Appendix A: Site Summary Reports

1. B-17-02 12cdb unnamed
Summary Report, Site ID 18793
Submitted 9/18/23 by Springs Stewardship Institute

Location: The B-17-02 12cdb unnamed ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the State. The site is located in the Arizona Game & Fish Department, in the Chino Valley North USGS Quad, at 34.86725, -112.42379 (NAD83). The elevation is approximately 1289 meters.

Physical Description: This location was imported from the AZDWR. It was reported as an unused water source with a perennial flow consistency and no spring manipulation. In May 2023 an SSI survey crew found no evidence of a spring at this location. However, Brush spring (237744) is located nearby, and is likely the spring to which this information refers.

Geomorphology: B-17-02 12cdb unnamed emerges as a fracture spring from a rock layer.

Access Directions: From North of Paulden turn east off Hwy 89 onto Old Hwy 89. Turn east on E. Sweet Valley Rd. Follow this dirt road as it turns southwest, then south and leads to near the top of the canyon rim just above the spring. A relatively easy trail leads down into the canyon.

5/15/23 Survey

This location was previously reported as a spring, but on 5/15/23 surveyors determined that there is no spring at this location.

Jeri Ledbetter verified the site on 5/15/23 at 15:10. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Survey Notes: The surveyor found no evidence of a spring at this location, but believed it likely refers to Brush Spring, located nearby (Site ID 237744).

2. Big Spring
Summary Report, Site ID 739
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Big Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Kaibab NF, Williams RD, in the Davenport Hill USGS Quad, at 35.15812, -112.08072 measured using a GPS (WGS84, estimated position error 2 meters). The elevation is approximately 2088 meters.

Physical Description: Big Spring is a hillslope spring. This spring is part of the SSI 4FRI Springs Monitoring Project and is located within a control area. Flow emerges from boulders in an eroding basalt flow margin. There are multiple seepage points located along the base of the colluvial slope. Flow converges and forms a channel downslope of the source. The surrounding area is heavily forested. The source has been manipulated with piping and subjected to long-term trampling. The site was fenced in the past, however as of 2019 the fencing and piping appeared to have been dysfunctional for some time. There is a Troll stream gauge (maintained by Northern Arizona University) about 100 meters downstream of the source. On October 12, 2019, Ed Schenk installed a Hobo Tidbit MX2203 data logger at the southern (smaller) source under a rock. On May 6, 2020, surveyors secured the Hobo device to rebar at the original location. On May 23, 2021, a surveyor was able to download data from the Hobo via Bluetooth but could not locate the device, and deployed a new one at the same location, secured to a PVC and 18-inch rebar with heavy wire. Therefore as of 2021, there are two Hobo devices at this spring. In 2022, surveyors did not detect the original Hobo, and re-installed the second Hobo in the same location. In 2023, surveyors found the original Hobo near the spring, up in the rocks and 20 meters from the water. The surveyor reinstalled it under the log on the left side of the left channel and covered it with rocks.

Geomorphology: Big Spring emerges as a contact spring from an igneous, basalt rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 93% of available solar radiation, with 8643 Mj annually.

Access Directions: From the town of Williams, drive south on County Road 73 (Perkinsville Rd) for 7.1 mi. Turn left (east) onto FR 139, looking for signs to the Overland Trailhead, and drive 4.5 miles. Turn south onto an unmarked dirt road at 35.16649, -112.08585. Follow the road until it becomes too rough. Park and hike 300-800 meters to the spring, depending on how far you drive on the rough road.

5/04/23 Survey
Larry Stevens, Jeri Ledbetter, John Souther, Hanna Grissom, and Cerissa Hoglander surveyed the site on 5/04/23 for 06:25 hours, beginning at 10:45, and collected data in

10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 2.1 Big Spring: Photo match from 11 meters facing up to the source.

Microhabitats: The microhabitats associated with the spring cover 414 sqm. The site has 3 microhabitats, including A -- a 135 sqm channel, B -- a 111 sqm terrace, C -- a 168 sqm colluvial slope. The geomorphic diversity is 0.47, based on the Shannon-Weiner diversity index.

Table 2.1 Big Spring Microhabitat characteristics.

Code	**A**	**B**	**C**
Name	Source Channel	Terrace	Colluvial slope
Area sqm	135	111	168
Surface type	CH	TE	CS
Surface subtype			
Slope variability	Low	Low	Med
Aspect TN	142		142
Slope degrees	5	2	12
Moisture (scale 1-10)	9	5	5
Water depth cm	14	3	3
Area % open water	90	4	3
Substrate			
1 - Clay %	4	3	2
2 - Silt %	45	30	25
3 - Sand %	10	5	3
4 - Fine gravel %	5	4	2

Code	A	B	C
5 - Coarse gravel %	5	10	3
6 - Cobble %	19	35	31
7 - Boulder %	2	3	20
8 - Bedrock %	0	0	7
Organic %	10	5	7
Other % (anthropogenic)	0	5	0
Precipitate %	0	0	0
Litter %	1	2	1
Wood %	9	3	0
Litter Depth (cm)	0.1	0.3	0.1

Survey Notes: During a survey on March 5, 2023 flow was exceptionally high due to heavy snowpack over the recent winter. The usually dry adjacent channel to the northeast had standing and flowing water. Seepage was emerging from the colluvial slope in areas not previously noted. Surveyors observed evidence of heavy elk use, including tracks and scat. There were pin flags set to mark the corners of planned fencing, to be installed in the summer of 2023. Noted also was an excess of barbed wire, which poses a hazard to wildlife.

Flow: Surveyors measured a flow of 17 liters/second, using a flume. Flow was adjusted for an estimate of 66% of site flow capture. Surveyors measured flow 47 meters below the constructed rock dam. This spring is perennial.

Water Quality: Surveyors measured water quality in flowing water at the first emergence of water upslope of the pipe. Location 1: at the spring source in flowing water at 15:15.

Table 2.2 Big Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.056	1	Hanna Multi 98194
pH (field)	6.72	1	Hanna Multi 98194
Specific conductance (field) (uS/cm)	113	1	Hanna Multi 98194
Temperature, air C	20	1	Handheld therm
Temperature, water C	10.11	1	Hanna Multi 98194

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 28 plant species at the site, with 0.0603 species/sqm. These included 23 native and 5 nonnative species.

Table 2.3 Big Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	23	9
Shrub	4	0
Mid-canopy	2	0
Tall canopy	0	0
Basal	0	0
Aquatic	0	0
Non-vascular	1	1

Table 2.4 Big Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Achillea millefolium	GC	NI	U		0	2	0
algae	NV	N?	A		7	1	0
Brassicaceae	GC	NI			0	0.1	0
Bromus tectorum	GC	I	U		0	0	2
Cirsium arvense	GC	I	F		0	0	1
Eleocharis	GC	N	W		1	5	0
Epilobium ciliatum	GC	N	W		0.1	0.1	0
Geranium caespitosum	GC	N	F		0	5	0.1
Humulus	SC	N	F		0.1	1	90
Hypericum scouleri	GC	N	WR		0.1	1	0
Iris missouriensis	GC	N	F		0	5	0
Juncus interior	GC	N	WR		2	5	0
Juncus xiphioides	GC	N	W		2	1	0
Mimulus guttatus	GC	N	WR		40	0.1	0
Muhlenbergia	GC	N	U		0.5	20	0
Pinus ponderosa	MC	N	U		0	0	3
Pinus ponderosa	SC	N	U		0	0.5	2
Poa pratensis	GC	NI	F		0.5	15	2
Quercus gambelii	MC	N	U		0	0	2
Quercus gambelii	SC	N	U		0	0	6
Ranunculus cymbalaria	GC	N	W		10	0	0
Rosa woodsii	SC	N	F		0	0.1	2
Rumex crispus	GC	I	F		0.1	2	0.1
Sidalcea neomexicana	GC	N	WR		0.1	4	1
Solidago	GC	N	F		0	0	0.1
Taraxacum officinale	GC	NI	F		0	0.5	0
Tragopogon dubius	GC	I	F		0	0.1	0
Trifolium	GC	NI			0	2	0
Verbascum thapsus	GC	I	U		0	1	0.1

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Viola nephrophylla	GC	N	WR		0	1	0

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 26 invertebrate taxa, including 16 aquatic and 5 terrestrial invertebrate taxa, and 2 vertebrate taxa. Surveyors conducted quantitative benthic sampling at this spring.

Table 2.5 Big Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Annelida	Ad		Collected spot		1	
Araneae Thomisidae	Ad	T	Uncollected benthic	1	1	
Basommatophora Physidae	Ad	A	Preserved benthic	2	2	
Bivalvia	Ad	A	Collected spot		13	
Coleoptera Dytiscidae	L	A	Preserved benthic	2	2	
Diptera	L		Collected spot		4	
Diptera Chironomidae	L	A	Uncollected benthic	3	26	
Diptera Chironomidae	L	A	Preserved benthic	2	20	
Diptera Tipulidae	L	A	Collected spot		1	
Diptera Tipulidae	L	A	Uncollected benthic	2	3	
Diptera Tipulidae	L	A	Uncollected benthic	1	1	
Ephemeroptera	L	A	Collected spot		1	
Ephemeroptera	L	A	Preserved benthic	1	1	
Hemiptera Belostomatidae Abedus herberti	L	A	Spot		1	No adults observed
Hirudinea	Ad		Collected spot		2	
Hirudinea Erpobdellidae Erpobdella obscura	Ad	A	Preserved benthic	3	4	
Hirudinida	Ad	A	Preserved benthic	3	3	Sp. 2
Hirudinida Erpobdellidae	Ad	A	Preserved benthic	2	2	
Lepidoptera Lycaenidae Plebejus acmon	Ad	T	Spot		3	
Lepidoptera Nymphalidae Vanessa cardui	Ad	T	Spot		1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		1	
Lumbriculida	Ad	A	Preserved benthic	1	1	
Mollusca	Ad		Collected spot		4	
Mollusca Gastropoda	Ad		Collected spot		2	
Odonata	Ad	T	Collected spot		1	
Odonata Coenagrionidae Argia	L	A	Uncollected benthic	1	1	
Odonata Coenagrionidae Argia	L	A	Preserved benthic	2	9	
Sphaeriida Sphaeriidae Pisidium	Ad	A	Preserved benthic	3	8	
Sphaeriida Sphaeriidae Pisidium	Ad	A	Preserved benthic	1	20	
Sphaeriida Sphaeriidae Pisidium	Ad	A	Preserved benthic	2	60	
Trichoptera Limnephilidae	L	A	Uncollected benthic	2	2	
Trichoptera Limnephilidae Hesperophylax	L	A	Uncollected benthic	2	1	
Turbellaria	Ad	A	Collected spot		4	

Table 2.6 Big Spring Benthic Invertebrate Sampling.

Rep#	Velocity (m/sec)	Depth (cm)	Area (sq m)	Time (sec)	Location	Substrate	Comments
1	0.15	3	0.09	60	source	15% 4; 25% 5; 60% 6	Right channel; less manipulated; 30% Mimulus cover
2	0.40	7	0.09	60	stump	10% 3; 20% 4; 20% 5; 50% 6	25% Mimulus cover
3	0.20	14	0.09	60	42 m	20% 3; 5% 4; 10% 5; 65% 6	

Table 2.7 Big Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Elk		Sign	Extensive Tracks And Scat
Common Raven	2	Obs	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.7) and there is moderate risk (average risk score 3.2). Geomorphology condition is moderate with some restoration potential (average condition score 3.6) and there is high risk (average risk score 4). Habitat condition is good with significant restoration potential

(average condition score 4) and there is low risk (average risk score 2.8). Biotic integrity is moderate with some restoration potential (average condition score 3.8) and there is low risk (average risk score 2.3). Human influence of site is good with significant restoration potential (average condition score 4.1) and there is moderate risk (average risk score 3.2). Overall, the site condition is good with significant restoration potential and there is moderate risk.

Table 2.8 Big Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.7	3.2
Geomorphology	3.6	4
Habitat	4	2.8
Biota	3.8	2.3
Human Influence	4.1	3.2
Overall Ecological Score	4	3

Management Recommendations: Surveyors recommend cutting a slab out of the dead standing tree for dendrochronology of the site.

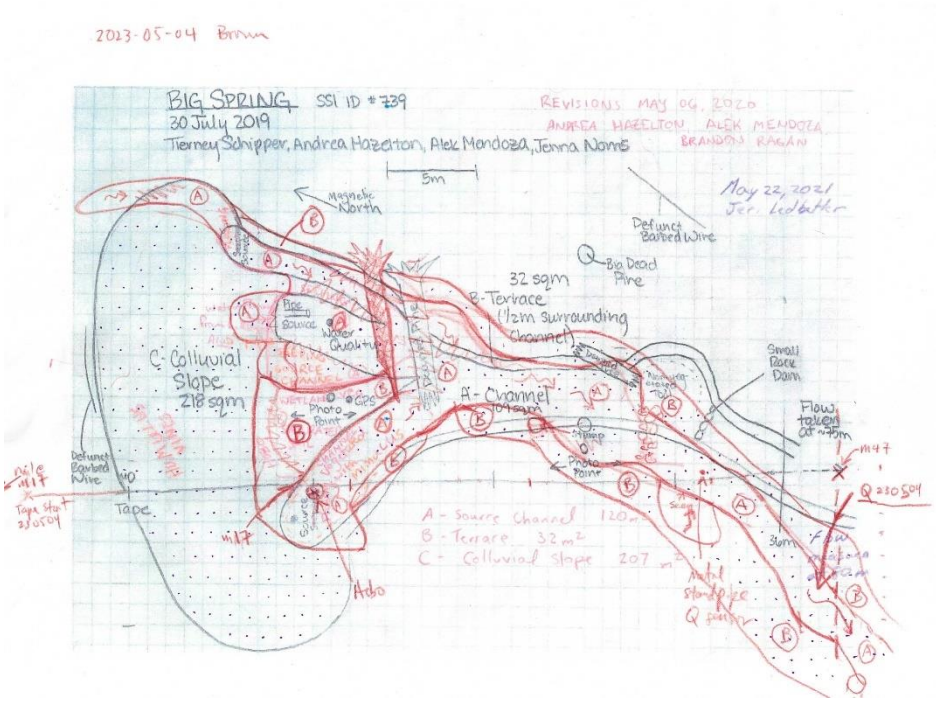

Fig 2.2 Big Spring Sketchmap: Sketchmap 2023.

Fig 2.3 Big Spring: Photo match; view facing downslope.

Fig 2.4 Big Spring: Photographer is at the original photo point next to a stump.

3. Bridge Pool Seep
Summary Report, Site ID 255222
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Bridge Pool Seep ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by a private US owner. The spring is located in the Munds Park USGS Quad, at 34.91031, -111.72767 measured using a GPS (WGS84, estimated position error 9 meters). The elevation is approximately 1387 meters.

Physical Description: Bridge Pool Seep is a hillslope spring. Seepage emerges into a 0.35 meter deep pool located 10 meters from a 3 meter high stone wall. The wall supports a house 20 meters downstream from Indian Gardens Bridge. The pool has been in place for at least 30 years, according to Georgie Pongyesva. There are three other seepages on creek left within 50 meters downstream, and at least one spring on creek right 10 meters downstream from the Indian Gardens Bridge.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Park just across the bridge and walk about 10 meters downstream, between the Indian Gardens neighborhood and the creek left bank of Oak Creek.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 15:40. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 3.1 Bridge Pool Seep: The pool viewed from the upstream end, facing downstream

Survey Notes: The pool is next to a semi-popular recreation area in Oak Creek and there are signs of human trash and past flooding, but no evidence of recent vegetation disturbance. The site supports sycamore, velvet ash, alder, horsetail Equisetum arvense, and non-native English ivy.

Fauna: Larry Stevens was the zoologist for this survey. Surveyors collected or observed 3 vertebrate taxa.

Table 3.1 Bridge Pool Seep Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Brown-crested Flycatcher		Call	
Black Phoebe		Call	
House Wren		Call	

4. Private Spring
(Data not available to the public)

5. Brush Springs
Summary Report, Site ID 237744
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Brush Springs ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the State. The spring is located in the Arizona Game & Fish Department, in the Chino Valley North USGS Quad, at 34.86697, -112.42397 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1293 meters.

Physical Description: Brush Springs is a rheocrene/limnocrene spring. Flow emerges from a side channel to the Verde River, forming a pool. The channel narrows and flows into the Verde River after about 50 meters. The channel is subject to heavy surface flow, both down the channel and from flooding of the Verde River. This spring is on the left bank. Coordinates may have been taken in the past just below the source.

Geomorphology: Brush Springs emerges as a seepage or filtration spring from the Redwall Formation, a sedimentary, limestone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 96% of available solar radiation, with 9207 Mj annually.

Access Directions: From North of Paulden, AZ turn east off Hwy 89 onto Old Hwy 89. Turn east on E. Sweet Valley Rd. Follow this dirt road as it turns southwest, then south as it leads near the top of the canyon rim just above the spring. A relatively easy trail leads down into the canyon, about 600 meters.

5/15/23 Survey
Larry Stevens, Jeri Ledbetter, and Joseph Holway surveyed the site on 5/15/23 for 01:35 hours, beginning at 15:10, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 5.1 Brush Springs: View of the spring from above the pool, looking downstream.

Microhabitats: The microhabitats associated with the spring cover 305 sqm. The site has 3 microhabitats, including A -- a 101 sqm channel, B -- a 56 sqm channel, C -- a 148 sqm terrace. The geomorphic diversity is 0.45, based on the Shannon-Weiner diversity index.

Table 5.1 Brush Springs Microhabitat characteristics.

Code	A	B	C
Name	Ponded source channel	Dry channel	Margin
Area sqm	101	56	148
Surface type	CH	CH	TE
Surface subtype	run	eph	LRZ

Code	A	B	C
Slope variability	Low	Low	Med
Aspect TN	160	160	
Slope degrees	0	12	60
Moisture (scale 1-10)	10	1	1
Water depth cm	40	0	0
Area % open water	90	0	0
Substrate			
1 - Clay %	50	49	50
2 - Silt %	50	49	50
3 - Sand %	0	0	0
4 - Fine gravel %	0	0	0
5 - Coarse gravel %	0	0	0
6 - Cobble %	0	1	0
7 - Boulder %	0	1	0
8 - Bedrock %	0	0	0
Organic %	0	0	0
Other % (anthropogenic)	0	0	0
Precipitate %	0	0	0
Litter %	60	5	3
Wood %	2	2	2
Litter Depth (cm)	1	1	1

Survey Notes: The channel is incised 2 meters. It was inundated in March 2023 from heavy runoff that resulted from snowmelt after an unusually wet winter. Flooding was both from the Verde River as well as runoff down the channel. The pool and runout channels are densely overgrown and choked with dead vegetation and roots. The channel is heavily vegetated with willow.

Flow: Surveyors measured a flow of 0.10 liters/second, using a v-notch weir. Surveyors measured flow at 26 meters on the tape. This spring is perennial.

Water Quality: Surveyors measured water quality using a bucket lowered into the source pool containing standing water. Location 1: at the spring source in standing water at 15:15.

Table 5.2 Brush Springs Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
pH (field)	7.1	1	Hanna Combo
Salinity (field) (ppt)	0.387	1	Hanna Combo
Specific conductance (field) (uS/cm)	776	1	Hanna Combo
Temperature, air C	24.5	1	Handheld therm
Temperature, water C	22.6	1	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Polygons A, B, and C were all recently flood-inundated. Surveyors identified 15 plant species at the site, with 0.0492 species/sqm. These included 12 native and 2 nonnative species; the native status of 1 species remains unknown.

Table 5.3 Brush Springs Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	6	1
Shrub	8	5
Mid-canopy	2	0
Tall canopy	1	1
Basal	0	0
Aquatic	0	0
Non-vascular	0	0

Table 5.4 Brush Springs Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Baccharis salicifolia	SC	N	R		10	8	40
Brickellia californica	SC	N	U		0	7	0.3
Bromus anomalus	GC	N	U	Verified by Glenn Rink	0	15	1
Bromus diandrus	GC	I	F		0	2	10
Celtis laevigata var. reticulata	SC	N	R		0	1	4
Forestiera pubescens	SC	N	R	Verified by Glenn Rink	0	5	0
Fraxinus pennsylvanica	MC	N	F		10	40	0
Fraxinus pennsylvanica	SC	N	F		0	20	0
Juglans major	SC	N	R		0	2	0
Juncus balticus	GC	N	W		0	2	0
Juniperus monosperma	MC	N	U		0	0	4
Juniperus monosperma	SC	N	U		0	0.5	2
Lactuca serriola	GC	I	F		0	0.8	0
Nicotiana trigonophylla	GC	N	F		0	0.1	0
Salix	TC	N	WR		25	20	10
Salix laevigata	SC	N	R	Verified by Glenn Rink	50	46	93
unknown herb	GC				0	0.1	0

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 5 invertebrate taxa, including 3 aquatic and 2 terrestrial invertebrate taxa, and 8 vertebrate taxa.

Table 5.5 Brush Springs Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Annelida	Ad	A	Spot		1	
Coleoptera Dytiscidae	Ad	A	Spot		1	
Coleoptera Staphylinidae	Ad	T	Collected spot		1	
Diptera Chironomidae	L	A	Collected spot		1	
Hymenoptera Pompilidae Pepsis grossa	Ad	T	Spot		1	

Table 5.6 Brush Springs Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Yellow-breasted Chat		Call	
Western Kingbird		Call	
Black-tailed Rattlesnake	1	Obs	
Deer		Sign	Tracks
Javelina		Sign	Tracks
American Beaver		Sign	
American Bullfrog	4	Obs	
Frogs And Toads	1	Call	Native, Possibly Hylidae

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4) and there is low risk (average risk score 2.3). Geomorphology condition is moderate with some restoration potential (average condition score 3.8) and there is low risk (average risk score 2.8). Habitat condition is moderate with some restoration potential (average condition score 3.4) and there is low risk (average risk score 2.6). Biotic integrity is good with significant restoration potential (average condition score 4.5) and there is moderate risk (average risk score 2.9). Human influence of site is good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2.3). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 5.7 Brush Springs Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4	2.3
Geomorphology	3.8	2.8
Habitat	3.4	2.6
Biota	4.5	2.9
Human Influence	4.8	2.3
Overall Ecological Score	4.2	2.6

Management Recommendations: This rheocrene spring is subject to severe surface flooding and, as such, is not easily enhanced by management activities. Bullfrog (and likely crayfish) control is warranted if the site is selected for rehabilitation.

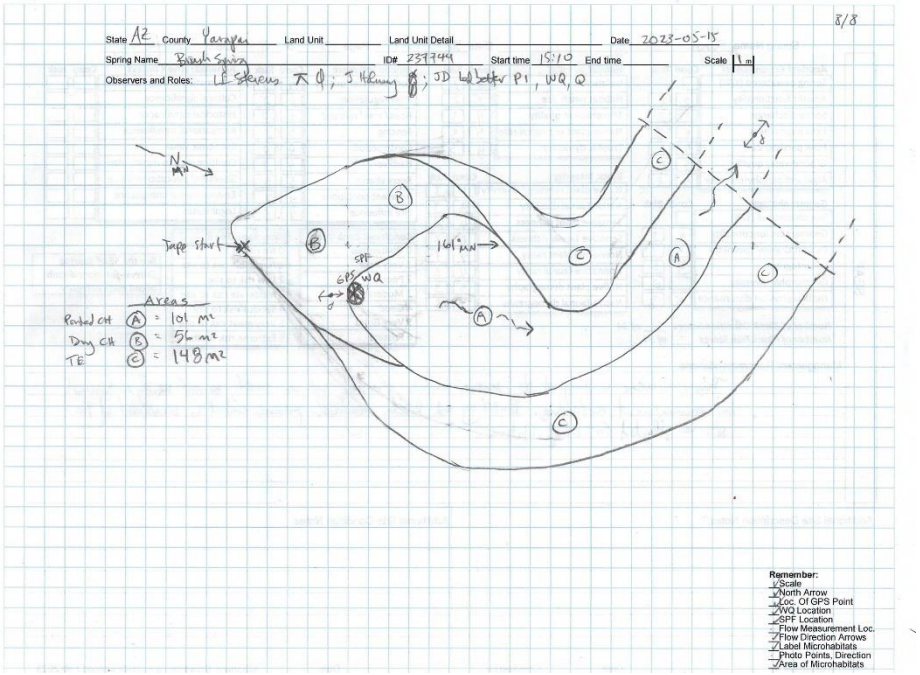

Fig 5.2 Brush Springs Sketchmap: 2023 Sketchmap

Fig 5.3 Brush Springs: View of the runout channel from 40 meters downstream, facing upstream

Fig 5.4 Brush Springs: View of the runout channel from 40 meters, facing downstream.

Fig 5.5 Brush Springs: *Crotalus molossus* (black-tailed rattlesnake)

6. Bubbling Spring
Summary Report, Site ID 255217
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Bubbling Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.90781, -111.72629 measured using a GPS (WGS84). The elevation is approximately 1387 meters.

Physical Description: Bubbling Spring is a hillslope/rheocrene spring. The site has two sources. The first emerges at the recorded location (34.90781, -111.72629) and the second about 1 meter upstream (34.90774, -111.72606), under dense riparian forest. Flow from both sources combines into a springbrook that feeds Fairy Creek, a tributary of Oak Creek.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Turn right where the road forks and drive about 300 meters. Hike south (road right) past Thompson Springhouse for roughly 200 meters. While the access road is private, the site is located on the National Forest between two private communities.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 13:50. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 6.1 Bubbling Spring: Outflow from both sources, viewed from the downstream source, facing downstream

Survey Notes: There is no sign of recent human visitation. Several trails pass by the spring, but do not lead to it. The springbrook is covered by non-native blackberry and watercress, and supports common Physidae aquatic snails.

Fauna: Larry Stevens was the zoologist for this survey. Surveyors collected or observed 5 invertebrate taxa, including 3 aquatic and 1 terrestrial invertebrate taxa, and 1 vertebrate taxon.

Table 6.1 Bubbling Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Amphipoda	Ad	A	Collected spot		3	
Coleoptera	Ad		Collected spot		6	
Hemiptera	Ad	T	Collected spot		1	
Odonata	L	A	Collected spot		2	
Odonata	Ex		Collected spot		1	
Trichoptera	L	A	Collected spot		4	

Table 6.2 Bubbling Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Summer Tanager	1	Obs	

Fig 6.2 Bubbling Spring: The upstream source, viewed from directly below the source, facing upstream

7. Castle-in-the-Canyon Seep
Summary Report, Site ID 255221
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Castle-in-the-Canyon Seep ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by a private US owner. The spring is located in the Munds Park USGS Quad, at 34.90990, -111.72792 measured using a GPS (WGS84, estimated position error 4 meters). The elevation is approximately 1385 meters.

Physical Description: Castle-in-the-Canyon Seep is a rheocrene spring. A small, iron-rich seepage emerges from the wall supporting a house in Indian Gardens into a small pool at the edge of Oak Creek.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Park just across the bridge and walk downstream, between the Indian Gardens neighborhood and the creek left bank of Oak Creek.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 15:20. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 7.1 Castle-in-the-Canyon Seep: The pool, viewed facing east. The orange color is due to orange algae.

