Arizona Water Protection Fund
Application Cover Page
FY 2017

Title of Project: Springs Ecosystem Restoration in Northern Arizona

Type of Project:
- ☒ Capital or Other
- ☐ Water Conservation
- ☐ Research

Stream Type:
- ☒ Perennial
- ☐ Intermittent
- ☐ Ephemeral

Your level of commitment to maintenance of project benefits and capital improvements:
☐ < 5 years ☐ 5-10 years ☐ 11-15 years ☒ 16-20 years

Applicant Information:

Name/Organization:	Springs Stewardship Institute
Address 1:	Museum of Northern Arizona
Address 2:	3101 N Fort Valley Rd.
City:	Flagstaff
State:	Arizona
ZIP Code:	86001
Phone:	928-774-5211 x 231
Fax:	
Tax ID No.:	86-0098920

Inside an AMA: Yes ☐ No ☒

If yes, which AMA:
- ☐ Phoenix
- ☐ Tucson
- ☐ Prescott
- ☐ Pinal
- ☐ Santa Cruz

Type of Application:
- ☒ New
- ☐ Continuation

Contact Person:

Name:	Dr. Larry Stevens
Title:	Director, Springs Stewardship Institute
Phone:	928-380-7724
Fax:	
e-mail:	larry@springstewardship.org

Any Previous AWPF Grants:
☒ Yes ☐ No

If yes, please provide Grant #(s):
AWPF 96-003; AWPF 98-059

Arizona Water Protection Fund Grant Amount Requested:

$299,899.00

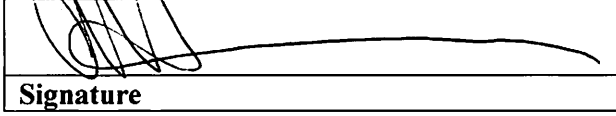
If the application is funded, will the Grantee intend to request an advance:
☒ **Yes** ☐ **No**

Matching Funds Obtained and Secured:

Applicant/Agency/Organization:	Amount ($):
1. Applicant	159,375.00
2. Northern Arizona University	39,413.44
3.	
Total:	198,788.44

Has your legal counsel or contracting authority reviewed and accepted the Grant Award Contract General Provisions?
☐ Yes ☐ No ☒ N/A

Signature of the undersigned certifies understanding and compliance with all terms, conditions and specifications in the attached application. Additionally, signature certifies that all information provided by the applicant is true and accurate. The undersigned acknowledges that intentional presentation of any false or fraudulent information, or knowingly concealing a material fact regarding this application is subject to criminal penalties as provided in A.R.S. Title 13. The Arizona Water Protection Fund Commission may approve Grant Awards with modifications to scope items, methodology, schedule, final products and/or budget.

Carrie M. Heinonen	Director & CEO, Museum of Northern Arizona; 928-774-5211 x 201
Typed Name of Applicant or Applicant's Authorized Representative	**Title and Telephone Number**
	10/14/2016
Signature	**Date Signed**

SPRINGS ECOSYSTEM RESTORATION IN NORTHERN ARIZONA

Executive Summary

Springs are among the most biologically, socio-culturally, and economically important water resources in the world. They contain a large proportion of the United States' endangered, rare, and endemic species, and they are highly sacred to indigenous cultures. While much research and conservation attention has been aimed at rivers and streams, springs ecosystems have largely been overlooked and, thus, inadequately protected. This lack of information has led to loss of springs and associated wildlife. We established the Springs Stewardship Institute in order to improve the understanding and stewardship of these critical ecosystems, and restoration of springs is a key part of our mission. In this project three-year project, we will restore six springs ecosystems of differing types and under varying degrees of decline in northern Arizona across multiple jurisdictional categories, including federal, city, and private jurisdictions. Restoration actions will include: (1) removal of non-historic flow alteration structures (e.g., tanks, piping, spring boxes, etc.) in order to re-establish natural flows, (2) reintroduction of natural geomorphologic attributes (e.g., creation of natural meanders, reduction of channelization, re-grading of excavated sites), (3) removal of nonnative invasive plant species and re-vegetation of the habitat with native flora, and (4) reduction of grazing pressure. These restoration actions will greatly enhance wildlife habitat at each site, return the sites to more naturally-functioning ecosystems, and allow us to better understand the potential for and limitations of springs restoration across jurisdictional boundaries, spring types, and human impact categories. Following the restoration ground work, we will carefully monitor the success of these actions in order to learn more about the restoration process at springs, from the compliance process to plan development to construction. Lessons learned from these projects will be invaluable in guiding future springs restoration projects in Arizona and across the southwestern United States.

Successful ecosystem restoration depends on development of partnerships with partners of entities, including landowners, land managers, water rights holders, wildlife biologists, botanists, hydrologists, GIS specialists, soil scientists, and environmental engineers. We have solicited support from a number of entities, including the U.S. Forest Service, the city of Flagstaff, and Northern Arizona University, to support this project and will establish formal collaborative agreements in order to ensure the project's success. Through these partnerships and our proposed restoration activities, we will greatly advance the understanding, appreciation, and health of springs ecosystems in northern Arizona. The project budget requested from AWPF is $299,899.00, and an additional $159,399 of cost-share will provided through foregone overhear, as well as the contributions of volunteers and contributed agency staff time.

A Proposal to

Conduct Springs ecosystem restoration

in northern Arizona

Proposal Prepared by:

The Springs Stewardship Institute

Museum of Northern Arizona

3101 N. Ft. Valley Rd.

Flagstaff, AZ 86001

Contact: Lawrence E. Stevens, Director – LARRY@SPRINGSTEWARDSHIP.ORG

Proposal Prepared for:

The Arizona Water Protection Fund

Attn: Ms. Stephanie Smallwood

1110 West Washington Street, Suite 310

Phoenix, AZ 85007

14 October 2016

PROJECT OVERVIEW

Springs—ecosystems where groundwater reaches the Earth's surface—are among the most biologically, socio-culturally, and economically important water resources (Stevens and Meretsky 2008). Many endangered, rare, and endemic species are found only at springs in the United States. Springs are highly sacred to indigenous cultures that use them for water supplies, ceremonies, and other purposes. Given the interactions between temperature, precipitation, infiltration, and aquifer dynamics, springs also are sensitive indicators of climate change. Yet while much attention and funding has been devoted to rivers and streams, springs ecosystems have been largely overlooked in conservation, research, and management. They are abundant across the United States, but in arid and mesic landscapes alike, springs are poorly understood, incompletely mapped, and inadequately protected. The lack of information and attention has resulted in the loss of many springs and springs-dependent natural, socio-cultural, and economic resources through poor management practices. Estimates of impairment or loss of springs in some landscapes exceed 90% (GCWC 2002).

We established the Springs Stewardship Institute (SSI), an initiative of the nonprofit Museum of Northern Arizona (MNA), to improve the understanding of springs ecology, to educate resource managers and the public about the importance of springs stewardship, and to partner with other organizations, agencies, Tribes, and researchers who are working to protect these critically endangered resources.

Fig. 1 Map of the six springs in northern Arizona for which we are proposing restoration actions. These six sites were chosen in an effort to implement springs restoration across jurisdictional boundaries.

The purpose of this project is to restore and rehabilitate six springs ecosystems (across multiple jurisdictional boundaries) in northern Arizona. Springs in this region have long been utilized by humans and many have been significantly altered via overuse, channelization, invasive species, overgrazing, diversion, and poor land management practices (Blinn 2008). Degradation of these habitats leads to impaired or lost ecosystem services, including water availability (for wildlife and humans), refugia locations for plants and animals in an otherwise arid landscape, and cultural accessibility (Stevens and Meretsky 2008). As water resources become more scarce in the face of climate change, it is imperative that we restore springs ecosystems to highly

functioning states and preserve them in order for them to continue to provide high quality ecosystem services.

To mitigate the negative impacts that springs are currently experiencing in northern Arizona, we strongly believe on-the-ground active restoration is a critical step. Springs that remain connected to functioning aquifers are readily restorable, and the actions taken will have long-term positive effects on the springs ecosystems. We have collected long-term baseline data on a number of springs throughout northern Arizona and have selected (in collaboration with U.S. Forest Service personnel, the City of Flagstaff, and MNA) six springs (of varying types) which present excellent restoration potential. Our cross-jurisdictional approach will have wide-ranging positive impacts in this region and will help inform future springs restoration across multiple land ownership categories (federal, local, and private).

The overall goal of our project is to restore these six impacted ecosystems and use the results to inform future springs restoration. The specific objectives will depend on the impacts at each individual site, but will include one or more of the following:

(1) Remove non-historic flow alteration structures (e.g., tanks, piping, spring boxes, etc.) to re-establish natural flows
(2) Reintroduce natural geomorphologic attributes (e.g., create natural meanders, reduce channelization, re-grade excavated sites)
(3) Remove nonnative invasive plant species and re-vegetate the habitat with native flora
(4) Reduction of grazing pressure by livestock and elk

The proposed project is an extension of previous pilot projects funded by the AWPF at Clover Springs, Hoxworth Springs, and Pakoon Springs. Lessons learned from these previous projects have helped inform the prioritization and planning of the restoration of significantly more springs. The outcomes of this restoration project will greatly benefit the functioning of these ecosystems and, in turn, current and future generations of people that utilize the springs. Because all of the springs selected for restoration remain connected to functioning aquifers and are either on U.S. Forest Service land or Museum of Northern Arizona grounds, the benefits of this project will last well into the future (>20 years) due to limited development pressure and human impact on the selected sites. The long-term benefits of this project will continue to increase over time in the face of a changing climate. In addition, the information we will gather as a result of this project (via long-term monitoring) will help inform future springs restoration projects and will allow for us to build on the limited amount of knowledge currently available on restoration of springs habitats. The project budget requested from AWPF is $299,899.00, and an additional $159,399 of cost-share will provided through foregone overhear, as well as the contributions of volunteers and contributed agency staff time.

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information

1. County: Coconino	2. Section: S14	3. Township: T0220N	4. Range: R0060E

5. Watershed: Little Colorado River Watershed

6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15020015

7. Name of USGS Topographic Map where project area is located: Humphreys Peak

8. State Legislative District: 7

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: U.S. Forest Service - Coconino National Forest

10. Current land use of project area: Grazing, timber, recreation

11. Size of project area (in acres): 1.1 acres

12. Stream Name: Big Leroux Spring

13. Length of stream through project area: 33 yards

14. Miles of stream benefited: 1 mile

15. Acres of riparian habitat: 1.1 acres will be:

- Enhanced
- Maintained
- X Restored
- Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for restoration is in a ponderosa pine-dominated forest. Human impacts at this site include flow capture via spring boxes and the presence of invasive plant species. Recent flow restoration work in 2013 created surface flow (via piping) at this site for the first time in decades. We plan to continue and improve upon the restoration of this site via improvement of fencing around the recently restored channel and spring source in order to limit effects of grazing by deer and elk. Invasive plant species will also be removed, and the site will be re-vegetated with native flora. These actions will greatly improve wildlife habitat, while at the same time maintaining the integrity of the site.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:
Take highway 180 north from Flagstaff. Turn right on Snowbowl Road and drive about 1 mile. When road curves right, go straight instead into small parking area. Walk north on old road approximately 600 m, then curve west and walk approximately 500 m. Then go up drainage to north for another 250 m. The spring is up on the west slope in a fenced area with a spring box.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information

1. County: Coconino	2. Section: S04	3. Township: T0210N	4. Range: R0070E

5. Watershed: Little Colorado River Watershed
6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15020015
7. Name of USGS Topographic Map where project area is located: Flagstaff West
8. State Legislative District: 6

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: Private - Museum of Northern Arizona
10. Current land use of project area: The area is used primarly for environmental education activities.
11. Size of project area (in acres): 1.0 acres
12. Stream Name: Coyote Spring
13. Length of stream through project area: 50 yards
14. Miles of stream benefited: 0.5 miles
15. Acres of riparian habitat: 1.0 acres will be:

Enhanced
Maintained
X Restored
Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for restoration is an open grassland containing three known spring sources flowing into channelized stream branches, which eventually converge into one branch. We are proposing restoration via removal of a large concrete spring box (non-historic), re-grading of the land to allow for water access to the once-marshy meadow area, and removal of nonnative plants (to be replaced by native species).
17. Provide directions to the project site from the nearest city or town. List any special access requirements:
From Flagstaff, the site can be reached by driving north on Hwy 180 (Fort Valley Road) for 2.6 miles. The site is located on the north side of the road, just east of the Museum of Northern Arizona Colton Research Center grounds.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information			
1. County: Coconino	2. Section: S30	3. Township: T0220N	4. Range: R0040E

5. Watershed: Verde River Watershed

6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15060202

7. Name of USGS Topographic Map where project area is located: Sitgreaves Mountain

8. State Legislative District: 6

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: U.S. Forest Service - Kaibab National Forest

10. Current land use of project area: Grazing, timber, recreation

11. Size of project area (in acres): 0.80 acres

12. Stream Name: Mineral Spring

13. Length of stream through project area: 60 yards

14. Miles of stream benefited: 0.080 miles

15. Acres of riparian habitat: 0.7 acres will be:

Enhanced
Maintained
X Restored
Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for restoration is a forested area dominated by ponderosa pine. The spring source has been built on top of by Interstate 40; a culvert allows flow to continue from the spring source into the proposed project site area. The site consists of two channels, one of which is dry, surrounded by fairly open grassy areas. Salt runoff from the interstate is leading to severe tree die-off at the site and increasingly saline water in the spring channel. We are proposing development of runoff diversion structures and vegetation with saline-tolerant plant species to mitigate the issues at this site. This would aid with the increasing salinity of the water and the negative impacts on the surrounding forest.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:
From I-40 east, take exit 178, then turn left on Parks Rd. Turn left at the stop sign onto Old Route 66, then left on N. Spitz Spring Rd, right on S Spitz Spring Rd, right on Somerset Ranch Rd, then right on 781 J. Follow a bumpy dirt road for about 1 mile; the spring emerges from below the Interstate.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information			
1. County: Coconino	2. Section: S15	3. Township: T0220N	4. Range: R0070E

5. Watershed: Little Colorado River Watershed

6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15020015

7. Name of USGS Topographic Map where project area is located: Humphreys Peak

8. State Legislative District: 7

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: U.S. Forest Service - Coconino National Forest

10. Current land use of project area: Grazing, timber, recreation

11. Size of project area (in acres): 0.80 acres

12. Stream Name: Orion Spring

13. Length of stream through project area: 40 yards

14. Miles of stream benefited: 0.6 miles

15. Acres of riparian habitat: 0.80 acres will be:

X Enhanced
Maintained
Restored
Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for enhancement is a forested area dominated by ponderosa pine. The spring source has been excavated, directed into a bermed channel, and piped to a tank 60 yards downslope. There is also a small dam in the channel. Currently (Fall 2016), there is no flow from the spring into the channel, but flow was reported by Dr. Larry Stevens in April 2000. To enhance this site, we plan to remove the piping and small dam. We will also re-grade the incised channel and excavated area. The enhancement of this site will allow for natural flow patterns once flow returns to the site and will eliminate large amounts of old, rusty piping, which is a hazard to humans and wildlife in the area. This project will also create habitat for wildlife at the site and further downstream.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:
From Flagstaff, take US-89 north and turn onto NF-743 (Pipeline) and travel west for 3.5 miles. The spring is identifiable by a metal water tank.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information			
1. County: Coconino	2. Section: S27	3. Township: T0210N	4. Range: R0030E

5. Watershed: Verde River Watershed

6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15060202

7. Name of USGS Topographic Map where project area is located: Davenport Hill

8. State Legislative District: 6

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: U.S. Forest Service - Kaibab National Forest

10. Current land use of project area: Grazing, timber, recreation

11. Size of project area (in acres): 1.0 acres

12. Stream Name: Rosilda Spring

13. Length of stream through project area: 65 yards

14. Miles of stream benefited: 0.5 miles

15. Acres of riparian habitat: 1.0 acres will be:

Enhanced
Maintained
X Restored
Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for restoration is an open, marshy cienega that has been bermed to form a pond. The source is tanked and piped (underground) to the ponded area. We are planning to remove the underground pipe in order to create a more diffuse flow from the source. This will restore more of the site to a natural helocrene-type spring ecosystem. Invasive plant species will also be removed, and the site will be re-vegetated with native flora. These actions will greatly improve wildlife habitat, while at the same time maintaining the integrity of the site.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:
From exit 167 on Interstate 40, travel south on S Garland Prairie Rd for 7 mi. Turn right onto NF-18, and continue for 1.6 mi. Hike 600 m due west up the drainage to the spring source and pond.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information

1. County: Coconino	2. Section: S27	3. Township: T0180N	4. Range: R0080E

5. Watershed: Verde River Watershed
6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15060202
7. Name of USGS Topographic Map where project area is located: Mormon Lake
8. State Legislative District: 6

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: U.S. Forest Service - Coconino National Forest
10. Current land use of project area: Grazing, timber, recreation
11. Size of project area (in acres): 1.6 acres
12. Stream Name: Sheep Spring
13. Length of stream through project area: 22 yards
14. Miles of stream benefited: 0.90 miles
15. Acres of riparian habitat: 1.6 acres will be:

Enhanced
Maintained
X Restored
Created

16. General description and/or delineation for the area of impact of the project within the watershed.
The area proposed for restoration is a partially forested area dominated by ponderosa pine. The spring source has been contained in a large underground tank and diverted into concrete stock watering tanks. We plan to remove piping to the tanks to re-establish natural flow into the marsh habitat surrounding the spring. In addition, nonnative flora will be removed and replaced with native species.
17. Provide directions to the project site from the nearest city or town. List any special access requirements:
From Mormon Lake Rd (CR-90) turn onto NF-90H and travel SW for 2.9 miles. Turn onto NF-219B and continue for 1.6 mi. Turn onto NF-91, and head NW for 1 mile. The spring is 120 m SW.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? **NO**

SCOPE OF WORK

Task 1 – Project Administration and Compliance

Task Description: We will obtain all necessary permits from the U.S. Forest Service (USFS), including Kaibab National Forest (Williams Ranger District) and Coconino National Forest (Peaks and Mormon Lake Ranger Districts), the city of Flagstaff, and the Museum of Northern Arizona. Two of the six sites (Mineral and Rosilda Springs) we are proposing for restoration have already received environmental (National Environmental Policy Act, NEPA) and archeological (State Historic Preservation Office, SHPO) clearance for restoration activities by the USFS (see letters of collaboration and Task 4). Three additional springs (Big Leroux, Sheep, and Orion Springs) are within the Four Forest Restoration Initiative (4FRI) boundary, which will enable categorical exclusion of these sites regarding NEPA compliance. The final spring, which is on Museum of Northern Arizona (MNA) grounds, is currently undergoing wetland delineation analysis to determine if the Army Corps of Engineers will exert jurisdiction over the site. If necessary, EPA Section 404 permitting will then completed at the site, and other sites.

Task Purpose: Obtaining these permits will allow us to remove non-historic water containment and diversion structures, re-establish natural geomorphology, remove invasive flora and fauna, and re-vegetate with native species.

Responsible Personnel: Dr. McDaniel is the person responsible for completion of Task 1.

Deliverable Description: We will deliver a permitting report to the Arizona Water Protection Fund (AWPF) and any other administrative entities required. The report will contain copies of all permits for all sites.

Deliverable Due Date: The deliverable due date is August 1, 2017.

Task Cost: $16,611.

Task 2 – Information assessment and pre-treatment monitoring

Task Description: Prior to initiating on-the-ground restoration activities, we will compile and analyze monitoring information from two previously restored sites (Clover and Hoxworth Springs) in northern Arizona that have been closely monitored for >15 years post-restoration. Hoxworth Springs and Clover Springs were both severely impacted by flow diversion and channelization. To restore the wet meadow habitat that existed at Hoxworth Springs prior to human influence, USFS re-graded the channel and surrounding terrace and eliminated water containment structures partially supported by AWPF 96-003. Additionally, long-term monitoring from Clover Springs and its associated restoration, partially supported by AWPF 98-059, will be evaluated and assessed. Following restoration, long-term hydrogeology data have been collected by Dr. Abraham Springer NAU. These data have not yet been analyzed in detail to determine trends over time and the responses of the systems to restoration. Thus, the first part of Task 2 involves analysis of these >15-year datasets from Clover and Hoxworth Springs. To accomplish this, Dr. Abe Springer will hire an NAU graduate student to perform statistical analyses of the data to look at long-term trajectory of the restoration actions completed. Dr. Springer and his student, with MNA assistance, will also repeat vegetation surveys at each site to document vegetation change since restoration.

The second part of Task 2 will involve compiling all available information on each of the 6 restoration site springs. These data will be compiled, quality controlled, and archived on the

Springs Stewardship Institute website and in Springs Online, to provide a long-term record of actions and history at each of the restoration sites.

Third, we will conduct springs inventories at each of the six proposed restoration sites. We will document spring flow, water quality, microhabitat structure, flora, vertebrate and invertebrate fauna, and human impacts, using the SSI springs ecosystem inventory protocols (www.SpringStewardshipInstitute.org). In addition, detailed topographic surveys will be completed with the assistance of Dr. Temuulen Sankey (NAU) at each site via LiDAR. Previous springs surveys have been completed intermittently at each of the sites over the past 15 years. We have included full reports on all six proposed sites in Appendix 1.

Task Purpose: The information gathered during Task 2 will be used to inform project plans (Task 3, below) to determine the most effective and efficient restoration actions.

Responsible Personnel: The responsible personnel for this task will be Dr. Stevens, Ms. Ledbetter, and Dr. McDaniel.

Deliverable Description: Deliverables will include a report summarizing the analysis of the monitoring data at Clover and Hoxworth Springs, information gathered on all other sites, and SSI inventory data reports, including the data listed above for each of the six restoration sites.

Deliverable Due Date: Task 2 will be completed by December 31, 2017.

Task Cost: $82,100.

Task 3 – Development of project plans

Task Description: For the third task of the proposed project, we will develop detailed restoration plans based on the information gathered and analyzed in Task 2. Plans will be developed for the following actions: (a) removal of water diversion and containment structures (e.g., concrete tanks, non-historic spring boxes, piping, etc.), (b) re-establishment of natural geomorphology, (c) removal of invasive plants and animals, (d) re-vegetation with native species, and (e) short- and long-term monitoring of the sites. Dr. Wilbur Odem (Professor of Environmental Engineering at Northern Arizona University, NAU) will be consulted regarding re-establishment of natural geomorphology. Dr. Odem was integral in this process during the Clover and Hoxworth Springs restoration projects as well (see below).

Task Purpose: Development of these plans will provide us (Springs Stewardship Institute, SSI), AWPF, USFS, the city of Flagstaff, and MNA with a detailed description of the steps involved in the restoration actions. We will also request feedback on these project plans from each stakeholder, and re-adjust the plans based on comments received.

Responsible Personnel: Dr. Stevens, Ms. Ledbetter, and Dr. McDaniel are the personnel responsible for completion of this task.

Deliverable Description: A final report detailing the restoration and monitoring plans (including site schematics) will be developed for each of the six sites, and provided to AWPF and all stakeholders (USFS, City of Flagstaff, and MNA).

Deliverable Due Date: We will complete Task 3 by December 31, 2017.

Task Cost: $29,765.

Task 4 – On-the-ground work

Task Description: Following permit acquisition, assessment of information from Clover and Hoxworth Springs and the proposed restoration sites, and approval of plans by stakeholders, we will begin on-the-ground restoration activities. Details of proposed restoration activities are included in the Supplemental Information section of this proposal. We will solicit help on Task 4

from underserved minorities, including Native American Tribes. The Springs Stewardship Institute has successfully partnered with a number of Tribes in the past for springs restoration and stewardship activities, and we look forward to including their input and help in this project as well.

Task Purpose: The objectives of these restoration actions are to return the sites to natural functioning conditions with regard to spring flow, geomorphology, flora, and fauna, to the extent possible. These actions are intended to improve water availability and wildlife habitat at each of the six sites.

Responsible Personnel: Dr. Stevens is the person responsible for oversight and completion of this task.

Deliverable Description: Deliverables for Task 4 will include final reports detailing the restoration actions taken and their outcomes at each of the six sites. Dr. Springer and the NAU graduate student will assist in this planning by informing the process with lessons learned from Clover and Hoxworth Springs. We will include images of the work-in-progress and the final result as well as site maps presenting the new configurations of sites that have been altered physically.

Deliverable Due Date: We will complete these actions completed by August 31, 2018.

Task Cost: $84,940.

Task 5 – Monitoring and feedback

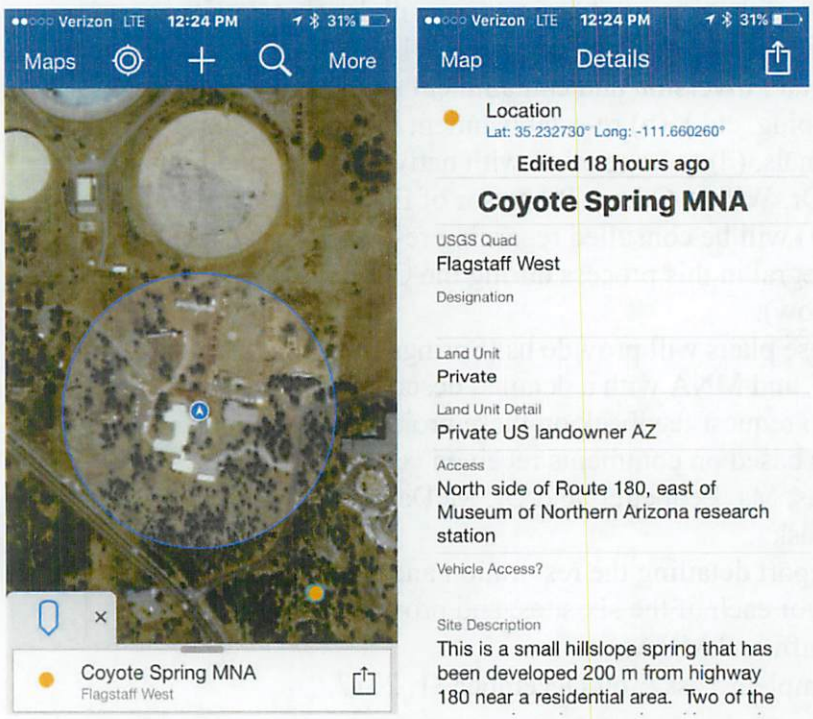


Fig. 2 Image of smartphone app page for Coyote Spring, Flagstaff. Map of the site location (left) and details for the site (right) are displayed, with the ability to enter and change the information as

***Task Description*:** SSI will closely monitor the progress of rehabilitation at each of the six restoration sites using our peer-reviewed Springs Inventory Protocols (SIP), which can be found at the following address: http://springstewardshipinstitute.org/protocols. Data collected using the SIP will include flow, water quality, microhabitat descriptions, flora, fauna (invertebrates and vertebrates), geomorphology, and human impacts. During the first two years following restoration, formal monitoring will occur quarterly to ensure all construction and re-vegetation efforts do not falter. Any issues that may develop will be dealt with immediately to prevent further degradation. After two years of quarterly monitoring, we will monitor each of the sites as needed for at least 18 additional years. This long-term monitoring is not included in the budget for this proposal, but in order to ensure success and understand which techniques and actions were particularly

successful, we feel it is necessary to continue monitoring for a longer period of time than budgeted in this proposal.

