REPORT
November 13, 2017

Prepared for:

RESOLUTION COPPER

2017 Oak Flat Surface Water Monitoring Program

Pinal County, Arizona

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RESOLUTION COPPER, PINAL COUNTY, ARIZONA

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1 EXECUTIVE SUMMARY

Montgomery & Associates (M&A) and WestLand Resources, Inc. (WestLand) have prepared this report for Resolution Copper (RC) to describe surface water features monitored in the Oak Flat area. Sites monitored, methods of data collection, and findings of data collection from March through September 2017 are presented. Fourteen sites were studied to provide baseline technical hydrologic monitoring in the Oak Flat area within or adjacent to the projected disturbance zone of the proposed RC block cave mine. The sites are within three local drainage basins: (1) Rancho Rio Canyon, within the Devil's Canyon watershed; (2) Number 9 wash; and (3) Oak Flat wash; both within the Queen Creek watershed.

The purpose of this monitoring program was to characterize surface water features, behavior and associated ecological values for typical hydrologic resources in the Oak Flat area. This report is part of RC's effort to help address issues raised during public scoping including (SWCA 2017):

Surface Water Resources, Issue 6C

- Quantitative assessment of number of stock watering tanks that would be lost to direct disturbance or reductions in surface flow.
- Quantitative assessment of change in volume, frequency, and magnitude of runoff from the project area.

Biological Resources, Issue 7C

- Qualitative assessment of impacts to aquatic habitats and surface water that support wildlife and plants, such as stock tanks, seeps, and springs.

Monitoring of the selected features includes photographic, qualitative, and quantitative information about the storage and release of water at these sites in response to precipitation and evapotranspiration. Continuous monitoring equipment (pressure transducers, barometers, rain gauges, trail cameras) was used selectively at many locations. RC support staff, in weekly coordination with M&A, visited the chosen Oak Flat features on a weekly to monthly basis, dependent on seasonal weather patterns. In addition, biological monitoring was undertaken by WestLand to provide indication of the persistence of water at these sites and to document the ecological function of these water features.

The Oak Flat area, as defined in this study, is bound by the western rim of Devil's Canyon in the east, the Queen Creek drainage to the north, the Apache Leap escarpment to the west, and Rancho Rio Canyon to the south. Apache Leap Tuff (Tal) bedrock outcrops over most of the Oak Flat area, except where it is covered by thin alluvial deposits. The regional groundwater system contained in the Tal is hundreds of feet beneath land surface and is hydraulically disconnected from the surface water system at Oak Flat. The Oak Flat area contains hundreds of man-made features such as check dams and reservoirs, many of which were constructed by the Civilian Conservation Corps (CCC) or by historic ranching and as such have been in place for decades. These man made features are located in natural drainages throughout the area and serve as water impounding structures, preventing some volume of storm water from flowing into Queen Creek and Devil's Canyon. Alluvial veneers within the study area are found in locations where manmade (check dams, reservoirs, stock ponds) or natural features (faults, joints, topography) capture and retain sediment. Water is often retained within these alluvial aquifers for weeks to months following precipitation.

Surface water is found across seasons and in many locations throughout Oak Flat. This study suggests that alluvial veneers are the main reason for the existence of surface water for prolonged periods on Oak Flat. These alluvial features retain precipitation derived surface water runoff, gradually releasing it over an extended period. Water released from the alluvium is conveyed in streams until it reaches bedrock pools, or tinajas that provide longer term storage of surface water. These bedrock pools are often deep and shaded, providing conditions that enable surface water to persist long into the dry, hot summer.

The 14 sites were observed during three distinct seasons: spring, summer (pre-monsoon & post-monsoon), and monsoon.

In late March water was present at most sites, either flowing or pooled, and vegetation/foliage was healthy. Average high temperatures during March and April ranged from approximately 83°F to 85°F.

Average high temperatures rose into the summer months of May and June, ranging from 87°F to 102°F. Surface flow stopped by the beginning of June at all locations, and water stored within the alluvial embayments, reservoirs, joints, and tinajas decreased substantially. Evapoconcentration of the pooled water in the reservoirs and tinajas resulted in increased electrical conductivity. Elevated temperatures and loss of moisture resulted in increased dieback of surrounding foliage during the summer months.

Heavy monsoon rains began on July 16 to the Oak Flat area. Steady monsoon events occurred over the next 2 weeks providing frequent surface water flow and refilling storage of these features. Summer rain events ended by August 1 and surface flow stopped shortly after. Hot, dry conditions resumed during August and September. By late September, many sites were dry and storage within tinajas, reservoirs, and alluvial embayments had decreased substantially. Average high temperatures during July through September ranged from approximately 97°F to 98°F. Water levels in alluvial aquifers and tinajas dropped more rapidly following the summer rains than in the spring, presumably because high temperatures and increased plant activity led to higher rates of evapotranspiration.

Generally speaking, vegetation response to seasonal precipitation was consistent with the expected pre-monsoon dieback period and post-monsoon growth period. At some of the sites, plant individuals and communities exhibited duller shades of green and brown during the hot and dry months and brighter colors during wetter months. Some of the plants exhibited stress and dieback during the pre-monsoon period, and new, healthy leaf growth during the post-monsoon period. The density of herbaceous vegetation at some of the sites fluctuated throughout the course of the year in response to changes in soil water availability.

2 INTRODUCTION

In accordance with a request from Ms. Heather Gluski, Resolution Copper, LLC (RC), Montgomery & Associates (M&A) and WestLand Resources Inc. (WestLand) has prepared this report to describe surface water features monitored in the Oak Flat area, methods of data collection, and findings from monitoring surface water features from March through September 2017. Sites were chosen to provide baseline technical hydrologic monitoring support in the Oak Flat area within or adjacent to the projected disturbance zone of the proposed RC block cave mine. Results of the monitoring program and activities are part of continued efforts to address the needs of the NEPA process for the Resolution Project.

2.1 Objective

The goal of this project is to document and characterize common surface and near surface hydrologic features in the Oak Flat area. Monitoring of the selected features was intended to provide photographic, qualitative, and quantitative information about the storage and release of water at these sites in response to precipitation and evapotranspiration. In addition, biological monitoring was undertaken to provide indication of the persistence water at these sites and to document the ecological function of these water features. This study focuses on surficial water features, in close proximity to the area that will be directly impacted by mining activities, separate from the extensive groundwater studies starting in 2002. All of the sites are located in areas that are likely to be directly or indirectly impacted by the maximum projected collapse zone of RC's proposed block cave mine (**Figure 1**). The sites are within three local drainage basins: (1) Rancho Rio Canyon, within the Devil's Canyon Watershed; (2) Number 9 wash; and (3) Oak Flat wash; both within the Queen Creek Watershed.

2.2 Project Background

2.2.1 Regulatory / Historical Framework

The National Environmental Policy Act (NEPA) requires the Forest Service (FS) to prepare an Environmental Impact Statement (EIS), because the proposed RC mine plan of operations contains facilities which are on national forest land. This study was undertaken by RC to support preparation of the EIS. The monitoring program was designed to characterize surface water features, behavior and associated ecological values

for typical hydrologic resources in the Oak Flat area which can be used to help address issues raised during public scoping (SWCA 2017).

2.2.2 Location

The study area is near the Oak Flat Campground, approximately 4 miles east of Superior, Arizona and includes all or parts of Sections 28, 29, 32, and 33, T. 1 S., R. 13 E., and all or parts of Sections 5 and 6, T. 2 S., R. 13 E., in Pinal County, Arizona. The Oak Flat area, as defined in this study, is bound by the western rim of Devil's Canyon in the east, the Queen Creek drainage to the north, the Apache Leap escarpment to the west, and Rancho Rio canyon to the south. Coordinates of each monitoring site are shown in **Table 1**.

2.2.3 Hydrogeologic Conditions

The Tertiary-aged Apache Leap Tuff (Tal) is a massive sequence of dacitic welded tuffs which thickens northward over the study area, ranging from 1,000 to 2,000 feet thick. The Tal bedrock outcrops over most of the Oak Flat area, except where it is covered by thin alluvial deposits in the channels, washes, reservoirs, and small flat-lying basins, usually less than 10-20 feet thick. Extensive sub-vertical jointing is observed across much of the uppermost surface of the Tal outcrop belt as a result of cooling of the tuff and/or subsequent structural deformation/faulting. Weathering of the Tal has resulted in enhanced erosion along these joints creating linear depressions that channel surface water flow and accumulate sediment. Rain water is stored in these joint-controlled features and can be observed flowing from these features in some instances weeks after rain events.

ALLUVIAL (Qal) AQUIFERS

Several small, perched aquifers of limited aerial extent and thickness occur within thin accumulations of Quaternary alluvial (Qal) deposits that are found along the bottoms of canyons and in topographic depressions on the surface of the tuff and adjacent areas such as Number 9 wash, Oak Flat wash, and Rancho Rio wash. These persistent water features store surface water runoff and support local vegetation. Most of these features dry up seasonally, or during drought periods.

APACHE LEAP TUFF (Tal) AQUIFER

A more extensive fractured-rock aquifer occurs within the Apache Leap Tuff in the Devil's Canyon and Upper Queen Creek drainages. Groundwater movement within the Tal aquifer is controlled by fractures, and perching of this aquifer is probably caused by

increased fracture-fill material in lower parts of the tuff, along with a general decrease in fracturing with depth. The Tal bedrock has a relatively low hydraulic conductivity ranging from 2×10^{-7} to 6×10^{-3} cm/s (M&A 2014). Depth to water in the Oak Flat area is generally greater than 300 to 500 feet. Groundwater from the Tal aquifer is documented to discharge into Devil's Canyon at several complexes of seeps and springs (M&A 2016).

3 COMMON WATER FEATURES IN OAK FLAT

Surface water on Oak Flat is often found weeks to months following the winter or summer rains because of the presence of several common anthropogenic or naturally occurring geologic features that enable capture, storage and release of runoff from the precipitation. Joint-fill material, and alluvial deposits and veneers that accumulate behind constructed check dams and masonry dams, or behind naturally occurring fault-controlled barriers all retain precipitation derived water, releasing it over an extended period. Stream channels convey these releases to tinajas, or bedrock pools that provide longer term storage of surface water that is available wildlife and ranch cattle in the area.

3.1 Alluvial Veneers

The stream channels and washes in the Oak Flat area are ephemeral to intermittent waterbodies. Alluvial sediment has accumulated in the active channels and floodways adjacent to natural geomorphological features and man-made structures such as check dams and masonry dams. Flow events saturate the alluvium, which retains and slowly release water for varying periods of time, depending on the thickness and extent of the alluvial deposit. The persistence of water within these thin alluvial veneers is impacted by temperature and evapotranspiration.

3.2 Joint-fill Materials

The jointing of the tuff and natural weathering patterns create linear depressions that channel surface flow and can accumulate sediment, soil, and vegetation which trap and slow the release of surface flow. Water is retained within the joint-fill material prolonging the release of water following rainy periods.

3.3 Dams

Hundreds of check dams made up of loose boulders were constructed during the 1930's and 1940's by the Civilian Conservation Corps (CCC) in the Oak Flat area as means of erosion control. These porous check dams range in scale from a single layer of boulders less than a foot tall and 5-10 feet long, to hundreds of boulders up to 6 feet tall and several 10s of feet long. The check dams have captured sediment over decades creating thin alluvial veneers and embayments. The shallow alluvial embayments retain surface water after rainy periods, delaying and potentially inhibiting the drainage of water from Oak Flat. The alluvial embayments and water retained in them also create suitable

growing conditions for a variety of plant life. In addition to the check dams, made up of loose boulders, Oak Flat wash and Number 9 wash have larger masonry dams, built to retain water into the dry, summer months. The critical placement of these features (flatter, wider areas in each wash) resulted in large accumulations of sediment and surface water building up behind the dams. Since these masonry dams have been filled in by sediment, their function is now very similar to that of the check dams which store water in alluvial sediment, preventing or prolonging its release downstream.

3.4 Tinajas

Tinajas are surface water pools found in naturally occurring bedrock channels. On Oak Flat, these tinajas, which are hundreds of feet above the regional aquifer, are solely fed by surface water runoff with no groundwater component. These depressions are carved out by the surface water runoff from rain events and are seasonally fed by the seepage of many of the other features encountered in Oak Flat. Tinajas are often deep, and shaded, providing conditions that enable surface water to persist long into the dry, hot summer.

4 FIELD PROCEDURES AND INVESTIGATIONS

4.1 Participating Parties

M&A and WestLand have combined efforts to provide technical hydrologic and biologic monitoring support for 14 surface water features. Field support has been provided by the RC permitting group for the weekly to monthly site monitoring. This report has been prepared by M&A and WestLand on behalf of RC.

4.2 Project Planning and Coordination

Multiple site visits were made to Oak Flat by members of M&A, WestLand, and RC staff since April 2016, prior to initiation of the monitoring program. These visits were part of the efforts of identifying representative and accessible locations of surface water features typical to the Oak Flat area.

Data collection for this study took place during the period from March 22 through September 22, 2017. Photographs, notes, and water chemistry parameters were obtained by RC personnel on a weekly to monthly basis, or as requested by M&A and WestLand. Monitoring frequency varied based on season and occurrence of precipitation events. Weekly visitation was requested during the spring and monsoon season; biweekly to monthly visitation was requested during the dry, summer months.

Five scheduled visits to the Oak Flat study area were made by M&A and WestLand during the monitoring program. Field instrumentation was installed during the first trip March 22 & 23, 2017. The remaining four trips were for routine monitoring, instrumentation maintenance, and data collection.

4.3 Monitoring Methods & Approach

4.3.1 Data Collection Procedures

RC support staff, in weekly coordination with M&A and WestLand, visited the chosen Oak Flat features on a weekly to monthly basis, dependent on seasonal weather patterns. Data collection during site visits included:

- General field observations generally include: visual estimations of flow, dimensions of streams and pools (length, width, and depth), and the state of surrounding soil and vegetation, including observed changes to individual plants and/or plant communities

over time, e.g. size, density, developmental phase (sprouting, flowering, seeding, and leaf abscission) and qualitative characteristics such as color and general health.

- Photographs of hydrological and biological conditions and observations during each visit (**Appendix A**).
- Field water quality parameters (pH, electrical conductivity (EC), temperature, and dissolved oxygen (DO)).
- Documentation of vegetation and wildlife species composition.
    - Presence or absence of special-status species. These species include species listed as threatened or endangered, or proposed for listing on the federal endangered species list for Pinal County, Arizona (USFWS 2017), and species considered sensitive by the Tonto National Forest (USFS 2013a and 2013b).
    - Presence or absence of species considered as invasive by the Tonto National Forest (USFS 2017).
    - Presence or absence of nonnative species (USDA 2017).
- Aquatic invertebrate samples from features containing surface water at the time of the survey events.
- WestLand used dipnets to collect aquatic invertebrate specimens from pools and streams and stored them in jars containing 70% ethanol. One sample jar was used per site.

4.3.2 Installed Instrumentation

HOBO® Water Level (13 ft) Data Logger – Operating range (0 to 21 psia) – transducer measures pressure and temperature; set to record a reading every 15 minutes. Six dataloggers in total are being used at chosen locations for the monitoring program.

Level TROLL® 400 (35 ft) – Operating range (0 to 30 psia) – integrated pressure transducer and datalogger for monitoring barometric pressure. One Level TROLL transducer is being used to provide barometric data from the Oak Flat area.

Cuddeback® Long Range IR & Reconyx® Hyperfire HC 500 Trail Cameras – Positioned to capture water presence at targeted features; set to take one picture every hour during daylight hours. Two of each camera type is being used at chosen locations

for the monitoring program. One of these cameras is also set to capture motion-triggered events to document the presence of wildlife at the site.

4.3.3 Existing RC Instrumentation

Campbell Scientific TE525WS-L Rain Gauge – Tipping-bucket rain gauge that measures rainfall in 0.01 inch increments and totalizes hourly precipitation measurements on CR-850 data logger. Installed in late 2010, the rain gauge is a component of the DHRES-07 meteorological station (**Figure 1**). Data from this monitoring location will represent precipitation for the entire study area (**Figure 2**).

Aqua TROLL® 200 (35 ft) – Operating range (0 to 30 psia) – integrated pressure transducer and datalogger for monitoring absolute pressure, temperature, and EC. One Aqua TROLL datalogger is being used to provide total head in a stream channel in the Rancho Rio wash (RR 1.5 C).

Baro TROLL® Data Logger – Operating range (0 to 30 psia) – measures and logs barometric pressure and temperature. Data is used to compensate for water level changes due to barometric fluctuations. One unit was used for monitoring program in the Rancho Rio wash (**Figure 2**).

