantage of special opportunities. This type of analysis requires some expertise about the concepts and the factors of change. Based on the subject content of the six scenarios and the watershed planning project concepts, a list of expertise needed for the expert workshop was identified, including hydrology, land development, water policy, range management, forestry, floodplain management, public lands, ranching, wildlife management and land use planning. For each area of expertise specific experts were identified and invited to the expert workshop.

This workshop was convened on September 18, 2014 and was attended by 21 experts (See Table 5). This workshop focused on identification of barriers, opportunities and strategies regarding implementation of the four watershed planning project concepts under the conditions of the six scenarios.

The scenarios were first reviewed and discussed as a whole group. This was followed by break-out group discussions, organized by project concepts. Each group reviewed the specific project concept of focus. This was followed by facilitated discussions examining how each of the first three scenarios (without climate change) could create opportunities and barriers for achieving the goal of the project concept. Strategies for overcoming the barriers or taking advantage of the opportunities were suggested by group members and discussed. Any information gaps regarding assessing impacts of potential response strategies were noted.

The three scenarios that included climate change as a factor were then discussed by the entire group following the same structure as employed in the breakout groups.

This expert review was concluded with a discussion with the entire group that examined the nine possible types of strategic insights identified above.

Table 5: List of Experts

Ann DeMarco
Brandon Van Horn
Carmen Ogden
Chris Duza
Craig Coronato
Craig Kornrumph
Dana Biscan
Ed McGavock
Jeanmarie Haney
Jim Gilsforf
Jim Leenhouts
John Bodenchuk
Jon Fuller
Keith Nelson
Kresta Faaborg
Larry Geare
Leslie Graser
Lora Lee Nye
Neil Wadsworth
Vivian Gonzalez
Wade Albrecht

Phase 4: Strategic Insights

Using the results of the expert workshop a further examination was conducted to create a list of strategic insights that can apply to the Watershed Management Plan and future planning. These insights were then categorized based on their content, tactical or strategic context, and relationships.

Experts' Strategic Insights

1) Project Implementation
   a) Select projects that can easily show results, sooner the better, particularly results that benefit those who can see or have contact with the project.
   b) Pick locations that would be less likely impacted by an extreme event or design to accommodate extreme events.
   c) Pick locations with high visibility to increase awareness.
   d) Pilot projects are experiments and should include monitoring and evaluation.

2) Education about dynamics of landscape, groundwater, and environmental flows in the Verde will be critical to develop and implement enhanced recharge strategies, but this education has three distinct audiences and purposes. Common barriers across concepts and scenarios have to do with level of engagement of public, knowledge of public, public understanding, and public perceptions. There are three distinct audiences for educational efforts.
   a) Individual Private Land Owners: Land owners must understand why enhance aquifer recharge benefits them.
   b) Engaged Public who may support funding: The public must understand how enhanced aquifer recharge enhances the community values that are most important to them.
   c) Youth/Long Term Future Decision Makers: enhanced aquifer recharge will be a long term (30+ years) effort, and decision makers for future efforts are students today.

3) Climate Change Uncertainty - Drought, temperature increase and more extreme storm events may have long term fundamental impacts on project concepts.
   a) Extreme storms may render some stream enhancements projects ineffective or destroyed, such considerations may influence the design or location of projects.
   b) Temperature and low precipitation may change the native vegetation patterns, thus changing the effectiveness of some vegetation treatments.
   c) Lower precipitation may affect the cost effectiveness of some stream recharge enhancement methods.

4) Research is needed to address questions about the future of landscape and groundwater that are unanswered.
   a) There are a lot of unanswered questions about the hydrologic and biological dynamics of the watershed.
   b) In order to improve science based regulations policies, more research to answer questions is needed.
   c) Research is needed about communicating, informing and engaging the public.

5) A political environment of strong support for smart growth and science-based policies may make strategies for enhancing recharge easier to develop, but are not critical to such efforts.

6) Economy
   a) Changes in the economy will affect the cost/benefit of various aquifer enhancement methods making some approaches (such as water rights acquisition) more or less cost effective, suggesting that understanding the triggers for cost/benefit would be useful to evaluate programs over changing economic conditions.
   b) Some interesting and unusual opportunities, such as acquiring abandon gravel extraction pits, may become available during poor economic conditions.
   c) Inefficient commercial utilization of natural resources may result in adverse impacts on stream recharge enhancement projects.
   d) Many of the barriers across scenarios and concepts have to do with the economy, markets and access to capital.