Survey Notes: The seep emerges into a pool next to a semi-popular recreation area in Oak Creek 60 meters downslope from an occupied house. There are several nonfunctional pipes emerging from the house's wall and foundation. Non-native English ivy and hemlock and native alder and ash are present at the site as of 5/26/2023.

8. Clarkdale Big Spring
Summary Report, Site ID 175510
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Clarkdale Big Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by a private US owner. The spring is located in the Clarkdale USGS Quad, at 34.76728, -112.04253 measured using a GPS (WGS84, estimated position error 6 meters). The elevation is approximately 1023 meters.

Physical Description: Clarkdale Big Spring is a hillslope/rheocrene spring. This springs complex emerges from a channel that is rather deeply incised into the upper riparian zone terraces of the Verde River. A 2.5 meter culvert underneath the Tuzigoot Road directs runoff into the main source channel. Several hillslope sources emerge along the east-facing bank of the Verde River, combining flow into a meandering, low gradient, floodplain stream that parallels the Verde River, and flows approximately 200 meters downstream before joining that river.

Geomorphology: Clarkdale Big Spring emerges as a seepage or filtration spring from the Verde Formation, a sedimentary, unconsolidated rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 91% of available solar radiation, with 8349 Mj annually.

Access Directions: From Clarkdale, AZ turn right towards Tuzigoot National Monument. South of the Tuzigoot Bridge is a gated dirt parking lot on the left where you can park. Walk through this parking lot and at the end of the lot, the trail begins. Follow the trail for a half mile to an opening on the right with cottonwood trees.

6/03/23 Survey
Larry Stevens, Jeri Ledbetter, and Brooke Laughter surveyed the site on 6/03/23 for 03:50 hours, beginning at 10:40, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 8.1 Clarkdale Big Spring: Source view where the two tapes meet (1/2).

Microhabitats: The microhabitats associated with the spring cover 2032 sqm. The site has 6 microhabitats, including A -- a 28 sqm channel, B -- a 26 sqm , C -- a 140 sqm channel, D -- a 1224 sqm terrace, E -- a 556 sqm terrace, F -- a 58 sqm terrace. The geomorphic diversity is 0.46, based on the Shannon-Weiner diversity index.

Table 8.1 Clarkdale Big Spring Microhabitat characteristics.

Code	A	B	C	D	E	F
Name	Rheocrene channel	Hillslope runout channel	Floodplain channel	Verde River floodplain terrace	Verde River URZ terrace	Rheocrene debris fan terrace
Area sqm	28	26	140	1224	556	58
Surface type	CH		CH	TE	TE	TE

Code	A	B	C	D	E	F
Surface subtype						
Slope variability	Low	Low	Low	Low	Med	Low
Aspect TN	61		101	91	56	101
Slope degrees	4		3	3	30	8
Moisture (scale 1-10)	10		10	7	3	4
Water depth cm	14		12	1	0	0
Area % open water	10		7	.5		
Substrate						
1 - Clay %	0	0	0	0	0	0
2 - Silt %	30	30	30	30	50	0
3 - Sand %	59.5	60	60	50	5	20
4 - Fine gravel %	0	5	0	0	3	20
5 - Coarse gravel %	0	2	0	0	2	40
6 - Cobble %	0	2	0	0	0	20
7 - Boulder %	0	.5	0	0	0	0
8 - Bedrock %	0	0	0	0	0	0
Organic %	10	0	10	20	40	0
Other % (anthropogenic)	.5	.5	0	0	0	0
Precipitate %	0	0	0	0	0	0
Litter %	20	20	20	20	20	20
Wood %	2	2	2	4	3	5
Litter Depth (cm)	.2	2	.5	.5	.5	1

Survey Notes: Car parts and metal debris are present at and above the source. The lower part of the runout was inundated by a flood from March 16, 2023 (71,000 cfs), yet the site is still overgrown with vegetation. There is very little flood debris despite flooding. Litter is not significant but some wooden furniture, a huge lightbulb, and some beer bottles are present. Flood debris reached about 3 meters high, but not enough debris is present to have a definitive measurement.

Flow: Surveyors measured a flow of 6.4 liters/second, using a flume. Flow was adjusted for an estimate of 95% of site flow capture. The first flow was measured between the two cottonwood trees. The second flow was measured at 35.5m on the main tape. This spring is perennial.

Water Quality: Sampling location one was the main eastern source. Sampling location two was Q3 farthest source west. Location 1: at the spring source in flowing water at 11:11. Location 2: at the spring source in flowing water at 11:11.

Table 8.2 Clarkdale Big Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Temperature, air C	25		Handheld therm
Dissolved oxygen (field) (mg/L)	7	1	CHEMets DO kit

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.643	1	Hanna Combo
pH (field)	6.72	1	Hanna Combo
Specific conductance (field) (uS/cm)	1286	1	Hanna Combo
Temperature, water C	19.2	1	Hanna Combo
Dissolved Solids (field) (ppt)	0.62	2	Hanna Combo
pH (field)	6.81	2	Hanna Combo
Specific conductance (field) (uS/cm)	1240	2	Hanna Combo

Flora: Surveyors identified 28 plant species at the site, with 0.0138 species/sqm. These included 19 native and 8 nonnative species; the native status of 1 species remains unknown.

Table 8.3 Clarkdale Big Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	18	11
Shrub	8	5
Mid-canopy	5	5
Tall canopy	4	4
Basal	0	0
Aquatic	0	0
Non-vascular	1	1

Table 8.4 Clarkdale Big Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D	E	F
Acer negundo	MC	N	R		0	0	5	10	5	0
Acer negundo	SC	N	R		0	0	6	10	5	0
Acer negundo	TC	N	R		0	10	4	5	7	0
Adiantum capillus-veneris	GC	N	W		0.1	0	0	0	0	0
Agrostis stolonifera	GC	I	W		1	0	1	1.5	0	0
Ailanthus altissima	SC	I	WR		0	0	1	1	1	0
Baccharis salicifolia	GC	N	R		0	0	1	1	0	0
Bromus diandrus	GC	I	F		0	0	1	2	0	0
Bromus rubens	GC	I	U		0	0	1	3	0	0
Celtis laevigata var. reticulata	MC	N	R		30	50	5	1	40	0
Celtis laevigata var. reticulata	SC	N	R		20	20	10	1	15	0
Celtis laevigata var. reticulata	TC	N	R		20	20	0	0	15	0

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D	E	F
Datura wrightii	GC	N	F		0	0	0	0.2	0	0
Equisetum arvense	GC	N	WR		3	7	1	2	0	15
Fraxinus pennsylvanica var. velutina	MC	N	WR		20	20	2	2	30	35
Fraxinus pennsylvanica var. velutina	SC	N	WR		15	15	3	3	20	10
Fraxinus pennsylvanica var. velutina	TC	N	WR		5	5	3	3	10	0
Lactuca serriola	GC	I	F		0	0	0	0.1	0	0
Lemna	GC	N	A		0	0	2	0	0	0
Lonicera	SC	N	U		1	2	3	2	2	2
Mentha arvensis	GC	N	WR		1	2	10	25	0	0
Mimulus guttatus	GC	N	WR		0	0	0	0.3	0	0
Nasturtium officinale	GC	I	W		5	1	8	3	0	0
Parthenocissus vitacea	SC	N	F		5	5	2	3	8	20
Polygonum	GC	N		red stem	0	0	0	0.1	0	0
Polypogon monspeliensis	GC	I	WR		0	0	0	0.3	0	0
Populus fremontii	MC	N	R		10	10	0	0	0	0
Populus fremontii	TC	N	R		0	0	25	20	0	0
Ribes	SC	N	F	spineless	0	0	1	1	5	0
Salix gooddingii	MC	N	R		0	0	3	1	0	0
Salix gooddingii	SC	N	R		0	0	1	0.5	0	0
Typha domingensis	GC	N	A		1	1	25	60	0	0
unknown	GC			round leaf	0	0	0.1	0.1	0	0
unknown moss	NV	N?	WR		0	0	0	0	1	0
Urtica dioica	GC	NI	WR		2	4	3	7	0	0
Vinca	GC	I	F		0	0	0	0.1	0	0

Fauna: Surveyors collected or observed 17 invertebrate taxa, including 4 aquatic and 13 terrestrial invertebrate taxa, and 14 vertebrate taxa.

Table 8.5 Clarkdale Big Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Architaenioglossa Ampullariidae	Ad	A	Spot		2	
Coleoptera Chrysomelidae Helocassis clavata	Ad	T	Collected spot		3	
Coleoptera Coccinellidae	Ad	T	Spot		1	
Coleoptera Meloidae	Ad	A	Spot		1	
Diptera Dolichopodidae Condylostylus	Ad	T	Spot		1	
Hemiptera Veliidae Rhagovelia distincta	Ad	T	Spot		10	
Hymenoptera Apidae Xylocopa	Ad	T	Spot		1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera Lycaenidae Hemiargus isola	Ad	T	Spot		10	
Lepidoptera Nymphalidae Polygonia	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio multicaudata	Ad	T	Spot		1	
Lepidoptera Pieridae Colias eurytheme	Ad	T	Spot		1	
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		1	
Odonata Calopterygidae Hetaerina vulnerata	Ad	T	Spot		1	
Odonata Coenagrionidae Argia	L	A	Spot		1	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		1	male
Odonata Libellulidae Plathemis subornata	Ad	T	Spot		1	
Turbellaria			Spot		1	

Table 8.6 Clarkdale Big Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Gila Woodpecker	1	Call	
Yellow-breasted Chat	1	Call	
Hooded Oriole	1	Call	
Yellow Warbler	1	Call	
Brown-crested Flycatcher	1	Call	
Domestic Cattle	1	Sign	Old Scat
Javelina	1	Sign	Tracks
Summer Tanager	3	Call	
Bewick's Wren	1	Call	
Song Sparrow	1	Call	
House Finch	1	Call	
Aspidoscelis Whiptail Lizard	2	Obs	
Towhee	2	Call	?
Northern Cardinal	1	Call	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.3) and there is low risk (average risk score 2.7). Geomorphology condition is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2.4). Habitat condition is good with significant restoration potential (average condition score 4) and there is low risk (average risk score 2.6). Biotic integrity is good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2.8). Human influence of site is very good with

excellent restoration potential (average condition score 5.1) and there is low risk (average risk score 2.4). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 8.7 Clarkdale Big Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.3	2.7
Geomorphology	4.4	2.4
Habitat	4	2.6
Biota	4.8	2.8
Human Influence	5.1	2.4
Overall Ecological Score	4.6	2.6

Management Recommendations: Occasional monitoring is all that is needed because nearly all of the site lies within the Verde River floodplain and is subject to occasionally scouring flows.

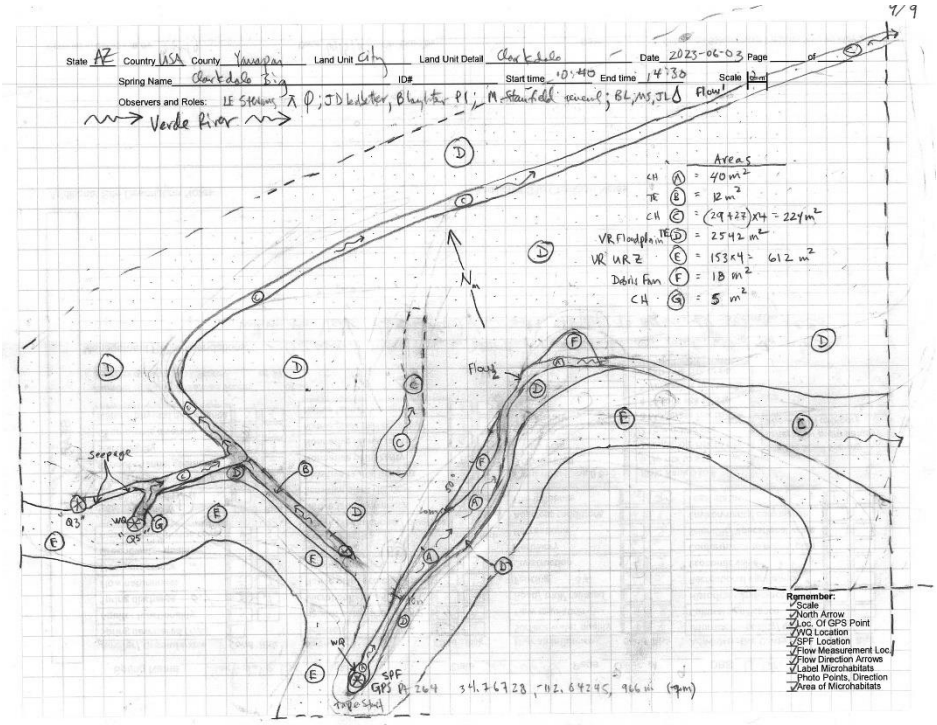

Fig 8.2 Clarkdale Big Spring Sketchmap.

Fig 8.3 Clarkdale Big Spring: Source view where the two tapes meet (2/2).

Fig 8.4 Clarkdale Big Spring: Flume placement at second location.

9. Private Spring
(Data not available to the public)

10. Cranefly Helocrene

Summary Report, Site ID 255218

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Cranefly Helocrene ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.90839, -111.72675 measured using a GPS (WGS84, estimated position error 4 meters). The elevation is approximately 1381 meters.

Physical Description: Cranefly Helocrene is a helocrene/rheocrene spring. Flow emerges from a 40 by 10 meter helocrene floodplain. The outflow feeds Fairy Creek, a tributary of Oak Creek. Surveyors noted this site as being a Carex dominated wetland.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Turn right where the road forks and drive 300 meters. Hike southwest (road right) past Thompson springhouse for roughly 100 meters. While the access road is private, the site is located on the National Forest between two private communities.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 14:20. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 10.1 Cranefly Helocrene: The wet meadow, viewed from the western edge facing south

Survey Notes: At the time of this survey, the site was unaffected by disturbance or humans. Surveyors determined a weir to be the most suitable method of flow measurement for future visits.

Fauna: Surveyors collected or observed 2 invertebrate taxa, including 2 terrestrial invertebrate taxa.

Table 10.1 Cranefly Helocrene Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Hemiptera Coreidae Acanthocephala thomasi	Ad	T	Collected spot		1	
Hemiptera Pentatomidae	Ad	T	Collected spot		1	

Fig 10.2 Cranefly Helocrene: The outflow channel, viewed from the wet meadow facing west

11. Cress Lower Spring
Summary Report, Site ID 255214
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Cress Lower Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Prescott NF, Chino Valley RD, in the Clarkdale USGS Quad, at 34.85156, -112.06636 measured using a GPS (WGS84, estimated position error 4 meters). The elevation is approximately 985 meters.

Physical Description: Cress Lower Spring is a hillslope/rheocrene spring. Flow emerges from a discrete source in the floodplain of the Verde River below the railroad tracks, on the south bank. The source is rolling sand. The outflow channels meander and gain with additional sources before joining the Verde River.

Geomorphology: Cress Lower Spring emerges as a seepage or filtration spring from an igneous, basalt rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 98% of available solar radiation, with 9111 Mj annually.

Access Directions: From Cottonwood, AZ follow the road toward Tuzigoot National Monument and continue 0.4 miles to Sycamore Canyon Road. Turn left on Sycamore Canyon Road and continue to the trailhead, approximately 9.4 miles. Take a side road on the left to an overlook before reaching Parsons Trail. Hike down a steep, rocky trail and cross the Verde River. Once across, continue upstream for approximately 200 meters to a stand of large cottonwoods.

5/13/23 Survey
Larry Stevens, Jeri Ledbetter, Lauren Vanier, and Joseph Holway surveyed the site on 5/13/23 for 02:15 hours, beginning at 9:30, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 11.1 Cress Lower Spring: The source as viewed from 1 meter upslope. The photographer is facing downstream of the runout channel.

Microhabitats: The microhabitats associated with the spring cover 231 sqm. The site has 2 microhabitats, including A -- a 20 sqm channel, B -- a 211 sqm terrace. The geomorphic diversity is 0.13, based on the Shannon-Weiner diversity index.

Table 11.1 Cress Lower Spring Microhabitat characteristics.

Code	A	B
Name	Source channel	Margin
Area sqm	20	211
Surface type	CH	TE
Surface subtype	run	MRZ
Slope variability	Low	Low

Code	A	B
Aspect TN	288	333
Slope degrees	3	
Moisture (scale 1-10)	9	4
Water depth cm	15	0
Area % open water	20	0
Substrate		
1 - Clay %	0	20
2 - Silt %	30	35
3 - Sand %	68	43
4 - Fine gravel %	1	1
5 - Coarse gravel %	1	1
6 - Cobble %	0	0
7 - Boulder %	0	0
8 - Bedrock %	0	0
Organic %	0	0
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	20	95
Wood %	5	5
Litter Depth (cm)	1	2

Survey Notes: The source and microhabitats were flooded to a depth of at least 3 meters, leaving woody debris collected in the surrounding trees. The geomorphology was altered, with hairpin meanders in the runout channel.

Flow: Surveyors measured a flow of 0.94 liters/second, using a timed flow volume capture method. Surveyors measured flow at 3.5 meters on the tape. This spring is perennial.

Water Quality: Surveyors measured water quality in flowing water at the source. Location 1: at the spring source in flowing water at 10:10.

Table 11.2 Cress Lower Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.275	1	Hanna Combo
pH (field)	7.04	1	Hanna Combo
Specific conductance (field) (uS/cm)	550	1	Hanna Combo
Temperature, water C	19.7	1	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 24 plant species at the site, with 0.1039 species/sqm. These included 20 native and 2 nonnative species; the native status of 2 species remains unknown.

Table 11.3 Cress Lower Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	13	9
Shrub	10	6
Mid-canopy	4	3
Tall canopy	4	3
Basal	2	2
Aquatic	0	0
Non-vascular	1	1

Table 11.4 Cress Lower Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
algae	NV	N?	A		1	0
Alnus oblongifolia	MC	N	R		0	2
Alnus oblongifolia	SC	N	R		2	2
Anemopsis californica	GC	N	W		0.1	3
Celtis laevigata var. reticulata	SC	N	R		0	0.3
Epipactis gigantea	GC	N	W		0	0.3
Equisetum arvense	GC	N	WR		0.1	0.5
Equisetum laevigatum	GC	N	WR		0	0.1
Fraxinus pennsylvanica	MC	N	F		30	50
Fraxinus pennsylvanica	SC	N	F		10	40
Fraxinus pennsylvanica	TC	N	F		15	20
Helianthus	GC	N	F		0	0.01
Juglans major	SC	N	R		0	1
Juncus	GC	N	W	tall	1.5	2
Mentha arvensis	GC	N	WR		0	0.1
Mimulus guttatus	GC	N	WR		0.3	0.1
Nasturtium officinale	GC	I	W		0.2	0.1
Parthenocissus vitacea	SC	N	F		0	7
Platanus wrightii	MC	N	R		3	5
Platanus wrightii	SC	N	R		1	2
Platanus wrightii	TC	N	R		20	25
Polygonum	GC	N			1	2
Polypogon monspeliensis	GC	I	WR		0	0.01
Populus fremontii	BC	N	R		0	1
Populus fremontii	SC	N	R		0	0.1
Populus fremontii	TC	N	R		10	20
Robinia neomexicana	SC	N	U		0	0.1

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Salix gooddingii	BC	N	R		0	0.8
Salix gooddingii	MC	N	R		10	7
Salix gooddingii	SC	N	R		2	3
Salix gooddingii	TC	N	R		10	8
Toxicodendron rydbergii	SC	N	F		0	0.2
unknown grass	GC				0.1	1
unknown herb	GC				0	0.2

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 14 invertebrate taxa, including 10 aquatic and 3 terrestrial invertebrate taxa, and 6 vertebrate taxa. Surveyors conducted quantitative benthic sampling at this spring.

Table 11.5 Cress Lower Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Amphipoda	Ad	A	Preserved benthic	2	2	
Amphipoda	Ad	A	Preserved benthic	1	2	
Coleoptera	Ad		Collected spot		3	
Coleoptera Dytiscidae Agabus	Ad	A	Preserved benthic	1	1	
Diptera	L	A	Preserved benthic	2	1	
Diptera Chironomidae	L	A	Uncollected benthic	2	100	
Diptera Chironomidae	L	A	Uncollected benthic	1	50	
Diptera Chironomidae	L	A	Preserved benthic	1	1	Blood worm
Diptera Chloropidae	Ad	T	Spot		1	many
Ephemeroptera	L	A	Preserved benthic	2	3	
Ephemeroptera	L	A	Preserved benthic	1	2	
Hemiptera Gerridae Aquarius remigis	Ad	A	Spot		1	
Lepidoptera	Ad	T	Collected spot		1	
Odonata Coenagrionidae Argia	L	A	Uncollected benthic	1	3	
Opisthopora	Ad	T	Uncollected benthic	1	1	Earthworm
Trichoptera	L	A	Preserved benthic	1	1	no casing

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Turbellaria	Ad	A	Preserved benthic	1	1	

Table 11.6 Cress Lower Spring Benthic Invertebrate Sampling.

Rep#	Velocity (m/sec)	Depth (cm)	Area (sq m)	Time (sec)	Location	Substrate	Comments
1	0.20	0	0.09	60	3.5 m	20% 3; 30% 2; 50% org	
2	0.50	3	0.09	60	16.5 m	50% 3; 40% 2; 10% org	Lots of roots

Table 11.7 Cress Lower Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Phainopepla	1	Obs	
Yellow Warbler		Call	
Yellow-breasted Chat		Call	
Brown-crested Flycatcher		Call	
Summer Tanager		Call	
Cooper's Hawk		Obs	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.3) and there is negligible risk (average risk score 1.8). Geomorphology condition is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2). Habitat condition is good with significant restoration potential (average condition score 4.8) and there is negligible risk (average risk score 1.8). Biotic integrity is very good with excellent restoration potential (average condition score 5.5) and there is negligible risk (average risk score 1.6). Human influence of site is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.3). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 11.8 Cress Lower Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.3	1.8
Geomorphology	4.4	2
Habitat	4.8	1.8
Biota	5.5	1.6
Human Influence	5.4	1.3
Overall Ecological Score	4.9	1.7

Management Recommendations: There are no management recommendations except for occasional monitoring.

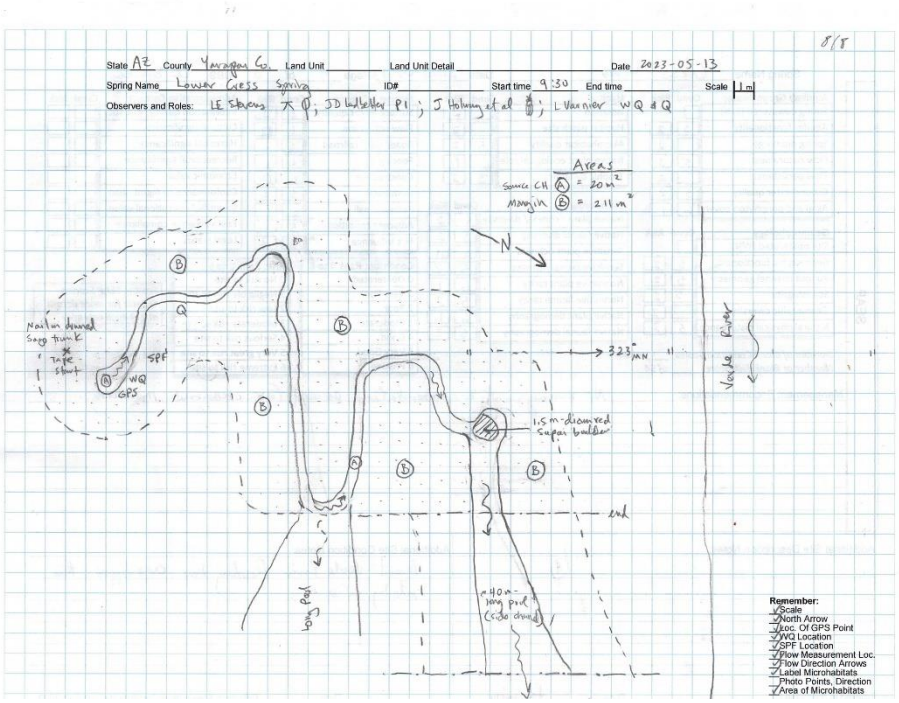

Fig 11.2 Cress Lower Spring Sketchmap: 2023 Sketchmap

Fig 11.3 Cress Lower Spring: Flow measurement at 4 meters below the source.

12. Cress Middle Spring
Summary Report, Site ID 255212
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Cress Middle Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Prescott NF, Chino Valley RD, in the Clarkdale USGS Quad, at 34.85144, -112.06660 measured using a GPS (WGS84). The elevation is approximately 1062 meters.

Physical Description: Cress Middle Spring is a hillslope/rheocrene spring. Flow emerges from a hillslope rheocrene source in a channel on river right of the Verde River and below a train track approximately 200 meters upslope. Flow from the spring creates a one to two meter-wide channel that flows opposite of the river for approximately 17 meters before curving toward and draining into the Verde River.

Access Directions: From Cottonwood, AZ take the turn for Tuzigoot National Monument and continue for 0.4 miles to Sycamore Canyon Road. Turn left on Sycamore Canyon Road for approximately 9.4 miles and take a side road on the left to an overlook before reaching Parsons Trail. Hike down a steep, rocky trail and cross the Verde River. Once across, continue upstream for approximately 200 meters to a stand of large cottonwoods.

5/13/23 Survey
Lauren Vanier verified the site on 5/13/23 at 11:15. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 12.1 Cress Middle Spring: The outflow channel just below the pinched source pool. The photographer is facing downstream of the spring channel and upstream of the Verde River.

Survey Notes: Outflow forms an upper pool that is pinched by vegetation and organic litter before opening up into a one to two meter-wide channel. There is flood debris from snowmelt runoff after an unusually wet winter approximately 3 meters above the spring emergence. The entire canyon bottom in this area is covered in about 1 cm of cottonwood and willow seed. Vegetation includes yerba mansa, horsetail Equisetum, poison ivy Toxicodendron, tall canopy Goodding's willow, abundant shrub cover, and a mid-canopy sycamore sapling. There is a small, round-leaved semi-aquatic plant growing in and around the spring emergence. The most suitable method for measuring flow is a volumetric method or a flume.

Water Quality: The surveyor measured water quality in the source pool in flowing water. Location 1: at the spring source in flowing water at 11:11.

