

Aquatic Species Management Plan

in Support of the Pima County Multi-species Conservation Plan

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Photographs (upper left to lower right): Lowland leopard frog, Huachuca water umbel, and Gila chub. Credit: Brian Powell (umbel, chub); Julia Fonseca (frog).

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1 Planning Framework

1.1 Introduction

Perennial or near-perennial surface water in arid environments is essential for a host of resources including native species such as fish, frogs, and aquatic invertebrates, but also for many terrestrial animals (O'Brien et al. 2006). The importance of water was recognized in the development of the Sonoran Desert Conservation Plan (SDCP), which had a significant focus on riparian and aquatic resources (e.g., Fonseca et al. 2000; Pima County 2000; Rosen 2000; Pima County 2002). Protection of water resources was a driver of Pima County's most recent and significant land acquisition program, which began in 2005 with voter-approved bonds and other funding sources (e.g., Floodprone Land Acquisition Program). As a result, Pima County and the Regional Flood Control District (District; collectively referred to as Pima County unless otherwise noted) now own over 107,000 acres of fee lands and hold over 143,000 acres of state and federal grazing leases. Important water resources exist throughout this preserve system, known collectively as Pima County Conservation Lands.

As part of Pima County's ongoing commitment to balancing conservation and responsible development activities, Pima County finalized our Multi-species Conservation Plan (MSCP) and associated Section 10(a)(1)(B) permit in 2016 (Pima County 2016). Among other things, the MSCP provides a set of management and monitoring principles and practices for a large portion of the County's Conservation Lands. One condition of permit issuance was for Pima County to develop an Aquatic Species Management Plan¹ (plan) by July 2019. The plan is intended to contribute to long-term conservation and recovery of the target, MSCP-covered species by identifying and prioritizing actions that will contribute to habitat occupancy within the County Conservation Lands system. This plan will be implemented for the duration of the MSCP Incidental Take Permit. The plan does not authorize or fund any particular action on land owned or managed by Pima County, but sets a foundation for these actions.

1.2 Species Addressed

This plan focuses on a host of aquatic species, known collectively as *target species*, which are addressed in the MSCP²:

¹ Originally termed the Riparian and Aquatic Species Management Plan in the MSCP, the plan name has been changed to reflect focus on aquatic resources and the species that inhabit those areas. Despite the name change, there is no change in the species addressed in this plan.

² Forty-four species, known as Covered Species, are addressed in the MSCP; some species are listed under the Endangered Species Act (ESA) and others have been determined to have the potential—during the course of the MSCP—to be listed.

- Gila topminnow (*Poeciliopsis occidentalis occidentalis*; ESA Endangered);
- Gila chub³ (*Gila intermedia*; ESA Threatened);
- Longfin dace (*Agosia chrysogaster*);
- Desert sucker (*Catostomus clarki*);
- Sonora sucker (*Catostomus insignis*);
- Chiricahua leopard frog (*Lithobates chiricahuensis*; ESA Threatened);
- Lowland leopard frog (*Lithobates yavapaiensis*);
- Northern Mexican gartersnake (*Thamnophis eques megalops*; ESA Threatened);
- Huachuca water umbel (*Lilaeopsis schaffneriana* var. *recurva*; ESA Endangered);

During the development of this plan it was determined that other native aquatic species could benefit from plan actions. Conservation actions that would promote the occupancy of these additional species supports the biological goal of the Sonoran Desert Conservation Plan⁴. However, where introductions and/or management of these additional species are contemplated, it will need to be determined whether an introduction action might compromise the quality of the habitat for target species or cause a reduction in target species' populations at these sites; in this case, the management action would not move forward. Management activities directed at these alternative species will be on a case-by-case basis and follow established protocols and rules, for example the Safe Harbor Agreement for the desert pupfish (Arizona Game and Fish Department and U.S. Fish and Wildlife Service 2007). Additional species include:

- Desert pupfish (*Cyprinodon macularis*; ESA Endangered);
- Razorback sucker (*Xyrauchen texanus*; ESA Endangered)
- Loach minnow (*Rhinichthys cobitis*; ESA Endangered);
- Speckled dace (*Rhinichthys osculus*)
- Sonoran mud turtle (*Kinosternon sonoriense*);
- Black-necked gartersnake (*Thamnophis cyrtopsis*);
- California floater (*Anodonta californiensis*).

³ Recent taxonomic changes have combined headwater, roundtail, and Gila chub into one species, the roundtail chub, *Gila robusta*. Pending a species status assessment, the USFWS continues to protect Gila chub, *Gila intermedia*, under the Endangered Species Act. All chub within County preserve lands would be of the fish formerly described as Gila chub.

⁴ The biological goal of the SDCP is to “ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the ecosystem structures and functions necessary for their survival.”

1.3 Plan Goals

The following goals will guide the planning and implementation of this plan:

- 1) Maintain existing populations of target species and their habitats where feasible;
- 2) Identify areas, known as Species Enhancement Areas (SEAs), with potential habitat for target species;
- 3) Work with our planning partners (Arizona Game and Fish Department and U.S. Fish and Wildlife Service) to translocate species to SEAs.
- 4) In cooperation with our planning partners (Arizona Game and Fish Department and U.S. Fish and Wildlife Service), assist with the monitoring of target and additional species.

1.4 Geographic Scope

All actions related to this plan will take place on County Conservation Lands. Species Enhancement Areas have been selected from a pool of potential sites that are under some level of County control, either as the underlying land owner or as the State Trust or BLM grazing lands lessee.

1.5 Integration with Other Planning Efforts

Pima County has been slowing the pace of land acquisitions in recent years and is instead focusing increasing attention on planning activities that will allow for the effective and efficient management of County properties. The MSCP was an important driver of this planning phase by mandating the creation of this plan, as well as property- and/or watershed-specific plans. It is currently envisioned that appropriate elements of this plan will be integrated into future property or watershed plans finalized during the course of the MSCP.

This plan also has the potential to support recovery of ESA listed species; therefore where appropriate and feasible, the plan will seek to address needs of—and integrate with—final or draft USFWS recovery plans (Weedman et al. 1998; U.S. Fish and Wildlife Service 2007, 2016). (Appendix A provides an overview of the recovery plan goals for listed species, where such plans are either draft or final.) For these and other target and additional planning species, Pima County will align our sites and actions to integrate with the native species element of the watershed-scale aquatic plans being developed by the Arizona Game and Fish Department (e.g., Arizona Game and Fish Department 2018).

1.6 Target Species: Key Consideration

Water is a key habitat component for all species considered in this plan; how the quantity, timing, and function of water affects species varies based on their life history. For example, considering the case of the early life stages of the two leopard frog species and all fish, water is needed at all times. For the Mexican gartersnake and post-metamorphic leopard frogs, including adult stages of the two leopard frog species, intermittent water is acceptable for most life stages, and for the Huachuca water umbel, water needs to take the form of saturated soils, but not necessarily standing water (however, permanent near-surface water is required for saturated soils). The current and historical distribution of target species will be considered in this plan. In general, species translocations are most successful in areas with habitat and in

close proximity to existing populations, which allows for dispersal and breeding by the target species. Management actions should also take into account potential genetic differences among populations and watersheds. For example, inter-watershed genetic differences are known to exist for the Gila topminnow (Hedrick et al. 2012) and Huachuca water umbel (herein umbel) (Fehlberg 2017). Details about key habitat requirements, distribution (in Pima County), recovery goals, disease, and genetic considerations of each target species can be found in Appendix A of this plan.

2 Sites and Species Enhancement Areas

2.1 Site Inventory

With over 230,000 acres of land in ownership or lease, Pima County has a host of streams, springs, stock tanks, dams, ponds, and wildlife drinkers at which management actions could occur. The first criterion for choosing areas is to find all sites or features (herein sites) with the potential to have perennial or near perennial water, which is a requirement for most target species. Sites are categorized first as either “supplemented” or “unsupplemented”.

Supplemented sites (ponds; above-ground, open storage tanks; and effluent-dependent streams) receive water from a well and associated features (pipes) or from effluent (treated wastewater). By contrast, unsupplemented sites (stock tanks, springs, and streams) receive no direct water input from human-built features, but—in the case of stock tanks—they can be manipulated to capture storm water flows.

For the purposes of this plan, there is no consideration of close-topped storage tanks, troughs, aquaria, backyard ponds or pool, or wildlife drinkers. Troughs, aquaria, wildlife drinkers and similar water features are generally too small in size for consideration. Instead, opportunities at these features can be addressed during other planning efforts (e.g., property-specific management plans). However, the USFWS has recently compiled updated guidelines for ensuring that constructed ponds, stock tanks, and troughs provide features that do not harm wildlife (Appendix B). Of particular relevance are features that can help ensure that above-ground water tanks and troughs do not become lethal traps for birds and other small animals by adding escape ramps. As time and resources permit, County staff will evaluate water features and work to install wildlife ramps or other measures.

2.1.1 **Unsupplemented: Stock tanks, springs, and streams.**

- **Stock tanks.** Human-made features that capture surface water runoff for use by cattle and/or wildlife. In some cases, developed waters such as stock tanks were built on top of springs, but lacking additional information, they are classified as stock tanks.
- **Springs.** Areas where groundwater discharges above the ground surface and mostly outside of a streambed or channel. Springs include hillside, limnocrene (water emerges as a pool), and rheocrene (water emerges from bedrock or where shallow groundwater intersects the surface in a stream channel; Springer and Stevens 2008) springs (Springer and Stevens 2008).
- **Streams.** Anywhere where water emerges in a streambed and (typically) flows for some distance. Most rheocrene springs, are also included, as are tinajas (bedrock pools) that are fed from either groundwater or precipitation (via runoff). Effluent-dependent streams are addressed in the next section.

2.1.2 **Supplemented: Ponds, tanks, and effluent-dominated streams**

- **Ponds.** These features usually receive groundwater via a well or municipal water supply and are usually lined or sealed to prevent leakage. One pond for consideration (see next section) receives effluent, and one receives storm water from an urban area.

- Above-ground, open water storage tanks. These are open-topped metal or concrete tanks that are used in cattle ranching operations to hold water prior to water being piped to a trough where cattle can access the water.
- Effluent-dependent streams. One feature under consideration (Santa Cruz River) is able to have perennial water only because of discharges of effluent from wastewater treatment facilities.

To identify potential sites for this plan, County staff have monitored dozens of unsupplemented sites since 2011. The report by Powell (2018) summarizes the findings from that study. Based on that effort and a recent inventory of supplemented waters (NRPR, unpublished data), 171 sites were evaluated for this plan (Appendix C). Twenty-five sites were brought forward as having potential to be included in the plan based on water permanence and other logistical considerations (Table 1, Figure 1, Appendix D). (It should be noted that above-ground storage tanks were not individually evaluated nor are they individually named in this plan).

2.1.3 Site Evaluations

In addition to documenting water parameters (presence, permanency, and length of flow) and infrastructure situation at sites under evaluation, Pima County staff have also been monitoring the presence of aquatic species (target, additional, and invasive species) and physical environmental condition at many of the sites under consideration. This information is summarized in Appendix D, which provides a site-by-site summary of these key features to allow Pima County and our planning partners a framework for making decisions about translocations.

Table 1. Sites under consideration for the Aquatic Species Management Plan. Sites were chosen based on water permanence, quantity, and location relative to other populations of target species. See Figure 1 for a map of sites. Individual above-ground open-topped metal/concrete stock tanks were not evaluated for this effort.

Site Type	Property	Site	
Dirt or concrete stock tank	A7 Ranch	Big Tank	
	Clyne Ranch	Hospital Tank	
	Kino Ecosystem Restoration Project	KERP ponds ^a	
	Rancho Seco Ranch	Cerro Colorado Tank	
Pond		Hopkins Tank	
	Aqua Caliente Park	Aqua Caliente Ponds	
	Bingham	Bingham Pond	
	Buckelew	Buckelew Farms Pond	
	Canoa Ranch	Historic Pond	
	Catalina Regional Park		South Pond
			Central Pond
	Roger Road WRRF	Roger Rd Ponds	
	Sands Ranch	Goat Well Wildlife Pond	
	Spring	A7 Ranch	Robles Spring
Clyne Ranch		Turney Spring	
Tesoro Nueve		Carpenter Spring	
Streams (supplemented and unsupplemented)	A7 Ranch	Espiritu Canyon	
		Youtcy Canyon	
	Bar V Ranch	Davidson Canyon	
	Buehman Canyon		Bullock Canyon
			Buehman Canyon
	Cienega Creek Natural Preserve	Cienega Creek	
	M Diamond Ranch	Edgar Canyon	
	(NA)	Santa Cruz River	
Sopori Ranch	Sparkplug Canyon		

^a KERP has multiple site types, including wetlands and irrigation ponds.

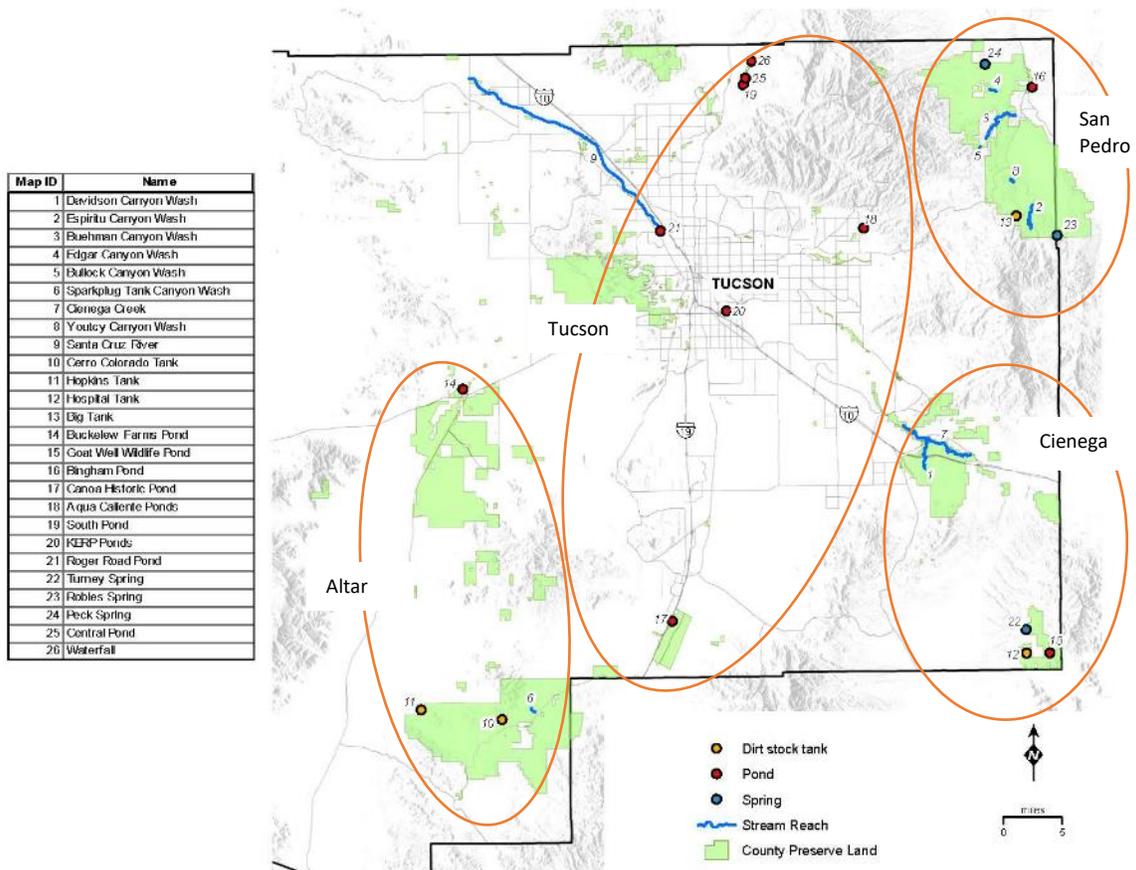


Figure 1. Location of sites considered for inclusion into the aquatic species management plan, arranged by area. Site-specific maps can be found in Appendix D.

2.2 Area Assessment

The next step in the assessment process was to evaluate the current and historical distribution of target species by general area, thereby determining the spatial distribution of plan opportunities. County conservation lands are located in four general areas: San Pedro Valley, Altar Valley, Cienega Valley, and Tucson Basin (Figure 1). Each area was designated because of similar characteristics with respect to precipitation, hydrology, elevation, human presence, and baseline and historical populations of target species (Table 2). As a result, the Plan will focus more conservation effort on some areas as compared to others. For the following assessment (and for Table 2), historical means the species has not been observed in the valley for 10 years or more. Current means that the species has been observed in the last 10 years and there is every reason to believe the species is still present.

2.2.1 Altar

This is a large area that includes lands in the Altar Valley (parts of Marley Ranch, Diamond Bell Ranch, King 98, and smaller properties north of Highway 86 in the Avra Valley), but also includes areas in the Santa Cruz watershed drained by Sopori Wash (Sopori Ranch, Rancho Seco, and parts of Marley Ranch). This is the most arid area and, as a result, has the fewest number of target species with current or historical ranges. A key species in this watershed is the Chiricahua leopard frog.

2.2.2 San Pedro

With the greatest number of sites with natural water sources and the most land under County management (as compared to other areas), the San Pedro is an important area for target species. Steeper gradient streams are the dominant water feature in this watershed, including along the Buehman, Youtcy, Espiritu, and Edgar canyon drainages.

2.2.3 Cienega Valley

All but two target species (suckers) have current or historical distribution within the Cienega Valley. The highest number of species occur at the Cienega Creek Natural Preserve, but other sites of importance include dirt tanks and ponds on the Sands and Clyne ranches. Some County sites in the valley are part of an Arizona Game and Fish Department (AZGFD) watershed management plan (Arizona Game and Fish Department 2018). Also, many aquatic conservation activities in the valley are focused on the Las Cienegas National Conservation Area (e.g., Bureau of Land Management 2003; Bodner et al. 2007; Stingelin 2009).

2.2.4 Tucson Basin

All but one of the target species (Chiricahua leopard frog) historically occurred in this watershed, which also holds the highest number of humans and density and extent of built environment. As a result, most water sources here are augmented or effluent-based and where challenges (e.g., invasive species) abound. Conversely, educational and community engagement opportunities are abundant. The Tucson Basin is also a focal area for an AZGFD watershed management plan (Arizona Game and Fish Department 2018).

2.3 Species Enhancement Areas (SEAs)

Not all sites where management action will occur or where target species currently exist have the same value to the conservation of target species. To account for discrepancies among sites, the MSCP outlined a 3-tiered approach to characterize the relative importance of each site for species enhancement credits. These were collectively referred to as Species Enhancement Areas (SEAs) in the MSCP.