7) Business opportunities
   a) A range of potentially profitable business opportunities were identified, including natural resource utilization, energy generation, project investment, and land development.

8) Partnerships and collaborations
   a) Partnerships with various types of organizations will be very useful – public land managers; private land owners; developers; governments (federal, state, local); businesses; educational institutions; leaders at all levels; and the public.
   b) Collaboration with partners is essential for funding, demonstration projects, education, planning, land management; project implementation, and to generate support.

Next Steps

This anticipatory analysis developed a number of strategic insights that can now be used to enhance the current Watershed Protection Plan and develop new planning goals, objectives, and actions. From this process, we have identified three next steps are suggested for the Coalition. 1) There are some strategic insights which the coalition may want to consider for short term action, 2) the Coalition should include in its next planning meeting a review of the full strategic insight list to identify potential changes or new additions to its current plan to address some of these insights. 3) In a couple of years, the Coalition should evaluate the need to for an updated anticipatory analysis.

Short-Term Actions

During the process of extracting the strategic insights from the experts' scenario assessments, WLC staff identified four areas of some short term actions the Coalition may want to consider.

Education: Education emerged as a critical set of strategies to respond to all scenarios for all the project concepts, thus it is a robust set of strategies. It was also discussed how education about the watershed for both young people and current community leaders, would have many benefits for a wide range of Coalition's project and beyond the Coalition's interests, thus it is a good set of no regrets strategies. Lastly it was discussed that this would take time, so the trigger to implement such strategies is now. Given this assessment, the coalition may want to consider including some simple educational projects within its short term project scope. The Coalition would benefit from conducting an internal assessment of the various groups whose engagement is important for the success of the Coalition and what types of knowledge and communication methods would be best for each. This assessment could suggest opportunities to incorporate such messaging in existing community activities and begin to plan for more extensive efforts.

Projects as Learning Opportunities: Another important insight that spanned all scenarios and project concepts is that our knowledge about the dynamics of the watershed and the effectiveness of different management strategies though extensive still leaves many questions unanswered. The experts suggested that the projects the Coalition was proposing were opportunities to help close this knowledge gap. To take advantage of such opportunities the coalition may what to consider including in its projects a more rigorous research element which could include:

1. An initial short narrative of what is the result that is hoped to be accomplished by the project, why the project may accomplish this result, and when this result is expected to happen.
2. A methodology, preferably simple, that could be used to measure the anticipated result of the project
3. A pre and post project measurement of the result using the suggested methodology.
4. A post project assessment of the results and some form of publication or referral of the analysis to all watershed managers in the region.

Such a research element could be conducted in house or in partnership with one of the local universities or community colleges.

Climate Adaptation: All the experts agreed that some level of climate change is likely to occur over the next 100 years around the watershed, but it is highly uncertain as to the magnitude of such change. Climate forces will likely include variable precipitation, increased heat, and storm intensity. Further the experts suggested that at the higher levels of possible change, climate change could have significant impacts on the success of vegetation and hydraulic management concepts. The Coalition could identify the major climate forces that will affect their watershed and employ regular monitoring of those climate forces and identify thresholds or trigger points for those climate forces. In addition, the Coalition should reevaluate the Watershed Management Plan project concepts as the climate thresholds approach. Given this the Coalition may want to begin planning using an anticipatory governance approach.

Watershed Plan Project Concepts: During the expert discussion as some of the experts tried to gain a better understanding of the goals and intent of the project concepts found some of the categories in which the project concepts are organized in the report to be confusing. In some cases it was hard to distinguish between similar projects in different categories. In addition, it was difficult to understand how a project concept aligned with the general intent of a particular category. Given this experience among the experts, it would be reasonable to expect a similar reaction among less knowledgeable public and decision makers, which may make it more difficult for the Coalition to promote its plan and projects. Based on discussions among the experts it does not appear that fixing this would require a major rewrite of the plan, but rather some simple reorganization of some project concepts among the categories and perhaps some renaming of some categories to better articulate the intent of the projects in it.