5 MONITORING SITES

5.1 Rancho Rio Sub-Basin

Rancho Rio wash is a tributary to Devil's Canyon. Rancho Rio wash runs from west to east, flowing down gradient through channels originating near the Tal escarpment (**Figure 1**). Three monitoring sites are located in Rancho Rio wash: Rancho Rio pond, Rancho Rio 1.5 C (RR 1.5 C) datasonde, and Rancho Rio Tinajas monitoring sites (**Figure 3**). The three Rancho Rio monitoring sites are hydrologically connected and were selected with the intent that they would be monitored in series. Rancho Rio spring is located downstream from Rancho Rio pond, and represents discharge from the alluvial deposit which his dispersed through fractures into Rancho Rio wash. There is no discreet discharge point, but seepage is observed in the area of the RR 1.5 C data sonde. Water chemistry field parameters, biology, and site characteristics obtained to date are summarized in **Tables 2a – 2d**. Photographs taken of each site during the monitoring program are provided in **Appendix A**.

5.1.1 Geology of Rancho Rio

A north-south trending, high angle fault intersects Rancho Rio wash perpendicular to the flow direction, roughly 1 mile upstream from the confluence with Devil's Canyon. The uplifted Tal east of the fault, creates a natural crest, damming the flow path and resulting in development of an extensive alluvial deposit. East of the fault, the flow is diverted south into Rancho Rio Canyon. The channel of Rancho Rio wash in the canyon is largely cut into bedrock with some small banks of alluvium along the canyon bottom. The channel steepens upon entering the canyon, resulting in less accumulation of alluvium.

5.1.2 Rancho Rio Pond

The Rancho Rio pond is a stock tank excavated from naturally-occurring alluvium, just west of the fault, approximately 1 mile from the confluence with Devil's Canyon (**Photo 1**). The main stream channel flows into the north end of the pond and pools in the depressed, stock tank feature. A pressure transducer was buried at the base of the alluvium on March 22, 2017. The transducer was installed in this location to monitor the storage of surface water in the alluvium, upstream from Rancho Rio Canyon. The thickness of the alluvium at the monitoring site is about 44 inches to bedrock at the center of the tank.

Photo 1. Rancho Rio pond, August 3, 2017

At the time of the transducer installation in March, the surface of the pond was dry. A hole was dug down to underlying bedrock and water was measured at 15.5 inches below land surface (bls), or 28.5 inches above the installation depth. The transducer was placed on the bedrock surface and re-buried under the alluvium**.**

5.1.3 Rancho Rio Aqua TROLL (RR 1.5 C)

The Aqua TROLL 200 (S/N 459725) is installed in a bedrock channel of Rancho Rio Canyon, approximately 120 feet downstream from Rancho Rio pond (**Photo 2**). The transducer was installed in 2011 to monitor surface flow in the canyon as part of the RC baseline surface water studies. A Baro TROLL logger is positioned in the shade on the east bank of the wash to atmospheric pressure and temperature in the region. Flow leaving the Rancho Rio pond alluvium is monitored by the RR 1.5 C Aqua TROLL.

Photo 2. Rancho Rio Aqua TROLL (RR 1.5 C), September 21, 2017

5.1.4 Rancho Rio Tinajas

The Rancho Rio Tinajas site consists of three bedrock pools (upper, middle, and lower) located approximately 0.3 miles (650 feet) downstream from RR 1.5 C (**Photo 3**). A trail camera is set up on a tree above the middle tinaja to the west, facing downstream. The placement of the camera was designated to capture flow into and out of the largest tinaja (middle). Flow entering the tinaja from the stream channel is monitored by the RR 1.5 C datasonde. The camera is set up to record hourly photographs during daylight hours only.

Photo 3. Rancho Rio Middle Tinaja from camera location, August 3, 2017

At the time of the March 23, 2017 installation, the tinajas were full and there was observed flow connecting the three pools.

Hydrologic Observations

Rainfall data from the DHRES-07 weather station, the water level in the alluvium/pond measured by the transducer from Rancho Rio pond, hydraulic head from RR 1.5 C Aqua TROLL, and hourly daytime photographs from the Rancho Rio Tinajas are shown on the time series video given in **Attachment 1**.

The monitoring period March through mid-July showed the system starting with abundant alluvial groundwater and surface flow in the spring, with all active flow ceasing into the pre-monsoon, mid-summer months. At the beginning of monitoring, starting March 22, the system showed approximately 28.5 inches of water in the alluvium, observed surface water flow in the channel at RR 1.5 C of approximately 1.5 inches of

head, and the tinajas were full and were connected with an estimated 2-3 gallons per minute (gpm) surface water flow. Water level in the alluvium spiked up to approximately 4 feet after a rain event on the morning of March 23. The same rain event did not result in increased water level at RR 1.5 C or increased flow rate at Rancho Rio Tinajas

From March 22 through June 2, 2017, observed hydraulic head above the Tal in the alluvium at Rancho Rio pond steadily decreased from approximately 4 feet of head to zero (dry), at a rate of 0.4 feet per week (**Figure 4**). At the beginning of the monitoring program, RR 1.5 C was measuring approximately 1.5 inches of water in the channel, indicating that flow was occurring in the stream. Hydraulic head was recorded until May 30, 2017, when the stream at RR 1.5 C went dry (**Figure 5**). EC increased from approximately 50 microsiemens per centimeter (µS/cm) to over 200 µS/cm by late May, before the reach stopped flowing.

Observed surface flow at the tinajas decreased into mid-May and ceased on May 23 (12:00). Water level in the middle tinaja appeared stable in photographs until inflow to the tinaja stopped. After inflow stopped, water level decline in the large tinaja accelerated with totaling over 2.5 feet by mid-July. During this period, EC increased from 110 µS/cm to 220 µS/cm. This increase in conductivity is due to the evapoconcentration of the stored water in the tinajas and the alluvium.

Small rain events were first observed on July 13 and 14, however did not result in surface flow. Substantial monsoon rain events began on July 16 (15:30), with frequent rain showers continuing until August 1. First pressure response at Rancho Rio pond transducer and RR 1.5 C Aqua TROLL was observed on July 18, following a heavy rain event of 0.75 inches. The response from this event in the alluvium was short lived showing no prolonged storage in the alluvium or surface flow. No flow was observed at the RR 1.5 C Aqua TROLL location. Periodic rain showers continued over the next week. Because runoff was not generated by these first rainfall events, it can be inferred that water from these events refilled available storage features in upstream locations including soils, alluvial deposits and veneers, joint-fill materials, and tinajas.

A large rain event, of 0.60 inches, occurred on July 24 resulting in flash flooding through the Rancho Rio alluvial basin and canyon channel. While this event was smaller than the July 18 event, it generated runoff rapidly because upstream storage had already been filled by previous storms. This event saturated the alluvium, increasing the head on top of the alluvial transducer to almost 7 feet of water, or over 3 feet of pooled water above the land surface. The Aqua TROLL recorded over 2 feet of water flowing through the

canyon. The camera at the tinaja recorded major flood events through the canyon channel and re-filling the storage within the tinajas.

Following the July 24 event, the water level in the alluvium and the water level in at RR 1.5 C can be seen gradually declining (and occasionally refilled by subsequent storms) as water exits the alluvium, providing water to the channel and inflow to the tinaja. The final significant monsoon event occurred on August 1, causing a slight increase in flow and storage. From beginning of August through the end of the monitoring program on September 22, water level decline occurred at a more rapid pace, as a result of much higher temperatures and increased phreatophyte activity in the late summer. Average high temperatures recorded from the RR 1.5 C barometer during August and September ranged from 97-98 degrees F.

No head was recorded in the alluvium by September 18. Little flow remained at RR 1.5 C on September 22, as the Aqua TROLL measured 1 inch of head in the channel. No surface flow was observed at the tinajas after September 15 and the water level in the middle tinaja began to drop. EC increased from 80 µS/cm following the monsoon flood events to 180 µS/cm as the system dried up and stored water evaporated and concentrated.

Biological Observations from Rancho Rio Pond

Vegetation at the Rancho Rio pond site is characteristic of the Interior Chaparral biotic community (Brown 1994). Other common native and nonnative herbaceous species occur in the interior regions of the site, likely due to the accumulation of alluvial sediment and greater soil water availability present in the depression of the stock tank, and possible disturbances associated with cattle grazing and the accessibility of the site to vehicles. Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

Towards the interior of the pond, woody shrubs and trees are absent, and a variety of low-lying grasses, annuals, and other herbaceous plants including cocklebur (*Xanthium* sp.), datura (*Datura* sp.), rush (*Juncus* sp.), and a number of unidentified forbs are prevalent, along with nonnative Bermuda grass (*Cynadon dactylon*), and the nonnative and invasive red brome (*Bromus rubens*). The outer perimeter of the pond is densely vegetated and exhibits high canopy cover. Species composition along the perimeter consists of brome grass in the understory, and a thicket of upland trees and shrubs including Emory oak (*Quercus emoryi*), shrub live oak (*Quercus turbinella*), catclaw mimosa (*Mimosa*

aculeaticarpa), and desert broom (*Baccharis sarothroides*) in the overstory. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. Notable observed changes in the vegetation community at the site over the course of the visits included a comparable change in the color and density of the grasses near the interior of the pond, from brown and patchy during the June visit to green and full during the September visit. The density of cocklebur at the site increased incrementally during each visit from March through September. No changes in vegetation species composition were observed at the site throughout the course of the site visits.

Observations of wildlife at the site were consistent with expected species composition for an ephemerally pooled water source in this region. Juvenile red spotted toads (*Bufo punctatus*), juvenile canyon tree frogs (*Hyla arenicolor*), and tadpoles were observed during the August visit (**Table 2c**).

An aquatic invertebrate sample was collected at this site during the August visit. Ephemeral water-associated fairy shrimp (Belk 1997) were observed (**Table 2c**).

In summary, although the site is not continuously saturated with surface water, the soil retains sufficient moisture to support rush, a wetland-associated species. The observations of tadpoles, juvenile frogs, and juvenile toads at the site during the only visit in which free surface water was present, but during no other visits, and the lack of detections of aquatic invertebrate species associated with persistent water presence, indicates that this site provides a water source and habitat to wildlife on an inconsistent basis.

Biological Observations from Rancho Rio Tinajas

Vegetation at the Rancho Rio Tinajas site is characteristic of the Interior Chaparral biotic community, along with elements of Madrean Evergreen Woodland (Brown 1994). The drainage bottom contains riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians, reptiles, and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

The drainage bottom exhibits lower plant density and lower canopy cover than the opposing hillsides (likely due to the predominantly bare bedrock substrate, and scouring of vegetation and soil substrate within the drainage during flow events). However, riparian and wetland-associated species do occur within the drainage. These species

include Goodding's willow (*Salix gooddingii*), New Mexico locust (*Robinia neomexicana*), deergress (*Muhlenbergia rigens*), rush, and yellow monkeyflower (*Mimulus guttatas*). The opposing hillsides above the drainage (the north-facing hillside in particular), are more heavily vegetated and exhibit higher canopy cover. Vegetation in these areas consists primarily of upland trees and shrubs, including one-seed juniper (*Juniperus monosperma*), pinyon pine (*Pinus* sp.), shrub live oak, and catclaw mimosa (*Mimosa arculeaticarpa*). Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. Notable observations recorded over the course of the visits included a Goodding's willow at the lower tinaja that exhibited a noticeable decline in health; it displayed healthy green leaves during visits in April and June, and brown leaves and a substantial amount of dieback during visits in August and September. Greater amounts of floating algae were observed in the tinajas during visits in March and April than during the visits in June, August, and September. Species composition at the site remained consistent throughout the course of the site visits.

Observations of wildlife at the site were consistent with expected species composition for a persistently pooled water source in this region. The following vertebrate species were observed over the course of the site visits: Sonora mud turtle (*Kinosternon sonoriense*), ornate tree lizard (*Urosaurus ornatus*), canyon tree frog, and red spotted toad. Tadpoles were observed at the site during visits in March, June, August, and September (**Table 2d**).

Aquatic invertebrate samples were collected from this site during the April, June, August, and September visits. *T. marmoratus*, a species associated with persistent water presence (McWilliams 1968, Bogan et al. 2013), was present during every sample period. *G. plicifer*, another species associated with persistent water presence, was collected during visits in April and June (**Table 2d**).

In summary, this site provides adequate moisture to support riparian and wetland-associated vegetation including the wetland obligate yellow monkeyflower (Lichvar 2016). Observations of amphibians in life cycle phases ranging from larval to adult, repeated observations of Sonora mud turtle, and the temporally repeated presence of multiple aquatic invertebrate species associated with persistent water presence detected in these tinajas suggest that this site provides a reliable water source and persistent aquatic habitat to a range of species.

5.2 Number 9 Wash Sub-Basin

The Number 9 wash watershed drains the majority of the projected mine collapse zone into Queen Creek Canyon (**Figure 1**). Features occurring in the main Number 9 wash channel include: The FS 2438 Check Dam, the Above Grotto and Grotto monitoring sites, KP Reservoir, and Number 9 Wash Tinajas. Monitoring sites that occur in tributaries and drainages of the Number 9 wash drainage sub-basin include: SS-1, Oak Flat Tinaja, and Anxiety Fault Pond.

Monitoring frequency of these locations varied based on season and occurrence of rain events, ranging from weekly to monthly. Water chemistry parameters, biology, and site characteristics were documented during each visit. Photographs taken of each site during the monitoring program are provided in **Appendix A**.

5.2.1 FS 2438 Check Dam

The FS 2438 Check Dam is located off of Forest Service Road #2438, in the main channel of Number 9 wash (**Figure 1**). In this area, the watershed is broad and relatively flat. The stream banks are populated by larger trees including willows, oaks, and sycamores. The check dam was built by the CCC to reduce floods and erosion from the Oak Flat Campground area. The check dam is constructed of Tal boulders stacked two to three layers high. The dam is approximately 2.5 feet tall and 15 feet wide across the full width of Number 9 wash channel. A thin, flat alluvial veneer has been deposited on the upstream side of the dam (**Figure 6**). The thickness of alluvium above the dam has filled in approximately 2 feet, leaving approximately 6 inches of freeboard.

A trail camera was installed below the dam, facing upstream. The view of the camera captures the embayment above the dam as well as the channel approximately 10 feet below the dam **(Photo 4)**.

Photo 4. FS 2438 Check Dam observed dry, April 17, 2017

Hydrologic Observations

Rainfall data from the DHRES-07 weather station and hourly daytime photos from the trail camera documenting retention of surface water above the dam and seepage directly below the dam are shown on the time series video given in **Attachment 2**.

During the March 23 installation visit to Oak Flat, no flowing or pooled water, or moist soil was observed (**Tables 3a**). The alluvial veneer above the dam was dry and the vegetation was healthy and green. From March through mid-July, the site remained dry and surrounding foliage further dried out.

The first significant monsoon rain occurred on July 16 (15:30) and reintroduced moisture to the alluvium. The resulting pooled water and surface water flow from the rain event was dry by mid-day July 17. Rainstorms occurred over the next few days, resulting in pooled water that remained for only a few hours. A significant rainstorm on July 24 resulted in sustained flowing water and pooling above and below the dam. Rain events continued until August 1, contributing flow to the local system. Water remained pooled above the dam and directly below the dam until August 8. From August 8 through September 21 the feature remained dry.

Biological Observations

Vegetation at the FS 2438 Check Dam site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with patches of herbaceous species that occur on the flat alluvial veneer above the dam. Wildlife species observed at the site include larval

amphibians and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

At the dam, small patches of moss are present, and lip fern (*Cheilanthes* sp.) grows in some of the crevices between the boulders. The flat area above the dam is sparsely vegetated with low-lying forbs in the interior, and patches of moss grow in shaded areas along the perimeter. Overstory vegetation along the perimeter consists primarily of upland trees and shrubs, including Emory oak, shrub live oak, and pointleaf manzanita (*Arctostaphylos pungens*). No wetland or riparian-associated herbaceous or woody plants were observed at the site over the course of the visits. During a visit in which surface water was present, algae was observed in a small pool of water at the base of the dam. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season, and expected decreases due to pre-monsoon dieback; the density of forbs above the dam was highest during the April visit and lowest during the June visit. Generally speaking, the patches of moss at the dam exhibited a bright green color during the August visit and a duller brown color during the June visit. Apart from the observation of algae during the August visit, species composition at the site remained consistent throughout the course of the site visits.

Observations of wildlife at the site were consistent with expected species composition for an ephemerally pooled water source in this region. Tadpoles were observed in pools above and below the dam during the August visit (**Table 3b**).

An aquatic invertebrate sample was collected during the August visit. A giant water bug (*Belostoma flumineum)* specimen was collected at the site during this visit (**Table 3b**). In contrast to the related *Abedus herberti*, it is capable of flight-based dispersal and occurs in both ephemeral features as well as features with more persistent water presence (Bogan et al. 2013).