2.3.1 Tier I

These are sites where habitat for species will be managed by Pima County, where reasonable efforts will be made to ensure persistence of the target species, and where such establishment has the greatest chance to contribute to recovery of listed species. Tier I sites do not rely on direct inputs of water from wells or other water-delivery structures. Examples include Cienega Creek and streams in the San Pedro River basin such as Youtcy, Buehman, and Edgar canyons.

Table 2. Current and historical distribution of target species in the four regions in eastern Pima County with significant surface water resources. Blank cells indicate no known records. Occurrence for the San Pedro and Santa Cruz areas refers only to areas of Pima County. If no populations currently are found in an area, historical populations are noted.

Species	Area			
	Altar	San Pedro Valley	Cienega Valley	Tucson Basin
Gila topminnow	Historical: Arivaca Creek	Historical: San Pedro River and tributaries	Current: Cienega Creek (County and BLM properties)	Current: Sabino Creek and Santa Cruz River (effluent dominated)
Gila Chub		Historical: San Pedro River and tributaries	Current: Cienega Creek (County and BLM properties)	Current: Sabino Creek
Longfin Dace		Current: Buehman Canyon	Current: Cienega Creek	Historical: Santa Cruz River
Desert and Sonora suckers		Historical: San Pedro River		Historical: Santa Cruz River
Chiricahua leopard frog	Current: Buenos Aires National Wildlife Refuge		Current: upper Cienega valley (Las Cienega NCA, and Sands/Clyne ranches)	
Lowland leopard frog	Historical: Near Three Points. Extirpated since the 1970s	Current: Many locations on County lands, some with large populations: Youtcy, Espiritu, Bullock, Buehman, and Edgar canyons. Scattered stock tanks	Current: Lower Cienega at Cienega Creek Preserve	Historical: Throughout including Santa Cruz River, Rillito, other tributaries (e.g., Pima Canyon)
Northern Mexican gartersnake	Current: Arivaca Creek/Cienega (not seen since 2000, but considered to be present at low density)	Current: San Pedro River and thought to be in tributaries, but no documented occurrences in recent years	Current: Pima County and BLM properties along Cienega Creek	Historical: Throughout including Santa Cruz River, Rillito, other tributaries
Huachuca water umbel		Historical: Bingham Cienega in 2001, but not recorded since.	Current: Throughout Las Cienegas National Conservation Area. Historical: Cienega Creek Preserve (last seen in 2001)	Historical: La Cebadilla Spring

Management costs are low at these sites, but opportunities for augmenting declines in natural flow are minimal.

2.3.2 Tier II

These are sites where Pima County will provide reasonable management actions to improve suitable habitat conditions for existing or translocated populations, and at the same time allow permitted site maintenance. Maintenance, construction, management, or other activities that may decrease habitat values in the short term will be preceded by efforts to salvage target and other desirable native aquatic and riparian species with the intent of translocating them to nearby, suitable locations. If actions on the part of Pima County occur that will cause the site to be unsuitable for target and other desirable native species, Pima County will provide reasonable management actions to restore supportive habitat conditions and re-establish

target and other desirable native species as feasible. Examples of Tier II areas could include sites such as the Pima County-owned lands along the Santa Cruz River, Kino Ecosystem Restoration Project at the Ajo Detention Basin, Agua Caliente Park, and ponds on Pima County lands where native fish and frogs could potentially be reared for distribution to additional sites in cooperation with Arizona Game and Fish.

2.3.3 Tier III

All Tier III sites will be above-ground metal or concrete stock tanks that are used for ranching operations and that otherwise contain non-native (and potentially invasive) fish species. These sites and features are located on County-owned and leased land and all are associated with nearby wells. Tier III sites will not be individually identified in this plan; an inventory of these sites is ongoing.

2.4 Translocation Opportunities at SEAs

Pima County has many unique opportunities to increase the known distribution and abundance of target species at SEAs on County lands (Table 3). While a general assessment of conditions has been made at many of these sites as it relates to appropriate habitat, in only a few cases has Pima County undertaken a detailed evaluation of sites with species experts. Because translocations at some of these sites may be years in the future, it will be prudent to make more detailed evaluations (sometimes with species experts) prior to any planned translocations.

Based on our assessment of current conditions, species with the most translocation opportunities are the Gila topminnow (15 sites) and Huachuca water umbel (14 sites) (Table 3). The most currently widespread species on County conservation lands is the lowland leopard frog (present at nine sites), yet there are eight additional sites to which the species could be translocated. All species have at least one opportunity for translocation.

2.5 Plan Implementation

This plan outlines the range of appropriate sites for maintenance and/or translocation of target and other species; it does not prioritize translocations at SEAs. Instead, translocation actions will depend on a variety of factors including funding and alignment of goals and work plans of our implementation partners. For example, the AZGFD translocated 564 Gila topminnow to a site in Pima County's Edgar Canyon property in April 2019, and is considering translocating topminnow into Buehman Canyon (pending discussions with ASLD), both actions that were inserted into their work plan when the County purchased the Tesoro Nueve property in 2018.

Pima County is in the process of developing land management plans that are compliant with the MSCP and that provide guidance for land management activities of the County. Pima County recently finalized the management plan for Bingham Cienega and future plans will focus on Cienega Creek Natural Preserve, and Altar Valley properties near Three Points. Where these land management plans include aquatic resources identified in this plan, they will be cited by reference. No additional scoping with the AZGFD nor USFWS will be needed.

Table 3. Sites under consideration for actions within the framework on this plan. Species are either present at the site currently (P) or an introduction action is required for that species to be present (A). More detailed information about each site can be found in Appendix D.

Area	Property	Site	Site Type	Tier	Gila topminnow	Gila Chub	Longfin Dace	Desert and Sonora Sucker	Chiricahua leopard frog	Lowland leopard frog	Mexican gartersnake	Huachuca water umber
Altar	Buckelew	Buckelew Farms Pond	Pond	II	A					A		
	Rancho Seco	Cerro Colorado Tank	Dirt stock tank	II					A			
		Hopkins Tank	Dirt stock tank	II					A			
Cienega	Sopori Ranch	Sparkplug Canyon	Stream reach	II					A	A		
	Bar V Ranch	Davidson Canyon	Stream reach	II						A		
	Cienega Creek Preserve	Cienega Creek	Stream reach	I	P	P	P			P	P	A
		Clyne Ranch	Hospital Tank	Dirt stock tank	II	A				P		
			Turney Spring	Spring	I				P?			A
	Sands Ranch	Goat Well Wildlife Pond	Pond	II	A				P			
San Pedro	A7 Ranch	Big Tank	Dirt stock tank	II	A					A		
		Espiritu Canyon	Stream reach	I						P		
		Robles Spring	Spring	II						A		A
		Youtcy Canyon	Stream reach	I	A					P		
	Bingham	Bingham Pond ^a	Pond	II	A			A		P		A
	Buehman Canyon +	Bullock Canyon	Stream reach	I	A	A	P			P	A	A
	Tesoro Nueve	Buehman Canyon	Stream reach	I	A	A	P			P	A	A
		Carpenter Spring	Spring	I								
M Diamond Ranch	Edgar Canyon	Stream reach	I	A		A			P		A	
Tucson Basin	Canoa Ranch	Historic Pond	Pond & wetland	II	A							A
	Agua Caliente Park	Agua Caliente Ponds	Pond	II	A			A		A		A
	Catalina Regional Park	South Pond	Pond	II	A					P ^b		A
		Central Pond	Pond	II	A					P ^b		A
	KERP	KERP ponds	Pond	II	A					A		A
	NA	Santa Cruz River	Stream reach	II	P		A	A				
	Roger Road WRRF	Roger Rd Pond	Pond	II	A					A		A

^a No action will take place at Bingham Pond for the foreseeable future.

^b Current population were apparently taken from somewhere in the San Pedro River basin and released at the park.

2.6 Management and Monitoring

The overarching goal of all introductions will be to provide native species with habitat conditions necessary for them to thrive. Prior to any translocations, therefore, Pima County and our partners will determine what resources (if any) are thought to be needed for the long-term persistence of the species. Resources necessary could range from those beyond the County's control, such as perennial conditions in streams and springs to water delivery tools in highly regulated systems. Pima County and/or our partners will not proceed on a translocation unless the appropriate habitat conditions are known or suspected to be in place at the time of translocation and for the foreseeable future.

After translocations, Pima County will make every effort to ensure continuity of habitat conditions. However, Pima County cannot—nor will not—guarantee that translocated populations will be safeguarded in perpetuity. There are many possibilities for failure such as loss or significant decline of a population because of invasive species, equipment malfunctions, and/or disease. Because translocations are a covered activity under the Pima County MSCP, Pima County will not be responsible for individuals or populations lost as a result of an action or condition, regardless of whether such action was the responsibility of Pima County. However, reasonable efforts will be made to remedy a situation that threatens a translocated population.

Monitoring of translocated populations will depend on the species being introduced and the location. For example, introductions of Gila topminnow by the Arizona Game and Fish Department are typically monitored for up to three years after an introduction. For all species, however, Pima County will monitor introductions according to the schedule set forth in the MSCP; in most cases monitoring will be at least every 3 years.

2.7 Preventing movement of pests and disease

Species introductions have the potential to introduce new pests or disease into a site. We will work with our planning team partners to determine—on a species and site-by-site case—where such concerns might arise and subsequently follow best practices to help ensure that no diseases or pests are inadvertently introduced at a site. For example, concerns over the movement of the highly lethal fungal pathogen Bd have meant that population introductions and augmentations of Chiricahua leopard frogs are most frequently achieved through wild-to-wild egg mass translocations; if adults or tadpoles are moved, a risk assessment is used coupled with disease testing (Audrey Owens, AZGFD, personal communication). The AZGFD has similar protocols for other organisms.

2.8 Permitting

All actions with species translocations for ESA listed species will be covered under the County's Section 10 permit except for the actual movement of vertebrate species to sites; those actions will be done by Arizona Game and Fish Department personnel under their permits. Translocation and transport of Huachuca water umbel to County lands would likely require consultation and cooperation with partners, including USFWS, growers such as the

Desert Botanical Gardens or County Native Plant Nursery, and land owners. Restoration, transplanting, and study of Huachuca water umbel within the MSCP permit area is covered under the Section 10 permit.

2.9 Outreach

The maintenance and introduction of species to County conservation lands will provide an important set of educational opportunities. In addition, it will be important to outreach to our ranching partners and adjacent private property owners to assure them that conservation actions affecting water features used for their cattle operations will not impede their day-to-day operations or property rights. To this end, Pima County will provide information on land ownership near or adjacent to release sites to AZGFD prior to Covered species translocations. Landowners that could be potentially impacted by movement of translocated species could be offered a Safe Harbor Agreement by AZGFD or a Biological Certificate of Inclusion under the County's MSCP, as relevant. Pima County will seek to engage AZGFD on discussions involving best practices associated with outreach to nearby landowners.

3 Planning and Implementation Partners

The District and NRPR will work with AZGFD on the timing of any vertebrate species translocations to target waterbodies, and carry out appropriate management and maintenance actions associated with the SEAs. OSC staff will monitor populations of translocated species according to the schedule outlined in the MSCP (Appendix Q) and in consideration of any monitoring committed to by the AZGFD or other partners. OSC will also assist NRPR in developing any biological certificates of inclusion needed for adjacent landowners (see Section 4.7 Species Reintroductions in the MSCP). NRPR will consult with appropriate ranch operators regarding activities planned for waters that are used for their livestock.

Introductions of all animal species must take place either by—or with the full cooperation of—the AZGFD. Further, the USFWS must approve of any species introductions for listed species. Therefore, the AZGFD and USFWS will be our Implementation Partners. Additional support, where needed, will be sought from:

- The University of Arizona
- Sky Island Alliance
- Tohono O'odham Nation
- Pascua Yaqui Tribe
- U. S. Bureau of Land Management
- U. S. Forest Service
- National Park Service
- Desert Botanical Garden
- Arizona Sonora Desert Museum

3.1 State Land Department

A number of the sites identified in this plan are on land owned by the Arizona State Land Department. At the time of this writing (December 2018), Pima County has not engaged the department about actions identified in this plan. Therefore, no actions will be undertaken on State land without the express permission of the State Land Department.

3.2 Plan Amendment Process

Pima County's Incidental Take Permit is for 30 years, and as such this plan will need to be periodically revised because of a host of factors including changes in cooperator goals, site conditions, and funding. In general, there will be two types of changes to this management plan: minor and major. Minor changes will include adjusting a site to a higher or lower Tier while major changes will include adding or eliminating a SEA, or the addition of a riparian or aquatic species to be covered by Pima County's MSCP. Decisions on minor amendments will be made jointly between Pima County and the Regional Flood Control District and reported in a section of the MSCP annual report. Major amendments will be made in consultation with the USFWS. Revised copies of the management plan will be provided to the USFWS outside of the annual report process.

4 Acknowledgements

Pima County received helpful comments on early drafts of this document from staff at the Arizona Game and Fish Department (Tom Jones, Don Mitchell, Audrey Owens, Mason Ryan, and Ross Timmons), U.S. Fish and Wildlife Service (Cat Crawford, Scott Richardson, and Jeff Servoss), and County staff (Jennifer Becker, Linda Mayro, Eric Shepp, and Karen Simms). Ian Murray provided text for Appendix A. Jeff Servoss provided updated guidelines for wildlife-friendly waters.

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Appendix A. Target Covered Species Status and Best Management Practices

This appendix summarizes the current status on County managed lands and any identified best management practices for all aquatic and riparian species covered under the County's Multi-Species Conservation Plan. The majority of information used to populate this document was extracted from the County's finalized MSCP and USFWS 90-day and 12-month listing decisions and subsequent species recovery plans (if available). The two sucker species did not have best management practices listed in any of the reference documents and were therefore not included.

Huachuca water-umbel (*Lilaeopsis schaffneriana* var. *recurva*)

Protection status: Federally ENDANGERED

Current occurrence on county open space lands: Extirpated from the Cienega Creek Natural Preserve (last observed in 2001) and Bingham Cienega (last observed in 2002). Also known to occur in Sonoita Creek in the upper Santa Cruz River watershed (USFS), the San Pedro Riparian National Conservation Area (BLM), and Cienega Creek within Las Cienegas National Conservation Area (BLM).

Habitat requirements: Water permanence: Requires permanent surface water:

1. Occurs in perennial, shallow, and slow-flowing or quiet waters or in active stream channels containing refugia sites where most plants can escape the effect of scouring floods.
2. A stream channel and riparian plant community that are relatively stable over time in which non-native species do not exist or are at a density that has little or no adverse effects on available resources.
3. Intermediate levels of disturbance from flooding, fire, grazing, or other sources are necessary to reduce competition and promote dispersal and the preservation of genetic diversity.

Local threats: Habitat loss, loss of stability in perennial base flows and riparian plant community, increased sediment transport from livestock grazing and recreation within the occupied watershed.

MSCP monitoring commitments:

1. Single-Species: The County will monitor occupancy at 2 sites (following County-led – reintroduction) every three years.
2. Habitat: This species requires permanent water, which will be monitored along Cienega Creek and Bingham Cienega, the 2 sites where this species has been found in the past. In addition, shallow groundwater levels will also be monitored.
3. Threats: Land-use change within the Cienega watershed will be reported as data become available

Best management practices:

1. Maintain permanent water sources, where feasible

2. Protect occupied habitats and watersheds from congregating livestock and recreation activities, especially during dry periods.
3. Control invasive non-native plants and prevent their spread in occupied habitat.

Longfin Dace (*Agosia chrysogaster*)

Protection status: AZGFD Species of Greatest Conservation Need; BLM Sensitive Species; USFWS Species of Concern; USFS Sensitive Species

Current occurrence on county open space lands: Occur in the Cienega Creek Natural Preserve and Buehman and Bullock Canyons. Also known to occur higher in the Cienega Creek watershed (BLM / State).

Habitat requirements:

Water permanence: Requires permanent surface water, natural flow, and occasional flooding.

1. Tend to occupy relatively small or medium size streams, with sandy or gravelly bottoms; shallow eddies and pools near overhanging banks or other cover.
2. Generally found in waters < 24 °C (75 °F).

Local threats: Competition from and predation by nonnative organisms (bullfrogs, fishes, and crayfish) and loss of surface water.

MSCP monitoring commitments:

1. Single-Species: Pima County will monitor the species in Buehman Canyon every two years. The County will also rely on a monitoring effort in Cienega Creek that is part of a non-native monitoring program, but which also monitors relative abundance of native fish species.
2. Habitat: The County and partners will continue to monitor the distribution of standing water, water quality, and quality of riparian vegetation at Cienega Creek Natural Preserve quarterly.
3. Threats: The County and partners will continue to monitor groundwater levels in Cienega Creek Natural Preserve. In addition, fish surveys will target invasive species such as nonnative fish, crayfish, and bullfrogs which will be addressed in an upcoming nonnative aquatic species monitoring protocol. Finally, Pima County will monitor land cover change within the Cienega Creek Watershed.

Best management practices:

1. Maintain permanent water sources, where feasible
2. Removal of non-native predators is important when present.
3. Potentially address fire management actions within occupied watersheds.

Desert sucker (*Catostomus clarki*)

Protection status: AZGFD Species of Greatest Conservation Need; USFS Sensitive Species; BLM Sensitive Species; USFWS Species of Concern

Current occurrence on county open space lands: No known natural occurrences within Pima County, but in 2004 a small number were stocked in a private pond south of Cienega Creek. Currently known to occur at higher elevations in the Santa Cruz and San Pedro Rivers and may eventually establish in Pima County.

Habitat requirements:

Water permanence: Requires permanent surface water, natural flow, and occasional flooding.

1. Likes streams with rapids and flowing pools with gravel-rubble and sandy silt in the interstices. Adults live in pools, moving at night to swift riffles and runs to feed. Young inhabit riffles throughout the day, feeding on midge larvae.
2. Require a diverse and abundant invertebrate prey base, however will also feed on algae.

Local threats: Loss of habitat due to reductions in perennial flows. Stocking of non-native fish species has increased competition and hybridization.

MSCP monitoring commitments:

1. Single-Species: None.
2. Habitat: None.
3. Threats: None.
4. Other: The County will survey along the Santa Cruz River downstream of the wastewater treatment plants every five years for occupancy by this and other covered species.