In addition to formal monitoring by SSI staff, we will also involve citizen scientists using a smartphone app developed by SSI and the Wildlands Network (Fig. 2). This app allows for rapid and accurate data collection by citizens, which would be hugely beneficial to not only the monitoring aspect of the project but also to our outreach and education efforts. Citizens could provide data and feedback to supplement our formal monitoring and would be excellent ambassadors for springs stewardship and restoration in Arizona. Data from all monitoring efforts will be entered and archived into the freely available Springs Online database (springsdata.org, Fig. 3)

Finally, we will solicit feedback from each of the project stakeholders requesting their impressions, suggestions, and criticisms of the project process and results. Along with regular monitoring, this feedback will help inform future springs restoration projects throughout the Southwest.

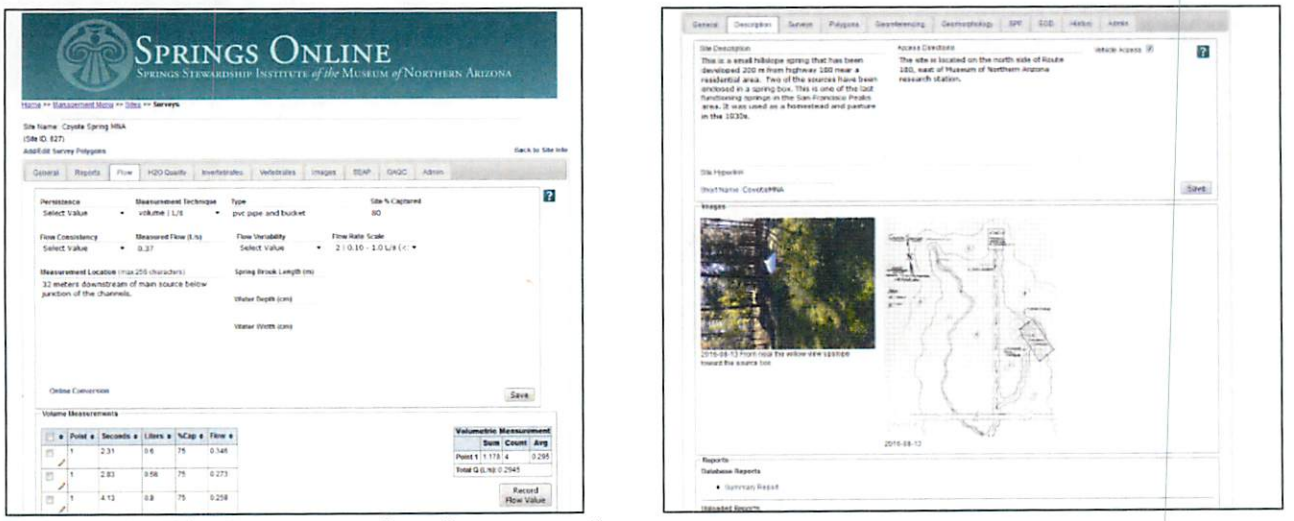
Task Purpose: Close monitoring of these sites will allow us to gauge the effectiveness of the restoration actions and will also help inform future restoration. The lessons we learn from these six springs will be invaluable in guiding future springs restoration projects throughout the Southwest. The citizen science portion of this task will help inform the public about the importance of springs and stewardship of the ecosystems. Feedback from project collaborators and stakeholders will help inform future springs restoration projects.

Responsible Personnel: Dr. Stevens and Ms. Ledbetter will be the responsible personnel for completion of Task 5.

Deliverable Description: We will provide the AWPF with annual reports for all monitoring activities at the six restoration sites, as well as details on any additional work needed to ensure successful long-term restoration.

Deliverable Due Date: This task will be ongoing in Years 2 through 3 as we continue to monitor the sites. However, we plan to have all formal monitoring completed and reported upon by December 1, 2019. Feedback from stakeholders will be included with the first round of monitoring reports and will be provided to the Arizona Department of Water Resources.

Task Cost: $51,534.



Task 6 – Final report and oral presentation

Fig. 3 Screenshots of the SSI Springs Online database (springsdata.org) showing the flow data page (left) and the description page (right) for Coyote Spring, Flagstaff. The database is available to anyone interested in learning about or collecting data on springs throughout the world. All data collected during initial surveys and post-restoration monitoring will be safely and securely stored here.

Task Description: The final task for this project will be preparation of a comprehensive report that will include project background and rationale, restoration plans, compiled information on Clover and Hoxworth Springs and the six proposed restoration sites, detailed descriptions of all on-the-ground restoration activities, results of the first round of post-restoration monitoring, and a summary of stakeholder comments. In addition, Dr. Stevens will present the results of this project once all tasks have been completed. As with the Pakoon Springs restoration project funded by AWPF (Burke et al. 2015), we intend to publish the results of this project in the peer-reviewed scientific literature, in a journal such as *Restoration Ecology.*

Task Purpose: The primary objective of Task 6 is to provide a complete picture of springs restoration, including detailed descriptions of what was done, what worked, and what did not work. This report will serve as documentation of project results, and importantly will provide other organizations and agencies with information on successful springs restoration strategies.

Responsible Personnel: Dr. Stevens, Ms. Ledbetter and Dr. McDaniel will be the personnel responsible for completing this task.

Deliverable Description: The report described above will be the deliverable for Task 6.

Deliverable Due Date: Task 6 will be completed and submitted by December 31, 2019.

Task Cost: $17,943.

Arizona Water Protection Fund
Springs Ecosystems Restoration in Northern Arizona

Personnel: Salary and wages	Rate	Unit	No.	Requested
Lawrence Stevens, Project Director	$70	/ hour	0	$29,400
Jeri Ledbetter, Project Manager	$50	/ hour	0	$25,000
Courtney McDaniel,Project Foreman	$40	/ hour	0	$32,800
Jeff Jenness, GIS Analyst	$40	/ hour	0	$11,200
Technician1	$22	/ hour	0	$17,600
Technician2	$22	/ hour	0	$12,980
Subtotal Salary & Wages	***All***	***/ hour***	***0***	***$128,980***
Fringe Benefits				
Lawrence Stevens, Project Director	SUM	10.74%	salary	$3,458
Jeri Ledbetter, Project Manager	SUM	15.74%	salary	$4,407
Courtney McDaniel,Project Foreman	SUM	10.74%	salary	$3,952
Jeff Jenness, GIS Analyst	SUM	10.74%	salary	$1,375
Technician1	SUM	10.74%	salary	$2,268
Technician2	SUM	10.74%	salary	$1,678
Subtotal Fringe Benefits	***SUM***	***All***	***salary***	***$17,138***
Total Salary plus Fringe	**SUM**	**All**	**salary**	**$146,118**
Outside Professional Services: Consultants	**Rate**	**Unit**	**No.**	**Requested**
NAU - see itemized NAU worksheet	All	All	All	$88,051
FlagIT	$60	hr	All	$13,200
Elk fence construction	$28	hr	All	$5,108
Other Outside Service CostsSubtotal	***All***	***All***	***All***	***$106,359***
Transportation	**Rate**	**Unit**	**No.**	**Requested**
Flagstaff to Phoenix, RT	$0.56	mi	300	$1,512
Flagstaff to fieldwork sites, RT	$0.56	mi	225	$2,394
Flagstaff to info summary sites, RT	$0.56	mi	175	$1,078
Per diem to PHX	$38	day/staff	2	$689
Per diem to fieldwork sites	$38	mi	2	$1,454
Per diem to info summary sites	$38	mi	1	$421
Lodging to fieldwork sites (camping)	$5	night/staff	3	$1,620
Travel Subtotal	***All***	***All***	***All***	***$9,167***
Total Other Direct Costs				
Equipment rental - mini excavator ($1783/mo) + accessories ($500/mo) + trailer rental ($750/mo)	$3,033.00	month	1	$9,099
Supplies - field tools, first aid kits, tool maintenance, radios, chain saw and accessories, etc.	$4,000	All	All	$4,000
Revegetation supplies (hoses, pots, watering, fertilizer, gardening supplies)	$2,500	All	All	$3,375
Supplies - elk fencing: 4 hedge&corner $50 ea+ unbarbed wire/400 m/roll X 4 rolls/site@$85/roll+8' steel post/rod@$10 ea X 60	$1,200	ea	5	$7,500
Other Direct Costs Subtotal	All	All	All	$23,974
Total Direct Costs	***All***	***All***	***All***	***$285,618***
Indirect Costs	5%	All	All	$14,281
Forgone Indirect Costs (cost-share)	44.2%	All	All	$159,375
Total Project Costs	**All**	**All**	**All**	**$299,899**

Year 1 Budget

Personnel: Salary and wages	Year one					
	Task 1		Task 2		Task 3	
	hours	salary	hours	salary	hours	salary
Lawrence Stevens, Project Director	40	$2,800	60	$4,200	60	$4,200
Jeri Ledbetter, Project Manager	40	$2,000	80	$4,000	80	$4,000
Courtney McDaniel,Project Foreman	80	$3,200	100	$4,000	80	$3,200
Jeff Jenness, GIS Analyst	40	$1,600	60	$2,400	40	$1,600
Technician1	80	$1,760	80	$1,760	20	$440
Technician2	40	$880	40	$880	10	$220
Subtotal Salary & Wages	***320***	***$12,240***	***420***	***$17,240***	***290***	***$13,660***
Fringe Benefits						
Lawrence Stevens, Project Director	All	$301	All	$451	All	$451
Jeri Ledbetter, Project Manager	All	$315	All	$630	All	$630
Courtney McDaniel,Project Foreman	All	$344	All	$430	All	$344
Jeff Jenness, GIS Analyst	All	$172	All	$258	All	$172
Technician1	All	$189	All	$189	All	$47
Technician2	All	$95	All	$95	All	$24
Subtotal Fringe Benefits	***All***	***$1,415***	***All***	***$2,052***	***All***	***$1,667***
Total Salary plus Fringe	**All**	**$13,655**	**All**	**$19,292**	**All**	**$15,327**
Outside Professional Services: Consultants	**No.**	**Amount**	**No.**	**Amount**	**No.**	**Amount**
NAU - see itemized NAU worksheet	All	$0	All	$54,615	All	$9,947
FlagIT	20	$1,200	40	$2,400	40	$2,400
Elk fence construction	0	$0	0	$0	0	$0
Other Outside Service CostsSubtotal	***All***	***$1,200***	***All***	***$57,015***	***All***	***$12,347***
Transportation	**No.**	**Amount**	**No.**	**Amount**	**No.**	**Amount**
Flagstaff to Phoenix, RT	1	$168	3	$504	1	$168
Flagstaff to fieldwork sites, RT	2	$252	3	$378	1	$126
Flagstaff to info summary sites, RT	1	$98	2	$196	1	$98
Per diem to PHX	1	$77	3	$230	1	$77
Per diem to fieldwork sites	2	$153	3	$230	1	$77
Per diem to info summary sites	1	$38	2	$77	1	$38
Lodging to fieldwork sites (camping)	12	$180	18	$270	6	$90
Travel Subtotal	***All***	***$966***	***All***	***$1,884***	***All***	***$673***
Total Other Direct Costs						
Equipment rental - mini excavator ($1783/mo) + accessories ($500/mo) + trailer rental ($750/mo)	0	$0	0	$0	0	$0
Supplies - field tools, first aid kits, tool maintenance, radios, chain saw and accessories, etc.	0	$0	0	$0	0	$0
Revegetation supplies (hoses, pots, watering, fertilizer, gardening supplies)	0	$0	0	$0	0	$0
Supplies - elk fencing: 4 hedge&corner $50 ea+ unbarbed wire/400 m/roll X 4 rolls/site@$85/roll+8' steel post/rod@$10 ea X 60	0	$0	0	$0	0	$0
Other Direct Costs Subtotal	All	$0	All	$0	All	$0
Total Direct Costs	***All***	***$15,820***	***All***	***$78,190***	***All***	***$28,347***
Indirect Costs	All	$791	All	$3,910	All	$1,417
Forgone Indirect Costs (cost-share)	All	$6,993	All	$34,560	All	$12,530
Total Project Costs	**All**	**$16,611**	**All**	**$82,100**	**All**	**$29,765**

Year 2 Budget

Personnel: Salary and wages	Year two			
	Task 4		Task 5	
	hours	salary	hours	salary
Lawrence Stevens, Project Director	160	$11,200	40	$2,800
Jeri Ledbetter, Project Manager	200	$10,000	60	$3,000
Courtney McDaniel,Project Foreman	360	$14,400	120	$4,800
Jeff Jenness, GIS Analyst	80	$3,200	40	$1,600
Technician1	300	$6,600	300	$6,600
Technician2	240	$5,280	240	$5,280
Subtotal Salary & Wages	***1,340***	***$50,680***	***800***	***$24,080***
Fringe Benefits				
Lawrence Stevens, Project Director	All	$1,203	All	$301
Jeri Ledbetter, Project Manager	All	$1,574	All	$472
Courtney McDaniel,Project Foreman	All	$1,547	All	$516
Jeff Jenness, GIS Analyst	All	$344	All	$172
Technician1	All	$709	All	$709
Technician2	All	$567	All	$567
Subtotal Fringe Benefits	***All***	***$5,943***	***All***	***$2,736***
Total Salary plus Fringe	**All**	**$56,623**	**All**	**$26,816**
Outside Professional Services: Consultants	**No.**	**Amount**	**No.**	**Amount**
NAU - see itemized NAU worksheet	All	$683	Part	$13,024
FlagIT	20	$1,200	40	$2,400
Elk fence construction	140	$3,920	40	$1,120
Other Outside Service CostsSubtotal	***All***	***$5,803***	***All***	***$16,544***
Transportation	**No.**	**Amount**	**No.**	**Amount**
Flagstaff to Phoenix, RT	3	$504	0	$0
Flagstaff to fieldwork sites, RT	4	$504	4	$504
Flagstaff to info summary sites, RT	0	$0	3	$294
Per diem to PHX	3	$230	0	$0
Per diem to fieldwork sites	4	$306	4	$306
Per diem to info summary sites	0	$0	3	$115
Lodging to fieldwork sites (camping)	24	$360	24	$360
Travel Subtotal	***All***	***$1,904***	***All***	***$1,579***
Total Other Direct Costs				
Equipment rental - mini excavator ($1783/mo) + accessories ($500/mo) + trailer rental ($750/mo)	2	$6,066	1	$1,517
Supplies - field tools, first aid kits, tool maintenance, radios, chain saw and accessories, etc.	1	$2,000	1	$1,000
Revegetation supplies (hoses, pots, watering, fertilizer, gardening supplies)	1	$2,500	0	$625
Supplies - elk fencing: 4 hedge&corner $50 ea+ unbarbed wire/400 m/roll X 4 rolls/site@$85/roll+8' steel post/rod@$10 ea X 60	5	$6,000	1	$1,000
Other Direct Costs Subtotal	All	$16,566	All	$4,142
Total Direct Costs	***All***	***$80,896***	***All***	***$49,080***
Indirect Costs	All	$4,045	All	$2,454
Forgone Indirect Costs (cost-share)	All	$35,756	All	$21,694
Total Project Costs	**All**	**$84,940**	**All**	**$51,534**

Year 3 Budget

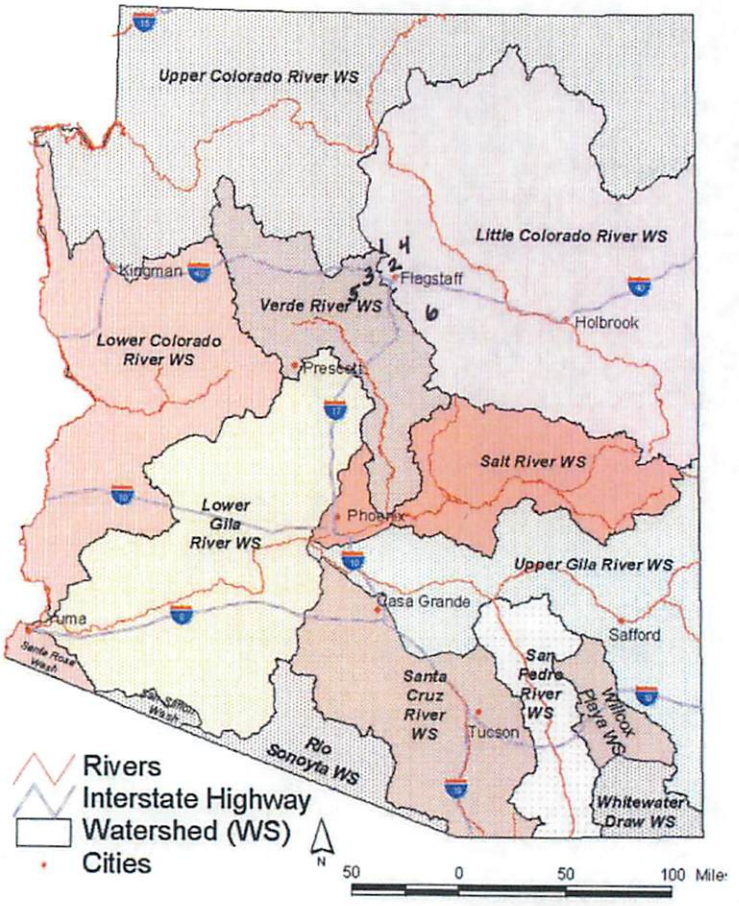
Personnel: Salary and wages	Year three			
	Task 5		Task 6	
	hours	salary	hours	salary
Lawrence Stevens, Project Director	40	$2,800	60	$4,200
Jeri Ledbetter, Project Manager	60	$3,000	40	$2,000
Courtney McDaniel,Project Foreman	100	$4,000	80	$3,200
Jeff Jenness, GIS Analyst	40	$1,600	20	$800
Technician1	160	$3,520	20	$440
Technician2	120	$2,640	20	$440
Subtotal Salary & Wages	***520***	***$17,560***	***240***	***$11,080***
Fringe Benefits				
Lawrence Stevens, Project Director	All	$301	All	$451
Jeri Ledbetter, Project Manager	All	$472	All	$315
Courtney McDaniel,Project Foreman	All	$430	All	$344
Jeff Jenness, GIS Analyst	All	$172	All	$86
Technician1	All	$378	All	$47
Technician2	All	$284	All	$47
Subtotal Fringe Benefits	***All***	***$2,036***	***All***	***$1,290***
Total Salary plus Fringe	**All**	**$19,596**	**All**	**$12,370**
Outside Professional Services: Consultants	**No.**	**Amount**	**No.**	**Amount**
NAU - see itemized NAU worksheet	Part	$6,710	All	$3,072
FlagIT	40	$2,400	20	$1,200
Elk fence construction	40	$68	0	$0
Other Outside Service CostsSubtotal	***All***	***$9,178***	***All***	***$4,272***
Transportation	**No.**	**Amount**	**No.**	**Amount**
Flagstaff to Phoenix, RT	0	$0	1	$168
Flagstaff to fieldwork sites, RT	4	$504	1	$126
Flagstaff to info summary sites, RT	4	$392	0	$0
Per diem to PHX	0	$0	1	$77
Per diem to fieldwork sites	4	$306	1	$77
Per diem to info summary sites	4	$153	0	$0
Lodging to fieldwork sites (camping)	24	$360	0	$0
Travel Subtotal	***All***	***$1,715***	***All***	***$447***
Total Other Direct Costs				
Equipment rental - mini excavator ($1783/mo) + accessories ($500/mo) + trailer rental ($750/mo)	1	$1,517	0	$0
Supplies - field tools, first aid kits, tool maintenance, radios, chain saw and accessories, etc.	1	$1,000	0	$0
Revegetation supplies (hoses, pots, watering, fertilizer, gardening supplies)	0	$250	0	$0
Supplies - elk fencing: 4 hedge&corner $50 ea+ unbarbed wire/400 m/roll X 4 rolls/site@$85/roll+8' steel post/rod@$10 ea X 60	0	$500	0	$0
Other Direct Costs Subtotal	All	$3,267	All	$0
Total Direct Costs	***All***	***$33,755***	***All***	***$17,089***
Indirect Costs	All	$1,688	All	$854
Forgone Indirect Costs (cost-share)	All	$14,920	All	$7,553
Total Project Costs	**All**	**$35,443**	**All**	**$17,943**

NAU Springs Ecosystems Restoration in Northern Arizona

Note: NAU financial system is not set up to support hourly wages for faculty. Financial reporting will reflect actual salary.					Requested
Personnel: Salary and wages				hours	
Wilber Odem - engineer		$66	/ hour	80	$5,280
Abe Springer - Hydrogeologist		$66	/ hour	180	$11,840
Teki Sankey - remote sensing		$55	/ hour	80	$4,400
Graduate Research Assistantship					
academic year		$16	/ hour	1,140	$18,422
summer		$16	/ hour	280	$4,480
Sugtotal Salary & Wages					*$44,422*
Fringe Benefits					
Odem		SUM	16.00%	salary	$845
Springer		SUM	16.00%	salary	$1,894
Sankey		SUM	16.00%	salary	$704
Graduate Research Asst. (AY)		AY	0.50%	salary	$92
Graduate Research Asst. (Summer)		SUM	8.15%	salary	$365
GRA tuition remission (2 years) inc. 5%/yr					
2017-2018			9,146	per year	$9,146
2018-2019			9,146	per year	$4,802
GRA health insurance (2 years) inc. 5%/yr					
2017-2018			2,423	per year	$2,423
2018-2019			2,423	per year	$1,565
Subtotal Fringe Benefits					*$21,836*
Total Salary plus Fringe					**$66,258**
Outside Prof. Services:					
Consultants					
					$0
Other Direct Costs:					
Supplies					
LIDAR surveys	$4,720	/ mobilization	2.00	times	$9,440
printing/publication					$400
water quality analyses					$1,200
					$0
Monitoring supplies (gaging stations)					$4,000
Subtotal Supplies					***$15,040***
Transportation					
Flagstaff to Phoenix	4	trips			
4 trips/year	280	miles/trip	$0.500	per mile	$560
Flagstaff to field sites	80	trips			
40 trips/year	20	miles/trip	$0.500	per mile	$800
two trips for two people to meetings to present results from the project					$1,200
Subtotal Transportation					***$2,560***
Total Other Direct Costs					**$17,600**
Total Direct Costs					**$83,858**
Indirect Costs		5.00%	TDC		**$4,193**
Forgone Indirect Costs		52.00%	MTDC		$39,413.44
Total Project Costs					**$88,051**

NAU Year one						NAU Year two and three					
Task 1		Task 2		Task 3		Task 4		Task 5		Task 6	
hours	salary	hours	salary	hours	salary	hours	salary	hours	salary	hours	salary
0	0	80	$5,280		$0		$0		$0		$0
0	0	80	$5,262	$60	$3,947		$0	$20	$1,316	$20	$1,316
0	0	80	$4,400		$0		$0		$0		$0
0	0	760	$12,281		$0		$0	$380	$6,141		
0	0	0	$0	$280	$4,480		$0		$0		
	0		*$27,223*		*$8,427*		*$0*		*$7,456*		*$1,316*
	0		$845		$0		$0		$0		$0
	0		$842		$631		$0		$210		$210
	0		$704		$0		$0		$0		$0
	0		$61		$0		$0		$31		$0
	0		$0		$365		$0		$0		$0
	0		$9,146		$0		$0		$0		$0
	0		$0		$0		$0		$4,802		$0
	0		$2,423		$0		$0		$0		$0
	0		$0		$0		$0		$1,565		$0
	0		*$14,021*		*$997*		*$0*		*$6,608*		*$210*
	0		**$41,245**		**$9,423**		**$0**		**$14,064**		**$1,526**
			$9,440								
			$50		$50		$50		$50		$200
			$600				$600				
									$4,000		
	0		***$10,090***		***$50***		***$650***		***$4,050***		***$200***
			$280						$280		
			$400						$400		
											$1,200
	0		***$680***		**$0**		***$0***		***$680***		***$1,200***
	0		**$10,770**		**$50**		**$650**		**$4,730**		**$1,400**
	0		$52,015		$9,473		$650		$18,794		$2,926
	0		$2,601		$474		$33		$940		$146
			$24,447		$4,453		$306		$8,833		$1,375
	0		**$54,615**		**$9,947**		**$683**		**$19,734**		**$3,072**

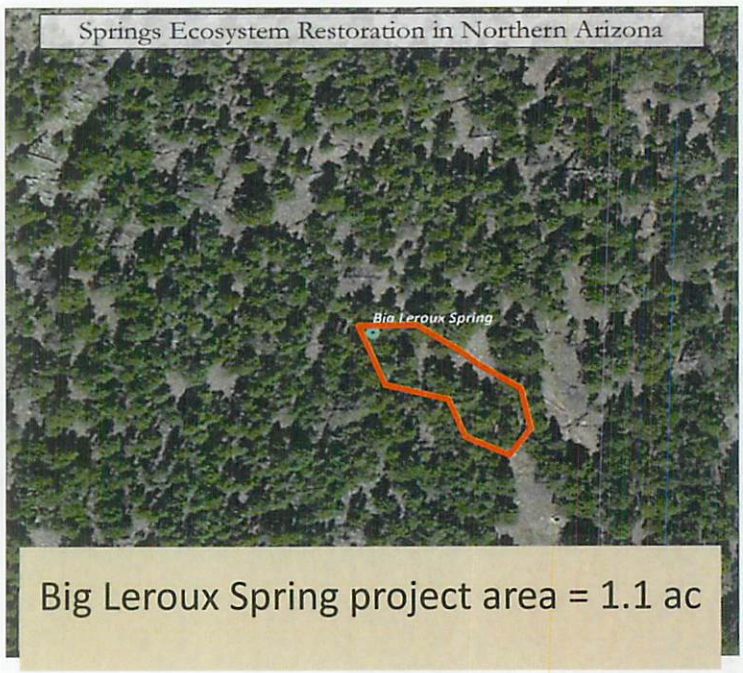
PROJECT MAPS & SCHEMATICS



Title of Project: Springs Ecosystem Restoration in Northern Arizona
Location: (UTM's and Tnshp./Sect./Range)
(1) Big Leroux Spring: 12N 434106.74m E, 3905814.13m N; T0220N/R0060E/S1
(2) Coyote Spring: 12N 439916.17m E, 3899051.28m N; T0210N/R0070E/S04
(3) Mineral Spring: 12N 409080.04m E, 3901431.66m N; T0220N/R0040E/S30
(4) Orion Springs: 12N 442065.42m E, 3905380.62m N; T0220N/R0070E/S15
(5) Rosilda Spring: 12N 403245.69m E, 3892980.35m N; T0210N/R0030E/S27
(6) Sheep Spring: 12N 366377.95m E, 3864716.58m N; T0180N/R0080E/S27

Fig. 4 Arizona Watershed Map (provided by AWPF) indicating the locations of the six proposed restoration sites in northern Arizona (numbers on map refer to Location numbers listed below the map).

