

Spring, Seep and Hanging Garden Monitoring Protocol Implementation Plan for Park Units in the Southern Colorado Plateau Network

Standard Operating Procedure (SOP) #3

Site Establishment and Characterization

Version SCPN_Springs_SOP3_20180930

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is adopted from the Northern Colorado Plateau Network's SOP # 3 Site Establishment and Characterization, Version 1.00 (June 2016) in Weissinger, R., M. Moran, S. Monroe, and H. Thomas. 2017. Springs and seeps monitoring protocol for park units in the Northern Colorado Plateau Network, Version 1.00. Natural Resource Report NPS/NCPN/NRR—2017/1439. National Park Service, Fort Collins, Colorado.

The site characterization should be completed during the initial site visit. It details structural elements of the site that remain stable such as lithology, topographic setting, and spring type. Prior to site characterization, read Springer and Stevens (2009) to correctly classify springs.

Accepting a site for monitoring

Spring and hanging gardens locations are taken from previous studies and institutional knowledge but have not necessarily been evaluated for monitoring suitability. Accept a spring if the following criteria are met:

1. The site is correctly classified as a spring or hanging garden.
2. The site is safely accessible. No ropes, small hand holds, or prolonged exposure is required. A fall is unlikely to cause a life-threatening injury.
3. The site can be sampled without excessive resource damage, usually associated with displacement of saturated soils and roots on slopes or unusually dense and extensive woody vegetation.
4. For hydrologic monitoring, a stable flow monitoring location is also necessary. See SOP #5 for additional details.

Site Orientation and Setup

Upon arrival at each spring all observers should take time to walk around and thoroughly familiarize themselves with the site's characteristics. Spring ecosystems are fragile and delicate. Take care to avoid unnecessary trampling or disturbance of wetlands, land-surfaces, or vegetation in spring associated areas. If a location is not a spring, is inaccessible, or if sampling would cause too much impact to the site, reject the location for monitoring and indicate why the site was rejected.

Observations should refer to the spring orifice and to the first 50 meters of wetted stream channel downstream of the spring orifice. If the spring-fed channel meets a runoff-dominated channel at a distance of less than 50 meters,

stop there. If this is a repeat visit use the same length and area as the previous visit, noting any changes. In some cases, such as a spring with associated wetland, survey the entire area including riparian/wetland vegetation. The total spring site encompasses the area dominated by riparian and wetland obligate vegetation, and includes unvegetated sub-areas such as those consisting of bare rock, gravel, or soil.

Guidelines for determining the extent of area to include (modified from USDA-FS 2012):

The study area should include the spring and a short distance of the run-out stream, or until it clearly becomes a stream, pool, or other ecosystem type. For this protocol, when appropriate we will use **50 meters** as a set run-out distance. This is the measured length of the spring-fed stream **downstream from the orifice**, up to a **maximum of 50 meters**, or to the point where the spring-fed **stream enters another stream or channel (wet or dry)**. Fifty meters is an arbitrary cut-off that has been established based on studies of numerous springs and because in most spring ecosystems at varying distances downstream the spring-fed stream changes from a spring-specific habitat to a lotic habitat due to cumulative changes in flow, temperature, and water quality.

Tips for recognizing the extent of the area to include in spring monitoring:

Hydrology: Water on the surface of the ground or saturated ground (not from recent precipitation)

Vegetation: The boundary (or edge) of the spring will generally be associated with a transition from vegetation dominated by obligate, facultative wet, and facultative species to more upland species, as distinguished by the Wetland Indicator Status of the US Fish and Wildlife Service (1996).

Landform: A change in slope (from steeper to flatter) can be associated with the edge of the spring.

A particular concern is to minimize investigator impacts such as trampling at the site. Trampling-intensive methods, such as using metric tapes to measure site dimensions and cover, are often not recommended as they often may damage sensitive habitats and plant populations. Instead, the investigators will use a laser rangefinder to describe the dimensions of the overall spring site and individual landform/geomorphic surfaces within the site.

Site Information

Accurate and consistent recording of site information is very important. The site name, date and times of site visit, and observer's names should always be recorded in the field. Other Site Information details can be completed in the office.