Planning

As the Coalition begins to assimilate the ideas introduced by the strategic insights it will ideally begin to see how these insights can be used to make the Coalition's planning and project implementation more resilient. The Coalition in its next planning session could include a review of these insights and how they can incorporated in the plans goals, objectives, and project concepts. For example, some of the strategic insights that were identified in the workshop and by the WLC staff may be things that the Coalition has not thought about during the initial drafting of the Watershed Management Plan. Such a review should also consider to what extent the Coalition goals should be revised. As the Coalition begins to identify new projects, they can be assessed against the six scenarios in a process similar to the expert workshop. This assessment can be combined with the assessment from the expert workshop to identify new strategic insights or reinforce the existing insights.

Re-assessment

After a couple of years, the Coalition should consider to a short reassessment of it the scenarios and factors of change in light of its experience and along what tract among the scenarios the future is unfolding. If the factors of change are still considered to be the most important and the six scenarios still define a reasonable range of future possibilities, then little further action may be needed. However, if the driving forces change or some scenarios are no longer considered realistic or new additional scenarios are considered possible, then the Coalition may want to consider revisiting the process used for this analysis. Different factors and factor states discussed in the first workshop can be used for developing another set of scenarios. These new scenarios can be used to test the current project concepts and new project concepts that may be proposed.

Appendix A: Stakeholder Workshop Notes

The notes below are a summary of the first workshops flipcharts on specific driving forces of change. These driving forces were the building blocks for the six scenarios that were developed.

Smart Growth Management

- Sustainable
- Cluster housing with open space
- Less infrastructure need
- Increased opportunity for efficient reuse
- Energy efficiency
- Incentives to ranchers
- Incentives for low impact development
- Local food growers – farmers markets
- Efficient water use
- Opportunity for more agriculture
- Maintain heritage

Science Based Regulation

- Long-term, sustainable water supply
- Increased conservation
- More resiliency
- Maintain ecosystems and habitats
- Better river flows
- More planning preparation
- Watershed consistency
- Reduced water use
- Change in water pricing
- Protect aquifer and environment
- Protects base flows
- Reduced wildlife threat
- Sustained economy
- Diverse recreational opportunities and increased of quality of life

Efficient Commercial Utilization

- Watershed restoration (vegetation) fuels management
- Reduced fire hazard
- Reduced soil erosion
- Increase recharge
- Improve water quality
- Water rates reflect true value
- Sustainable energy production
- Less importation
- Wildlife for future generations

- Better air quality
- Economic boost
- Competing interests
- New policy adopted

Uninformed and Less Engaged Public

- Lower quality of life/ disgruntled public
- Less support for public projects relating to water (opposition)
- Less trust in government
- Mixed messages (source of education material)
- Status quo in decline

Weak Local Economy

- Less Culture, parks and community life
- Crime increase
- Loss of skilled workers
- Government cannot meet community needs
- Poor planning
- Loss of jobs
- Cannot develop resources
- New employment not able to occur
- Worse water quality
- More environmental impacts
- Less engaged public

Inefficient Utilization/commercialization of natural resources

- Watershed degradation
- Desirable by some
- Narrow focused economic
- Economic dependence on others
- Less recharge
- Poor air quality
- No policy change/stagnant

Appendix B: Expert Workshop Notes

Scenario Analysis

PROJECT CONCEPT: LAND USE, FOCUSED ON AQUIFER PROTECTION

SCENARIO #1:

Barriers

- Weak Economy – no money for projects
- Poorly informed public – no votes for water projects

- Conflicting priorities related to the public – need for essential services only in weak economy
- Independent-minded folks may/ do not want to participate
- Misinformed maybe engaged but will scuttle good projects
- "informed" public is biased or carries own agenda
- Weak economy usually means no growth
- Public less engaged except for essential items – there is no energy to engage in waste issues
- Less volunteerism and involvement in water/environment

Opportunities

- Opportunities better for low/no impact development
- Public not engaged allows quickened approval of policy

Strategies

- Partnerships to bring in federal money
- Weak economy may create gateway for purchase of development rights
- Use science and demonstration projects to help inform public and to create local buy in
- Bring in public to engage and control information to ensure no misinformation
- Leadership – must create new ones and those in place
- Lack of information causes suspicion, suspicion of motives prevents information
- Bring in potential developers before they make their economic model

Areas where we need more information or knowledge

- How do we approach those folks who are not affected by the economy, don't want growth, and don't feel they should participate in strategies?