Project location maps



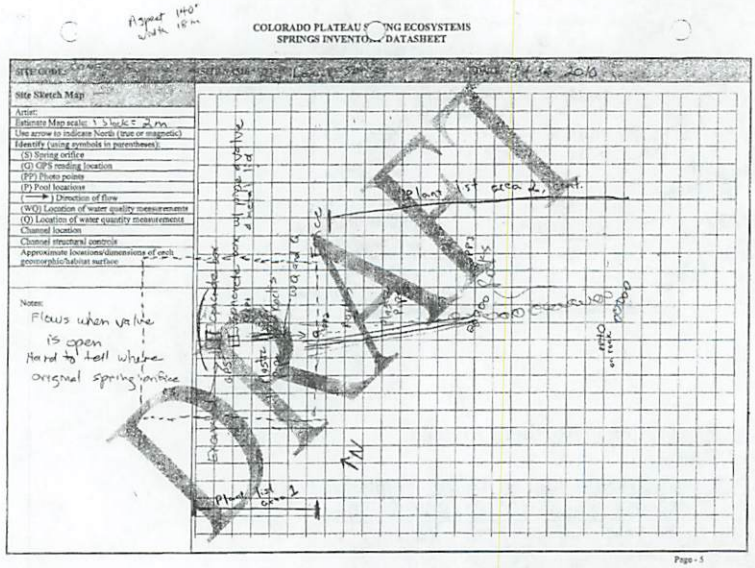
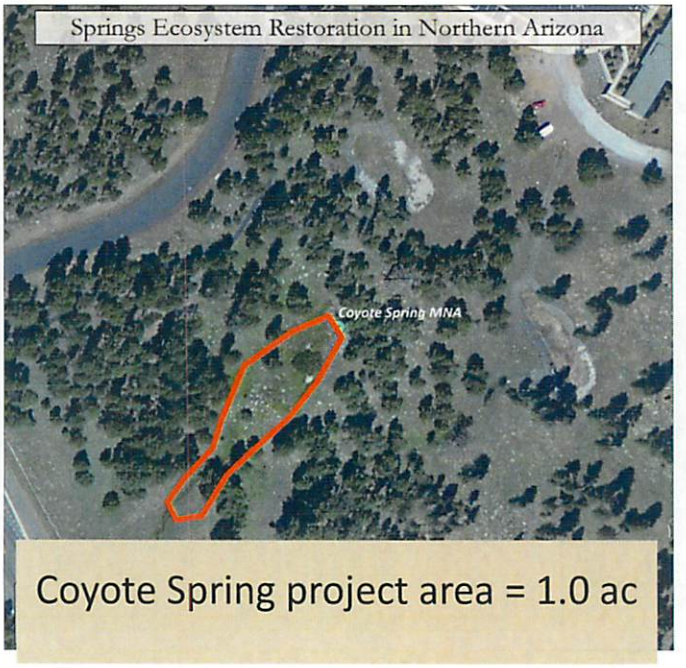


Fig. 5 Aerial map and schematic of Big Leroux Spring, Coconino National Forest.



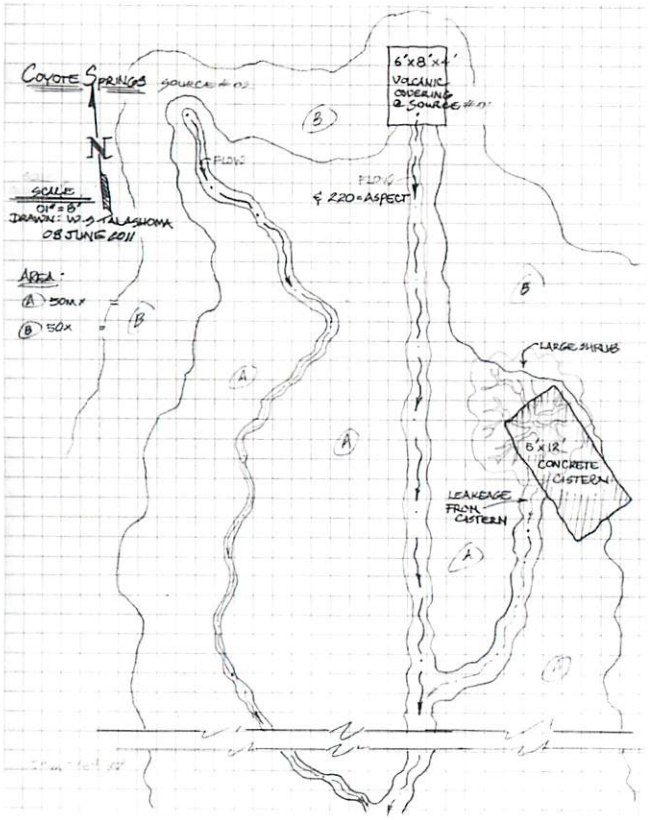
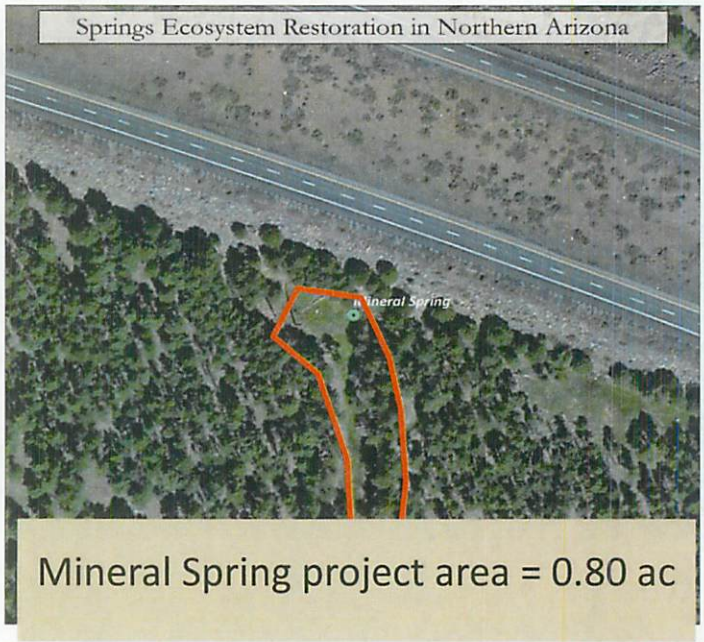


Fig. 6 Aerial map and schematic of Coyote Spring, Museum of Northern Arizona.



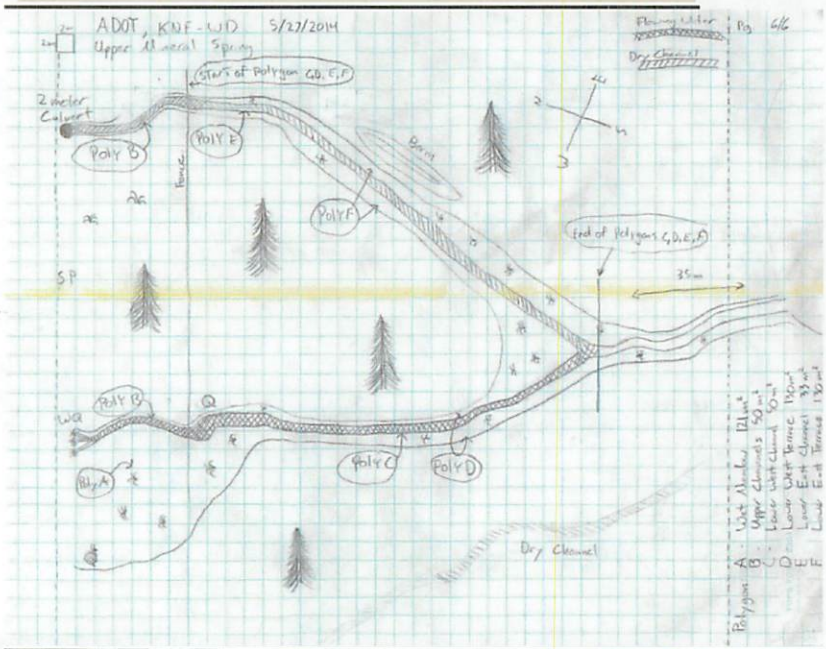
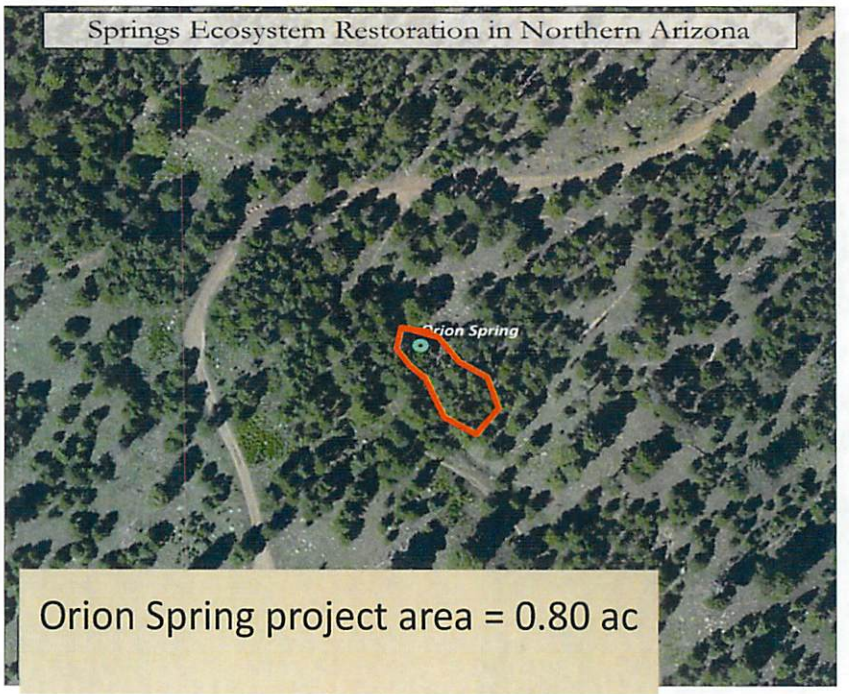


Fig. 7 Aerial map and schematic of Mineral Spring, Kaibab National Forest.



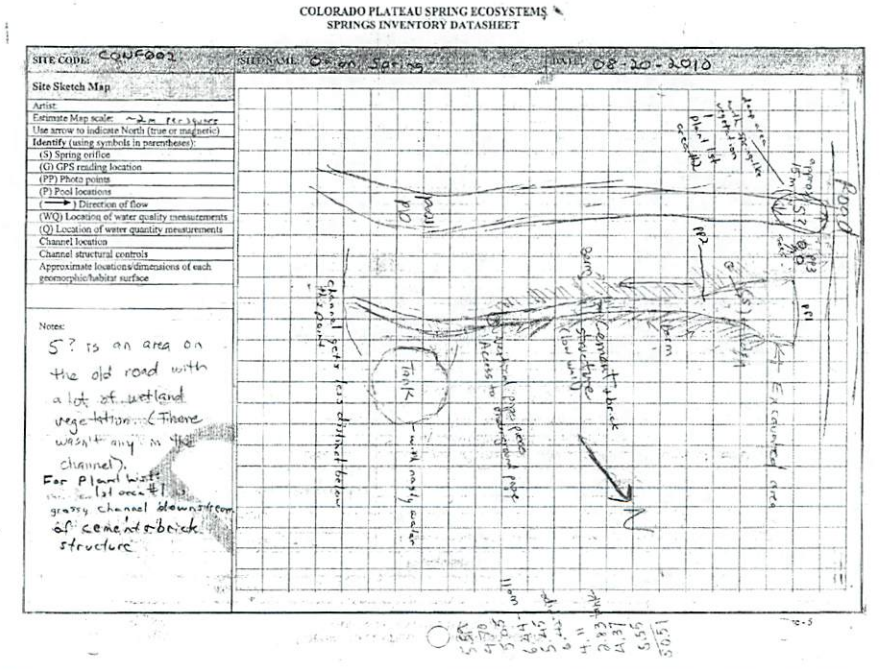
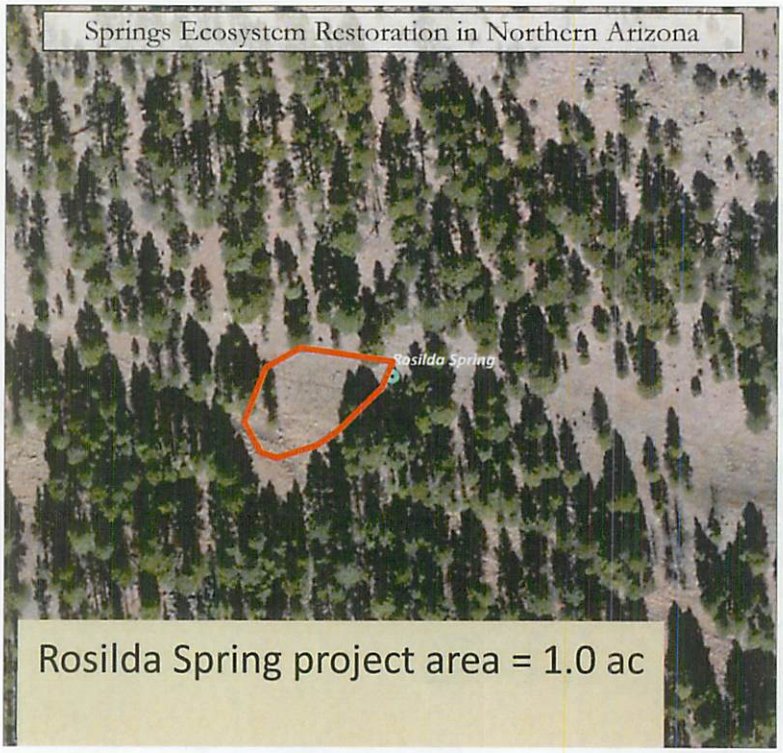


Fig. 8 Aerial map and schematic of Orion Spring, Coconino National Forest.



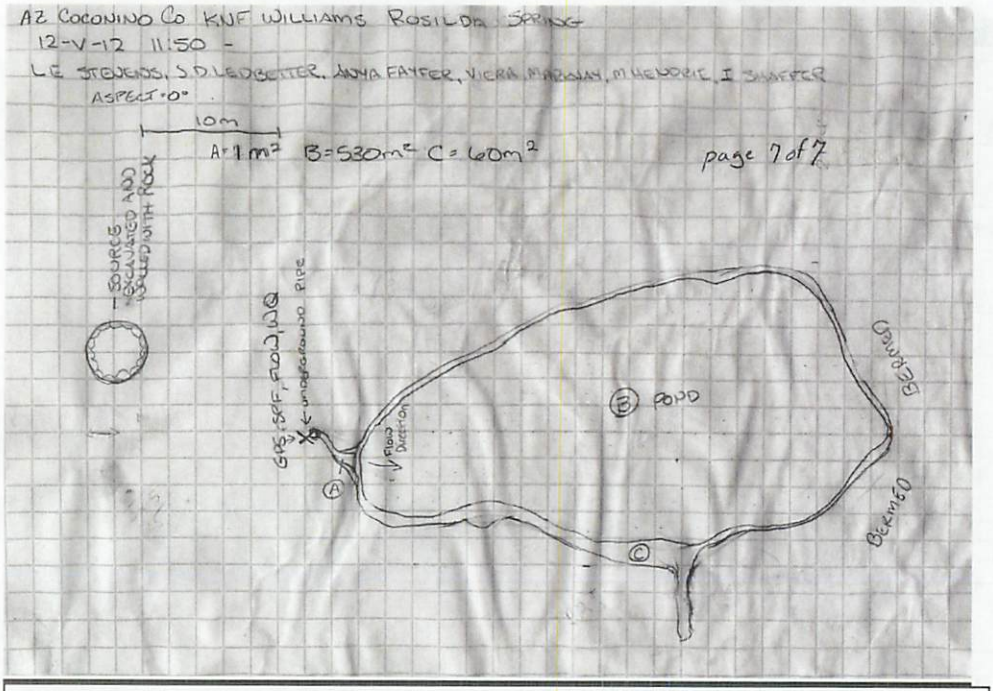
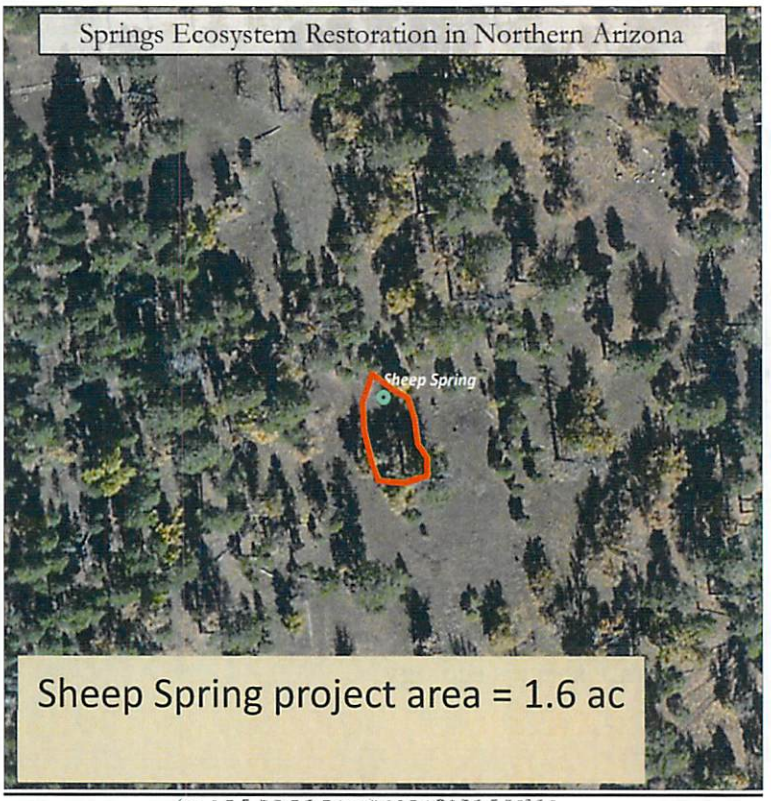


Fig. 9 Aerial map and schematic of Rosilda Spring, Kaibab National Forest.



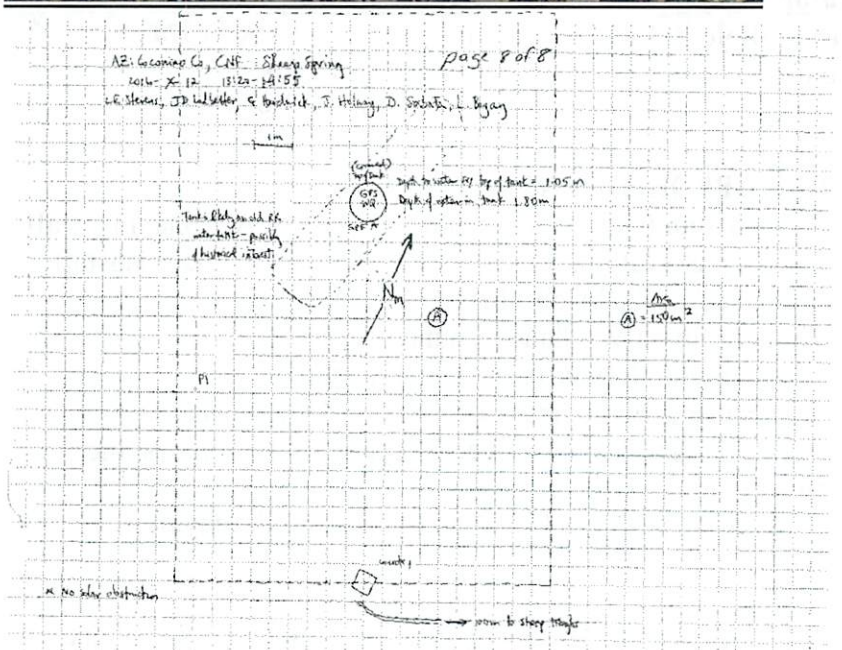


Fig. 10 Aerial map and schematic of Sheep Spring, Coconino National Forest.

SUPPLEMENTAL INFORMATION

Key Personnel:

LAWRENCE E. STEVENS, PhD (Project Coordinator)
MNA Springs Stewardship Institute, Director
Museum of Northern Arizona
3101 N. Fort Valley Rd.
Flagstaff, AZ 86001 (928) 380-7724
larry@springstewardship.org

A. EXPERTISE

Biodiversity of the Colorado Plateau and western North America; biogeography of large, deep canyons; museum collections curation; invertebrate taxonomy; data entry and analysis; springs ecosystem ecology; river and riparian ecology; rare species ecology.

B. PROFESSIONAL PREPARATION

College/University	Major	Degree & Year
Prescott College, Prescott, Arizona	Biology and fine arts (honors)	B.A., 1974
Northern Arizona University	Biology	M.S., 1985
Northern Arizona University	Zoology	Ph..D., 1989

C. ACADEMIC/PROFESSIONAL APPOINTMENTS

2010-present: Director, Springs Stewardship Institute, Museum of Northern Arizona, Flagstaff
2006-present: Curator of Ecology and Conservation, Museum of Northern Arizona, Flagstaff
2006-present: Grand Canyon National Park, ATBI Coordinator
2006-present: Senior Ecologist, Grand Canyon Wildlands Council, Flagstaff
2004-2006 Board of Directors, Museum of Northern Arizona, Flagstaff
2002-present: Principal Investigator, Stevens Ecological Consulting, LLC, Flagstaff
1994-1999: Data Analyst, Bureau of Reclamation and Applied Technology Associates, Inc.
1988-1994: Ecologist, Grand Canyon National Park
1974-present: Commercial river guide and trip leader, Colorado River, Grand Canyon.

D. SELECTED PUBLICATIONS

Stevens, LE. and A.S. Menke. 2014. Biogeography of *Ammophila* (Hymenoptera: Sphecidae) in the Grand Canyon ecoregion, southwestern USA. *Western North American Naturalist* 74:216-222.

Stevens, LE. 2012. The biogeographic significance of a large, deep canyon: Grand Canyon of the Colorado River, Southwestern USA. Pp. 169-208 *in* Stevens, L.E., editor. *Global Advances in Biogeography*. InTech Publications, Rijeka. ISBN: 978-953-51-0454-4. Available on-line at: http://cdn.intechopen.com/pdfs/34661/InTech.

Stacey, C.J., A.E. Springer, and L.E. Stevens. 2011. Have aridland springs restoration projects been effective in restoring hydrology, geomorphology, and invertebrate and plant species composition comparable to natural springs with minimal anthropogenic disturbance? Collaboration for Environmental Evidence Review 10-002 (SR87).; http://www.environmentalevidence.org/Documents/Completed_Reviews/SR87.pdf.

Scarbrough, A.G., L.E. Stevens, and C.R. Nelson. 2012. Synopsis of the *albibarbis* complex of *Efferia* Coquillett from the Grand Canyon region, southwestern USA, with description of new species (Diptera: Asilidae). *Pan-Pacific Entomologist* 88:58-86.

Stevens, LE and RA Bailowitz. 2009. Odonata biogeography in the Grand Canyon ecoregion, southwestern U.S.A. *Annals of the Entomological Society of America* 102:261-274.

Perla, B.S. and L.E. Stevens. 2008. Biodiversity and productivity at an undisturbed spring, in comparison with adjacent grazed riparian and upland habitats. Pp. 230-243 *in* Stevens, L.E. and V. J. Meretsky, editors. Aridland Springs in North America: Ecology and Conservation. University of Arizona Press, Tucson.

Springer, A.E. and L.E. Stevens. 2008. Spheres of discharge of springs. Hydrogeology Journal DOI 10.1007/s10040-008-0341-y.

Springer, A.E., L.E. Stevens, D. Anderson, R.A. Parnell, D. Kreamer, and S. Flora. 2008. A comprehensive springs classification system: integrating geomorphic, hydrogeochemical, and ecological criteria. Pp. 49-75 *in* Stevens, L.E. and V. J. Meretsky, editors. Aridland springs in North America: ecology and conservation. University of Arizona Press, Tucson.

Stevens. L.E. 2008. Every last drop: future of springs ecosystem ecology and management. Pp. 332-346 i*n* Stevens, L.E. and V. J. Meretsky, editors. Aridland Springs in North America: Ecology and Conservation. University of Arizona Press, Tucson.

Stevens, LE and JT Polhemus. 2008. Biogeography of aquatic and semi-aquatic Heteroptera in the Grand Canyon ecoregion, southwestern USA. *Monographs of the Western North American Naturalist* 4:38-76.

Stevens, L.E., F.B. Ramberg, and R.F. Darsie, Jr. 2008. Biogeography of Culicidae (Diptera) in the Grand Canyon region, Arizona, USA. *Pan-Pacific Entomologist* 84:92-109.

Stevens, L. 2008. Water and biodiversity on the Colorado Plateau. Plateau: *The Land & People of the Colorado Plateau* 4(1): 48-55.

Stevens, LE and VJ Meretsky, editors. 2008. *Aridland Springs in North America: Ecology and Conservation*. University of Arizona Press, Tucson.

Stevens, LE, TL Griswold, O Messinger, WG Abrahamson II, and TJ Ayers. 2007. Plant and pollinator diversity in northern Arizona. *The Plant Press* 31:5-7.

E. SYNERGISTIC ACTIVITIES

1. Director, Springs Stewardship Institute, Museum of Northern Arizona, Flagstaff, 2010-present
2. Conservation Representative for GCWC on the Federal Advisory Committee Glen Canyon Dam Adaptive Management Work Group and Technical Work Group, 2006-present
3. Board of Directors, Museum of Northern Arizona, Flagstaff, 2004-2006
4. Grand Staircase National Monument, Chair and Science Advisor, 2003-2005
5. Grand Canyon Wildlands Council, Inc., Senior Science Advisor, 2000- present

Co-editors (last 2 years): A.E. Springer, J.D.Ledbetter, M. Joyce

Graduate Advisors: D.W. Blinn, P.W. Price, C. N. Slobodchikoff, T.G. Whitham.

Senior and Masters Theses and Dissertation Advisor since 1990 (total: 16 women, 7 men): J. Barnes, K.A. Buck, C. Cooley, R. England, S. Ferrier, V. Hallam, K. Hamman, R. Harms, K. Junghans, A. LaBrake, J.D. Ledbetter, S.G. Mortenson, E.G. North, K. Paffett, K. Rowell, J. Schultz, J.P. Shannon, G.M. Siemion, K. Slutz, K. Sparks, D. Stanitski-Martin, K. A. Whitley, G. Wimp.

JERI D. LEDBETTER, MGIS
MNA Springs Stewardship Institute, Program Manager
3101 N. Fort Valley Rd., Flagstaff AZ 86001
(928) 774-5211 ext 231
jeri@springstewardship.org

(a) Expertise:

GIS analyst with extensive experience in relational database design for scientific field work, project and natural resource management, and biological inventory. GIS analysis using ESRI ArcMap and ArcGIS for Server 10.x software, development of relational databases using MySQL, design and development of web mapping and database technologies, and custom geospatial applications.

(b) Professional Preparation:

Prescott College, Prescott, Arizona, 2009	BA Mass Communications
The Pennsylvania State University, 2011 (MGIS)	MS Geographic Information Systems

(c) Appointments:

2010-present Program Manager, Springs Stewardship Institute, Museum of Northern AZ, Flagstaff
2010-present Data Management Consultant, METI, Inc., El Paso, TX
2010-2012 Team Field Leader, Northern Arizona University, Flagstaff, AZ
2000-2005 Membership Director, Executive Director, Glen Canyon Institute, Flagstaff AZ
2005-2006 President, Grand Canyon River Guides, Inc.
1990-1996 Membership Director, Board of Directors, Grand Canyon River Guides, Flagstaff AZ

1989-present Commercial river guide and trip leader, Colorado River, Grand Canyon.