Table 12.1 Cress Middle Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.273	1	Hanna Combo
pH (field)	7.12	1	Hanna Combo
Specific conductance (field) (uS/cm)	545	1	Hanna Combo
Temperature, water C	19.7	1	Hanna Combo

Assessment: Assessment scores were compiled in 5 categories and 0 subcategories, with 42 null condition scores, and 42 null risk scores. Aquifer functionality and water quality are very good with excellent restoration potential (average condition score 5) and there is low risk (average risk score 2). Geomorphology condition is very good with excellent restoration potential (average condition score 5) and there is low risk (average risk score 2). Habitat condition is very good with excellent restoration potential (average condition score 5) and there is low risk (average risk score 2). Biotic integrity is very good with excellent restoration potential (average condition score 5) and there is low risk (average risk score 2). Human influence of site is very good with excellent restoration potential (average condition score 5) and there is moderate risk (average risk score 3). Overall, the site condition is good with significant restoration potential and there is negligible risk.

Table 12.2 Cress Middle Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	5	2
Geomorphology	5	2
Habitat	5	2
Biota	5	2
Human Influence	5	3
Overall Ecological Score	4.2	1.8

13. Cress Spring
Summary Report, Site ID 18827
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Cress Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Prescott NF, Chino Valley RD, in the Clarkdale USGS Quad, at 34.85083, -112.06735 measured using a GPS (WGS84). The elevation is approximately 1172 meters.

Physical Description: Cress Spring is a hillslope spring. Flow emerges from two sources on a sand bar slope on the banks of the Verde River. This spring provides baseflow for the river. It is within a large fenced area, approximately 100 x 14.5 meters on the southern side of the river. The two sources converge shortly after their emergence and flow into the river. Previous site description is as follows: Imported from AZDWR. Unused water use. Data source USGS. Hillside topographic setting. Site Geology 310SUPI. Fracture spring type. Undetermined spring manipulation. Perennial flow consistency. The site is accessible from Sycamore Canyon Wilderness Rd, although on the south side of the Verde River, near the train track.

Geomorphology: Cress Spring emerges as a seepage or filtration spring from an igneous, basalt rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 89% of available solar radiation, with 8251 Mj annually.

Access Directions: From Cottonwood, AZ take the turn for Tuzigoot National Monument and continue for 0.4 miles to Sycamore Canyon Road. Turn left on Sycamore Canyon Road for approximately 9.4 miles and take a side road on the left to an overlook before reaching Parsons Trail. Hike down a steep, rocky trail and cross the Verde River. Once across, continue upstream for approximately 200 meters to a stand of large cottonwoods.

5/13/23 Survey
Larry Stevens, Jeri Ledbetter, Joseph Holway, and Lauren Vanier surveyed the site on 5/13/23 for 01:00 hours, beginning at 12:00, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 13.1 Cress Spring: The site as viewed from the fenceline at 14.5 meters on the tape, looking upslope.

Microhabitats: The microhabitats associated with the spring cover 115 sqm. The site has 2 microhabitats, including A -- a 11 sqm channel, B -- a 104 sqm terrace. The geomorphic diversity is 0.14, based on the Shannon-Weiner diversity index.

Table 13.1 Cress Spring Microhabitat characteristics.

Code	**A**	**B**
Name	Channel	Terraces
Area sqm	11	104
Surface type	CH	TE
Surface subtype	riffle	LRZ
Slope variability	Low	Low
Aspect TN	323	323
Slope degrees	8	8
Moisture (scale 1-10)	9	4
Water depth cm	15	0
Area % open water	70	0
Substrate		
1 - Clay %	0	0
2 - Silt %	0	25
3 - Sand %	50	60
4 - Fine gravel %	10	0
5 - Coarse gravel %	10	0
6 - Cobble %	30	13
7 - Boulder %	0	2
8 - Bedrock %	0	0

Code	A	B
Organic %	0	0
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	5	30
Wood %	0.1	10
Litter Depth (cm)	0.1	0.2

Survey Notes: The site is heavily disturbed by cattle, though there is no recent sign of cattle use. The channels are incised slightly due to a legacy of trampling. This site was recently inundated up to 4 meters by flooding from an exceptionally wet winter. The fence surrounding the site is intact and in good condition considering that it held through the force of flooding. The spring sources have tall- and mid-canopy cover, while the rest of the fenced area is mostly open and vegetated by Yerba Mansa and an array of grasses. The two sources converge and form a 0.5 to 1 meter-wide channel that cuts through a sand bar to reach the river. Surveyors were not able to search for invertebrates, as thunderstorms were moving over the immediate area and up-river of the site.

Flow: Surveyors measured a flow of 3.3 liters/second, using a timed flow volume capture method. Surveyors measured flow from both sources; they measured flow for the southern source at 9 meters on the tape, and the northern source at 10 meters on the tape. This spring is perennial.

Water Quality: Surveyors measured water quality at the southern source. They took an additional measurement from the Verde River, 2 meters upstream from the confluence with spring outflow. Location 1: at the spring source in flowing water at 12:12. Location 2: at another location in flowing water at 12:12.

Table 13.2 Cress Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.275	1	Hanna Combo
pH (field)	7.07	1	Hanna Combo
Specific conductance (field) (uS/cm)	549	1	Hanna Combo
Temperature, air C	28	1	Handheld therm
Temperature, water C	19.8	1	Hanna Combo
Dissolved Solids (field) (ppt)	0.264	2	Hanna Combo
pH (field)	7.78	2	Hanna Combo
Specific conductance (field) (uS/cm)	527	2	Hanna Combo
Temperature, water C	19.8	2	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 21 plant species at the site, with 0.1826 species/sqm. These included 15 native and 6 nonnative species.

Table 13.3 Cress Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	14	9
Shrub	7	6
Mid-canopy	3	3
Tall canopy	2	2
Basal	1	1
Aquatic	0	0
Non-vascular	0	0

Table 13.4 Cress Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Acer negundo	MC	N	R		15	20
Acer negundo	SC	N	R		20	15
Alnus oblongifolia	BC	N	R		0	0.3
Alnus oblongifolia	MC	N	R		1	10
Alnus oblongifolia	SC	N	R		5	7
Anemopsis californica	GC	N	W		0	3
Baccharis salicifolia	SC	N	R		0.1	0.5
Bromus diandrus	GC	I	F		0	2
Carex praegracilis	GC	N	W	Golden, verified by Glenn Rink	0	0.2
Cynodon dactylon	GC	I	F		0.3	7
Equisetum arvense	GC	N	WR		0	0.1
Equisetum laevigatum	GC	N	WR		0	0.1
Festuca sororia	GC	N	U	Verified by Glenn Rink	0	2
Fraxinus velutina	SC	N	R		0	5
Fraxinus velutina	TC	N	R		20	20
Helianthus annuus	GC	N	F		0	0.1
Juncus articulatus	GC	N	W		0	0.1
Juncus saximontanus	GC	N	W	Verified by Glenn Rink	0	0.1
Lactuca serriola	GC	I	F		0	0.1
Melilotus	GC	I	WR		0	0.01
Nasturtium officinale	GC	I	W		0.1	0.1
Parthenocissus vitacea	SC	N	F		0	0.1

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Plantago major	GC	I	WR		0	0.2
Salix gooddingii	MC	N	R		15	15
Salix gooddingii	SC	N	R		4	5
Salix gooddingii	TC	N	R		7	20
Vitis arizonica	SC	N	R		0	0.1

Fauna: Lauren Vanier recorded faunal observations for this survey. Surveyors collected or observed 7 invertebrate taxa, including 4 aquatic and 1 terrestrial invertebrate taxa, and 1 vertebrate taxon.

Table 13.5 Cress Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Acari	Ad	A	Collected spot		1	
Amphipoda	Ad	A	Collected spot		5	
Coleoptera	Ad		Collected spot		2	
Coleoptera	L		Collected spot		2	
Coleoptera Dytiscidae	Ad	A	Collected spot		1	
Diptera	L		Collected spot		1	
Ephemeroptera	L	A	Collected spot		2	
Homoptera	Ad	T	Collected spot		1	

Table 13.6 Cress Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Domestic Cattle		Sign	Bones, Old Scat, Legacy Trampling Effects

Assessment: Assessment scores were compiled in 6 categories and 31 subcategories, with 11 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.2) and there is low risk (average risk score 2.2). Geomorphology condition is moderate with some restoration potential (average condition score 3.2) and there is moderate risk (average risk score 3). Habitat condition is moderate with some restoration potential (average condition score 3.3) and there is low risk (average risk score 2.6). Biotic integrity is good with significant restoration potential (average condition score 4.1) and

there is low risk (average risk score 2.8). Human influence of site is very good with excellent restoration potential (average condition score 4.9) and there is low risk (average risk score 2.2). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 13.7 Cress Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.2	2.2
Geomorphology	3.2	3
Habitat	3.3	2.6
Biota	4.1	2.8
Human Influence	4.9	2.2
Overall Ecological Score	4.1	2.5

Management Recommendations: This site is heavily used by livestock. If selected for rehabilitation, fencing the source, restricting livestock access, and occasional monitoring would be warranted.

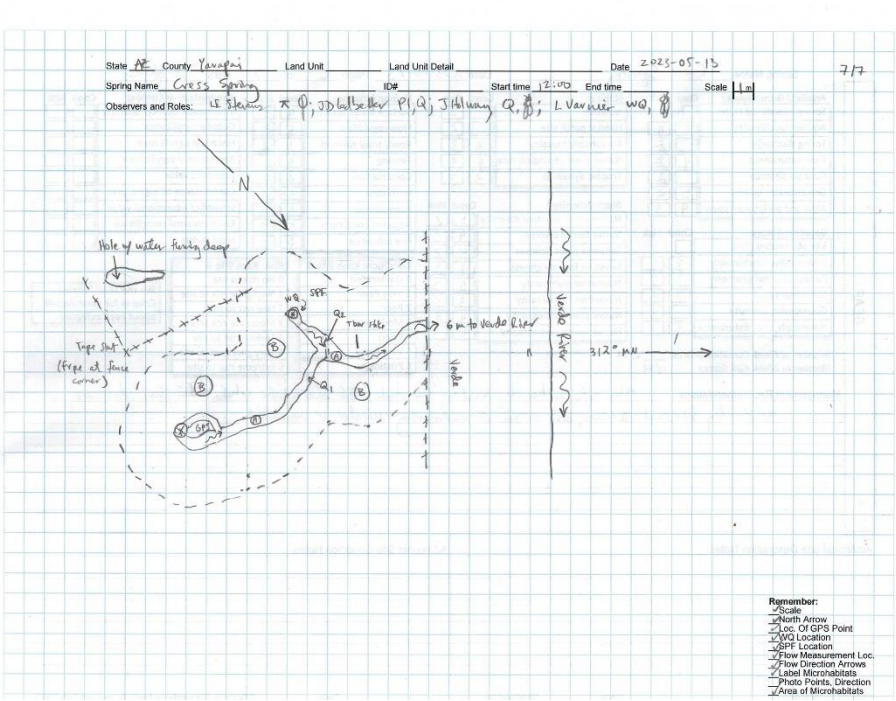

Fig 13.2 Cress Spring Sketchmap: 2023 Sketchmap.

Fig 13.3 Cress Spring: The northern source as viewed from the confluence of the outflow channels.

Fig 13.4 Cress Spring: The southern source as viewed from the confluence of the outflow channels. A surveyor searches for invertebrates.

Fig 13.5 Cress Spring: The site as viewed from the outflow channel of the northern source, facing downstream. The Verde River is in the background.

14. Crossing Spring
Summary Report, Site ID 237742
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Crossing Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the State. The spring is located in the State Trust AZ, in the Chino Valley North USGS Quad, at 34.86546, -112.42632 measured using a GPS (WGS84, estimated position error 4 meters). The elevation is approximately 1291 meters.

Physical Description: Crossing Spring is a rheocrene spring. A minor flow emerges close to the baseflow stage of the Verde River right (looking downstream). The seepage emerges from coarse sand. This site was previously called "Poison Ivy Spring"

Access Directions: From North of Paulden, AZ turn east off Hwy 89 onto Old Hwy 89. Turn east on E. Sweet Valley Rd. Follow this dirt road as it turns southwest, then south as it leads near the top of the canyon rim just above the spring. A relatively easy trail leads down into the canyon. Hike half a kilometer downstream from the confluence of the Verde River and Granite Creek. The spring is on creek right at the crossing.

5/15/23 Survey

Larry Stevens, Jeri Ledbetter, and Joseph Holway verified the site on 5/15/23 at 13:45. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 14.1 Crossing Spring: The spring as viewed from 3 meters upslope of the source, facing downstream.

Survey Notes: The Verde River sustained high flow in March-April 2023 at this location with a stage of 3.5 meters above the baseflow elevation. At time of survey, the shorelines were densely covered with cocklebur (Xanthium), dock (Rumex), sweet clover (Melilotus), grass (Poa), knotweed (Polygonum), Virginia creeper (Parthenocissus), and common reed (Phragmites), but no poison ivy (Toxicodendron). Surveyors observed much sign of horse tracks along this recreational path that runs through the riparian corridor. The most suitable method for measuring flow is a volumetric method, perhaps with a large garbage bag.

Fauna: Larry Stevens served as the wildlife biologist for this survey. Surveyors collected or observed 4 vertebrate taxa.

Table 14.1 Crossing Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Yellow Warbler			
Great Blue Heron			
Common Raven			
Yellow-breasted Chat			

Assessment: Assessment scores were compiled in 6 categories and 30 subcategories, with 12 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.2) and there is negligible risk (average risk score 1.7). Geomorphology condition is very good with excellent restoration potential (average condition score 5.8) and there is negligible risk (average risk score 0.8). Habitat condition is good with significant restoration potential (average condition score 4.3) and there is negligible risk (average risk score 1.6). Biotic integrity is good with significant restoration potential (average condition score 4.1) and there is low risk (average risk score 2.3). Human influence of site is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.8). Overall, the site condition is good with significant restoration potential and there is negligible risk.

Table 14.2 Crossing Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.2	1.7
Geomorphology	5.8	0.8
Habitat	4.3	1.6
Biota	4.1	2.3
Human Influence	5.4	1.8
Overall Ecological Score	4.8	1.7

Management Recommendations: No management recommended for this rheocrene.

15. Dragonfly Medicine Springs
Summary Report, Site ID 19233
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Dragonfly Medicine Springs ecosystem is located in Gila County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Tonto NF, Payson RD, in the Strawberry USGS Quad, at 34.42436, -111.57309 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1330 meters.

Physical Description: Dragonfly Medicine Springs is a rheocrene spring. Flow emerges from the bank of an island in Fossil Creek and merges with the stream flow. The site and associated microhabitats are heavily influenced by surface runoff. The site name was provided to an SSI survey crew by an Apache Tribal member in 2013. The site was within the perimeter of the Backbone Fire in June 2021, but the immediate area around the spring source was a low-intensity burn. The source and runout channel are dominated by a diverse stand of mature deciduous trees. The primary source is the upwelling, but is not at a height to describe it as a fountain. A much smaller secondary source is adjacent to the primary source. Both are in a side channel that flows directly into the creek channel. Trails and signs lead visitors directly to the source. This is one of the many sources emerging from the stream channel in the heavily forested area. The spring is at the base of a huge sycamore tree.

Geomorphology: Dragonfly Medicine Springs emerges as a seepage or filtration spring from a sedimentary, limestone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 98% of available solar radiation, with 9345 Mj annually.

Access Directions: From Strawberry, AZ drive about five miles west on Fossil Creek Rd to the Bob Bear Trailhead. Hike about 4 miles on a well-marked trail, changing about 1500' in elevation, until you reach the creek bed. Follow Fossil Creek downstream about 500 meters. The spring is on creek right just downstream from a section of flat Supai bedrock.

5/02/23 Survey
Larry Stevens and Jeri Ledbetter surveyed the site on 5/02/23 for 03:15 hours, beginning at 12:45, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 15.1 Dragonfly Medicine Springs: The upwelling source as viewed from 2 meters downstream and across the channel.

Microhabitats: The microhabitats associated with the spring cover 400.5 sqm. The site has 4 microhabitats, including A -- a 2 sqm channel, B -- a 52 sqm channel, C -- a 159 sqm terrace, D -- a 188 sqm terrace. The geomorphic diversity is 0.44, based on the Shannon-Weiner diversity index.

Table 15.1 Dragonfly Medicine Springs Microhabitat characteristics.

Code	A	B	C	D
Name	Upwelling Source	Channel	LRZ Terrace	MRZ Terrace
Area sqm	1.5	52	159	188
Surface type	CH	CH	TE	TE
Surface subtype	run	run	LRZ	MRZ

Code	A	B	C	D
Slope variability	Low	Low	Med	Med
Aspect TN	82	132		
Slope degrees	1	1	30	20
Moisture (scale 1-10)	10	10	2	2
Water depth cm	52	90	0	0
Area % open water	98	98	0	0
Substrate				
1 - Clay %	0	0	0	0
2 - Silt %	0	0	35	15
3 - Sand %	0	5	40	15
4 - Fine gravel %	20	5	3	5
5 - Coarse gravel %	40	10	10	5
6 - Cobble %	40	75	10	55
7 - Boulder %	0	5	2	5
8 - Bedrock %	0	0	0	0
Organic %	0	0	0	0
Other % (anthropogenic)	0	0	0	0
Precipitate %	0	0	0	0
Litter %	0	3	30	30
Wood %	0	3	4	4
Litter Depth (cm)	0	0.5	2	2

Survey Notes: Spring runoff from an unusually wet winter and heavy snowpack produced flow approximately 3.5 meters over the source, inundating all of the microhabitats. Flooding had diminished by the time of the survey, although surface runoff in the channel was higher than normal. Areas on the terraces were burned at low intensity in the Backbone Fire in June 2021. Surveyors on May 2, 2023 reported limited mortality of mature trees in the immediate area. Himalayan blackberry has been cut out and piled above the spring area, perhaps in the summer of 2022. The USFS has limited visitation to day use only, requiring a permit to park at the trailhead and to hike. This seems to have reduced human impacts to the spring and surrounding area, with surveyors noticing much less trash and discarded items compared to the last survey. The sycamore tree at the source survived the recent fire, while the large ash tree was severely affected. A significant amount of non-native blackberry appears to have been cut away, although it was growing back at the time of survey.

Flow: Surveyors measured a flow of 147 liters/second, using a non-traditional method. Surveyors used a tagline method to measure flow at this spring. This spring is perennial.

Water Quality: Surveyors measured water quality at both sources in flowing water; they measured specific conductance, pH, water temperature, and total dissolved solids at the primary upwelling, while dissolved oxygen was measured at the secondary source. Location 1: at the spring source in flowing water at 13:13. Location 2: at the spring source in flowing water at 13:13.

Table 15.2 Dragonfly Medicine Springs Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.386	1	Hanna Combo
pH (field)	6.82	1	Hanna Combo
Specific conductance (field) (uS/cm)	763	1	Hanna Combo
Temperature, air C	25	1	Handheld therm
Temperature, water C	21.5	1	Hanna Combo
Dissolved oxygen (field) (mg/L)	5	2	CHEMets DO kit

Flora: Larry Stevens recorded floral observations for this survey. Surveyors identified 23 plant species at the site, with 0.0547 species/sqm. These included 18 native and 5 nonnative species.

Table 15.3 Dragonfly Medicine Springs Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	13	9
Shrub	8	6
Mid-canopy	5	4
Tall canopy	4	3
Basal	5	4
Aquatic	0	0
Non-vascular	1	1

Table 15.4 Dragonfly Medicine Springs Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
Acer negundo	BC	N	R		0	0	0	0.1
Acer negundo	MC	N	R		0	0.1	0.1	2
Acer negundo	SC	N	R		0	0	0.2	3
algae	NV	N?	A		20	80	0	0
Alnus incana ssp. tenuifolia	BC	N	R		0	0	1	2
Alnus incana ssp. tenuifolia	MC	N	R		5	12	15	5
Alnus incana ssp. tenuifolia	SC	N	R		2	7	10	5
Alnus incana ssp. tenuifolia	TC	N	R		0	0	0	4
Aquilegia chrysantha	GC	N	W		0	0	1	0
Artemisia ludoviciana	GC	N	F		0	0	0.1	0
Ballota	GC	I	F		0	0	0	2

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
Cyperus	GC	N	W		0	0.1	0.2	0
Descurainia	GC	NI?	F		0	0	0	0.1
Equisetum arvense	GC	N	WR		0	1	2	0
Fraxinus velutina	BC	N	R		5	0	1	2
Fraxinus velutina	MC	N	R		0	1	5	2
Fraxinus velutina	SC	N	R		5	3	7	2
Fraxinus velutina	TC	N	R		20	5	8	10
Juglans major	BC	N	R		0	0	0.1	0
Juglans major	MC	N	R		0	0	1	0
Juglans major	SC	N	R		0	0	3	0
Melilotus	GC	I	WR		0	0	0.2	0
Mimulus guttatus	GC	N	WR		2	0.2	0	0
Nasturtium officinale	GC	I	W		0	0.1	0	0
Platanus wrightii	BC	N	R		0	0	0	5
Platanus wrightii	MC	N	R		0	0	0	1
Platanus wrightii	SC	N	R		0	0	0	1
Platanus wrightii	TC	N	R		30	5	20	5
Rhamnus betulifolia	SC	N	WR		0	0	0	1
Robinia neomexicana	SC	N	F		0	0	0	0.2
Rubus armeniacus	GC	I	R	cut back last year	0	0	0	12
Salix gooddingii	TC	N	R		0	40	20	30
Salix lasiolepis	GC	N	R		0	0.1	0	0
Sorghum halepense	GC	I	F		1	2	10	20
Typha domingensis	GC	N	A		0	1	0.1	0
Vitis arizonica	SC	N	R		0	0	0	1

Fauna: Larry Stevens was the zoologist for this survey. Surveyors collected representative specimens from benthic invertebrate sampling. Surveyors collected or observed 28 invertebrate taxa, including 9 aquatic and 19 terrestrial invertebrate taxa, and 10 vertebrate taxa. Surveyors conducted quantitative benthic sampling at this spring.

Table 15.5 Dragonfly Medicine Springs Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Amphipoda	Ad	A	Collected spot		2	
Coleoptera	Ad		Collected spot		15	
Coleoptera Carabidae Cicindela oregona maricopa	Ad	T	Spot		1	female

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Coleoptera Dytiscidae	Ad	A	Preserved benthic	2	1	
Diptera	Ad	T	Collected spot		1	
Diptera Chironomidae	L	A	Preserved benthic	2	18	
Diptera Chironomidae	L	A	Preserved benthic	3	5	
Ephemeroptera	L	A	Collected spot		17	
Ephemeroptera	L	A	Preserved benthic	2	3	
Ephemeroptera	L	A	Preserved benthic	1	9	
Ephemeroptera	L	A	Preserved benthic	3	66	61
Hemiptera Gerridae Aquarius remigis	M	A	Spot		6	
Hymenoptera Apidae Apis mellifera	Ad	T	Spot		3	
Hymenoptera Formicidae Formica	Ad	T	Spot		100	
Hymenoptera Sphecidae Podalonia	Ad	T	Spot		1	
Lepidoptera Nymphalidae Junonia coenia	Ad	T	Spot		10	
Lepidoptera Nymphalidae Phyciodes	Ad	T	Spot		1	
Lepidoptera Nymphalidae Phyciodes mylitta	Ad	T	Collected spot		1	
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		1	
Lepidoptera Pieridae Colias alexandra	Ad	T	Spot		2	
Lepidoptera Pieridae Nathalis iole	Ad	T	Spot		2	
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		1	
Mollusca Gastropoda	E	A	Preserved benthic	1	3	egg mass
Odonata Calopterygidae Hetaerina vulnerata	Ad	T	Spot		6	
Odonata Coenagrionidae Argia translata	Ad	T	Spot		3	vertical upright male in copulation
Odonata Libellulidae Libellula saturata	Ad	T	Spot		2	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Odonata Libellulidae Paltothemis lineatipes	Ad	T	Spot		2	in copulation
Orthoptera Gryllidae Gryllus	Ad	T	Spot		1	field cricket
Trichoptera	L	A	Collected spot		4	
Trichoptera	Ad	T	Collected spot		1	
Trichoptera Helicopsychidae	L	A	Preserved benthic	3	6	
Trichoptera Helicopsychidae	L	A	Preserved benthic	1	1	
Trichoptera Hydroptilidae Metrichia	Ad	T	Spot		1	

Table 15.6 Dragonfly Medicine Springs Benthic Invertebrate Sampling.

Rep#	Velocity (m/sec)	Depth (cm)	Area (sq m)	Time (sec)	Location	Substrate	Comments
1	1.00	30	0.09	60	3 meters in upwelling (source	50% 4; 50% 5	
2	0.10	40	0.05	60	10 meters	20% 3; 10% 4; 5% 5; 65% 6	
3	0.30	20	0.09	60	20 meters	20% 3; 10% 4; 15% 5; 55% 6	

Table 15.7 Dragonfly Medicine Springs Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
House Wren		Call	
Plumbeous Vireo		Call	
Yellow-rumped Warbler	16	Obs	
Yellow Warbler	1	Call	
Spotted Towhee	1	Call	
Turkey Vulture	1	Obs	Dead On Trail Near Spring
Hairy Woodpecker	1	Call	
Brown-crested Flycatcher	1	Call	
Javelina		Sign	Tracks
Broad-tailed Hummingbird	1	Obs	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are very good with excellent restoration potential (average condition score 5.7) and there is negligible risk (average risk score 1). Geomorphology condition is good with significant restoration potential (average condition score 4.6) and there is negligible risk (average risk score 1). Habitat condition is moderate with some restoration potential (average condition score 3.6) and there is negligible risk (average

risk score 1.6). Biotic integrity is very good with excellent restoration potential (average condition score 4.9) and there is low risk (average risk score 2.4). Human influence of site is very good with excellent restoration potential (average condition score 5.1) and there is negligible risk (average risk score 1.6). Overall, the site condition is good with significant restoration potential and there is negligible risk.

Table 15.8 Dragonfly Medicine Springs Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	5.7	1
Geomorphology	4.6	1
Habitat	3.6	1.6
Biota	4.9	2.4
Human Influence	5.1	1.6
Overall Ecological Score	4.8	1.6

Management Recommendations: Surveyors recommend determining the status of the Pyrgulopsis springsnail through intermittent monitoring.