Site Name: The name of the site as it appears on a topographic map or official documents from the Park Service. If the site is unnamed use a local, named topographic feature such as a stream or drainage name. For example, an unnamed spring in Cottonwood Canyon could be called Cottonwood Spring. Use permanent features to distinguish each spring, e.g. Cottonwood Boulder Spring or Cottonwood Ledge Spring. If possible this name should be unique. ***The site name should be recorded in the provided field on every side of every field form.***

Date: Use mm/dd/yy format, e.g. 06/12/13 for June 12, 2013.

Park Code: Enter the appropriate acronym for the park unit (CACH=Canyon de Chelly National Monument, CHCU=Chaco Culture National Historical Park, ELMO=El Morro National Monument, GLCA=Glen Canyon National Recreation Area, YUHO=Yucca House National Monument).

Observers: Fill in the full name of all crew members.

Access Description: Provide detail on access, using prominent features for reference and including estimates of distance and travel time for each leg of the route. Use words that are unambiguous, e.g. "south" instead of "left", "downcanyon" instead of "below." The access description is very important for relocating the spring in the future,

so please be thorough and accurate. Also record any hazard or safety information that may prompt alternate equipment or additional care, such as high cover of invasive weeds during the hike, water crossings, unstable slopes, mountain lion activity, etc.

Geographic Description

GPS coordinates: Using a handheld GPS unit, make sure the datum is set to NAD83, and make sure that the unit is set to the correct time zone. UTM x/y coordinates are a rectangular coordinate system with units in meters from the equator (the "y" or "Northing" value) and meters from a central meridian (the "x" or "Easting" value). Record a **waypoint** (UTM Easting and Northing) as near as possible to the spring orifice. Record the local UTM **zone**. If there is no GPS coverage at the orifice, find a nearby area with clear coverage, take a waypoint, and note the distance and bearing to the orifice. While in the field, mark the spring's location on a **topographic map** using a dot within a circle. If there is no GPS coverage at the site, UTMs can be estimated later using the position identified on the topographic map and GIS.

Aspect: Set the declination on the compass to true North. With your back facing the orifice, determine the representative aspect of the spring in degrees.

Slope: Measure the representative slope of the dominant surface around the spring orifice in degrees using a clinometer or compass.

Slope Variability: Indicate the general variability of the slope on the site by choosing one of the following categories: high (3 or more abrupt changes in slope across site, e.g., a hanging garden with vertical backwall, steep colluvial slope, and low-gradient channel), medium (1-2 changes, e.g., a rheocrene spring with steep banks), low (0 changes, e.g., a wet meadow).

Potential Solar Radiation: In the dominant aspect of the spring near the middle of the site, place the Solar Pathfinder tripod and dome in a level area facing true south. Use the appropriate latitude template (37-43°), and level the dome using the level bubble. Locate the horizon in the reflection of the dome, and read the vertical (sunrise/sunset) and horizontal (month) white lines transecting the reflection of the horizon on the sunpath diagram. The vertical lines in contact with the east horizon will indicate the time of day the sunlight will be contacting the site and the vertical lines contacting the west horizon will indicate the time the sunlight will leave the site. On the datasheet, record the sunrise and sunset time for each month of the year, in the order they are presented on the solar pathfinder. In the office, calculate the sum of the unshaded numbers along a particular monthly sunpath, located on the sunpath diagram, to obtain the percent of the total available solar energy for an average day in that month. Average potential percent solar radiation (in relation to the unshaded potential budget) will be calculated for monthly, seasonal (spring, summer, fall, winter) and annual periods in the database.

Site Description

Spring Type

Identify spring types based on the descriptions below (from Springer and Stevens 2009). There may be more than one spring type represented at a spring. Note all present at site. Visual representations of the spring types are available in Appendix A.