Best management practices:

1. Maintain permanent water sources, where feasible.

Sonora sucker (*Catostomus insignis*):

Protection status: AZGFD Species of Greatest Conservation Need; BLM Sensitive Species; USFS Sensitive Species; USFWS Species of Concern

Current occurrence on county open space lands: Does not currently occur on county open space lands, but in 2004 a small group was stocked in a private pond south of Cienega Creek. Legacy occurrences in the lower San Pedro River and upper Santa Cruz River.

Habitat requirements:

Water permanence: Requires permanent surface water, natural flow, and occasional flooding.

1. Likes streams with gravelly or rocky pools, and relatively deep, quiet waters. Adults tend to remain near cover in daylight, but move to runs and deeper riffles at night. Young live and utilize runs and quiet eddies.
2. Require a diverse and abundant invertebrate prey base, however will also feed on algae.

Local threats: Loss of habitat due to reductions in perennial flows. Additionally, general watershed erosion leading to excessive sand deposition has decreased available pool habitat.

MSCP monitoring commitments:

1. Single-Species: None.
2. Habitat: None
3. Threats: None
4. Other: The County will survey every 5 years along the Santa Cruz River downstream of the wastewater treatment plants for occupancy by this species.

Best management practices:

1. Maintain permanent water sources, where feasible.

Gila chub (*Gila intermedia*):

Protection status: Federally ENDANGERED; AZGFD Species of Greatest Conservation Need

Current occurrence on county open space lands: Occurs in the Cienega Creek Natural Preserve. Also known to occur higher in the Cienega Creek watershed (BLM / State) and in Sabino Canyon (USFS).

Habitat requirements:

Water permanence: Requires permanent surface water, natural flow, and occasional flooding.

1. Requires complex stream bank structure comprised of undercut banks, terrestrial vegetation, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation in deeper waters, especially pools. In Cienega Creek, Gila chub mostly use pool habitats and are not typically found in marsh and run habitats.
2. Appropriate water temperatures for spawning ranging from 17.2°C to 23.9 °C (63°F to 75 °F), and seasonally appropriate temperatures for all life stages (varying from about 10°C to 30 °C [50°F to 86 °F]).
3. Water quality with reduced levels of contaminants, including excessive levels of sediments adverse to Gila chub health, and adequate levels of pH, dissolved oxygen, and conductivity.
4. Prey base consisting of invertebrates (i.e., aquatic and terrestrial insects) and aquatic plants (i.e., diatoms and filamentous green algae).

5. Habitat devoid of nonnative aquatic species detrimental to Gila chub or habitat in which detrimental nonnative species are kept at a level that allows Gila chub to continue to survive and reproduce.

Local threats: Competition from and predation by nonnative organisms (bullfrogs, nonnative fishes, and crayfish) and loss of surface water.

MSCP monitoring commitments:

1. Single-Species: Work with partners to maintain quarterly wet-dry monitoring efforts in the Cienega Creek Natural Preserve, which also functions to monitor presence of native and non-native fish species and pool habitat.
2. Habitat: The County and partners will continue to monitor the distribution of standing water, water quality, and quality of riparian vegetation at Cienega Creek Natural Preserve quarterly during wet-dry mapping.
3. Threats: The County and partners will continue to monitor for exotic species at Cienega Creek Natural Preserve through observations during wet-dry mapping and an upcoming protocol for non-native aquatics. Landscape pattern monitoring will provide reports on trends in land-use change within the species' PCA as data become available.

Best management practices (USFWS):

1. Maintain permanent water sources, where feasible
2. Livestock management activities: Limit direct access of livestock to inhabited riparian area (fencing, seasonal access), and do not allow complete consumption of stream bank vegetation to allow for stable water temperature and stream bank stability.
3. Off-highway vehicle use: Limit / restore route incursions within occupied watersheds to reduce the chance of increased frequency / severity of floods and to allow for full movement of fish within potential habitat.

Gila topminnow (Poeciliopsis occidentalis):

Protection status: Federally ENDANGERED; AZGFD Species of Greatest Conservation Need

Current occurrence on county open space lands: Known to occur in the Cienega Creek Natural Preserve. Also occurs upstream in Cienega Creek on BLM's Las Cienegas National Conservation Area; which is considered the largest remaining native population in U.S. Topminnow naturally reestablished in the lower Santa Cruz River northwest of Tucson in 2017. The species is also known to occur in the upper Santa Cruz River in Santa Cruz County.

Habitat requirements:

Water permanence: Requires nearly permanent surface water, can avoid occasional drying by burrowing in mud for 1-2 days.

1. Habitat generalists, however prefer shallow, warm, fairly quiet waters. Will occupy pools, glides, and backwaters more frequently than marshes or areas of fast flow.

2. Can tolerate an extremely wide range of water temperatures, including high temperatures of shallow streams.
3. Water quality with reduced levels of contaminants, including excessive levels of sediments adverse to Gila topminnow health, and adequate levels of pH, dissolved oxygen, and conductivity.
4. Prey base consisting of invertebrates (i.e., aquatic and terrestrial insects) and aquatic plants (i.e., diatoms and filamentous green algae).
5. Habitat nearly devoid of nonnative aquatic species detrimental to topminnow.

Local threats: Competition from and predation by nonnative organisms (bullfrogs, exotic fishes, and crayfish) and loss of surface water.

MSCP monitoring commitments:

1. Single-Species: Pima County will rely on a monitoring effort in Cienega Creek that is part of a non-native monitoring program, but which also monitors relative abundance of native fish species. The recent discovery of the topminnow in the effluent-dominated stretch of the Santa Cruz River in Pima County also requires the County to monitor for the species there.
2. Habitat: The County and partners will continue to monitor the distribution of standing water, water quality, and quality of riparian vegetation at Cienega Creek Natural Preserve quarterly through wet-dry mapping.
4. Threats: The County and partners will continue to monitor for exotic species at Cienega Creek Natural Preserve through observations during wet-dry mapping and an upcoming protocol for non-native aquatics. Landscape pattern monitoring will provide reports on trends in land-use change within the species' PCA as data become available.

Best management practices (USFWS):

1. Maintain permanent water sources, where feasible
2. Remove non-native competitors and predators if possible.
3. Livestock management activities: Limit direct access of livestock to inhabited riparian area (fencing, seasonal access), and do not allow complete consumption of stream bank vegetation to allow for stable water temperature and stream bank stability.
4. Off-highway vehicle use: Limit / restore route incursions within occupied watersheds to reduce the chance of increased frequency / severity of floods and to allow for full movement of fish within potential habitat.

Chiricahua leopard frog (*Lithobates chiricahuensis*):

Protection status: Federally THREATENED; AZGFD Species of Greatest Conservation Need

Current occurrence on county open space lands: Natural recolonization of Hospital Tank and Goat Well pond, on the County's Sands Ranch (identified October 2016 and April 2018, respectively). A tentative observation of larval Chiricahua leopard frogs at Turney Spring

(Clyne Ranch) awaits confirmation. Also known to occur in Las Cienegas NCA (BLM), the eastern slope of the Santa Rita Mountains (USFS), and Buenos Aires NWR (USFWS).

Habitat requirements:

1. Require permanent to nearly permanent water that is free or relatively free of non-native aquatic predators. Is locally known to occur in dirt livestock tanks and small free flowing creeks and streams.
2. Shallow water with emergent and perimeter vegetation that provide egg deposition, tadpole and adult thermoregulation sites, and foraging sites.
3. Deeper water, root masses, undercut banks that provide refuge from predators and potential hibernacula during the winter.
4. Substrate that includes some mud that allows for the growth of alga and diatoms (food for tadpoles) and to allow for hibernacula.
5. Relatively clean water not overly polluted by livestock excrement or chemical pollutants.
6. A diversity or complex of nearby aquatic sites including a variety of lotic and lentic aquatic habitats, to provide habitat for breeding, post-breeding, and dispersing individuals.

Local threats: Predation by nonnative organisms (bullfrogs, crayfish, and exotic fishes), loss of surface water, and Chytrid fungus. Other threats include drought, floods, wildfires, degradation and destruction of habitat, water diversions and groundwater pumping.

MSCP monitoring commitments:

1. Single-Species: The County will monitor any newly occupied habitat every year for the first three years, and every three years thereafter.
2. Habitat: The County will assess availability of water and general water quality (clarity) when visiting occupied sites during annual wet-dry mapping efforts in June.
3. Threats: The County will monitor non-native predators (bullfrogs, crayfish) through an upcoming nonnative aquatic species monitoring protocol, and any additional potential threats when visiting occupied sites.

Best management practices (USFWS):

1. Always disinfect equipment when moving between inhabited locations.
2. Maintain water permanence within occupied habitat.
3. Construction: Avoid construction activities and minimize disturbance around inhabited habitat, (pumping of groundwater, construction of impoundments, and diversion of surface water).
4. Native fish recovery activities: Collect eggs/tadpoles/frogs prior to activity, avoid direct impacts of equipment to frogs.
5. Livestock management activities: Allow for regeneration of emergent and submergent vegetation around occupied livestock tanks, maintain utilization standards upstream from stock tanks, and establish a non-grazed buffer around occupied sites to allow for sediment and excrement filtering above stock tanks.

Lowland leopard frog (*Rana yavapaiensis*):

Protection status: AZGFD Species of Greatest Conservation Need; BLM Sensitive Species; USFS Sensitive Species; USFWS Species of Concern

Current occurrence on county open space lands: Known to occur broadly on County properties in canyons with perennial water, springs, and occasionally in livestock tanks. Known locations include the Cienega Creek Natural Preserve, Catalina Regional Park, Youtcy Canyon (A7 Ranch), Espiritu Canyon (A7 Ranch), Grapevine Spring (A7 Ranch), Buehman Canyon, and Edgar Canyon (M Diamond and Six Bar Ranch). This species also occurs widely in the lower San Pedro River valley and in several small populations in the north part of the Whetstone Mountains (USFS).

Habitat requirements:

1. Require riparian areas with perennial refugia (tinajas) that are free or relatively free of non-native aquatic predators.
2. Shallow water with emergent and perimeter vegetation that provide egg deposition, tadpole and adult thermoregulation sites, and foraging sites.
3. Deeper water, root masses, undercut banks that provide refuge from predators and potential hibernacula during the winter.
4. Substrate that includes some mud that allows for the growth of alga and diatoms (food for tadpoles) and to allow for hibernacula.
5. Relatively clean water not overly polluted by livestock excrement or chemical pollutants.
6. A diversity or complex of nearby aquatic sites including a variety of lotic and lentic aquatic habitats, to provide habitat for breeding, post-breeding, and dispersing individuals.

Local threats: Predation by native (gartersnakes) and nonnative organisms (bullfrogs, crayfish, and fishes), loss of surface water, and Chytrid fungus. Other threats include drought, floods, wildfires, degradation and destruction of habitat, water diversions and groundwater pumping.

MSCP monitoring commitments:

1. Single-Species: The County will monitor six known occupied habitats every three years.
2. Habitat: The County will assess availability of water and general water quality (clarity) when visiting occupied sites during annual wet-dry mapping efforts in June.
3. Threats: The County will monitor non-native predators (bullfrogs, crayfish) through an upcoming nonnative aquatic species monitoring protocol, and any additional potential threats when visiting occupied sites.

Best management practices (USFWS):

1. Always disinfect equipment when moving between inhabited locations.

2. Maintain water permanence within occupied habitat.
3. Construction: Avoid construction activities and minimize disturbance around inhabited habitat, (pumping of groundwater, construction of impoundments, and diversion of surface water).
4. Livestock management activities: Limit livestock access into occupied drainages, allow for regeneration of emergent and submergent vegetation around occupied livestock tanks, maintain utilization standards upstream from occupied habitat.

Northern Mexican gartersnake (*Thamnophis eques megalops*):

Protection status: Federally THREATENED; AZGFD Species of Greatest Conservation Need; USFS Sensitive Species

Current occurrence on county open space lands: Occurs in the Cienega Creek Natural Preserve. Also known to occur in the upper Cienega Creek watershed (BLM), upper Santa Cruz River subbasin, Bueno Aires NWR (USFWS), and San Pedro River subbasin.

Habitat requirements:

Water permanence: Requires permanent or temporally intermittent surface water, occurs in both lentic and lotic features needed for maintenance of prey base.

1. Requires substantial terrestrial vegetation adjacent to perennial water feature, suitable for prey foraging and refuge.
2. Suitable density of native prey species (adult and larval leopard frogs, native fish). May also supplement diet with earthworms, leeches and vertebrates such as lizards, small rodents, salamanders, treefrogs, toads, and juvenile nonnative bullfrogs.

Local threats: Competition from—and predation by—nonnative organisms (bullfrogs, exotic fishes, and crayfish), dewatering of habitat, and genetic effects from population fragmentation.

MSCP monitoring commitments:

1. Single-Species: None
2. Habitat: Pima County and its partners will continue to monitor the distribution of standing water at Cienega Creek Preserve during wet-dry mapping. Pima County will also monitor vegetation at the Preserve and other locations within the species' PCA in the County preserve system by way of remote sensing tools such as National Land Cover Dataset, orthophotography and/or LiDAR.
5. Threats: Pima County will continue to monitor exotic species in the Cienega Creek Natural Preserve through observations during wet-dry mapping and an upcoming protocol for non-native aquatics. Landscape pattern monitoring will provide reports on trends in land-use change within the species' PCA as data become available.

Best management practices:

1. Livestock management activities: Limit direct access of livestock to inhabited riparian area (fencing, seasonal access), and do not allow complete consumption of stream bank vegetation to allow for stable water temperature and stream bank stability.
2. Off-highway vehicle use: Limit / restore route incursions within occupied watersheds to reduce the chance of increased frequency / severity of floods and subsequent channelization / down cutting of stream channel.

Appendix B. Updated guidelines for wildlife-friendly water features in Arizona (USFWS).



United States Department of the Interior

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**Recommended Guidelines for Development and Management of
Wildlife-Friendly Water Features in Arizona
February 2019**

Water resources on arid landscapes are instrumental for managing livestock operations and also help maintain healthy wildlife communities. Below, we have summarized available guidance on water developments to both maximize their benefits and reduce their potential risks.

Ponds

Minimizing sediment — Ponds/tanks can be developed in succession within an ephemeral drainage to slow water, encourage settling of sediment out of the water column, and improve water quality of downstream impoundments (NRCS 2016a).

Minimizing disturbance — If excavating a pond/tank, stockpile topsoil for placement on previously disturbed areas to facilitate revegetation (NRCS 2016a).

Minimizing connectivity — Ponds should be located outside the floodplain to avoid any hydrologic connection during flood events which helps minimize the threat of nonnative species expanding their range.

Inspecting earthen tanks — Inspections focusing on breaches, water levels, shoreline integrity, aquatic inhabitants, etc. are recommended periodically, including after heavy rains (NRCS 2016b).

Maintaining earthen dam integrity — Trees should not be permitted to grow on embankment dams because they can cause leaks/seepage (NRCS 2016b). Promoting the establishment of native shoreline vegetation will also reduce effects of sheet erosion and enhance water quality.

Fish

Fish health and vitality — Consider installing supplemental aeration equipment in ponds/tanks to improve gas transfer and water quality, and lower stress levels of resident fish.

Mosquito control — Mosquitos are attracted to water sources for breeding purposes. Consider using native fish such as Gila topminnow (consult the Arizona Game and Fish Department and US Fish and Wildlife Service for permitting information) for mosquito control.

Considerations for Longfin Dace — If stocking longfin dace into a feature, provide clean wash sand near the inlet to promote reproduction; the sand may need to be replaced periodically with fresh wash sand to continue to promote reproduction (THS *et al.* 2010).

Wildlife

Enhancing habitat structure — Consider promoting vegetated banks (NRCS 2011) around ponds/tanks and providing rock piles or enhancing existing rock outcrops around the feature to promote important herpetofaunal habitat structure for thermoregulation and other natural behaviors.

Frog-specific features — To enhance habitat features for native frogs, stack slabs of concrete or flagstone with 1 to 2 inch spacers along the shoreline that gets the most sun exposure (THS *et al.* 2010); see Figure 1.

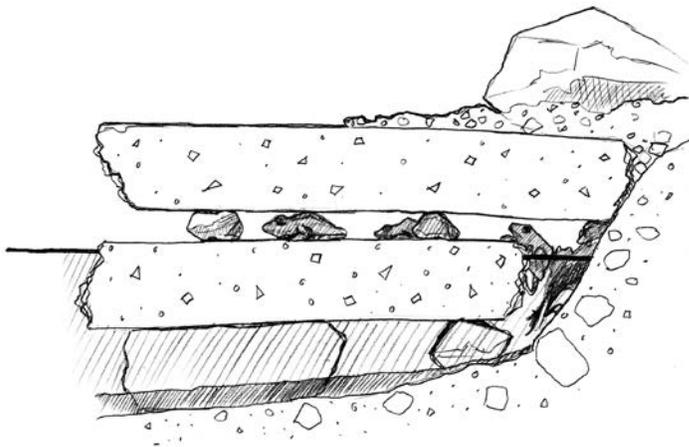


Figure 1: Angle the slabs slightly so the crevasses between the slabs have air pockets where the frogs can hide for extended periods of time. These pockets will protect sluggish frogs on cold winter nights when they are extra vulnerable (Image and figure text courtesy of THS *et al.* (2010)).

Protection and foraging — When at capacity, tanks and ponds should have both deep areas with large rocks or other forms of structure for aquatic vertebrates to use in predator avoidance, as well as shallow, sun-lit areas to provide basking sites, areas of prey acquisition, and general biological productivity (THS *et al.* 2010).

Escape ramps — While important sources of water for livestock and wildlife alike, artificial troughs and drinkers also pose a risk of drowning to small animals that become trapped inside. To help reduce the risk of accidental death of wildlife, Taylor and Tuttle (2007, 2012) provide guidelines for escape ramps. Escape ramps should:

- Extend into the water and meet the inside wall of the watering facility,
- Reach to the bottom of the watering facility or to the depth of the lowest possible water level,
- Be firmly secured to the rim of the watering facility so as not to be displaced by livestock,
- Be built of graspable, long-lasting materials, such as painted or coated metal grating, roughened fiberglass, concrete, rock and mortar, or high-strength plastic composites,
- Have a slope no steeper than 45 degrees,
- Be located to cause minimal interference with livestock drinking, and
- Provide one structure for every 30 linear feet of watering facility edge.

Obstruction concerns — Birds and bats are uniquely at risk of accidental death in artificial waters and require obstructions near the water surface be minimized, adjusted, or preferably removed altogether. NRCS (2014) provides guidance to accomplish this goal:

- All wire fencing material up to 36 inches above the water must be removed. Board and other echolocation material, at least one-inch-wide, may be installed at a height of at least 18 inches above the water, or
- Rearrange the fence line to create an adjustable pivot point thereby removing any obstructions above the water surface while allowing full access to a single trough from two different grazing areas.