In summary, based on our observations, this site does not support riparian or wetland-associated vegetation (**Table 3b**). The coincidence of observations of tadpoles and aquatic invertebrates during the only visit in which surface water was present, but during no other visits, indicate that this site is utilized by wildlife, but it does not provide wildlife with a consistent, long term source of water.

5.2.2 Grotto/Above Grotto

The "Grotto" feature is in Number 9 wash approximately 0.6 miles upstream from the culvert under Magma Mine Road (**Figure 1**). In contrast to FS 2438, which is in a broad,

flat section of the watershed, the Grotto is located where Number 9 wash begins its drop into the steeper terrain and canyons incising the Apache Leap escarpment. The Grotto is approximately 120 horizontal feet downstream from where Number 9 wash first begins its steeper decent. Over this distance the channel drops approximately 30 feet in elevation. This sloped stretch is comprised of sandy, gravelly alluvium and boulder colluvium. The Grotto is a cave-like feature created beneath a stack of several large colluvial boulders. Water is retained in the pockets of alluvium above the Grotto during rainy periods and provides a source of water into the Grotto (**Figure 7**).

The eastern bedrock face of the Grotto is the discharge location of the seepage through the upstream alluvium (**Photo 5**). This natural alcove seepage is known as the "Grotto" spring. The total area percentage of moisture coverage on the wall face has been monitored and directly correlates with the availability of water retained above the Grotto.

Photo 5. Grotto Wall with estimated 25% moisture coverage, August 24, 2017

A transducer was installed in one of the alluvial pools directly above the Grotto seep to monitor the collection, retainment, and infiltration of runoff from the natural dam of accumulated colluvium (**Photo 6**).

Photo 6. "Above Grotto" monitoring location. Transducer is hung on braided steel cable between pinch point of two boulders and on top of sandy bottom

Hydrologic Observations

On March 22, water level in the alluvial pool above the Grotto was 17 inches deep, while observed saturated coverage of the Grotto wall was 95%. Water level decreased in the pool from 17 inches to zero (dry) by April 15. The pool remained dry from mid-April through mid-July. Observations from the Grotto show that as the pooling water in the alluvium began to dry, saturated wall coverage decreased correspondingly (**Figure 8)**. The wall surface was first observed as completely dry on May 10, and remained dry through mid-July.

The summer monsoon rains began on July 16, resulting in water level increasing from zero to 3.6 feet of hydraulic head in the alluvial pool from 17:30 to 18:00. Seepage through the alluvium resulted in flow in the Grotto and coverage to the wall face. Approximately 95% of the wall was wet on July 27 and August 4, along with dripping seepage from the Grotto roof (**Tables 4a and 4b**).

Following the cessation of the consistent monsoon rainstorms by August 1, the water level in the pools in the upstream boulder alluvium started to subside through September. Correspondingly, saturation of the Grotto wall became dry on September 5.

A final rain event on September 8 and 9 increased the water level in the pool from 3 inches to 2.5 feet. During a site visit on September 14, moisture on the Grotto wall had increased from dry to 80% coverage. By September 21, the water level in the above pool

was approximately one foot deep and the Grotto wall was no longer wet and only damp patches remained on approximately 10% of the wall.

Biological Observations

Vegetation at the Grotto and Above Grotto site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with small patches of riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region, and a roosting colony of big brown bats (*Eptesicus fuscus*), a species that is widely distributed across the United States (AZGFD 2004). No special-status species were observed during the site visits.

The grotto is devoid of vegetation apart from algae, which is present on a rock wall on the upstream side, and a patch of moss that grows at the interface of this rock wall and the sandy sediment below. At the ponding area above the grotto, small amounts of rush, and lip fern occur in pockets of sediment at the base of large boulders, along with nonnative Bermuda grass. The drainage in which the site is situated is sparsely vegetated; an open canopy consisting of upland species such as Emory oak, shrub live oak, and pointleaf manzanita exists along the perimeter. No obvious changes in vegetation density were observed throughout the course of the site visits. Generally speaking, the moss at grotto exhibited a brighter green color during the April and June visits and a duller green color during the August and September visits. Species composition at the site remained consistent throughout the course of the site visits.

Observations of amphibians at the site were consistent with expected species composition for an ephemerally pooled water source in this region. Tadpoles were observed at the site during the August visit. Juvenile red spotted toads were observed during the following visit in September. Additionally, a colony of big brown bats were observed roosting in a rock crevice at the grotto during the June and August visits. The bats were absent during the following visit in September (**Table 4c**).

Observations of aquatic invertebrates at the site were consistent with expected species composition for an ephemerally pooled water source in the region. Aquatic invertebrate samples were collected at the site during the April, August, and September visits. Species diversity was generally low. A single *Laccophilus* specimen was present in sample collected in August. Unfortunately, the individual was teneral (i.e., soft and not fully colored because of incomplete sclerotization) and thus could not be keyed to species (**Table 4c**).

In summary, although the site is not continuously saturated, it exhibits sufficient shade and moisture to support small patches of rush, a wetland-associated plant. Observations of tadpoles during the August visit and juvenile red spotted toads during the September visit indicate that enough water persists at the site for amphibians to complete at least part of their life cycle, from larval phase to juvenile phase. Additionally, the site provides suitable microclimatic conditions for bats to utilize as a day roost.

5.2.3 KP Reservoir

Located roughly 900 feet downstream from the Grotto is a large masonry dam (**Figure 1**). The constructed masonry dam is approximately 6 feet tall and 50 feet wide across the whole width of Number 9 wash (**Figure 6**). Alluvium has accumulated up to the height of the dam with little to no freeboard.

Water is retained in the alluvial sediments behind the dam and seeps through the cemented wall (**Photo 7**). During high flow events, water also flows over the dam. A transducer was placed in a pool at the base of the dam on the downstream side. The pool dries out during the arid summer months, and may have over 1 foot of ponding during wet periods.

Photo 7. Water seeping through KP Dam. Transducer is set in pool below dam

Hydrologic Observations

Water was pooled below KP dam during the March 22 visit to install the instrumentation (**Table 5a**). The transducer was installed in one of the deeper pools, under roughly 5 inches of water. Transducer data indicates that the pool became dry on April 3rd and

remained dry until mid-July. Summer monsoon rainstorms started on July 16, resulting in surface flow through the Number 9 wash, filling the alluvium, resuming seepage through the dam, and refilling the pools below the dam. Depth the pool increased to approximately 1.75 feet deep from 17:30 til 18:30, as a result of the runoff.

Steady monsoon rain events continued from July 16 through August 1, keeping the water level in the pool full to 1.2 feet on average. However during heavy runoff events water levels can be elevated to 1.7 to 2.6 feet, possibly due to flood waters pouring over the dam.

The water level in the pool decreased from 1.1 feet to zero (dry) from August 7 through August 19, and remained dry through the end of monitoring, on September 21 (**Figure 9**). In contrast to observations from the Grotto, no water level response was observed at KP Reservoir from the September 8 and 9 rainstorms.

Biological Observations

Vegetation at the KP Reservoir site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

Towards the interior of the reservoir, woody trees and shrubs are absent, and various grasses including deergrass and plains lovegrass (*Eragrostis intermedia*) occur in high densities, along with nonnative Bermuda grass, and nonnative and invasive red brome. Large Goodding's willow and Emory oak trees line the outer perimeter of the reservoir, creating a patchy overstory canopy. Along the face of the dam, patches of moss persist in cracks and crevices. Immediately below the dam, the substrate consists of a mixture of boulders and fine to course alluvial sediment. Within the drainage bottom below the dam, a variety of riparian and wetland-associated species are present, including deergrass and rush. Upland species, including Emory oak, shrub live oak, and pointleaf manzanita line the perimeter of the drainage and provide moderate canopy cover. Approximately 20 meters (m) below the dam, the substrate consists of shallow pockets of fine and course alluvial sediment overlain on bedrock. This area is sparsely vegetated apart from a lone, small, Goodding's willow tree and small patches of unidentified forbs and nonnative Bermuda grass. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. Above the dam, towards the interior of

the reservoir, the grasses exhibited a bright green color during the March visit, and a dull brown color during the June visit. The patches of moss along the face of the dam showed a similar trend, exhibiting bright green colors in March and April, and much duller shades of green in June. During visits when surface water was present, algae was common in the pools at the base of the dam and along the drainage below the dam. During a visit in which no surface water was present, the amount of algae observed at the site was much lower. Apart from observed changes in the presence of algae, vegetation density downstream from the dam remained consistent throughout the course of the site visits. No changes in vegetation species composition were observed at the site throughout the course of the site visits.

Observations of amphibians at the site were consistent with expected species composition for an intermittently pooled water source in this region. Tadpoles were observed at the pooled water feature approximately 20 m) downstream of the dam during the August and September visits. Juvenile red spotted toads were observed at the base of the dam and at the pooled water feature approximately 20 m downstream of the dam during the September visit (**Table 5b**).

A variety of native aquatic invertebrate species were observed at the site, some of which are associated with persistent water presence. Aquatic invertebrate samples were collected at this site during visits in April, August, and September. Specimens were collected between the base of the dam and the pooled water feature approximately 20 m downstream of the dam during these visits; no samples were collected above the dam. On the three dates in which samples were collected, diving beetles associated with persistent water presence were observed (**Table 5b**). In April, both the persistent water-associated *Ilybiosoma lugens* and *Sanfilippodytes* sp. were present. *I. lugens* occurs in small streams and springs with mineral substrates. In the Southwest, the species is associated primarily with continuously flowing streams but can also be found in isolated pools of spatially intermittent streams and is known to disperse by flight (Larson 1997). Members of the genus *Sanfilippodytes* are small (i.e., 2.1 to 4.2 mm) and many specimens can be collected from interstitial spaces of aquatic environments (Larson et al. 2000, p. 204). *Thermonectus marmoratus* was present at this site during the August and September visits. *T. marmoratus* is typically associated with persistent pools in spatially intermittent streams and is capable of flight-based dispersal (McWilliams 1968, Bogan et al. 2013).

In summary, although the site is not continuously saturated, it exhibits adequate moisture to support numerous species of riparian and wetland-associated vegetation. Observations of tadpoles at the site during the August visit and juvenile red spotted toads during the

September visit indicate that a sufficient amount of surface water persists at the site for amphibians to complete at least part of their life cycle, from larval phase to juvenile phase. Temporally repeated samples containing multiple aquatic invertebrate species associated with persistent water presence, along with the observation of surface water presence during all but the June visit, suggest that the site provides a reliable source of water and habitat to wildlife, albeit not on a permanent basis. It is unclear if the aquatic invertebrate species present at the site are able to withstand periodic dry periods and remain at the site, or if they are forced to disperse to more permanent water features in the vicinity during dry periods to avoid desiccation.

5.2.4 Number 9 Wash Tinajas

The Number 9 Wash Tinajas are located 50-100 feet upstream from the confluence of Number 9 Wash and Queen Creek (**Figure 1**). The feature contains a series of three pools carved into the Tal bedrock, before dropping into the alluvial channel of Queen Creek Canyon (**Photo 8**). No continuous monitoring instrumentation was installed at this location.

Photo 8. Number 9 Wash Tinajas, looking downstream, August 3, 2017

Hydrologic Observations

During the late March 23 installation visit, the channel was flowing and all three tinajas (upper, middle, and lower) were connected with continuous surface water runoff of an estimated 1-2 gpm. Surface flow had stopped by the April 17 visit and remained absent

into mid-July. The storage within the tinajas decreased over the arid, summer months, drying up the three tinajas from late June through mid-July. Evapoconcentration of the pooled water in the tinajas resulted in increasing EC from ~100 µS/cm to 205 µS/cm, as temperatures steadily rose from spring into summer. Monsoon rains arrived on July 16, bringing surface runoff through the wash, refilling the tinajas. Summer rain events ended by August 1 and surface flow stopped by August 24. Hot, dry conditions during August and September again resulted in concentration of the pooled water, increasing measured EC from 100 µS/cm to higher than 200 µS/cm. By September 21, only water remained in the upper and lower pools, with approximately 400 total gallons of remaining storage (**Table 6a**).

Biological Observations

Vegetation at the Number 9 Wash Tinajas site is characteristic of the Interior Chaparral biotic community (Brown 1994). The drainage bottom contains native and nonnative riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

The drainage bottom exhibits lower plant density and lower canopy cover than the opposing hillsides (likely due to the predominantly bare bedrock substrate, and scouring of vegetation and soil substrate within the drainage during flow events). However, riparian and wetland-associated species do occur within the drainage. These species include Goodding's willow, deergress, and rush, as well as nonnative and invasive tamarisk (*Tamarix* sp. [USFS 2017]). The opposing hillsides above the drainage are more heavily vegetated and exhibit higher canopy cover. Vegetation in these areas consists primarily of upland species, including Emory oak and shrub live oak. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. A Goodding's willow at the upper tinaja exhibited notable dieback during the June visit, and prominent regrowth during the September visit. During the June visit, when the site was completely dry, forbs were noted to have colonized sandy areas that had been submerged in water and devoid of vegetation during previous visits. Species composition at the site remained consistent throughout the course of the site visits.

Observations of amphibians at the site were consistent with expected species composition for intermittently pooled water sources in this region. Tadpoles were observed at the site

during the March, April, and August visits. Juvenile red spotted toads were observed during the September visit (**Table 6b**).

A variety of native aquatic invertebrate species were observed at the site, some of which are associated with persistent water presence. Aquatic invertebrate samples were collected from this site during the April, August, and September visits. Persistent water-associated *I. lugens* (Larson 1997) was present in April and *T. marmoratus*, another species associated with persistent water presence (McWilliams 1968, Bogan et al. 2013), was present during August and September site visits. One species typically associated with ephemeral aquatic environments, *Laccophilus vacaensis* (Zimmerman 1970), was present in the August sample (see **Table 6b**).

In summary, although the site is not continuously saturated, it exhibits adequate moisture to support low densities of riparian and wetland-associated vegetation. Observations of tadpoles at the site during three visits, and the presence of juvenile red spotted toads during the September visit indicate that a sufficient amount of surface water persists at the site for amphibians to complete at least part of their life cycle, from larval phase to juvenile phase. Temporally repeated detections of aquatic invertebrate species associated with persistent water presence, along with the observation of surface water presence during all but the June visit, suggest that the site provides a reliable source of water and habitat to wildlife, albeit not on a permanent basis. It is unclear if the aquatic invertebrate species present at the site are able to withstand periodic dry periods and remain at the site, or if they are forced to disperse to more permanent water features in the vicinity during dry periods to avoid desiccation.

5.2.5 Sample Site 1 (SS-1)

SS-1 consists of three tinajas (upper, middle, and lower) within an unnamed drainage located approximately 150 feet west of Magma Mine Road (**Figure 1**). The substrate consists primarily of bedrock, with large boulders and shallow pockets of sand and gravel occurring in the drainage bottom. These tinajas stored surface water continuously throughout the arid summer months. The watershed above SS-1 drains 0.13 square miles of jointed and fractured Apache Leap Tuff (Tal) bedrock and extends west to the top of the prominent Apache Leap escarpment. Water is retained within the fill material of joints and fractures, and discharge over time into the drainage (**Figure 10**).

The site has been equipped with a south facing (upstream) trail camera to record flow events through the channel (**Photo 9**). The photos from June 5 through July 14, were lost because the camera malfunctioned due to excessive heat. The camera was replaced and

functioned properly for the rest of the monitoring period. A time-series video of hourly daytime photographs and rain gauge data from the DHRES-07 weather station is given in **Attachment 3**.

Photo 9. SS-1 tinajas, from trail camera location, September 21, 2017

Hydrologic Observations

During the March 23 installation visit, the channel at SS-1 was flowing and all tinajas were connected by surface water runoff. Surface flow stopped at the end of March and remained absent into mid-July. The storage within the tinajas decreased over the arid, summer months, from late June through mid-July, as some tinajas became completely dry. Evapoconcentration of the pooled water in the tinajas resulted in increasing EC, as temperatures steadily rose from March through mid-July.

Monsoon rainstorms began on July 16. Over the next 2 weeks, the video shows a series of precipitation events resulting in flash flooding through the channel and refilling the tinajas. The EC measurements in the tinajas following rain events ranged from approximately 60 to 80 µS/cm (**Table 7a**). Summer rain events ended by August 1 and surface flow stopped by August 16 (10:00). Hot, dry conditions during August and September again resulted in concentration of the pooled water and increased EC. All three tinajas contained water at the time of the final visit on September 21.