(d) (i) Five Publications Most Closely Related to the Proposal Research

2015. Ledbetter, Jeri D. Desert LCC Springs: publicly available data. Mapping Service. Available at http://dlcc.databasin.org/datasets/e4bff9b28ade42a391fa145512bbd94b.
2014. Ledbetter, Jeri D., MGIS, Lawrence E. Stevens, PhD, Abraham Springer, PhD, and Benjamin Brandt, MGIS. Springs Inventory Database. Online Database. Springs and Springs-Dependent Species Database. Vers. 1.0. Springs Stewardship Institute, January 2014. Web. September 17, 2015. Available online at springsdata.org.
2014. Springer, A.E., L.E. Stevens, J.D. Ledbetter, E.M. Schaller, K.M. Gill, and S.B. Rood. Ecohydrology and stewardship of Alberta springs ecosystems. Ecohydrology. DOI: 10.1002/eco.1596. Available at http://onlinelibrary.wiley.com/doi/10.1002/eco.1596/abstract.
2013. Ledbetter, Jeri D. Groundwater Dependent Ecosystems Database. Developed for USFS. Microsoft Access 2007. Description available at http://www.fs.fed.us/emc/rig/protocols/master.shtml.
2013. Pendleton, Burton K., R. Pendleton, C. Woodleif, J. Ledbetter, C. Giffen, L. Boehnke, S. Solem. Final Program Report for 2010-2012. Appendix B - Conservation Agreement Species Fact Sheets and Potential Habitat Models. Monitoring and Evaluation for Conserving Biological Resources of the spring Mountains National Recreation Area. May 3, 2013. Available at http://www.treesearch.fs.fed.us/pubs/44827.

(ii) Five Other Significant Publications

2015. Kreamer, David K., Lawrence E. Stevens and Jeri D. Ledbetter. Groundwater Dependent Ecosystems - Science, Challenges, and Policy Directions (pp. 205-230). Available at https://www.novapublishers.com/catalog/product_info.php?products_id=52986.
2014. Springer, A.E., L.E. Stevens, J.D. Ledbetter, E.M. Schaller, K.M. Gill, and S.B. Rood. Ecohydrology and stewardship of Alberta springs ecosystems. Ecohydrology. DOI: 10.1002/eco.1596. Available at http://onlinelibrary.wiley.com/doi/10.1002/eco.1596/abstract.
2013. Solem, Stephen J., B. Pendleton, C. Giffen, M. Coles-Ritchie, J. Ledbetter, K. McKelvey, J. Berg, J. Menlove, C. Woodleif, and L. Boehnke. Final Program Report for 2010-2012. Monitoring and Evaluation for Conserving Biological Resources of the Spring Mountains National Recreation Area. May 3, 2013. Available at http://www.treesearch.fs.fed.us/pubs/44827.
2011. Solem, Stephen J., B. Pendleton, M. Coles-Ritchie, J. Ledbetter, K. McKelvey, J. Berg, K. Nelson, and J. Menlove. 2010 Annual Report: Monitoring and Evaluation for Conserving Biological Resources of the Spring Mountains National Recreation Area. Available at http://www.fs.fed.us/rm/pubs_other/rmrs_2011_solem_s001.pdf.
2005. Ledbetter, Jeri D. Hardly a Deadly Sin: a Documentary Film. http://perezosoproductions.com/about.htm.

(e) Synergistic Activities:

2014-present Adjunct professor, Prescott College, Prescott AZ
2005-2006 President, Grand Canyon River Guides, Inc.
1996-present Principal Investigator, Perezoso Media, Flagstaff AZ
1990-2005 Membership Director, Board of Directors, Grand Canyon River Guides, Inc.

1990-present Private pilot, instrument rating, backcountry and mountain/canyon flight training
>1500 hours pilot in command

Collaborators and Other Affiliations:

Co-editors (last 2 years): A.E. Springer, L.E. Stevens, D.K. Kreamer, S.B. Rood, S. Solem, B. Pendleton, M. Coles-Ritchie, K. McKelvey, J. Menlove, J. Berg

Graduate Advisors: Douglas Miller, Penn State

COURTNEY MCDANIEL, PhD
Springs Stewardship Institute, Postdoctoral Scholar
3101 N Ft. Valley Rd., Flagstaff, AZ 86001
courtney@springstewardship.org

Education
Ph.D. Entomology, University of Georgia, May 2016
M.S. Biological Sciences, Auburn University, May 2008
B.S. Biology, Centre College, May 2005

Research Experience
Postdoctoral Scholar, Springs Stewardship Institute, Flagstaff, AZ, January 2016 - present
Doctoral Researcher, University of Georgia, Dept. of Entomology, August 2011 – May 2016
Field technician, Alabama Natural Heritage Program, Auburn, AL, April – June 2008
Intern, Cincinnati Zoo and Botanical Garden, Cincinnati, OH, June – August 2004
Intern, Centre College Biology Department, Danville, KY, June – August 2003

Professional Experience
Natural Resources Specialist, Fort Gordon, GA, August 2010 – August 2011
Conservation Biologist, Callaway Gardens, Pine Mountain, GA, July 2008 – August 2010

Teaching Experience
TA, Medical Entomology Lab, University of Georgia, Fall 2014, Spring 2015
TA, Aquatic Entomology Lab, University of Georgia, Spring 2014
TA, Principles of Biology II Lab, University of Georgia, Fall 2012, Fall 2013
TA, Anatomy and Physiology II Laboratory, Auburn University, Spring 2008
TA, Principles of Ecology Laboratory, Auburn University, Spring 2007, Fall 2007
TA, Principles of Biology Laboratory, Auburn University, Fall 2005 – Fall 2007

Funding
American Association of University Women American Dissertation Fellowship, 2015 – 2016
The Wetland Foundation Student Travel Grant, 2015
UGA Graduate School Travel Funding, 2014
Society of Wetland Scientists, South Atlantic Chapter Student Travel Grant, 2014

Society of Wetland Scientists Student Research Grant, 2013
Society of Wetland Scientists South Atlantic Chapter Research Grant, 2013
UGA Interdisciplinary Life Sciences Fellowship, 2012

Publications (Peer-reviewed)

*Last name changed from Holt to McDaniel in July 2016

McDaniel, C.H. and D.P. Batzer. In review. Effects of river regulation beyond the channel: multifaceted changes within a group of invertebrate floodplain specialists. Submitted to Ecological Applications.

McDaniel, C.H., J.V. McHugh, D.P. Batzer. In review. Congeneric predaceous diving beetle species fail to segregate in a floodplain system: a case of amplified sympatry. Submitted to Environmental Entomology.

Holt, C.R., D. Pfitzer, C. Scalley, B.A. Caldwell, P.I. Capece, and D.P. Batzer. 2015. Macroinvertebrate assemblages of the Chattahoochee River National Recreation Area: an 11-year study. *In*: McDowell, R.J., C.A. Pruitt, and R.A. Bahn, eds. Proceedings of the 2015 Georgia Water Resources Conference, April 28-29, 2015, University of Georgia, Athens, GA.

Holt, C.R., D. Pfitzer, C. Scalley, B.A. Caldwell, and D.P. Batzer. 2015. Macroinvertebrate community responses to annual flow variation from river regulation: an 11-year study. River Research and Applications 31: 798-807.

Holt, C.R., D. Pfitzer, C. Scalley, B.A. Caldwell, P.I. Capece, and D.P. Batzer. 2015. Longitudinal variation in macroinvertebrate assemblages below a large-scale hydroelectric dam. Hydrobiologia 755: 13-26.

Mendelssohn, I.A., D.P. Batzer, **C.R. Holt**, and S.A. Graham. 2014. Abiotic constraints for wetland plants and animals. *In*: Ecology of Freshwater and Estuarine Wetlands. 2nd ed. Eds. D.P. Batzer and R.R. Sharitz. Berkeley: University of California Press.

Holt, C.R., G.W. Folkerts, and D.R. Folkerts. 2011. A floristic study of a steephead stream in northwestern Florida. Southeastern Naturalist 10: 289-302.

Holt, C.R. 2008. Insects of Alabama. Encyclopedia of Alabama. URL: http://www.encyclopediaofalabama.org/face/Article.jsp?id=h-1809

Honors and Awards

1st place in the Oral Paper Competition, 2015
Society of Wetland Scientists South Atlantic Chapter Meeting, Athens, GA
Outstanding Teaching Assistant Award, University of Georgia, 2015
C.M. Beckham Award – 1st place in the Ph.D. Oral Paper Competition, 2014
Georgia Entomological Society Annual Meeting, Valdosta, GA
2nd place in the Oral Paper Competition, 2014
H.O. Lund Week, UGA Dept. of Entomology, Athens, GA

Professional Activities

Society of Wetland Scientists – South Atlantic Chapter Meeting, 2015
Meeting Committee, Session Moderator
H.O. Lund Entomology Club, President, 2014 –2015
Georgia Science and Engineering Fair Judge, 2013, 2015
The American Chestnut Foundation, Board Member, 2010 –2012
Beta Beta Beta Biological Honor Society, Historian, 2004 – 2005

Centre College Biology Department, Student Representative, 2003 – 2005

Volunteer & Outreach
Rivers Alive River Monitoring, Athens, GA, 2015
University of Georgia Entomology Outreach Events, Athens, GA, 2012-2015
Reforestation of Clarks Run, Danville, KY, 2004
ESL Tutor, Junction City Elementary School, Junction City, KY, 2003

ABRAHAM E. SPRINGER, PhD
School of Earth Sciences and Environmental Sustainability
Northern Arizona University
P.O. Box 4099, Flagstaff, AZ 86011
(928) 523-7198; e-mail abe.springer@nau.edu

PROFESSIONAL PREPARATION

The College of Wooster, Wooster, Ohio, Geology, B.A. with Departmental Honors, 1987.
The Ohio State University, Columbus, Ohio, Hydrogeology, M.S. 1990.
The Ohio State University, Columbus, Ohio, Hydrogeology, Ph.D. 1994.

APPOINTMENTS

Academic

Professor, Northern Arizona University, School of Earth Sciences and Env Sustainability, 2008-present.
Fulbright Visiting Chair in Water and the Environment, Alberta Ingenuity Centre for Water Resources, University of Lethbridge, Alberta, Canada, 2007.
Water Coordinator, Northern Arizona University, Arizona Water Institute, 2005-2009
Associate Professor, Northern Arizona University - Department of Geology, 1999-2008
Visiting Associate Professor, University of Wisconsin - Madison, Spring 2001
Assistant Professor, Northern Arizona University - Department of Geology, 1994-1999
Graduate Research Associate, The Ohio State University, Department of Geological Sciences, 1989-1994

Administrative

Inaugural Director, Interdisciplinary SESES PhD Program. Northern Arizona University – School of Earth Sciences and Environmental Sustainability, 2009-2013.
Inaugural Director, School of Earth Sciences and Environmental Sustainability, Northern Arizona University 2009-2011.

PUBLICATIONS

Springer, A.E., L.E. Stevens, J.D. Ledbetter, E.M. Schaller, K. Gill, and S.B. Rood. 2015. Ecohydrology and Stewardship of Alberta Springs Ecosystems, Ecohydrology, doi: 10.1002/eco.1596.

Coles-Ritchie, Marc; Solem, Stephen J.; Springer, Abraham E.; Pendleton, Burton. 2014. Framework for Springs Stewardship Program and proposed action development: Spring Mountains National Recreation Area, Humboldt-Toiyabe National Forest. Gen. Tech. Rep. RMRS-GTR-330. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 63 p.

Ha, W., T.E. Kolb, **A.E. Springer,** S. Dore, S. Masek Lopez, F.C. O'Donnell, R.M. Morales, G.W. Koch. 2015. Evapotranspiration comparisons among eddy covariance, meteorological and remote sensing-based models in disturbed ponderosa pine forests, Ecohydrology doi: 10.1002/eco.1586.

Wyatt, C.J.W. F.C. O'Donnell, and **A.E. Springer**. 2014. Semi-arid aquifer responses to forest restoration treatments and climate change, Groundwater, doi: 10.1111/gwat.12184.

Mueller, J., W. Swaffar, E. Nielsen, **A.E. Springer**, S. Masek Lopez. 2013. Estimating the value of watershed services following forest restoration, Water Resources Research, 49, 1773-1781, doi:10.1002/wrcr.20163,

OTHER SIGNIFICANT PUBLICATIONS

Ramsted, K.M,, J.A. Allen, **A.E. Springer**. 2012. Have wet meadow restoration projects in the southwestern U.S. been effective in restoring geomorphology, hydrology, soils and plant species composition? Environmental Evidence 1:11, doi:10.1186/2047-2382-1-11.

Davis, C.J., **A.E. Springer**, L.E. Stevens. 2011. Have arid land springs restoration projects been effective in restoring hydrology, geomorphology, and invertebrate and plant species composition comparable to natural springs with minimal anthropogenic disturbance?, *Collaboration for Environmental Evidence*, Systematic Review CEE 10-002, 72 p.

Springer, A.E, M.A. Amentt, T.E. Kolb, R.M. Mullen. 2006. Evapotranspiration of two vegetation communities in a high-elevation riparian meadow at Hart Prairie, Arizona. Water Resources Research, 42, W03412, doi:10.1029/2004WR003863.

Springer, A.E. and L.E. Stevens. 2009. Spheres of Discharge of Springs, Hydrogeology Journal, doi: 10.1007/s10040 008 0341 y.

SYNERGISTIC ACTIVITIES

1) NSF-EAR1038842, Building an economically sustainable restoration and monitoring plan for forested watershed in Northern Arizona, Lead PI, Co-PIs E. Nielsen, J. Mueller, X. Zhao.
2) Project funded by U.S. Bureau of Reclamation-Water Smart Program through the Desert Landscape Conservation Cooperative, Assessing evapotranspiration rate changes for proposed restoration of the forested uplands of the Desert LCC, Lead P.I., Co-PI T. Kolb, 9/12-12/14.
3) Project funded by Salt River Project, Predicting hydrologic and other natural resource responses to forest restoration treatments in the Verde and Salt River watersheds, Lead PI W Covington, 11/1/11-5/30/14
4) Fellow Geological Society of America

JEFF S. JENNESS, MGIS
MNA Springs Stewardship Institute, GIS Analyst
3001 N. Fort Valley Rd.
Flagstaff, AZ 86001 928-607-4638
jeffj@jennessent.com

A. EXPERTISE

I am a GIS analyst and developer with over 22 years of experience developing analytical applications for a wide variety of spatial analyses, focusing primarily on ecological and wildlife-related projects. I am the primary author of the African Water Resources Database, developed for the Food and Agriculture Organization of the United Nations and distributed to developing countries in Africa. I have developed several analytical GIS tools related specifically to wildlife corridors, species diversity and habitat analysis.

B. PROFESSIONAL PREPARATION

College/University	Major	Degree & Year
Northern Arizona University	Forestry	B.S., 1989
Northern Arizona University	Educational Psychology	M.A., 1993
Northern Arizona University	Wildlife Biology	M.S., 2000

C. ACADEMIC/PROFESSIONAL APPOINTMENTS

2012 – Present : GIS Instructor in the School of Forestry, Northern Arizona University
2008 – Present: Chair and Past-Chair of the Spatial Ecology and Telemetry Working Group of The Wildlife Society.

D. PUBLICATIONS AND TOOLS

Publications Most Closely Related to Proposal

Jenness, J.S., J. Dooley, J. Aguilar-Manjarrez, and C. Riva. 2007. *African water resource database: GIS-based tools for inland aquatic resource management. 1. concepts and application case studies.* CIFA Technical Paper. No. 33, Part 1. Food and Agriculture Organization of the United Nations. Rome, Italy. 165 pp.

Jenness, J.S., J. Dooley, J. Aguilar-Manjarrez, and C. Riva. 2007. *African water resource database: GIS-based tools for inland aquatic resource management. 2. technical manual and workbook.* CIFA Technical Paper. No. 33, Part 2. Food and Agriculture Organization of the United Nations. Rome, Italy. 305 pp.

Rudnick, D.A., S. J. Ryan, P. Beier, S.A. Cushman, F. Dieffenbach, C.W. Epps, L.R. Gerber, J.

Hartter, J.S. Jenness, J. Kintsch, A.M. Merenlender, R.M. Perkl, D.V. Preziosi, and S.C. Trombulak. 2012. *The role of landscape connectivity in planning and implementing conservation and restoration priorities*. Issues in Ecology. 16:1-20

Jenness, J.S., P. Beier and J.L. Ganey. 2004. *Associations between forest fire and Mexican spotted owls in Arizona and New Mexico.* Forest Science. 50(6):765-772

Drake, J.C., J.S. Jenness, J. Calvert and K.L. Griffis-Kyle. 2015. *Testing a model for the prediction of isolated waters in the Sonoran Desert.* Journal of Arid Environments. 118:1-8

Dickson, B., J.S. Jenness and P. Beier. 2005. *Influence of vegetation topography, and roads on cougar movement in southern California.* Journal of Wildlife Management. 69(1):264-276

Tools Most Closely Related to Proposal

Jenness, J.S., B. Brost and P. Beier. 2010. *Land Facet Corridor Designer:* 30th Annual ESRI International Users Conference - Application Fair, San Diego, California. http://www.jennessent.com/arcgis/land_facets.htm

Majka, D., J.S. Jenness and P. Beier. 2007. *Corridor Designer: A Suite of ArcGIS Tools to Identify and Evaluate Corridors Between Fragmented Habitat Blocks.* 27th Annual ESRI International Users Conference - Application Fair, San Diego, California. http://www.corridordesign.org/downloads

Jenness, J.S. 2004. *Mahalanobis distances.* 24th Annual ESRI International Users Conference - Application Fair, San Diego, California. http://www.jennessent.com/arcview/mahalanobis.htm

Jenness, J.S. and J.J. Wynne. 2005. *Cohen's Kappa and classification table metrics 2.0: an ArcView 3.x extension for accuracy assessment of spatially explicit models.* U.S. Geological Survey Open-File Report OF 2005-1363. U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ, USA.

Other Significant Publications and Tools

Jenness, J.S. 2004. *Calculating landscape surface area from digital elevation models.* Wildlife Society Bulletin. 32(3):829-839

Jenness, J.S. 2009. *Analyzing raster elevation datasets.* Earth Imaging Journal. September / October 2009, 6(5):32-33.

Jenness, J.S. 2005. *Grid and Theme Regression.* 25th Annual ESRI International Users Conference - Application Fair, San Diego, California.

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de Graaf, G., F.J.B. Marttin, J. Aguilar-Manjarrez, and J.S. Jenness. 2003. *Manual on the use of Geographical Information Systems in fisheries management and planning.* FAO Fisheries Technical Paper. No. 449. Rome, FAO. 173p.

Tagil, S. and J.S. Jenness. 2008. *GIS-based automated landform classification and topographic, landcover and geologic attributes of landforms around the Yazoren Polje, Turkey.* Journal of Applied Sciences. 8(6):910-92

E. SYNERGISTIC ACTIVITIES

1. GIS Instructor for Northern Arizona University School of Forestry. I teach GIS to undergraduates in the professional forestry program.
2. GIS Analyst at the Springs Stewardship Institute, Museum of Northern Arizona, Flagstaff, AZ. I perform GIS analysis on issues related to springs, focusing mainly on potential threats to springs due to climate change, human population trends and general evolving conditions at spring locations.
3. Chair and Past-Chair of Spatial Ecology and Telemetry Working Group of The Wildlife Society. I work to enhance the ability of ecological professionals to learn about and use spatial tools and concepts.

Graduate and postdoctoral advisors

Paul Beier (Northern Arizona University), Joe Ganey (USFS Rocky Mountain Research Station) and Charles Van Riper III (USGS)

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Education

Ph.D.	Civil Engineering, Environmental Engineering Emphasis	University of Arizona	1991
M.S.	Civil Engineering, Environmental Engineering Emphasis	University of Arizona	1985
B.A.	Geosciences and Geography	University of Texas, Austin	1981

Academic Experience

Northern Arizona University	Professor, Department of Civil Engineering, Construction Management, and Environmental Engineering	2002 – present	Full Time
	Interim Chair, Department of Construction	2009	

	Management		
	Chair, Department of Civil and Environmental Engineering	2008 – 2009	
	Associate Professor, Department of Civil and Environmental Engineering	1997 – 2002	Full Time
	Assistant Professor, Department of Civil and Environmental Engineering	1992 – 1997	Full Time
University of Colorado, Boulder	Research Associate	1991 – 1992	Full Time
University of Arizona	Research Associate	1988 – 1991	Full Time
	Research Assistant	1984 – 1985	Part Time

Non-academic Experience

Los Alamos National Laboratory	Research Fellow	Research Engineer	Summer, 1993	Full Time
HDR Engineering, Cameron Park, CA	Environmental Engineer	Environmental Engineer	1987 – 1988	Full Time
Radian Corporation, Sacramento, CA	Environmental Engineer	Environmental Engineer	1986 – 1987	Full Time
HydorGeoChem, Tucson, AZ	Hydrogeological Technician	Research Technician	1984	Part Time

Certifications or Professional Registrations

- Civil Engineer, State of Arizona. Registration # 28114; State of Montana, Civil, Reg. # 21148
- Board Certified Environmental Engineer, American Association of Environmental Engineers.

Current membership in professional organizations

- Arizona Water Pollution Control Association
- American Water Resources Association

Honors and Awards

- Recognition by Hopi Tribe for Outstanding Contributions to the Hopi Junior/Senior High School Water Improvement Project, 1998.
- Dean's Award, NAU College of Engineering and Technology, 1998-1999.
- Boeing Outstanding Educator Award. Member of NAU College of Engineering and Technology Design4Practice Project Team, 1999.

Publications and Presentations – Last 5 years

- Drainage Study, Town of Tusayan, Final Report. April 2012. Submitted to South Grand Canyon Sanitation District, Town of Tusayan, and USFS Kaibab National Forest. Funded via USFS Rural Community Assistance Program.
- Final Report, Hidden Springs Water System Rehabilitation Recommendations and Design. Dec. 2011. Submitted to Arizona Water Infrastructure Financing Authority
- Business Plan, NAU On-Site Wastewater Treatment Facility. Draft. 2010. Authored with Shawn Newell.
- Lower Hoxworth Springs Channel Restoration Design and Implementation, August 2009. Submitted to USFS, Coconino National Forest.
- Spring Creek: A Bank Erosion Study, submitted to Yavapai County Flood Control, March 2008.

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Professional Preparation

- Ph.D, Land Resources and Environmental Sciences, Montana State University, 2006.
- MS, Land Resources and Environmental Sciences, Montana State University, 2001.
- BA, Foreign Language University, Ulaanbaatar, Mongolia, 1996. Major: English, Minor: Russian

Research Emphasis and Technical Skills

- Remote Sensing, multispectral satellite data and 3-dimensional lidar data
- Hyperspectral data and point cloud data fusion
- UAV image applications and analysis

- Geoinformatics, GIS/GPS, geostatistics
- Statistical Analysis, Experimental Design
- Global, regional, and local scale analysis of land cover change

Appointments

- Assistant Professor, Informatics and Computing Program, NAU Aug, 2014-Present
- Assistant Research Professor, School of Earth Sciences and Environmental Sustainability, NAU Jan 2013-Aug 2014
- Assistant Research Professor, Boise Center Aerospace Laboratory, Idaho State University, Sep 2008-Jan, 2013
- Post-doctorate Research Associate, GIS Training and Research Center, Idaho State University, 2006-2008

Peer-Reviewed Publications

- **Sankey, T.,** B. Dickson, S. Sesnie, O. Wang, and L. Zachmann. 2014. WorldView-2 high resolution improves desert invasive plant detection. *Photogrammetric Engineering and Remote Sensing (In Print)*
- **Sankey, T.,** R. Shreshtha, J. Sankey, and S. Hardegree. 2013. Lidar-derived carbon estimates in woody encroachment. *Journal of Geophysical Research* 118: 1144-1155
- Gould, S., N. Glenn, **T. Sankey,** and J. McNamara. 2013. Influence of a dense, low-height shrub species on the accuracy of a lidar-derived DEM. *Photogrammetric Engineering and Remote Sensing* 79: 421-431
- Sankey, J., M. Germino, A. Hoover, and **T. Sankey.** 2012. Fire effects on the spatial patterning of soil properties in sagebrush steppe, USA: Meta-analysis. *International Journal of Wildland Fires* doi:10.1071/WF11092
- Mitchell, J., N. Glenn, **T. Sankey,** D. Derryberry, and M. Germino. 2012. Remote sensing of sagebrush canopy nitrogen. *Remote Sensing of Environment* 124: 217-223
- **Sankey, T.** 2011. Decadal-scale aspen change detection using Landsat 5TM and lidar data. *Applied Vegetation Science* 2012: 84-98
- Glenn, N., Spaete, L., **Sankey, T.,** Derryberry, D., Hardegree, S., and J. Mitchell. 2011. Errors in LiDAR-derived shrub height and crown area on sloped terrain. *Journal of Arid Environments* 75 (4):377-382
- **Sankey, T.** and N. Glenn. 2011. Landsat 5 TM and lidar fusion for sub-pixel juniper tree cover estimates. *Photogrammetric Engineering and Remote Sensing* 77 (12):1241-1248
- Mitchell, J., Glenn, N., **Sankey, T.,** Derryberry, D., Anderson, M., and R. Hruska. 2011. Small-footprint LiDAR estimations of sagebrush canopy characteristics. *Photogrammetric Engineering and Remote Sensing* 77(5): 521-530
- **Sankey, T.T.,** and P. Bond. 2011. LiDAR-based classifications of sagebrush communities. *Rangeland Ecology and Management* 64: 92-98.