Spring Type	Definition
Cave	Emergence in a cave in mature to extreme karst with sufficiently large conduits
Exposure	Cave, rock shelter fractures, or sinkholes where an unconfined aquifer is exposed near the land surface
Fountain	Artesian fountain with pressurized CO ₂ in a confined aquifer
Geyser	Explosive flow of hot water from confined aquifer
Gushet	Discrete source flow gushes from a cliff wall of a perched, unconfined aquifer
Hanging garden	Dripping flow emerges usually horizontally along a geologic contact along a cliff wall of a perched,

	unconfined aquifer
Helocrene	Emerges from low gradient wetlands; often indistinct or multiple sources seeping from shallow, unconfined aquifers
Hillslope	Emerges from confined or unconfined aquifers on a hillslope (30-60° slope); often indistinct or multiple sources
Hypocrene	A buried spring where flow does not reach the surface, typically due to very low discharge and high evaporation or transpiration
Limnocrene	Emergence of confined or unconfined aquifers in pool(s)
Mound	Emerges from a mineralized mound, frequently at magmatic or fault systems
Rheocrene	Flowing spring, emerges into one or more stream channels

Describe Spring Orifice

Write a brief description of the spring orifice setting. Include information such as *emerges as diffuse flow from bottom of small pool, or orifice is located on hillslope and has been heavily trampled by livestock.*

Multiple Spring Orifices and Other Nearby Springs

Identify if there is more than one spring orifice. Spring orifices separated by more than 200 meters should be identified as separate springs. Note if there are other springs in the area that are further away than 200 meters, but closer than 0.5 miles (0.8 km).

Geology

Describe the geology at the source of the spring. Identify the primary lithology from rock types listed on the following table and the mapped rock unit using published geologic maps. If unable to identify the rock unit on site, take photos and write a brief description, then after the trip consult with persons knowledgeable about local geology.

Rock Type	
Sedimentary	
Shale	Fine grained, bedding planes present (fine grains smooth, not visible to eye)
Sandstone	Sand grains, visible to eye 0.06 to 2 mm
Limestone	Predominately calcite (fizzes easily)
Other	Describe in comments field
Evaporites	Salt, gypsum
Coal	Peat, lignite, subbituminous, bituminous
Conglomerate	Grains coarser than 2mm in a finer grain matrix
Mudstone	Fine grained, bedding planes absent (fine grains smooth, not visible to eye)
Siltstone	Fine grained, bedding planes present (fine grains gritty, not visible to eye)
Quaternary Alluvium	Alluvial deposits found in and adjacent to wash bottoms

Spring Channel Characterization

Spring, seep and hanging garden sites may or may not have an associated stream channel. Channel attributes including length, flow type, and channel type should refer to the most representative channel on the site within the first 50 m of the spring orifice or the first meander downstream of the spring orifice. This is the measured length of the spring-fed stream downstream from the orifice, up to a **maximum of 50 meters**, or to the point where the spring-fed **stream enters another stream channel (wet or dry)**.

Channel Presence

Indicate whether or not a stream channel is present. If a stream channel is present but is associated with a water or run-off source other than the spring, mark that the stream channel geomorphology is run-off dominated (see channel type below).

Number of Channels

Enter the number of channels present on site within the first 50 m of the spring orifice.

Channel Length

Record in meters (m) up to a maximum of 50m the length of the flowing channel (if it exists), along the channel thalweg, directly below the spring orifice.

Channel Type

The morphology of the channel should be examined (if a channel exists) to determine if it is spring-dominated or surface-flow dominated. If a channel is spring discharge dominated, the channel should be nearly bank full at base-flow conditions of the spring. If the channel is surface-flow dominated, typically the channel is oversized for the base-flow of the spring. Typically there are two bankfull stages for surface-flow dominated channels; a small, incised channel for base-flow condition, and a larger, wider channel for surface-flow dominated conditions.

Channel Type	
Spring discharge dominated	Only one terrace or bankfull channel and channel starts at or near the spring orifice.
Runoff dominated	High terrace or two bankfull channels, one terrace typically higher than a lower, smaller spring-discharge terrace. Channel features are evident upstream of spring flow affected area.
Mixed discharge	Both spring discharge and runoff, two terraces or bankfull channels. Channel features evident upstream of spring-flow affected area, but some channel features are different below orifice because of spring flow.