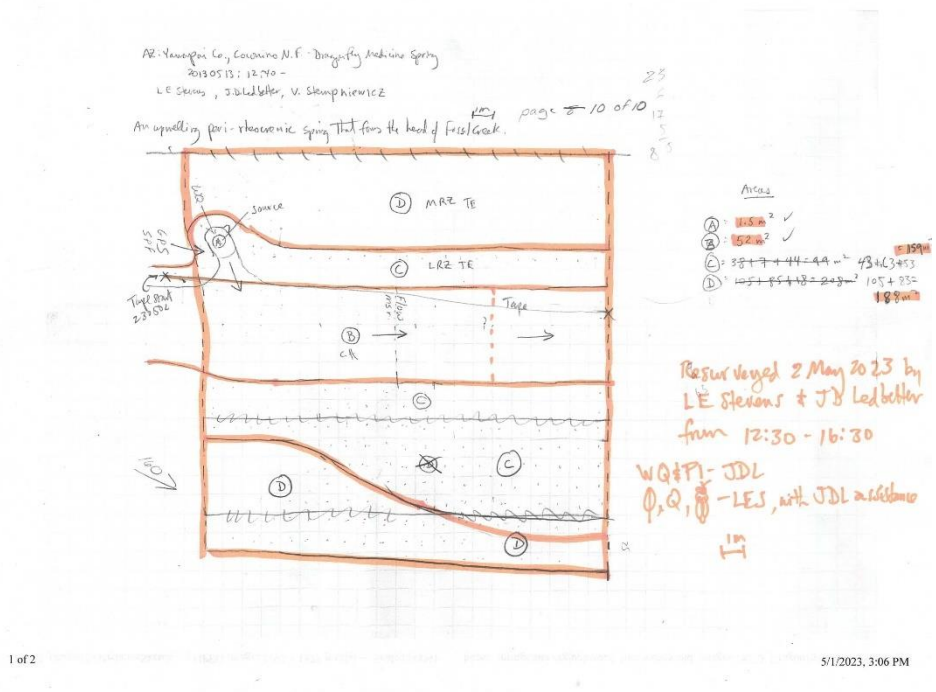

Fig 15.2 Dragonfly Medicine Springs Sketchmap: 2023 Sketchmap

Fig 15.3 Dragonfly Medicine Springs: View downstream from the source. The surveyor is at 20 meters on the tape in the channel.

Fig 15.4 Dragonfly Medicine Springs: There was some mortality of mature trees nearby as a result of the fire, but trees at the site survived.

Fig 15.5 Dragonfly Medicine Springs: Evidence of high surface flows. This example is approximately 2 meters above the current water level.

16. Fumann 5 Spring
Summary Report, Site ID 255228
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Fumann 5 Spring ecosystem is located in Gila County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Tonto NF, Payson RD, in the Pine USGS Quad, at 34.43740, -111.42914 measured using a GPS (WGS84, estimated position error 8 meters). The elevation is approximately 1843 meters.

Physical Description: Fumann 5 Spring is a hillslope spring. Flow emerges from two discrete sources on a south facing rocky slope about 50 meters east of Pine Creek, and about 80 meters east of Pine Creek Trail. The slope is heavily forested, with a mix of coniferous canopy such as Douglas fir and deciduous canopy such as alder and box elder.

Geomorphology: Fumann 5 Spring emerges as a seepage or filtration spring from the Coconino, a sedimentary, sandstone rock layer. The emergence environment is subaerial, with a geothermal flow force mechanism. The site receives approximately 82% of available solar radiation, with 7797 Mj annually.

Access Directions: From Pine, Arizona drive north on Pine Creek Rd to the Lo Mia Youth Camp gate. Contact Sister Brewer at (928)707-4756 or Elder Brewer at (928)240-4756 for permission to access. From the northern gate of the camp hike north on the Pine Creek Trail 3.4 kilometers. Hike east off trail about 80 meters to reach the spring. Surveyors in 2023 observed multiple rattlesnakes present on trail, prepare accordingly.

6/29/23 Survey
Larry Stevens, Jeri Ledbetter, Izzie Speer, Ingrid French, Helen Waltz and Genna Watson surveyed the site on 6/29/23 for 02:00 hours, beginning at 13:30, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 16.1 Fumann 5 Spring: View downslope below west source. The photographer is standing at 2.5 meters on the measuring tape.

Microhabitats: The microhabitats associated with the spring cover 192 sqm. The site has 2 microhabitats, including A -- a 112 sqm channel, B -- a 80 sqm terrace. The geomorphic diversity is 0.30, based on the Shannon-Weiner diversity index.

Table 16.1 Fumann 5 Spring Microhabitat characteristics.

Code	A	B
Name	Source channel	Channel margins
Area sqm	112	80
Surface type	CH	TE
Surface subtype		
Slope variability	Med	Med

Code	A	B
Aspect TN	234	234
Slope degrees	9	9
Moisture (scale 1-10)	9	4
Water depth cm	15	0
Area % open water	1	0
Substrate		
1 - Clay %	0	0
2 - Silt %	5	5
3 - Sand %	10	5
4 - Fine gravel %	10	5
5 - Coarse gravel %	10	5
6 - Cobble %	50	39
7 - Boulder %	0	1
8 - Bedrock %	0	0
Organic %	15	40
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	10	50
Wood %	12	12
Litter Depth (cm)	2	3

Survey Notes: At time of survey, the site was overgrown with watercress and fallen trees were present over most of the channel. This site appears to have seen very little human visitation and is near pristine. Forest helicopter logging is planned in the near future.

Flow: Surveyors measured a flow of 2.6 liters/second, using a timed flow volume capture method. Flow was adjusted for an estimate of 70% of site flow capture. Surveyors built a pipe dam to measure flow at 22 meters on the measuring tape. This spring is perennial.

Water Quality: Surveyors measured water quality at the western source at 1.8 meters on the tape, and at the eastern source where it emerges from underneath a large slab. The dissolved oxygen ChemMets kit surveyors used had expired in February of 2022. Location 1: at the spring source in flowing water at 13:13. Location 2: at the spring source in standing water at 13:13.

Table 16.2 Fumann 5 Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved oxygen (field) (mg/L)	4	1	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.102	1	Hanna Combo
pH (field)	6.75	1	Hanna Combo
Specific conductance (field) (uS/cm)	208	1	Hanna Combo

Characteristic Measured	Value	Location Number	Device
Temperature, air C	27.5	1	Handheld therm
Temperature, water C	12.2	1	Hanna Combo
Dissolved oxygen (field) (mg/L)	5	2	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.102	2	Hanna Combo
pH (field)	6.92	2	Hanna Combo
Specific conductance (field) (uS/cm)	203	2	Hanna Combo
Temperature, water C	12	2	Hanna Combo

Flora: Surveyors identified 19 plant species at the site, with 0.099 species/sqm. These included 14 native and 2 nonnative species; the native status of 3 species remains unknown.

Table 16.3 Fumann 5 Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	12	5
Shrub	5	2
Mid-canopy	4	2
Tall canopy	2	1
Basal	0	0
Aquatic	0	0
Non-vascular	2	1

Table 16.4 Fumann 5 Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Acer negundo	MC	N	R		40	40
Acer negundo	SC	N	R		10	15
Acer negundo	TC	N	R		25	20
Alnus	MC	N	WR	oblongifolia?	3	4
Alnus	SC	N	WR	oblongifolia?	3	2
Aquilegia chrysantha	GC	N	W		1	2
Asteraceae	GC	NI		bidens or cosmos, same as Parsnip	0	0.4
Equisetum laevigatum	GC	N	WR		0	0.3
Galium rubioides	GC	I			0.5	0
Lichen	NV	N	U		1	0.1

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Mimulus guttatus	GC	N	WR	now known as Erythranthe guttata	0.2	0
Nasturtium officinale	GC	I	W		90	12
Pinus ponderosa	MC	N	U		1	3
Prunus virginiana	SC	N	F		0.2	2
Pseudotsuga menziesii	GC	N	U		0	0.2
Pseudotsuga menziesii	MC	N	U		3	5
Pseudotsuga menziesii	SC	N	U		1	5
Pseudotsuga menziesii	TC	N	U		25	40
Pteridium	GC	N	U		6	5
Quercus gambelii	SC	N	U		0	0.01
unknown grass	GC			fine inflorescence, same as Parsnip	2	4
unknown grass	GC			long barley, same as Parsnip	0.1	0.1
unknown herb	GC			hope (mature) at source	0	3
unknown moss	NV	N?	WR		10	2
Viola	GC	N	WR		0.1	0.1

Fauna: Surveyors collected or observed 15 invertebrate taxa, including 4 aquatic and 10 terrestrial invertebrate taxa, and 7 vertebrate taxa.

Table 16.5 Fumann 5 Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Araneae Tetragnathidae Tetragnatha	Ad	T	Collected spot		2	
Coleoptera	Ad		Collected spot		1	
Coleoptera Tenebrionidae	Ad	T	Collected spot		1	
Diptera	Ad	T	Collected spot		1	
Diptera Simuliidae	L	A	Collected spot		1	
Isopoda	Ad	T	Collected spot		1	
Lepidoptera Nymphalidae Cercyonis	Ad	T	Spot		1	
Lepidoptera Nymphalidae Polygonia gracilis	Ad	T	Spot		2	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera Pieridae Eurema mexicana	Ad	T	Collected spot		1	Male
Lepidoptera Riodinidae Emesis zela	Ad	T	Collected spot		1	
Mollusca Gastropoda	Ad		Collected spot		1	
Odonata	L	A	Collected spot		2	
Odonata Zygoptera	Ad	T	Collected spot		3	
Plecoptera	L	A	Collected spot		4	
Plecoptera	Ad	T	Collected spot		1	
Trichoptera	L	A	Collected spot		4	

Table 16.6 Fumann 5 Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Golden Eagle	1	Obs	
Steller's Jay	2	Call	
Chipping Sparrow	1	Call	
Plumbeous Vireo	1	Call	
Northern Flicker	1	Call	
Elk		Sign	Tracks And Scat
Dove	1	Call	Sp.

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.7) and there is low risk (average risk score 2). Geomorphology condition is very good with excellent restoration potential (average condition score 5.2) and there is negligible risk (average risk score 1.4). Habitat condition is good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2.2). Biotic integrity is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.8). Human influence of site is very good with excellent restoration potential (average condition score 5.7) and there is negligible risk (average risk score 1.3). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 16.7 Fumann 5 Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.7	2

Category	Condition	Risk
Geomorphology	5.2	1.4
Habitat	4.8	2.2
Biota	5.4	1.8
Human Influence	5.7	1.3
Overall Ecological Score	5.2	1.7

Management Recommendations: Surveyors recommend occasional monitoring with emphasis on comparing wet versus dry years to determine discharge variation.

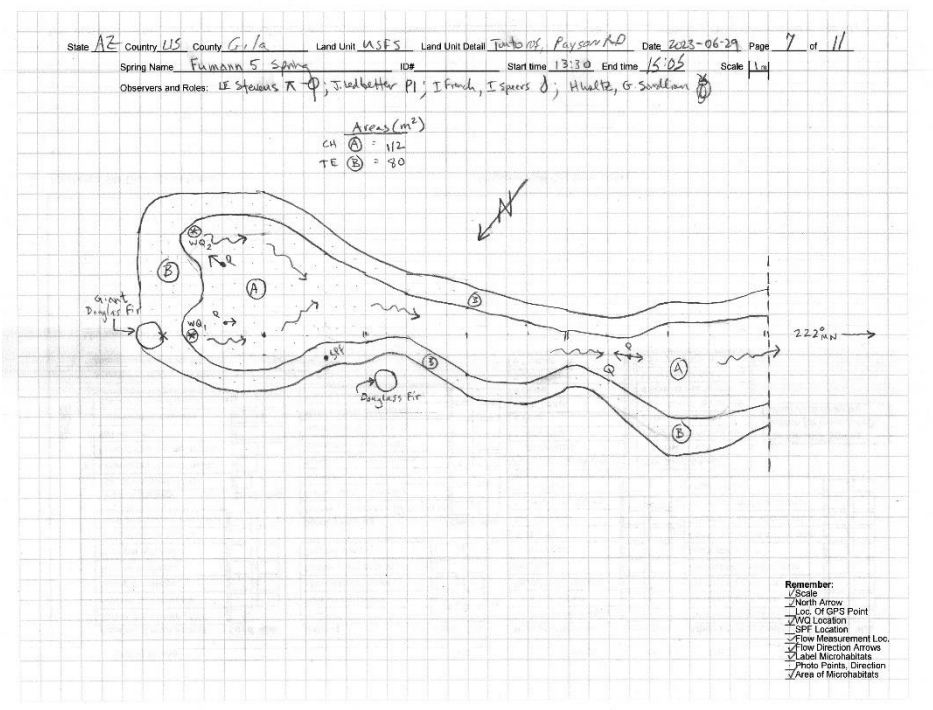

Fig 16.2 Fumann 5 Spring Sketchmap: June 29th, 2023.

Fig 16.3 Fumann 5 Spring: The eastern source emerges beneath a large slab of Coconino Sandstone.

Fig 16.4 Fumann 5 Spring: Surveyors built a pipe dam to measure flow at 22 meters.

17. Indian Garden Spring
Summary Report, Site ID 255216
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Indian Garden Spring ecosystem is located in Yavapai County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Prescott NF, Verde RD, in the Horner Mountain USGS Quad, at 34.41304, -111.78385 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 879 meters.

Physical Description: Indian Garden Spring is a hillslope/rheocrene spring. Flow emerges from two discrete sources in a heavily wooded area 50 meters upslope of Gap Creek. An old, out-of-use road and a barbed wire fence with an access gate pass through the lower runout of the spring. This spring was not on maps, nor was it in the NHD database. There was some scattered travertine at the site.

Geomorphology: Indian Garden Spring emerges as a seepage or filtration spring from an igneous, basalt rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 95% of available solar radiation, with 8596 Mj annually.

Access Directions: From the main exit off I-17 to Camp Verde (HWY 260) drive east 0.25 miles, then turn south (right) on Oasis Rd. In 0.1 mi, after the road curves to the east, turn south on South Salt Mine Rd. In 7.5 miles, turn south (right) on FS 574 (which is on some maps a continuation of South Salt Mine Rd). Follow this winding dirt road for about 8 miles to the entrance of Brown Ranch, where there is a locked gate and permission is required. If you have not obtained permission, this site is accessible from the Gap Creek trail. Hike down the trail approximately 600 meters to the spring. Alternatively, this site is accessible from the Verde River.

5/16/23 Survey
Larry Stevens, Jeri Ledbetter, Joseph Holway, and Lauren Vanier surveyed the site on 5/16/23 for 01:35 hours, beginning at 12:35, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 17.1 Indian Garden Spring: View of the source areas, concealed by the large fallen tree, from 18 meters on the tape. The photographer is facing upstream.

Microhabitats: The microhabitats associated with the spring cover 183 sqm. The site has 2 microhabitats, including A -- a 39 sqm channel, B -- a 144 sqm terrace. The geomorphic diversity is 0.22, based on the Shannon-Weiner diversity index.

Table 17.1 Indian Garden Spring Microhabitat characteristics.

Code	A	B
Name	Source channel	Terrace
Area sqm	39	144
Surface type	CH	TE
Surface subtype	riffle	LRZ
Slope variability	Low	Low

Code	A	B
Aspect TN	335	335
Slope degrees	5	5
Moisture (scale 1-10)	9	2
Water depth cm	5	0
Area % open water	70	0
Substrate		
1 - Clay %	30	25
2 - Silt %	40	30
3 - Sand %	5	5
4 - Fine gravel %	0	0
5 - Coarse gravel %	5	10
6 - Cobble %	5	10
7 - Boulder %	0	0
8 - Bedrock %	0	0
Organic %	15	20
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	10	35
Wood %	25	20
Litter Depth (cm)	0.5	2

Survey Notes: Surveyors observed the site dominated by mature ash trees. A large, mature ash tree fell over the sources, upper channels, and terraces, affording some protection from livestock trampling. The lower channel is heavily trampled in a flat area where an old road passes through the runout. Surveyors found springsnail shells in the upper channel, although none were alive. They also found egg masses that could be from springsnails. The source forms a pool that is muddy with few rocks, then flows into a rockier channel. The second side source has more gravel in the source pool than the first. The fencing and gate are in good condition, although the fencing is girdling the trees.

Flow: Surveyors measured a flow of 0.33 liters/second, using a timed flow volume capture method. Surveyors measured flow at 19.5 meters on the tape. This spring is perennial.

Water Quality: Surveyors measured water quality in flowing water at the smaller, rocky, flowing source from a small excavation that the surveyor created. Location 1: at the spring source in flowing water at 12:12.

Table 17.2 Indian Garden Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.343	1	Hanna Combo
pH (field)	7.16	1	Hanna Combo

Characteristic Measured	Value	Location Number	Device
Specific conductance (field) (uS/cm)	688	1	Hanna Combo
Temperature, air C	27	1	Handheld therm
Temperature, water C	14.6	1	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 17 plant species at the site, with 0.0929 species/sqm. These included 13 native and 4 nonnative species.

Table 17.3 Indian Garden Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	14	9
Shrub	4	3
Mid-canopy	2	1
Tall canopy	1	1
Basal	1	1
Aquatic	0	0
Non-vascular	0	0

Table 17.4 Indian Garden Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Agrostis semiverticillata	GC	I	W	Verified by Glenn Rink	2	5
Aquilegia chrysantha	GC	N	W		1	1
Celtis laevigata	SC	N	R		0	0.1
Chenopodium	GC	NI		Immature, verified by Glenn Rink	0.1	0.01
Cupressus arizonica	MC	N	F		3	15
Cupressus arizonica	SC	N	F		3	5
Eleocharis montevidensis	GC	N		Verified by Glenn Rink	6	8
Fraxinus velutina	BC	N	R		2	2
Fraxinus velutina	GC	N	R		0.2	0.3
Fraxinus velutina	MC	N	R		25	30
Fraxinus velutina	SC	N	R		25	25
Fraxinus velutina	TC	N	R		10	15
Juglans major	GC	N	R		0	0.2

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Lactuca serriola	GC	I	F		0.1	0.1
Maurandya antirrhiniflora	GC	N	U		0	0.01
Mimulus guttatus	GC	N	WR		6	1
Nasturtium officinale	GC	I	W		0.3	0
Plantago major	GC	I	WR		0.1	0.3
Ranunculus	GC	N	WR		0.1	0
Taraxacum officinale	GC	NI	F		0	0.1
Veronica anagallis-aquatica	GC	N	W		0.1	0.1
Vitis arizonica	SC	N	R		0	0.1

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 13 invertebrate taxa, including 9 aquatic and 2 terrestrial invertebrate taxa, and 5 vertebrate taxa.

Table 17.5 Indian Garden Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Amphipoda	Ad	A	Collected spot		3	
Coleoptera	Ad		Collected spot		4	
Coleoptera Carabidae Pasimachus californicus	Ad	T	Collected spot		1	
Coleoptera Dytiscidae	Ad	A	Collected spot		1	
Coleoptera Staphylinidae	Ad	T	Collected spot		1	
Decapoda	Ad	A	Collected spot		1	crayfish
Diptera Tipulidae	L	A	Collected spot		1	
Hemiptera Belostomatidae	Ad	A	Collected spot		1	
Mollusca Gastropoda	Ad		Collected spot		10	
Neotaenioglossa Hydrobiidae	Ad	A	Collected spot		1	springsnail
Odonata	L	A	Collected spot		1	
Plecoptera	L	A	Collected spot		1	
Trichoptera	L	A	Collected spot		1	

Table 17.6 Indian Garden Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Gila Woodpecker		Call	
Domestic Horse		Sign	Tracks
Domestic Cattle		Sign	Tracks
Hummingbird		Call	
Brown-crested Flycatcher	1	Obs	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4) and there is low risk (average risk score 2.2). Geomorphology condition is moderate with some restoration potential (average condition score 3.6) and there is moderate risk (average risk score 3). Habitat condition is good with significant restoration potential (average condition score 4.2) and there is moderate risk (average risk score 3). Biotic integrity is good with significant restoration potential (average condition score 4.6) and there is low risk (average risk score 2.8). Human influence of site is very good with excellent restoration potential (average condition score 4.9) and there is low risk (average risk score 2.2). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 17.7 Indian Garden Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4	2.2
Geomorphology	3.6	3
Habitat	4.2	3
Biota	4.6	2.8
Human Influence	4.9	2.2
Overall Ecological Score	4.4	2.6

Management Recommendations: This site could benefit from fencing to protect it from livestock grazing and trampling. The presence of springsnail shells and Pasimachus ground beetles, plus many bird species, warrants occasional monitoring and determination of springsnail population viability.

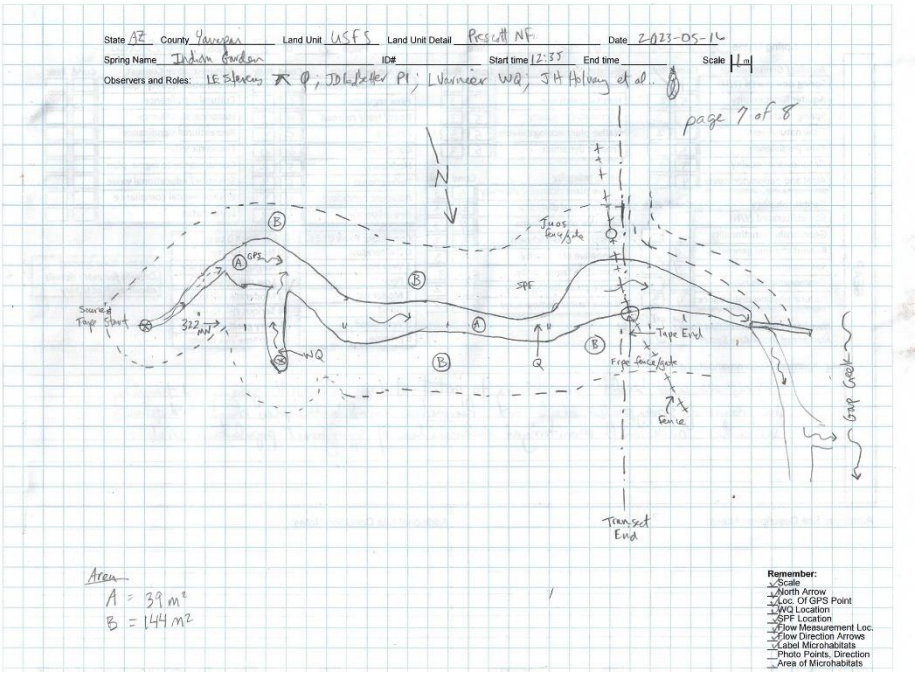

Fig 17.2 Indian Garden Spring Sketchmap: 2023 Sketchmap.

Fig 17.3 Indian Garden Spring: The runout channel as viewed at 18 meters on the tape, facing downstream.

Fig 17.4 Indian Garden Spring: The main source pool as viewed from immediately below. The second source is 1 to 2 meters behind the photographer.

Fig 17.5 Indian Garden Spring: Surveyors measured flow at 19.5 meters on the tape.

18. Ivy Spring

Summary Report, Site ID 255224

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Ivy Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.91180, -111.72606 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1391 meters.

Physical Description: Ivy Spring is a hillslope/rheocrene spring. A small seepage (about 0.3 L/s) emerges from the Schnebly Hill Formation wall at the edge of Munds Creek, flowing 8 meters downstream through large boulders into Munds Creek.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Take the first left and park at the end of the road. The spring is on creek right of Munds Creek.

5/27/23 Survey

Larry Stevens and Georgie Pongyesva verified the site on 5/27/23 at 10:00. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 18.1 Ivy Spring: The source viewed facing towards Schnebly Hill.

Survey Notes: Surveyors observed that the site was heavily covered with non-native English ivy. The source and springbrook were entirely inundated by high flows during the March-April floods in 2023. Surveyors determined volumetric measurement to be the most suitable method of flow measurement at this site.

19. King Spring
Summary Report, Site ID 10508
Submitted 9/18/23 by Springs Stewardship Institute

Location: The King Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Prescott NF, Chino Valley RD, in the Hell Point USGS Quad, at 34.94559, -112.32746 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1365 meters.

Physical Description: King Spring is a rheocrene spring. Seepage emerges from the floor of Hell Canyon, a tributary of the Verde River. A large amount of travertine lines the terraces. The source likely moves around, and surveyors found an additional source about 100 meters upstream. The site is dominated by mid and tall canopy trees including a very mature velvet ash near the upper pool. The area has been heavily used for livestock for a long time, as well as recently. All microhabitats are subject to heavy surface runoff.

Geomorphology: King Spring emerges as a seepage or filtration spring from an igneous, basalt rock layer. The emergence environment is subaerial, with a gravity flow force mechanism.

Access Directions: Go 1.6 miles east from Hwy 89 north of Paulden, turn east onto 71 toward the Drake cement plant. Just short of the plant entrance, turn south on FR 182. In 0.6 miles, turn right on NF9899 North. Follow it to the southeast through an unlocked gate. In 3.3 miles at another unlocked gate, hike 500 meters down a trail into the wash. The source is across the creek.

5/10/23 Survey
Larry Stevens and Jeri Ledbetter surveyed the site on 5/10/23 for 02:35 hours, beginning at 13:30, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 19.1 King Spring: From the top of the big pool, view downslope, at 15 meters on the tape.

Microhabitats: The microhabitats associated with the spring cover 1542 sqm. The site has 3 microhabitats, including A -- a 230 sqm pool, B -- a 1044 sqm channel, C -- a 268 sqm terrace. The geomorphic diversity is 0.37, based on the Shannon-Weiner diversity index.

Table 19.1 King Spring Microhabitat characteristics.

Code	A	B	C
Name	Pools	Channel	Stream terrace
Area sqm	230	1044	268
Surface type	P	CH	TE
Surface subtype	wet	run	MRZ

Code	A	B	C
Slope variability	Low	Low	Med
Aspect TN		13	303
Slope degrees	0	2	20
Moisture (scale 1-10)	10	3	2
Water depth cm	110	0	0
Area % open water	98	0	0
Substrate			
1 - Clay %	0	0	5
2 - Silt %	30	13	10
3 - Sand %	29	7	15
4 - Fine gravel %	15	25	20
5 - Coarse gravel %	10	30	20
6 - Cobble %	10	21	15
7 - Boulder %	1	2	5
8 - Bedrock %	0	0	10
Organic %	5	2	0
Other % (anthropogenic)	0	0	0
Precipitate %	0	0	0
Litter %	10	1	10
Wood %	1	1	2
Litter Depth (cm)	1	0.5	0.5

Survey Notes: Precipitation during the previous winter produced up to 3 meters of runoff in the channel. However, water in the pools is influenced by, or dominated by, groundwater, with specific conductance of 550-600 in the pools. In spite of recent heavy runoff, the fencing is somewhat effective, but is in need of repair if the goal is to keep livestock away from the source.

Flow: Surveyors measured a flow of 0.37 liters/second, using a timed flow volume capture method. Flow was adjusted for an estimate of 80% of site flow capture. GPS SSI 3 King Spr Q230510 a 150 meter downslope from start of tape. This spring is perennial.

Water Quality: Surveyors measured water chemistry field parameters in a pool at the first emergence. Location 1: at the spring source in standing water at 14:14.

Table 19.2 King Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.298	1	Hanna Combo
pH (field)	7.49	1	Hanna Combo
Specific conductance (field) (uS/cm)	596	1	Hanna Combo
Temperature, air C	24	1	Handheld therm
Temperature, water C	24.2	1	Hanna Combo

Flora: Larry Stevens served as botanist on this survey. Surveyors identified 34 plant species at the site, with 0.022 species/sqm. These included 30 native and 1 nonnative species; the native status of 3 species remains unknown.