- **Sankey, T.T.,** Glenn, N., Ehinger, S., Boehm, A., and S. Hardegree. 2010. Characterizing western juniper expansion via a fusion of Landsat 5 Thematic Mapper and lidar data. *Rangeland Ecology and Management* 63: 514-523
- Spaete, L., Glenn, N., Derryberry, D., **Sankey, T.,** and S. Hardegree. 2010. Vegetation and slope effects on accuracy of a LiDAR-derived DEM in the sagebrush steppe. Remote Sensing Letters 2 (4): 317-326
- Theau, J., **Sankey, T.,** and K. Weber. 2010. Multi-scale analysis of vegetation indices in a semi-arid environment. *GIScience and Remote Sensing* 42 (2):1-16
- Weber, K., **Sankey, T.,** and J. Theau. 2010. Local-scale validation of the surface observation gridding system dataset with in-situ weather observation in a semi-arid environment. *International Journal of Remote Sensing* 31: 4411-4422
- **Sankey, T.,** Sankey, J., Weber, K., and C. Montagne. 2009. Geospatial assessment of grazing regime shifts and socio-political changes in a Mongolian rangeland. *Rangeland Ecology and Management* 62: 522-530
- **Sankey, T.T.** 2009. Regional assessment of aspen change and spatial variability at decadal time scales. *Remote Sensing* 1(4): 896-914
- **Sankey, T.,** and M. Germino. 2008. Assessment of juniper encroachment with the use of satellite imagery and geospatial data. *Rangeland Ecology and Management* 61: 412-418
- **Sankey, T.** 2008. Learning from spatial variability: Aspen persistence in the Centennial Valley, Montana. *Forest Ecology and Management* 255: 1219-1225
- **Sankey, T.,** Moffet, C., and K. Weber. 2008. Post-fire recovery of sagebrush communities: Assessment using SPOT-5 and Very Large-Scale Aerial Imagery. *Rangeland Ecology and Management* 61: 598-604.
- **Sankey, T.** 2008. Spatial patterns of Douglas-fir and aspen forest expansion. *New Forests* 35:45-55.
- **Sankey, T.** 2007. Woody-herbaceous-livestock species interaction. *Annals of Arid Zone* 46(2):1-28
- **Sankey, T.,** Graumlich, L., Montagne, C., Lawrence, R., and J. Nielsen. 2006. Twentieth century forest-grassland ecotone shift in Montana under differing livestock grazing pressure. *Forest Ecology and Management* 234: 282-292
- **Sankey, T.,** Graumlich, L., Montagne, C., Lawrence, R., and J. Nielsen. 2006. Lower forest-grassland ecotones and 20th century livestock herbivory effects in northern Mongolia. *Forest Ecology and Management* 233: 36-44

Grants and Funding

- **Sankey, T.** and R. Horne. 2014. NAU NASA Space Grant Program. $3,000
- Thenkabail, P., Congalton, R., Milesi, C., Ozdogan, M., and **T. Sankey.** 2013. Global Food Security-support Data and Analysis at 30m. NASA. $3,500,000

- Munson, S. and **T. Sankey.** 2013. Climate change and plant community composition in national parks of the southwestern US: Forescasting regional long-term effects to meet management needs. USGS. $122,617
- **Sankey, T.,** Springer, A., and F. O'Donnell. 2013. Predicting snow water equivalence (SWE) and soil moisture response to restoration treatments in headwater ponderosa pine forests of the Desert LCC. BOR. $302,974
- **Sankey, T.** 2013. Instrumentation request for a cutting-edge UAV remote sensing program at NAU. NAU. $200,000
- **Sankey, T.** and N. Glenn. 2012. StateView Program Development and Operations for the state of Idaho. AmericaView Program. $23,765
- **Sankey, T.** and N. Glenn. 2011. StateView Program Development and Operations for the state of Idaho. AmericaView Program. $23,765
- **Sankey, T.,** McCurry, M., Welhan, J., and D. Rodgers. 2010. Developing a new technique to detect hidden geothermal resources in eastern Idaho. Idaho State University Research Committee. $18,224
- **Sankey, T.,** McCurry, M., Welhan, J., and D. Rodgers. 2010. Remote sensing exploration of hidden geothermal resources in eastern Idaho. NASA Idaho Space Grant Consortium. $4000
- **Sankey, T.** 2010. Tree ring analysis. Idaho State University WeLEAD Seed Grant Proposal. $3,400
- **Sankey, T.** 2009. Change detection of aspen and juniper in southwestern Idaho. Idaho State University Faculty Research Committee. $4,950
- **Sankey, T.** 2008. Aspen change detection in Targhee National Forest, eastern Idaho. USDA Forest Service. $9,000

Teaching:

- Applied Remote Sensing, NAU (Spring and Fall, 2013)
- MSU Study Abroad Program—Mongolia Program (1998-2005)

Current Graduate Students (graduate committee chair* or committee member^):

- Richard Massey* (PhD in Climate and Landscape Change, NAU, started in Aug, 2013)
- Jonathon Donald* (PhD in Climate and Landscape Change, NAU, starting in June, 2014)
- Danial Solazzo* (MS in Environmental Science and Policy, NAU, starting in Aug, 2014)
- Ashton Bredford^ (MS in Applied Geography, NAU, started in Jan, 2014)

Project site photographs

Big Leroux Spring

Fig. 11 This image shows the diversion pipe and old channel of Big Leroux Spring, taken facing NNW. The area will be protected from overgrazing via exclosure fencing. Nonnative plants will be removed from the site shown and the area will be re-vegetated with native flora.

Fig. 12 Image of one spring box at the site, taken facing NNW.

Coyote Spring

Fig. 13 View upslope of Coyote Spring. The historic spring box can be seen in the upper left, and the modern concrete spring box is hidden behind the willow (center of photo). We will be removing the non-historic spring box and re-introducing meander to the spring runout channels at the site. Picture taken facing NE.

Mineral Spring

Fig. 14 General view of Mineral Spring site, facing I-40 (NNW). Ponderosa pine die-off can be seem in this and the following image (due to salt runoff from the interstate). Actions here will include creating runoff diversion structures and planting saline-tolerant plant species.

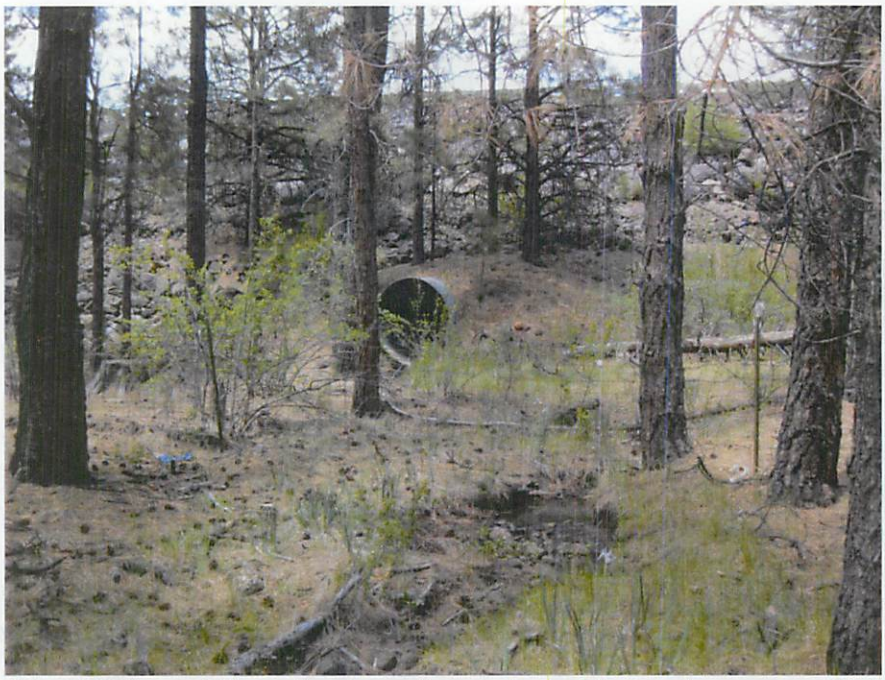


Fig. 15 View of the culvert running under I-40 at spring source (facing NNW).

Orion Spring

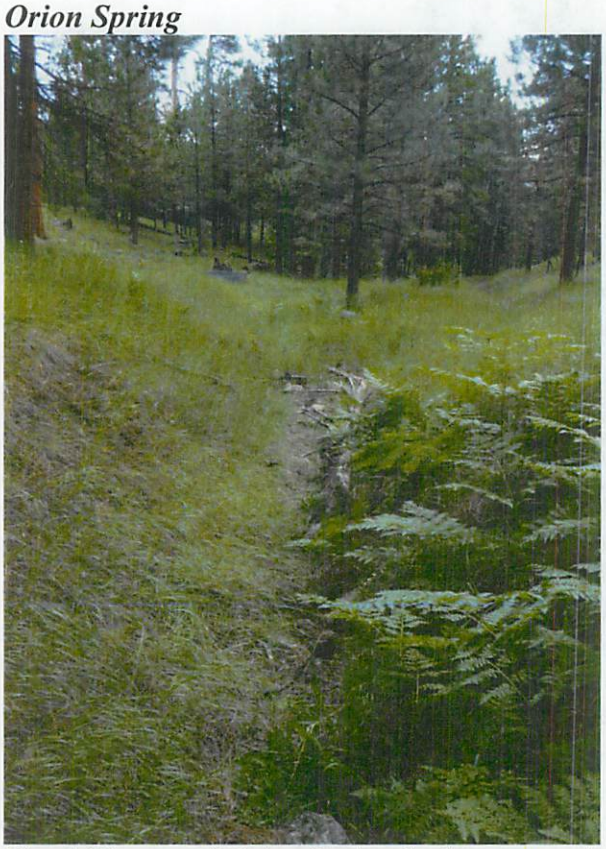


Fig. 16 Image of Orion Spring looking away from (downstream of) spring source; photo taken facing ESE. Channelization (seen above) will be reduced via re-grading.

Fig. 17 Picture of wildlife watering trough installed at Orion Spring site (facing ESE). We are proposing the addition of a wildlife escape ladder to increase safety at this tank, which collects rainwater and provides water for local wildlife when the spring is not flowing.

Fig. 18 Tank at Orion Spring site which once collected water from the spring for use by the City of Flagstaff. The piping (see figure below) is no longer functional, however, making the tank non-functional as well. We propose securely closing the top of this tank to prevent injuries to humans and wildlife. Picture taken facing E.

Fig. 19 Image of non-functional piping at Orion Spring site (picture taken facing E). We propose removing this piping as it presents hazards to humans and wildlife at the site.

Rosilda Spring

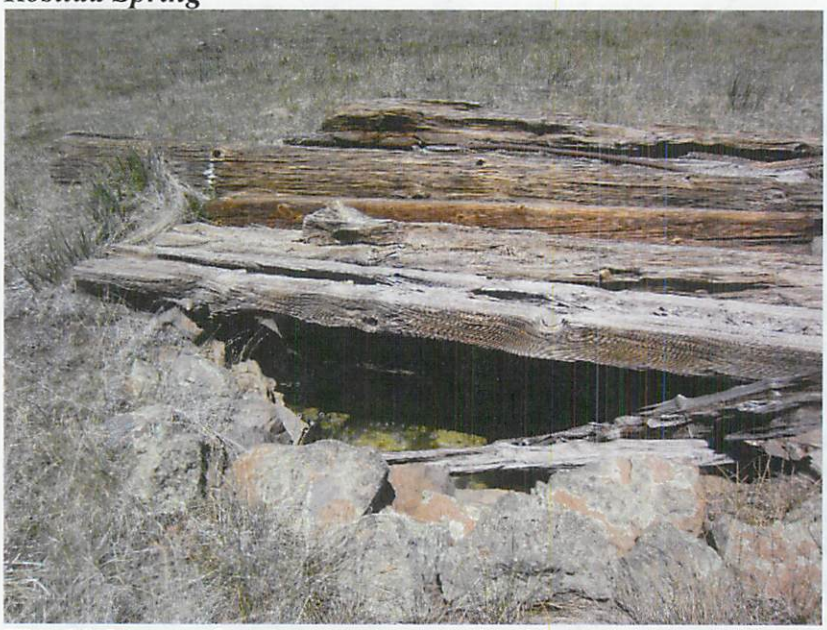


Fig. 20 Image of spring source contained in a well. The cover is dilapidated and we will be replacing it during the restoration process.

Fig. 21 This image shows the ponded area created by berms downslope of the spring source. The area is overgrazed by deer and elk, and we will be constructing an exclosure fence around the site. This will allow for other types of wildlife (birds, amphibians, insects, etc.) to access the wetland area and at the same avoid overgrazing by ungulates. Photo taken facing NNE.

Sheep Spring

Fig. 22 Site photo of Sheep Spring, taken facing S. The site will be re-graded to reduce channelization, which can be seen in the image above.

Fig. 23 Cement troughs previously used for watering livestock (93 m long trough). Piping to these troughs will be decommissioned to allow for flow to the large we meadow surrounding them.

Fig. 24 Above-ground sections of buried tank currently containing the majority of the spring flow. Piping to and from this tank will be decommissioned and replaced with piping to carry spring water to the large wet meadow at the site.

Detailed Restoration Action Plans

Below, we present our proposed on-the-ground actions at each of the six restoration sites.

Big Leroux Spring

Big Leroux Spring is a hillslope spring located in the Peaks Ranger District of Coconino National Forest. Human impacts at this site include flow capture via spring boxes and the presence of invasive plant species. Recent flow restoration work in 2013 created surface flow (via piping) at this site for the first time in decades. These restoration actions garnered much public attention and have received positive public feedback. We plan to continue and improve upon the restoration of this site via improvement of fencing around the recently restored channel and spring source. Invasive plant species will also be removed, and the site will be re-vegetated with native flora.

Coyote Spring

Coyote Spring is a helocrenic hillslope spring on Museum of Northern Arizona property. The spring flow is currently being diverted and contained by two spring boxes, one of which is historical and will not be impacted by our restoration actions. The second spring box is concrete and will be removed to return flow to the channel and marsh area downstream. The incised channel will be re-graded, and channel meanders will be re-introduced to create a more natural outflow and avoid future channel incision. Fairly intense grazing impacts by elk and deer are also occurring at this site, and we plan to install exclosure fences to reduce the grazing pressure. Finally, nonnative plant species will be removed and the site will be re-vegetated with native flora.

Mineral Spring

Mineral Spring is a helocrene spring in the Williams Ranger District of Kaibab National Forest. This site is located directly adjacent to Interstate 40. The spring source has been built on by I-40 but continues to flow into a marshy area next to the highway. This site is currently experiencing severe impacts of salt intrusion due to road salting activities. Dieback of ponderosa pine has been documented, and electrical conductivity at the site is well above the normal range. Restoration actions at this site will include creation of runoff diversion structures and planting of saline-tolerant species.

Orion Spring

Orion Spring is a rheocrenic hillslope spring in the Peaks Ranger District of Coconino National Forest. The City of Flagstaff currently holds water rights to this spring (see letter of collaboration). This site has been manipulated in the form of a tank, to which piping directs water via a bermed channel. There is also a low brick wall/dam in the channel and the source of the spring has been excavated. Currently (October 2016) there is no flow from the spring, but flow was reported in April 2000 by Dr. Larry Stevens. We propose enhancing this site in order to allow ephemeral flows to reach the surface, which would greatly enhance wildlife habitat. We will remove the in-channel wall and piping and re-grade the incised channel and excavated area. We will also secure the top of the tank to avoid injuries to wildlife and humans. In addition, a rainwater-collection trough has recently been installed at the site to provide wildlife with a water source during drier seasons. This trough already acts as a wildlife enhancement, and our work

would further this effort. We plan to install a wildlife camera at the site to document use by wildlife.

Rosilda Spring

Rosilda Spring is a helocrene spring in the Williams Ranger District of Kaibab National Forest. The source is contained in a tank, from which underground piping directs water into a bermed area, creating a shallow pond/wet meadow. We propose removal of the underground piping in order to create diffuse flow to the marsh habitat. There is also evidence of intense grazing by elk and deer, for which we will construct an exclosure fence to help mitigate this issue. Finally, we will remove invasive plant species and re-vegetate the site with native flora.

Sheep Spring

Sheep Spring is a helocrenic rheocrene spring in the Mormon Lake Ranger District of Coconino National Forest. A large underground tank captures the majority of the flow at this site and is the main focus of restoration at this site. We plan to decommission the large underground tank and associated piping to re-establish natural flow into the marsh habitat surrounding the spring. Piping to the livestock watering tanks will also be decommissioned. In addition, nonnative flora will be removed and replaced with native species.

Existing Plans, Reports, and Information

For each of the six proposed restoration sites, we have included detailed reports from past springs surveys completed by SSI. These reports are included in Appendix 1 of this document.

Community support

Our proposed restoration project is support by the USFS, the city of Flagstaff, and Northern Arizona University. We have included letters of support from each entity in Appendix 2.

Evidence of control and tenure of land

A letters of support from USFS is provided in Appendix 2. This letter serves as evidence that the property owner is in support of our efforts, and we will develop formal cooperative agreements with USFS prior to contract finalization. In addition, SSI currently has a memorandum of understanding with USFS to survey and assess springs on Forest Service property (FS Agreement No. 15-MU-11132420-282).

Evidence of physical and legal availability of water

Water rights across these six proposed restoration sites are owned by three entities: USFS, the city of Flagstaff, and MNA. Below, we have included a table (Table 2) with information from the Arizona Department of Water Resources database detailing the water rights for each of the six proposed sites. In addition, the letters of support included in Appendix 2 provide evidence that the water rights holders are supportive of our efforts and the proposed project.

Table 2. Current water rights holders for proposed restoration sites (downloaded from Arizona Department of Water Resources database 10/6/2016).

Site Name	Appl. No.	File Date	Holder Name	Holder City	Water Source	Cadastral	UTM (X, Y)
Big Leroux Spring	10292	5/15/1979	Coconino Natl Forest	Flagstaff	Big Leroux	A22006014AC0	434063.2, 3905451.9
Coyote Spring MNA	3215	9/22/1952	Northern Az Soc of Science & Art	Flagstaff	Mc Millan	A21007004BD0	439984.3, 3899017.6
Mineral Spring	71751	12/8/1978	Kaibab Natl Forest	Williams	Unnamed	A22004030DD0	408817.7, 3901332.1
Orion Spring	105002	1/8/1998	Flagstaff, City of	Flagstaff	San Francisco Peaks Springs	A22007015AC0	442078.2, 3905377.2
Rosilda Spring	69952	9/1/1978	Kaibab Natl Forest	Williams	Rosilda Spring	A21003027AC0	403503.9, 3892512.6
Sheep Spring	2645	12/10/1943	Coconino Natl Forest	Flagstaff	Bootlegger Clay Spring	A18008027BA0	451058.7, 3863762.8

APPENDIX 1 – SITE REPORTS

We have compiled information for each of the proposed restoration sites below from Springs Online, a springs database developed and maintained by SSI.

Big Leroux Spring (Report #1)
Survey Summary Report, Site ID 806

Location: The Big Leroux Spring ecosystem is located in Coconino County in the Canyon Diablo Arizona 15020015 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Peaks RD at 35.293333, -111.724694 in the Humphreys Peak USGS Quad, measured using a GPS (NAD83, estimated position error 8 meters). The elevation is approximately 2332 meters. An invertebrate survey by L.E. Stevens, and P.L. Stevens was completed at the site on 9/15/08, and data were collected in 2 of 12 categories.

Physical Description: Big Leroux Spring is a hillslope spring. This hillslope spring has been diverted into two spring boxes.

Big Leroux Spring emerges from an igneous, basalt rock layer in an unknown unit. The emergence environment is subaerial, with a gravity flow force mechanism. The distance to the nearest spring is 1133 meters.

Fauna: Surveyors collected or observed 17 terrestrial invertebrate specimens.

Table 1 Big Leroux Spring Invertebrates.

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Coleoptera Chrysomelidae Altica	Ad	T			1	Meadow
Coleoptera Melyridae	Ad	T			1	Meadow
Coleoptera Tenebrionidae Stenomorpha corrugans	Ad	T			1	
Diptera Asilidae Efferia frewingi	Ad	T			1	Meadow
Diptera Asilidae Proctacanthus milberti	Ad	T			1	Meadow
Hemiptera	Ad	T			1	meadow
Hymenoptera	Ad	T			1	meadow
Hymenoptera Sphecidae Ammophila azteca	Ad	T			1	meadow
Hymenoptera Sphecidae Podalonia	Ad	T			1	meadow
Lepidoptera Lycaenidae Celastrina	Ad	T			1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Iadon						
Lepidoptera Lycaenidae Echinargus isola	Ad	T			1	
Orthoptera Acrididae	Ad	T			1	Meadow (Melanoplinae)
Orthoptera Acrididae Arphia pseudonietana	Ad	T			1	Meadow
Orthoptera Acrididae Camnula pellucida	Ad	T			1	Meadow
Orthoptera Acrididae Dissosteira carolina	Ad	T			1	Meadow
Orthoptera Acrididae Melanoplus	Ad	T			1	Meadow
Orthoptera Acrididae Melanoplus bivitattus	Ad	T			1	Meadow

BIG LEROUX SPRING (REPORT #2)
SURVEY SUMMARY REPORT, SITE ID 806

Location: The Big Leroux Spring ecosystem is located in Coconino County in the Canyon Diablo Arizona 15020015 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Peaks RD at 35 17' 36", -111 43' 28.9" in the Humphreys Peak USGS Quad, measured using a GPS (NAD83, estimated position error 8 meters). The elevation is approximately 2332 meters. S. Monroe, S. Ordway, J. Norris, and V. Markgraf surveyed the site on 9/14/10 for 03:15 hours, beginning at 13:45, and collected data in 7 of 12 categories.

Fig 1 Big Leroux Spring.

Survey Notes: This survey was conducted by volunteers under the CNF volunteers project, under the direction of Steve Monroe. The spring flow is entirely captured by a pipe; a valve allows flow to be temporarily directed to the original channel. It is difficult to tell where the original spring orifice is located. The spring flows downslope and joins the runoff channel. There was flow modification (pipe diversion, encasement, and excavation). There was evidence of historic human occupation/use.

Water: Measurements were made at the outlet pipe from the spring box, using a Hanna Multimeter.

Table 2 Big Leroux Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
pH (field)	6.99	
Specific conductance (field) (uS/cm)	147	
Temperature, water C	8.6	

Flora: Surveyors identified 51 plant species at the site. These included 40 native and 5 nonnative species; the native status of 6 species remains unknown.

Table 3 Big Leroux Spring Cover Type.

Cover Type	Species Count	Wetland Species Count
Ground	47	9
Shrub	4	0
Mid-canopy	0	0
Tall canopy	0	0
Basal	0	0
Aquatic	0	0
Non-vascular	0	0

Table 4 Big Leroux Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A	B	C	D
Ageratina herbacea	GC	N	U	0	0.5	0	0.5
Artemisia carruthii	GC	N	U	0	0	0	1
Artemisia dracunculus	GC	N	F	0	1	0	1
Bahia dissecta	GC	N	U	0	0.5	0	0
Bouteloua	GC		U	0	0	0	0
Bromus ciliatus	GC	N	F	1	0	0	1
Carex occidentalis	GC	N	W	0	0.5	0	1
Ceanothus fendleri	GC	N	U	0	0.5	0	0
Chenopodium graveolens	GC	N	F	0	0.5	0	0
Cirsium vulgare	GC	I	F	0	0	0	0
Cyperus fendlerianus	GC	N	W	0	0	0	0.5
Elymus elymoides	GC	N	F	0	3	0	1
Elymus trachycaulus	GC	N	F	0	0	0	0.5
Epilobium ciliatum	GC	N	W	0	0.5	0	0
Erigeron neomexicanus	GC	N	U	0	0.5	0	0.5
Festuca arizonica	GC	N	U	0	0	0	0
Geranium caespitosum	GC	N	F	1	0	0	1

Species	Cover Code	Native Status	Wetland Status	A	B	C	D
Heliomeris multiflora	SC	N	U	1	0	0	0.5
Iris missouriensis	GC	N	F	0	0	0	0
Juncus bufonius	GC	N	W	0	0	0	0
Juncus tenuis	GC	N	W	0	0	0	0
Lappula occidentalis	GC	N	F	0	0.5	0	0
Machaeranthera canescens ssp. canescens var. canescens	GC	N	F	0	0	0	1
Mahonia repens	SC	N	U	1	0	0	0
Melilotus officinalis	GC	I	WR	0	0.5	0	0
Mirabilis decipiens	GC	N	U	0	0.5	0	0.5
Monarda fistulosa	GC	N	F	5	1	0	0
Muhlenbergia montana	GC	N	U	1	20	0	30
Nama dichotomum	GC	N	U	0	0.5	0	0
Penstemon eatonii	GC	N	U	0.5	0	0	1
Poa pratensis	GC	I	F	0	1	0	0
Polygonum douglasii	GC	N	W	0	0	0	0.5
Pseudognaphalium macounii	GC	N	W	0	0.5	0	0
Pteridium aquilinum	GC	N	U	5	1	0	5
Pterospora andromedea	GC	N	U	0	0	0	0
Ratibida columnifera	GC	N	U	0	0	0	1
Ribes cereum	SC	N	U	1	1	0	0
Rosa woodsii	SC	N	F	1	0	0	0
Rubus idaeus	GC	NI	F	0	0	0	1
Senecio	GC		F	0	0.5	0	0
Solidago canadensis	GC	N	WR	1	0	0	0
Sonchus oleraceus	GC	I	F	0	0	0	0.5
Thalictrum fendleri	GC	N	F	1	0	0	1
Thermopsis divaricarpa	GC	N	F	1	1	0	0
Tragia ramosa	GC	N	F	0	0	0	0.5
unknown	GC			0	0	0	0.5
unknown grass	GC			60	0	0	0
unknown grass	GC			0	0.5	0	0
Verbascum thapsus	GC	I	F	0	0.5	0	0
Verbena	GC		F	0	0	0	1
Vicia americana	GC	N	F	0	0.5	0	0

Fauna: Surveyors collected or observed 1 terrestrial invertebrate and 3 vertebrate specimens.

Table 5 Big Leroux Spring Vertebrates.

Species Common Name	Count	Detection
Steller's jay		
lesser goldfinch		
mountain chickadee		

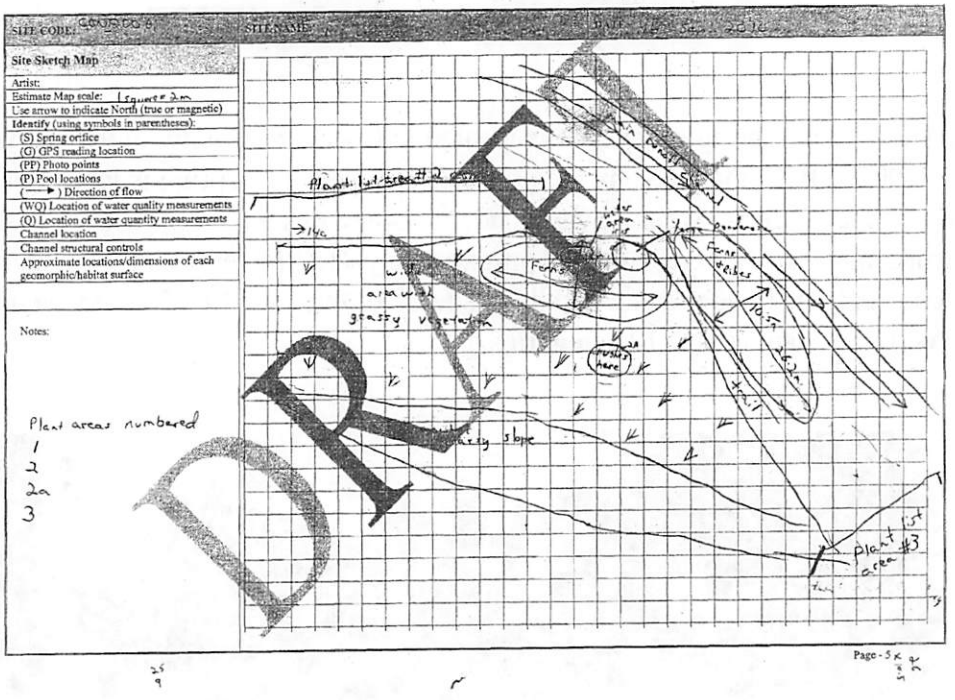


Fig 2 Big Leroux Spring Sketchmap.