Managing water levels — Taylor and Tuttle (2007, 2012) recommend maintaining consistent water levels, at full capacity, especially during periods of drought and during the maternity season for bats which in Arizona, spans April – July. This is most important for small- or medium-sized troughs where it may be advisable to implement a “full or dry” management objective; large troughs with adequate escape structures may still be useful to wildlife without posing increased risks, at intermediate water levels (Taylor and Tuttle 2007, 2012). These water level maintenance goals not only provide more reliable water, but reduce the likelihood of accidental drowning caused by steep sidewalls.

Nonnative species — Under no circumstances should nonnative species (*i.e.* bullfrogs, mosquitofish, warm water sportfish, crayfish, etc.) be introduced into any water feature. Nonnative species remain one of the most significant threats to native aquatic wildlife in the Southwest and continue to drive rangewide declines in many species. See THS *et al.* (2010) for basic information about removing existing nonnative species from your water feature.

Size considerations — When developing water sources for livestock and/or wildlife, whether earthen or artificial, planners should strive to account for lengthening the hydroperiod (the period of time water remains available) and maximizing the versatility of the development for various species of wildlife. These critical factors improve the reliability of water sources on the landscape and account for drinking limitations based on wide-ranging flying capabilities of winged vertebrate species. In short, when installing water developments, the deeper, the larger, the longer (at least 10 feet long by 2.5 feet wide, unobstructed), the better (Taylor and Tuttle 2012).

Engineering specifications for wildlife waters — If designing a water feature specifically for the benefit of native wildlife, we recommend reviewing Arizona Game and Fish Department’s (2014) “Wildlife Water Construction Standards” for many design specifications and considerations.

Future Reading

We recommend reviewing the following references referenced in this guidance and exploring other references that may exist or as they become available online for more information on improving the design, installation, and management of water features to benefit Arizona’s native wildlife.

Literature Cited

Arizona Game and Fish Department. 2014. Wildlife water development standards. Arizona Game and Fish Department, Phoenix, AZ. 53 pp.

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Appendix C. Sites that were evaluated for the aquatic species management plan. Sites that were carried through for future analysis and consideration are noted in the table. UTM's are NAD 83.

Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
Altar	Buckelew	Buckelew Farms Pond	Pond	470100	3549956	Pima County	Dirt tank receives runoff from agricultural fields. Poor water quality might be an issue, but located near documented, historical Lowland leopard frog site. Invasives not known to be a problem at this site. Site will be incorporated into the Lower Altar Valley Area plan (LAVA)
	Diamond Bell Ranch	Calera Tank	Dirt stock tank	467429	3532889	State of Arizona	Not a reliable water
		Garambolo Tank	Dirt stock tank	467819	3535875	State of Arizona	Not a reliable water
		Javelina Tank	Dirt stock tank	470048	3543213	State of Arizona	Not a reliable water
		Juan Tank	Dirt stock tank	472363	3542369	State of Arizona	Not a reliable water
		Lost Tank	Dirt stock tank	470056	3541488	State of Arizona	Not a reliable water
		Soldier Well Tank	Dirt stock tank	465474	3536540	State of Arizona	Not a reliable water
		Tank #32	Dirt stock tank	468305	3540105	State of Arizona	Not a reliable water
		Tank #4	Dirt stock tank	469291	3538256	State of Arizona	Not a reliable water
	Unnamed Tank	Dirt stock tank	473746	3540387	State of Arizona	Not a reliable water	
	King 98 Ranch	Charles Tank	Dirt stock tank	465461	3544027	Pima County	Dirt tank receives runoff from abandoned agricultural fields. Dried in April 2018. Staff visit the area fairly frequently and can watch for issues. Plans exist for renovating, but it is not funded at this time. Will be incorporated into the LAVA plan
	Rancho Seco Ranch	Basin Tank	Dirt stock tank	477401	3504584	Pima County	Not a reliable water
		Big Sandy Tank	Dirt stock tank	471508	3506242	Pima County	Not a reliable water
		Buddy Tank	Dirt stock tank	470773	3505125	BLM	Not a reliable water
		Campos Tank	Dirt stock tank	471436	3497039	Pima County	Not a reliable water
		Campos Tank East	Dirt stock tank	471554	3497158	Pima County	Not a reliable water
		Canez Wash Tank	Dirt stock tank	477431	3502475	Pima County	Not a reliable water
		Cerro Colorado Tank	Dirt stock tank	475100	3504406	State of Arizona	Excellent dirt tank that has consistently held water. Location is not close to any known population for target species. State is unlikely to support introduction of CLF
		Colorado Wash Tank	Dirt stock tank	474937	3502567	State of Arizona	Not a reliable water
		Compressor Tank	Concrete dam	479098	3509345	State of Arizona	Water catchment in drainage with cement dam. Dry in 2006, 2011
		Craddle Tank	Dirt stock tank	475325	3505910	State of Arizona	Not a reliable water
		Cut-across Tank	Dirt stock tank	473073	3504720	Pima County	Not a reliable water
		Durazno Tank	Dirt stock tank	467043	3501050	Pima County	Not a reliable water
		Easter Tank	Dirt stock tank	471325	3504801	BLM	Not a reliable water
		Fernstrom Tank	Dirt stock tank	465079	3503982	State of Arizona	Not a reliable water
	Flint Tank	Dirt stock tank	471372	3501641	State of Arizona	Not a reliable water	
	Foreman Tank	Dirt stock tank	479062	3503190	Pima County	Not a reliable water	

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Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		Foreman Tank East	Dirt stock tank	479098	3503201	Pima County	Not a reliable water
		Honeymoon Tank	Dirt stock tank	472755	3499186	State of Arizona	Not a reliable water
		Hopkins Tank	Dirt stock tank	464003	3505842	State of Arizona	Reliable water, even in drought. Close to populations of Chiricahua leopard frog at Buenos Aires, but is located on state land, which is unlikely to support introductions
		Horse Trap Tank	Dirt stock tank	472192	3503464	State of Arizona	Not a reliable water
		Horseshoe Tank	Concrete dam	476823	3506830	State of Arizona	Water catchment in drainage with cement dam. Not a reliable site
		House Tank West	Dirt stock tank	471782	3505313	Pima County	mini dirt tank
		Lower Horse Trap Tank	Dirt stock tank	472229	3504424	Pima County	Not a reliable water
		Martinez Trough	Trough	462938	3504707	Pima County	Unknown situation regarding capacity, but not near or connected to other aquatic populations except CLF at BANWR
		Mud Tank	Dirt stock tank	481244	3509093	State of Arizona	Not a reliable water
		Peaks Tank	Dirt stock tank	469426	3505401	BLM	Not a reliable water
		Pesquiera Tank	Dirt stock tank	468017	3499627	BLM	Split pasture tank. dry 3 times in GE imagery
		Placer Tank	Dirt stock tank	466943	3501276	Pima County	Not a reliable water
		Ramosa Trough	Trough	475473	3499775	State of Arizona	Unknown situation regarding capacity, but not near or connected to other aquatic populations except CLF at BANWR
		Roadside Tank	Dirt stock tank	472575	3505189	Pima County	Not a reliable water
		Rock Tank	Concrete dam	478738	3505529	State of Arizona	Not a reliable water
		Summit Tank	Dirt stock tank	471796	3502644	State of Arizona	Not a reliable water
		Suzy Q Tank	Dirt stock tank	480712	3500731	Pima County	Not a reliable water
		Tabla Tank	Dirt stock tank	472345	3502351	State of Arizona	Not a reliable water
		unnamed	Dirt stock tank	468993	3499637	BLM	Not a reliable water
		unnamed	Dirt stock tank	478854	3504203	Pima County	Not a reliable water
		unnamed	Dirt stock tank	467317	3501139	Pima County	Not a reliable water
		unnamed	Dirt stock tank	472358	3503900	Pima County	A small tank; not reliable water.
		unnamed	Dirt stock tank	471349	3501984	State of Arizona	Not a reliable water
		Upper Horse Trap Tank	Dirt stock tank	471944	3504416	Pima County	Not a reliable water
	Sopori Ranch	Sparkplug Canyon Wash	Steam reach	479085	3505978	State of Arizona	Fed by the backing up of water for Sparkplug tank; water seeps under the cement dam to feed reach. Narrow slot canyon with bullfrogs (2016, 2017) that likely have a source population not far away off Arivaca Rd.
		Bee Tank	Dirt stock tank	488113	3511213	State of Arizona	Old data refers to this as Bee Tank: named by Dale? Not named on topo map.
		Bull Pasture East Tank	Dirt stock tank	490862	3510618	State of Arizona	Dried up in 2007, 2011
		Cedar Canyon Tank	Dirt stock tank	479868	3495775	State of Arizona	Not a reliable water
		Cemetery Trough	Trough	477622	3498757	Pima County	
		Horse Pasture Tank	Dirt stock tank	481997	3505171	State of Arizona	Not a reliable water

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Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		Horse Pasture Tank South	Dirt stock tank	482049	3505032	State of Arizona	Unknown earthen dam that is filled with sediment Flows to Horse Pasture Tank? Not reliable
		Horse Tank	Dirt stock tank	490292	3510983	State of Arizona	Old data refers to this as Horse Tank: named by Dale? not named on topo map. Only dry in 2011
		Line Tank	Dirt stock tank	482861	3500346	BLM	Not a reliable water
		Papalote Horse Trap Tank	Dirt stock tank	480619	3496957	State of Arizona	Not a reliable water
		Papalote Tank	Dirt stock tank	477461	3498184	State of Arizona	Not a reliable water
		Sparkplug Tank	Concrete dam	479081	3505989	State of Arizona	Created by cement dam, which is almost entirely filled in by sediment. Not a reliable water
		Steer Pasture Tank	Dirt stock tank	484168	3502766	State of Arizona	Not a reliable water
		unnamed	Dirt stock tank	481028	3500416	Pima County	Not a reliable water
		unnamed	Dirt stock tank	479273	3500162	Pima County	Old data refers to this as Blacktail Tank: named by Dale? not named on topo map
		unnamed	Dirt stock tank	478668	3499829	State of Arizona	Not a reliable water
		unnamed	Dirt stock tank	479536	3498364	State of Arizona	Not a reliable water
		unnamed	Dirt stock tank	479400	3498483	State of Arizona	Not a reliable water
	Verdugo	Verdugo Tank	Dirt stock tank	465303	3545148	Pima County	Good quality tank near to NAWA tank, but has gone dry 2 or 3 times in the last 10 years. Near historical location for Lowland leopard frog. Pump back storage tank on Verdugo also has potential to be managed for native fish. Water will be pumped into adjacent drinker as part of Section 6 grant.
Cienega	Agua Verde	Agua Verde Wash	Steam reach	544662	3545044	RFCD	Not a reliable water
	Bar V Ranch	Becky Spring	Spring	536703	3532913	Pima County	Hillside spring that is boxed and piped to the ranch headquarters and other locations, but some water feeds into a cattle trough and it might be possible to divert some flow into a small pond that could work for lowland leopard frogs. Also, there is some overflow at the headquarters that feeds a metal trough that could support an educational pond here for topminnow and frogs. For future consideration
		Bobo Spring	Spring	536706	3534139	Pima County	Boxed spring with no surface expression
		Cedar Tank	Dirt stock tank	534632	3539383	State of Arizona	Not a reliable water
		Cliff Spring	Spring	536563	3533027	Pima County	Hillside spring with small amount of water near the main channel. Property line for Pima County and state land appears to be directly through the spring expression site.
		Davidson Canyon	Steam reach			Pima County	Dry in recent years in June, but has the potential for future
		Davidson Spring	Spring	533360	3538579	State of Arizona	Spring expression site appears to be on State land and in wetter years may express water and therefore get leopard frogs naturally.
		Davidson Tank	Dirt stock tank	533042	3537238	Pima County	Not a reliable water
		Fleming Tank	Dirt stock tank	538132	3533717	Pima County	Not a reliable water

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Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		Fleming Tank South	Dirt stock tank	538152	3533472	Pima County	Not a reliable water
		Highway Tank	Dirt stock tank	538323	3539259	State of Arizona	Not a reliable water
		Mescal Spring	Spring	537180	3534222	Pima County	Old spring with many calcium deposits. Area has been dug out. Occasionally has water
		Mountain View Tank	Dirt stock tank	531883	3539215	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	534867	3538846	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	532560	3540667	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	534482	3539303	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	539065	3536245	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	539177	3536207	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	535738	3532514	State of Arizona	Not a reliable water
		Unnamed	Dirt stock tank	534535	3532131	State of Arizona	Not a reliable water
	Unnamed	Dirt stock tank	539116	3536434	State of Arizona	Not a reliable water	
	Colossal Cave Mountain Park	Posta Quemada Wash	Steam reach	534502	3546490	Pima County	Recent headcut has exposed two small pools that could house lowland leopard frogs and Gila topminnow. More information is needed on permanence
	Cienega Creek Natural Preserve	Cienega Creek	Steam reach			RFCD	The County's best aquatic habitat site with many target species present.
	Clyne Ranch	Hospital Tank	Dirt stock tank	547213	3512974	Pima County	Known to be a consistent water source for many years, apparently never having gone dry since the 1950s. Renovated in 2012 and invasive fish removed. Chiricahua leopard frogs recolonized the site, but were relocated in spring of 2019 to again renovate the tank and remove invasive bullfrogs and mosquitofish.
		Turney Spring	Spring	547169	3516208	Pima County	Spring complex. Water expresses in approximately 4 sites, but none have very much water. Could be reworked to provide habitat for some target species. Cattle fencing is needed. Tentative observation of larval Chiricahua leopard frogs made June 2019.
	Empirita Ranch	Crystal Well Tank	Dirt stock tank	549312	3532689	Pima County	Not a reliable water
		Haystack Tank	Dirt stock tank	551314	3531031	Pima County	Not a reliable water
		Unnamed	Dirt stock tank	551538	3533906	Pima County	Not a reliable water
		Unnamed	Dirt stock tank	551366	3533814	Pima County	Not a reliable water
West Well		Water storage tank (open)			Pima County	Reliable well for eastside of ranch and could source a pond if developed nearby; power is present at well	
Sands Ranch	Bear Springs Canyon Wash	Steam reach	548011	3517263	Pima County	Rheochrene spring that is often dry, sonoran mud turtles observed here	
	Blacktail Spring	Spring	547992	3517157	Pima County	Small spring site with little capacity.	
	Boulder Tank	Dirt stock tank	548703	3514103	Pima County	Not a reliable water	
	Goat Well Tank	Dirt stock tank	550455	3512967	Pima County	Not a reliable water	
	Goat Well Wildlife Pond	Pond	550408	3512951	Pima County	Pond built in 2016 for the purposes of Chiricahua leopard frogs, which colonized in 2018. Topminnow could be added.	

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Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		MacNally Tank	Dirt stock tank	548669	3515575	Pima County	Not a reliable water
		Maverick Trough	Trough	548431	3518907	Pima County	Drinker status is not thought to be functional. Great distance from road access means that difficulty in maintaining any feature
		Ramsey Trough	Trough	547722	3516937	Pima County	Small drinker installed in 2016. Insufficient for wildlife and cultural resources issues conflict here
San Pedro	A7 Ranch	Barrow Tank	Dirt stock tank	544346	3574894	Pima County	
		Bear Dirt Tank	Dirt stock tank	549689	3572642	Pima County	Not a reliable water
		Bear Tank	Dirt stock tank	549595	3572925	State of Arizona	Not much is known about this site, but appears to be in-channel spring with some historical ponding because of berming. More information is needed
		Bicycle Joe Tank	Dirt stock tank	554645	3574825	State of Arizona	Not a reliable water
		Big Tank	Dirt stock tank	546288	3573164	State of Arizona	Large stock tank. Many cattle on site, so some fencing would be needed.
		Cloud Tank	Dirt stock tank	546677	3584737	State of Arizona	Not a reliable water
		County Tanks	Dirt stock tank	552621	3574230	Pima County	Storage Tank Filled Browns Farm
		County Tanks	Dirt stock tank	552636	3574175	Pima County	Storage Tank Filled Browns Farm
		Cows Pasture Tank	Dirt stock tank	551794	3582249	BLM	
		Espiritu Canyon Wash	Stream reach	547942	3572159	State of Arizona	Stream reach with a number of tinajas. Consistently holds water. Lowland leopard frogs present. Current proposal to install a cattle lane. Longfin dace used to occur in lower reach, documented in 1990. Floods would eliminate Gila topminnow from this site.
		Grapevine Spring	Spring	547566	3571447	State of Arizona	Hillside spring emanating from a potential mine adit (or perhaps dug out for the water). In some years, water seeps downhill from the adit. LLF present in 2017, but not a good site for aquatic species work
		Grapevine Trough	Trough	547557	3571535	State of Arizona	water piped from spring to storage tank, which feeds a concrete drinker
		Hughes Trough	Trough	555776	3575314	State of Arizona	Situation unknown
		Jerry Tank	Dirt stock tank	542689	3575224	Pima County	Not a reliable water
		Kidney Pond Tank	Dirt stock tank	546673	3581053	State of Arizona	Not a reliable water
		Panzer Tank	Dirt stock tank	548206	3579816	State of Arizona	Not a reliable water
		Piety Hill Tank #1	Dirt stock tank	542936	3580388	State of Arizona	Not a reliable water
		Piety Hill Tank #2	Dirt stock tank	542497	3581371	Pima County	Not a reliable water
		Red Tank	Dirt stock tank	544859	3580333	State of Arizona	Not a reliable water
		Redington Rd Tank	Dirt stock tank	545964	3584543	State of Arizona	Not a reliable water
Roble Spring Tank	Dirt stock tank	551982	3570466	BLM	Not a reliable water		
Roble Tank	Dirt stock tank	553189	3570492	Pima County			
Robles Spring Wash	Spring	551882	3570425	BLM	Rheochrene and hillside spring complex with consistent, albeit small amount of water.		