SCENARIO #3:

Barriers

- Large upfront capital investment needed
- NEPA on National forest land
- Need assurance of product
- State Land – there is no wood removal
- Impact to roads – more traffic from natural resource extraction and harvesting
- Agency conflict – steal money from forest maintenance for wildfire
- Public is not making the link between healthy forests and public benefit
- Landowners opposed to INA
- STL formula is too rigid

Opportunities

- Create markets for wood pellets, energy production
- Energy at Drake Industries
- Good time for PDR
- More uses for products on the land
- May implement INA
- STL will figure out how to share values between trustees

Strategies

- Overcome capital investment using private funds
- Get NEPA complete on NF lands:
    - Educate about negative aspects of NEPA i.e. fire intensity
    - Learn from past experience
    - More focus on economic and social aspects
    - Forest-wide NEPA (EIS)
    - Tort reform
- Increase trustee's ability to share revenues on STL and recognize value from conservation
- Exchange state trust land and consolidate the land
- Educate those affected by wildfire in the need for fuels management and the benefits to the water supply
- Use existing successes to build more
- Have industry and economic benefits to pay for restoration
- Public education on the links between watershed health and healthy forests, etc.
- Use public lands to jump start economy activity
- Hydrologic monitoring – need more data!
- Legislative mandate in order to move forward on the integrated non-agriculture policy (INA)

Areas where we need more information or knowledge

- We need more information on the hydrologic response to juniper and other vegetation to make link to healthy forests and public benefit
- Hydrologic monitoring

SCENARIO #5:

Barriers

- Low public engagement
- Low investments
- Hostile Public
- No $ for PDR
- Overgrazing/overcutting

Opportunities

- Purchase prices on land are lower
- Create economic value from woody products
- A driver for innovation and investment
- Public get reengaged
- Water use declines/stagnant – but we have more time to develop policies

Strategies

- Need proactive planning before crisis occurs
- See previous scenario notes with weak local economy
- Pre-programmed investment opportunities to secure a revenue stream in bad times

PROJECT CONCEPT: VEGETATION

SCENARIO #1:

Barriers

- Monetary – where does the money come from?
- Developing viable economic markets for biomass utilization – have to be able to use to effectively thin the forests
- Weakened economic leads to continual degradation
- Uninformed public
- Ability to economically treat land
- Doing things backwards – need market first!

Opportunities

- Develop policies to incentivize use of biomass
- Direct available funds to address priorities through smart growth (overlap with land use policy development)
- Inform and engage public
- Incentives for private sector – builds confidence for long-term investment
- Entrepreneurial opportunities by development industries

Strategies

- Business opportunity – educate/ help small business owners access and comply with financial programs – directly through regulatory process
- More investment in business opportunities – more important than on the ground treatment
- More funding to developing markets
- Private investment critical and where solutions will arise
- Increased incentives for biomass business utilization

Areas where we need more information or knowledge

- Universalities to engaged public
- Comprehensive outreach to informed/engaged public
- Economic developers must be engaged
- Integrated work groups
- Focused groups with specific goals
- Planning must remain regional

SCENARIO #3:

Barriers

- Change in political leadership
- Apathy

Opportunities

- Engage public
- Further develop technology/ increased innovation
- Further develop small business opportunities
- Private supplants government for thinning – private property thinning
- Opportunity to achieve groundwater balance

Strategies

- Community education and marketing campaign
- Transition from public to private
    - Regulatory environment
    - Continued supply of raw materials
    - Public/private partnerships
    - Sustainable plans for all lands with non-profit facilitation

Areas where we need more information or knowledge

- Hydrologic data
- Oversight for range land and hydrologic monitoring, surveys, track fire data, soil health
- Gather information on economic impact of woody biomass utilization
- Develop baseline followed by monitoring plans:
    - Wildlife survey
    - Hydrologic monitoring
    - Vegetation surveys
- Need common plan for collection/reporting data and common depository for info

SCENARIO #5:

Barriers

- Lack of political clout at all levels
- No markets – lack of diverse markets
- Uninformed public/apathy
- No self-sufficient = limited ability to act
- No funds to treat land and resolve problems

Opportunities

- Incentivize private sector
  - Greater demand for product utilization
  - Engage non-profit sector for outreach
  - Engage national chains to support and develop maintenance of efficient commercialization of natural resources
- Citizen grassroots efforts to drive public policy initiative

Strategies

- Public education of government officials to develop policies that encourage efficient commercial utilization of natural resources (non-profit or universities doing the outreach)
- Improve economy through better policies
- Grassroots efforts with private sectors without government involvement
  - Develop private capital opportunities
  - Work with colleges/ universities on the demonstration projects

Areas where we need more information or knowledge

- Impact and response strategies (negative impacts = scare into action)
- Impact of too much vegetation:
  - Continued degradation of forest/rangeland
  - Increased fire danger
  - Economic analysis of the "do nothing" approach - Real economic costs and human costs to wildfire
  - Analyze the increased cost of water, permits, impact fees
- Consequences of not reaching safe yield
  - Cost of not reaching safe yield
  - Monetary
  - Increased regulation
- Define "healthy watershed", so public and government understands goals

PROJECT CONCEPT: INFILITRATION ENHANCEMENTS

SCENARIO #1:

Barriers

- Awareness that uncertainty still exists in modeling
- Less data exchange from public/private sectors – financing differences
- Low staffing – less hands to accomplish needs and objectives and data exchange

Opportunities

- Science on recharge area is increasing
- Area well equipped with data collection
- Uninformed, weak economy

Strategies

- Under or misinformed public:
    - Community education
    - Specific engagement with land owner
    - Long-term education (k-12)
    - Short-term education (focus groups)
    - Advocacy groups (foot men)
    - ID drivers (values, needs, etc…)
    - Determine simple messages (base principles) and show results and plan for and show successes
    - Find commonalities in science and message

SCENARIO #3:

Barriers

- Likely no instant results
- Differences to justify what may be a long term project to see results
- Science gaps
- Feedback loops and cause/effect issues
- Ability to optimize the commercial use to maximize recharge
- Not enough applied science to differentiate or determine a benefit or regulation

Opportunities

- Young scientists bringing to technologies and their applications

Strategies

- Multiple benefit to project
    - Forest thinning/sediment – drop out sediments
    - Take water from storage and link with gabion recharge
- Give monitoring high priority before and after installation of gabion
- Monitor further increase watershed that originally anticipated

- Coordination with learning institutions, local learning and teaching centers – collaborations and partnerships
- Re-engage as a region
- Use ADWR models to inform gabion locations
- Integrate NARGISM w/PRAMA to address entire coalition project

SCENARIO #5:

Barriers

- Over utilization of gravels in water sources may affect gabion
- Without strong/site specific science it would be hard to deter gravel extractions
- Science is not in agreement say btw grazing and recharge
- Inefficient use of commercial utilization can result in catastrophic wildfire

Opportunities

- Use old gravel pits to redesign for gabion recharge
- Less wk to push recharge with lower economy because less pumping (slows rate of depletion)
- Trade out/buyout a gravel, farmer, etc. work with offering efficiency (Explore cost effectiveness of other options for the land)

Strategies

- Prioritize partnerships in areas to help improve successes of your project
- In planning prepare, locate obstacles, or opportunities
- Develop applied and site specific data or tools
- ID gravel pits in good recharge locations and also ID new locations to resource development
- Have an inventory of prime sites with a cost-benefit analysis
- Be ready with evidence in a reg process to protect locations of recharge location (existing or future)

PROJECT CONCEPT: URBANIZATION

SCENARIO #1:

Barriers

- Lack of funding for implementation
- Local hydrologic conditions could limit benefit to Verde, could even reduce benefits to Verde
- Public opposition to spending
- Steep slope requires additional mitigation
- Inability to recharge in Prescott

Opportunities

- Demonstrate benefits of smart growth policies
- Lowe's has high visibility
- Policy makers support and engage and inform public
- Casino could spur redevelopment and create additional smart growth
- Quality of life improvements i.e. riparian area gains support