COYOTE SPRING
SURVEY SUMMARY REPORT, SITE ID 827

Location: The Coyote Spring ecosystem is located in Coconino County in the Canyon Diablo Arizona 15020015 HUC, managed by the private US owner. The spring is located at 35.232722, -111.660311 in the Flagstaff West USGS Quad, measured using a GPS (WGS84, estimated position error 2 meters). The elevation is approximately 2154 meters. Workshop participants, Larry Stevens, and Jeri Ledbetter surveyed the site on 6/08/11 for 01:15 hours, beginning at 13:15, and collected data in 9 of 12 categories.

Fig 1 Coyote Spring: Panoramic view of the site

Physical Description: Coyote Spring is a hillslope/helocrene spring. This is a small hillslope spring that has been developed 200 m from highway 180 near a residential area. Two of the sources have been enclosed in a spring box. This is one of the last functioning springs in the San Francisco Peaks area. It was used as a homestead and pasture in the 1930s. The microhabitats associated with the spring cover 475 sqm. The site has 2 microhabitats, including A -- a 75 sqm channel and B -- a 400 sqm low gradient cienega. The geomorphic diversity is 0.19, based on the Shannon-Weiner diversity index.

Coyote Spring emerges as a seepage or filtration spring from an igneous, basalt rock layer in an unknown unit. The emergence environment is subaerial, with a gravity flow force mechanism. The distance to the nearest spring is 399 meters. The site receives approximately 100% of available solar radiation, with 7333 Mj annually.

Survey Notes: Spring was surveyed on a warm, sunny, breezy day. Some litter and trash was found at the site along with old fencing and barbed wire on the ground.

Table 1 Coyote Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
Alkalinity, Total (mg/L)	89.333333333	1 inch "M"
Dissolved Solids (field)	0.2	1 inch "M"
pH (field)	10.246666667	1 inch "M"
Specific conductance (field) (uS/cm)	348.666666667	1 inch "M"
Temperature, air C	25.4	
Temperature, water C	14.5	1 inch "M"

Flora: Larry Stevens was the botanist. Surveyors identified 30 plant species at the site, with 0.0632 species/sqm. These included 17 native and 11 nonnative species; the native status of 2 species remains unknown.

Table 2 Coyote Spring Cover Type.

Cover Type	Species Count	Wetland Species Count
Ground	22	8
Shrub	6	1
Mid-canopy	1	0
Tall canopy	1	0
Basal	0	0
Aquatic	0	0
Non-vascular	2	1

Table 3 Coyote Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A	B
Achillea millefolium	GC	NI	U	1.1	8
Agoseris	GC		U	0	0.01
algae	NV	N		0	1
Brassica	GC	I	F	0	0.11
Carex	GC	N		8	20
Carex nebrascensis	GC	N	W	45	26
Erigeron	GC	N	F	0	0.11
Iris missouriensis	GC	N	F	10	5
Koeleria macrantha	GC	N	F	1	22
Lathyrus	GC	N	R	0	0.01
Lichen	NV	N	U	1	3
Linaria dalmatica	GC	I	F	0	0.2
Medicago lupulina	GC	I	WR	0	3.1

Species	Cover Code	Native Status	Wetland Status	A	B
Melilotus	GC	I	WR	0	0.4
Mimulus	GC	N	W	10	0
Onopordum acanthium	GC	I	WR	0	0.4
Opuntia phaeacantha	SC	N	U	0	0.1
Phleum pratense	GC	I	F	0	0.2
Pinus ponderosa	MC	N	F	1	12
Pinus ponderosa	SC	N	F	1	8
Pinus ponderosa	TC	N	F	0	7
Poa pratensis	GC	I	F	13	85
Potentilla	GC	N	F	0	8
Quercus gambelii	SC	N	F	0	1.1
Rosa woodsii	SC	N	F	1	2.5
Rumex	GC	I	WR	0	0.11
Salix lasiolepis	SC	N	R	5	16
Sambucus	SC		F	0	0.3
Sidalcea neomexicana	GC	N	WR	18	8
Stephanomeria pauciflora	GC	I	U	0	0.01
Tragopogon dubius	GC	I	F	0	0.2
Verbascum	GC	I	F	0	0.61

Fauna: Surveyors collected or observed 1 aquatic and 8 terrestrial invertebrates and 7 vertebrate specimens.

Table 4 Coyote Spring Invertebrates.

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Coleoptera Hydrophilidae		A				
Lepidoptera Hesperiidae Erynnis meridianus		T				
Lepidoptera Hesperiidae Thorybes pylades	Ad	T			1	
Lepidoptera Lycaenidae Callophrys		T				
Lepidoptera Nymphalidae Junonia coenia		T				
Lepidoptera Papilionidae		T				
Lepidoptera Pieridae Colias eurytheme		T				
Odonata Coenagrionidae Argia vivida	Ad	T				mating adults
Trichoptera Limnephilidae						species 1
Trichoptera Limnephilidae						species 2

Table 5 Coyote Spring Vertebrates.

Species Common Name	Count	Detection
common raven	1	obs
western bluebird	1	obs
elk	4	sign
vole		obs
Wandering Gartersnake	2	obs
American crow	1	obs
pygmy nuthatch	4	obs
dark-eyed junco	2	obs
pine siskin	10	obs
Steller's jay	1	obs
violet-green swallow	1	obs
American robin	1	obs
broad-tailed hummingbird	1	obs
black-tailed jackrabbit	1	obs

Assessment: Assessment scores were compiled in 6 categories and 9 subcategories, with 33 null condition scores, and 33 null risk scores. Aquifer functionality and water quality are good with significant restoration potential and there is moderate risk. Geomorphology condition is good with significant restoration potential and there is moderate risk. Habitat condition is good with significant restoration potential and there is moderate risk. Biotic integrity is good with significant restoration potential and there is moderate risk. Human influence of site is moderate with some restoration potential and there is high risk. Administrative context status is good with significant restoration potential and there is moderate risk. Overall, the site condition is good with significant restoration potential and there is moderate risk.

Table 6 Coyote Spring Assessment Scores.

Category	Condition	Risk
Aquifer Functionality & Water Quality	4.17	3.5
Geomorphology	4	3.2
Habitat	4	3.2
Biota	3.88	3.25
Human Influence	3.67	3.88
Administrative Context	4	3.11
Overall Ecological Score	4.01	3.29

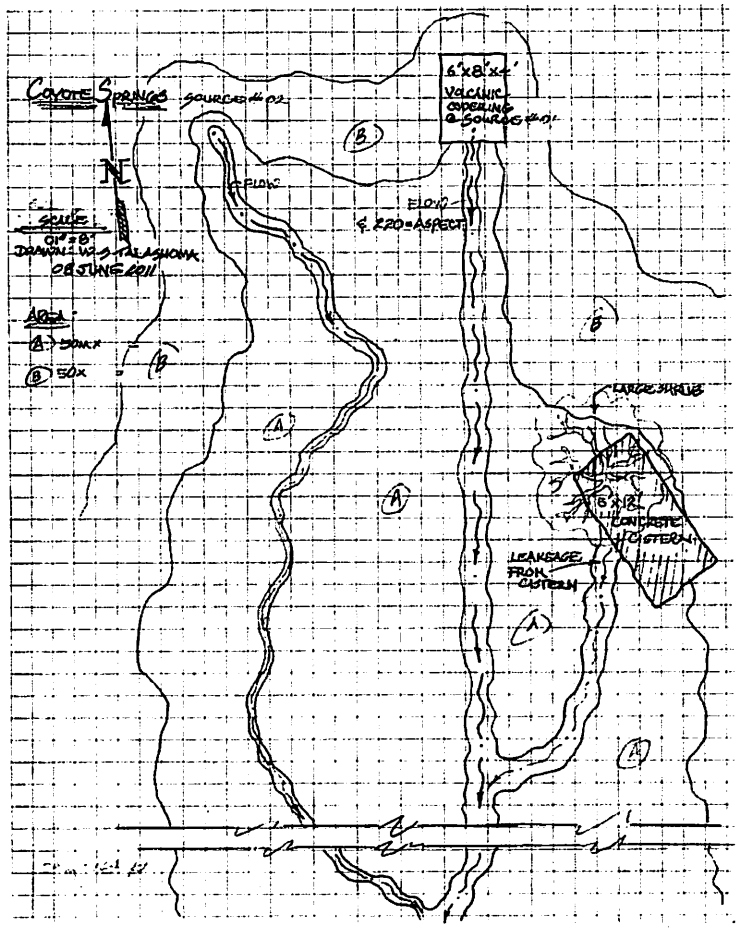


Fig 2 Coyote Spring Sketchmap.

MINERAL SPRING
SURVEY SUMMARY REPORT, SITE ID 768

Location: The Mineral 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 at 35.25186, -111.99942 in the Sitgreaves Mountain USGS Quad, measured using a GPS (WGS84, estimated position error 4 meters). The elevation is approximately 2124 meters. The Prescott College Springs Ecology Class along with Glenn Rink, Jeri Ledbetter, and Larry Stevens surveyed the site on 5/27/14 for 01:55 hours, beginning at 11:10, and collected data in 10 of 12 categories.

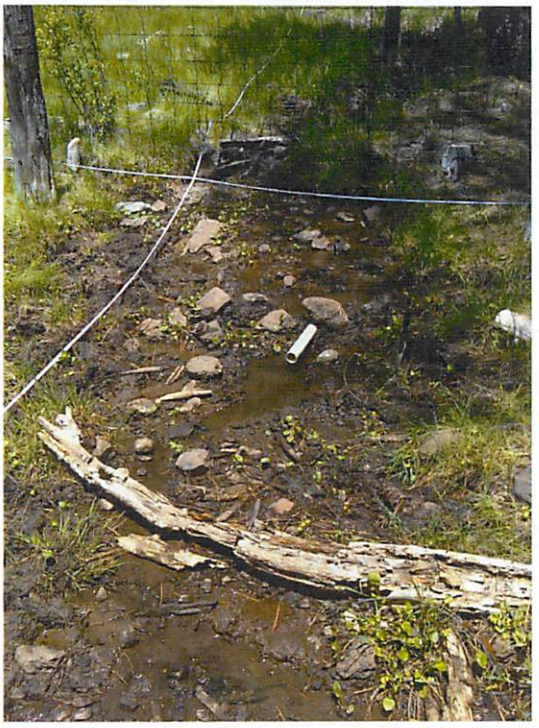


Fig 1 Mineral Spring.

Physical Description: Mineral Spring is a helocrene spring. The spring is a low-graded cienega in a forested area. The source has been built on top of by the creation of Interstate 40. From the source the water channelizes for approximately 70 meters into a pool. The microhabitats associated with the spring cover 514 sqm. The site has 6 microhabitats, including A -- a 121 sqm low gradient cienega, B -- a 50 sqm channel, C -- a 50 sqm channel, D -- a 130 sqm terrace, E -- a 33 sqm channel, and F -- a 130 sqm terrace. The geomorphic diversity is 0.72, based on the Shannon-Weiner diversity index.

Mineral Spring emerges as a seepage or filtration spring from a igneous, basalt rock layer in an unknown unit. The emergence environment is subaerial, with a gravity flow force mechanism. The distance to the nearest spring is 2386 meters.

Survey Notes: The fence 12.5 m from the source is effective: the rest of the channel and pool is well-trampled. Ponderosa Pines near I-40 as well as those that flank the channel moving from source to downstream are dying (likely from salt run off from I-40). Ponderosa Pines in surrounding area are evenly aged and in abundance. There is trash on the 'bank' on both sides of the channel. SEAP recommendations include encouragement of dialogue with ADOT and land managers regarding high salinity water runoff.

Table 1 Mineral Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
pH (field)	7.995	
Salinity (field) (ppt)	1.31	
Specific conductance (field) (uS/cm)	2746	EC converted to SC
Temperature, air C	29.4	
Temperature, water C	19.6	

Flora: Surveyors identified 20 plant species at the site, with 0.0389 species/sqm. These included 10 native and 9 nonnative species; the native status of 1 species remains unknown. *Onopordum acanthium* was present nearby.

Table 2 Mineral Spring Cover Type.

Cover Type	Species Count	Wetland Species Count
Ground	17	8
Shrub	1	0
Mid-canopy	0	0
Tall canopy	1	0
Basal	0	0
Aquatic	1	1
Non-vascular	0	0

Table 3 Mineral Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A	B	C	D	E	F
Achillea	GC	N	U	1	0	0	0	0	0
algae	AQ	N	A	0	0.2	2	0	0	0
Aster	GC			5	0	0	0	0	0
Bromus tectorum	GC	I	F	0	0	0	0	0.01	0

Species	Cover Code	Native Status	Wetland Status	A	B	C	D	E	F
Carex occidentalis	GC	N	W	5	0.1	0	1	3	2
Carex subfusca	GC	N	W	0	0	0.5	0.1	0	0
Cirsium vulgare	GC	I	F	1	0	0	0	0	0
Dactylis glomerata	GC	I	W	0	0	0	0	0	0.01
Elymus	GC	I	F	0	0	3	1	1	0
Iris missouriensis	GC	N	F	3	0.1	0	5	0.5	5
Juncus saximontanus	GC	N	W	2	0	0.1	0	0	0
Melilotus officinalis	GC	I	WR	0	0	0	0	0	0.2
Pinus ponderosa	TC	N	F	4	40	0	6	12	12
Poa pratensis	GC	I	F	70	1	1	40	20	8
Ranunculus	GC	N	WR	0	0.02	8	0.2	5	0
Ribes cereum	SC	N	U	5	4	0	0.1	0.2	2
Rumex crispus	GC	I	WR	1	0	0	0.2	0.01	0.2
Symphyotrichum falcatum	GC	N	WR	5	0	0	0	0	0
Taraxacum officinale	GC	I	F	3	0.02	0.1	0.5	0.01	0.1
Verbascum thapsus	GC	I	F	0.5	0	0	0	0	0

Fauna: Surveyors collected or observed 3 aquatic and 16 terrestrial invertebrates and 10 vertebrate specimens.

Table 4 Mineral Spring Invertebrates.

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Amphipoda	Ad	A			10	
Chilopoda					1	
Coleoptera	Ad				1	
Coleoptera	Ad				1	Iris Vacinity of Mineral Spring
Coleoptera	Ad				1	West of Parks
Coleoptera Dytiscidae	Ad	A			1	
Diplopoda	Ad	T			1	
Diptera	L				1	
Diptera	Ad	T			1	West of Parks, AZ
Hymenoptera	Ad	T			1	Iris Vacinity of Mineral Spring
Hymenoptera	Ad	T			1	West of Parks, AZ
Isopoda	Ad	T			1	

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Lepidoptera	Ad	T			1	
Mollusca					1	
Odonata	L	A			4	
Odonata Coenagrionidae Ischnura	Ad	T			1	Along springs outflow
Odonata Coenagrionidae Ischnura	Ad	T			1	Along springs outflow channel
Odonata Coenagrionidae Ischnura damula	Ad	T			1	Along springs outflow
Odonata Libellulidae Erythemis collocata	Ad	T			1	
Odonata Libellulidae Erythemis collocata	Ad	T			1	Forest springs
Odonata Libellulidae Libellula luctuosa	Ad	T	Spot		3	
Odonata Libellulidae Libellula lydia	Ad	T	Spot		1	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		7	
Odonata Libellulidae Tramea	Ad	T	Spot		1	

Table 5 Mineral Spring Vertebrates.

Species Common Name	Count	Detection
American robin	3	obs
Steller's jay	3	obs
violet-green swallow	15	obs
mountain chickadee	1	obs
Brewer's Blackbird	1	obs
dove	2	obs
western bluebird	1	obs
common raven	6-8	obs
mule deer		sign
fence lizard	1	obs

Assessment: Assessment scores were compiled in 6 categories and 40 subcategories, with 2 null condition scores, and 2 null risk scores. Aquifer functionality and water quality are poor with limited restoration potential and there is moderate risk. Geomorphology condition is moderate with some restoration potential and there is moderate risk. Habitat condition is moderate with some restoration potential and there is low risk. Biotic integrity is moderate with some

restoration potential and there is low risk. Human influence of site is very poor with very limited restoration potential and there is moderate risk. Administrative context status is good with significant restoration potential and there is moderate risk. Overall, the site condition is moderate with some restoration potential and there is moderate risk.

Table 6 Mineral Spring Assessment Scores.

Category	Condition	Risk
Aquifer Functionality & Water Quality	2.33	3.33
Geomorphology	3	3
Habitat	3.6	2.8
Biota	3.14	2.63
Human Influence	1.5	3
Administrative Context	3.89	3.25
Overall Ecological Score	2.97	3.08

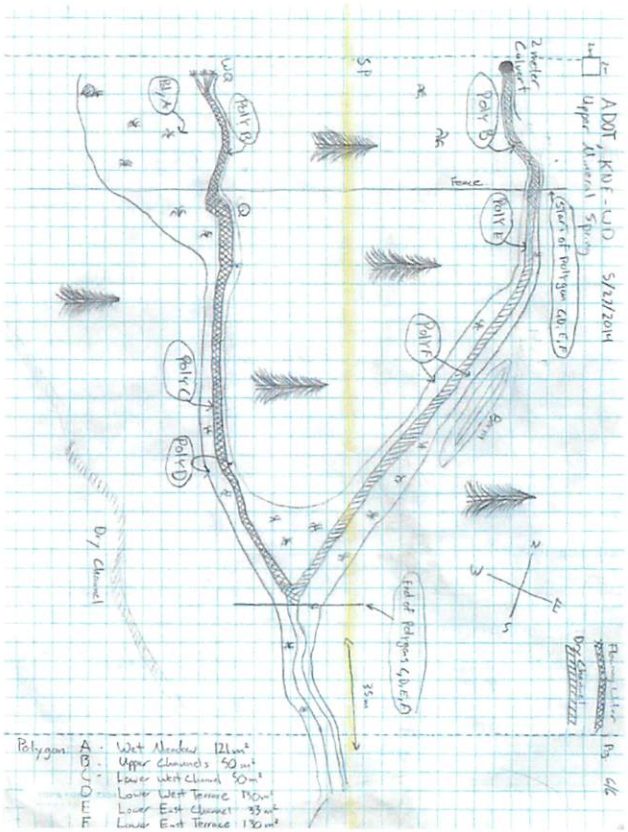


Fig 2 Mineral Spring Sketchmap.

SURVEY SUMMARY REPORT, SITE ID 804

Location: The Orion Spring ecosystem is located in Coconino County in the Canyon Diablo Arizona 15020015 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Peaks RD at 35.289917, -111.637139 in the Humphreys Peak USGS Quad, measured using a GPS (NAD83, estimated position error 3 meters). The elevation is approximately 2498 meters. An invertebrate survey by L. Stevens, E. North, M. Erhart was conducted at the site on 5/31/01, and data was collected in 2 of 12 categories. The surveyors reported flowing water at the site during the survey.

Fauna: Surveyors collected or observed 2 aquatic and 37 terrestrial invertebrate specimens.

Table 1 Orion Spring Invertebrates.

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Araneae Anyphaenidae Anyphaena pacifica					1	Riparian wetland
Araneae Theridiidae Steatoda					1	Riparian wetland
Coleoptera Buprestidae Anthaxia aeneogaster	Ad	T			1	Riparian wetland
Coleoptera Dytiscidae Agabus lugens	Ad	A			1	Riparian wetland
Coleoptera Meloidae						Riparian wetland
Coleoptera Scarabaeidae Diplotaxis magna						Riparian wetland
Diptera						Riparian wetland
Diptera Acalypterate muscoid						Riparian wetland
Diptera Calliphoridae						Riparian wetland
Diptera Muscidae						Riparian wetland
Diptera Syrphidae Eristalis tenax	Ad	T			1	Riparian wetland
Diptera Syrphidae Eupeodes volucris	Ad	T			1	Riparian wetland
Diptera Syrphidae Xylota analis	Ad	T			1	Riparian wetland
Diptera Syrphidae Xylota flavitibia	Ad	T			1	Riparian wetland
Diptera Tachinidae						Riparian wetland
Diptera Therevidae						Riparian wetland
Hemiptera Gerridae Aquarius remigis	Ad	A			1	Riparian wetland macropterous
Hymenoptera Formicidae Camponotus laevigatus						Riparian wetland
Hymenoptera Formicidae Camponotus laevigatus						Riparian wetland alate; Duplicate ID# - Jeri

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Hymenoptera Formicidae Formica densiventris	Ad	T			1	Riparian wetland
Hymenoptera Formicidae Formica gnava	Ad	T			1	Riparian wetland
Hymenoptera Formicidae Formica lasioides	Ad	T			1	Riparian wetland
Hymenoptera Ichneumonidae						Riparian wetland
Hymenoptera Pompilidae Arachnospila fumipennis eureka	Ad	T			1	Riparian wetland
Hymenoptera Siricidae						Riparian wetland
Hymenoptera Sphecidae						Riparian wetland
Hymenoptera Sphecidae Crabro	Ad	T			1	Riparian wetland
Hymenoptera Sphecidae Podalonia	Ad	T			1	Riparian wetland
Hymenoptera Sphecidae Podalonia mexicana	Ad	T			1	Riparian wetland
Hymenoptera Vespidae Euodynerus foraminatus foraminatus	Ad	T			1	Riparian wetland
Hymenoptera Vespidae Vespula atropilosa	Ad	T			1	Riparian wetland
Hymenoptera Vespidae Vespula vulgaris	Ad	T			1	Riparian wetland
Lepidoptera Hesperiidae Erynnis pacuvius	Ad	T			1	Senecio flowers
Lepidoptera Hesperiidae Erynnis persius	Ad	T			1	Senecio flowers
Lepidoptera Hesperiidae Erynnis persius	Ad	T			1	Senecio flowers w/ tube
Lepidoptera Hesperiidae Thorybes mexicana	Ad	T			1	Senecio flowers
Lepidoptera Hesperiidae Thorybes pylades	Ad	T			1	Senecio flowers
Lepidoptera Lycaenidae Callophrys eryphon	Ad	T			1	Senecio flowers
Lepidoptera Lycaenidae Glaucopsyche lygdamus	Ad	T			1	Senecio flowers
Lepidoptera Lycaenidae Plebejus acmon	Ad	T			1	Senecio flowers
Lepidoptera Lycaenidae Strymon melinus	Ad	T			1	Senecio flowers
Lepidoptera Noctuidae						Riparian wetland
Lepidoptera Nymphalidae Junonia coenia	Ad	T			1	Senecio flowers
Lepidoptera Nymphalidae	Ad	T			1	Senecio flowers

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Nymphalis californica						
Lepidoptera Nymphalidae Oeneis alberta daura	Ad	T			1	Pinus ponderosa meadow
Lepidoptera Nymphalidae Oeneis alberta daura	Ad	T			1	Senecio flowers
Lepidoptera Nymphalidae Poladryas arachne	Ad	T			1	Senecio flowers
Lepidoptera Nymphalidae Vanessa cardui	Ad	T			1	Pinus ponderosa meadow
Lepidoptera Nymphalidae Vanessa cardui					1	Senecio flowers
Lepidoptera Pieridae Colias eurytheme	Ad	T			1	Senecio flowers
Lepidoptera Pieridae Colias eurytheme	Ad	T			1	Senecio flowers White form, very small
Lepidoptera Pieridae Nathalis iole	Ad	T			1	Senecio flowers
Lepidoptera Pieridae Pontia occidentalis	Ad	T			1	Pinus ponderosa meadow
Lepidoptera Pieridae Pontia occidentalis	Ad	T				Senecio flowers
Lepidoptera Sphingidae Sphinx vashti						Drowned in stocktank Sympholocarpos
Orthoptera	Ad	T			1	Riparian wetland
Orthoptera Acrididae Trimerotropis pallidipennis	Ad	T			1	Riparian wetland

ORION SPRING (REPORT #2)
SURVEY SUMMARY REPORT, SITE ID 804

Location: The Orion Spring ecosystem is located in Coconino County in the Canyon Diablo Arizona 15020015 HUC, managed by the US Forest Service. The spring is located in the Coconino NF, Peaks RD at 35 17' 23.7", -111 38' 13.7" in the Humphreys Peak USGS Quad, measured using a GPS (NAD83, estimated position error 3 meters). The elevation is approximately 2498 meters. V. Markgraf, S. Ordway, and J. Norris surveyed the site on 8/20/10 for 03:30 hours, beginning at 9:00, and collected data in 6 of 12 categories.

Physical Description: Orion Spring is a hillslope spring. This is a rheocrene, hillslope spring and was surveyed by NPS volunteers in 2010. On 6/7/2013, there was no water present and no evidence of recent discharge. The site has extensive modification. The site has 2 microhabitats.

Orion Spring emerges as a contact spring from an igneous rock layer in an unknown unit. The emergence environment is subaerial, with a gravity flow force mechanism. The distance to the nearest spring is 2503 meters.

Survey Notes: This survey was conducted by volunteers under the CNF volunteers project, under the direction of Steve Monroe. The spring orifice is an excavated bowl approximately 5 m in diameter and 1-2 m below local land surface in existing runoff channel. There was no flow at the orifice at time of the survey, and there were no signs of flow near the orifice. Pipes appear to extend from the orifice to a metal trough (but no flow or signs of flow are present). The bowl is lined with volcanic cobbles and boulders. The wettest area is approximately 10 m west of the bowl. The tank needs a wildlife escape ladder. The channel form is dominated by excavation up to metal tank. The very indistinct channel continues downstream below the spring area; a small depression marks the end of the obvious channel, approximately 50.5 m. The channel is mostly cobbles and boulders with some soil. The channel bottom is mostly litter up to the cement and brick structure, then grassy bottom below that. There was evidence of roads/OHV trails at site, and there was flow modification (pipe diversion, open trough/tank, and excavation). There was evidence of fire at the site but not recent.

Water: Measurements were taken in the metal tank; the tank does not appear to be connected to the spring. A Hanna combo was used to take measurements at a depth of 14.5 cm. The flow condition was still/pooled.

Table 2 Orion Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
pH (field)	9.16	
Specific conductance (field) (uS/cm)	97.666666667	
Temperature, water C	23.833333333	

Flora: Vera Markgraf was the botanist. Surveyors identified 34 plant species at the site. These included 27 native and 7 nonnative species.

Table 3 Orion Spring Cover Type.

Cover Type	Species Count	Wetland Species Count
Ground	33	13
Shrub	0	0
Mid-canopy	0	0
Tall canopy	0	0
Basal	0	0

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

Table 4 Orion Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A	B
Achillea millefolium	GC	NI	U	0.5	0
Agrostis scabra	GC	N	W	0	0.5
Astragalus rusbyi	GC	N	U	0	0
Bromus ciliatus	GC	N	F	1	0
Carex siccata	GC	N	W	0	10
Chenopodium	GC	I	F	0.5	0
Cirsium wheeleri	GC	N	U	0.5	0
Elymus elymoides	GC	N	F	0.5	0
Epilobium ciliatum	GC	N	W	0	5
Erigeron formosissimus	GC	N	U	0.5	0
Festuca arizonica	GC	N	U	0.5	0
Fragaria	GC	N	U	0	0.5
Geranium richardsonii	GC	N	F	0	1
Iris missouriensis	GC	N	F	0	1
Juncus bufonius	GC	N	W	0	0.5
Juncus ensifolius	GC	N	W	0	1
Juncus tenuis	GC	N	W	0	1
Kelloggia galioides	GC	N	U	0	0.5
Lupinus argenteus	GC	N	U	2	0
Mimulus floribundus	GC	N	WR	0	0.5
Mimulus guttatus	GC	N	W	0	1
moss	NV	N	F	0	5
Oxalis	GC	N	WR	0	0.01
Perideridia parishii	GC	N	F	0	0
Phleum pratense	GC	I	F	0	0.5
Polygonum douglasii	GC	N	W	0	1
Pseudognaphalium	GC	N	W	0	1
Pteridium aquilinum	GC	N	U	1	0
Rumex crispus	GC	I	WR	0	0.5
Taraxacum officinale	GC	I	F	1	0
Thinopyrum intermedium	GC	I	F	80	0
Trifolium pratense	GC	I	WR	0.5	1
Verbascum thapsus	GC	I	F	0.5	0
Vicia americana	GC	N	F	0.5	0

Fauna: Surveyors collected or observed 1 aquatic invertebrates and 2 vertebrate specimens.