Biological Observations

Vegetation at the SS-1 site is characteristic of the Interior Chaparral biotic community (Brown 1994). The drainage bottom contains small patches of riparian and wetland-

associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians, reptiles, and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

The drainage bottom is sparsely vegetated and exhibits low canopy cover, but rush, a wetland-associated species, is present, along with upland species including desert broom, bullgrass (*Muhlenbergia emerslyi*), catclaw mimosa, and brickellbush (*Brickellia* sp.). The opposing hillsides above the drainage are also sparsely vegetated, though larger Emory oak and one-seed juniper trees do occur, and offer a higher level of canopy cover. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. Species composition at the site remained consistent throughout the course of the site visits.

A variety of native upland and aquatic-associated wildlife were observed at the site. The species observed over the course of the site visits include Clark's spiny lizard (*Sceloporus clarkii*), ornate tree lizard, adult and juvenile canyon tree frogs, juvenile red spotted toad, and tadpoles (**Table 7b**).

A diverse range of native aquatic invertebrate species were observed at the site, some of which are associated with persistent water presence. An aquatic invertebrate sample was collected from this site during each visit. Species associated with persistent water presence were present during the April, June and September collection periods, and included *A. herberti* (Boersma and Lytle 2014), *L. horni* (Zimmerman 1970), *Sanfilippodytes* sp. (Larson et al. 2000, p. 204) and *T. marmoratus* (McWilliams 1968, Bogan et al. 2013) (**Table 7b**).

In summary, the site exhibits sufficient moisture to support rush, a wetland-associated plant. Observations of amphibians in life cycle phases ranging from larval to adult, and the temporally repeated presence of multiple aquatic invertebrate species associated with persistent water presence suggest that the site provides a reliable water source and persistent aquatic habitat to a range of species. The detection of *A. herberti* in particular suggests that the site exhibits persistent aquatic habitat, as *A. herberti* is flightless and dependent upon aquatic environments at all life stages (Boersma and Lytle 2014).

5.2.6 Oak Flat Tinaja

Oak Flat Tinaja is a large bedrock pool located in the first major drainage east of the RC East Plant site (**Figure 1**). This drainage is a tributary of the Number 9 wash drainage basin. The tinaja is located in the unnamed drainage approximately 620 feet northwest from RC exploration core hole RES-006, and 120 vertical feet down from the access road. The canyon is steep and is shaded from the exposure of the sun most of the day (**Photo 10**).

A pressure transducer was installed up at the bottom of the deepest part of the tinaja and is secured to a large boulder wedged in the channel on the upstream end of the tinaja. In addition, a trail camera was installed on the eastern wall of the canyon, facing upstream. The placement of the camera was intended to monitor water levels in the pool. The trail camera is set up to record hourly photographs. At this location, the camera is also set up to capture motion activated photos for wildlife purposes. Water parameters and site characteristics were only documented during M&A and WestLand scheduled visits due to the difficulty accessing this location.

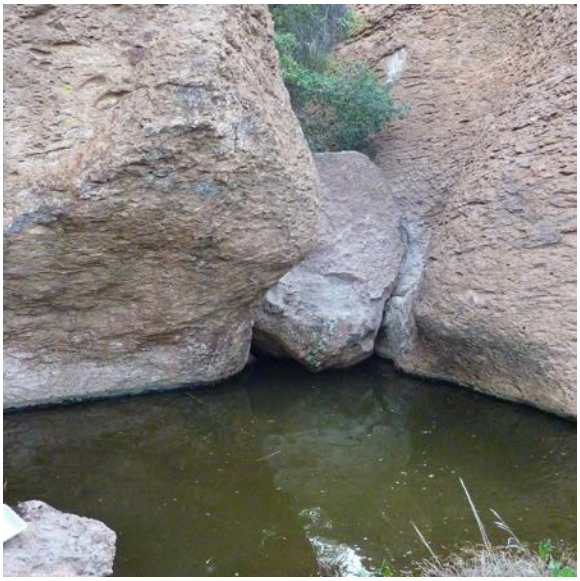

Photo 10. Oak Flat Tinaja, March 23, 2017

Hydrologic Observations

Rainfall data from the DHRES-07 weather station, along with water level in the tinaja, and hourly photos from the trail camera are shown on the time series video given in **Attachment 4**.

During the March 22 installation visit, the tinaja was filled to the high water mark on the surrounding bedrock (**Table 8a**). The water level in the tinaja was approximately 4 feet and estimated flow into the tinaja was estimated at 1 gpm. From March 22 into mid-July the water level in the tinaja dropped to a minimum depth of approximately 2 inches, at an average rate of 1.3 ft per month due to evaporation (**Figure 11**). The site is hidden from sun exposure for most of the day, so the rate of evaporation is slower than other exposed sites. Over the same duration, EC increased from 137 µS/cm to 275 µS/cm as the stored water evapoconcentrated.

From June 8 through July 16, the transducer data shifts multiple times. The shift in the data indicates that the transducer had physically moved at approximately 01:00 on June 8. The transducer was placed back in the bottom of the tinaja on June 23. The transducer data shifted again on June 25, at approximately 20:00. These shifts are assumed be caused by wildlife; this theory is supported by bite marks on the transducer shell.

The first large monsoon rain event arrived on July 16, filling the tinaja up to approximately 5 feet deep before draining down to the prominent water line observed at approximately 4.2 feet. The water line appears to indicate the pool depth during times of steady inflow and outflow. During high runoff events, water levels rise briefly above the water line. During no inflow periods, evaporation causes the water level to drop beneath the water line. Steady rainstorms occurred from July 16 through August 1, providing consistent flow into the tinaja, keeping the water level moderately constant. Water level into the tinaja remained at approximately 4.1 feet until August 18, which would indicate that steady flow into the pool continued till this date. From August 18 through September 22, water level in the tinaja dropped from 4.1 feet to 2.5 feet. From the beginning of August through September 22, EC increased from 158 µS/cm to 217 µS/cm.

Biological Observations

Vegetation at the Oak Flat Tinaja site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with various native and nonnative herbaceous species. Wildlife species observed at the site include amphibians and aquatic invertebrates as well as a variety of reptiles, mammals and birds native to the region.

The upstream portion of the site is surrounded by tall, barren bedrock, and is shaded throughout much of the day. This portion of the site is typically inundated in water and is devoid of vegetation (**Photo 10**). The downstream portion of the site has less water availability, but contains more soil substrate and is exposed to more sunlight than the upstream portion, and is more densely vegetated. Perimeter vegetation at the downstream

portion of the site consists of Emory oak and shrub live oak in the overstory and a variety of herbaceous species, namely, bullgrass, deergrass, and dropseed (*Sporobolus* sp.), as well as nonnative Bermuda grass and curly dock (*Rumex crispus*) in the understory. Canopy cover surrounding the tinaja is low, but it abruptly increases further downstream within the drainage. A small of amount of algae was observed in the pooled water during each of the visits. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. Species composition at the site remained consistent throughout the course of the site visits.

Tadpoles were observed during the August site visit. Juvenile red spotted toads were observed during the following visit in September (**Table 8b**). Additionally, a wildlife camera deployed at this site has recorded numerous species of wildlife at or near the tinaja, including but not limited to, Clark's spiny lizard, American black bear (*Ursus americanus* [WestLand unpublished data]), raccoon (*Procyon lotor*), white-nosed coati (*Nasua narica*), hooded skunk (*Mephitis macroura*), and common black hawk (*Buteogallus anthracinus*) (WestLand 2014).

A diverse range of native aquatic invertebrate species were observed at the site, some of which are associated with persistent water presence. An aquatic invertebrate sample was collected during each site visit. *Deronectes corvinus*, *Gyrinus plicifer*, *Laccophilus horni*, and *T. marmoratus*, all species associated with persistent water presence (McWilliams 1968, Bogan et al. 2013), were present during each sample period. No primarily ephemeral water-associated species were observed during any of the sample periods (**Table 8b**).

In summary, the observations of surface water presence at the site during all visits conducted in 2017, temporally repeated detections of multiple aquatic invertebrate species associated with persistent water presence, and observations of a diverse range of wildlife throughout several years of wildlife camera monitoring indicate that this site serves as a reliable water source and persistent aquatic habitat to a range of species. The lack of wetland-associated vegetation observed at this site could be explained by the barren bedrock substrate and the heavily-shaded setting of the portion of the site that exhibits persistent water presence.

5.2.7 Anxiety Fault Pond

Anxiety Fault Pond is an anthropogenic, earthen pond off of Magma Mine Road, approximately 1.5 miles from the Highway 60 turnoff (**Figure 1**). The pond is in a

naturally flat lying area, south of the Number 9 wash drainage (**Photo 11**). The source of water in the pond is runoff from rain events and seepage from the jointed and fractured Tal topography above the pond. The watershed contributing to the pond encompasses 0.6 square miles of area to the south and southwest towards the Tal escarpment. The retention of water is most likely due to the construction of Magma Mine Road over the natural drainage direction. Water flows under the road in a culvert when the pond fills up beyond its storage capacity.

Photo 11. View of Anxiety Fault Pond from Magma Mine Road, May 4, 2017

Hydrologic Observations

Dimensions of the pond were first measured on April 19, 2017. The pond was 336 feet long from north to south, and 228 feet wide from the east to west. Due to safety concerns of entering pond, depth measurements were not obtainable. The pooled area in the pond decreased from April through mid-July, prior to monsoon season. Dimensions of the pond on July 14 were 96 feet by 72 feet.

Monsoon rain events began on July 16 and continued through August 1. Dimensions of the pond increased to 522 by 240 feet on July 28, and water was entering the pond by a channel from the south at an estimated rate of 20 gpm. From August 1 through September 22, evaporation of the pooled water decreased water level in the pond. Dimensions were measured at 273 by 168 feet, and flow into the pond had stopped (**Table 9a)**.

Biological Observations

Vegetation at the Anxiety Fault Pond site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with native and nonnative herbaceous species, and riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region, and evidence of raccoon presence. No special-status species were observed during the site visits.

The interior regions of the ponding areas exhibit more consistent surface water presence than along the perimeter. These regions are devoid of woody trees and shrubs, and are densely vegetated with cocklebur and wetland-associated rush, as well as nonnative and invasive red brome. Spurge (*Euphorbia* sp.) also occurs in these interior regions, albeit less frequently. Along the perimeter of the ponding areas, an open canopy consisting of isolated patches of large Goodding's willow trees occurs, along with upland trees and shrubs including Emory oak, shrub live oak, and catclaw mimosa. In the understory, fleabane (*Erigeron* sp.) and nonnative, invasive red brome is prevalent. Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season, and expected decreases due to pre-monsoon dieback; as surface water within the ponding areas receded during the pre-monsoon dry period, rush and red brome near the perimeter of the ponds dried out and took on duller brown colors, and the interior regions exhibited an increase in the density of spurge. No changes in vegetation species composition were observed at the site throughout the course of the site visits.

Raccoon tracks were observed at the ponding area downstream of the unpaved road during the June visit. Tadpoles were observed in the ponding area upstream of the unpaved road during the August visit (**Table 9b**).

Aquatic invertebrate species observed at the site included ephemeral water-associated species as well as a species associated with more persistent water presence. Aquatic invertebrate samples were collected at this site during all visits between April and September. Ephemeral water-associated species including *Agabus disintegrates* (Larson et al. 2000), *Notonecta unifasciata* and *Notonecta indica* or *undulata* (Bogan et al. 2013) were observed in the April, June, and September samples. *Laccophilus maculosus shermani*, a species associated with persistent water presence (Zimmerman 1970) was present in the September sample. *L. m. shermani* is typically associated with persistent pools within intermittent streams, but other subspecies of *L. maculosus* have a broader

ecological tolerance and occur in nearly any type of non-marine aquatic habitat (Zimmerman 1970) (**Table 9b**).

In summary, the site provides adequate moisture to support riparian-associated vegetation including large Goodding's willow trees and large, dense patches of rush. Observations of raccoon tracks and tadpoles, the detection of an aquatic invertebrate species associated with persistent water presence, and the presence of surface water at the site during all visits conducted in 2017 indicate that this site serves as a reliable water source and habitat to a range of species. The presence of multiple ephemeral water-associated aquatic invertebrate species at this site could be explained by the location at which some of the aquatic invertebrate samples were collected; for safety reasons, samples were collected from the outer regions of the site rather than the deeper, interior portion of the main pond. Some specimens were collected from outer ponding areas that were observed to be disconnected from the larger, main pond of the site during some visits, and completely dry during other visits. These smaller, disconnected ponds thereby act as ephemeral sub-features of the overall, more consistently saturated site, and may have been colonized by species associated with ephemeral water at the time of sampling.

5.2.8 Oak Flat Wash Sub-Basin

Oak Flat wash begins north of Highway 60, west of Devils Canyon, encompassing most of the northern section of Oak Flat Campground. The monitoring sites within the sub-basin include: Oak Flat Reservoir, Gibson Well and Gibson Spring (**Figure 1**). Water chemistry parameters, biology, and site characteristics were documented during each visit. Photographs taken of each site during the monitoring program are provided in **Appendix A**.

5.2.9 Oak Flat Reservoir

The Oak Flat Reservoir monitoring site is located just south of Magma Mine Road, 0.5 miles from the entrance off on Highway 60. The reservoir is located in Oak Flat wash, approximately 900 feet from the confluence with Queen Creek. The reservoir is held back by a large masonry dam, approximately 150 feet long and 6 feet tall (**Figure 6**). A large basin of alluvium has accumulated on the upstream end of the dam, retaining water most of the year **(Photo 12)**.

Below the dam is a flat lying, marshland funneling flow to a culvert that passes under Magma Mine Road towards Queen Creek. A pressure transducer was installed below the galvanized steel casing of the culvert just upon entering the underpass, secured by a braided steel cable attached to a hole in the casing (**Photo 13**). The installed depth of the

transducer in the channel is approximately 7 inches below the culvert. Flow rates and water parameters were measured from the downstream end of the culvert (**Table 10a**). Flow rates and parameters were also monitored at a seep that emerges from the soil approximately 5 feet from the culvert (**Table 10b**).

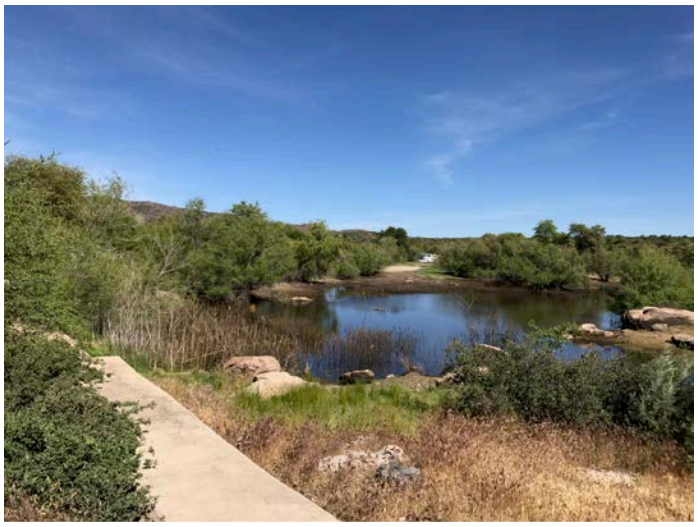

Photo 12. Oak Flat Reservoir, April 26, 2017

Photo 13. Oak Flat Reservoir Culvert, transducer location, April 26, 2017

Hydrologic Observations

During the March 23 installation visit, Oak Flat Reservoir was filled to approximately 3 feet below the top of the dam. Water level in the stream leading to the culvert remained

fairly constant from March 22 through May 5, with 9-10 inches of water. From May 5 through May 14, the seepage rapidly declined until no more flow was observed at the transducer location (**Figure 12**). Measured EC increased from 167 µS/cm to 200 µS/cm before drying up. The channel remained dry through mid-July.

The first monsoon rain event occurred on July 16 and an immediate response of 0.5 feet was recorded by the transducer at 18:00, and was back to dry within a few hours. Steady rain storms occurred from July 16 through August 1, providing consistent flow into Oak Flat wash. During substantial rain events, recorded water levels at the culvert were measured between 2 to 2.5 feet, but leveled off around 8-9 inches during the monsoon season. Water level in the channel declined slowly from August 6 through September 22 only dropping approximately 1 inch. Although water level remained moderately stable, EC increased from 127 µS/cm to 260 µS/cm over the same period.

Biological Observations

Vegetation at the Oak Flat Reservoir site is characteristic of the Interior Chaparral biotic community (Brown 1994), along with native and nonnative herbaceous species, and riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include native and nonnative amphibians, native aquatic invertebrates, and evidence of mammal presence. No special-status species were observed during the site visits.