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Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		Saucito Canyon Spring	Spring	549983	3570663	State of Arizona	Not much is known about this site, but appears to be in-channel spring with potential for small structure in channel. More information is needed for this site
		Unnamed Trough	Trough	552837	3570884	State of Arizona	Situation unknown
		Upper Tank	Dirt stock tank	545345	3574557	State of Arizona	
		Youtcy 2	Spring	545507	3577927	State of Arizona	Very low production spring on hillside, just up from the Youtcy canyon wash bottom. Shallow depression made by animals, though spring expression in 2017 showed broader geographic scope
		Youtcy Canyon Wash	Stream reach	5455271	3577840	State of Arizona	Stream reach with a rheochrene spring site on state land and two consistent tinajas further upstream (on County land). Cattle a recurring problem at this site, and there is a proposal to install cattle lane, LLF very abundant in some years. Sonoran mud turtles observed
		Youtcy Tank	Dirt stock tank	544557	3574734	Pima County	Not a reliable water
	Bingham	Bingham Pond	Pond	548654	3590906	Other	Large pond used by Kelly's for agricultural purposes. No progress can be made on this until life estate clause ends. Potential to remain in use, but maintenance will be critical.
	Buehman Canyon	Bullock Canyon Wash	Stream reach	541282	3582596	RFCD	Spring expression in the main channel, various pools to a concrete dam. Assessment by G&F indicated the possibility of chub above the dam, but that features fills in with sediment periodically. Longfin dace present below dam and lowland leopard frogs throughout.
		Lower Buehman Canyon Wash	Stream reach	542119	3583011	RFCD	Stream reach with varied resources, from tinajas to hillside spring (Carpenter Spring). Large populations of lowland leopard frogs and longfin dace.
		Upper Buehman Canyon Wash	Spring	540248	3583470	RFCD	Long stream reach that is dry much of the year except this site, which is a rheochrene spring of rather defined extent. Cattle can be a problem on this site. Presence of dace and lowland leopard frogs is variable, but last two years has been largely dry in June.
	M Diamond Ranch	Edgar Canyon Wash	Stream reach	542904	3589919	Pima County	Stream reach with consistent water in one stretch and pools throughout a 1/4 mile section. Fence work is needed. LLF common. AZGFD released topminnow at site in spring 2019.
		Fossil Tank	Dirt stock tank	545214	3591185	State of Arizona	Not a reliable water
		Homestead Spring	Spring	543334	3590444	Pima County	Off-channel spring with (at best) very small pool of water. Dry in 2017, 18, 19.
		Peck Spring	Spring	542179	3594101	Pima County	Hillside spring that underwent modification in 2018. Spring is no longer flowing much and water is not being managed to fill old cattle troughs that once held LLF. Only way this would work as a site is if a pond was created, if water table comes up enough, or if a standpipe was installed to pump water to a depression above current spring location, might need a booster pump and success is uncertain
		Pink Tank	Dirt stock tank	544713	3588443	State of Arizona	Not a reliable water

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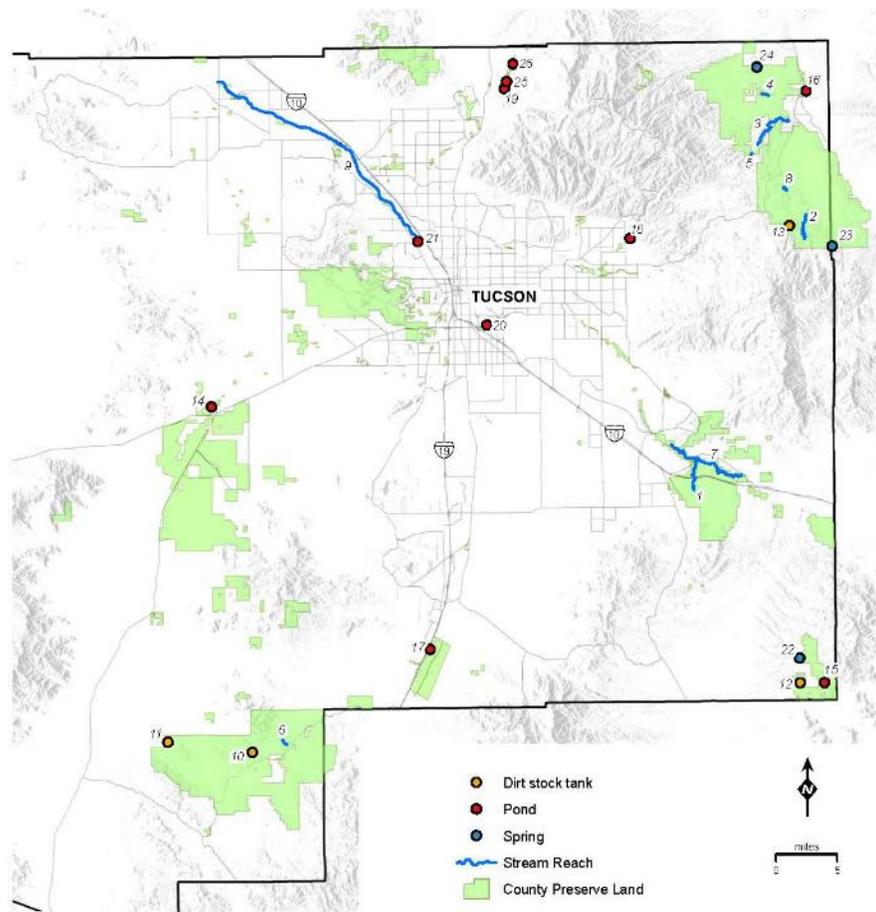
Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		unnamed	Dirt stock tank	543055	3592178	State of Arizona	dirt stock tank, overgrown with Bermuda grass
	Oracle Ridge	Geesaman Wash	Stream reach	528044	3593306	Pima County	Water situation in this canyon is strange and flows in 2010 may have been from mine site pumping. No water in June during 2016-18, but small amount in June 2019.
		Gibb Tributary Wash	Stream reach	526493	3593507	Pima County	Water not consistent and does not contribute significantly for any target species
	Six Bar Ranch	Burleson Trough	Trough	538263	3591241	Pima County	Not a reliable water
		Davis Mesa Tank	Dirt stock tank	534761	3593277	State of Arizona	Berm running north-south on the Davis Mesa captures sheet flow and feeds dirt tank. LLF present in 2017, but not in 2018. Source population likely Alder Canyon. Visit to tank in 2018 revealed the tank is at or close to being anoxic.
		Lone Hill Tank	Dirt stock tank	539144	3586685	State of Arizona	May have dried once in 1996, but isolated from source populations for any target species
		Mesa Trough	Trough	538366	3593142	State of Arizona	Concrete drinker next to windmill. Far from any known populations of target species
		Old Dirt Tank	Dirt stock tank	539831	3588344	State of Arizona	
		Parker Homestead Spring	Spring	538443	3585232	Pima County	In-channel and off-channel spring near old homestead site. Cement box and piping is old and no longer useful. Not permanent water.
		Split Tank	Dirt stock tank	536933	3592174	Pima County	
White Tank	Dirt stock tank	537205	3589485	State of Arizona	Not a reliable water		
Tucson Basin	Canoa Ranch	Historic Pond	Pond	498598	3517766	Pima County	Historic pond restoration effort. Invasives are likely to be a problem, but public outreach would be beneficial. Caretaker is actively removing bullfrogs (July 2019).
	Agua Caliente Park	Agua Caliente Spring	Spring	525331	3571573	Pima County	Dry in recent years, flowing in June 2019.
		Aqua Caliente Ponds	Pond	525330	3571659	Pima County	Site undergoing pond renovations and opportunities exist for native species reintroductions. Educational opportunities. Proposed for Gila Topminnow, Desert pupfish, Gila Chub, Sonora Sucker, Razorback Sucker. Experimenting with AZ eryngo transplanting on site.
	Carpenter Ranch	Carpenter Tank	Dirt stock tank	492959	3599248	Pima County	Called Carpenter Ranch Spring by NRPR. No conservation value because of geographic location
		Cochie Spring	Spring	492893	3598498	Pima County	Dry spring
		Cottonwood Canyon	Spring	492000	3600176	Pima County	Not a reliable water
		Unnamed Tank	Dirt stock tank	492279	3600218	Pima County	Not a reliable water
	Catalina Regional Park	South Pond	Pond	508971	3591539	RFCD	Pond is lined and fed by well. LLF in pond already as well as mud turtles, has mosquitofish so would need to dry thoroughly if want to try and replace with topminnow. A marshy area at one end could possibly be planted with umbel

Pima County Aquatic Species Management Plan-Appendix C

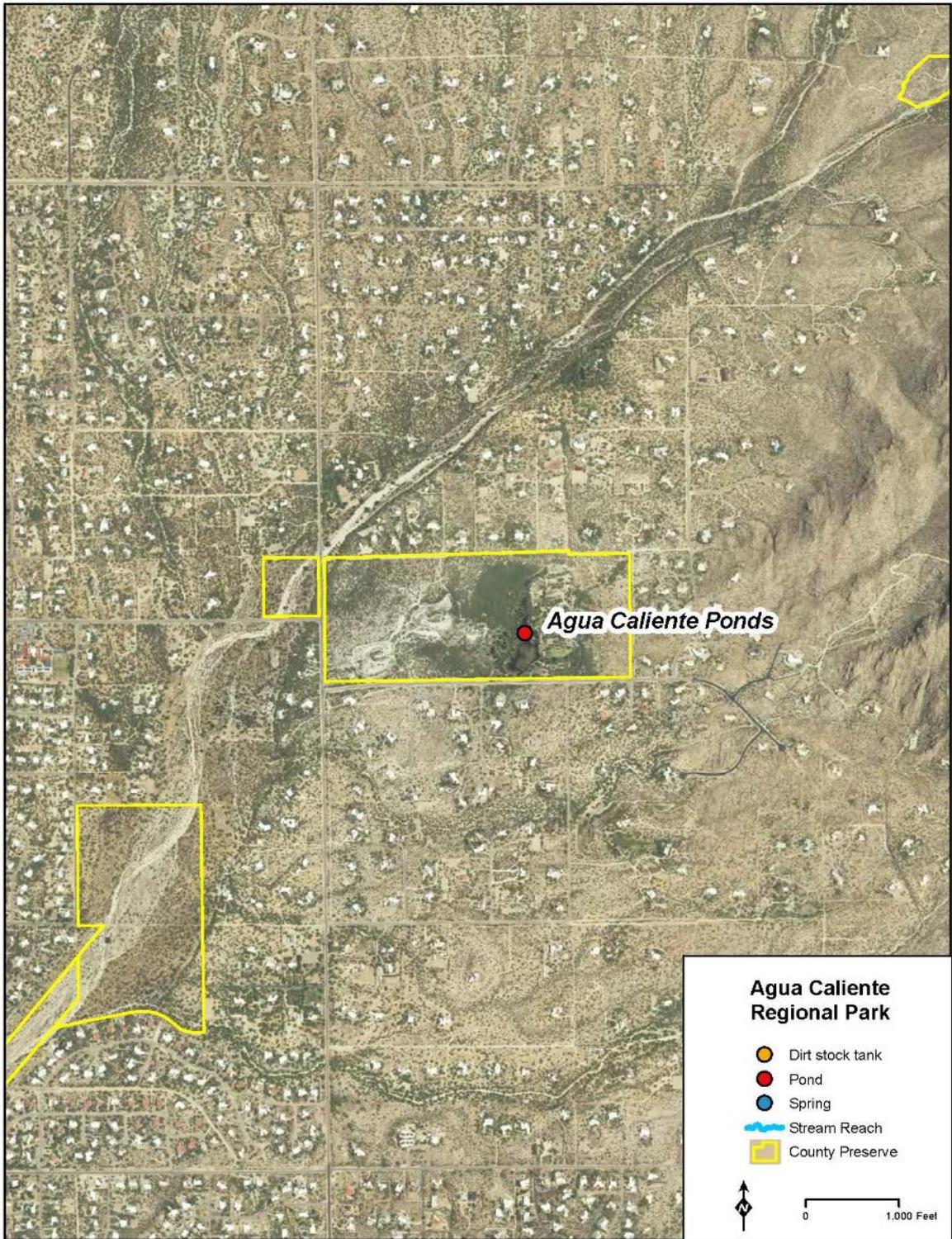
Watershed	Property	Site Name	Site Type	UTM E	UTM N	Ownership	Site/condition description and notes
		Waterfall	Pond	510129	3594793	RFCD	Concrete pond fed by solar well and may have lowland leopard frogs. Mosquitofish present. Could dry and replace with topminnow. Tends to get covered with duckweed so may need aeration.
		Central Pond	Pond	509266	3592470	RFCD	Lined pond fed by leaking from Lo Cerro water supply. LLF in pond and probably mosquitofish.
	Kino Ecosystem Restoration Project	KERP ponds	Pond	506411	3560414	RFCD	Consistent water source that captures water from the uplands for storage and future use on sports fields. Bullfrogs have been a past problem and <i>Gambusia</i> are also present
	NA	Santa Cruz River	Stream reach	497060	3572305	Other	Various ownership and conditions, but good chances for species introductions, especially at Cortaro (suckers, longfin dace)
	Rancho Fundoshi	Bear Canyon Wash	Stream reach	518963	3574681	RFCD	Not a reliable water
	Roger Road WRRF	Roger Rd Pond	Pond	497430	3571496	Pima County	Large pond fed by reclaimed water. Lots of work would be needed to get invasives (bullfrogs and exotic turtles) out and to provide for greater aeration, lessen duckweed, but a good site for education and rearing
	Tortolita Mountain Park	Tennis Spring	Spring	496738	3594430	Pima County	Too isolated and horses have seriously damaged the site.

Appendix D. Site maps and descriptions.

Map ID	Name
1	Davidson Canyon Wash
2	Espiritu Canyon Wash
3	Bushman Canyon Wash
4	Edgar Canyon Wash
5	Bullock Canyon Wash
6	Sparkplug Tank Canyon Wash
7	Cienega Creek
8	Youtcy Canyon Wash
9	Santa Cruz River
10	Cerro Colorado Tank
11	Hopkins Tank
12	Hospital Tank
13	Big Tank
14	Bucklew Farms Pond
15	Goat Well Wildlife Pond
16	Bingham Pond
17	Canoa Historic Pond
18	Agua Caliente Ponds
19	South Pond
20	KERP Ponds
21	Roger Road Pond
22	Turney Spring
23	Rebles Spring
24	Pack Spring
25	Central Pond
26	Waterfall



Agua Caliente Park: Ponds 1 and 2 Map



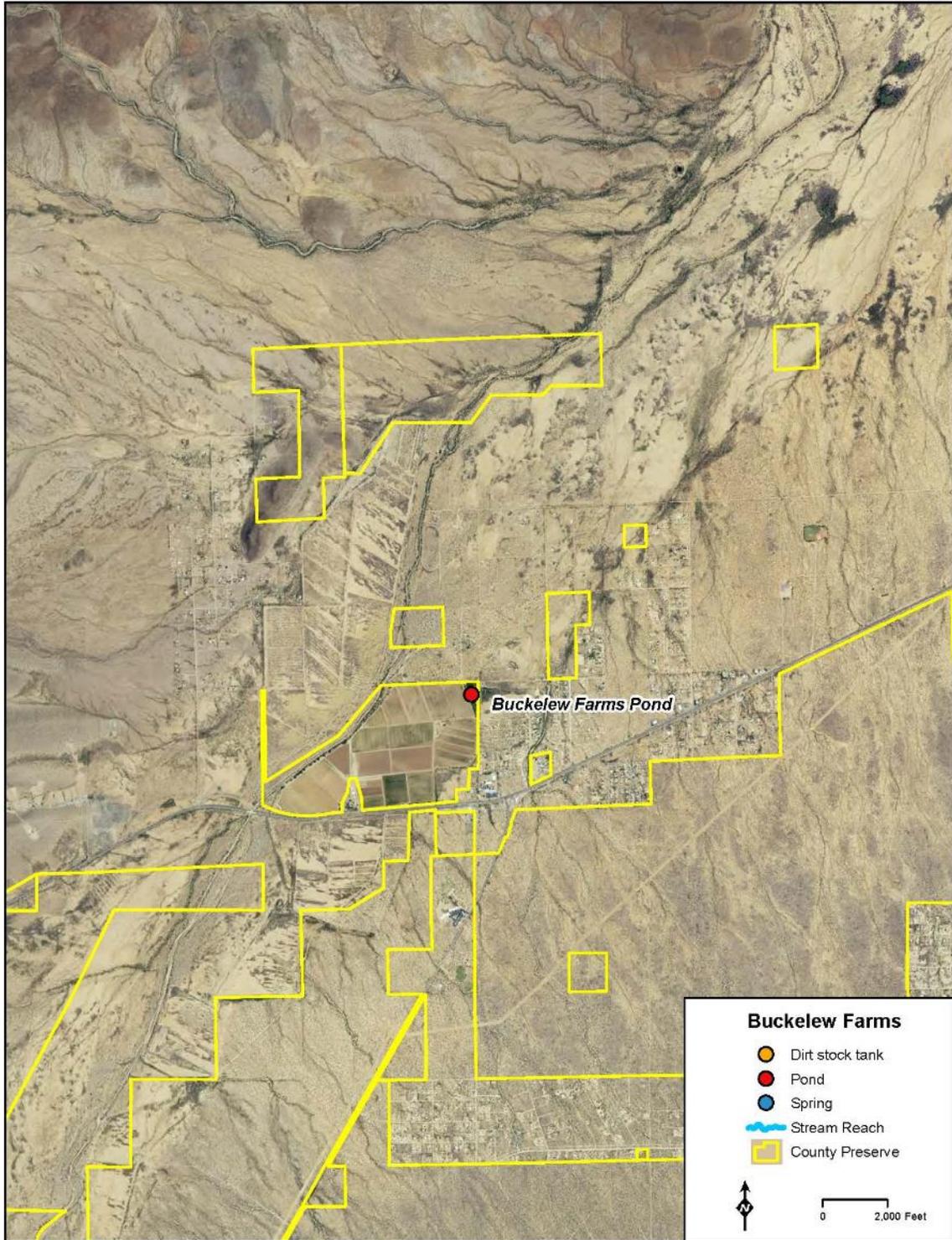
Agua Caliente Park: Ponds 1 and 2 Description



Agua Caliente Park Pond 1, 2010.