Strategies

- Grant Funding and private funding – NPO partnerships. Volunteers, capitalize on downstream benefits, life cycle cost reductions, special tax district
- Careful site selection, tap local knowledge, more stringent development standards to enforce best implementation, increase scope
- Distribute information – outreach and education – small, highly visible pilot projects, spend private money
- Development overlay districts (Scottsdale example)
- Get water to recharge areas
- Incentives, demonstrate benefits, ROI, find balance between environmental and developer needs

Areas where we need more information or knowledge

- Site characteristics
- Societal trends – need to monitor all relevant trends
- Communication style

SCENARIO #3:

Barriers

- More people, increase water demand
- Complacent public
- Optimized for commercial, not environmental
- Need adaptive management
- Circumvent regulation

Opportunities

- Ecotourism/tourism
- Increased property value
- Appeal to younger population
- Adjust land use and tax policies to support low impact development
- Excellent environment for additional policies and support

Strategies

- Determine carrying capacity, new policies to reduce sprawl, redevelopment/infill, increase effluent use, increase conservation, update subdivision code, master planning
- Celebrate successes - increased education and outreach and continue adjusting water rates
- Dynamic land management plan, reevaluate "optimized"
- Adapt/enforce regulations – build better mouse trap
- Take Advantage of:
  - Plan for increased revenues to yield more revenue – tourism plan
  - Increased property tax, more public support, people will invest in their properties, developer more apt to implement in a positive manner
  - Affordable housing policies, diversity in development

Areas where we need more information or knowledge

- Carrying capacity – what is it?
- Future communication styles
- What is the balance between community and environment
- External factors

SCENARIO #5:

Barriers

- Lack of funding/variable funding
- Lack of support
- Funding sources
- Leniency to developers exacerbates the problem
- No development
- Lack of planning
- Lack of active management

Opportunities

- Increase use of natural resources
- Develop policies
- Good time to plan
- Public outreach needs to understand concern
- More potential project areas
- Improved economic makes projects

Strategies

- See S1, B1 strategies
- Education, develop leadership
- Moratorium on developers, requires enforcement

- Other funding sources
- Administrative support, develop policies for retrofits – anticipate bad practices, focus on problem at hand, developer accountability and impacts
- See B6
- Take advantage of:
    - Decrease permit fees – streamline to promote quality of resources
    - Lack of opposition pushes policies faster, engage public
    - Like great depression – CCC program

Areas where we need more information or knowledge

- Characterize natural resources
- Ceiling and floor of capacity

Scenario Analysis w/Climate Change as factor

Scenario #2

Barriers

- Outcomes of vegetation response and changes with climate change
- Hydrologic responses also changes with climate change are uncertain
- With dry climate – harder to see benefits of projects and harder to get developers to do projects
- In panic, harder to do science-based regulations
- Intensity of events make projects more difficult to predict and prepare for
- Increased water demand increased pressure on water sources

Opportunities

- Understand where and when recharge occurs
- Scare tactic opportunity and an understanding of the threat that motivates change
- Look at past climate records data to get an idea of future conditions
- Expanded opportunities for urban projects (population growth from PHX)
- Easier for future regulation

Strategies

- Dual plumbing to capture large rain events and pipe to common storage
- Rethink the current planning process
- Highly visible projects with corporate and other partners support
- Expand horizons to other areas with same problems – collaborate with their groups
- More aggressive approaches in urban areas

- Create dedicated funding source for future projects – partners
- Public-private partnerships
- Need Partnerships/Coalitions to carry out research – as grant funding decreases

Areas where we need more information or knowledge

- Apply climate data to juniper and other species
- More research needed for vegetation response and recharge using current and future climate regimes
- Need extreme weather event data modeled

Scenario #4

Barriers

- Hard to have a conversation about carrying capacity when there are strong growth drivers – opportunities for growth need to be constrained
- Climate Change will decrease supply and increase demand

Opportunities

- Continued education of the issue

Strategies

- Translate science into accessible form for public consumption
- Talk about issue in terms of ranges (temperature ranges, etc)
- Understand and measure land needs for growth – bring science to carrying capacity
- Educate future generations about the issue and how it connects to watershed

Areas where we need more information or knowledge

- Can you constrain water use enough to offset growth?