Channel Comments

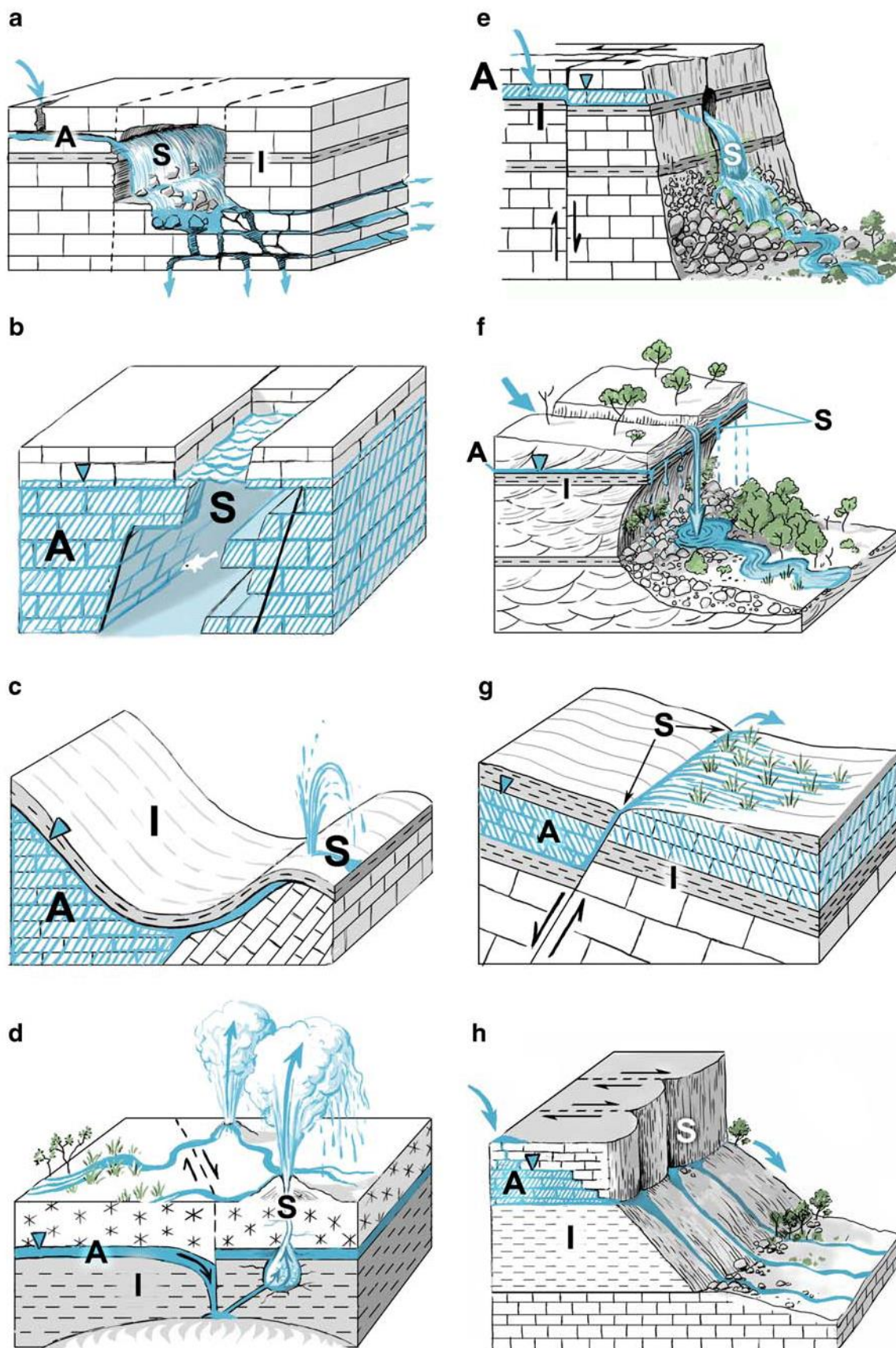
Provide additional explanatory comments, especially for mixed type.