Above the dam, along the perimeter of the upper ponding area, cocklebur, brome grasses (*Bromus* sp.), common sunflower (*Helianthus annuus*), and wetland-associated rush are prevalent in the understory. Isolated patches of large riparian-associated Goodding's willow and Fremont cottonwood (*Populus fremontii*) trees line the dam and the perimeter of this ponding area, creating an open canopy. Below the dam, Goodding's willow trees are also present, along with the nonnative and invasive tree of heaven (*Ailanthus altissima* [USFS 2017]). The understory is more densely vegetated; rush and common sunflower are abundant, along with nonnative curly dock. Below the culvert, canopy cover is higher, and the vegetation is composed primarily of upland trees and shrubs, including Emory oak, pointleaf manzanita, and netleaf hackberry (*Celtis reticulata*). Observations of changes in vegetation density throughout the course of the site visits were consistent with expected increases during the growing season and expected decreases due to pre-monsoon dieback. During visits where surface water was present, floating algal mats were observed on the ponded water upstream from the dam. During a visit in which no surface water was present, algae was absent from this area, and a variety herbaceous species from the surrounding area had colonized it. Downstream from the

culvert, vegetation density remained consistent throughout the course of the site visits. Apart from the observations of algae, no changes in vegetation species composition were observed at the site throughout the course of the site visits.

Observations of wildlife at the site were consistent with expected species composition for an ephemerally pooled water source in this region. Tadpoles and juvenile red spotted toads were observed above the dam during the course of the site visits, along with salamander larvae (likely the nonnative barred tiger salamander [*Ambystoma mavortium*]). Deer tracks, raccoon tracks, and deer and fox scat were observed above the dam over the course of the visits as well (**Table 10c**).

Aquatic invertebrate samples were collected at this site during all visits apart from the June visit, when no surface water was present. Specimens were only collected from the ponded water upstream from the dam. The samples showed temporally repeated detection of species associated with ephemeral water, including *Agabus disintegratus* (Larson 1997) and fairy shrimp (*Anostraca* sp.) (Belk 1997). No perennial water-associated species were observed during any of the sampling periods (**Table 10c**).

In summary, although the site is not continuously saturated, it appears to provide adequate moisture to support riparian and wetland-associated vegetation including large Goodding's willow trees and dense patches of rush. Observations of deer and raccoon tracks, and the presence tadpoles and juvenile red spotted toads indicate that this site serves as a water source and habitat to a range of species, albeit not on a permanent basis.

5.2.10 Gibson Well and Gibson Spring

The Gibson Homestead site contains two surface water monitoring features: the Gibson well and Gibson Spring. The Gibson Homestead is located at the confluence of Oak Flat wash and Queen Creek, approximately 900 feet downstream from the Oak Flat Reservoir (**Figure 1**). The homestead rests on top of an alluvial fan of sediment deposited along the main channel of the Oak Flat wash. The watershed in this area is broad and relatively flat before entering Queen Creek Canyon. The Tal bedrock is uplifted west of the homestead site, resulting in the deposition of sediment at this location. Gibson Spring is a result of subsurface alluvial groundwater being uplifted as the bedrock protrudes upward, forcing the water up to surface, seeping from the alluvium (**Photo 14**). Gibson Well is a hand dug well within the alluvium, approximately 7 feet to bottom.

A pressure transducer was installed at the bottom of Gibson Well to monitor the groundwater level within the local alluvium (**Photo 15**). No continuous monitoring equipment was installed at Gibson Spring.

Photo 14. Gibson Spring, March 21, 2017

Photo 15. Gibson Well, transducer location, March 21, 2017

Hydrologic Observations

During the March 22 installation visit, the water level in the well was measured at approximately 17 inches bls. The observed flow from the spring was estimated at 2-3 gpm. From March 22 through June 2, water level in the well dropped from 5.4 feet to dry, or an average of 0.5 feet per week. The spring was also observed as dry in on the June 5 visit. Over the same duration, EC only slightly increased from 133 µS/cm to 161 µS/cm in the well and from 133 µS/cm to 175 µS/cm (**Tables 11a and 11b**).

The first large monsoon rain event occurred on July 16, although change in the water level in the well observed. On July 24, significant rain events saturated the alluvium and water level in the well rose almost 6 feet. Consistent rain events continued until August 1, keeping the water level constant around 5.5 feet. During large runoff events, parameters from Gibson Spring were not measured because discharge from Oak Flat wash flowed into the spring discharge location.

From August through September 16, the measured water level in the well decreased from 5.5 feet of head to 0 (dry), or an average of 0.8 feet per week (**Figure 13**). Gibson Spring was first observed at dry on August 25 and remained dry through September 21.

Biological Observations

Vegetation at the Gibson Well and Gibson Spring site is characteristic of the Interior Chaparral biotic community (Brown 1994). The drainage bottom contains native and nonnative herbaceous vegetation, and riparian and wetland-associated species commonly observed at water features outside of the Oak Flat area (WestLand 2017). Wildlife species observed at the site include amphibians and aquatic invertebrates native to the region. No special-status species were observed during the site visits.

Vegetation along this stretch of Queen Creek includes New Mexico locust, deergrass, and bullgrass, as well as nonnative curly dock. Small patches of moss, and wetland-associated rush and yellow monkeyflower also occur, generally in shaded areas. Vegetation in the vicinity of the well and along the upland banks of this portion of Queen Creek consists largely of shrub live oak, pointleaf manzanita, Emory oak, and netleaf hackberry. No obvious changes in vegetation density were observed throughout the course of the site visits. Species composition at the site remained consistent throughout the course of the site visits.

Observations of amphibians at the site were consistent with expected species composition for ephemerally pooled water sources in this region. Tadpoles were observed at the site during the August visit (**Table 11c**).

Aquatic invertebrate samples were collected at the site during the April, August, and September visits. Two specimens of, *Ilybiosoma lugens*, a diving beetle associated with persistent water presence (Larson 1997), were collected at the site during the April visit (**Table 11c**).

In summary, the site is not continuously saturated year-round, as it was completely dry during the June visit, and it exhibited only a small amount of water presence in the form of damp soil at the bottom of the well during the September visit. However, the site exhibits adequate moisture to support the wetland obligate yellow monkeyflower (Lichvar et al. 2016), and *I. lugens*, an aquatic invertebrate species associated with persistent water presence. These data suggest that site provides a somewhat reliable source of water and habitat to wildlife, albeit not on a permanent basis. It is unclear if *I. lugens* is able to withstand periodic dry periods and remain at the site, or if it is forced to disperse to more permanent water features in the vicinity during dry periods to avoid desiccation.

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7 GLOSSARY

The following list is a glossary for selected hydrogeological terms used in this report.

General Hydrology

Aquifer: A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield usable quantities of water to wells or springs.

Confining Bed / Unit / Layer: A body of impermeable or distinctly less permeable material that lies stratigraphically adjacent to one or more aquifers; an aquitard.

Discharge: The release or extraction of water from an aquifer by natural means (evapotranspiration, flow to springs and surface water bodies), by gravity-driven flow to artificial drains, or by pumping of wells.

Evapotranspiration [ET]: The process by which water is discharged to the atmosphere as a result of evaporation from soil and ponded water surfaces and transpiration by plants. *See also: Phreatophyte*

Flood Plain: A flat geographic zone bordering a stream channel that is at times inundated with flood waters. A flood plain is typically underlain by alluvium deposited during floods. *See also: Alluvium*

Groundwater: Subsurface water that occurs under saturated or unsaturated conditions in soils and geologic formations. *See also: Aquifer*

Hydraulic Conductivity (Permeability) [K]: The rate of groundwater flow through a unit area in a unit of time under a unit hydraulic gradient perpendicular to the direction of flow. Expressed in units of length/time.

Infiltration: The downward movement of water from land surface into and through soil or porous rock. *See also: Seepage*

Phreatophyte: A plant that obtains much or most of its water supply from groundwater, either directly from the saturated zone or indirectly from the capillary fringe. *See also: Evapotranspiration*

Seepage: The slow movement of water through small cracks, pores, interstices, etc., of a material into or out of a body of surface or subsurface water. *See also: Infiltration*

Soil: The layer of mineral and organic material at and near land surface that serves as a natural medium for plant growth.

Water Table: The upper surface of the saturated zone at which the pore water pressure equals atmospheric pressure.

Geology Terms

Alluvial Veneer: A thin deposit of alluvium lain upon a gently sloping erosion surface or plain of low relief. *See also: Alluvium*

Alluvium: Clay, silt, sand, gravel, or other sediments that have been deposited by a stream or other body of flowing water in a streambed, on a flood plain, on a delta, or at the base of a mountain.

Bedrock: The consolidated, low-permeability rock formation(s) commonly underlying or forming the lateral boundaries of an aquifer.

Colluvium: A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. *See also: Alluvium*

Surface Water

Base Flow: The sustained minimum flow of a stream in the absence of direct runoff; the source of base flow is groundwater inflow to the channel. *See also:* Runoff

Confluence: The flowing together of two or more streams; the place where a tributary joins the main stream.

Ephemeral: Indicates that a feature flows only briefly during and following a period of rainfall in the immediate locality.

Runoff: The fraction of precipitation or snowmelt that appears in stream channels or surface water bodies. *See also: Base Flow*

Spring: A discrete location where groundwater flows naturally to land surface or into a surface water body from a geologic formation or soil.

Streamflow: The total discharge of water in a natural drainage channel.

Surface Water: Water that occurs above ground in an open body such as a stream, lake, river, or reservoir.

Tributary: A smaller river or stream that flows into a larger river or stream.

Water Feature: Natural (tinajas, faults, joints, topography) and manmade (dams, reservoirs, stock tanks) structures within streams and channels of a surface water system that capture and retain alluvium and/or water.

Watershed: The land area that drains water to a particular stream, river, or lake. A watershed is commonly delineated by tracing a line along the highest land elevations between adjoining drainage areas on a map.

Wetlands: Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Water Quality

Electrical Conductivity [EC]: A measure of the ability of a liquid to conduct an electrical current. *See also: Specific Electrical Conductance*

pH: A measure of the acidity or alkalinity of water or a solution on a scale from 0 to 14, where values of less than 7 are acidic, values greater than 7 are alkaline (basic), and a value of 7 is neutral.

Oxidation Reduction Potential [ORP]: A measurement that indicates the degree to which a substance is capable of oxidizing or reducing another substance.

Dissolved Oxygen [DO]: A measure of the amount of gaseous oxygen (O_2) dissolved in the water. The value of dissolved oxygen within a body of water is an important parameter in assessing water quality because of its influence on aquatic life.

TABLE 1. OAK FLAT MONITORING STATION LOCATIONS

Site ID	Sub-basin	AZSPC Coordinates[a]		Approximate Elevation (feet)	Site Description	Installed Equipment
		Easting (feet)	Northing (feet)			
Rancho Rio Pond	Rancho Rio	966775	832603	3914	Alluvial Stock Pond	Transducer
RR 1.5 C (Aqua TROLL)	Rancho Rio	967005	832381	3881	Bedrock Channel	Transducer
Rancho Rio Tinaja	Rancho Rio	967311	832276	3901	Tinajas	Game Camera
FS 2438 Check Dam	No. 9 Wash	966972	838994	3985	Check Dam	Game Camera
Above Grotto	No. 9 Wash	964495	838341	3948	Boulder Alluvium Pool	Transducer
Grotto	No. 9 Wash	964497	838333	3936	Seep/Spring	None
KP Reservoir	No. 9 Wash	963653	838371	3926	Seepage Beneath Masonry Dam	Transducer
No. 9 Wash Tinajas	No. 9 Wash	961045	840911	3761	Uppermost tinaja	None
Anxiety Fault Pond	No. 9 Wash	961809	836584	3986	Constructed Earthen Pond	None
SS-1	No. 9 Wash	960849	837439	4078	Tinajas	Game Camera
Oak Flat Tinaja	No. 9 Wash	960146	838613	4029	Tinaja	Transducer
Oak Flat Reservoir	Oak Flat Wash	963213	841089	3921	Seepage Beneath Masonry Dam	Transducer in culvert
Gibson Well	Oak Flat Wash	961823	841715	3842	Alluvial Well	Transducer
Gibson Spring	Oak Flat Wash	961828	841713	3842	Spring	None

[a] All coordinates are projected in NAD 1983 Arizona Central State Plane

TABLE 2a. FIELD OBSERVATIONS FROM RANCHO RIO POND MONITORING LOCATION

Site Description: Alluvial Stream Channel **Instrumentation**: Transducer

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	16:05	Damp	0	17.2	5.85	426.7	-19	---	Y	N	Buried transducer 44 inches below land surface on top of Tal bedrock. Alluvium was saturated ~1.5 feet below surface.
6/23/2017	8:05	Dry	0	---	---	---	---	---	N	N	Dry, no signs of water.
7/14/2017	8:55	Dry	0	---	---	---	---	---	Y	N	---
8/3/2017	11:20	Flowing	60-80	29.4	7.27	80.2	208	6.42	Y	Y	Pooled (32 yards x 23 yards), reddish brown water, lots of algae, tadpoles.
8/24/2017	13:00	Moist	0	---	---	---	---	---	Y	N	Soil was moist. Lots of healthy grass.
9/5/2017	10:10	Dry	0	---	---	---	---	---	Y	N	---
9/21/2017	11:45	Dry	0	---	---	---	---	---	Y	N	Dry, lots of toads, dry grass. Dug out transducer to download. Re-buried transducer at same depth.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute

[b] °C = Degrees Celsius

[c] pH = Potential of Hydrogen, unitless

[d] µS/cm = microsiemens per centimeter

[e] ORP (mV) = Oxidation Reduction Potential, in millivolts

[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter

--- = not applicable

* = edited after review of field data

TABLE 2b. FIELD OBSERVATIONS FROM RANCHO RIO TINAJAS MONITORING LOCATION

Site Description: Bedrock Tinajas in Rancho Rio Canyon **Instrumentation**: Camera

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
4/17/2017	13:24	Flowing	5	17.6	8.1	118.8	113.1	---	Y	N	Parameters were taken at middle pool (main)
4/26/2017	13:25	Flowing	4	19.3	7.94	131.7	118.5	---	Y	N	Parameters were taking at middle poo
5/5/2017	13:35	Flowing	6	22.8	7.74	144.1	145.8	---	Y	Y	Upper pool
5/5/2017	---	Flowing	8	20.5	8.46	143.6	126.6	---	Y	Y	Middle pool
5/10/2017	12:20	Flowing	5	18.9	7.84	143.5	119.2	11.7	Y	Y	Camera is operating properly
5/10/2017	---	Flowing	7	17.5	8.54	144.4	106.7	12.1	Y	Y	Partly cloudy
5/19/2017	10:45	Flowing	5	18.3	7.52	165.8	128.7	11.7	Y	Y	Upper pool
5/19/2017	10:57	Flowing	5	17.7	8.35	156.7	132.1	12.7	Y	Y	Middle pool
6/5/2017	11:30	Pooled	0	26.9	8.14	274.7	124.8	11.4	Y	N	Upper pool - No flow. Water in both pools has dropped approximately 2 - 2.5 feet. Camera is working properl
6/5/2017	11:40	Pooled	0	24.2	8.76	190.9	126.9	12	Y	N	Middle pool - No flow. Pool has green murky wate
6/23/2017	8:15	Pooled	0	23	9.11	221	132	6.56	Y	N	Main Tinaja - 5'9", depths, 15.3m x 6.5m, mud turtle, tadpole
7/14/2017	8:35	Dry	0	---	---	---	---	---	Y	N	Upper pool and up stream pools are completely dry. Surrounding plant life has died and dried ou
7/14/2017	8:40	Pooled	0	---	---	---	---	---	Y	N	Middle pool has dropped below sand bank. Water has a murky green color
7/27/2017	11:15	Flowing	---	27.9	7.52	106.4	48.6	---	Y	N	Upper pool - flash flood damage; tons of tadpols in all three pools
7/27/2017	11:40	Flowing	---	27.7	7.49	105.5	50.2	---	Y	N	Middle pool
8/3/2017	12:27	Flowing	80-100	28.1	7.41	79.8	211	6.61	Y	Y	Waterfall, pool (big pool, middle), yellow-red tint, no odor, some algae
8/24/2017	13:28	Flowing	15	27.2	8.75	153.4	57.2	6.83	Y	N	Middle pool
9/5/2017	10:35	Flowing	5	24.6	8.67	159.2	103.2	8.17	Y	N	Middle pool
9/14/2017	14:40	Pooled	0	25.7	8.99	173.7	62.7	5.98	Y	N	Upper pool
9/14/2017	---	Pooled	0	24.3	8.69	167.2	65.7	6.08	Y	N	Middle pool
9/21/2017	12:15	Pooled	0	21.7	9.07	153	62	---	Y	N	Upper pool - water is slightly cloudy, grass growing around edges, algae on rock surface
9/21/2017	12:18	Pooled	0	21.2	8.64	180.3	69	---	Y	N	Middle pool - clear, with green-brown tint, 9m x 14.3m, 2.2 m dee
9/21/2017	---	Pooled	0	21.4	8.99	180	76	---	Y	N	Lower pool - clear, sandy bottom