Table 5 Orion Spring Vertebrates.

Species Common Name	Count	Detection
pinyon jay		
northern flicker		

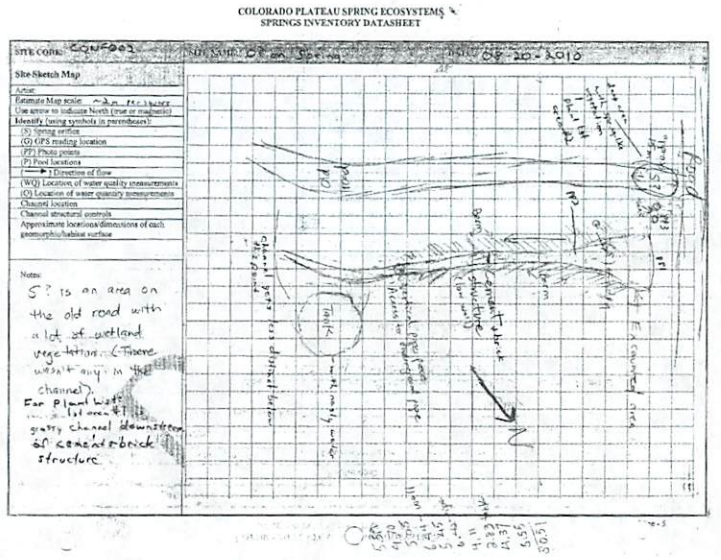


Fig 1 Orion Spring Sketchmap.

Fig 2 Orion Spring.

ROSILDA SPRING

SURVEY SUMMARY REPORT, SITE ID 588

Location: The Rosilda 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 at 35.17512, -112.06255 in the Davenport Hill USGS Quad, measured using a GPS (NAD83, estimated position error 2 meters). The elevation is approximately 2046 meters. Larry Stevens, Jeri Ledbetter, Marguerite Hendrie, Anya Fayfer, and Vera Markgraf surveyed the site on 5/12/12 for 02:30 hours, beginning at 11:30, and collected data in 10 of 12 categories.

Fig 1 Rosilda Spring.

Physical Description: Rosilda Spring is a helocrene spring. This is a low gradient cienega that has been excavated. A 3-m well has been rocked-in and piped into a bermed pond. The site is 150 m from where it is mapped on the DRG. The total area in 2016 was about 379.5 sq. meters. The microhabitats associated with the spring cover 591 sqm. The site has 3 microhabitats, including A -- a 1 sqm channel, B -- a 530 sqm pool, C -- a 60 sqm pool margin. The geomorphic diversity is 0.15, based on the Shannon-Weiner diversity index.

Rosilda Spring emerges as a seepage or filtration spring from a igneous, basalt rock layer in an unknown unit. The emergence environment is subaerial, with a gravity flow force mechanism. The distance to the nearest spring is 2205 meters. The site receives approximately 100% of available solar radiation.

Survey Notes: This site is heavily trampled by elk and heavily altered by humans. The flow emerges from a pipe about 2 meters from the edge of an anthropogenic pond. The flow and water quality is heavily influenced by recent precipitation. The well is open at the top. There are extensive historic remains on the north-facing terrace.

Table 1 Rosilda Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
Alkalinity, Total (mg/L)	0	
Hardness, Ca + Mg (mg/L)	0	
Nitrogen, Nitrate (NO3) as NO3 (mg/L)	0	
Nitrogen, Nitrite (NO2) as NO2 (mg/L)	0	
pH (field)	6.675	
Specific conductance (field) (uS/cm)	77	
Temperature, air C	31.1	
Temperature, water C	10.1	

Flora: Vera Markgraf was the botanist. Surveyors identified 22 plant species at the site, with 0.0372 species/sqm. These included 15 native and 6 nonnative species; the native status of 1 species remains unknown.

Table 2 Rosilda Spring Cover Type.

Cover Type	Species Count	Wetland Species Count
Ground	17	8
Shrub	0	0
Mid-canopy	0	0
Tall canopy	0	0
Basal	0	0
Aquatic	3	3
Non-vascular	1	0

Table 3 Rosilda Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A	B	C
Alopecurus aequalis	GC	N	W	0	0.1	0
Callitriche palustris	AQ	N	A	0	0.1	0
Carex occidentalis	GC	N	W	0	0	0.1
Cladophora glomerata	AQ	N	A	80	0	0
Eleocharis palustris	GC	N	W	0	0	10
Eleocharis pauciflora	GC	I	W	0	5	0
Glyceria borealis	GC	N	W	0	5	0
Iris missouriensis	GC	N	F	0	0	5
Juncus interior	GC	N		0	0	5
Juncus interior	GC	N		0	1	0
Juniperus deppeana	GC	N	U	0	0	0.01
Marsilea vestita		N	A	0	0.1	0
moss	NV	N	F	0	0	3

Species	Cover Code	Native Status	Wetland Status	A	B	C
Muhlenbergia rigens	GC	N	U	0	0	10
Oenothera flava	GC	N	R	0	0	0.1
Poa pratensis	GC	I	F	0	0	0.5
Potamogeton nodosus	AQ	N	A	0	0.6	0
Rorippa	GC		A	0	0	1
Rumex crispus	GC	I	WR	0	0	0.1
Taraxacum officinale	GC	I	F	0	0	0.5
Trifolium pratense	GC	I	WR	0	0	0.1
Verbascum thapsus	GC	I	F	0	0	0.1

Fauna: Surveyors collected or observed 12 aquatic and 49 terrestrial invertebrates and 3 vertebrate specimens.

Table 4 Rosilda Spring Invertebrates.

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Araneae	Ad	T			1	
Coleoptera	Ad				1	
Coleoptera Carabidae	Ad	T			1	
Coleoptera Curculionidae	Ad	T			1	
Coleoptera Dytiscidae	Ad	A			1	
Coleoptera Hydrophilidae	Ad	A			1	
Coleoptera Tenebrionidae	Ad	T			1	
Diptera	Ad	T			1	
Diptera Sarcophagidae	Ad	T			1	
Diptera Stratiomyidae	Ad	T			1	
Hemiptera	Ad	T			1	
Hemiptera Gerridae Gerris	Ad	A			1	
Hemiptera Miridae	Ad	T			1	
Homoptera Cicadellidae	Ad	T			1	
Hymenoptera Formicidae	Ad	T			1	
Lepidoptera Hesperiidae Erynnis meridianus	Ad	T			1	
Lepidoptera Hesperiidae Zestusa dorus	Ad	T			1	
Lepidoptera Lycaenidae Plebejus saepiolus	Ad	T			1	
Lepidoptera Nymphalidae Chlosyne acastus	Ad	T			1	
Lepidoptera Pieridae Pontia sisymbrii	Ad	T			1	
Mollusca	Ad				1	
Mollusca Sphaeriidae Pisidium	Ad	A			2	

Species	Lifestage	Habitat	Method	Rep#	Count	Species detail
Odonata	L	A			1	
Odonata Aeshnidae	Ad	T	Spot		1	
Odonata Coenagrionidae	Ad	T	Spot		1	
Odonata Coenagrionidae	Ad	T			1	Returned from R.A. Bailowitz with unknown identification
Odonata Coenagrionidae	Ad	T	Spot		1	stream chann
Odonata Coenagrionidae	Ad	T			1	stream channel
Odonata Coenagrionidae Enallagma praevarum	Ad	T			1	
Odonata Coenagrionidae Enallagma praevarum	Ad	T	Spot		1	stream chann
Odonata Coenagrionidae Enallagma praevarum	Ad	T			1	stream channel
Odonata Coenagrionidae Ischnura demorsa	Ad	T	Spot		1	stream chann
Odonata Coenagrionidae Ischnura demorsa	Ad	T			1	stream channel
Odonata Libellulidae	L	A			1	
Odonata Libellulidae Libellula saturata	Ad	T	Spot		1	
Odonata Libellulidae Sympetrum	Ad	T	Spot		1	
Orthoptera	L	T			1	
Orthoptera Acrididae	Ad	T			1	

Table 5 Rosilda Spring Vertebrates.

Species Common Name	Count	Detection
elk		sign
Canada goose		sign
northern flicker		call

Assessment: Assessment scores were compiled in 6 categories and 42 subcategories, with 0 null condition scores, and 1 null risk score. Aquifer functionality and water quality are moderate with some restoration potential and there is low risk. Geomorphology condition is moderate with some restoration potential and there is low risk. Habitat condition is moderate with some restoration potential and there is moderate risk. Biotic integrity is good with significant restoration potential and there is low risk. Human influence of site is moderate with some restoration potential and there is moderate risk. Administrative context status is moderate with some restoration potential and there is low risk. Overall, the site condition is moderate with some restoration potential and there is low risk.

Table 6 Rosilda Spring Assessment Scores.

Category	Condition	Risk
Aquifer Functionality & Water Quality	3.33	2.17
Geomorphology	3	2.8
Habitat	3.8	3
Biota	3.88	2.75
Human Influence	3.56	2.88
Administrative Context	3.67	2.5
Overall Ecological Score	3.5	2.68

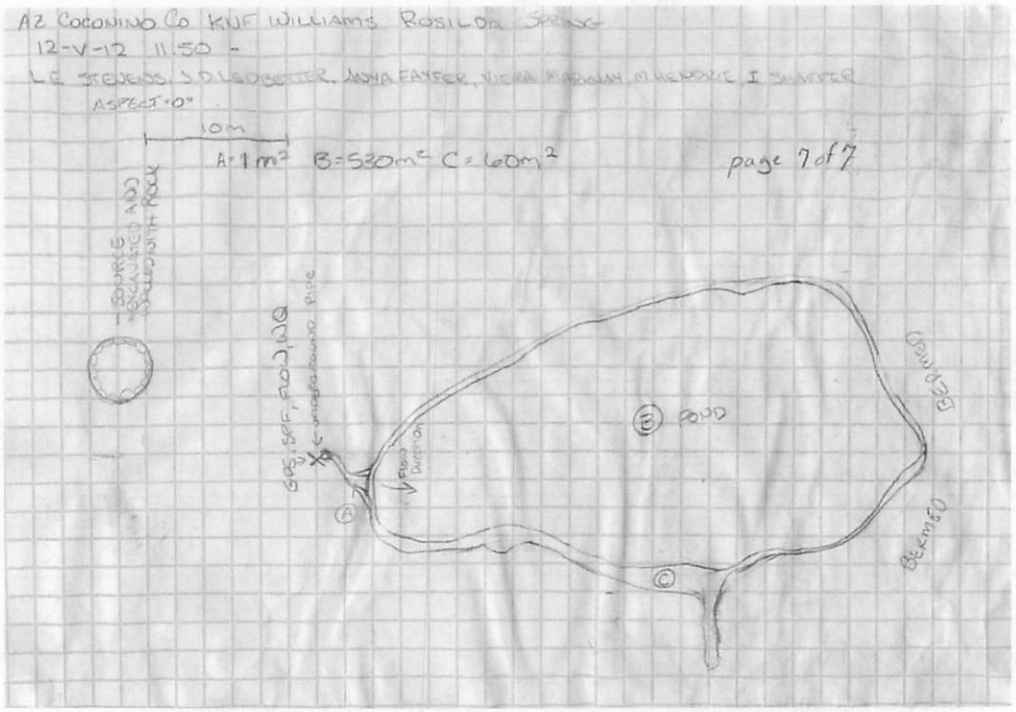


Fig 2 Rosilda Spring Sketchmap.

SHEEP SPRING
SURVEY SUMMARY REPORT, SITE ID 1087

Location: The Sheep 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, Mormon Lake RD at 34.916111, -112.462778 in the Mormon Mountain USGS Quad, measured using a Map (NAD83). The elevation is approximately 2189 meters. Chantel Cook, Diane Meuse, Cerissa Hoglander surveyed the site on 9/06/16 for 01:14 hours, beginning at 14:12, and collected data in 5 of 12 categories.

Fig 1 Sheep Spring: Overflow channel from spring source

Physical Description: Sheep Spring is a helocrene spring. This site was imported from the geodatabase, a compilation from multiple sources. This spring emerges into a broad meadow and shallow channel. The site has 1 microhabitat, A -- a 20 sqm channel. The geomorphic diversity is 0.00, based on the Shannon-Weiner diversity index.

The distance to the nearest spring is 312 meters.

Table 1 Sheep Spring Water Quality with multiple readings averaged.

Characteristic Measured	Average Value	Comments
pH (field)	7.5	
Specific conductance (field) (uS/cm)	0.244	
Temperature, air C	28.9	
Temperature, water C	14.3	

Survey Notes: The source was covered with a large spring box, with water 1.5 meters below the opening. Water was inaccessible to wildlife.

Flora: Surveyors identified 4 plant species at the site, with 0.2 species/sqm. These included 2 native and 2 nonnative species.

Table 2 Sheep Spring Cover Type.

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

Table 3 Sheep Spring Vegetation % Cover in Microhabitats.

Species	Cover Code	Native Status	Wetland Status	A
Agropyron	GC		F	1
Dactylis			F	5
Elymus elymoides	GC	N	F	1
Pinus ponderosa	MC	N	F	10

Fig 2 Sheep Spring: Cement drinkers filled with spring water

Fig 3 Sheep Spring: Source in spring box

APPENDIX 2 – LETTERS OF SUPPORT

NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry & Natural Sciences

School of Earth Sciences and Environmental Sustainability, Northern Arizona University,
PO Box 4099, Flagstaff, AZ 86011-4099, ph: 928-523-7198, fax: 928-523-9220

Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

October 10, 2016

Dear AWPF Commission,

As Professor of Hydrogeology and Ecohydrology at Northern Arizona University, I am pleased to offer my full support of the Spring Stewardship Institute's efforts to restore nine springs in the Northern Arizona region, including Big Leroux Spring, Coyote Springs, Sheep Spring, Babbitt Spring, Mineral Spring, Rosilda Spring, Spitz Spring Lower, Orion Springs, and Willow Spring. As a hydrogeologist, I am acutely aware of the impacts humans have had on the groundwater resources of the southwestern U.S. The Spring Stewardship Institute's mission to rehabilitate and steward springs ecosystems is a critical component of increasing the scientific understanding of our groundwater resources and to improving upon the quality of our freshwater ecosystems.

I have conducted collaborative research with the Springs Stewardship Institute since its inception in 2013 and have worked closely with Dr. Larry Stevens on multiple projects over the past 15 years. Projects we have worked together on include a comprehensive inventory of the springs of the Spring Mountains of Nevada and the springs of Alberta, Canada. As a result of these collaborations, we have mentored numerous NAU students with related thesis research and published the results in peer-reviewed journals.

As a collaborator on the restoration project being proposed by the Springs Stewardship Institute, I will provide my expertise and knowledge regarding groundwater hydrology as well as results from a long-term (20 year) study on restored springs ecosystems at Hoxworth and Clover Springs in northern Arizona. Together with the Springs Stewardship Institute, I am committed to helping return these nine springs ecosystems to a more natural state with unimpeded flow and native flora and fauna so that they may be enjoyed and used by future generations.

Sincerely,

Abe Springer, PhD
Professor

Bobbie Ursin
Associate Director, OSP

City of Flagstaff

October 13, 2016

Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

Dear AWPF Commission,
As Water Resources Manager for the City of Flagstaff, I am pleased to offer my full support of the Spring Stewardship Institute's efforts to restore Orion Springs on the San Francisco Peaks in Coconino County, Arizona. Prudent management of existing and future water supplies is essential to maintaining a sustainable community in Flagstaff. The Spring Stewardship Institute's mission to rehabilitate and steward springs ecosystems aligns perfectly with our mission to ensure a secure, high quality, and dependable water supply to the citizens of Flagstaff.

The Springs Stewardship Institute and the City of Flagstaff have been collaborators for years on broader springs stewardship actions through the regional partnership of the Coconino Plateau Water Advisory Council, specifically in serving on the Technical Advisory Committee. This restoration project would be the first official collaboration between the City of Flagstaff and Springs Stewardship Institute and would pave the way for future cooperation and springs-related projects.

The City of Flagstaff will provide the Springs Stewardship Institute with any data they deem necessary to successfully complete the restoration project, including hydrologic data and information on use of Orion Springs by the City. Together with the Springs Stewardship Institute, we are committed to restoring the Orion Springs ecosystem to a more natural state with unimpeded flow and native vegetation.

Sincerely,

Erin Young
Water Resources Manager
City of Flagstaff

USDA United States Department of Agriculture | Forest Service | Kaibab National Forest | 800 South Sixth Street Williams, AZ 86046-2899 (928) 635-8200

File Code: 2510
Date: October 14, 2016

Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

Dear AWPF Commission,

As Soil and Watershed Program Manager for Coconino and Kaibab National Forests, I am pleased to offer my full support of the Spring Stewardship Institute's efforts to restore eight springs in the Coconino and Kaibab National Forests, including Big Leroux Spring, Sheep Spring, Babbitt Spring, Mineral Spring, Orion Springs, Rosilda Spring, Spitz Spring Lower, and Willow Spring. A primary goal of the U.S. Forest Service is to improve our understanding and management of groundwater resources for wildlife and human use. The Spring Stewardship Institute's mission to rehabilitate and steward springs ecosystems aligns perfectly with our mission to increase understanding of our groundwater resources and to improve upon the quality of our freshwater ecosystems.

The Springs Stewardship Institute and both Coconino and Kaibab National Forests have a rich history of collaboration in monitoring and rehabilitating springs ecosystems on the Forests. The Spring Stewardship Institute has greatly increased our understanding of springs ecosystems and assisted the Coconino and Kaibab Nation Forests with restoration planning efforts across the northern Arizona.

Coconino and Kaibab National Forests will provide the Springs Stewardship Institute with access to all eight springs as well as any data they deem necessary to successfully complete the restoration project. Three of the eight springs (Mineral Spring, Rosilda Spring, and Spitz Spring Lower) have already received NEPA and SHPO clearance and, thus, are "shovel-ready." In addition, I will be able to obtain categorical exclusions (regarding NEPA) for restoration actions on the five remaining National Forest springs (Big Leroux, Babbitt, Sheep, Willow, and Orion Springs) due to their presence in the Four Forest Restoration Initiative (4FRI) boundary. The Forest is also willing and able to provide 240 hours worth of on-the-ground assistance to help with flow containment structure removal, re-vegetation efforts, and invasive species removal. Together with the Springs Stewardship Institute, we are committed to restoring these eight springs ecosystems to a more natural state with unimpeded flow and native flora and fauna.

Sincerely,

KIT MACDONALD
Soils and Watershed Program Manager
Coconino and Kaibab National Forest

STATE HISTORIC PRESERVATION OFFICE
Review Form

In accordance with the State Historic Preservation Act (SHPO), A.R.S. 41-861 *et seq*, effective July 24, 1982, each State agency must consider the potential of activities or projects to impact significant cultural resources. Also, each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. Therefore, it is understood that **recipients of state funds are required to comply with this law** throughout the project period. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance, **including those on private and federal lands.**

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service - Coconino National Forest, Peaks Ranger District

5. Project Location, including Township, Range, Section: Flagstaff, Arizona, on Mt. Humphreys; T0220N/R0060E/S14

6. Total Project Area in Acres (or total miles if trail): 0.40 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: We will be improving existing fencing in order to decrease grazing pressure at the spring habitat. Nonnative flora will be replaced with native species.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The primary disturbance at this site is the presence of springboxes. The two springboxes cover approximately 4 yards squared each (horizontally) and are approximately 1.5 feet tall. In addition there is a partially buried pipe running from the spring boxes. Otherwise, the ground remains fairly undisturbed. See attached photographs.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? NO

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? NO

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

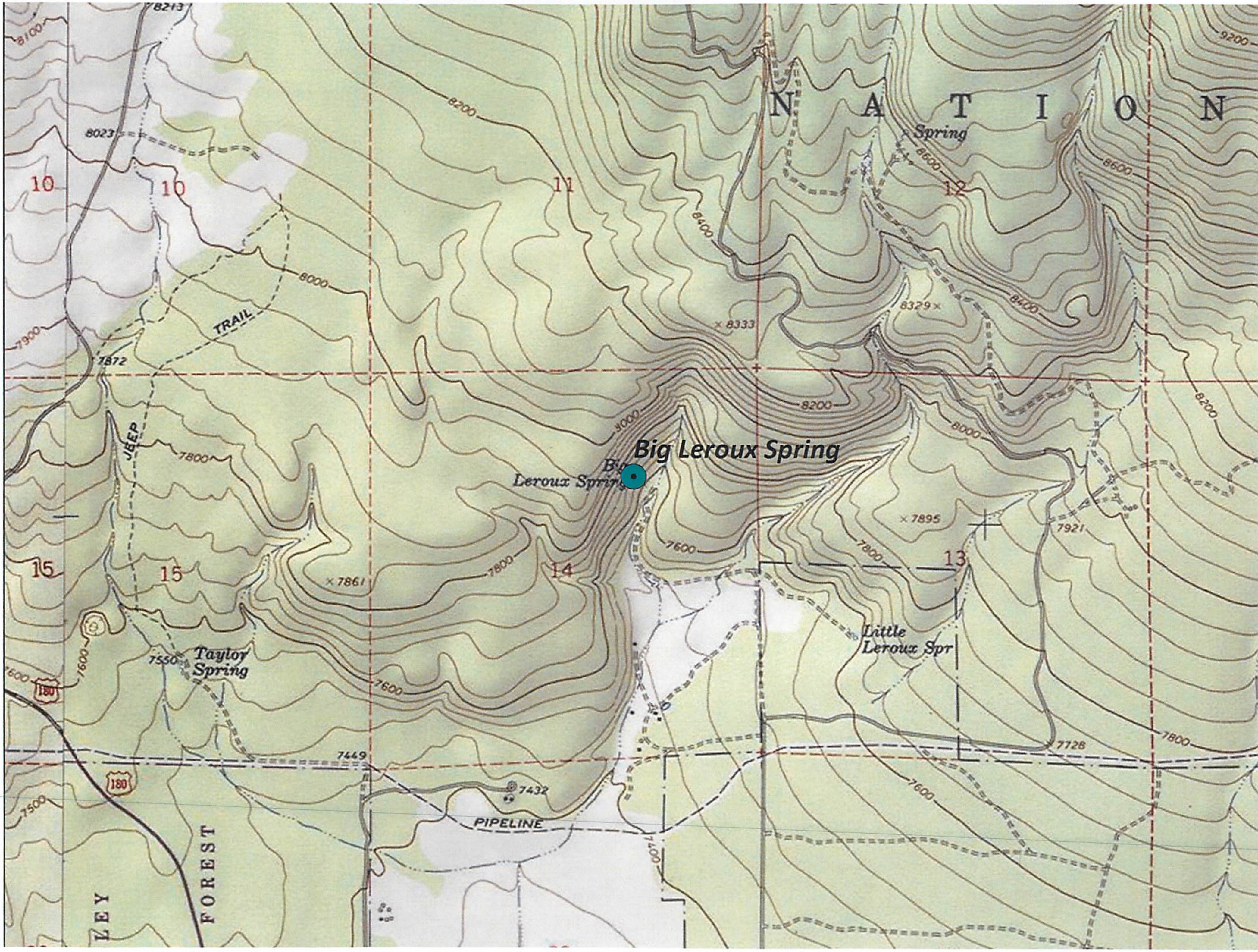
13. Is your project area within or near a historic district? NO

    If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

Applicant Signature	/Date	Applicant Printed Name
[signature]	10/14/2016	Lawrence E. Stevens

FOR SHPO USE ONLY
SHPO Finding: Funding this project will not affect historic properties. Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments
For State Historic Preservation Office: Date:



Big Leroux Spring
Big
Leroux Spring
Little
Leroux Spr
Taylor
Spring
Spring
N A T I O N
TRAIL
JEEP
PIPELINE
FOREST
LEY
8213
8100
8023
8200
8400
8600
9200
8000
8333
8329
7900
7872
7800
8000
7600
7895
7921
7861
7550
7600
7500
7449
7432
7728
7800
7600
10
10
11
12
13
14
15
15
180
180

SHPO Attachment – Big Leroux Spring

This image shows the diversion pipe and old channel of Big Leroux Spring, taken facing NNW (photo taken May 2011). Fencing around the site will be improved and enhanced to eliminate grazing pressure. Nonnative plants will be removed from the site shown and the area will be re-vegetated with native flora.

Image of one spring box, taken facing W (photo taken May 2011).

STATE HISTORIC PRESERVATION OFFICE
Review Form

In accordance with the State Historic Preservation Act (SHPO), A.R.S. 41-861 *et seq*, effective July 24, 1982, each State agency must consider the potential of activities or projects to impact significant cultural resources. Also, each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. Therefore, it is understood that **recipients of state funds are required to comply with this law** throughout the project period. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance, **including those on private and federal lands.**

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): Museum of Northern Arizona

5. Project Location, including Township, Range, Section: Flagstaff, Arizona, on the Museum of Northern Arizona's property; T0210N/R0070E/S04

6. Total Project Area in Acres (or total miles if trail): 0.22 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: The spring and its associated channel will be re-graded to decrease channelization impacts in the channel and to allow water access to the surrounding

marsh-type habitat. A large concrete springbox will be removed, and nonnative plants will be eliminated and replaced by native species.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The site has experienced ground disturbance via construction of two springboxes. The historic springbox is approximately 5 feet x 3 feet x 3.5 feet. The non-historic concrete springbox is approximately 10 feet x 3.5 feet x 4 feet. Photographs attached.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? NO

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? YES

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? NO

    If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

[signature]	10/14/2016	Lawrence E. Stevens
Applicant Signature	/Date	Applicant Printed Name

FOR SHPO USE ONLY
SHPO Finding: Funding this project will not affect historic properties. Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments
For State Historic Preservation Office: Date:

STATE OF ARIZONA
HISTORIC PROPERTY INVENTORY FORM

Please type or print clearly. Fill out each applicable space accurately and with as much information as is known about the property.

PROPERTY IDENTIFICATION

For properties identified through survey: Site No. _____ Survey Area:

Historic Names (*enter the name(s), if any that best reflect the property's historic importance*):

Address: 3100 N Fort Valley Rd., Flagstaff, AZ 86001

City or Town: Flagstaff Vicinity County: Coconino Tax Parcel No.: 11101005D

Township: T0210 Range: R0070E Section: S04 Quarters: SENW Acreage: 0.35

Block: _____ Lot(s): _____ Plat (Addition): _____ Year of plat (addition):

UTM Reference – Zone: 12N Easting: 439916.17m E Northing: 3899051.28m N

USGS 7.5' quadrangle map: Flagstaff West

ARCHITECT: _____ not determined

BUILDER: _____ not determined

CONSTRUCTION DATE: 1935 estimated based on nearby buildings

STRUCTURAL CONDITION

X Good (*well maintained; no serious problems apparent*)
Fair (*some problems apparent*) Describe:
Poor (*major problems; imminent threat*) Describe:
Ruin/Uninhabitable

USES/FUNCTIONS

Attach a recent photograph of property in this space.
Additional photographs may be appended.