Site Type	Pond
Description	2.6 acre Pond 1 and 0.4 acre Pond 2 once captured abundant spring flow, but are now entirely dependent on groundwater. Pond 2 was recently sealed to prevent water loss and work to reseal and restore Pond 1 are expected to be complete by fall 2019.
Water conditions and permanence	Excessive pumping to support the pond is resulting in restoration of Pond 1. Work in 2019 will include dredging existing pond and lining, thereby helping to ensure adequate surface water for years. Water level will remain relatively constant
Aquatic vertebrate species status	No known target species, but many invasive species
Invasive species issues	Many invasive species including bass, sunfish, mosquitofish, and non-native turtles.
Potential target species translocations	Gila topminnow, Sonora sucker, and lowland leopard frog have been determined to be suitable for this site once invasives are removed and habitat improved. Umbel habitat is being created as part of the project.
Other species to consider	Sonoran mud turtle, humpback chub, Arizona eryngo
Maintenance and Management Needs	<ul style="list-style-type: none"> • Pond 1 restoration (starting summer of 2019) will remove all invasive fish. Slider turtles will likely remain a problem and may need to be periodically removed. • Periodic removal of invasive species
Biological Inventory and Monitoring Needs	Periodic surveys to determine population status of target species

Buckelew: Buckelew Farms Pond Map



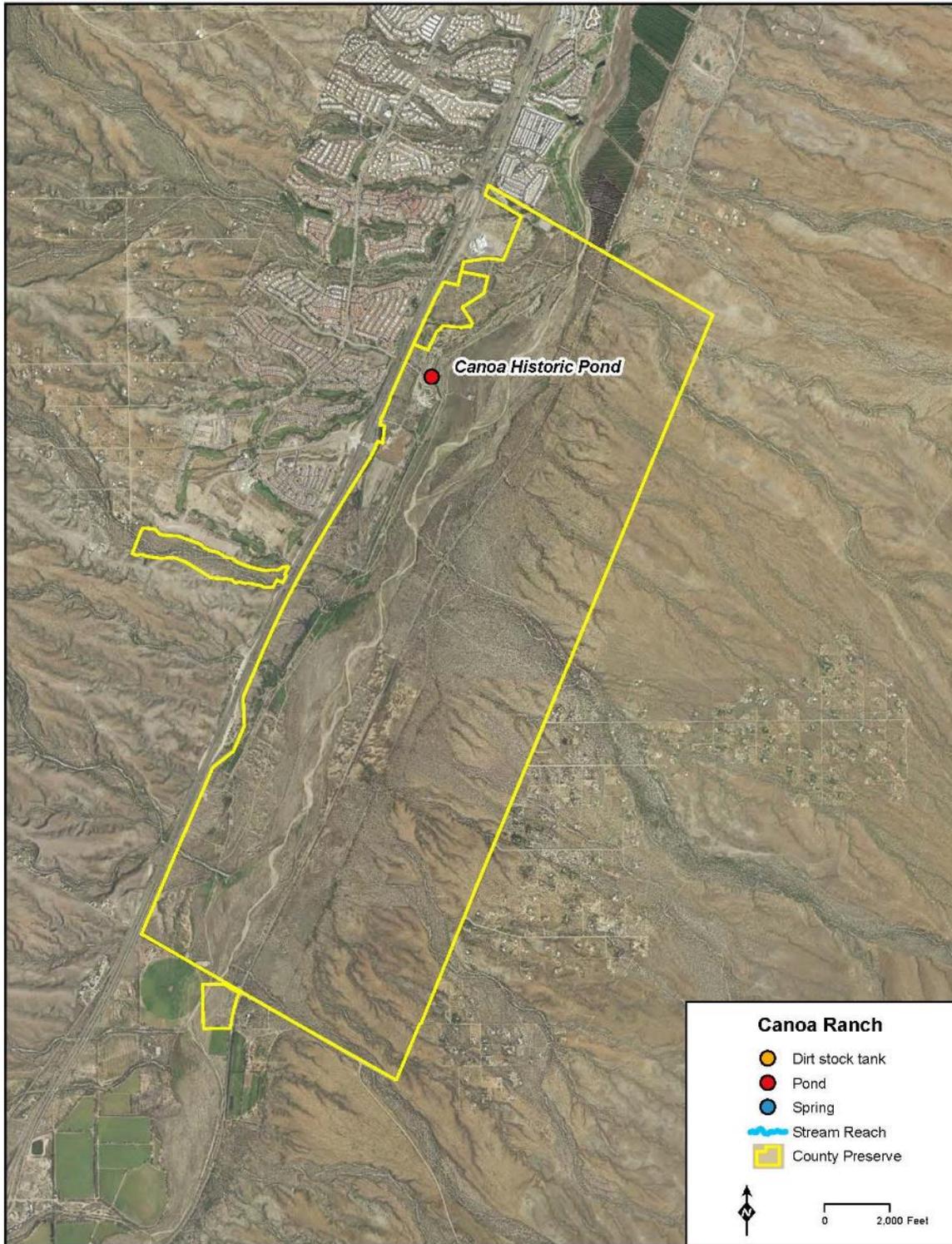
Buckelew: Buckelew Farms Pond Description



Buckelew Farms Pond, 2011.

Site Type	Pond
Description	1.0 acre dirt tank is entirely fed by agricultural runoff from nearby fields.
Water conditions and permanence	Known to always have water, yet water quality issues are a concern at this site because of agricultural runoff. Use of agricultural chemicals is unknown. Future of Buckelew family farming operation is also uncertain.
Aquatic vertebrate species status	No known target species, but the pond might contain invasive fishes (see inventory needs)
Invasive species issues	None known, but no surveys have occurred.
Potential target species translocations	Gila topminnow in open water and to control mosquitoes. Huachuca water umbel because of relatively consistent water elevation. Lowland leopard frog; site is near to historical collection sites (1970s).
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	<ul style="list-style-type: none"> • Water quality issues need to be investigated prior to any introduction. • Backup well and pump system would need to be installed if there is uncertainty about runoff
Biological Inventory and Monitoring Needs	Inventory to determine if the pond currently contains invasive species.

Canoa Ranch: Historic Pond Map



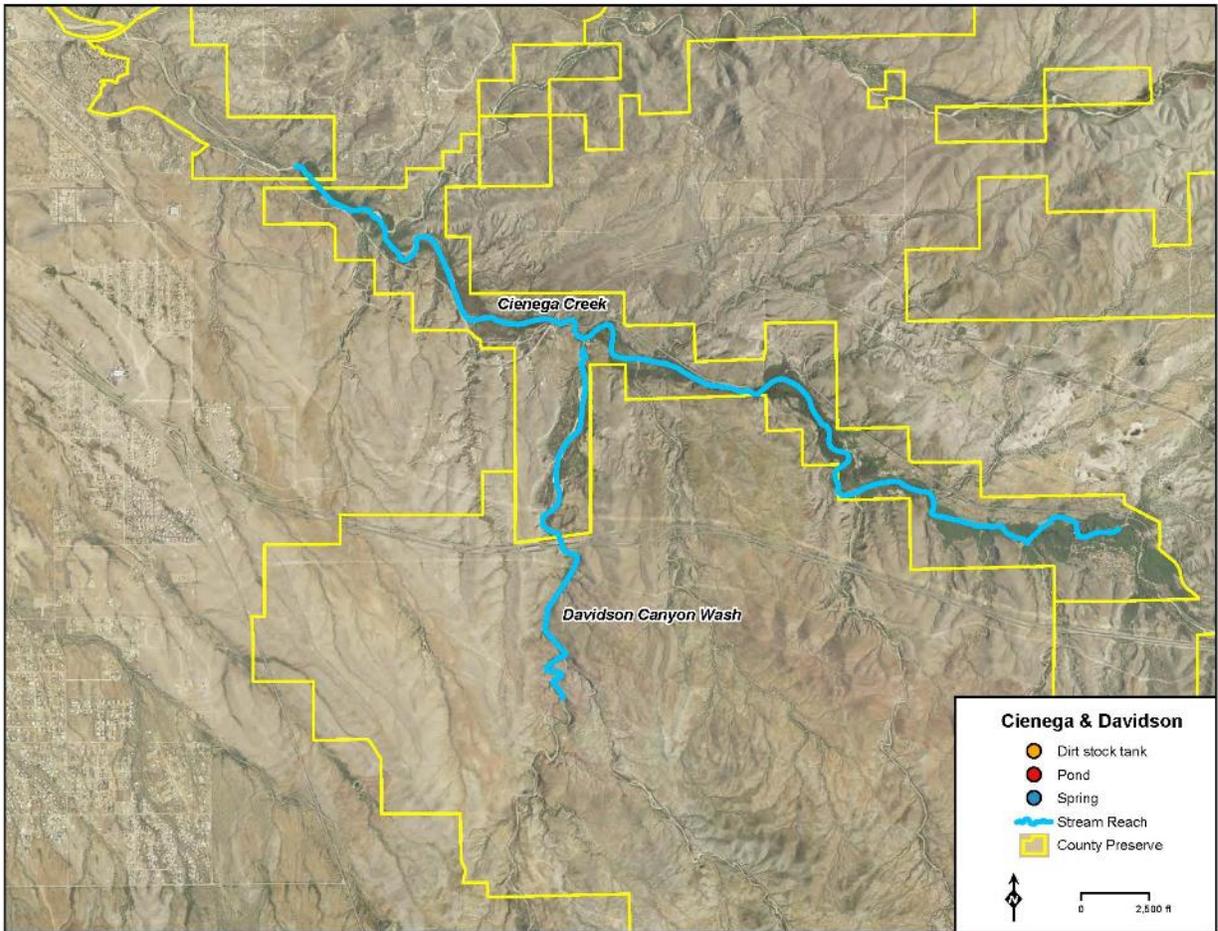
Canoa Ranch: Historic Pond Description



Canoa Historic Pond, 2018.

Site Type	Pond
Description	A new element of the historic ranch environment, the newly created pond uses groundwater. The pond is sealed to ensure that seepage is not an issue.
Water conditions and permanence	New well and water lines help ensure the permanence of water at this site
Aquatic vertebrate species status	No known species
Invasive species issues	Bullfrogs are present and actively being removed by the caretaker
Potential target species translocations	Gila topminnow in open water and to control mosquitoes. Huachuca water umbel because of relatively consistent water elevation and planned spill-over area to create wetland habitat.
Other species to consider	Sonoran mud turtle, pupfish
Maintenance and Management Needs	Plan for (eventual) removal of non-native species
Biological Inventory and Monitoring Needs	None

Bar-V: Davidson Canyon Wash and Cienega Creek Natural Preserve: Cienega Creek and Davidson Canyon Wash Map



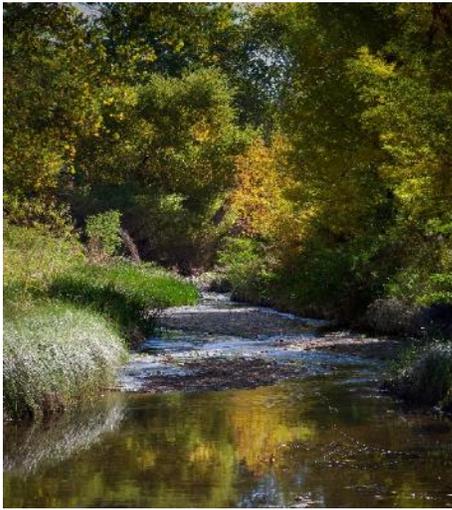
Bar-V and Cienega Creek Natural Preserve: Davidson Canyon Wash Description



Davidson Canyon Wash, July 2017.

Site Type	Stream reach
Description	Well described stream reach, which an Outstanding Arizona Water along much of its length.
Water conditions and permanence	Once holding perennial stretches, now intermittent because of drought.
Aquatic vertebrate species status	Longfin dace and lowland leopard frog occupied site in 2005, but no longer occur there because of the current drought.
Invasive species issues	None known
Potential target species translocations	Fish and lowland leopard frogs will colonize from the Cienega Creek if water conditions change (and assuming continued persistence of source populations in Cienega Creek).
Other species to consider	
Maintenance and Management Needs	Continue to monitor extent of surface water at this site.
Biological Inventory and Monitoring Needs	None needed.

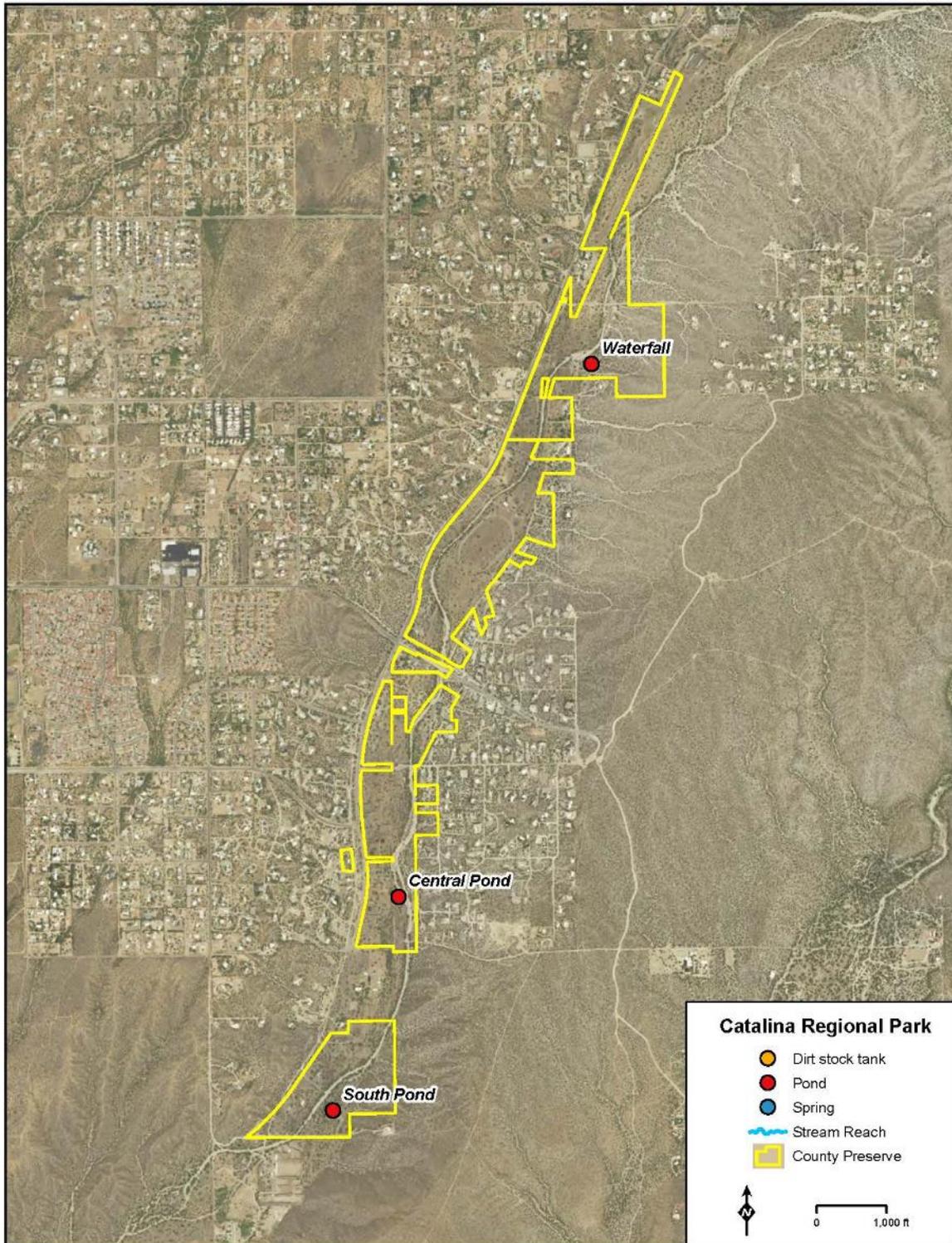
Cienega Creek Natural Preserve: Cienega Creek Description



Cienega Creek, August 2013.

Site Type	Stream reach
Description	The "crown jewel" of County riparian and aquatic habitats. Contains the longest stretch of perennial water in the county preserve system and the highest number of target species of any other site covered in this plan.
Water conditions and permanence	Maintains water year around. Length of flow is monitored by the Pima Association of Governments and OSC on a quarterly basis.
Aquatic vertebrate species status	Currently contains three target fish species (Gila topminnow, Gila chub, and longfin dace), lowland leopard frog, and Mexican gartersnake. American bullfrogs present at a few sites, though not very abundant and not confirmed to be breeding on site.
Invasive species issues	See above. Crayfish, which were thought to have been seen in 2017 have not been subsequently confirmed.
Potential target species translocations	Huachuca water umbel.
Other species to consider	
Maintenance and Management Needs	Eradication of bullfrogs from the site, if possible.
Biological Inventory and Monitoring Needs	A better assessment of lowland leopard frog abundance and locations would be ideal. Periodic walk-throughs of the site by PAG/OSC provides a good overview of select covered species.