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Lite
--- = not applicable
* = edited after review of field data

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Table 2c Rancho Rio Pond

Feature ID	Metric	Date					
		3/22/2017	3/23/2017	4/19/2017	6/23/2017	8/3/2017	9/21/2017
Entire Site	Length (m)	0.0	0.0	0.0	0.0	29.3	0.0
	Width (m)	0.0	0.0	0.0	0.0	21.0	0.0
	Depth (m)	0.00	0.00	0.00	0.00	0.88	0.00
	Flowing/ Pooled/ Wet/ Damp/ Dry	Damp	Damp	Damp	Dry	Flowing	Dry
	Invertebrate Observations	NO	NO	Insufficient water	Insufficient water	*Anostraca, Laccophilus fasciatus terminalis*	Insufficient water
	Vertebrate Observations	NO	NO	NO	NO	juvenile red spotted toad, juvenile canyon tree frog, tadpoles	NO
	Vegetation Observations	NO	NO	NO	species composition appears to be the same as the previous visit, but density has increased as the middle of the pond has filled in with colonizing species	species composition appears to be similar to the previous visit. Grass along perimeter is much greener. Cocklebur is more robust.	vegetation within the pond is green and appears healthy. Cocklebur is particularly robust.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**

*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

Table 2d Rancho Rio Tinajas

Feature ID	Metric	Date						
		3/22/2017	3/23/2017	3/24/2017	4/19/2017	6/23/2017	8/3/2017	9/21/2017
Upper Tinaja	Length (m)	NM	NM	2.0	2.0	0.0	2.1	1.75
	Width (m)	NM	NM	5.2	7.4	0.0	7.2	5.0
	Depth (m)	NM	NM	0.65	0.70	0.00	0.80	ND
Middle Tinaja	Length (m)	14.5	NM	NM	13.6	15.3	13.9	14.3
	Width (m)	9.1	NM	NM	10.3	6.5	9.8	9.0
	Depth (m)	NM	NM	NM	NM	1.75	2.30	2.20
Lower Tinaja	Length (m)	NM	NM	15.0	17.2	5.7	16.4	8.9
	Width (m)	NM	NM	7.7	12.5	2.0	9.0	3.3
	Depth (m)	NM	NM	1.20	1.23	0.39	1.30	0.95
Entire Site	Flowing/ Pooled/ Wet/ Damp/ Dry	Flowing	Flowing	Flowing	Flowing	upper = dry, middle and lower =pooled	flowing	pooled
	Invertebrate Observations	NO	NO	NO	*Desmopachria mexicana, Gyrinus plicifer, Thermonectus marmoratus*	*Gyrinus plicifer, Notonecta lobata, Thermonectus marmoratus, Thermonectus nigrofasciatus*	*Buenoa arizonis, Notonecta lobata, Thermonectus marmoratus*	*Laccophilus pictus, Notonecta lobata, Ranatra quadridentata, Thermonectus marmoratus*
	Vertebrate Observations	Sonora mud turtle, canyon tree frog, anuran tadpole	NO	Ornate tree lizard active on rocks	Sonora mud turtles (n=2), Canyon tree frog (adult)	Sonora mud turtle, canyon tree frog tadpoles	tadpoles (red spotted toad or canyon tree frog)	several red spotted toad toadlets. Canyon tree frog tadpoles
	Vegetation Observations	NO	NO	Moss w/ spore samples collected	NO	species density, composition similar to previous visit; no obvious changes	species density, composition similar to previous visit; no obvious changes	vegetation is bright green for the most part. One Goodding's willow at the lower tinaja appears dead

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 3a. FIELD OBSERVATIONS FROM FS 2438 CHECK DAM MONITORING LOCATION

Site Description: Check Dam in Number 9 Wash East drainage **Instrumentation**: Trail Camera

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/23/2017	10:00	Dry	---	---	---	---	---	---	Y	N	Installation of trail camera.
4/17/2017	9:32	Dry	---	---	---	---	---	---	Y	N	Moss has dark green color and dry. Camera is working properly.
4/26/2017	11:50	Dry	---	---	---	---	---	---	Y	N	Camera is working properly.
5/4/2017	11:48	Dry	---	---	---	---	---	---	Y	N	---
5/10/2017	11:16	Dry	---	---	---	---	---	---	Y	Y	Camera is working properly.
5/19/20107	12:54	Dry	---	---	---	---	---	---	Y	N	Camera is working properly.
6/5/2017	14:35	Dry	---	---	---	---	---	---	Y	N	---
6/24/2017	8:26	Dry	---	---	---	---	---	---	Y	N	Very dry, no sign of recent water. Dry vegetation upstream from check dam.
7/11/2017	12:35	Damp	---	---	---	---	---	---	Y	N	Camera is working properly. Vegetation is green and alive. No observed effect from dry spell.
7/25/2017	11:09	Flowing	<1	9:36	3:36	19:12	7:12	20.8	Y	N	Above Dam - Photos taken of two main flows coming into upper pool.
7/25/2017	11:44	Flowing	<1	19:12	17:02	12:00	7:12	19.8	Y	N	Below Dam - Vegetation is alive, no sign of dead vegetation, moss has brightened in color and is collecting a lot of moisture.
8/4/2017	13:10	Pooled	0	19:12	7:40	12:00	0:00	6.65	Y	N	Above Dam - Water pooled, hundreds of tadpoles. No visible flow through dam.
8/24/2017	11:12	Dry	---	---	---	---	---	---	Y	N	Surrounding trees and moss look healthy. Camera is working properly.
9/5/2017	14:26	Dry	---	---	---	---	---	---	Y	N	Camera is working properly.
9/14/2017	12:00	Dry	---	---	---	---	---	---	Y	N	Camera is working properly. Moss has dark green color with shades of light green. Surrounding trees are starting to change color due to weather change.
9/21/2017	15:30	Dry	---	---	---	---	---	---	Y	N	Ground above and below dam is completely dry. Little green moss above dam in shaded area.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

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Table 3b Check dam at FS Road 2438

Feature ID	Metric	Date				
		3/23/2017	4/18/2017	6/24/2017	8/4/2017	9/21/2017
Entire Site	Flowing/ Pooled/ Wet/ Damp/ Dry	damp	dry	dry	pooled	dry
	Length (m)	0.0	0.0	0.0	18.1 (above dam)	0.0
	Width (m)	0.0	0.0	0.0	9.2 (above dam)	0.0
	Depth (m)	0.00	0.00	0.00	0.16 (above dam)	0.00
	Invertebrate Observations	NO	insufficient water	insufficient water	*Belostoma flumineum*	insufficient water
	Vertebrate Observations	NO	NO	NO	tadpoles	NO
	Vegetation Observations	NO	NO	vegetation community appears similar to the time of the previous visit. Moss patches have dried up. Some remain bright green, some have taken on a duller, darker brown color.	perimeter vegetation is similar to previous visit. Ferns at the dam have taken on a brighter color. Bright green algae in some areas, as well as a tawny muck on the surface.	vegetation in reservoir above dam is dull, dried out, and possibly dead. Some moss patches at and above dam are green, but appear to be duller than during previous visit.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**

*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 4a. FIELD OBSERVATIONS FROM THE ABOVE GROTTO MONITORING LOCATION

Site Description: Boulder alluvium above Grotto Cave **Instrumentation**: Transducer

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Water Level at transducer location (inches)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
					Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	11:05	Pooled	17	0	12.2	6.06	74.86	-14	---	Y	N	Set up transducer in middle sandy alluvial pool, 17" deep.
4/17/2017	11:05	Pooled	7.5	0	11.1	6.78	88.5	108.3	---	Y	N	Dark, murky water, no oder, shaded.
4/26/2017	10:54	Pooled	3	0	12.3	7.2	0.8	99.6	---	Y	N	Water has dropped since last visit 04/19. Clear/brown color, surrounding area around pool is damp.
5/5/2017	12:22	Damp	0	0	---	---	---	---	---	Y	Y	---
5/10/2017	10:28	Damp	0	0	---	---	---	---	---	Y	Y	---
5/19/20107	13:40	Dry	0	0	---	---	---	---	---	Y	N	---
6/5/2017	14:15	Dry	---	0	---	---	---	---	---	Y	N	---
6/24/2017	10:05	Dry	0	0	---	---	---	---	---	Y	N	No sign of recent water. Download transducer @ 10:02, place back in spot.
7/14/2017	9:55	Dry	---	0	---	---	---	---	---	Y	N	---
7/27/2017	10:10	Pooled/Flowing	31	---	23.9	6.36	94.6	321.2	---	Y	N	Surrounding pools are flowing, with small flow flowing into transducer location.
8/4/2017	12:20	Pooled/Flowing	23.6	1	23.3	6.4	100.3	59	0.5	Y	N	Water has brownish-yellow tint. Dead leaves. Little observed flow (~1 gpm).
8/24/2017	9:30	Pooled	---	0	21.9	6.96	60.7	-273.8	1.01	Y	N	Surrounding areas are mostly dry with some spots at base of rocks have damp areas. Murky brown color water.
9/5/2017	13:15	Pooled	6	0	20.3	7.29	118.1	602.3	2.91	N	N	Tip of transducer was out of water. No photo taken due to moving too quickly.
9/14/2017	10:44	Pooled	15	0	21.7	6.4	95.4	62.6	1.6	Y	N	Water has risen since last visit due to past rain over weekend. Water was murky gray color with spots of red (dead leaves).
9/21/2017	14:12	Pooled	13	0	18.9	6.84	92.1	105.4	---	Y	N	Murky brown water. Dimensions of pool: 1.6m x 0.5m.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

TABLE 4b. FIELD OBSERVATIONS FROM GROTTO MONITORING LOCATION

Site Description: Cave-like Structure with Seep below Boulder Pool **Instrumentation**: None

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Visual Estimation of coverage of wall face (%)	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
				Temperature (°C)[a]	pH[b]	Electrical Conductivity (µS/cm)[c]	ORP (mV)[d]	DO (mg/L)[e]			
3/22/2017	10:52	Flowing/Dripping	95	11.7	6.88	102.6	-11	---	Y	N	Main wall - dripping, 297", algae growth: 41" height, 98" width, pooled water in sand below algae growth <1 gallon.
4/17/2017	10:59	Flowing/Wet	30	---	---	---	---	---	Y	N	Not enough flow or pooled water for parameters. Slow drip in 3-4 places. Moss has slight green color, wall is dry surrounding moss.
4/26/2017	10:38	Flowing/Wet	5	---	---	---	---	---	Y	N	One to two small drips from top of wall. Moss has slight light green color, no sign of color difference from last visit. Small flow not enough flow for parameters. Drips found on left side of wall, two different drip spots located at this flow. Photos taken.
5/5/2017	12:15	Damp	0	---	---	---	---	---	Y	N	Rattlesnake found, no flow.
5/10/2017	10:20	Dry	0	---	---	---	---	---	Y	N	---
5/19/2017	---	Dry	0	---	---	---	---	---	Y	N	---
6/5/2017	14:13	Dry	0	---	---	---	---	---	Y	N	---
6/23/2017	9:51	Dry	0	---	---	---	---	---	Y	N	Completely dry, no sign of recent water. No plant life, wildlife, green algae mat.
7/14/2017	10:00	Dry	0	---	---	---	---	---	Y	N	Tons of bat droppings. No sign of any water flow from previous rain.
7/27/2017	9:40	Flowing	95	22.4	7.61	60.7	120.1	---	Y	N	Drips/flow from top of wall and is polled at base of wall.
8/4/2017	12:03	Flowing	95	22.4	7.5	139.7	-9	---	Y	Y	Parameters collected from a dripping feature, small pool is 0.2 x 0.4, depth: 8 mm.
8/24/2017	9:45	Wet	25	---	---	---	---	---	Y	Y	4 to 5 small drips in coverage area. Base of wall is damp.
9/5/2017	13:35	Dry	0	---	---	---	---	---	Y	N	Drips have dried, wall is dry.
9/14/2017	10:47	Flowing	80	---	---	---	---	---	Y	N	Dripping in 10-15 locations. Signs of flow at base of wall.
9/21/2017	14:02	Damp	10	---	---	---	---	---	Y	N	No wet surface or pooled water, little algae at base of wall, no bats.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] °C = Degrees Celsius
[b] pH = Potential of Hydrogen, unitless
[c] µS/cm = microsiemens per centimeter
[d] ORP (mV) = Oxidation Reduction Potential, in millivolts
[e] DO (mg/L) = Dissolved Oxygen, in milligrar
--- = not applicable
* = edited after review of field data

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Table 4c Grotto Seep and Pools

Feature ID	Metric	Date				
		3/22/2017	4/18/2017	6/24/2017	8/4/2017	9/21/2017
Grotto Seep	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	wet (very slow drip)	dry	flowing	damp
	Coverage of Wall (m)	5.56	NM	0.0	NM	0.6
	Coverage of Wall (%)	NM	NM	0.0	NM	NM
Pools	Flowing/ Pooled/ Wet/ Damp/ Dry	NM	pooled	dry	flowing	pooled
	Length (m)	NM	3.7	0.0	5.9	1.6
	Width (m)	NM	1.7	0.0	4.2	0.5
	Depth (m)	NM	0.24	0.0	0.7	0.3
Entire Site	Invertebrate Observations	NO	no ecologically informative species	insufficient water	no ecologically informative species	no ecologically informative species
	Vertebrate Observations	NO	NO	big brown bat colony roosting in a crack between overhanging boulders at the grotto site	bat colony still using site. Tadpoles present at pool above grotto.	red spotted toad toadlets at seep. Bats are absent from the grotto crevice.
	Vegetation Observations	NO	moss patch on grotto floor is still bright green	algae along grotto wall is dry and exhibits black and rusted orange colors. Moss patch at the grotto floor remains bright green but is completely dry.	algae and moss at grotto wall and floor are much duller in color than during previous visit. Dull orange and dull green, respectively.	orange, green colors on the grotto wall appear duller than during previous visit. Water at pool above grotto is stagnant, murky, and has a cloudy sheen on the surface.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 5a. FIELD OBSERVATIONS FROM KP RESERVOIR MONITORING LOCATION

Site Description: Seepage Below Masonry Dam **Instrumentation**: Transducer

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Depth of water at transducer location (inches)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
					Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	12:35	Pooled	5	0	16.1	5.56	99.1	8	---	Y	N	Installed monitoring transducer in pool below dam.
4/17/2017	10:31	Damp	0	0	---	---	---	---	---	Y	N	No water at transducer location. Moss is damp, green color.
4/26/2017	10:24	Dry	0	0	---	---	---	---	---	Y	N	Moss is dry, light green color.
5/5/2017	12:03	Dry	0	0	---	---	---	---	---	Y	N	---
5/10/2017	10:47	Dry	0	0	---	---	---	---	---	Y	N	---
5/19/2017	13:15	Dry	0	0	---	---	---	---	---	Y	N	---
6/5/2017	14:05	Dry	0	0	---	---	---	---	---	Y	N	---
6/23/2017	10:30	Dry	0	0	---	---	---	---	---	Y	N	DL transducer @ 10:25, re-install in location @ 10:29, completely dry, no sign of recent water.
7/14/2017	9:45	Dry	0	0	---	---	---	---	---	Y	N	---
7/27/2017	9:15	Pooled/Flowing	11.5	---	21.8	7.48	90.4	116.6	---	Y	N	Seeps all along wall face. Stream above pool is flowing. Heavy flow damage to grass and small trees, flow observed downstream from dam.
8/4/2017	10:50	Pooled/Flowing	13	2	24.2	6.19	126.3	128	3.09	Y	N	Reddish yellow tint to water, seepage through dam, recorded flow from transducer pool.
8/24/2017	9:03	Wet	0	0	---	---	---	---	---	Y	Y	No flow, small pool (<3 inches deep) right of the transducer location, water has reddish-brown color. Not enough water to take parameters. Photos taken of small pool. Vegetation is very green and alive.
9/5/2017	13:37	Damp	0	0	---	---	---	---	---	Y	N	---
9/14/2017	14:43	Dry	0	0	---	---	---	---	---	Y	N	---
9/21/2017	14:59	Dry	0	0	---	---	---	---	---	Y	N	Download transducer. Dried algae and red spotted toads.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