Table 19.3 King Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	13	5
Shrub	18	5
Mid-canopy	2	1
Tall canopy	0	0
Basal	2	1
Aquatic	0	0
Non-vascular	3	2

Table 19.4 King Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
algae	NV	N?	A		2	0	0
Ambrosia	GC	N			0	0	0.01
Amorpha fruticosa	SC	N	F	or Robinia neomexicana, Ver. G.R.	0.1	0.5	1
Artemisia tridentata	SC	N	U		0	0	0.1
Berberis	SC			yellow phloem	0	0	1
Brickellia californica	SC	N	U		0	0	0.2
Carex praegracilis	GC	N	W	Verified by Glenn Rink	0	0.4	0
Clematis	GC	N?	R		0	0	0.1
Eleocharis montevidensis	GC	N		Verified by Glenn Rink	0.3	0.1	0
Elymus elymoides	GC	N	F		0	0	0.01
Forestiera pubescens	SC	N	R	Verified by Glenn Rink	0	0	0.7
Frangula californica	SC	N	U	Verified by Glenn Rink	1	1	0.1
Fraxinus pennsylvanica	BC	N	F		0	2	1
Fraxinus pennsylvanica	GC	N	F		0	0.1	0
Fraxinus pennsylvanica	MC	N	F		2	5	10
Fraxinus pennsylvanica	SC	N	F		3	15	8
Gutierrezia sarothrae	SC	N	U		0	0	0.1

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Juncus balticus	GC	N	W		0.1	0.2	0.1
Juniperus monosperma	SC	N	U		0	1	3
Lichen	NV	N	U		0	0.1	0.2
Melilotus	GC	I	WR		0	0.01	0
Nicotiana trigonophylla	GC				0	0.01	0
Nolina microcarpa	SC	N	U		0	0	0.2
Opuntia phaeacantha	SC	N	U		0	0	0.1
Penstemon	GC	N	U		0	0	0.01
Poa fendleriana ssp. longiligula		N		Verified by Glenn Rink	0	0	2
Poa pratensis	GC	NI	F		0	0.1	0.2
Prunus virginiana	SC	N	F		0	0.1	0.3
Rhus trilobata	SC	N	F		0	0	0.1
Ribes	SC	N	F	thornless	0	0	0.1
Salix exigua	SC	N	WR		0	2	1
Salix gooddingii	BC	N	R		0.1	0	0
Salix gooddingii	MC	N	R		5	3	2
Salix gooddingii	SC	N	R		20	10	5
Salix laevigata	SC	N	R	Verified by Glenn Rink	38	20	12
Typha	GC	N	W	domingensis?	0.1	0.001	0
unknown grass	GC			sp 2	0	0	0.01
unknown moss	NV	N?	WR		0	1	0
Vitis arizonica	SC	N	R		0	8	1

Fauna: Larry Stevens was the zoologist for this survey. Surveyors collected or observed 19 invertebrate taxa, including 5 aquatic and 15 terrestrial invertebrate taxa, and 8 vertebrate taxa.

Table 19.5 King Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Basommatophora Physidae	Ad	A	Collected spot		1	
Coleoptera Gyrinidae Gyrinus plicifer	Ad	A	Spot		2	
Coleoptera Lycidae	Ad	T	Collected spot		1	
Diptera Asilidae	Ad	T	Collected spot		3	
Diptera Chironomidae	L	A	Collected spot		1000	
Diptera Culicidae Culiseta	Ad	T	Spot		1	
Diptera Culicidae Culiseta	L	A	Spot		10	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Diptera Sarcophagidae Sarcophaga	Ad	T	Spot		20	
Hemiptera Gerridae Aquarius remigis	Ad	A	Spot		2	
Hymenoptera Apidae Apis mellifera	Ad	T	Spot		10	
Lepidoptera	Ad	T	Collected spot		1	
Lepidoptera Hesperiidae Erynnis meridianus	Ad	T	Spot		1	
Lepidoptera Hesperiidae Heliopetes ericetorum	Ad	T	Spot		2	both males
Lepidoptera Hesperiidae Pyrgus scriptura	Ad	T	Spot		3	
Lepidoptera Lycaenidae Leptotes marina	Ad	T	Collected spot		6	
Lepidoptera Nymphalidae Junonia coenia	Ad	T	Spot		2	
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		2	
Lepidoptera Pieridae Colias eurytheme	Ad	T	Spot		2	
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		2	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		3	

Table 19.6 King Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Ornate Tree Lizard	1	Obs	
Domestic Cattle	1	Sign	And Pelvis
Black-tailed Rattlesnake	1	Obs	
Turkey Vulture	1	Obs	
Yellow Warbler	1	Call	
Smooth-Toothed Pocket Gophers	1	Sign	
Deer	1	Sign	
Mourning Dove	3	Obs	

Assessment: Assessment scores were compiled in 6 categories and 32 subcategories, with 10 null condition scores, and 10 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.2) and there is low risk (average risk score 2). Geomorphology condition is good with significant restoration potential (average condition score 4) and there is low risk (average risk score 2.3). Habitat condition is good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2). Biotic integrity is good with significant restoration potential (average condition score 4.5) and

there is low risk (average risk score 2.5). Human influence of site is good with significant restoration potential (average condition score 4.7) and there is low risk (average risk score 2.3). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 19.7 King Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.2	2
Geomorphology	4	2.3
Habitat	4.8	2
Biota	4.5	2.5
Human Influence	4.7	2.3
Overall Ecological Score	4.5	2.3

Management Recommendations: No management is recommended, due to the emergence of this spring in the channel of the large surface drainage here. Occasional (once every 5 years) monitoring is warranted.

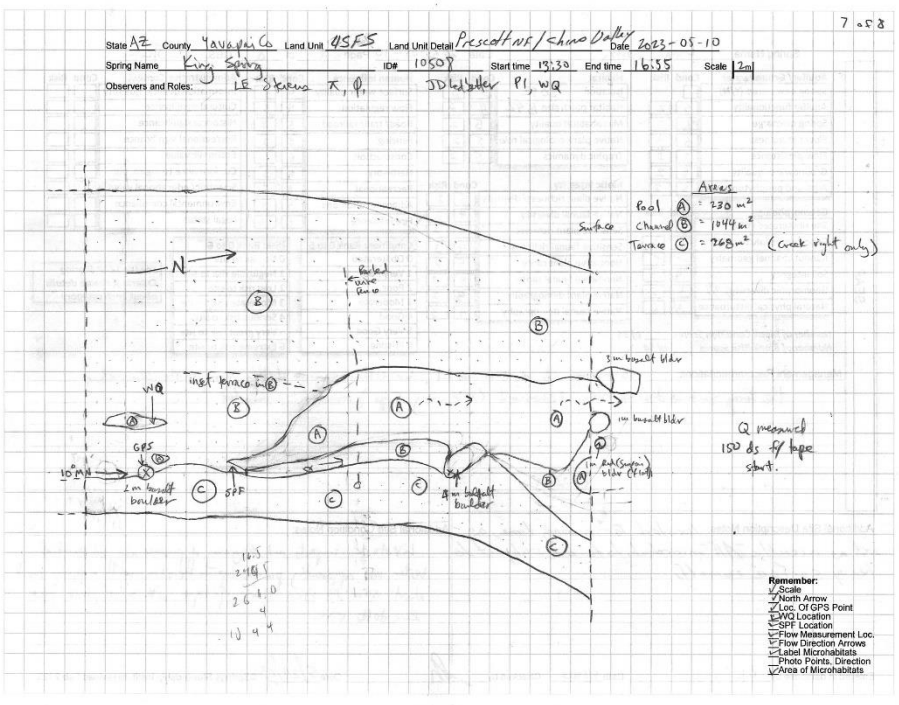

Fig 19.2 King Spring Sketchmap.

Fig 19.3 King Spring: Surveyors measured flow 150 meters downslope from the source.

Fig 19.4 King Spring: *Crotalus molossus* (black-tailed rattlesnake)

20. Low Wall Spring
Summary Report, Site ID 19146
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Low Wall Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Sycamore Basin USGS Quad, at 34.88419, -112.07300 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1191 meters.

Physical Description: Low Wall Spring is a hillslope/rheocrene spring. Flow emerges from the base of a west-facing Redwall limestone wall in Sycamore Creek, within the Sycamore Canyon wilderness area. The Parson Trail passes along a ledge at the base of the wall. Flow emerges just below the trail into a pool. The geomorphology has changed as a result of heavy spring runoff flooding in March 2023.

Geomorphology: Low Wall Spring emerges as a fracture spring from the Redwall Formation, a sedimentary, limestone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 78% of available solar radiation, with 7300 Mj annually.

Access Directions: From Clarkdale, AZ drive toward Tuzigoot National Monument. Pass the Monument, the mine and the road to the boat launch. Continue as the road becomes dirt and increasingly bumpy to the Parsons trailhead. Hike about 2 miles where the trail follows a Redwall Limestone ledge.

5/12/23 Survey
Larry Stevens, Jeri Ledbetter, Lauren Vanier, and Joseph Holway surveyed the site on 5/12/23 for 01:20 hours, beginning at 9:25, and collected data in 9 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 20.1 Low Wall Spring: View of the site from the top of the tape, the source is on the left at the 90 degree corner of the wall. The photographer is facing south.

Microhabitats: The microhabitats associated with the spring cover 334 sqm. The site has 3 microhabitats, including A -- a 184 sqm pool, B -- a 74 sqm sloping bedrock, C -- a 76 sqm terrace. The geomorphic diversity is 0.43, based on the Shannon-Weiner diversity index.

Table 20.1 Low Wall Spring Microhabitat characteristics.

Code	A	B	C
Name	Pool	Sloping bedrock	Margin
Area sqm	184	74	76
Surface type	P	SB	TE
Surface subtype			MRZ

Code	A	B	C
Slope variability	Low	Low	Low
Aspect TN		219	39
Slope degrees	0	90	15
Moisture (scale 1-10)	10	2	5
Water depth cm	60	0	0
Area % open water	98	0	0
Substrate			
1 - Clay %	0	0	0
2 - Silt %	50	0	5
3 - Sand %	0	0	80
4 - Fine gravel %	0	0	5
5 - Coarse gravel %	0	0	10
6 - Cobble %	49	0	0
7 - Boulder %	0	0	0
8 - Bedrock %	1	100	0
Organic %	0	0	0
Other % (anthropogenic)	0	0	0
Precipitate %	0	0	0
Litter %	5	0.1	0.5
Wood %	0	0	3
Litter Depth (cm)	5	0.1	0.5

Survey Notes: Heavy flooding produced by an unusually large snowpack over the 2022/2023 winter covered the microhabitats and the source, scouring the pool and modifying the terrace. An estimated 3.5 meters of runoff flooded the site, downing large trees on the terrace between the spring and the Sycamore Creek bed, which is 2 meters below. Algae covers 85% of the pool. There was much bird activity in the area.

Flow: Surveyors found diffuse outflow pouring through rocks. This spring is perennial. Surveyors were unable to measure flow because the outflow was too diffuse to capture.

Water Quality: Surveyors measured water chemistry field parameters at the source. Location 1: at the spring source in flowing water at 09:09.

Table 20.2 Low Wall Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.285	1	Hanna Combo
pH (field)	7.05	1	Hanna Combo
Specific conductance (field) (uS/cm)	570	1	Hanna Combo
Temperature, air C	21	1	Handheld therm
Temperature, water C	10.7	1	Hanna Combo

Flora: Larry Stevens served as botanist on this survey. Surveyors identified 13 plant species at the site, with 0.0389 species/sqm. These included 12 native and 1 nonnative species.

Table 20.3 Low Wall Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	6	3
Shrub	4	4
Mid-canopy	2	2
Tall canopy	1	1
Basal	0	0
Aquatic	0	0
Non-vascular	1	1

Table 20.4 Low Wall Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
algae	NV	N?	A		85	1	1
Alnus oblongifolia	MC	N	R		3	10	2
Artemisia ludoviciana	GC	N	F		0	0.1	0
Bromus diandrus	GC	I	F		0	0.2	0
Celtis laevigata var. reticulata	SC	N	R		0	0.15	0
Equisetum laevigatum	GC	N	WR		0.01	0.1	0
Fraxinus velutina	MC	N	R		1	1	8
Fraxinus velutina	SC	N	R		4	6	2
Fraxinus velutina	TC	N	R		4	5	3
Hordeum jubatum	GC	N	F		0	0.1	0
Juglans major	SC	N	R		0	0	0.2
Lycium fremontii		N		Verified by Glenn Rink	0	0.2	0
Muhlenbergia asperifolia	GC	N	WR		0	0	0.2
Salix exigua	SC	N	WR		0.2	0.01	0
Typha	GC	N	W	domingensis	1.5	0.1	5

Fauna: Jeri Ledbetter was the zoologist for this survey. Surveyors collected or observed 14 invertebrate taxa, including 6 aquatic and 7 terrestrial invertebrate taxa, and 14 vertebrate taxa.

Table 20.5 Low Wall Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Coleoptera Dytiscidae	L	A	Collected spot		3	
Diptera Chironomidae	L	A	Collected spot		1	
Diptera Culicidae	P		Collected spot		1	
Diptera Culicidae	L	A	Collected spot		2	
Diptera Simuliidae	L	A	Collected spot		6	
Ephemeroptera	L	A	Collected spot		3	
Hymenoptera Apidae Apis mellifera	Ad	T	Spot		1	
Lepidoptera Hesperiidae Copaeodes aurantiaca	Ad	T	Collected spot		1	
Lepidoptera Nymphalidae Adelpha eulalia	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio aristodemus	Ad	T	Spot		1	
Lepidoptera Pieridae Colias eurytheme	Ad	T	Spot		1	
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		1	
Mollusca Gastropoda	Ad		Collected spot		1	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		1	
Turbellaria	Ad	A	Collected spot		1	

Table 20.6 Low Wall Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Canyon Wren		Call	
Yellow-breasted Chat		Call	
Yellow Warbler	1	Obs	Female
Brown-crested Flycatcher	2	Call	
Raccoon		Sign	Tracks
White-throated Swift	6	Obs	
Tadpole Madtom	1	Obs	Red Spotted
Common Black Hawk	1	Obs	Nesting In Sycamore Across Creek
Mourning Dove		Call	
Western Wood-Pewee	1	Obs	
Canyon Treefrog	1	Obs	

Vertebrate Species Common Name	Count	Detection	Comments
Hooded Oriole	1	Obs	
Spotted Towhee	1	Call	
Ornate Tree Lizard	1	Obs	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are very good with excellent restoration potential (average condition score 5.2) and there is negligible risk (average risk score 1.3). Geomorphology condition is very good with excellent restoration potential (average condition score 5.2) and there is negligible risk (average risk score 1). Habitat condition is good with significant restoration potential (average condition score 4.2) and there is negligible risk (average risk score 1.2). Biotic integrity is very good with excellent restoration potential (average condition score 5) and there is negligible risk (average risk score 1). Human influence of site is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.4). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 20.7 Low Wall Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	5.2	1.3
Geomorphology	5.2	1
Habitat	4.2	1.2
Biota	5	1
Human Influence	5.4	1.4
Overall Ecological Score	5.1	1.2

Management Recommendations: No management action is necessary, aside from occasional monitoring.

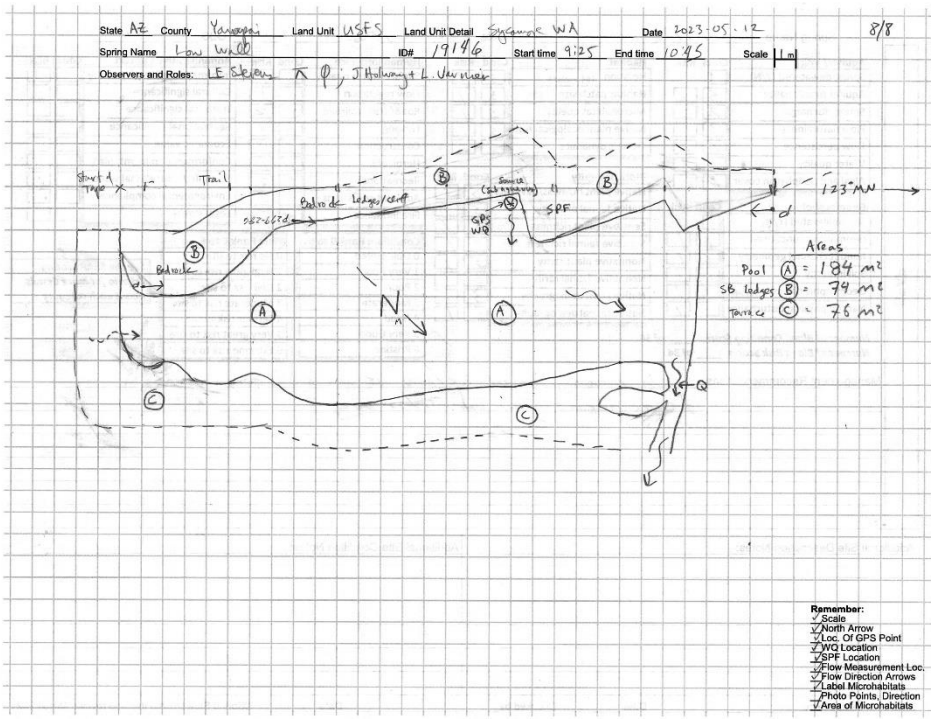

Fig 20.2 Low Wall Spring Sketchmap: 2023.

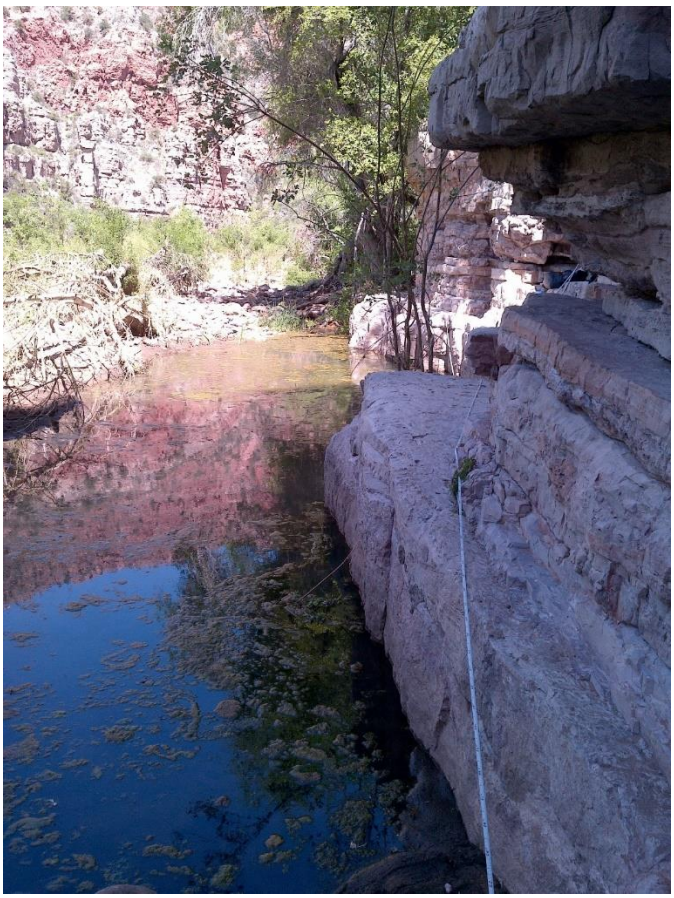

Fig 20.3 Low Wall Spring: View of the site from the bottom of the tape looking north along the bedrock ledge.

Fig 20.4 Low Wall Spring: *Hyla arenicolor* (Canyon Treefrog)

21. Montezuma Well

Summary Report, Site ID 263

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Montezuma Well ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the National Park Service. The spring is located in the Montezuma Castle NM, in the Lake Montezuma USGS Quad, at 34.64916, -111.75223 measured using a map (NAD83). The elevation is approximately 1083 meters.

Physical Description: Montezuma Well is a mound-form/limnocrene spring. This site is a collapsed carbonate mound, limnocrene spring. It is located in Montezuma Castle National Monument. It has a rich human history in spite of a high naturally-occurring arsenic level that likely posed health risks to those who used the water. The NPS has constructed trails that, for the most part, keep people from trampling the site that receives around 200,000 visitors per year.

Geomorphology: Montezuma Well emerges as a tubular or conduit spring from the Verde formation, a sedimentary, limestone rock layer. The emergence environment is subaqueous-lentic freshwater, with a gravity flow force mechanism. The site receives approximately 91% of available solar radiation, with 6781 Mj annually.

Access Directions: From the I-17 McGuireville exit, follow the signs for Montezuma Well about 5 miles.

5/08/23 Survey

Larry Stevens and Lauren Vanier surveyed the site on 5/08/23 for 02:45 hours, beginning at 13:30, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 21.1 Montezuma Well: Montezuma Well as viewed from the trail overlook.

Microhabitats: The microhabitats associated with the spring cover 16395 sqm. The site has 4 microhabitats, including A -- a 9855 sqm pool, B -- a 896 sqm terrace, C -- a 5500 sqm colluvial slope, D -- a 144 sqm terrace. The geomorphic diversity is 0.38, based on the Shannon-Weiner diversity index.

Table 21.1 Montezuma Well Microhabitat characteristics.

Code	**A**	**B**	**C**	**D**
Name	Pool	Limnocrene wetland	Desert slope	Tunnel
Area sqm	9855	896	5500	144
Surface type	P	TE	CS	TE
Surface subtype				
Slope variability		Low	Med	Med
Aspect TN				1
Slope degrees	0	5	45	15
Moisture (scale 1-10)	10	9	2	8
Water depth cm	1700	40	0	25
Area % open water	95	15	0	15
Substrate				
1 - Clay %	0	0	2	0
2 - Silt %	20	0	3	20
3 - Sand %	5	0	0	0
4 - Fine gravel %	0	0	5	5
5 - Coarse gravel %	0	0	30	10
6 - Cobble %	0	0	20	45
7 - Boulder %	0	2	35	10
8 - Bedrock %	0	0	5	10
Organic %	75	98	0	0
Other % (anthropogenic)	0	0	0	0
Precipitate %	0	0	0	25

Code	A	B	C	D
Litter %	70	98	70	90
Wood %	0	1	1	3
Litter Depth (cm)	100	50	2	5

Survey Notes: This visit included four attendees of the Pulliam Verde 2023 volunteer workshop. The park had good attendance, with at least 40 other visitors at the time of this survey. The creek next to the Well was low (approximately 30-40 cfs) after having recently flooded after an especially wet winter. There was a black hawk nest in the creek riparian zone, and surveyors and volunteers observed one bathing in the creek. There is an NPS staff gauge, and NPS employee Jim Starkey reported 1.06 feet on the gauge on this day. Mr. Starkey reported Montezuma Well as being lower than he had seen it in years, and a dead patch of Tule in polygon D may be related to the lowering water table. Invasive Bromus grass is common and poses a fire risk.

Flow: Surveyors measured a flow of 69.4 liters/second. Flow information was gathered from an NPS website (updated Nov 29, 2021) that reports the Well has a constant inflow of 4,164 L/min. Information from https://www.nps.gov/subjects/protectingwater/his-parkreport.htm?unitType=Park&Site=MOCA. This spring is perennial.

Water Quality: Surveyors measured water quality down-gradient from the well at 20 meters downstream of the tunnel in flowing water in the irrigation ditch. Location 1: down-gradient from the spring source in flowing water at 14:14.

Table 21.2 Montezuma Well Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.451	1	Hanna Combo
pH (field)	6.68	1	Hanna Combo
Specific conductance (field) (uS/cm)	864	1	Hanna Combo
Temperature, air C	29	1	Handheld therm
Temperature, water C	25	1	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 30 plant species at the site, with 0.0018 species/sqm. These included 25 native and 3 nonnative species; the native status of 2 species remains unknown.

Table 21.3 Montezuma Well Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	13	5
Shrub	13	5
Mid-canopy	4	4

Cover Type	Species Count	Wetland Species Count
Tall canopy	0	0
Basal	0	0
Aquatic	1	1
Non-vascular	2	1

Table 21.4 Montezuma Well Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
Acacia greggii	SC	N	F		0	0	1	0
algae	NV	N?	A		20	3	0	80
Atriplex canescens	SC	N	F		0	0	10	0
Berula	GC		W		1	3	0	2
Bromus diandrus	GC	I	F		0	5	12	0
Bromus rubens	GC	I	U		0	0	15	0
Celtis laevigata var. reticulata	MC	N	R		0	0	2	5
Celtis laevigata var. reticulata	SC	N	R		0	2	5	5
Eleocharis	GC	N	W		1	20	0	0
Ephedra viridis	SC	N	U		0	0	2	0
Equisetum laevigatum	GC	N	WR		0	2	0	0
Fraxinus pennsylvanica var. velutina	MC	N	WR		0.5	3	2	0
Fraxinus pennsylvanica var. velutina	SC	N	WR		0.5	3	2	0
Gutierrezia sarothrae	SC	N	U		0	0	1	0
Juglans major	MC	N	R		0	0	4	0
Juniperus monosperma	SC	N	U		0	0	2	0
Mirabilis multiflora	GC	N	U		0	0	0.1	0
Nasturtium officinale	GC	I	W		0	0	0	20
Nicotiana trigonophylla	GC	N	U		0	0	0.1	0
Penstemon palmeri	GC	N	U	On north-facing slopes	0	0	0.1	0
Potamogeton	AQ	NI	A		18	0	0	0
Prosopis glandulosa	SC	N	F		0	3	20	0
Rhus trilobata	SC	N	F		0	0	0.1	0
Salix exigua	SC	N	WR		0	8	1	0
Salix gooddingii	MC	N	R		0	1	3	0
Salix gooddingii	SC	N	R		2	2	3	8
Schoenoplectus acutus var. occidentalis	GC	N	WR		5	50	0	0
Sphaeralcea	GC	N	U		0	0	0.2	0
Toxicodendron rydbergii	SC	N	F		0	0.5	0	5
Typha domingensis	GC	N	A		1.5	3	0	0

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
unknown Bryophyte (moss, liverwort, hornwort)	NV	N?			0	0	1	0
unknown grass	GC				0	80	0	0
Vitis arizonica	SC	N	R		0	0	3	0

Fauna: Larry Stevens was the wildlife biologist for this survey. Surveyors collected or observed 22 invertebrate taxa, including 7 aquatic and 15 terrestrial invertebrate taxa, and 26 vertebrate taxa.