Catalina Regional Park: Central and South Ponds Map



Catalina Regional Park: South Pond Description

Site Type	Pond
Description	Fed from a nearby well, this pond is quite small (approximately 200m ²), but is the largest of the features at Catalina Regional Park
Water conditions and permanence	Always kept full of water, but duckweed covers the entire surface.
Aquatic vertebrate species status	Lowland leopard frogs (unknown origin, but apparently from the San Pedro River Valley) were released to the site approximately 4-5 years ago by a neighbor.
Invasive species issues	Duckweed covers this feature.
Potential target species translocations	Gila topminnow in open water and to control mosquitoes. Huachuca water umbel because of relatively consistent water elevation.
Other species to consider	Sonoran mud turtle, pupfish
Maintenance and Management Needs	<ul style="list-style-type: none"> Control of duckweed will require considerable effort over the long term. Also, considerable shading of the site and downed debris might be a problem for topminnow.
Biological Inventory and Monitoring Needs	None needed

Catalina Regional Park: Central Pond Description

Site Type	Pond
Description	Fed from a nearby well, this pond is extremely small (approximately 20m ²) and entirely hidden under a single mesquite tree.
Water conditions and permanence	Always kept full of water, but like South Pond, duckweed covers the entire surface.
Aquatic vertebrate species status	Lowland leopard frogs (unknown origin, but apparently from the San Pedro River Valley) were released to the site approximately 4-5 years ago by a neighbor. Abundant at this site
Invasive species issues	Duckweed covers this feature.
Potential target species translocations	Gila topminnow in open water and to control mosquitoes. Huachuca water umbel because of relatively consistent water elevation.
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	<ul style="list-style-type: none"> Control of duckweed will require considerable effort over the long term. Also, considerable shading of the site and downed debris might be a problem for topminnow.
Biological Inventory and Monitoring Needs	None needed

Kino Ecosystem Restoration Project: KERP Ponds Map



Kino Ecosystem Restoration Project: KERP ponds Description



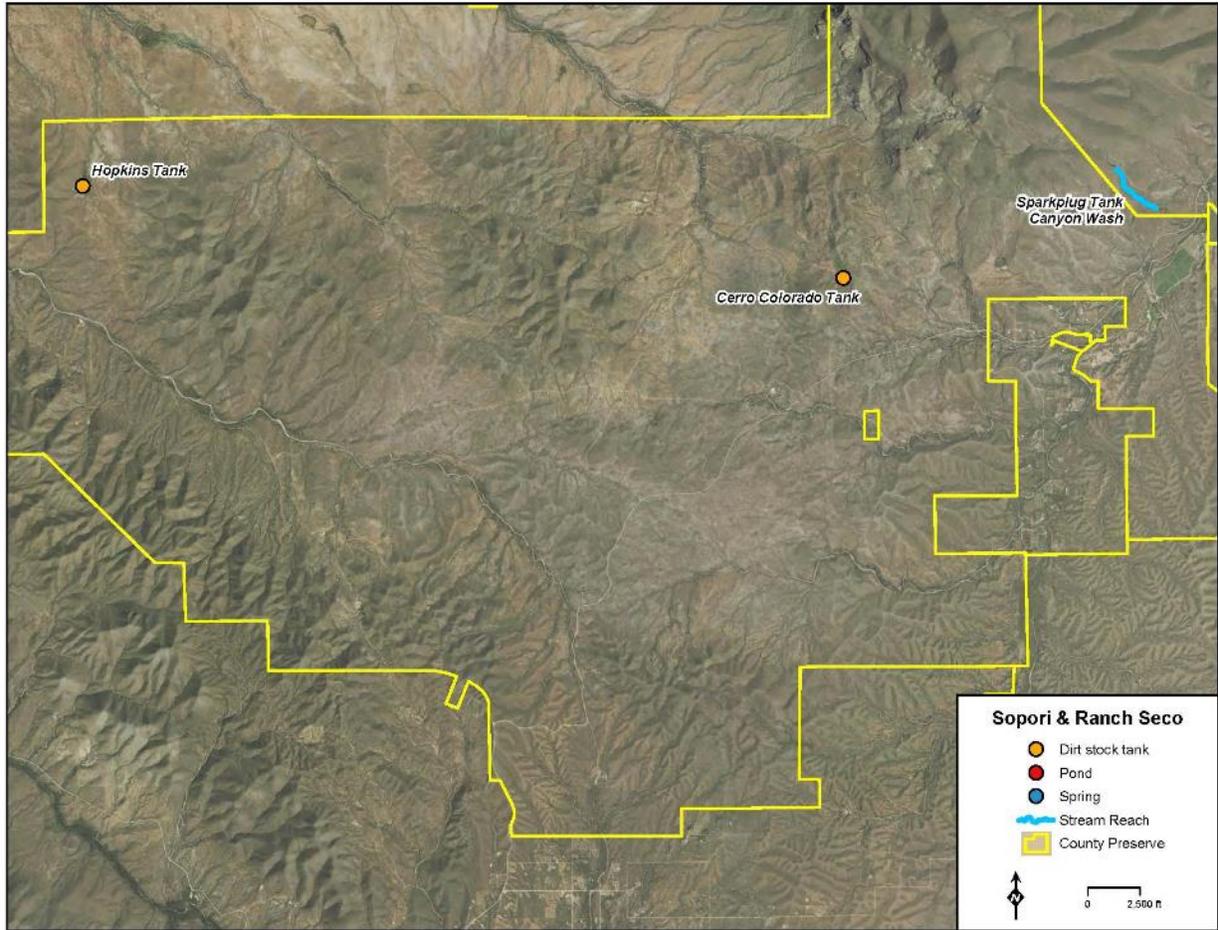
Aerial view of KERP ponds, 2011.



Pond-side view of KERP ponds, 2011

Site Type	Pond
Description	Dirt and concrete tanks that capture water from areas east of the property, most notably Davis Monthan Air Force Base. Water is used to irrigate nearby sports fields (see aerial view, above).
Water conditions and permanence	Not known to have gone dry, but elevation fluctuates considerably depending on runoff and use on sports fields. There is a backup system that can add water to the pond. Water quality issues unknown, but likely has some pollution because of areas drained.
Aquatic vertebrate species status	No target species present, but non-native species abound.
Invasive species issues	Bullfrogs were intentionally introduced by a member of the public. Bass are maintained to keep the bullfrogs in check. Crayfish have been present since 2015, though in low numbers. Western mosquitofish are abundant. Other reported species include sunfish and koi.
Target species translocations	Gila topminnow, lowland leopard frog, Huachuca water umbel.
Other species to consider	Desert pupfish, Sonora mud turtle
Maintenance and Management Needs	<ul style="list-style-type: none"> • Mosquitofish must be removed for topminnow to succeed in this environment. • Continued bullfrog removals are critical. (Bass will likely stay because of bullfrog control, but the species will impact target vertebrates)
Biological Inventory and Monitoring Needs	None needed

Rancho Seco and Sopori Ranch: Hopkins Tank, Cerro Colorado Tank, and Sparkplug Wash Map



Rancho Seco: Cerro Colorado Tank Description



Cerro Colorado Tank, 2016.

Site Type	Pond
Description	3.2 acre dirt tank captures water from rangelands
Water conditions and permanence	Known to have gone dry twice in the last 10 years. Usually a reliable water source in many of the last drought years. No backup water system.
Aquatic vertebrate species status	None known
Invasive species issues	None known
Target species translocations	Chiricahua leopard frog
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	If leopard frogs are introduced, would be best to fence off a portion of the tank where vegetation can grow to provide habitat
Biological Inventory and Monitoring Needs	Periodically monitor core water quality parameters (dissolved oxygen and temperature)

Sopori: Sparkplug Tank Canyon Wash Description



View of Sparkplug Canyon from above, June 2016.

Site Type	Stream reach
Description	Very short stream reach below concrete dam. Very difficult access to this site because of very steep cliffs. Access precluded in 2016 and 2017 because of bee hive on the south end, the only access into and out of the canyon.
Water conditions and permanence	Maintains water all year around.
Aquatic vertebrate species status	American bullfrogs present in 2016 and 2017
Invasive species issues	See above
Potential target species translocations	Chiricahua or leopard frog.
Other species to consider	
Maintenance and Management Needs	<ul style="list-style-type: none"> • Determine if eradication of bullfrogs is feasible or desirable at this site. • Unknown source population of bullfrogs on private land to the south. • Permission from State Land Department for introductions
Biological Inventory and Monitoring Needs	Because of bees, no surveys have been done at this site. Inventory is needed.

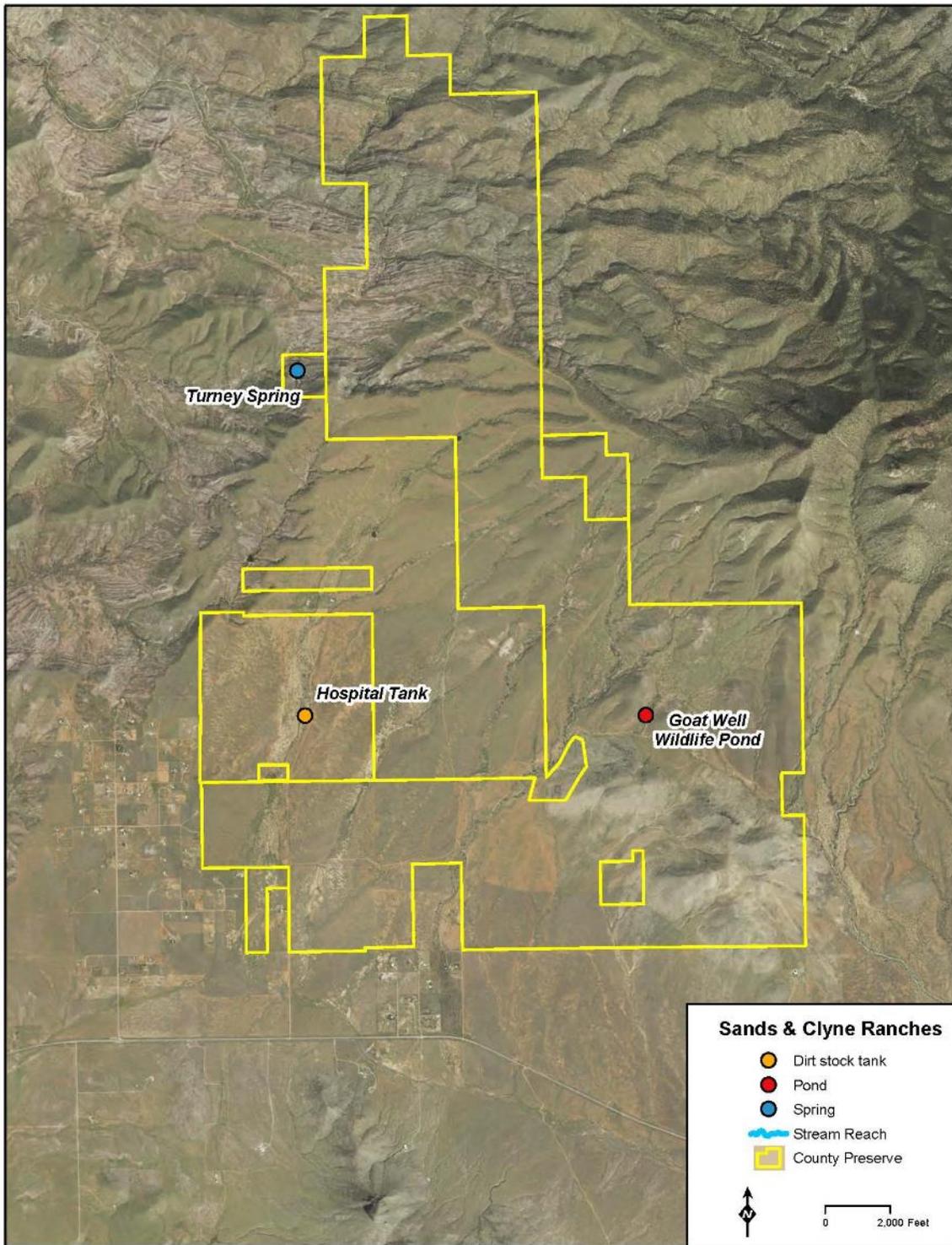
Rancho Seco: Hopkins Tank Description



Hopkins Tank, June 2016.

Site Type	Pond
Description	0.9 acre dirt tank captures water from rangelands.
Water conditions and permanence	Most consistent dirt tank along all tanks in the Altar Valley. Not known to have gone dry in the last 15 years. No backup water system.
Aquatic vertebrate species status	No known target species or any aquatic vertebrate
Invasive species issues	None known
Target species translocations	Chiricahua leopard frog. Closest tank on County land to known populations at the Buenos Aires National Wildlife Refuge.
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	If leopard frogs are introduced, would be best to fence off a portion of the tank where vegetation can grow to provide habitat
Biological Inventory and Monitoring Needs	Periodically monitor core water quality parameters (dissolved oxygen and temperature)

Sands and Clyne Ranch: Turney Spring, Hospital Tank, and Goat Well Wildlife Pond Map



Clyne Ranch: Hospital Tank Description



Hospital Tank, 2012.

Site Type	Pond
Description	0.8 acre dirt tank captures water from rangelands
Water conditions and permanence	Never known to have gone dry (even as far back as the 1950s according to Doc Clyne). No backup water system. In 2015, tank was drained and deepened and invasive vertebrates removed
Aquatic vertebrate species status	Chiricahua leopard frogs were noted in 2017 - 2019. Breeding confirmed in 2018. Western mosquitofish and American bullfrogs present. Tank drained to remove bullfrogs and mosquitofish in summer 2019. CLF relocated.
Invasive species issues	Gambusia and bullfrogs accidentally introduced in 2016. Bullfrog eradication has been ongoing.
Target species translocations	Gila topminnow
Other species to consider	Desert pupfish, Northern Mexican gartersnake
Maintenance and Management Needs	<ul style="list-style-type: none"> • Mosquitofish must be removed. • Continued bullfrog removals are critical.
Biological Inventory and Monitoring Needs	None needed

Sands Ranch: Goat Well Wildlife Pond Description



Description	Fed from a nearby Goat Well, this pond is small (approximately 30m ²) and was built in 2016 by Don Carter specifically for the Chiricahua leopard frog.
Water conditions and permanence	Always kept full of water from well. However, if the well fails or power is cut off, site will dry up.
Aquatic vertebrate species status	Chiricahua leopard frogs found their way to the site in 2018
Invasive species issues	None
Potential target species translocations	Gila topminnow
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	Ensure water supply remains uninterrupted. Ensure canopy doesn't completely shade site.
Biological Inventory and Monitoring Needs	Bullfrogs are at the nearby Hospital tank, so it will be important to stay vigilant to ensure they don't get to this site. Monitor the Chiricahua leopard frog population.

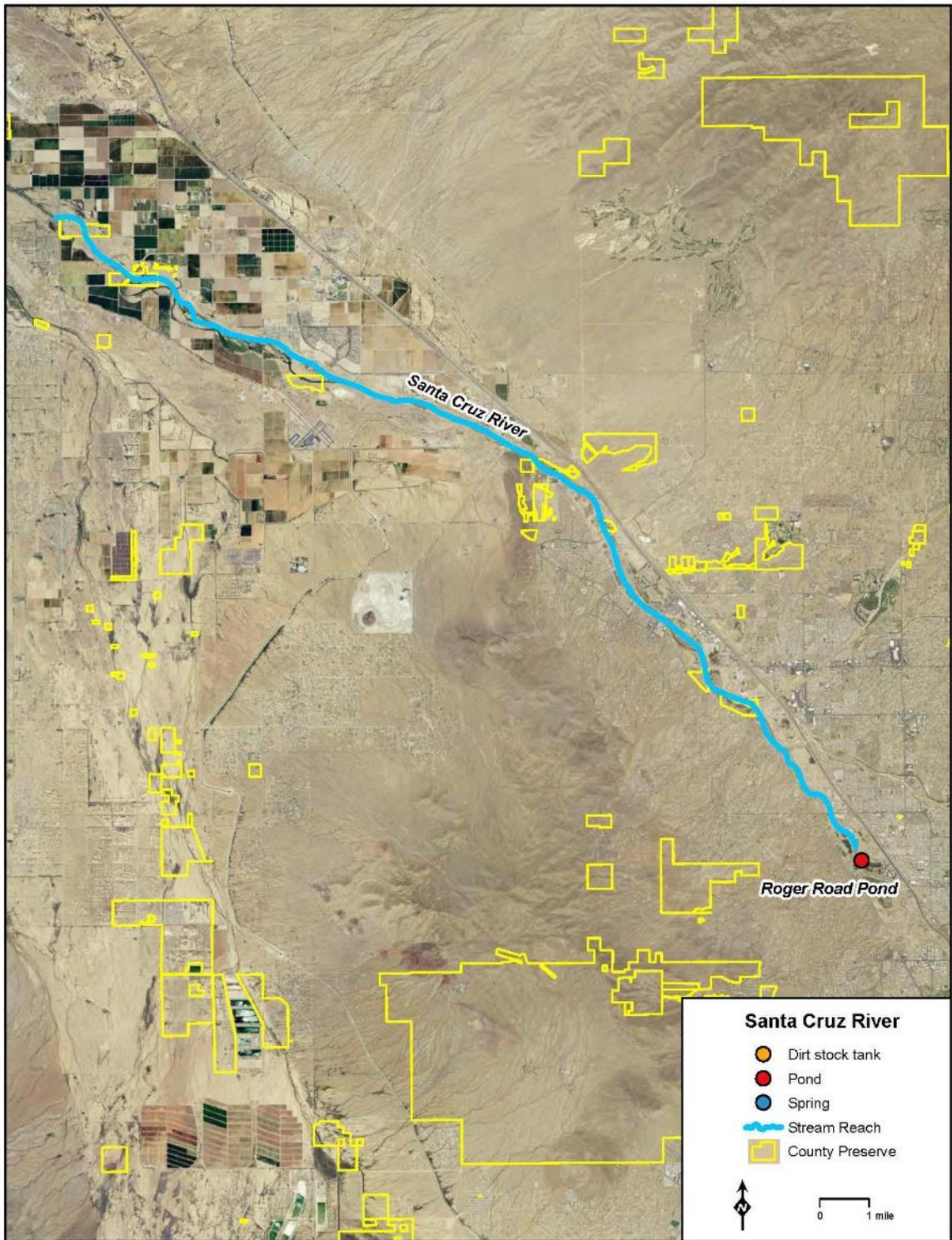
Clyne Ranch: Turney Spring Description



Turney Spring, April 2016.

Description	This hillside spring complex is located on the northern-most and difficult-to-access portion of the Clyne Ranch. Spring source is multiple sites in close proximity and together forms some surface water features such as small pools and wetlands.
Water conditions and permanence	Visited each June for the last three years, Turney retains a small amount of water in the dry season and more in other periods
Aquatic vertebrate species status	Tentative observation of at least 5 Chiricahua leopard frog tadpoles in June 2019. Also two black-necked gartersnakes hunting them.
Invasive species issues	None
Potential target species translocations	Chiricahua leopard frogs would do well with slight modification to wetland features such as pools. Because most of the spring is out of the scour zone, the Huachuca water umbel is likely suitable for a few areas.
Other species to consider	
Maintenance and Management Needs	Enlarge some spring features to make pools for Chiricahua leopard frogs
Biological Inventory and Monitoring Needs	Continue to monitor June conditions during very dry years to ensure adequate water supply. Confirm tentative observation of tadpoles

Santa Cruz River and Roger Road Pond Map



Roger Road Wastewater Treatment Facility: Roger Road Pond Description



Aerial view of Roger Road Ponds, 2018.

Site Type	Pond
Description	Two ponds, with a combined 1.2 acres, are located along the banks of the Santa Cruz River. Water is effluent from the Agua Nueva treatment plant. Ponds are being dried and excavated but not lined providing opportunity to replace exotic fish with native fish.
Water conditions and permanence	Always kept full of water, but duckweed covers the entire surface. Water quality issues are a concern
Aquatic vertebrate species status	Western mosquitofish and bullfrogs are likely a problem at this site.
Invasive species issues	Duckweed often covers this feature.
Potential target species translocations	Gila topminnow in open water and to control mosquitoes. Lowland leopard frogs, which were once abundant along the Santa Cruz River at downtown Tucson. Huachuca water umbel because of relatively consistent water elevation.
Other species to consider	Sonoran mud turtle, pupfish
Maintenance and Management Needs	Control of duckweed and bullfrogs will require considerable effort over the long term. Sweetwater Wetlands ponds across the street represent source population for bullfrogs, sliders, and mosquitofish
Biological Inventory and Monitoring Needs	Inventory is needed to determine if other species are present.