Describe how the property has been used over time, beginning with the original use: The historic structure is a spring box and was used to cover the source of Coyote Spring.

Sources:

PHOTO INFORMATION
Date of photo: 05/21/2015
View Direction (looking towards): North

SIGNIFICANCE
To be eligible for the National Register, a property must represent an important part of the history or architecture of an area. The significance of a property is evaluated within its historic context, which are those patterns, themes, or trends in history by which a property occurred or gained importance. Describe the historic and architectural contexts of the property that may make it worthy of preservation.

A. HISTORIC EVENTS/TRENDS – *Describe any historic events/trends associated with the property:*

B. PERSONS – *List and describe persons with an important association with the building:*

C. ARCHITECTURE – Style: _____ no style

Stories: _____ Basement Roof Form:

Describe other character-defining features of its massing, size and scale:

INTEGRITY
To be eligible for the National Register, a property must have integrity (i.e. it must be able to visually convey its importance). The outline below lists some important aspects of integrity. Fill in the blanks with as detailed a description of the property as possible.

Location - Original Site Moved: Date: _____ Original Site:

DESIGN
Describe alterations from the original design, including dates:

MATERIALS
Describe the materials used in the following elements of the property:

Walls (structure):

Walls (sheathing):

Windows:

Roof:

Foundation:

SETTING
Describe the natural and/or built environment around the property: Residences have been built near the property, but have not affected the spring area itself.

How has the environment changed since the property was constructed? The spring area and spring box have not been largely affected by the development nearby.

WORKMANSHIP
Describe the distinctive elements, if any, of craftsmanship or method of construction:

NATIONAL REGISTER STATUS (*if listed, check the appropriate box*)
Individually Listed; Contributor; Non-contributor to _____ Historic District

Date Listed: _____ Determined eligible by Keeper of National Register (date: _____)

RECOMMENDATIONS ON NATIONAL REGISTER ELIGIBILITY (opinion of SHPO staff or survey consultant)

Property is is not eligible individually.

Property is is not eligible as a contributor to a listed or potential historic district.

More information needed to evaluate.

If not considered eligible, state reason:


Coyote Spring MNA
Gravel Pit
Flagstaff Country Club
PIPELINE
Flagstaff City Reservoirs
Museum of Northern Arizona
The Narrows
Matson Tank
Rio de Flag
Switzer
BOUNDARY
BUFFALO PARK
CORPORATE
FLAGSTAFF
PINE AVE
McPherson
CEDAR

SHPO Attachment – Coyote Spring

View upslope of Coyote Spring. The historic spring box can be seen in the upper left and the modern concrete spring box is hidden behind the willow (center of photo). Picture taken facing NE (photo taken May 2015).

Photo of historic spring box at Coyote Spring (Museum of Northern Arizona). Picture taken facing N (photo taken May 2015).

STATE HISTORIC PRESERVATION OFFICE
Review Form

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The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service - Kaibab National Forest, Williams Ranger District

5. Project Location, including Township, Range, Section: Williams, Arizona, adjacent to Interstate 40; T0220N/R0040E/S30

6. Total Project Area in Acres (or total miles if trail): 0.80 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: Due to salt runoff from the highway, much of the ponderosa

pine forest has begun to die off. We will be constructing runoff diversions to mitigate this issue and planting the area with salt-tolerant native species.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The primary disturbance at this site is the presence of Interstate 40 above the spring source. Road construction has affected the area, but no direct grading, paving, etc. in the proposed restoration area has occurred. Photographs attached.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? UNKOWN

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? NO

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? NO

    If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

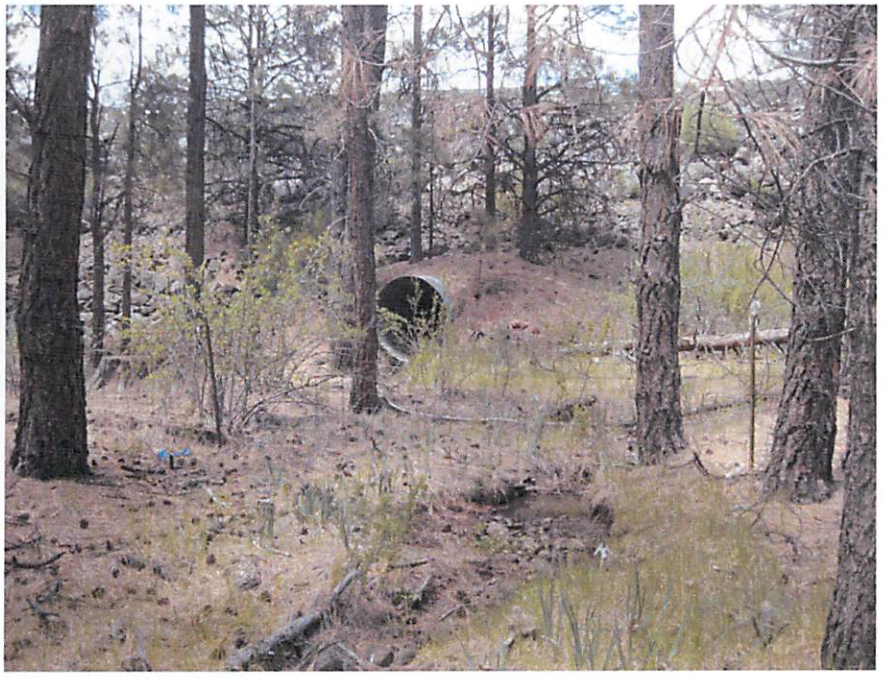
[signature]	10/14/2016	Lawrence E. Stevens
Applicant Signature	/Date	Applicant Printed Name

FOR SHPO USE ONLY
SHPO Finding: Funding this project will not affect historic properties. Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments
For State Historic Preservation Office: Date:


Rock Tank
Spitz Hill
Spitz Spring lower
Spitz Spring
Oak Hill
South Tank
Mineral Spring
Halo
Reed Tank
ATCHISON TOPEKA AND
T 22 N
T 21 N
R3E
R4E
2 LANE
4WD

SHPO Attachment – Mineral Spring

General view of Mineral Spring, facing I-40 (NNW) (photo taken May 2014). Ponderosa pine dieoff can be seem in this and the following image (due to salt runoff from interstate). Actions here will include creating runoff diversion structures and planting saline-tolerant plant species.



View of the culvert running under I-40 at spring source (photo taken May 2014).

STATE HISTORIC PRESERVATION OFFICE
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  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service - Coconino National Forest, Peaks Ranger District

5. Project Location, including Township, Range, Section: Flagstaff, Arizona, near Humphreys Peak; T0220N/R0070E/S15

6. Total Project Area in Acres (or total miles if trail): 0.30 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: We will be removing non-functional piping (partially

underground). We will also be re-grading an excavated area at the spring source and the outflow channel due to channelization and human impacts.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The primary disturbance at this site is the presence of piping which originally diverted flow to an underground tank. The piping covers approximately 60 yards (linearly), and the tank is approximately 2.5 x 2.5 x 5 ft. Photographs attached.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? UNKOWN

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? NO

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? NO

    If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

Applicant Signature	/Date	Applicant Printed Name
[signature]	10/14/2016	Lawrence E. Stevens

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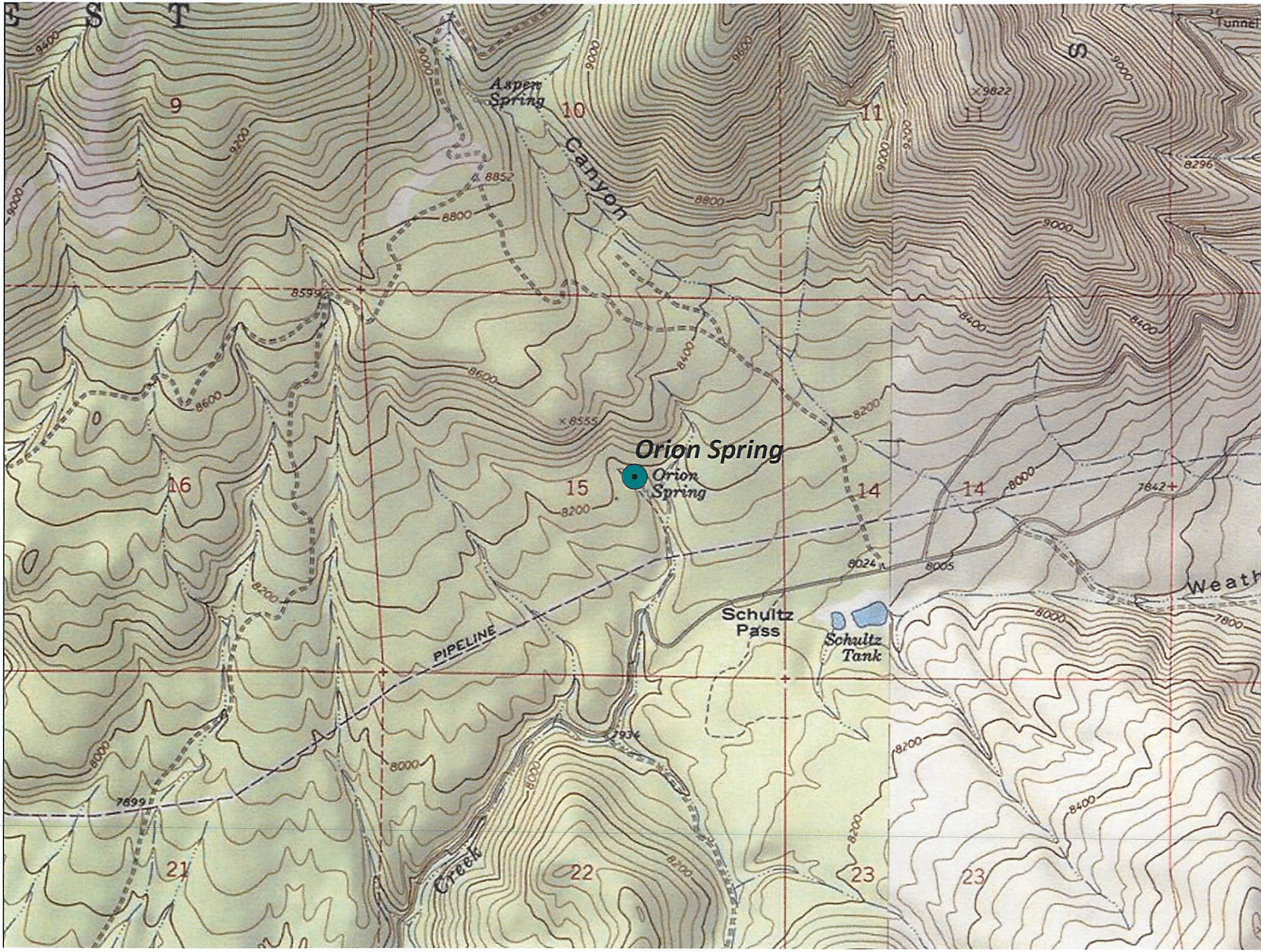
SHPO Comments
For State Historic Preservation Office: Date:


Aspen Spring
Canyon
Orion Spring
Orion Spring
Schultz Pass
Schultz Tank
PIPELINE
Creek
Tunnel
9
10
11
15
16
14
21
22
23

SHPO Attachment – Orion Spring

Image of Orion Spring looking downstream from spring source; photo taken facing ESE (photo taken June 2013). Channelization (seen above) will be reduced via re-grading and the dam will be removed to restore natural flow.

Image of the in-ground tank at Orion Spring site (photo taken October 2016).

Photo of non-functional piping running from Orion Spring source to tank (see above image) (photo taken October 2016).

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  OR
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Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service - Kaibab National Forest, Williams Ranger District

5. Project Location, including Township, Range, Section: Southwest of Parks, Arizona; T0210N/R0030E/S27

6. Total Project Area in Acres (or total miles if trail): 0.45 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: Underground piping will be removed to restore a diffuse flow pattern to the wetland area. Exclosure fencing will be constructed to decrease grazing

impacts by deer and elk. The well cover will be replaced with a more secure structure. Nonnative plants will be replaced with native species.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: This site has been bermed to form a shallow ponded area. The bermed area is approximately 30 yards in width and creates a ponded area of approximately 20 x 40 yards. Also, there is an in-ground tank (approximately 2 yards in diameter) containing the spring source. See attached photographs.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? UNKOWN

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? NO

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? NO

    If YES, name of the district:

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SHPO Comments
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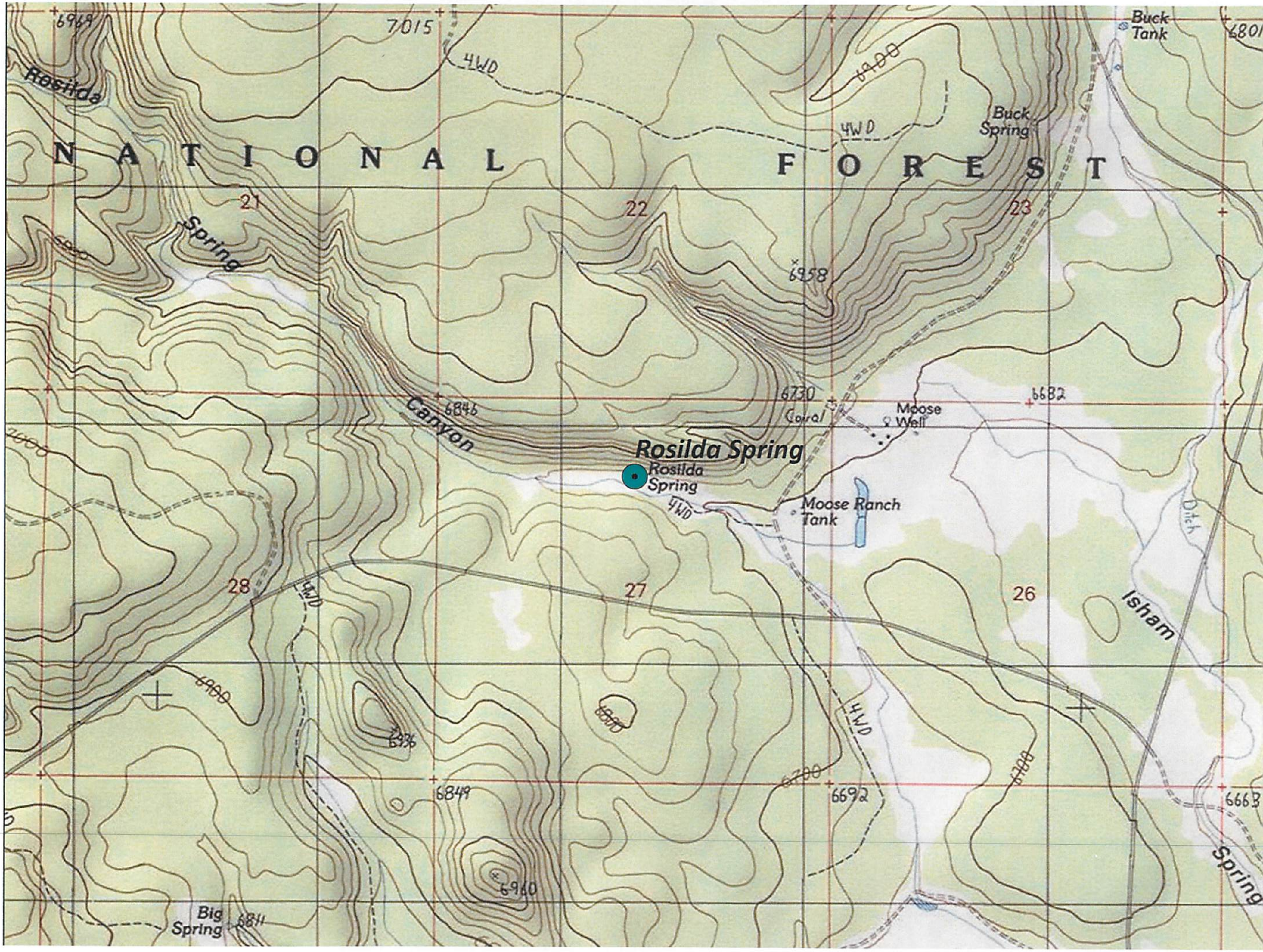
NATIONAL FOREST
Rosilda
Spring
Canyon
Rosilda Spring
Rosilda
Spring
Buck
Tank
Buck
Spring
Moose
Well
Coral
Moose Ranch
Tank
Isham
Spring
Ditch
Big
Spring
4WD
21
22
23
26
27
28
7015
6969
6900
6958
6730
6682
6846
6849
6692
6663
6960
6811
6700

SHPO Attachment – Rosilda Spring

Image of Rosilda Spring, taken facing North (photo taken May 2012). The berm retaining the water in the shallow pond can be seen on the far side of the pond. The channel feeding the pond is to the right in this image.

Picture of the ineffective well cover at Rosilda Spring (photo taken May 2012). We will replace this cover with a more secure well cover.

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Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund

2. Project Title: Springs Ecosystem Restoration in Northern Arizona

3. Applicant Name and Address: Springs Stewardship Institute, 3101 N Fort Valley Rd., Flagstaff, AZ 86001

4. Current Land Owner/Manager(s): U.S. Forest Service - Coconino National Forest, Mormon Lake Ranger District

5. Project Location, including Township, Range, Section: Munds Park, Arizona, west of Mormon Lake; T0180N/R0080E/S27

6. Total Project Area in Acres (or total miles if trail): 0.07 acres

7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? YES

8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: A large underground tank will be removed along with above-ground stock watering tanks. Nonnative flora will be replaced with native species.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: The primary disturbance at this site is the presence of large underground and above-ground tanks (each approximately 1 yard in diameter). The depth of the tanks is unknown See attached photographs.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? UNKOWN

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? NO

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13. Is your project area within or near a historic district? NO

    If YES, name of the district:

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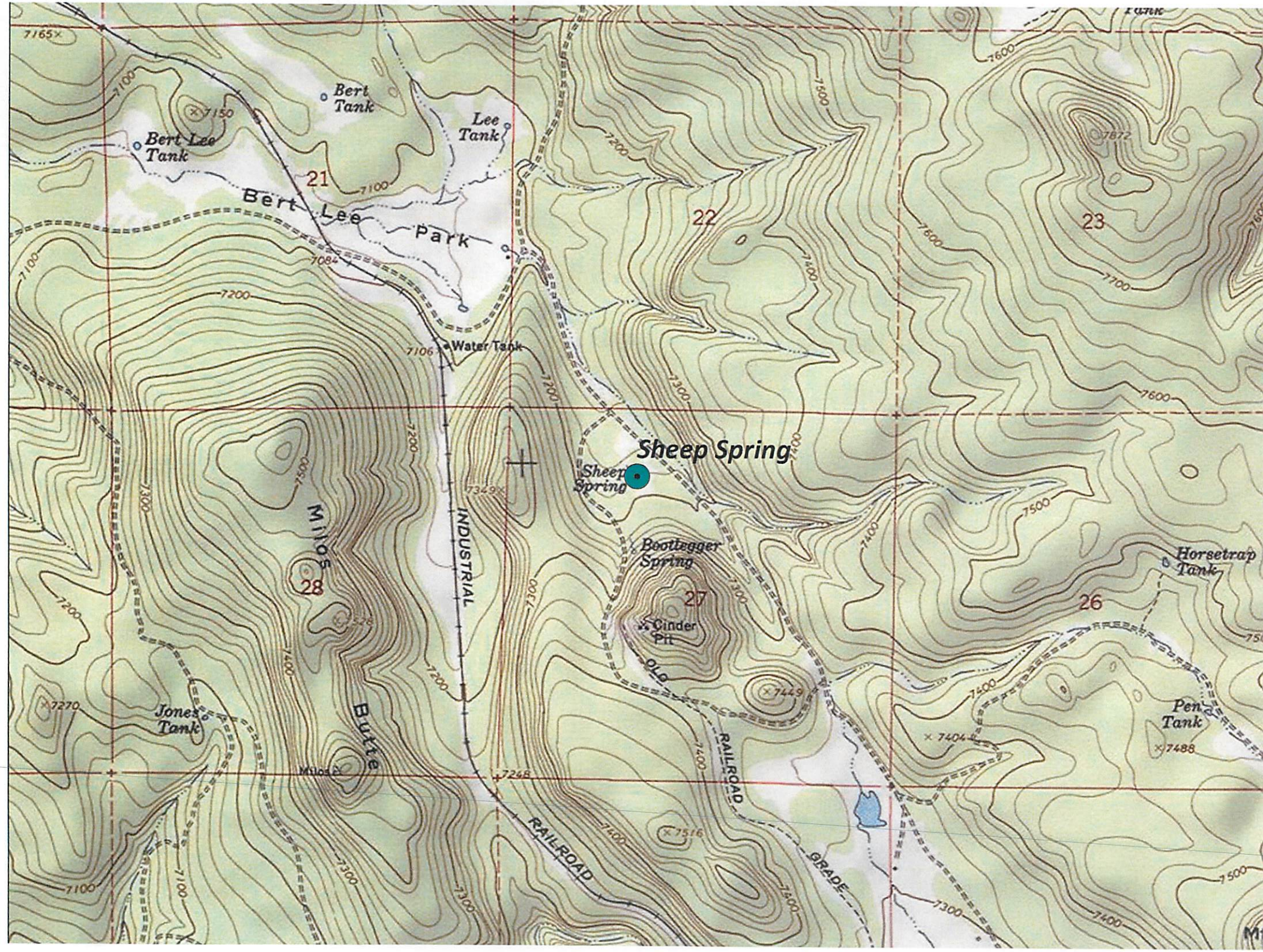
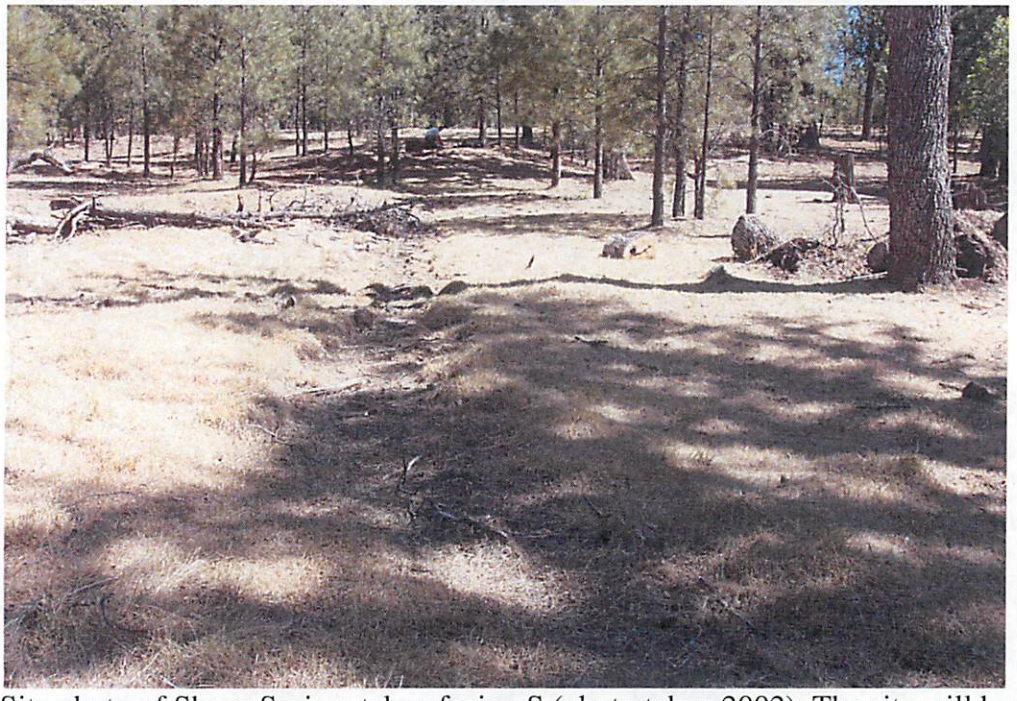
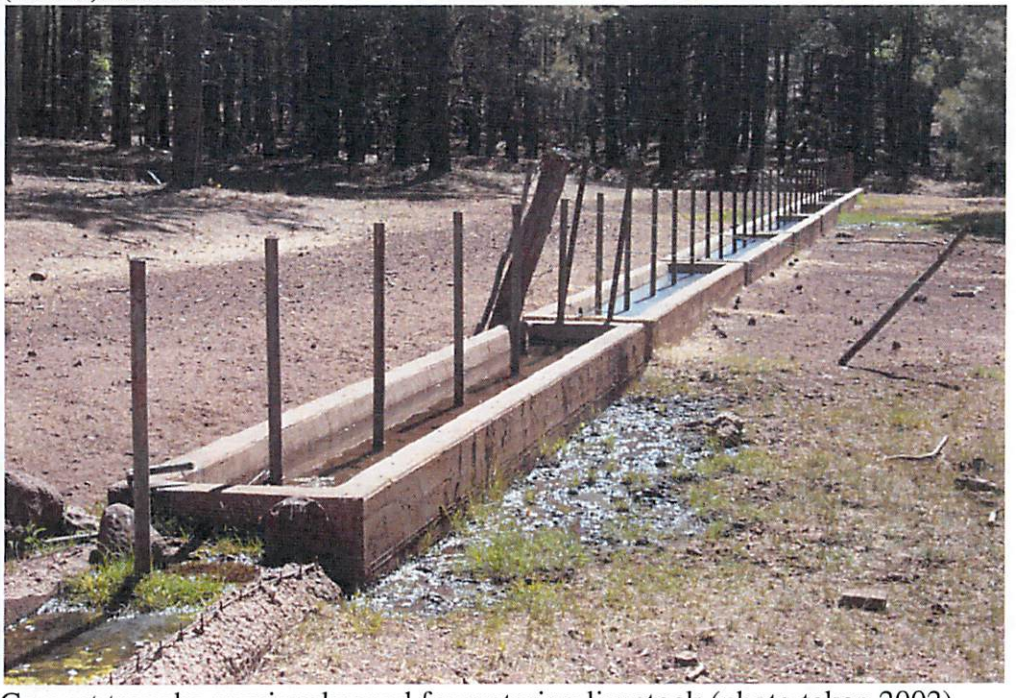

Sheep Spring
Bert Tank
Lee Tank
Bert Lee Tank
Bert Lee Park
Water Tank
Sheep Spring
Bootlegger Spring
Cinder Pit
Horsetrap Tank
Pen Tank
Jones Tank
Milos Butte
INDUSTRIAL
RAILROAD
GRADE
OLD
21
22
23
26
27
28

SHPO Attachment – Sheep Spring



Site photo of Sheep Spring, taken facing S (photo taken 2002). The site will be re-graded to reduce channelization, which can be seen in the image above, and cement troughs and the tank (below) will be removed.



Cement troughs previously used for watering livestock (photo taken 2002).

Above-ground part of tank to be removed in order to restore flow to the site (photo taken 2016).