Scenario #6

Barriers

- Climate changes causes rethinking of projects and may cause the projects to stop
- More difficult to do larger projects
- Public understanding and perceptions on policies and projects makes it hard to move forward on various projects
- Economy may be impacted

Opportunities

- Fear factor will [hopefully] motivate people to do things differently

Strategies

- Do projects that will accommodate wider range of uncertainty
- Anticipate worst case and prepare while times are good
- Be diligent about funding for agencies (ADWR) when budgets are tight/decreasing
- Reach out to other (federal) agencies that are incorporating climate change into planning efforts
- Adaptive policies based on climate conditions
- Public outreach and economic impact – make the connection between the two related to climate change
- Long-term thinking and planning on climate change
- Effective and Realistic public education – toilet to tap issues and energy connection to changing climate

Areas where we need more information or knowledge

- Understand how to communicate about climate change

Group Discussion

1. Can you find the same impact or opportunity that was listed across the scenarios? Can you find a place where a strategy was listed across all three scenarios? Can you find a place where more information is listed across all three scenarios?
    - Education – public engagement and outreach
    - Funding Sources and the need for public support for public support; Lack of funding
    - Opportunities for public-private financing
    - Public/Private Strategies
    - Need for better science or more science/data
    - Need for advanced planning for long-term
    - Data collection (around individual projects)
    - Data incorporated into the project (demo projects)
    - Informing the public and helping them understand uncertainty
    - Need to communicate the "need to do something" and motivate the public to take action
    - Educate people to specific benefit: economic benefits, etc
    - Importance of NEPA on projects on public lands and assistance on the project to get on the ground
    - Need to show results as a strategy and proof of impact
    - Policy development – planning
    - Communication techniques – science and public

2. Can you find strategies that you are already doing?
    - Were doing a lot, but everything were doing is not enough
    - Lesson learned: already doing a lot, rather than reinventing need to focus on institutions and learn to enhance or modify to be more effective
    - Education is occurring, but it is not influencing a behavioral change
    - Doing planning, but need to do more
    - Public private partnerships, public/public groups, workshops – need to do more of this effective
    - Need to do pilot projects and we are developing pilot projects in the watershed management plan

3. Can you find impacts that were catastrophic or worse case?
    - Trying to stop growth
    - Apathy
    - Losing the momentum to the next generation and losing the momentum ("wait for the pot to boil")
    - Inaction
    - Coalition's are necessary to get things done, but political changes to get things done

4. Can you find strategies that have significant benefits other than recharge?
    - Eco-tourism and quality of life benefits
    - Open space and recreation
    - Wildlife and grassland health/restoration
    - Secondary benefit to the private property owners
    - Economic benefits – new market, etc.
    - Healthy watershed (defined more broadly) - everything from top of tree to bottom of aquifer
    - Collaborations

5. Were there impacts, opportunities, or strategies that were unexpected?
    - Using gravel pits as recharge basins
    - Celebrate success
    - Grants aren't enough to cover projects
    - Public sector foster private sector entrepreneurial projects
    - Not enough data
    - Expected but didn't see: water credits and recharge
    - Rethinking strategies – likely because of the climate change aspect of the modeling, etc. Until "climate change" is more widely accepted probably won't be widely applied

6. Were there factor in the scenarios that did not seem to make a difference in the discussion?
    - Land Use/Aquifer protection project use:
        i. scenario 1/5 similarities
        ii. Commercialization of natural resources
        iii. did not make much of a difference to the Land Use/Aquifer protection project
        iv. Climate – employing the strategies and better managing of the land to have landscapes adapt
    - Infiltration:
        i. Climate made a big difference – made the range change for projects – beyond a tipping point
    - Urban:
        i. No correlation between weak economy and public support – but smart growth and science base related
        ii. Not a whole lot of change for Urbanization
    - Vegetation
        i. Efficient Use of Water Resources not in play
        ii. Climate will effect because the numbers will be different and will have to rerun the numbers – made stressors worse
        iii. Smart growth didn't matter as much – more demand than there is water, so smart growth was not as large of an issue – if it makes more water that is good (main goal)

7. Were there any unexpected points or particularly significant of discussion in your group?
    - Don't disagree with the need to educate with data, but be careful when educating (misused data) – might be good to anticipate that issue or that it is happening. Also could be good to understand what data has been given that is misinformed.