Table 21.5 Montezuma Well Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Araneae Pisauridae Dolomedes triton	Ad	A	Spot		1	In irrigation ditch
Diptera Chironomidae	Ad	T	Spot		100	
Hemiptera Aphididae	M	T	Spot		200	Large, brown; on Plantago major
Hemiptera Belostomatidae Belostoma bakeri	L	A	Spot		1	
Hemiptera Naucoridae Ambrysus	M	A	Spot		2	newly detected
Hemiptera Veliidae Rhagovelia distincta	M	A	Spot		200	
Hirudinida Erpobdellidae	L	A	Spot		1	
Hymenoptera Pompilidae Pepsis thisbe	Ad	T	Spot		1	
Isopoda	M	A	Spot		2	
Lepidoptera Hesperiidae Heliopetes ericetorum	Ad	T	Spot		2	
Lepidoptera Hesperiidae Pyrgus scriptura	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio polyxenes	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		1	
Lepidoptera Pieridae Abeis nicippe	Ad	T	Spot		1	
Lepidoptera Pieridae Colias eurytheme	Ad	T	Spot		3	
Lepidoptera Pieridae Nathalis iole	Ad	T	Spot		1	
Lepidoptera Pieridae Pontia protodice	Ad	T	Spot		16	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Neotaenioglossa Hydrobiidae Pyrgulopsis montezumensis	M	A	Spot		100	
Odonata Aeshnidae Rhionaeschna multicolor	Ad	T	Spot		1	
Odonata Coenagrionidae Telebasis salva	Ad	T	Spot		1	red
Odonata Libellulidae Libellula saturata	Ad	T	Spot		1	
Trichoptera Hydroptilidae Metrichia	Ad	T	Spot		25	

Table 21.6 Montezuma Well Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Common Black Hawk	1	Obs	Bathing In Creek Adjacent To Nesting Site.
Red-winged Blackbird	8	Obs	Calls From Many
Mallard	2	Obs	Male And Female Pair
Turkey Vulture	5	Obs	
Brown-crested Flycatcher		Call	In Creek
Hummingbird	2	Obs	
Rock Squirrel	2	Obs	
Lesser Goldfinch	1	Obs	
Canyon Wren	1	Obs	
Red-tailed Hawk	1	Obs	
Pied-billed Grebe	1	Obs	
Northern Rough-winged Swallow	8	Obs	
Violet-green Swallow	2	Obs	
Virginia Rail		Call	
Sora		Call	
Vermilion Flycatcher	1	Obs	
White-throated Swift	2	Obs	
Sonora Mud Turtle		Rep	Reported Last Week
House Finch	1	Obs	
Mourning Dove		Call	
Common Muskrat	1	Rep	Reported Last Week, Swimming In Well.
Common Raven	2	Obs	
Townsend's Big-eared Bat		Rep	Maternity Roost - Lower Trail Is Closed As A Result.
Gray Fox	3	Rep	Reported Last Week; Mother With Kits
White-nosed Coati	1	Rep	Reported Last Week
Tree Swallow		Rep	Reported Last Week

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are very good with excellent restoration potential (average condition score 5.3) and there is low risk (average risk score 2.5). Geomorphology condition is good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2.4). Habitat condition is very good with excellent restoration potential (average condition score 5.2) and there is low risk (average risk score 2.6). Biotic integrity is very good with excellent restoration potential (average condition score 5.5) and there is low risk (average risk score 2.1). Human influence of site is very good with excellent restoration potential (average condition score 5.3) and there is low risk (average risk score 2). Overall, the site condition is very good with excellent restoration potential and there is low risk.

Table 21.7 Montezuma Well Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	5.3	2.5
Geomorphology	4.8	2.4
Habitat	5.2	2.6
Biota	5.5	2.1
Human Influence	5.3	2
Overall Ecological Score	5.3	2.3

Management Recommendations: Continue ecological investigation, especially of the Ambrysus creeping water bug that has been newly detected in the Well. Monitor flow on a daily basis, monitor groundwater within the catchment, and integrate all existing information.

Fig 21.2 Montezuma Well Sketchmap: Aerial photograph of Montezuma Well.

22. Mushroom Rock Seep
Summary Report, Site ID 255220
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Mushroom Rock Seep ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.90755, -111.72709 measured using a GPS (WGS84, estimated position error 5 meters). The elevation is approximately 1381 meters.

Physical Description: Mushroom Rock Seep is a hillslope/rheocrene spring. Seepage emerges from creek left of Fairy Creek and fills a small pool. The pool is 2 by 1.5 meters and 15 centimeters deep. The seep is regularly overtopped by Fairy Creek.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Turn right where the road forks and drive 300 meters. Hike southwest (road right) approximately 250 meters to Fairy Creek. While the access road is private, the site is located on the National Forest between two private communities.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 14:50. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 22.1 Mushroom Rock Seep: View of the pool from the source looking upstream.

Survey Notes: The pool supports abundant invertebrate life.

Fauna: Surveyors collected or observed 7 invertebrate taxa, including 5 aquatic and 1 terrestrial invertebrate taxa.

Table 22.1 Mushroom Rock Seep Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Coleoptera Carabidae Bembidion	Ad	T			1	
Coleoptera Hydrophilidae Tropisternus	Ad	A			1	
Diptera Culicidae Culiseta	L	A			1	
Hemiptera Gerridae Aquarius remigis	Ad	A			1	
Lumbriculida Lumbriculidae		A			1	
Trichoptera Limnephilidae	L	A	Collected spot		1	
Trichoptera Limnephilidae			Spot		1	Glyphotalius

23. Mushroom Rock Spring
Summary Report, Site ID 255219
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Mushroom Rock Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.90752, -111.72724 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1381 meters.

Physical Description: Mushroom Rock Spring is a hillslope/rheocrene spring. Flow emerges creek right and plunges 1 meter into Fairy Creek where the creek forms a natural pond. The spring has flowed consistently for at least 30 years, according to Georgie Pongyesva.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Turn right where the road forks and drive 300 meters. Hike southwest (road right) approximately 250 meters to Fairy Creek. While the access road is private, the site is located on the National Forest between two private communities.

5/26/23 Survey
Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 14:50. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 23.1 Mushroom Rock Spring: Outflow into Fairy Creek, viewed from creek left, facing west.

Survey Notes: The site was observed to be unaffected by disturbance or humans. Surveyors determined volumetric measurement as suitable for measuring flow at this site.

Fauna: Surveyors collected or observed 1 invertebrate taxon, including 1 aquatic invertebrate taxon.

Table 23.1 Mushroom Rock Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Trichoptera	L	A	Collected spot		1	

24. Parsnip Spring
Summary Report, Site ID 11621
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Parsnip Spring ecosystem is located in Gila County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Tonto NF, Payson RD, in the Pine USGS Quad, at 34.43330, -111.43149 measured using a GPS (WGS84, estimated position error 6 meters). The elevation is approximately 1831 meters.

Physical Description: Parsnip Spring is a hillslope spring. Flow emerges from the base of a west facing colluvial slope 30 meters east of Pine Creek and 30 meters east (upslope) of the Pine Creek Trail. A sign on the trail points to the spring and a well-established trail leads to the source that is also signed.

Geomorphology: Parsnip Spring emerges as a seepage or filtration spring from the Coconino, a sedimentary, sandstone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism.

Access Directions: From Pine, Arizona drive north on Pine Creek Rd to the Lo Mia Youth Camp gate, where you will need permission to enter. Contact Sister Brewer at (928)707-4756 or Elder Brewer at (928)240-4756 ahead of time for permission to access. From the northern end of the camp hike north on the Pine Creek Trail 1.89 kilometers. The spring is 30 meters on the east side of the trail. Rattlesnakes have been reported on the trail, prepare accordingly.

6/29/23 Survey
Larry Stevens, Jeri Ledbetter, Izzie Speer, Ingrid French, Helen Waltz, and Genna Watson surveyed the site on 6/29/23 for 01:30 hours, beginning at 11:30, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Microhabitats: The microhabitats associated with the spring cover 113 sqm. The site has 3 microhabitats, including A -- a 40 sqm channel, B -- a 55 sqm terrace, C -- a 18 sqm colluvial slope. The geomorphic diversity is 0.44, based on the Shannon-Weiner diversity index.

Fig 24.1 Parsnip Spring: View from 3.5 meters on tape, looking upslope at the source and Parsnip Spring sign.

Table 24.1 Parsnip Spring Microhabitat characteristics.

Code	**A**	**B**	**C**
Name	Source channel	Channel margins	Colluvial slope
Area sqm	40	55	18
Surface type	CH	TE	CS
Surface subtype	run		
Slope variability	Low	Low	Low
Aspect TN	296	296	296
Slope degrees	6	6	55
Moisture (scale 1-10)	10	4	2
Water depth cm	15	0	0
Area % open water	10	0	0
Substrate			
1 - Clay %	0	0	0
2 - Silt %	5	5	25
3 - Sand %	50	40	25
4 - Fine gravel %	15	10	20
5 - Coarse gravel %	8	10	20
6 - Cobble %	7	10	10
7 - Boulder %	0	2	0

Code	A	B	C
8 - Bedrock %	0	0	0
Organic %	15	23	0
Other % (anthropogenic)	0	0	0
Precipitate %	0	0	0
Litter %	10	70	5
Wood %	15	12	.1
Litter Depth (cm)	2	3	.1

Survey Notes: A trail leads directly to the source, which has been excavated. Surveyors noted little other human impact. Trees have been removed for thinning. The US Forest Service is planning to helicopter log in the area. A tree above the source is marked to retain. A second tree near the source is to be removed and may be a good specimen for dendrochronology. The outflow continues downslope and crosses the Pine Creek Trail.

Flow: Surveyors measured a flow of 0.94 liters/second, using a flume. Flow was adjusted for an estimate of 95% of site flow capture. The flume used was 4 inches and was placed 13.7 meters downstream of the source.

Water Quality: Surveyors measured water quality in a previously excavated pool at the source. Location 1: at the spring source in standing water at 11:11.

Table 24.2 Parsnip Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved oxygen (field) (mg/L)	5	1	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.089	1	Hanna Combo
pH (field)	6.85	1	Hanna Combo
Specific conductance (field) (uS/cm)	178	1	Hanna Combo
Temperature, air C	26	1	Handheld therm
Temperature, water C	11.8	1	Hanna Combo

Flora: Surveyors identified 22 plant species at the site, with 0.1947 species/sqm. These included 21 native and 1 nonnative species.

Table 24.3 Parsnip Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	13	8
Shrub	5	1
Mid-canopy	3	1
Tall canopy	4	2
Basal	1	0
Aquatic	0	0
Non-vascular	1	1

Table 24.4 Parsnip Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Acer negundo	MC	N	R		15	20	10
Acer negundo	SC	N	R		15	18	25
Acer negundo	TC	N	R		3	4	0
Alnus oblongifolia	TC	N	R	Verified by Glenn Rink	15	18	0
Aquilegia chrysantha	GC	N	W		3	5	0.2
Carex occidentalis	GC	N	W	Verified by G. Rink.	2	1	0
Elymus glaucus ssp. glaucus	GC	N	U	Verified by Glenn Rink	0.1	0.3	0
Equisetum laevigatum	GC	N	WR		0	0.001	0
Frangula californica	SC	N	U	Verified by Glenn Rink	0	0.2	0
Galium triflorum	GC	N	F	Verified by Glenn Rink	0.1	0.2	0
Glyceria striata	GC	N	W	Verified by Glenn Rink	2	2	0
Juglans nigra	GC	N	R		0	0.1	0.1
Lactuca tatarica	GC	N	WR	Mulgedium oblongifolium Ver G.Rink	0	0.1	0
Lonicera arizonica	SC	N	U	Verified by Glenn Rink.	0	0.1	0
Nasturtium officinale	GC	I	W		85	1	0
Osmorhiza chilensis	GC	N	U	Verified by Glenn Rink.	0	0.1	0
Pinus ponderosa	BC	N	U	2 giant at source, dendrochronology	0	0	8
Pinus ponderosa	MC	N	U		2	5	0
Pinus ponderosa	TC	N	U		5	8	80
Poa pratensis	GC	NI	F	Verified by Glenn Rink	0	2	0
Prunus virginiana	SC	N	F		1	8	1
Pseudotsuga menziesii	MC	N	U		3	5	0
Pseudotsuga menziesii	SC	N	U		5	7	2
Pseudotsuga menziesii	TC	N	U		10	6	0
Pteridium	GC	N	U	brackenfern	5	5	0
unknown moss	NV	N?	WR		5	2	0

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C
Viola	GC	N	WR		0.1	0.1	0

Fauna: Larry Stevens and Helen Waltz recorded fauna during this survey. Surveyors collected or observed 31 invertebrate taxa, including 8 aquatic and 23 terrestrial invertebrate taxa, and 4 vertebrate taxa.

Table 24.5 Parsnip Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Annelida	Ad		Collected spot		1	
Araneae	Ad	T	Collected spot		4	
Araneae Tetragnathidae Tetragnatha	Ad	T	Collected spot		1	
Bivalvia	Ad	A	Collected spot		1	
Coleoptera Carabidae	Ad	T	Collected spot		2	
Coleoptera Lampyridae	Ad	T	Collected spot		2	
Coleoptera Lycidae	Ad	T	Collected spot		2	
Coleoptera Tenebrionidae	Ad	T	Collected spot		1	
Diptera	L		Collected spot		1	
Diptera	Ad	T	Collected spot		5	
Diptera Asilidae	Ad	T	Collected spot		2	
Diptera Culicidae	Ad	T	Collected spot		1	
Diptera Simuliidae	L	A	Collected spot		4	
Hemiptera	Ad	T	Collected spot		1	
Hemiptera Belostomatidae Abedus herberti	Ad	A	Spot		1	
Hemiptera Cicadellidae	Ad	T	Collected spot		1	
Hemiptera Cicadidae	Ad	T	Collected spot		2	
Hemiptera Gerridae Aquarius remigis	Ad	A	Spot		2	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Hymenoptera Formicidae Camponotus	Ad	T	Spot		100	many
Isopoda	Ad	T	Collected spot		1	
Lepidoptera Lycaenidae Celastrina echo	Ad	T	Spot		3	
Lepidoptera Nymphalidae Adelpha eulalia	Ad	T	Spot		2	
Lepidoptera Nymphalidae Junonia coenia	Ad	T	Spot		2	
Lepidoptera Nymphalidae Speyeria nokomis	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio multicaudata	Ad	T	Spot		1	
Lepidoptera Pieridae Colias	Ad	T	Spot		1	
Odonata	Ad	T	Collected spot		2	
Odonata	L	A	Collected spot		18	
Odonata Zygoptera	Ad	T	Collected spot		2	
Opiliones	Ad	T	Collected spot		2	
Plecoptera	L	A	Collected spot		9	
Trichoptera	L	A	Collected spot		3	
Zooplankton Ostracoda	Ad	A	Collected spot		3	

Table 24.6 Parsnip Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Steller's Jay	1	Obs	
Elk		Sign	Scat And Tracks
Acorn Woodpecker		Sign	Tree Holes
Arizona Black Rattlesnake	1	Obs	See Jeri's Cell Phone

Assessment: Assessment scores were compiled in 5 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.5) and there is negligible risk (average risk score 1.3). Geomorphology condition is good with significant restoration potential (average condition score 4.6) and there is low risk (average risk score 2). Habitat condition is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2.2). Biotic integrity is very good with excellent restoration potential (average condition score 5.1) and there is low risk (average risk score 2.1). Human influence of site is very good with

excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.4). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 24.7 Parsnip Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.5	1.3
Geomorphology	4.6	2
Habitat	4.4	2.2
Biota	5.1	2.1
Human Influence	5.4	1.4
Overall Ecological Score	4.9	1.8

Management Recommendations: No management activity is needed except for occasional monitoring. The site is suitable for use as a long-term reference site. Conduct a more detailed inventory of riparian and aquatic invertebrates as time and funding permits. A dendrochronological analysis of the large conifers at the spring source would be informative for determining long-term groundwater responses to climate change over the past half millennium.

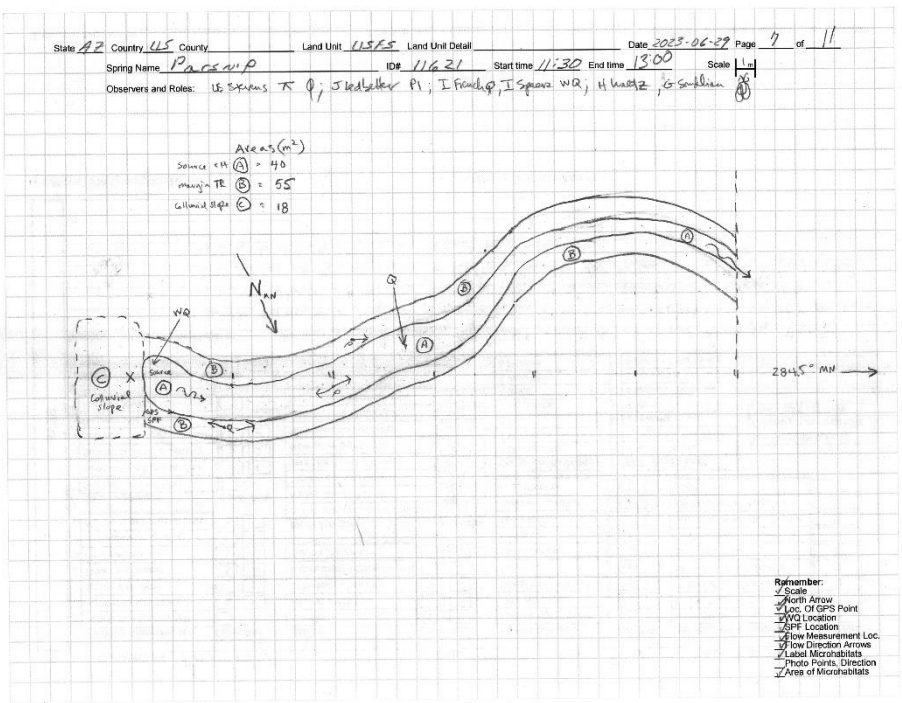

Fig 24.2 Parsnip Spring Sketchmap: June 29, 2023.

Fig 24.3 Parsnip Spring: Surveyors measured flow with a 4 inch flume at 13.7 meters downstream of the source.

25. Parsons Spring
Summary Report, Site ID 10591
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Parsons Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Sycamore Basin USGS Quad, at 34.90362, -112.06434 measured using a GPS (WGS84, estimated position error 5 meters). The elevation is approximately 1135 meters.

Physical Description: Parsons Spring is a rheocrene spring. Flow emerges from the floor of Sycamore Canyon, where a fracture elevates the Redwall Formation for several tens of meters. This spring is subject to heavy surface runoff. This is a linear series of lentic rheocrenic pools emerging from the upstream dry Sycamore Canyon. Flooding after an exceptionally wet winter in 2022-2023 has significantly altered the geomorphology and vegetation.

Geomorphology: Parsons Spring emerges as a seepage or filtration spring from the Redwall Formation, a sedimentary, limestone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 71% of available solar radiation, with 6688 Mj annually.

Access Directions: From Cottonwood, AZ follow the road toward Tuzigoot National Monument and continue 0.4 miles to Sycamore Canyon Road. Turn left on Sycamore Canyon Road and continue to the Parsons trailhead, approximately 9.4 miles. Proceed 3.7 mi upstream along Parsons Trail to the uppermost exposure of water in the creek.

5/12/23 Survey
Larry Stevens, Jeri Ledbetter, Joseph Holway, and Lauren Vanier surveyed the site on 5/12/23 for 02:10 hours, beginning at 13:10, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 25.1 Parsons Spring: The first emergence is below a large sandstone boulder immediately behind the photographer. The photographer is facing downstream, where many additional sources are located on the channel banks, primarily from the right bank.

Microhabitats: The microhabitats associated with the spring cover 2382 sqm. The site has 4 microhabitats, including A -- a 362 sqm pool, B -- a 1180 sqm channel, C -- a 656 sqm terrace, D -- a 184 sqm sloping bedrock. The geomorphic diversity is 0.52, based on the Shannon-Weiner diversity index.

Table 25.1 Parsons Spring Microhabitat characteristics.

Code	A	B	C	D
Name	Pool	Channel	Terrace	Sloping bedrock
Area sqm	362	1180	656	184

Code	A	B	C	D
Surface type	P	CH	TE	SB
Surface subtype				
Slope variability	Low	Low	Med	Med
Aspect TN		201	305	125
Slope degrees	2	3	20	90
Moisture (scale 1-10)	10	2	2	2
Water depth cm	30	0	0	0
Area % open water	80	0	0	0
Substrate				
1 - Clay %	0	0	0	0
2 - Silt %	0	0	20	1
3 - Sand %	5	5	20	1
4 - Fine gravel %	10	15	2	0
5 - Coarse gravel %	40	35	5	0
6 - Cobble %	45	45	50	0
7 - Boulder %	0	0	0	0
8 - Bedrock %	0	0	0	98
Organic %	0	0	3	0
Other % (anthropogenic)	0	0	0	0
Precipitate %	0	0	0	0
Litter %	2	2	1	0
Wood %	2	1	5	2
Litter Depth (cm)	1	0.5	1	0

Survey Notes: Seepage emerges 140 meters upstream from where it was previously mapped. The heavy surface runoff from 2022-2023 snowfall produced an extreme flood event that altered the stream channel, source, and microhabitats. The first seepage emerges at (34.904529, -112.063264), just above a large pool that could be remaining runoff. Many mature trees were uprooted, while others are live and recovering from the 5 meter flood. Surveyors estimated the location of the previous survey and inventoried the same area. The spring appears to be reestablishing itself. Several additional sources emerge from the banks and wall downstream.

Flow: Surveyors measured a flow of 57.48 liters/second, using a current meter. Surveyors estimated flow at 2.5cfs near the end of the tape and converted the value to 70.8L/s. USGS Water Data reported Sycamore Creek stream gauge, which was determined to be in the vicinity by surveyors, read 2.03ft3/s (57.48L/s) at 14:15 on 5/12/2023. This spring is perennial.

Water Quality: Location 1: at the spring source in standing water at 13:13. Location 2: at the spring source in flowing water at 13:13. Location 3: down-gradient from the spring source in flowing water at 13:13.

Table 25.2 Parsons Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.233	1	Hanna Combo
pH (field)	7.52	1	Hanna Combo
Specific conductance (field) (uS/cm)	468	1	Hanna Combo
Temperature, air C	29	1	Handheld therm
Temperature, water C	26.3	1	Hanna Combo
Dissolved Solids (field) (ppt)	0.326	2	Hanna Combo
pH (field)	7.25	2	Hanna Combo
Specific conductance (field) (uS/cm)	660	2	Hanna Combo
Temperature, water C	25.7	2	Hanna Combo
Dissolved Solids (field) (ppt)	0.294	3	Hanna Combo
pH (field)	6.98	3	Hanna Combo
Specific conductance (field) (uS/cm)	585	3	Hanna Combo
Temperature, water C	20.1	3	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 23 plant species at the site, with 0.0075 species/sqm. These included 20 native and 2 nonnative species; the native status of 1 species remains unknown.

Table 25.3 Parsons Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	11	6
Shrub	11	7
Mid-canopy	1	0
Tall canopy	1	0
Basal	0	0
Aquatic	0	0
Non-vascular	1	1

Table 25.4 Parsons Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
Acer negundo	SC	N	R		0	0	3	0
algae	NV	N?	A		90	0	0	0
Apocynum cannabinum	GC	N	WR		0	0.2	0	0
Artemisia ludoviciana	GC	N	F		0	0	0	1
Bromus diandrus	GC	I	F		0	1	30	0
Carex	GC	N	W		0	1.5	0	0

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B	C	D
Celtis laevigata var. reticulata	SC	N	R		0	0.1	8	0
Equisetum arvense	GC	N	WR		1	0	0	2
Equisetum laevigatum	GC	N	WR		0	0.1	0.1	0
Fraxinus pennsylvanica	MC	N	F		3	3	12	10
Fraxinus pennsylvanica	SC	N	F		20	8	20	12
Fraxinus pennsylvanica	TC	N	F		8	3	3	6
Helianthus annuus	GC	N	F		0	0.1	0.1	0
Juglans major	SC	N	R		0	0.1	3	0
Melilotus officinalis	GC	I	WR		0	1	0.1	0
Opuntia	SC	N?	U	cf phaeacanthra	0	0	0	0.2
Parthenocissus vitacea	SC	N	F		0	0.4	0.1	0
Pascopyrum smithii	GC	N	F		0	0	0.1	0
Platanus wrightii	SC	N	R		0	2	0	0
Prosopis juliflora	SC	NI?			0	0	0	0.5
Rhamnus betulifolia	SC	N	WR		0	0.3	3	0
Salix gooddingii	SC	N	R		1	1	0	0
Typha	GC	N	W	domingensis?	0	0.2	0	0
unknown grass	GC				0	0	0	0.1
Vitis arizonica	SC	N	R		0	0.2	10	0

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 11 invertebrate taxa, including 5 aquatic and 5 terrestrial invertebrate taxa, and 6 vertebrate taxa.

Table 25.5 Parsons Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Blattodea	Ad	T	Collected spot		1	
Coleoptera	Ad		Collected spot		3	
Coleoptera Dytiscidae Thermonectus marmoratus	Ad	A	Spot		3	
Diptera Asilidae	Ad	T	Collected spot		1	
Diptera Simuliidae	L	A	Collected spot		2	
Ephemeroptera	L	A	Collected spot		3	
Hemiptera Corixidae	Ad	A	Collected spot		1	
Hymenoptera Sphecidae	Ad	T	Collected spot		1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		1	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		1	
Turbellaria	Ad	A	Collected spot		1	

Table 25.6 Parsons Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Summer Tanager	1	Obs	
Raccoon		Sign	Tracks
Canyon Wren		Call	
Yellow-breasted Chat		Call	
Hummingbird	1	Obs	Black-chinned Or Calliope
Deer		Obs	Carcass

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2). Geomorphology condition is good with significant restoration potential (average condition score 4.6) and there is low risk (average risk score 2.2). Habitat condition is good with significant restoration potential (average condition score 4.2) and there is low risk (average risk score 2.2). Biotic integrity is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2.6). Human influence of site is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.7). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 25.7 Parsons Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.8	2
Geomorphology	4.6	2.2
Habitat	4.2	2.2
Biota	4.4	2.6
Human Influence	5.4	1.7
Overall Ecological Score	4.8	2.1

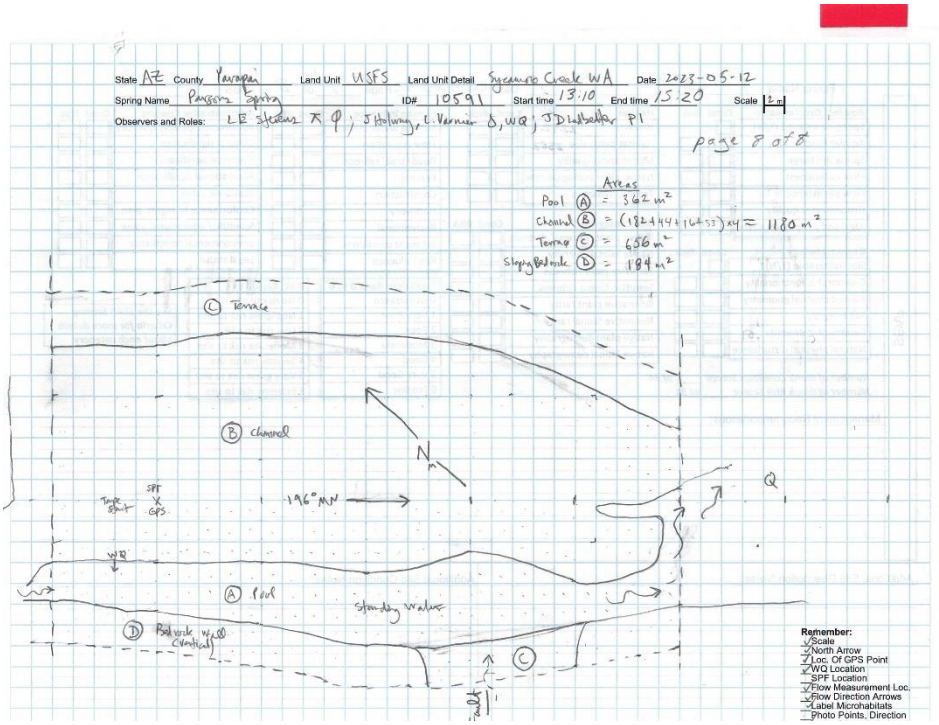

Fig 25.2 Parsons Spring Sketchmap: 2023 Sketchmap.