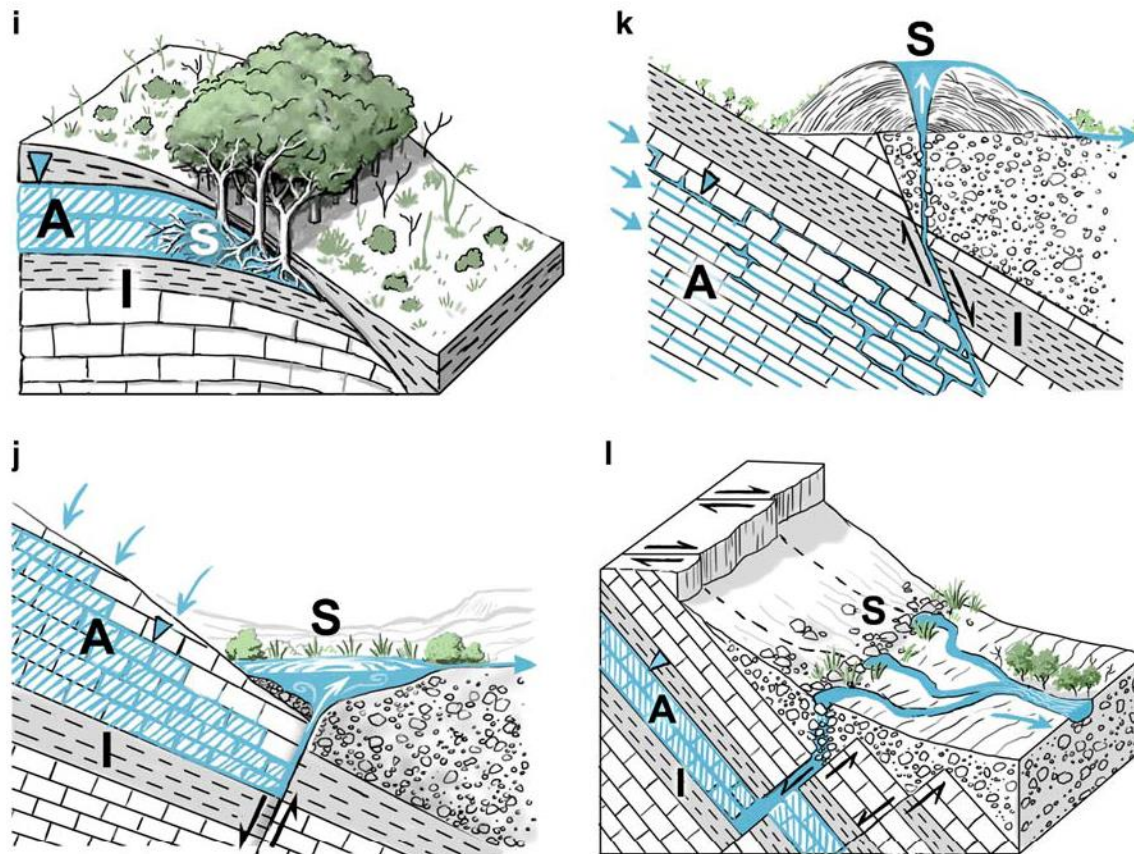
Literature Cited

Springer, A.E. and L.E. Stevens. 2009. Spheres of discharge of springs. *Hydrogeology* 17: 83-93.

United States Department of Agriculture – Forest Service (USDA-FS). 2012. Groundwater dependent ecosystems: Level II inventory field guide. General Technical Report WO-86b. USDA, Washington, D.C.

Appendix A. Spring types from Springer and Stevens (2009).





Sketches of springs spheres of discharge: **a** cave, **b** exposure, **c** fountain, **d** geyser, **e** gushet, **f** hanging garden, **g** helocrene, **h** hillslope, **i** hypocrene, **j** limnocrene, **k** mound form, **l** rheocrene. **A** aquifer, **I** impermeable stratum, **S** spring source. The inverted triangle represents the water table or piezometric surface. Fault lines are also shown, where appropriate.

Reprinted with permission, Figure 1 in:

Springer, A.E. and L.E. Stevens. 2009. Spheres of discharge of springs. *Hydrogeology* 17: 83-93

SCPN Springs Monitoring Site Characterization Datasheet - v. 1.00

Site Information

Site Name

Park Code

Date

Observers

Access Description

UTM - X

UTM - Y

Zone

Aspect (deg.)

Declination (deg.)

Slope (deg.)

Reject?

Y

N

Slope variability

high

medium

low

If, Y, why?