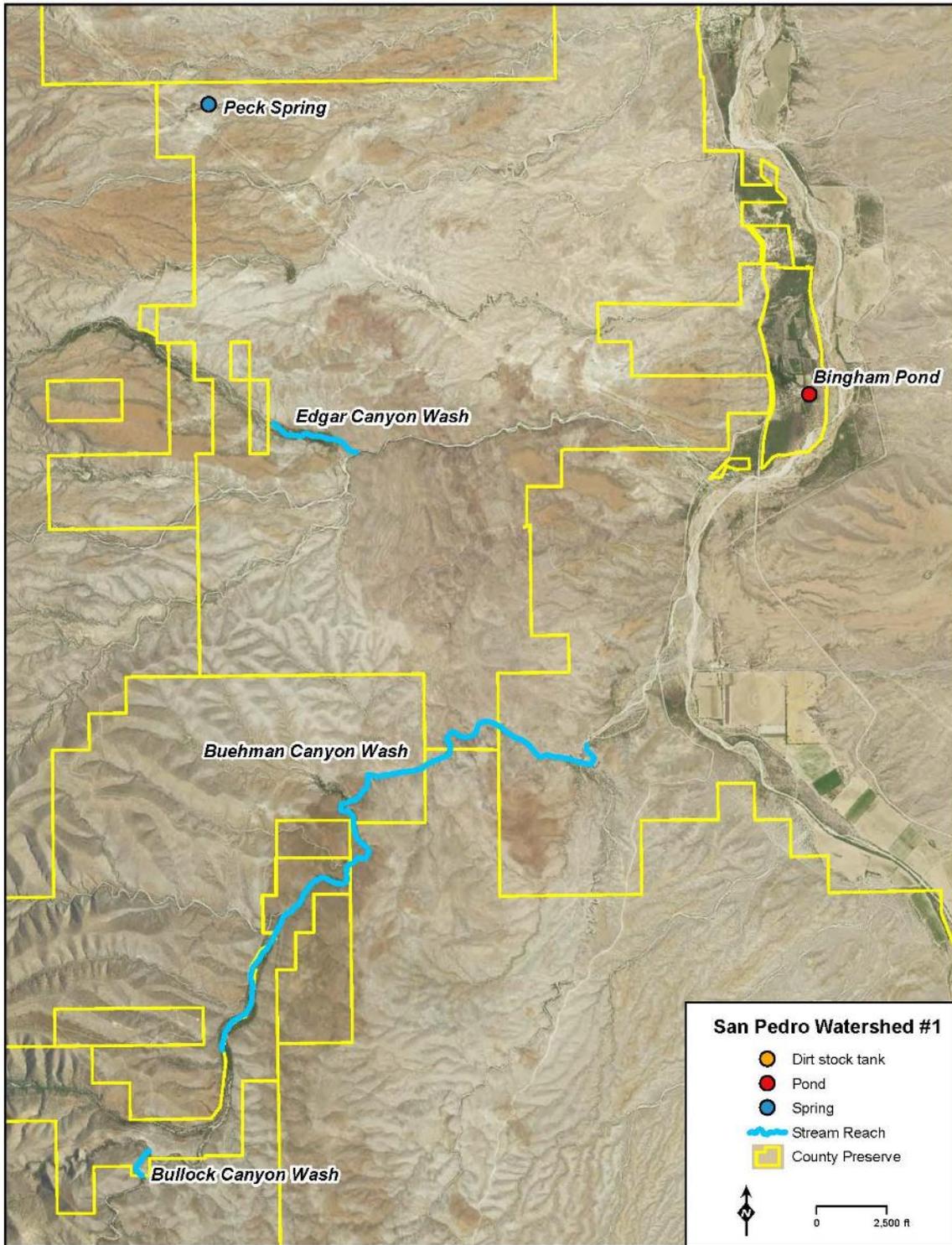
Santa Cruz River Description



Santa Cruz River, November 2013.

Site Type	Stream reach, effluent dominated
Description	Fed from the Agua Nueva and Tres Rios facilities, the perennial water in the Santa Cruz has a variety of aquatic habitat types (pool, riffles, and runs). Conditions for presence of native aquatic species has been improving since treatment plant upgrades in 2013, as shown by the Living River project.
Water conditions and permanence	Perennial water extent is approximately 23 miles.
Aquatic vertebrate species status	Gila topminnow was discovered in the river in 2017 (and confirmed again in 2018). Other fish species include common carp, green sunfish, bluegill, western mosquitofish, and black bullhead (all non-native).
Invasive species issues	None known
Potential target species translocations	Longfin dace and Sonora and desert suckers.
Other species to consider	Mexican gartersnakes historically occurred throughout the Santa Cruz River and may be a candidate for translocation given the secured flow downstream of the treatment plant, assuming that a sufficient prey base occurs.
Maintenance and Management Needs	Maintain contributions of effluent to the river.
Biological Inventory and Monitoring Needs	Annual fish surveys will be important to maintain.

San Pedro Watershed #1: Peck Spring, Edgar Canyon Wash, Bingham Pond, Buehman and Bullock Canyon washes Map



Bingham Cienega: Bingham Pond Description



Bingham Pond, 2016.

Site Type	Pond
Description	0.3 acre pond is part of the agricultural operation run by the Kelly family. It is located within the Kelly life estate
Water conditions and permanence	Pond always contains water from a production well located on the life estate
Aquatic vertebrate species status	Lowland leopard frogs are known from the site, but likely not reproducing give nonnative fish
Invasive species issues	Bass and catfish are present.
Potential target species translocations	Gila topminnow, Sonora sucker, and umbel are suitable for this site.
Other species to consider	Sonoran mud turtle, California floater, Northern Mexican gartersnake
Maintenance and Management Needs	No actions will take place on this site until the life estate has been exercised.
Biological Inventory and Monitoring Needs	None

Buehman Canyon: Bullock Canyon Description



Dam at Bullock Canyon, October 2017.

Site Type	Stream reach
Description	Spring-fed stream reach that begins on Bellota Preservation Corporation land and runs through a series of pools to an area backed up by a low concrete dam. Conditions at the dam are variable, from completely silted in to scoured and able to hold water (see photo)
Water conditions and permanence	Maintains water year around in short stream segment. Presence of water behind dam is variable.
Aquatic vertebrate species status	Longfin dace inhabit pools below the dam, but not above. Lowland leopard frogs are found in abundance throughout. Sonoran mud turtles also occur here.
Invasive species issues	None known
Potential target species translocations	Gila chub would do well in the pool behind the dam, but only when open. Gila topminnow throughout. If Mexican gartersnakes are translocated to Buehman Canyon and do well there, they would likely do well in Bullock because of prey base. Huachuca water umbel would likely do well near spring, though considerable and regular scour occurs.
Other species to consider	
Maintenance and Management Needs	
Biological Inventory and Monitoring Needs	Continue to monitor water conditions in pool behind the dam.

Tesoro Nueve: Carpenter Spring Description



Carpenter Spring, May 2017.

Description	This hillside spring complex is located in a small tributary upstream of the confluence with Buehman Canyon. In this tributary area, small seeps are numerous and aggregate into a very low-flow channel with wetlands. (Note: this writeup does not refer to the portion of the spring that is in Buehman Canyon, which is covered elsewhere in this document).
Water conditions and permanence	Visited only a few times, but there is thought to be a small amount of water in the channel all year around
Aquatic vertebrate species status	None. Large population of lowland leopard frogs very nearby in Buehman; individual frogs have been observed using riparian habitat in the lower reaches of this drainage.
Invasive species issues	None
Potential target species translocations	Huachuca water umbel is likely suitable for a few areas in the tributary bottom.
Other species to consider	
Maintenance and Management Needs	Maintain fencing to ensure cattle do not trample the site.
Biological Inventory and Monitoring Needs	Continue to monitor June conditions during very dry years to ensure adequate water supply.

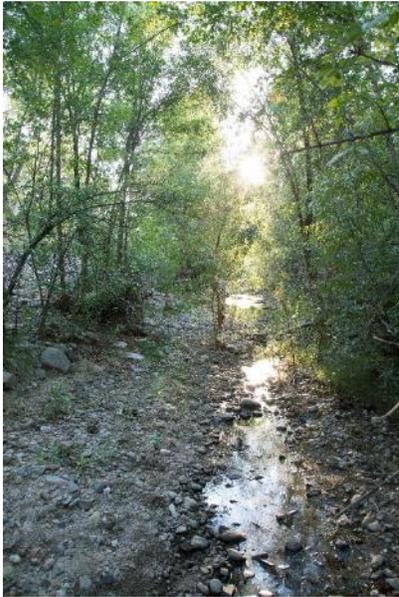
Buehman Canyon: Buehman Canyon Description



Buehman Canyon, Tesoro Nueve property, May 2017.

Site Type	Stream reach
Description	Three sections of the creek have perennial water, with the largest being in proximity (and certainly associated with) Carpenter Spring on the Tesoro Nueve property. Two other very short segments of perennial water are: 1) near the National Forest boundary and the Korn Kob Mine and approximately 600 meters downstream of the confluence of Bullock and Buehman canyons. Several tinajas also hold permanent water during most years in the downstream portion of Buehman.
Water conditions and permanence	At the Tesoro Nueve site the extent of wetland conditions in June vary, but is typically approximately 0.3 miles.
Aquatic vertebrate species status	Longfin dace and lowland leopard frogs are abundant on most segments, though their populations are especially variable at the site near to Korn Kob, and both species haven't been found at that site for several years which has nearly gone dry during June 2018, 2019
Invasive species issues	None known
Potential target species translocations	Gila topminnow are a prime species for translocations and the Arizona Game and Fish Department would like to investigate translocations (pending discussions with the Arizona State Land Department). Although the stream gradient within Buehman Canyon is slightly elevated for Mexican gartersnakes, the prey density is superb should the species find adequate reaches for occupancy, whether through natural or artificial means. Huachuca water umbel.
Other species to consider	
Maintenance and Management Needs	Continue to maintain fence to prevent cattle from entering the canyon.
Biological Inventory and Monitoring Needs	Continue to monitor water extent in June.

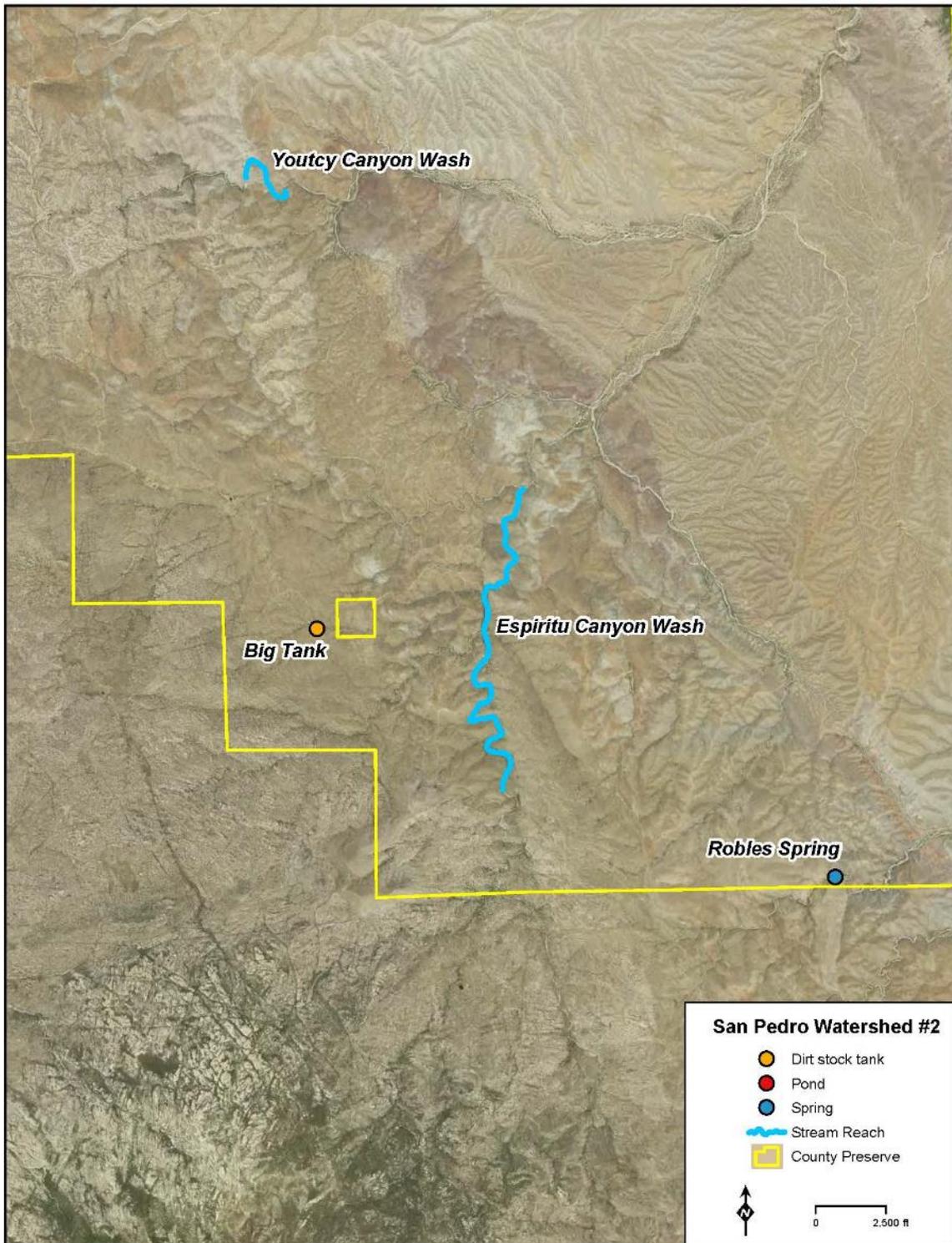
M Diamond Ranch: Edgar Canyon Description



Edgar Canyon, June 2015.

Site Type	Stream reach
Description	Short stretches of perennial water and pool segments mark this ash and sycamore-lined stream.
Water conditions and permanence	Pools and flowing water are present along about 150-200m segment.
Aquatic vertebrate species status	Lowland leopard frogs are abundant in most years. During April 2019, AZGFD released 564 Gila topminnow at this site.
Invasive species issues	None known
Potential target species translocations	Longfin dace would do well at this site
Other species to consider	
Maintenance and Management Needs	When grazing resumes at M Diamond Ranch, make sure cattle are prevented from entering the site.
Biological Inventory and Monitoring Needs	Continue to monitor water extent in June and assess topminnow occupancy during wet-dry mapping.

A7 Ranch: Youtcy Canyon Wash, Big Tank, Espiritu Canyon Wash, and Robles Spring Map



A7 Ranch: Big Tank Description



Eastern portion of Big Tank, 2018.

Site Type	Dirt stock tank
Description	2.6 acre tank (at capacity) that receives runoff from rangelands, most of which are on the Coronado National Forest.
Water conditions and permanence	This is a large tank by County standards and can hold a considerable amount of water when full. However, it has dried out a few times in the last 10 years.
Aquatic vertebrate species status	None known
Invasive species issues	None known
Potential target species translocations	Lowland leopard frog due to relatively close proximity to nearby populations in Edgar and Youtcy canyons
Other species to consider	Sonoran mud turtle
Maintenance and Management Needs	Backup well and pump system would need to be installed if there is uncertainty about runoff
Biological Inventory and Monitoring Needs	Inventory to determine if the pond currently contains invasive species.

A7 Ranch: Youtcy Canyon Description



View of Youtcy Canyon from the north.



Streamside view of Youtcy Spring

Site Type	Spring (Rheochrene)
Description	Spring-fed system that creates wetland conditions for approximately 100-400m. Willow trees in the overstory and wetland plants dominate.
Water conditions and permanence	June mapping from 2011-17 revealed conditions that vary annually, from a single pool (2013; though cows were present on the site which might have changed conditions considerably) to >400m of continuous flow. Bedrock conditions over much of the site and considerable scour mean the water features (i.e., pools, runs, and riffles) do not vary significantly year-to-year. Site contains numerous small pools with relatively shallow depths (<1m). Flowing stretches are fairly narrow and track eroded limestone grooves in some areas.
Aquatic vertebrate species status	Lowland leopard frogs have been recorded each year except in 2013. Now abundant and mostly overwinter as tadpoles and/or metamorphs. Ample downed logs, water, and wetland vegetation for all life stages.
Invasive species issues	None known
Potential target species translocations	Gila topminnow and longfin dace might do well at this site. Umbel is possible, but considerable scour at this site.
Other species to consider	Loach minnow, California floater
Maintenance and Management Needs	<ul style="list-style-type: none"> • Permanent solution to fence cows from the site so they do not get into the spring • Assure protection of water quality and preclusion of disease introduction • Permission from State Land Department for introductions
Biological Inventory and Monitoring Needs	Ensure cattle remain excluded from the main spring-fed riparian stretch

A7 Ranch: Robles Spring Description



Robles Spring, April 2018.

Site Type	Spring (rheochrene and hillside)
Description	This rheochrene and hillside spring complex is on BLM land on the southern end of A7 Ranch. This system creates short stretches with wetland conditions and a few, very small pools.
Water conditions and permanence	June mapping from 2011-17 revealed conditions that vary considerably among years, though there was always some water present.
Aquatic vertebrate species status	None known
Invasive species issues	None known
Potential target species translocations	Lowland leopard frog is the only target vertebrate species that would be suitable for this site. Huachuca water umbel may also be suitable for a few areas, though considerable scour occurs on the site.
Other species to consider	
Maintenance and Management Needs	<ul style="list-style-type: none"> • Investigate opportunities for increasing spring flow. • Permission needed from the BLM prior to introductions
Biological Inventory and Monitoring Needs	Monitor June conditions during very dry years to ensure adequate water supply.

A7 Ranch: Espiritu Canyon Description



Espiritu Canyon, April 2016.

Site Type	Spring (rheochrene) and tinajas
Description	Stream with intermittent conditions over much of its length. During the dry June period, tinajas are the only places with consistent water.
Water conditions and permanence	June mapping from 2011-17 revealed conditions that vary annually. Like Youtcy, bedrock conditions over much of the stream reach.
Aquatic vertebrate species status	Lowland leopard frogs have been recorded many years in select tinajas and have been reliably reproducing in the lower stretches for at least 2017-2019. Longfin dace previously occupied the lower stretches and were documented in a 1990 survey.
Invasive species issues	None known. Green sunfish once occupied the tinajas in the canyon
Potential target species translocations	Gila topminnow and longfin dace might do well at this site.
Other species to consider	
Maintenance and Management Needs	<ul style="list-style-type: none"> • Assure protection of water quality and preclusion of disease introduction • Permission from State Land Department for introductions
Biological Inventory and Monitoring Needs	Continue to monitor stretch near National Forest boundary to determine foresummer conditions there.