Fig 25.3 Parsons Spring: Additional sources downstream of the first emergence. Flow is emerging from the areas where red algae is growing.

Fig 25.4 Parsons Spring: View upstream at the stagnant pool from the top of the survey tape. First emergence is upstream of the pool.

26. Pieper Hatchery North Spring
Summary Report, Site ID 255810

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Pieper Hatchery North Spring ecosystem is located in Gila County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Tonto NF, Payson RD, in the Kehl Ridge USGS Quad, at 34.43588, -111.25515 measured using a GPS (WGS84, estimated position error 6 meters). The elevation is approximately 1928 meters.

Physical Description: Pieper Hatchery North Spring is a hillslope spring. Flow emerges from Coconino Sandstone on a rocky southwest facing drainage and flows down a steep slope. The source is located about 100 meters upslope of Pieper Hatchery South.

Geomorphology: Pieper Hatchery North Spring emerges from the Coconino, a sedimentary, sandstone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism.

Access Directions: A 4WD vehicle is recommended. From Pine, Arizona drive southeast on Hwy 87. Turn left (east) onto Fire Control Rd and follow it for 9.3 miles, then turn left (northeast) onto NF-32. Continue of NF-32 for 3.3 miles, staying right at the fork, before turning right onto an unnamed road. Make a quick left (240ft) and continue for one mile to Washington Park Trailhead. From the trailhead, hike the Arizona Trail for .3 miles then scramble east about 367 meters upslope, past Pieper Hatchery South. Surveyors in 2023 noted many downed logs, a steep slope, rattlesnake present on trail, and bear sign nearby site. Prepare accordingly.

6/30/23 Survey

Izzie Speer and Helen Waltz verified the site on 6/30/23 at 10:20. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 26.1 Pieper Hatchery North Spring: View of spring source from 3 meters downslope, looking northeast.

Microhabitats: The site has 1 microhabitat, X.

Table 26.1 Pieper Hatchery North Spring Microhabitat characteristics.

Code	**x**
Name	Source
Area sqm	
Surface type	
Surface subtype	
Slope variability	
Aspect TN	
Slope degrees	

Code	x
Moisture (scale 1-10)	
Water depth cm	
Area % open water	
Substrate	
1 - Clay %	0
2 - Silt %	0
3 - Sand %	0
4 - Fine gravel %	0
5 - Coarse gravel %	0
6 - Cobble %	0
7 - Boulder %	0
8 - Bedrock %	0
Organic %	0
Other % (anthropogenic)	0
Precipitate %	0
Litter %	0
Wood %	0
Litter Depth (cm)	

Survey Notes: In June 2023, surveyors noted little sign of human disturbance, with sign of recent fire within the last 20 years such as downed and charred logs. The dense ground and shrub cover consisting of bracken fern and raspberry provided little overshadowing, giving the source plenty of direct sunlight. Watercress, moss, and liverwort were noted in the channel. Elk sign was present downstream but minimal near the source. The boulders, downed logs, and steep hike seemed to have hindered human visitation to this spring.

Flow: Surveyors recommend volumetric method of measurement for this spring.

Water Quality: Location 1: at the spring source in flowing water at 10:10.

Table 26.2 Pieper Hatchery North Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved oxygen (field) (mg/L)	5	1	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.099	1	Hanna Combo
pH (field)	7.23	1	Hanna Combo
Specific conductance (field) (uS/cm)	198	1	Hanna Combo
Temperature, water C	11.3	1	Hanna Combo

Flora: This is a plant list only; surveyors did not identify microhabitats. Surveyors identified 12 plant species at the site. These included 9 native and 2 nonnative species; the native status of 1 species remains unknown.

Table 26.3 Pieper Hatchery North Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	6	3
Shrub	2	1
Mid-canopy	1	0
Tall canopy	0	0
Basal	0	0
Aquatic	0	0
Non-vascular	2	2

Table 26.4 Pieper Hatchery North Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	X
Aconitum	GC	N	F		
Carex	GC	N	W		
Equisetum	GC	N	WR		
Juglans					
liverwort	NV	N	WR		
Nasturtium officinale	GC	I	W		
Pinus ponderosa	SC	N	U		
Pteridium	GC	N	U		
Quercus gambelii	MC	N	U		
Rubus	SC	NI	R	arizonensis or leucodermis?	
unknown moss	NV	N?	WR		
Verbascum	GC	I	F		

Fauna: Surveyors collected or observed 7 invertebrate taxa, including 1 aquatic and 4 terrestrial invertebrate taxa, and 1 vertebrate taxon.

Table 26.5 Pieper Hatchery North Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Ephemeroptera	L	A	Collected spot		6	
Lepidoptera Lycaenidae Celastrina echo		T			1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera Nymphalidae Adelpha eulalia		T			1	
Lepidoptera Nymphalidae Limenitis weidemeyerii weidemeyerii		T			1	
Lepidoptera Papilionidae		T	Spot		1	large swallowtail, many tailed or tiger
Odonata Coenagrionidae Argia			Spot		1	
Plecoptera					1	collected

Table 26.6 Pieper Hatchery North Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Elk		Sign	Scat

27. Pieper Hatchery South Spring
Summary Report, Site ID 145
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Pieper Hatchery South Spring ecosystem is located in Gila County in the Lower Verde Arizona 15060203 HUC, managed by the US Forest Service. The spring is located in the Tonto NF, Payson RD, in the Kehl Ridge USGS Quad, at 34.43516, -111.25588 measured using a GPS (WGS84, estimated position error 7 meters). The elevation is approximately 1933 meters.

Physical Description: Pieper Hatchery South Spring is a hillslope spring. Flow emerges from Coconino Sandstone into a deeply incised, heavily vegetated channel. Flow from this and a nearby spring was historically used to support a fish hatchery. All traces of the hatchery have been removed except for barrel ponds and sign of channel manipulation. The source is 80 meters upslope from where it is mapped at the hatchery. This is the southern of two large springs emerging from this southwest facing slope. This spring is likely part of a larger springs complex emerging from a mixed conifer forest.

Geomorphology: Pieper Hatchery South Spring emerges as a tubular or conduit spring from the Coconino, a sedimentary, sandstone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 91% of available solar radiation, with 8559 Mj annually.

Access Directions: A 4WD vehicle is recommended. From Pine, Arizona drive southeast on Hwy 87. Turn left (east) onto Fire Control Rd and follow it for 9.3 miles, then turn left (northeast) onto NF-32. Continue of NF-32 for 3.3 miles, staying right at the fork, before turning right onto an unnamed road. Make a quick left (240ft) and continue for one mile to Washington Park Trailhead. From the trailhead, hike the Arizona Trail for .3 miles then scramble east .17 miles (267 meters) upslope until you reach the source. A survey team in 2023 noted many downed logs, steep slopes, rattlesnake present on trail, and bear sign nearby the site. Prepare accordingly.

6/30/23 Survey
Larry Stevens, Jeri Ledbetter, Izzie Speer, Ingrid French, Helen Waltz, and Genna Watson surveyed the site on 6/30/23 for 02:10 hours, beginning at 10:20, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 27.1 Pieper Hatchery South Spring: View looking down channel from log directly above source.

Microhabitats: The microhabitats associated with the spring cover 115 sqm. The site has 2 microhabitats, including A -- a 17 sqm channel, B -- a 98 sqm terrace. The geomorphic diversity is 0.18, based on the Shannon-Weiner diversity index.

Table 27.1 Pieper Hatchery South Spring Microhabitat characteristics.

Code	A	B
Name	Chan-lotic	Rip Terr
Area sqm	17	98
Surface type	CH	TE
Surface subtype	riffle	MRZ
Slope variability	Med	High

Code	A	B
Aspect TN	238	238
Slope degrees	18	50
Moisture (scale 1-10)	10	6
Water depth cm	16	0
Area % open water	15	0
Substrate		
1 - Clay %	0	0
2 - Silt %	0	20
3 - Sand %	0	20
4 - Fine gravel %	25	0
5 - Coarse gravel %	20	0
6 - Cobble %	35	8
7 - Boulder %	0	0
8 - Bedrock %	0	2
Organic %	20	50
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	10	75
Wood %	10	20
Litter Depth (cm)	.2	5

Survey Notes: In June of 2023 the survey team reported no evidence of recent human disturbance, however there was sign of recent fire within the last 20 years with much deadfall in and around the spring channel. Additionally non-native blackberry was present on site, and surveyor Jeri Ledbetter reported hearing noise of water gurgling underneath a sandstone ledge. Vegetation nearby but not onsite included periwinkle (Vinca major), liverwort, and blue lettuce (Mulgedium oblongifolium). These species were verified by Glen Rink.

Flow: Surveyors measured a flow of 3.1 liters/second, using a timed flow volume capture method. Flow was adjusted for an estimate of 95% of site flow capture. Surveyors measured flow 22 meters downstream of source. This spring is perennial.

Water Quality: Surveyors measured water quality where flow exits the Coconino Sandstone. Location 1: at the spring source in flowing water at 10:10.

Table 27.2 Pieper Hatchery South Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved oxygen (field) (mg/L)	5	1	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.114	1	Hanna HI991300
pH (field)	7.08	1	Hanna HI991300
Specific conductance (field) (uS/cm)	228	1	Hanna HI991300
Temperature, air C	28	1	Handheld therm

Characteristic Measured	Value	Location Number	Device
Temperature, water C	12.2	1	Hanna HI991300

Flora: Larry Stevens was the botanist for this survey. Surveyors identified 13 plant species at the site, with 0.1092 species/sqm. These included 10 native and 3 nonnative species.

Table 27.3 Pieper Hatchery South Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	6	3
Shrub	6	1
Mid-canopy	3	1
Tall canopy	0	0
Basal	0	0
Aquatic	0	0
Non-vascular	1	0

Table 27.4 Pieper Hatchery South Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Acer grandidentatum	MC	N	F		10	12
Acer grandidentatum	SC	N	F		20	20
Acer negundo	MC	N	R		8	8
Acer negundo	SC	N	R		5	10
Bromus tectorum	GC	I	U	Verified by Glen Rink	0	1
Equisetum arvense	GC	N	WR		0	0.1
Equisetum laevigatum	GC	N	WR		0.2	1
Nasturtium officinale	GC	I	W		7	1
Pteridium	GC	N	U	Brackenfern	25	20
Ribes	SC	N	F	spineless	1	5
Rubus bifrons	SC	I	F	Verified by Glen Rink	1	3
Rudbeckia laciniata	GC	N	F	Verified by Glenn Rink	2	2
Sambucus glauca	MC	N	F	Verified by Glen Rink	5	10

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Sambucus glauca	SC	N	F	Verified by Glen Rink	0	10
Sambucus glauca	SC	N	F	Verified by Glenn Rink	7	0
unknown Bryophyte (moss, liverwort, hornwort)	NV	N?			1	0

Fauna: Surveyors collected or observed 16 invertebrate taxa, including 2 aquatic and 14 terrestrial invertebrate taxa, and 7 vertebrate taxa.

Table 27.5 Pieper Hatchery South Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Coleoptera Lycidae	Ad	T	Collected spot		1	
Diptera	Ad	T	Collected spot		1	
Diptera Asilidae	Ad	T	Collected spot		1	
Diptera Cuterebridae Cuterebra jellisoni	Ad	T	Spot		1	
Hemiptera Cicadidae	Ad	T	Collected spot		1	
Hymenoptera Formicidae Camponotus	Ad	T	Spot		100	
Lepidoptera Hesperiidae Epargyreus clarus	Ad	T	Spot		3	
Lepidoptera Lycaenidae Celastrina echo	Ad	T	Spot		3	
Lepidoptera Nymphalidae Adelpha eulalia	Ad	T	Spot		6	
Lepidoptera Nymphalidae Megisto rubricata	Ad	T	Collected spot		1	
Lepidoptera Nymphalidae Speyeria	Ad	T	Spot		5	
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		1	
Odonata	Ad	T	Spot		1	
Orthoptera Gryllidae Oecanthus fultoni	L	T	Spot		1	
Plecoptera	L	A	Spot		10	
Trichoptera	L	A	Spot		10	

Table 27.6 Pieper Hatchery South Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Garter Snake	1	Obs	Green 7in Long
Northern Flicker	2	Call	
Elk		Sign	Scat
Red Squirrel	1	Obs	Grey
American Black Bear	1	Sign	Scratch On Tree
Spotted Towhee	1	Call	
Plumbeous Vireo	1	Call	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.7) and there is low risk (average risk score 2). Geomorphology condition is moderate with some restoration potential (average condition score 3.8) and there is low risk (average risk score 2.6). Habitat condition is good with significant restoration potential (average condition score 4.6) and there is low risk (average risk score 2.4). Biotic integrity is good with significant restoration potential (average condition score 4.6) and there is low risk (average risk score 2.4). Human influence of site is very good with excellent restoration potential (average condition score 4.9) and there is low risk (average risk score 2). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 27.7 Pieper Hatchery South Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.7	2
Geomorphology	3.8	2.6
Habitat	4.6	2.4
Biota	4.6	2.4
Human Influence	4.9	2
Overall Ecological Score	4.6	2.2

Management Recommendations: If this site is to be restored for leopard frog habitat it will require development of a rehabilitation and monitoring plan, and coordination with Arizona Game and Fish Department regarding stock and transportation. The previously constructed ponds have filled with fire sediment and the spring brook has eroded through the berries. Re-excavating the ponds and reconnecting inflow into them should be done in such a fashion to minimize maintenance while ensuring long-term sustainability. Lastly, a more detailed inventory of both springs would be useful prior to rehabilitation.

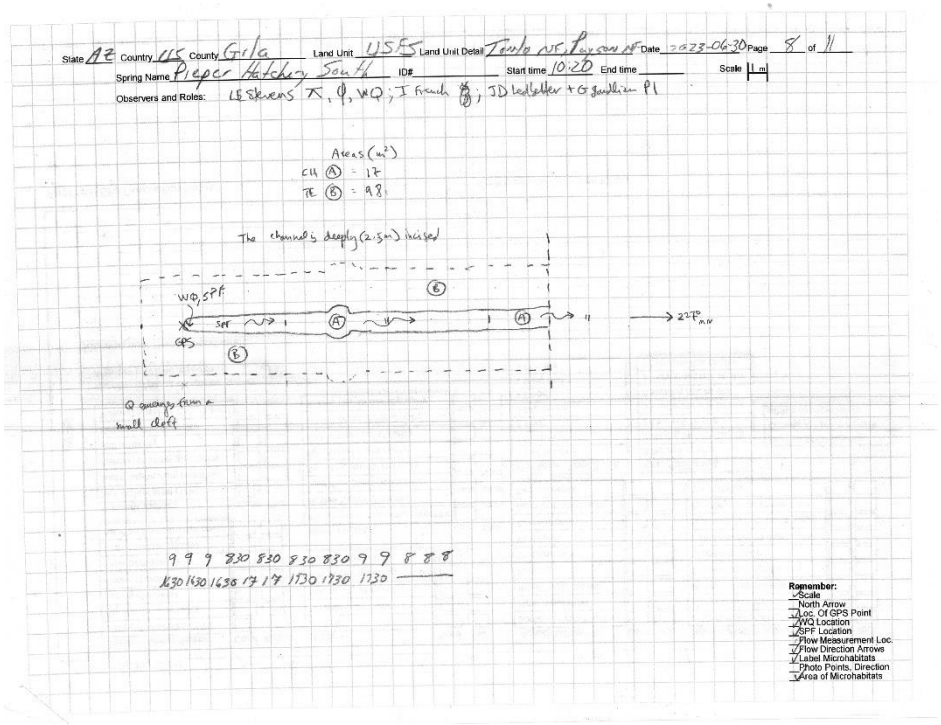

Fig 27.2 Pieper Hatchery South Spring Sketchmap: June 30th, 2023.

28. Summer Spring

Summary Report, Site ID 147

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Summer Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Sycamore Basin USGS Quad, at 34.88078, -112.06630 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1099 meters.

Physical Description: Summer Spring is a hillslope/rheocrene spring. This Redwall Formation aquifer spring emerges at the edge of Sycamore Creek, 3 kilometers from the mouth, in a dense riparian forest. Flow primarily emerges from two discrete sources, with a third seeping source located downslope. After 200 meters, flow confluences with Sycamore Creek. The source is near a heavily used trail. The sources and microhabitats are subject to occasional surface runoff. In the spring of 2023, a huge flow passed through Sycamore Creek, produced by snowmelt after an extremely high snowpack. The flow significantly altered the geomorphology of the spring ecosystem.

Geomorphology: Summer Spring emerges as a seepage or filtration spring from the Redwall Formation, a sedimentary, limestone rock layer. The emergence environment is subaerial, with a gravity flow force mechanism.

Access Directions: From Cottonwood, AZ follow the road toward Tuzigoot National Monument and continue 0.4 miles to Sycamore Canyon Road. Turn left on Sycamore Canyon Road and continue to the trailhead, approximately 9.4 miles. Hike a little over 1 mile upstream on Parsons Trail to the spring.

5/11/23 Survey

Larry Stevens, Jeri Ledbetter, Joseph Holway, and Lauren Vanier surveyed the site on 5/11/23 for 03:30 hours, beginning at 13:50, and collected data in 10 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 28.1 Summer Spring: Surveyors collect invertebrates in the outflow channel. The photographer is standing on a log at the confluence of the outflow of the two sources at 12 meters on the tape.

Microhabitats: The microhabitats associated with the spring cover 608 sqm. The site has 4 microhabitats, including I -- a 21 sqm pool, J -- a 48 sqm pool, K -- a 466 sqm terrace, L -- a 73 sqm channel. The geomorphic diversity is 0.34, based on the Shannon-Weiner diversity index.

Table 28.1 Summer Spring Microhabitat characteristics.

Code	**I**	**J**	**K**	**L**
Name	Pools	Pool B	Terrace	Channel
Area sqm	21	48	466	73
Surface type	P	P	TE	CH
Surface subtype			MRZ	
Slope variability	Low	Low	Med	Low
Aspect TN			263	259
Slope degrees	0	0	15	3
Moisture (scale 1-10)	10	10	4	10
Water depth cm	30	30	0	40
Area % open water	100	100	0	100
Substrate				
1 - Clay %	0	0	0	0
2 - Silt %	50	50	50	50
3 - Sand %	50	50	50	50
4 - Fine gravel %	0	0	0	0
5 - Coarse gravel %	0	0	0	0
6 - Cobble %	0	0	0	0
7 - Boulder %	0	0	0	0
8 - Bedrock %	0	0	0	0
Organic %	0	0	0	0
Other % (anthropogenic)	0	0	0	0

Code	I	J	K	L
Precipitate %	0	0	0	0
Litter %	1	2	5	5
Wood %	60	3	30	65
Litter Depth (cm)	.5	0.5	4	0

Survey Notes: Major spring runoff in March produced a flood of at least 7 meters above the levels of the spring sources, covering both the sources and all the microhabitats. The geomorphology has been significantly altered and is still in the process of stabilizing. Much woody debris and sand covers the cobble that was previously exposed. Surveyors found very little aquatic life in the source and runout channels. Many large downed trees and driftwood have washed onto the site.

Flow: Surveyors measured a flow of 45.74 liters/second, using a non-traditional method. Flow was adjusted for an estimate of 99% of site flow capture. Surveyors used the tagline method in the main outflow channel for both sources at 14 meters on the tape. Flow for the very small diffuse source in the perpendicular channel was not accounted for. Channel cross-section was calculated in lab to be 45.74 L/s

Water Quality: Surveyors measured water quality in flowing water at both primary sources, the small seeping channel source, and in standing water at the end of the perpendicular channel. Location 1: at the spring source in flowing water at 15:15.

Table 28.2 Summer Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved Solids (field) (ppt)	0.26	1	Hanna Combo
pH (field)	6.99	1	Hanna Combo
Specific conductance (field) (uS/cm)	522	1	Hanna Combo
Temperature, air C	26.5	1	Handheld therm
Temperature, water C	19.9	1	Hanna Combo

Flora: Larry Stevens served as the botanist for this survey. Surveyors identified 13 plant species at the site, with 0.0214 species/sqm. These included 7 native and 5 nonnative species; the native status of 1 species remains unknown.

Table 28.3 Summer Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	7	4
Shrub	5	4
Mid-canopy	3	2
Tall canopy	3	2
Basal	2	1

Cover Type	Species Count	Wetland Species Count
Aquatic	0	0
Non-vascular	1	1

Table 28.4 Summer Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	I	J	K	L
Acer negundo	BC	N	R		0	0	0.5	0
Acer negundo	MC	N	R		30	0	15	0
Acer negundo	SC	N	R		20	0	10	0
Acer negundo	TC	N	R		20	0	15	0
algae	NV	N?	A		5	60	0	0
Alnus	MC	N	WR		0	8	8	10
Alnus	SC	N	WR		0	0.1	0.2	5
Alnus	TC	N	WR		0	15	20	12
Aquilegia chrysantha	GC	N	W		0	0	0.2	0
Bromus diandrus	GC	I	F		10	0	40	3
Elymus virginicus	GC	N	F	Verified by Glenn Rink	0	0	0.2	0.1
Fraxinus	GC		R		0	0	0.01	0
Fraxinus pennsylvanica	BC	N	F		0	0	1	0
Fraxinus pennsylvanica	MC	N	F		0	10	14	20
Fraxinus pennsylvanica	SC	N	F		0	5	3	8
Fraxinus pennsylvanica	TC	N	F		0	70	45	60
Nasturtium officinale	GC	I	W		0	2	0.1	2
Rubus armeniacus	SC	I	R		15	15	40	20
Salix gooddingii	SC	N	R		0	0	0.01	0
Sonchus asper	GC	I	WR		3	0	0.1	0
Verbascum	GC	I	F		0	0	0.1	0.05

Fauna: Jeri Ledbetter recorded faunal observations for this survey. Surveyors collected or observed 21 invertebrate taxa, including 11 aquatic and 10 terrestrial invertebrate taxa, and 5 vertebrate taxa. Surveyors conducted quantitative benthic sampling at this spring.

Table 28.5 Summer Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Annelida	Ad		Collected spot		1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Bivalvia	Ad	A	Preserved benthic	1	1	Clam
Coleoptera	Ad		Collected spot		4	
Coleoptera	Ad	A	Preserved benthic	2	1	
Coleoptera	Ad	A	Preserved benthic	1	1	
Coleoptera Chrysomelidae	Ad	T	Collected spot		1	
Coleoptera Coccinellidae	L	T	Collected spot		1	
Coleoptera Curculionidae	Ad	T	Collected spot		1	
Diptera Chironomidae	L	A	Collected spot		5	
Diptera Chironomidae	L	A	Preserved benthic	1	3	
Diptera Chironomidae	L	A	Preserved benthic	3	1	light brown
Diptera Chironomidae Chironomus	L	A	Uncollected benthic	3	5	Blood worm
Diptera Culicidae	Ad	T	Spot		1	Many
Ephemeroptera	Ad	T	Collected spot		1	
Ephemeroptera	L	A	Preserved benthic	2	1	
Ephemeroptera	Ad	T	Preserved benthic	3	1	Dead
Hemiptera Aphididae	Ad	T	Collected spot		3	
Hemiptera Berytidae	Ad	T	Collected spot		1	
Hemiptera Gerridae Aquarius remigis	Ad	A	Collected spot		1	
Hemiptera Notonectidae Notonecta	Ad	A	Preserved benthic	1	1	
Mollusca	Ad		Collected spot		2	
Mollusca Gastropoda	Ad		Collected spot		4	
Mollusca Gastropoda	S	A	Preserved benthic	3	1	
Odonata Calopterygidae Hetaerina vulnerata	L	A	Uncollected benthic	3	1	
Odonata Calopterygidae Hetaerina vulnerata	Ad	T	Spot		3	
Odonata Coenagrionidae Argia vivida	Ad	T	Spot		2	in copulation
Sphaeriida Sphaeriidae Pisidium	Ad	A	Preserved benthic	1	3	

Table 28.6 Summer Spring Benthic Invertebrate Sampling.

Rep#	Velocity (m/sec)	Depth (cm)	Area (sq m)	Time (sec)	Location	Substrate	Comments
1	0.30	30	1.39	60	14 m	50% 2; 50% 3	Covered with woody debris

Rep#	Velocity (m/sec)	Depth (cm)	Area (sq m)	Time (sec)	Location	Substrate	Comments
2	0.30	25	1.39	60	17 m	60% 3; 40% Org	Covered with woody debris
3	0.30	13	1.39	60	22 m	60% 3; 40% Org	

Table 28.7 Summer Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Yellow Warbler		Call	
Mourning Dove		Call	
Hummingbird	1	Obs	
House Finch	2	Call	
Rock Squirrel	1	Call	

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.8) and there is low risk (average risk score 2). Geomorphology condition is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2.2). Habitat condition is moderate with some restoration potential (average condition score 3.8) and there is low risk (average risk score 2.2). Biotic integrity is good with significant restoration potential (average condition score 4.4) and there is low risk (average risk score 2.6). Human influence of site is very good with excellent restoration potential (average condition score 5.4) and there is negligible risk (average risk score 1.7). Overall, the site condition is good with significant restoration potential and there is low risk.

Table 28.8 Summer Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.8	2
Geomorphology	4.4	2.2
Habitat	3.8	2.2
Biota	4.4	2.6
Human Influence	5.4	1.7
Overall Ecological Score	4.7	2.1

Management Recommendations: Monitor occasionally.