Solar Radiation:

Sunrise: D____ J____ N____ F____ O____ M____ S____ A____ A____ M____ J____ J____

Sunset: D____ J____ N____ F____ O____ M____ S____ A____ A____ M____ J____ J____

Site Description

Spring Type

Geology

Type (circle one)	Description
Cave	Emergence in a cave in mature to extreme karst with sufficiently large conduits
Exposure	Cave, rock shelter fractures, or sinkholes where an unconfined aquifer is exposed near the land surface
Fountain	Artesian fountain with pressurized CO ₂ in a confined aquifer
Geyser	Explosive flow of hot water from confined aquifer
Gushet	Discrete source flow gushes from a cliff wall of a perched, unconfined aquifer
Hanging garden	Dripping flow emerges usually horizontally along a geologic contact along a cliff wall of a perched, unconfined aquifer
Helocrene	Emerges from low gradient wetlands; often indistinct or multiple sources seeping from shallow, unconfined aquifers
Hillslope	Emerges from confined or unconfined aquifers on a hillslope (30-60° slope); often indistinct or multiple sources
Hypocrene	A buried spring where flow does not reach the surface, typically due to very low discharge and high evaporation or transpiration
Limnocrene	Emergence of confined or unconfined aquifers in pool(s)
Mound	Emerges from a mineralized mound, frequently at magmatic or fault systems
Rheocrene	Flowing spring, emerges into one or more stream channels

Geology		
Aquifer Rock Type (circle one):	Sedimentary	
	Limestone	
	Sandstone	
	Shale	
	Other	
Geologic unit:		

Measured Size (m2):

Multiple Spring Orifices - closer than 200 m

Yes

No

Other Springs Nearby - greater than 200 m and less than 0.5 miles

Yes

No

Channel Present:

Yes

No

Number of channels:

Channel Length (m):

Channel type

spring discharge dominated

run-off dominated

mixed

Spring Orifice Description:

Channel Description:

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NCPN Springs Monitoring Site Characterization Datasheet - v. 1.00

Site Information

Site Name Cov Can 3

Park Code ARCH

Date 15 May 2014

Observers R. Weissinger

Access Description

From the pipeline access, follow the pipeline into Salt Wash. A social trail goes close to the northern wall at the end of the side canyon with the pipeline, or route find across to Cordova Canyon. Once in Cordova Canyon, walk along the north wall to an alcove at ground level in the north wall. Access includes clay roads and washes that are impassable when raining and may take a few days to dry. Hiking goes through lots of weeds including cheatgrass, tumbleweed & knapweeds. Access in the seep is easy. UTM Zone

Aspect (deg.) 191° Declination (deg.) 11° E Slope (deg.) 31°
Slope variability high medium low

Solar Radiation:

Sunrise: D 6:00 J 8:30 N 8:30 F 9:30 O 11:30 M NS S A A M J J J
Sunset: D 15:00 J 15:00 N 14:30 F 14:00 O 14:00 M NS S A A M J J J

Site Description

Spring Type

Type (circle one)	Description
Cave	Emerge entirely within a cave environment and not directly connected to surface flow
Limnocrene	Emerge as one or more lentic pools
Rheocrhene	Emerge as flowing streams
Mound-form	Emerge from (usually carbonate) precipitate mounds
Heleocrene	Emerge usually in a diffuse fashion in cienega (marshy, wet meadow) settings.
Hillslope	Emerge from non-vertical hillslopes at 30-60° slope, and usually have indistinct or multiple sources
Gushette	Pour from cliff faces
<u>Hanging gardens</u>	Complex, multi-habitat springs emerge along geologic contacts and seep, drip, or pour onto underlying walls
Geysers	Geothermal springs that emerge explosively and usually erratically
Fountain	Cool-water artesian springs that are forced above the land surface by stratigraphic head-driven pressure
Exposure	Settings in which ground water is exposed at the surface but does not flow
Hypocrhene	Springs in which ground water the water never reaches the surface

Geology

Aquifer Rock Type (circle one):	Sedimentary
	Limestone
	<u>Sandstone</u>
	Shale
	Other
Geologic unit: <u>Moab Member of Curtis Fm</u>	

Measured Size (m²): 716 m²

Multiple Spring Orifices - closer than 200 m Yes No

Other Springs Nearby - greater than 200 m and less than 0.5 miles Yes No

Channel Present: Yes No

Number of channels: N/A

Channel Length (m):

Channel type spring discharge dominated run-off dominated mixed

Spring Orifice Description:

~70 m long seeping backwall with some drips, much of BW is ~3m high and is wet the whole width

Channel Description:

From Sand Dune Arch via pipeline - about 2 hrs.