Table 5b KP Reservoir Dam

Feature ID	Metric	Date				
		3/22/2017	4/18/2017	6/23/2017	8/4/2017	9/21/2017
Base of Dam	Flowing/ Pooled/ Wet/ Damp/ Dry	wet	wet	dry	flowing	dry
	Length (m)	NM	0.0	0.0	1.1	0.0
	Width (m)	NM	0.0	0.0	15.5	0.0
	Depth (m)	NM	0.0	0.0	0.5	0.0
Pool below Dam	Flowing/ Pooled/ Wet/ Damp/ Dry	pooled	pooled	dry	flowing	pooled
	Length (m)	7.4	7.9	0.0	9.8	1.40
	Width (m)	11.0	8.3	0.0	10.7	1.65
	Depth (m)	0.45	0.54	0.0	0.65	0.08
Entire Site	Invertebrate Observations	NO	*Ilybiosoma lugens, Rhantus gutticollis, Sanfilippodytes* sp.	insufficient water	*Rhantus gutticollis, Thermonectus marmoratus* (observed but not collected)	*Notonecta lobata, Rhantus gutticollis, Thermonectus marmoratus*
	Vertebrate Observations	NO	NO	NO	tadpoles	red spotted toad toadlets at dam and at pool below dam. Tadpole at pool below dam (red spotted toad or canyon tree frog?)
	Vegetation Observations	NO	NO	vegetation composition, density is similar to the previous visit. Some patches of algae and moss have taken on a duller color of green than was observed during the previous visit.	species composition, density similar to previous visit. Grasses upstresam and downstream of the dam are more brightly colored. Moss patches are very bright green in some places.	small pockets of moss on the dam wall have a bright green color. Pool below dam is stagnant and murky.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 6a. FIELD OBSERVATIONS FROM NUMBER 9 WASH TINAJAS MONITORING LOCATION

Site Description: Series of tinajas near confluence with Queen Creek **Instrumentation**: None

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/23/2017	8:45	Flowing	---	---	---	---	---	---	Y	N	---
4/17/2017	8:37	Pooled	0	11.8	6.78	105.3	-32.9	---	Y	N	Top pool
4/17/2017	8:50	Pooled	0	12	7.35	112.2	-50.9	---	Y	N	Middle pool
4/17/2017	9:00	Pooled	0	13.2	7.18	113	-25.5	---	Y	N	Bottom pool
4/26/2017	9:35	Pooled	0	13.4	7.28	123.3	152.4	---	Y	N	Top pool - water level dropped 3 to 4 inches for all pools; dead leaves
4/26/2017	9:35	Pooled	0	12.3	---	146.3	148.9	---	Y	N	Middle pool - dead leaves
4/26/2017	9:35	Pooled	0	13.8	---	129.9	130.5	---	Y	N	Bottom pool - covered in dead leaves
5/4/2017	11:13	Pooled	---	16.4	7.19	126	145	---	Y	Y	Top pool
5/4/2017	11:20	Pooled	---	18.2	7.72	205.3	145.6	---	Y	Y	Middle pool
5/4/2017	11:30	Pooled	---	15.6	7.5	1459.7	167.5	---	Y	Y	Lower pool
5/10/2017	9:37	Pooled	---	---	---	---	---	---	Y	N	---
5/19/2017	9:20	Pooled	---	13.3	7.24	138.5	123.3	1.21	Y	Y	Top pool
5/19/2017	9:33	Pooled	---	12.5	7.64	300.5	120.3	1.9	Y	Y	Middle pool
5/19/2017	9:46	Pooled	---	13.1	7.6	175.7	116.8	1.31	Y	Y	Lower pool
6/5/2017	10:30	Pooled	---	18.2	7	125	116.2	1.15	Y	N	Top pool - one small pool with surrounding area completely dry
6/5/2017	10:30	Dry	---	---	---	---	---	---	Y	N	Middle pool - dry
6/5/2017	10:30	Pooled	---	19.9	7.61	259.9	119	1.25	Y	Y	Lower pool - pool has murky green color with no odor
6/24/2017	9:35	Dry	---	---	---	---	---	---	Y	N	Some bees and damp sand in upper pool, all three pools dry, sand in bottom pool, dry
7/10/2017	9:30	Dry	---	---	---	---	---	---	Y	N	Top pool - big tree right of pool is drying out due to change of leaves; surrounding plant life around pool edge has dried
7/10/2017	9:35	Dry	---	---	---	---	---	---	Y	N	Middle pool
7/10/2017	9:38	Dry	---	---	---	---	---	---	Y	N	Lower pool
7/25/2017	10:00	Flowing	---	23.8	7.32	101.9	103.6	13.9	Y	N	Top pool - flow damage to surrounding plant life
7/25/2017	10:15	Flowing	---	23.8	7.31	103.5	102	14.9	Y	N	Middle pool
7/25/2017	10:30	Flowing	---	23.8	7.39	103.6	90.9	15.6	Y	N	Lower pool
8/4/2017	7:55	Flowing	80	22.9	7.37	101.2	183	6.39	Y	Y	All pools are connected by surface flow, parameters measured in upper pool
8/24/2017	7:40	Flowing	0.5	20.8	6.98	168.6	102.9	2.81	Y	N	Upper pool - small flow, less than 1 gpm flows into middle pool and pools
8/24/2017	7:50	Pooled	---	20.5	7.57	171.7	79.6	3.41	Y	N	Middle pool - parameters were taken from shaded area
8/24/2017	8:01	Pooled	---	21.9	7.3	171.5	76.3	3.21	Y	N	Lower pool - pool in direct sunlight
9/5/2017	9:40	Pooled	---	20.6	7.12	177.3	91.9	3.98	Y	Y	Upper pool - water has lowered down to the sand, making two separate pools
9/5/2017	---	Pooled	---	---	---	---	---	---	Y	Y	Middle pool - not enough water to collect parameters; pools filled with tadpoles and other insects
9/5/2017	9:55	Pooled	---	21.7	7.38	196.4	94.8	4.09	Y	Y	Lower pool - bottom pool is dry around edges and damp in middle
9/14/2017	14:00	Pooled	---	20.5	7.26	178.7	51.7	2.06	Y	N	Upper pool - parameters taken in shade
9/14/2017	---	Pooled	---	28.3	9.36	157	31.3	3.13	Y	N	Middle pool - parameters were taken in direct sunlight
9/14/2017	14:20	Pooled	---	23.5	8.03	189.2	50.5	4.19	Y	N	Lower pool - parameters were taken in shaded area
9/21/2017	9:10	Pooled	---	16	7.39	190.3	114	---	Y	Y	Upper pool - ~150 gallons, brown tint, algae around edges, dead leaves on bottom
9/12/2017	---	Dry	---	---	---	---	---	---	Y	Y	Middle pool - dry
9/21/2017	9:15	Pooled	---	17.7	7.43	212.7	98	---	Y	Y	Lower pool - ~250 gallons, brown tint, brown algae around edges

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

Table 6b No. 9 Wash Tinajas at Mouth

Feature ID	Metric	Date				
		3/24/2017	4/19/2017	6/24/2017	8/4/2017	9/21/2017
Upper Tinaja	Length (m)	5.7	7.3	0.0	9.9	3.6
	Width (m)	5.0	3.8	0.0	5.9	2.8
	Depth (m)	0.60	0.32	0.00	0.90	0.60
Middle Tinaja	Length (m)	12.8	14.5	0.0	11.2	0.0
	Width (m)	2.8	2.6	0.0	2.8	0.0
	Depth (m)	0.50	0.62	0.00	0.60	0.00
Lower Tinaja	Length (m)	8.0	9.5	0.0	8.9	4.2
	Width (m)	2.8	6.7	0.0	6.7	2.1
	Depth (m)	1.20	1.11	0.00	1.10	0.75
Entire Site	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	pooled	dry	flowing	upper and lower tinaja = pooled, middle tinaja = wet
	Invertebrate Observations	NO	*Ilybiosoma lugens*	insufficient water	*Buenoa arida, Laccophilus vacaensis, Notonecta lobata, Thermonectus marmoratus*	*Desmopachria mexicana, Buenoa* sp.*, Laccophilus fasciatus terminalis, Laccophilus pictus, Notonecta lobata, Ranatra quadridentata, Rhantus gutticollis, Thermonectus marmoratus*
	Vertebrate Observations	tadpole (very small, gills covered)	red spotted toad tadpoles	apparent paw scrape in sand at upper tinaja	tadpoles	raven, multiple red spotted toad toadlets
	Vegetation Observations	NO	NO	similar species composition as that observed during previous visit. Small amount of grasses and annuals have colonized the sand pocket downstream of the tinajas. Goodding's willow tree at upper tinaja exhibits brown, dry leaves.	species density, composition similar to previous visit. Grasses are greener than previous visit. Goodding's willow tree at upper tinaja exhibits dieback with new growth at base of tree.	Goodding's willow at upper tinaja exhibits dieback but has bright green leaves at the base. Small tamarisk shrub at the lower tinaja. Forbs and grasses have colonized the sandy depression below the tinajas.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 7a. FIELD OBSERVATIONS FROM SS-1 MONITORING LOCATION

Site Description: Tinajas and Waterfall Adjacent to Road **Instrumentation**: Trail Camera

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µs/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/23/2017	8:45	Flowing	5-8	---	---	---	---	---	Y	N	Replacing camera, more flow than yesterday
4/18/2017	9:59	Pooled	0	18.5	7.7	83.8	---	---	Y	N	No flow, surface water camera captured photos from 3/23-4/18; parameters from Upper pool.
4/26/2017	14:29	Pooled	0	14.2	7.46	74.8	17.4	---	Y	N	Upper pool - completely shaded, murky water, no oder; water level dropped approximately 1.5 inches.
4/26/2017	14:36	pooled	0	18.2	7.1	86.5	29.3	---	Y	N	Middle pool - water level dropped approximately 2.5-3 inches.
4/26/2017	14:45	Pooled	0	23.6	7.21	113.9	39.9	---	Y	N	Lower pool - water level dropped 4 to 4.5 inches.
5/5/2017	12:38	Pooled	---	16.3	6.94	91.6	130.5	---	Y	Y	Parameters taken from top pool.
5/10/2017	13:18	Flowing	0.5	15.4	6.5	132.1	58.7	12.3	Y	N	Top pool - small flow from upper pool directly into lower pool; water has risen about 6 inches since last visit; parameters only from upper pool.
5/19/2017	12:00	Pooled	0	15.1	6.83	68.5	130.9	12.3	Y	N	---
6/5/2017	13:16	Pooled	0	24.6	6.99	111.3	120.8	12.8	Y	N	Parameters taken from upper pool. Lower pool has very small pool, possibly be dry by next visit. Upper pool water has dropped about 6-8 inches. Middle pool has small pool, possible dry by next visit as well.
6/23/2017	5:50	Pooled	0	22.9	8.61	100.6	132	6.47	Y	N	WP 212 is from above the waterfall. Large tinaja (Top pool), 5 ft deep, 6 x 5 oval, canyon tree frog, tadpoles.
7/14/2017	9:19	Wet	---	---	---	---	---	---	Y	N	Lower pool has small puddle not enough water for parameters. Replaced old camera with new.
7/14/2017	9:21	Damp/Dry	---	---	---	---	---	---	Y	N	Middle pool is damp due to light rain night of 7/31/17.
7/14/2017	9:23	Damp	---	---	---	---	---	---	Y	N	Upper pool is damp on outer edges. Two small pools in pockets of the flow route (water is pooled).
7/14/2017	9:26	Pooled	---	26.6	6.97	60.4	117.6	24.9	Y	N	Top pool near oak tree has good amount of water . Water level seems to have dropped about 1 inch. Surrounding area has very small pool from rain night before.
7/25/2017	2:15	Flowing	---	27.7	7.15	67.8	109.4	---	Y	N	Middle pool
7/25/2017	2:05	Flowing	---	27.9	7.23	67.6	103.2	---	Y	N	Upper pool
7/25/2017	1:56	Flowing	---	27.9	7.07	67.5	119.2	---	Y	N	Top pool
8/3/2017	8:38	Flowing	30-40	22.7	6.71	60.9	248	6.57	Y	Y	All pools connected by flow, murky light brown color.
8/24/2017	12:32	Pooled	0	21.9	7.18	92.9	122.9	4.63	Y	N	Top pool - half shaded
8/24/2017	12:32	Pooled	0	23.8	6.92	84.8	129.5	7.24	Y	N	Upper pool - water has dark brown color
8/24/2017	12:32	Pooled	0	24.5	6.79	86	109.9	2.63	Y	N	Middle pool
8/24/2017	12:32	Pooled	0	26.7	9.04	88.3	78.8	8.3	Y	N	Lower pool
9/5/2017	15:40	Pooled	0	24	7.51	84.9	142.4	9.01	Y	N	Top pool
9/5/2017	15:40	Pooled	0	21.4	7.32	111.3	136.3	8.93	Y	N	Upper pool
9/5/2017	15:40	Pooled	0	24.6	6.98	88.1	129	8.63	Y	N	Middle pool
9/5/2017	15:40	Pooled	0	28.2	8.77	113	56.3	7.92	Y	N	Lower pool
9/14/2017	---	Pooled	0	21.4	7.36	99.5	101.3	5.24	Y	N	Top pool
9/14/2017	16:45	Pooled	0	23.4	7.32	84.8	118.1	3.77	Y	N	Upper pool
9/14/2017	---	Pooled	0	25.3	7.64	126.6	52.2	4.19	Y	N	Middle pool
9/14/2017	16:00	Pooled	0	26.6	8.07	106.1	37.9	6.3	Y	N	Lower pool
9/21/2017	9:53	Pooled	0	21	7.03	92	-283	---	Y	N	Top pool
9/21/2017	9:45	Pooled	0	16.8	7.2	101.7	83	---	Y	N	Upper pool
9/21/2017	9:48	Pooled	0	20.3	6.8	87.1	-9	---	Y	N	Middle pool
9/21/2017	9:51	Pooled	0	19.1	6.97	107.9	204	---	Y	N	Lower pool

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

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Table 7b SS-1 Pour-off

Feature ID	Metric	Date					
		3/23/2017	3/24/2017	4/18/2017	6/23/2017	8/3/2017	9/21/2017
Upper Tinaja	Length (m)	NM	3.6	2.9	0.0	2.8	2.8
	Width (m)	NM	1.4	1.8	0.0	1.5	1.5
	Depth (m)	NM	0.30	0.40	0.00	0.50	0.20
Middle Tinaja	Length (m)	NM	3.6	2.8	0.0	3.6	2.3
	Width (m)	NM	1.8	2.3	0.0	1.7	1.3
	Depth (m)	NM	0.60	0.50	0.00	0.60	0.45
Lower Tinaja	Length (m)	NM	4.3	3.8	0.3	6.7	3.0
	Width (m)	NM	1.7	1.7	0.1	1.8	0.9
	Depth (m)	NM	0.55	0.40	0.02	0.70	0.40
Entire Site	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	flowing	pooled	upper and middle tinajas = dry, lower tinaja = pooled	flowing	pooled
	Invertebrate Observations	NO	NO	*Abedus herberti, Sanfilippodytes* sp.	*Desmopachria mexicana, Desmopachria portmanni, Laccophilus horni, Notonecta lobata, Thermonectus marmoratus*	*Buenoa arida, Desmopachria mexicana, Notonecta lobata*	*Buenoa arida, Desmopachria mexicana, Desmopachria portmanni, Laccophilus pictus, Notonecta lobata, Thermonectus marmoratus, Sanfilippodytes* sp.
	Vertebrate Observations	Clark's spiny lizard	NO	Canyon tree frog tadpoles (n>10)	Adult female canyon tree frog observed between upper tinaja and a pool located upstream of the "site." This pool also contained many canyon tree frog tadpoles.	tadpoles	numerous canyon tree frogs: 2 adults, approx. 10 juveniles. Juvenile red spotted toad. Ornate tree lizard.
	Vegetation Observations	NO	NO	NO	Tinaja walls retain dark black color after drying. Species composition, density is similar to that observed during the previous visit.	species composition, density similar to previous visit. Black sheen on tinaja walls has expanded since the onset of the dry season.	vegetation appears green, healthy. Some dieback on desert broom. Algae present in pools.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**

*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 8a. FIELD OBSERVATIONS FROM OAK FLAT TINAJA MONITORING LOCATION

Site Description: Perennial Tinaja **Instrumentation**: Transducer & Camera

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Dimensions of pool (feet)	Estimated Flow Rate (gpm)[a]	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
					Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	17:15	Flowing	29 x 26 x 5.0	1	14.2	7.29	136.5	-22	---	Y	N	Water level 4" below high water line, depth of tinaja is ~4 deep, water is fairly clear; installed transducer.
4/18/2017	---	Pooled	23 x 26 x 4.6	0	15.6	8.22	172.1	---	---	Y	N	---
6/23/2017	7:00	Pooled	10 x 9 x 1.4	0	20.6	7.55	275.1	158	10.95	Y	N	Logger was up on sandy ledge behind boulder. DL logger @ 7:06, place logger back in water @ deepest possible spot.
8/3/2017	9:44	Flowing	23 x 32 x 6.2	30	22.5	7.75	157.5	223	6.6	Y	Y	Download logger. Sandy area around tinaja completely covered in water.
9/22/2017	10:59	Pooled	20 x 26 x 4.7	0	16.2	7.56	217	58	6.1	Y	N	Water is murky brown, green bubbles on surface, sheen on surface of water.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members. This site was only visited when members of RC staff were accompanied by M&A and WRI.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