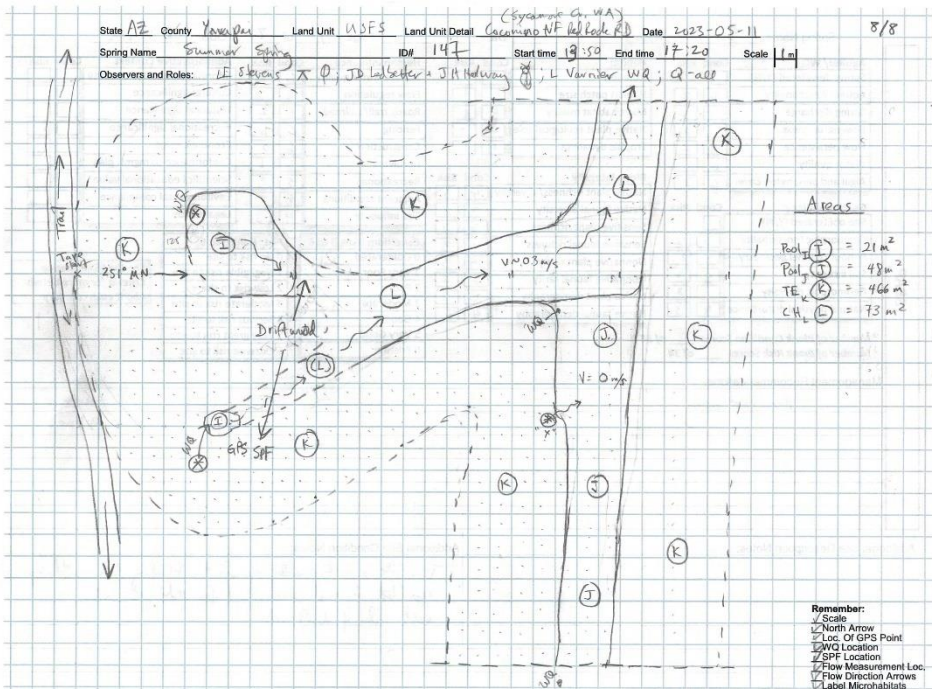

Fig 28.2 Summer Spring Sketchmap: 2023 Sketchmap

Fig 28.3 Summer Spring: The southern source as viewed from the left bank at 8 meters on the tape.

Fig 28.4 Summer Spring: The northern source with a large log for reference.

29. Thompson Spring
Summary Report, Site ID 255223
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Thompson Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.91241, -111.72318 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1361 meters.

Physical Description: Thompson Spring is a hillslope/rheocrene spring. Flow emerges approximately 10 meters above Munds Creek baseflow stage within an established channel and continues about 30 meters downslope to Munds Creek. The spring is the baseflow source of Munds Creek.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Take the first left and park at the end of the road. Hike about 300 meters upstream in Munds Creek. The spring is on the high terrace on creek right. While access via Thompson Road passes through private communities, the site itself is located on the National Forest.

5/27/23 Survey
Larry Stevens and Georgie Pongyesva verified the site on 5/27/23 at 9:30. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

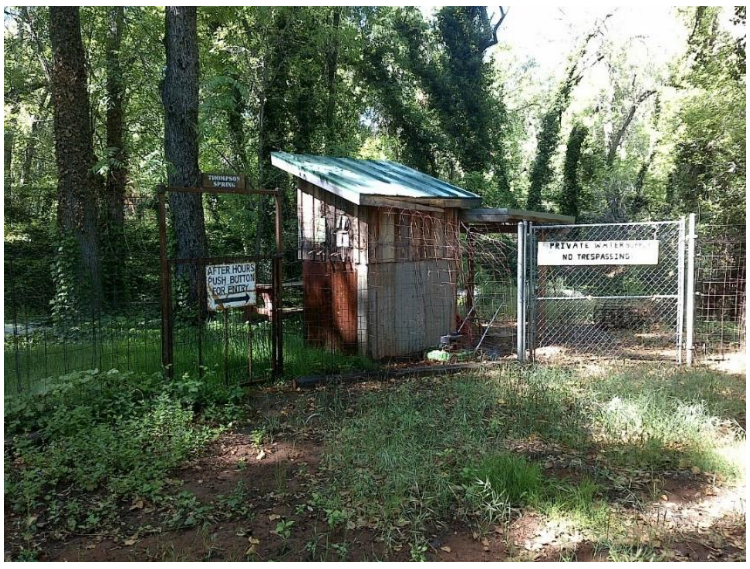

Fig 29.1 Thompson Spring: The spring, fencing, and helocrene, viewed looking towards Munds Creek.

Survey Notes: Surveyors reported a highly manipulated site with multiple pipes, an irrigation system, roads, and complex recent fencing. A 30 by 15 meter partially irrigated helocrene was observed at the site, surveyors were unable to determine the reason for irrigation. The site was strongly dominated by non-native English ivy. Surveyors determined flume to be the most suitable method of measuring flow at this site.

Fauna: Surveyors collected or observed 4 invertebrate taxa, including 2 aquatic and 2 terrestrial invertebrate taxa.

Table 29.1 Thompson Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Amphipoda	Ad	A	Collected spot		3	
Diptera Culicidae	Ad	T	Collected spot		3	
Hemiptera Aphididae	Ad	T	Collected spot		2	
Trichoptera	L	A	Collected spot		2	

30. Thompson Springhouse Spring
Summary Report, Site ID 255215

Submitted 9/18/23 by Springs Stewardship Institute

Location: The Thompson Springhouse Spring ecosystem is located in Coconino County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Munds Park USGS Quad, at 34.90897, -111.72660 measured using a GPS (WGS84, estimated position error 3 meters). The elevation is approximately 1393 meters.

Physical Description: Thompson Springhouse Spring is a hillslope/rheocrene spring. The spring emerges within a historic springhouse and flows under the downstream wall, where the springbrook is joined by outflow from a small spring in a decomposing concrete springbox. The springhouse is built of sandstone and timber, with a tin roof. Six meters from the springhouse, the channel has been culverted and emerges at nine meters. The springbrook flows about 100 meters to form the headwaters of Fairy Creek, a tributary of Oak Creek. The spring emerges in the floodplain of Oak Creek in deciduous riparian forest dominated by ash (Fraxinus), sycamore (Platanus), alder (Alnus), and bamboo (Bambusa).

Geomorphology: Thompson Springhouse Spring emerges as a seepage or filtration spring from a sedimentary rock layer. The emergence environment is subaerial, with a gravity flow force mechanism. The site receives approximately 99% of available solar radiation, with 9029 Mj annually.

Access Directions: From Highway 89A in Oak Creek Canyon, enter the Indian Gardens community (gate code 3479 as of May 2023). Turn right where the road forks and drive 300 meters. The springhouse is visible to the right of the road, about 50 meters downslope at the downstream end of the meadow. While the access road is private, the site is located on the National Forest between two private communities.

5/26/23 Survey

Larry Stevens, Helen Waltz, and Georgie Pongyesva verified the site on 5/26/23 at 13:30. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Fig 30.1 Thompson Springhouse Spring: Flow emerges from the downstream (southeast) side of the historic springhouse, forming a springbrook.

Survey Notes: There is no sign of recent human visitation, except for a trail leading to the site. The March 2023 high flow in Oak Creek did not reach the springhouse. The springbrook is densely covered by non-native blackberry and native Indian hemp, and supports common Physidae aquatic snails and Helicopsychidae caddisflies. Surveyors determined flume measurement of flow to be the most suitable method at this site.

Fauna: Surveyors collected or observed 4 invertebrate taxa, including 2 aquatic and 1 terrestrial invertebrate taxa.

Table 30.1 Thompson Springhouse Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Lepidoptera	Ad	T	Collected spot		1	
Mollusca Gastropoda	Ad		Collected spot		5	
Trichoptera	L	A	Collected spot		9	
Turbellaria	Ad	A	Collected spot		1	

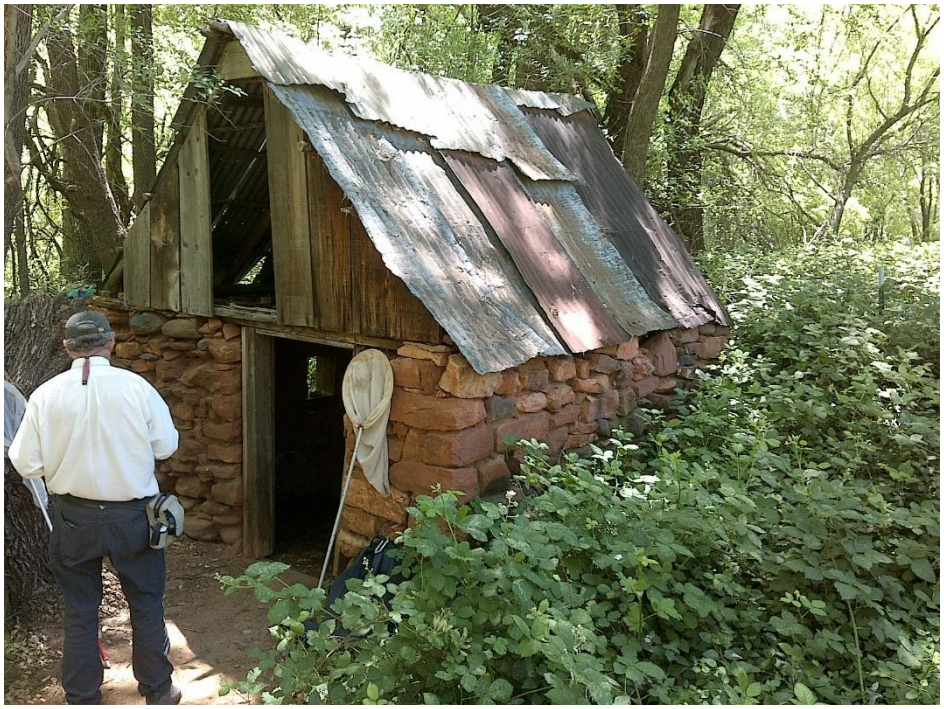

Fig 30.2 Thompson Springhouse Spring: The historic springhouse, as viewed facing south

Fig 30.3 Thompson Springhouse Spring: The springhouse interior and spring source

31. Wet Beaver Headwaters Spring
Summary Report, Site ID 255225
Submitted 9/18/23 by Springs Stewardship Institute

Location: The Wet Beaver Headwaters Spring ecosystem is located in Yavapai County in the Upper Verde Arizona 15060202 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Red Rock RD, in the Apache Maid Mountain USGS Quad, at 34.68667, -111.57535 measured using a GPS (WGS84, estimated position error 20 meters). The elevation is approximately 1573 meters.

Fig 1.1 Wet Beaver Headwaters Spring: 6/04/23. View of seepage and pool.

Physical Description: Wet Beaver Headwaters Spring is a rheocrene spring. Seepage emerges from Wet Beaver Creek channel floor and creates a large (30 meter long) pool. Discharge increases from the source area downstream to Wet Beaver Creek Alcove (1118) to create the entire flow of the creek that is gauged by the USGS downstream.

Geomorphology: The site receives approximately 76% of available solar radiation, with 7257 Mj annually.

Access Directions: Turn off I-17 at the Stoneman Lake exit, and proceed east to the end of the pavement. Go right (south) at the T-intersection for 4.8 miles, passing by Apache Maid Mountain which is now to the west. At the next T junction at Apache Maid Cabin, turn right (west) and continue 1.6 miles towards the lookout tower which is on top of Apache Maid Mountain. Before the switchbacks that climb the mountain, turn left (west) onto 620 E. Go 0.2 miles on this very rough road, park and walk to the rim edge. The

hike into the creek is extremely brushy with some elk trails on the upper half. Once you reach the creek, hike downstream 1.5 kilometers to the source.

Summary Data

Survey History: Springs Online contains 2 surveys for this site on 6/04/23 and 6/04/23, with the highest extent of data (EOD) in 9 of 10 categories and an average EOD of 6.

Table 1.1 Wet Beaver Headwaters Spring Surveys.

Date	Extent of Data	Survey Protocol	Project Name	Surveyors
6/04/23	**9**	Stevens et al. Level 2	Pulliam Verde 2023	Larry Stevens, Helen Waltz, and Lynne Westerfield
6/04/23	**3**	Stevens et al. Level 1	Pulliam Verde 2023	Larry Stevens

Table 1.2 Available Data from each Wet Beaver Headwaters Spring Survey.

Date	Microhabitats	Soils	Flow	Water Quality	Photos	Flora	Invert	Vert	SEAP
6/04/23	**X**	**X**		**X**	**X**	**X**	**X**	**X**	**X**
6/04/23					**X**				**X**

Flow: Surveyors measured flow during 1 of the surveys. The average flow rate recorded at Wet Beaver Headwaters Spring is 0.1 L/s. Flow rates ranged from 0.1 L/s to 0.1 L/s.

Table 1.3 Wet Beaver Headwaters Spring Flow Measurements.

Date	Measured Flow Rate (L/s)	Technique	Percent of Flow Captured	Measurement Location/Notes
6/04/23	**.1**	**other**		USGS stream flow gauge data reports a discharge flow of 6.21ft3/second for Wet Beaver Creek on June 4, 2023 at 17:00. Surveyors estimated flow at 0.1 L/s.

Water Quality: Surveyors measured water quality during 1 of the surveys.

Table 1.4 Wet Beaver Headwaters Spring Water Quality Measurements.

Date	Dissolved Oxygen (field) (mg/L)	pH (field)	Specific Conductance (field) (uS/cm)	Temperature, Air C	Temperature, Water C	Dissolved Solids (field) (ppt)	Other Variables
6/04/23	**8**	**7.44**	**169**	**28**	**16.5**	**0.084**	

Flora: Surveyors recorded vegetation data during 1 of the surveys. The table below includes all plant taxa recorded during surveys of this site.

Table 1.5 Wet Beaver Headwaters Spring Vegetation Presence.

Plant Taxon	6/04/23
Acer grandidentatum	X
Adiantum	X
Alnus oblongifolia	X
Brickellia californica	X
Mimulus cardinalis	X
Parthenocissus	X
Platanus wrightii	X
Salix	X
Vitis arizonica	X
unknown grass	X
unknown herb	X

Fauna: Surveyors recorded observations of invertebrate taxa during 1 of the surveys. Surveyors recorded observations and sign of vertebrate taxa during 1 of the surveys. The tables below list all invertebrate and vertebrate taxa observed during surveys of this spring.

Table 1.6 Wet Beaver Headwaters Spring Invertebrates.

Invertebrate Taxon	6/04/23
Diptera Calliphoridae	X
Diptera Ceratopogonidae	X
Diptera Muscidae	X
Lepidoptera Hesperiidae Epargyreus clarus	X
Lepidoptera Lycaenidae	X
Lepidoptera Nymphalidae Junonia coenia	X
Lepidoptera Papilionidae Papilio rutulus	X
Trichoptera Philopotamidae	X

Table 1.7 Wet Beaver Headwaters Spring Vertebrate Taxa Observations. Surveyors recorded observations of animals, as well as sign such as scat and tracks.

Common Name	6/04/23
Black-headed Grosbeak	X
Canyon Treefrog	X
Canyon Wren	X
Gila Chub	X
Longfin Dace	X
Red-tailed Hawk	X
Rock Wren	X
Sonora Sucker	X

Assessment: Spring ecological condition and risk were assessed using the SSI Springs Ecosystem Assessment Protocol (SEAP) during 2 of the surveys. Assessment scores were assigned based on the results of the ecological inventory. The tables below present average condition and risk scores for each of the SEAP categories, and overall condition and risk scores.

Table 1.8 Wet Beaver Headwaters Spring Assessment Condition scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition).

Category	6/04/23	6/04/23
Aquifer Functionality & Groundwater Quality	**4.8**	**4.8**
Geomorphology	**5.2**	**6**
Habitat	**5.4**	**4.5**
Biota	**5.9**	**5.9**
Human Influence	**5.8**	**5.8**
Overall Condition Score	**5.5**	**5.5**

Table 1.9 Wet Beaver Headwaters Spring Assessment Risk scores. Risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	6/04/23	6/04/23
Aquifer Functionality & Groundwater Quality	**1.7**	**1.7**
Geomorphology	**1**	**1**
Habitat	**2**	**2**
Biota	**1.6**	**1.6**
Human Influence	**1**	**1**
Overall Risk Score	**1.4**	**1.4**

6/04/23 Survey

Larry Stevens, Helen Waltz, and Lynne Westerfield surveyed the site on 6/04/23 for 00:57 hours, beginning at 13:43, and collected data in 9 of 10 categories. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 2 protocol.

Fig 1.2 Wet Beaver Headwaters Spring: At 23.9 m on the measuring tape, looking east.

Microhabitats: The microhabitats associated with the spring cover 368 sqm. The site has 2 microhabitats, including A -- a 312 sqm channel, B -- a 56 sqm backwall. The geomorphic diversity is 0.19, based on the Shannon-Weiner diversity index.

Table 1.10 Wet Beaver Headwaters Spring Microhabitat characteristics.

Code	A	B
Name	Channel	Bedrock
Area sqm	312	56
Surface type	CH	BW
Surface subtype		
Slope variability	High	Med
Aspect TN	320	228

Code	A	B
Slope degrees	8	25
Moisture (scale 1-10)	2	6
Water depth cm	18	10
Area % open water	5	6
Substrate		
1 - Clay %	0	0
2 - Silt %	0	0
3 - Sand %	5	0
4 - Fine gravel %	10	0
5 - Coarse gravel %	10	0
6 - Cobble %	60	5
7 - Boulder %	15	0
8 - Bedrock %	0	95
Organic %	0	0
Other % (anthropogenic)	0	0
Precipitate %	0	0
Litter %	1	2
Wood %	1	0
Litter Depth (cm)	.1	.1

Survey Notes: The spring emerges in a naturally flood-scoured channel with no sign of human disturbance, but much sign of scour impacts, particularly from the March 2023 flood. The surrounding landscape is in excellent condition but the plateau lands are heavily affected by livestock and elk. Flow seeps from the Coconino Sandstone at the edge of site, but rheocrenic flow emerges beneath the stream channel boulders, going through this reach to the full base flow of Wet Beaver Creek.

Flow: Surveyors measured a flow of .1 liters/second, using a non-traditional method. USGS stream flow gauge data reports a discharge flow of 6.21ft3/second for Wet Beaver Creek on June 4, 2023 at 17:00. Surveyors estimated flow at 0.1 L/s. This spring is perennial. Surveyors were unable to measure flow because the outflow was too diffuse to capture.

Water Quality: Surveyors measured water quality at 1 meter on the measuring tape. Location 1: at the spring source in standing water at 13:13.

Table 1.11 Wet Beaver Headwaters Spring Water Quality Measurements.

Characteristic Measured	Value	Location Number	Device
Dissolved oxygen (field) (mg/L)	8	1	CHEMets DO kit
Dissolved Solids (field) (ppt)	0.084	1	Hanna Combo
pH (field)	7.44	1	Hanna
Specific conductance (field) (uS/cm)	169	1	Hanna
Temperature, air C	28	1	Handheld therm

Characteristic Measured	Value	Location Number	Device
Temperature, water C	16.5	1	Hanna

Flora: Larry Stevens was the botanist for this survey. Surveyors identified 11 plant species at the site, with 0.0299 species/sqm. These included 8 native and 0 nonnative species; the native status of 3 species remains unknown.

Table 1.12 Wet Beaver Headwaters Spring Vegetation Cover Type. Wetland species are defined here as any taxon assigned a wetland status of aquatic (A), wetland (W), riparian (R), or wetland/riparian (WR).

Cover Type	Species Count	Wetland Species Count
Ground	5	1
Shrub	6	5
Mid-canopy	2	2
Tall canopy	1	1
Basal	0	0
Aquatic	0	0
Non-vascular	0	0

Table 1.13 Wet Beaver Headwaters Spring Vegetation % Cover in Microhabitats. Cover codes refer to nonvascular plants (NV), ground cover (GC; herbaceous vascular plants), shrub cover (SC; woody plant cover <4m height), mid-canopy cover (MC; woody plant cover 4m- 10m in height), tall canopy cover (TC; woody plant cover >10m tall), and basal cover (BC; cover of woody stems where they emerge from the ground). Native status codes are native (N), invasive (I), and taxon is both native and invasive (NI), according to USDA Plants database. Wetland status codes are aquatic (A), wetland (W), riparian (R), wetland/riparian (WR), facultative wetland (F), and upland (U).

Plant Species	Cover Code	Native Status	Wetland Status	Comments	A	B
Acer grandidentatum	SC	N	F		5	0
Adiantum	GC				0	1
Alnus oblongifolia	MC	N	R		10	1
Alnus oblongifolia	SC	N	R		6	1
Brickellia californica	GC	N	U		0.1	0
Mimulus cardinalis	GC	N	W		0.1	4
Parthenocissus	SC	N	R	ivy creeper	0.2	0
Platanus wrightii	MC	N	R		20	0
Platanus wrightii	SC	N	R		7	0
Platanus wrightii	TC	N	R		25	0
Salix	SC	N	WR	tree	0	0.1
unknown grass	GC				0.1	0.1
unknown herb	GC				0.1	0
Vitis arizonica	SC	N	R		1	0

Fauna: Surveyors collected or observed 8 invertebrate taxa, including 8 terrestrial invertebrate taxa, and 8 vertebrate taxa.

Table 1.14 Wet Beaver Headwaters Spring Invertebrates. Lifestage codes refer to adult (Ad), larvae (L), mixed (M), shell (S), exuviae (Ex), egg (E), and case (C). Habitat codes are terrestrial (T) and aquatic (A).

Species	Lifestage	Habitat	Method	Rep#	Count	Species Detail
Diptera Calliphoridae	Ad	T	Spot		1	many, blue bottle
Diptera Ceratopogonidae	Ad	T	Spot		1	Many, juniper gnats
Diptera Muscidae	Ad	T	Spot		1	Many
Lepidoptera Hesperiidae Epargyreus clarus	Ad	T	Spot		1	
Lepidoptera Lycaenidae	Ad	T	Spot		1	
Lepidoptera Nymphalidae Junonia coenia	Ad	T	Spot		1	
Lepidoptera Papilionidae Papilio rutulus	Ad	T	Spot		1	
Trichoptera Philopotamidae	Ad	T	Collected spot		2	

Table 1.15 Wet Beaver Headwaters Spring Vertebrates.

Vertebrate Species Common Name	Count	Detection	Comments
Canyon Treefrog	1	Obs	
Canyon Wren	1	Call	
Rock Wren	1	Obs	
Red-tailed Hawk	2	Obs	Immature
Black-headed Grosbeak	1	Call	
Sonora Sucker	50	Obs	
Longfin Dace	200	Obs	
Gila Chub	10	Obs	?

Assessment: Assessment scores were compiled in 6 categories and 33 subcategories, with 9 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.8) and there is negligible risk (average risk score 1.7). Geomorphology condition is very good with excellent restoration potential (average condition score 5.2) and there is negligible risk (average risk score 1). Habitat condition is very good with excellent restoration potential (average condition score 5.4) and there is low risk (average risk score 2). Biotic integrity is excellent with no need for restoration (average condition score 5.9) and there is negligible risk (average risk score 1.6). Human influence of site is very good with excellent restoration potential (average condition score 5.8) and there is negligible risk (average risk score 1). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 1.16 Wet Beaver Headwaters Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.8	1.7
Geomorphology	5.2	1
Habitat	5.4	2
Biota	5.9	1.6
Human Influence	5.8	1
Overall Ecological Score	5.5	1.4

Management Recommendations: Surveyors recommend identifying the native fish species. As this site is steep, narrow, extremely isolated, and in pristine condition, it will be important to protect the canyon from future dams.

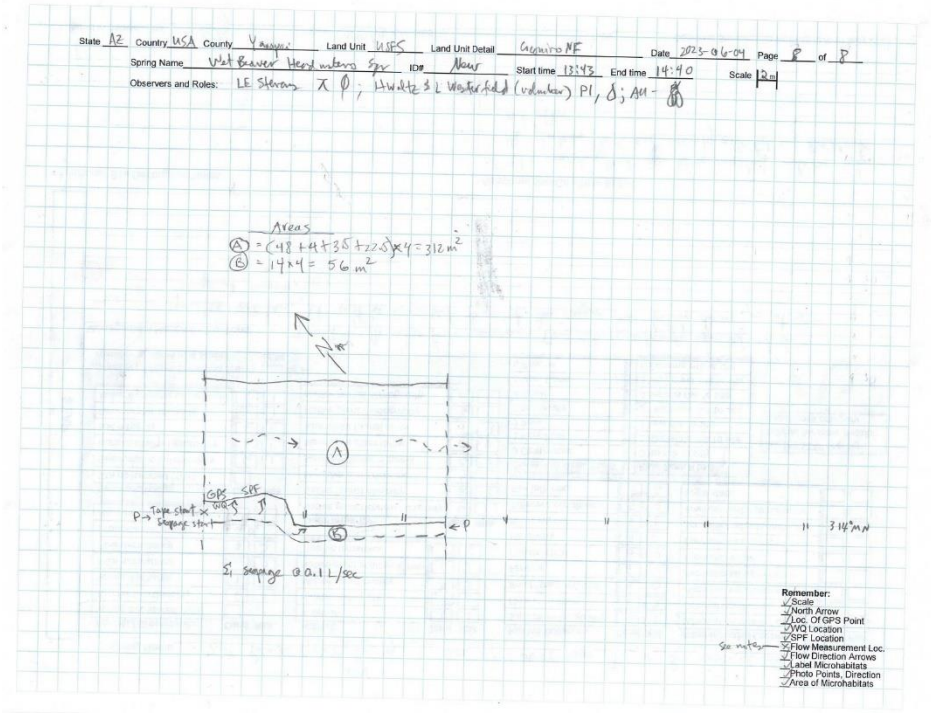

Fig 1.3 Wet Beaver Headwaters Spring Sketchmap: June 4, 2023.

Fig 1.4 Wet Beaver Headwaters Spring: Looking west along measuring tape with water visible.

6/04/23 Survey

Larry Stevens verified the site on 6/04/23 at 1:50. This survey was conducted under the Pulliam Verde 2023 project using the Stevens et al. Level 1 protocol.

Survey Notes: The site was visited during the dry season, so this site provides most or virtually all of the baseflow for Wet Beaver Creek. The channel had been scoured recently (likely March 2023) by a 4+ meter flood. The pools sustain abundant native fish (a sucker, agosia dace, and a Gila chub). There is no sign of recent human visitation at this difficult-to-reach site.

Flow: Utilize channel cross-section or use USGS gauge data to determine flow at this site. Surveyors were unable to measure flow.

Assessment: Assessment scores were compiled in 6 categories and 31 subcategories, with 11 null condition scores, and 9 null risk scores. Aquifer functionality and water quality are good with significant restoration potential (average condition score 4.8) and there is negligible risk (average risk score 1.7). Geomorphology condition is excellent with no need for restoration (average condition score 6) and there is negligible risk (average risk score 1). Habitat condition is good with significant restoration potential (average condition score 4.5) and there is low risk (average risk score 2). Biotic integrity is excellent with no need for restoration (average condition score 5.9) and there is negligible risk (average risk score 1.6). Human influence of site is very good with excellent restoration potential (average condition score 5.8) and there is negligible risk (average risk score 1). Overall, the site condition is very good with excellent restoration potential and there is negligible risk.

Table 1.17 Wet Beaver Headwaters Spring Assessment Scores. Condition scores range from 0 (extremely poor condition) to 6 (pristine condition) and risk scores range from 0 (no risk to the site) to 6 (extreme risk to the site).

Category	Condition	Risk
Aquifer Functionality & Groundwater Quality	4.8	1.7
Geomorphology	6	1
Habitat	4.5	2
Biota	5.9	1.6
Human Influence	5.8	1
Overall Ecological Score	5.5	1.4