Table 8b Oak Flat Tinaja

Feature ID	Metric	Date				
		3/22/2017	4/19/2017	6/23/2017	8/3/2017	9/22/2017
Entire Site	Flowing/ Pooled/ Wet/ Damp/ Dry	NM	pooled	pooled	flowing	pooled
	Length (m)	NM	7.8	3.1	9.9	7.8
	Width (m)	NM	7.0	2.8	7.0	6.1
	Depth (m)	NM	too deep to sample	0.42	1.90	1.42
	Invertebrate Observations	NO	*Deronectes corvinus, Gyrinus plicifer, Thermonectus marmoratus*	*Buenoa arida, Notonecta lobata, Rhantus gutticollis, Thermonectus marmoratus*	*Desmopachria mexicana, Gyrinus plicifer, Notonecta lobata, Thermonectus marmoratus*	*Desmopachria mexicana, Laccophilus horni, Neoclypeodytes fryii, Notonecta lobata, Ranatra fusca, Ranatra quadridentata, Thermonectus marmoratus*
	Vertebrate Observations	NO	NO	NO	tadpoles	red spotted toad toadlets.
	Vegetation Observations	NO	water is down noticeably from last visit - surface water level is 0.5 m below the high-water stain on the rock	curly dock has bloomed since the previous visit. Overall vegetation composition, density is similar to that observed during the previous visit.	species density, composition is similar to previous visit. Grass is greener than during previous visit.	water is murky and stagnant, with frothy green bubbles and a cloudy white sheen on the surface. Grasses downstream of the tinaja show vigorous growth and appear healthy.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**

*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 9a. FIELD OBSERVATIONS FROM ANXIETY FAULT POND MONITORING LOCATION

Site Description: Constructed Earthen Pond **Instrumentation**: None

Date	Time	Rangefinder North-South measurement (feet)	Rangefinder East-West measurement (feet)	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
				Temperature (°C)[a]	pH[b]	Electrical Conductivity (µS/cm)[c]	ORP (mV)[d]	DO (mg/L)[e]			
3/23/2017	9:15	---	---	---	---	---	---	---	Y	N	Chose photo locations for monitoring program.
4/19/2017	9:46	336	228	23.3	8.25	182.5	---	---	Y	N	---
4/26/2017	14:11	333	228	26.7	9.37	180.6	296.1	---	Y	N	Water is covered in dead leaves. Weeds surrounding water.
5/5/2017	9:12	324	216	22.3	8.65	180.3	183.2	---	Y	Y	---
5/10/2017	13:10	315	204	15.9	6.99	203.4	126.3	15.80	Y	N	Leaves covering surface of water.
5/19/2017	11:47	276	198	16.5	6.98	234.1	81.4	15.20	Y	N	---
6/5/2017	12:30	267	201	32.9	6.82	311.4	-41.8	12.60	Y	N	---
6/24/2017	7:45	No Data	No Data	20.2	7.29	398.2	-44.0	3.57	Y	N	2 feet depth in middle. Deepest in NE corner, ~3 feet.
7/14/2017	9:02	96	72	21.6	6.21	110.2	202.1	---	Y	N	Water was murky green color with no odor. Pool below fence is dry. Vegetation is still alive and green.
7/28/2017	11:30	522	240	27.1	7.07	123.6	215.1	---	Y	N	N-S range includes smaller pool upstream from large pond bank point. Sign of heavy flow due to flooding.
8/3/2017	14:10	390	240	29.2	6.61	99.3	189.0	4.87	Y	N	Grassy. Reddish-yellow tint to water, flow into pond from stream entering from south of ~20 gpm.
8/24/2017	14:15	306	228	30.9	9.37	118.7	215.7	8.77	Y	N	Vegetation on pond bank has overgrown due to recent rain.
9/5/2017	16:08	288	213	24.2	7.42	141.7	93.0	6.33	Y	N	Sheet of leaves on top of water. Surrounding vegetation on bank is very overgrown and green.
9/14/2017	13:00	273	204	24.7	6.92	151.0	52.4	2.73	Y	N	Greenish-brown water with layer of leaves on top.
9/22/2017	10:00	273	168	16.5	7.42	151.0	45.0	5.03	Y	N	Green, thick grassy weeds throughout. Tall grass around the outside of the pond.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] °C = Degrees Celsius
[b] pH = Potential of Hydrogen, unitless
[c] µS/cm = microsiemens per centimeter
[d] ORP (mV) = Oxidation Reduction Potential, in millivolts
[e] DO (mg/L) = Dissolved Oxygen, in milligram
--- = not applicable
* = edited after review of field data

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Table 9b Anxiety Fault Pond

Feature ID	Metric	Date				
		3/24/2017	4/19/2017	6/24/2017	8/3/2017	9/22/2017
Anxiety Fault Pond (main pond)	Flowing/ Pooled/ Wet/ Damp/ Dry	NM	pooled	pooled	flowing	pooled
	Length (m)	105	102.0	NM	NM	83.0
	Width (m)	54	69.0	NM	NM	51.0
	Depth (m)	NM	ND	NM	NM	NM
Smaller, southern pond	Flowing/ Pooled/ Wet/ Damp/ Dry	NM	pooled	dry	pooled	dry
	Length (m)	30	NM	0.0	NM	0.0
	Width (m)	14	NM	0.0	NM	0.0
	Depth (m)	0.3	NM	0.0	NM	0.0
Entire Site	Invertebrate Observations	NO	*Agabus disintegratus, Rhantus gutticollis*	*Notonecta unifasciata*	*Belostoma flumineum*	*Laccophilus maculosus shermani, Notonecta indica or undulata, Rhantus gutticollis*
	Vertebrate Observations	NO	NO	NO	tadpoles	NO
	Vegetation Observations	NO	smaller pond to the south of Anxiety Fault pond is isolated from Anxiety Fault Pond; no contiguous connection.	species composition is similar to that observed during the previous visit. Density has changed; the newly dried areas have filled in with colonizing species found nearby. Willows appear to have taken on a brighter green color since the previous visit. Grasses have taken on a duller color than since the previous visit.	emergent vegetation has taken on a brighter green color than during the previous visit. Cockleburs are more robust. Willows appear similar to previous visit.	rush, annual growth is abundant. General appearance of vegetation is green, healthy.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 10a. FIELD OBSERVATIONS FROM OAK FLAT RESERVOIR MONITORING LOCATION

Site Description: Seepage Below Masonry Dam **Instrumentation**: Transducer

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Depth of water at transducer location (inches); location at the up end of the culvert	Flow Rate (gpm)[a]; from the downstream end of the culvert	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
					Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/23/2017	18:24	Flowing	10	15	15.9	6.2	142.7	-21	---	Y	N	Installed transducer on dam side of Magma Mine Road in channel below culvert.
4/17/2017	12:20	Flowing	12	20	15.4	6.58	167.4	101	---	Y	N	---
4/26/2017	15:30	Flowing	10*	10	16	6.43	199.2	68.8	---	Y	N	Water at transducer location has risen since last visit.
5/5/2017	8:40	Flowing	---	5	19.3	7.65	115.2	133.4	---	Y	Y	Pond is pooled; culvert is flowing.
5/10/2017	13:40	---	---	---	---	---	---	---	---	Y	N	---
5/19/2017	12:25	---	---	---	---	---	---	---	---	Y	Y	No flow
6/5/2017	1:37	---	---	---	---	---	---	---	---	Y	N	---
6/24/2017	7:10	Dry	---	---	---	---	---	---	---	Y	N	Download transducer, place back under culvert; reservoir completely dry, no water at culvert or north of Magma Mine Road.
7/10/2017	9:46	Dry	---	---	---	---	---	---	---	Y	N	Pond and culvert
7/28/2017	11:06	Flowing	9.5	---	26	6.71	103.3	140.3	---	Y	N	Water seeping through dam wall into culvert.
8/3/2017	15:17	Flowing	10	40-60	26.6	6.72	126.8	89	4.95	Y	Y	Culvert - slight yellow tint to water, little algae growth, thick vegetation.
8/24/2017	11:50	Flowing	5.5	2.25	24	6.34	219.5	56.8	1.26	Y	Y	Stream has murky, brown, reddish water, streaks of white foam/bubbles (video); water has strong nasty odor.
9/5/2017	12:30	Flowing	5	2	24.4	6.34	231.1	-122.2	2.67	Y	Y	Water was measured with a 2 gallon bucket; 1 gallon in 30.32 seconds.
9/14/2017	12:51	Flowing	5	0.5	22.5	6.7	306	92.32	3.36	Y	Y	Murky red with red moss; has strong odor in culvert.
9/22/2017	7:55	Flowing	8	1-2	19.7	7	259.4	80.5	2.68	Y	Y	Reddish-brown algae, yellow foam on surface with sheen; stagnant water smell.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

TABLE 10b. FIELD OBSERVATIONS FROM OAK FLAT RESERVOIR SEEP MONITORING LOCATION

Site Description: Seep emerging from soil on north side of Magma Mine Road **Instrumentation**: None

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Flow Rate (gpm)[a] observed at the seep location	Water Quality Parameters					Photos Taken (Y/N)	Video Taken (Y/N)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/23/2017	18:24	Flowing	15	14	6.27	144.7	-21	---	Y	N	Chemistry suggests that water comes from Oak Flat Reservoir.
4/17/2017	12:20	Flowing	20	14.6	6.41	175.1	89.7	---	Y	N	---
4/26/2017	15:45	Flowing	10	15.4	6.43	185	65.3	---	Y	N	---
5/5/2017	---	Flowing	5	15.9	6.38	0.2	80.4	---	Y	Y	---
5/19/2017	---	Dry	0	---	---	---	---	---	Y	Y	---
7/28/2017	11:20	Flowing	---	22.7	6.09	125	163.8	---	Y	N	---
8/3/2017	15:20	Flowing	5	24.1	6.71	128.9	81	---	Y	Y	Little algae growth around discharge area.
9/22/2017	8:05	Flowing	<1	21.6	6.41	239	85.8	---	Y	Y	Little flow, red algae mat, some green moss, sheen on surface of water.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

Table 10c Oak Flat Reservoir

Feature ID	Metric	Date				
		3/22/2017	4/19/2017	6/23/2017	8/4/2017	9/22/2017
Oak Flat Reservoir	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	flowing	dry	flowing	pooled at pond, but flow in culvert
	Length (m)	NM	66	0.0	NM	NM
	Width (m)	NM	34	0.0	NM	NM
	Depth (m)	NM	NM	0.0	NM	NM
Seep near the downstream end of the culvert	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	flowing	dry	flowing	flowing
Entire Site	Invertebrate Observations	NO	*Agabus disintegratus*	insufficient water	*Agabus disintegratus, Anostraca, Belostoma flumineum, Laccophilus fasciatus terminalis*	*Buenoa arizonis, Laccophilus fasciatus terminalis*
	Vertebrate Observations	NO	Several salamander larvae were observed, likely nonnative barred tiger salamander	deer, fox scat	tadpoles	red spotted toad toadlets. Deer tracks, raccoon tracks.
	Vegetation Observations	NO	NO	vegetation has filled in at the reservoir since the previous visit. There appears to be a decrease in vegetation density between the dam and the culvert	perimeter vegetation above current water level is greener. Vegetation between the dam and the culvert is greener. Floating algae present. Annuals observed colonizing the reservoir during previous visit are now submerged.	vegetation is bright green, healthy. Numerous annuals have sprouted since last visit. Vegetation density has increased since last visit. Cloudy sheen layer on top of the surface water downstream of the culvert. Pond is pooled, but culvert is flowing and the downstream seep is flowing.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**

TABLE 11a. FIELD OBSERVATIONS FROM GIBSON WELL MONITORING LOCATION

Site Description: Shallow alluvial well near the confluence of Oak Flat Wash and Queen Creek **Instrumentation**: Transducer

Date	Time	Depth to water in well at transducer location (inches, bls)[a]	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
			Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	8:57	16.75	12.4	6.34	247	-12	---	Y	N	Saturated soil surrounding well, slightly murky water, dead leaves on surface of water, sunny day, partly cloudy.
4/18/2017	14:44	23	15.4	6.58	148.7	---	n/a	Y	N	Slightly murky with dead leaves. Water level has dropped since last visit.
5/5/2017	9:57	37	13.9	6.36	155.7	143.3	---	Y	Y	---
5/10/2017	14:30	47	13.9	6.34	159.3	148.6	12.7	Y	N	---
5/19/2017	14:30	51	14.2	6.43	157.2	161.2	17.2	N	N	---
6/4/2017	15:04	Dry	---	---	---	---	---	Y	N	---
6/24/2017	9:18	Dry	---	---	---	---	---	Y	N	Downloaded transducer, then put back on bottom of well. Well dry. Transducer indicates the well has been dry since ~June 1.
7/11/2017	13:40	Dry	---	---	---	---	---	Y	N	---
7/28/2017	12:00	14	21.7	6.26	294.8	48.4		Y	N	---
8/3/2017	15:55	16	22.4	6.33	236	112	2.35	Y	N	---
8/25/2017	11:01	27	22.3	6.3	231.6	49.9	3.22	Y	N	Soil around well is damp. Water in well has reddish color. No odor.
9/5/2017	14:50	51*	20.2	6.39	158.8	34.9	3.19	Y	N	---
9/14/2017	13:25	84	18.1	6.48	86	19.9	3.16	Y	N	---
9/21/2017	15:45	Damp	---	---	---	---	---	Y	N	---

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] bls = below land surface
[b] °C = Degrees Celsius
[c] pH = Potential of Hydrogen, unitless
[d] µS/cm = microsiemens per centimeter
[e] ORP (mV) = Oxidation Reduction Potential, in millivolts
[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter
--- = not applicable
* = edited after review of field data

TABLE 11b. FIELD OBSERVATIONS FROM GIBSON SPRING MONITORING LOCATION

Site Description: Spring near the confluence of Oak Flat Wash and Queen Creek **Instrumentation**: None

Date	Time	Presence of Water (flowing, pooled, wet, damp, dry)	Estimated flow rate from Gibson Spring (gpm)[a]	Water Quality Parameters					Photos Taken (y/n)	Video Taken (y/n)	Comments*
				Temperature (°C)[b]	pH[c]	Electrical Conductivity (µS/cm)[d]	ORP (mV)[e]	DO (mg/L)[f]			
3/22/2017	9:15	Flowing	2-3	12.8	6.82	133.7	-10	---	Y	N	Little flow, water clear, some algae growth.
4/18/2017*	15:00	Flowing	2	19.1	6.45	135	---	---	Y	N	Pooled/small amount of flow. Flowing into another small pool in Oak Flat Wash.
5/10/2017	14:40	Flowing	3	14.3	6.58	148.7	160.7	14.6	Y	N	---
5/19/2017	14:40	Flowing	2	13.2	6.88	175.3	226.1	14.6	Y	N	---
6/5/2017	15:10	Dry	0	---	---	---	---	---	Y	N	Dry
7/11/2017	13:52	Dry	0	---	---	---	---	---	Y	N	---
7/28/2017	12:10	Flowing	---	27.7	6.78	132.8	41.3	---	Y	N	Signs of heavy flood flow, vegetation is damaged, photos taken.
8/3/2017	15:55	Flowing	25	29.1	7	130.6	125	5.52	Y	N	Oak Flat wash is flowing into spring discharge.
8/25/2017	11:01	Wet	---	26.9	6.68	186.2	38.3	3.63	Y	N	No flow, surrounding area is damp upstream, vegetation is very overgrown and green. Water has slight red/brown color.
9/5/2017	14:50	Damp	---	---	---	---	---	---	Y	N	Damp soil
9/14/2017	13:25	Dry	---	---	---	---	---	---	Y	N	Dry
9/21/2017	15:45	Dry	---	---	---	---	---	---	Y	N	Vegetation is drying. No sign of recent flow.

Notes: Field observations have been compiled from field notes described during site visits by RC, M&A, and WRI staff members.

[a] gpm = gallons per minute

[b] °C = Degrees Celsius

[c] pH = Potential of Hydrogen, unitless

[d] µS/cm = microsiemens per centimeter

[e] ORP (mV) = Oxidation Reduction Potential, in millivolts

[f] DO (mg/L) = Dissolved Oxygen, in milligrams per Liter

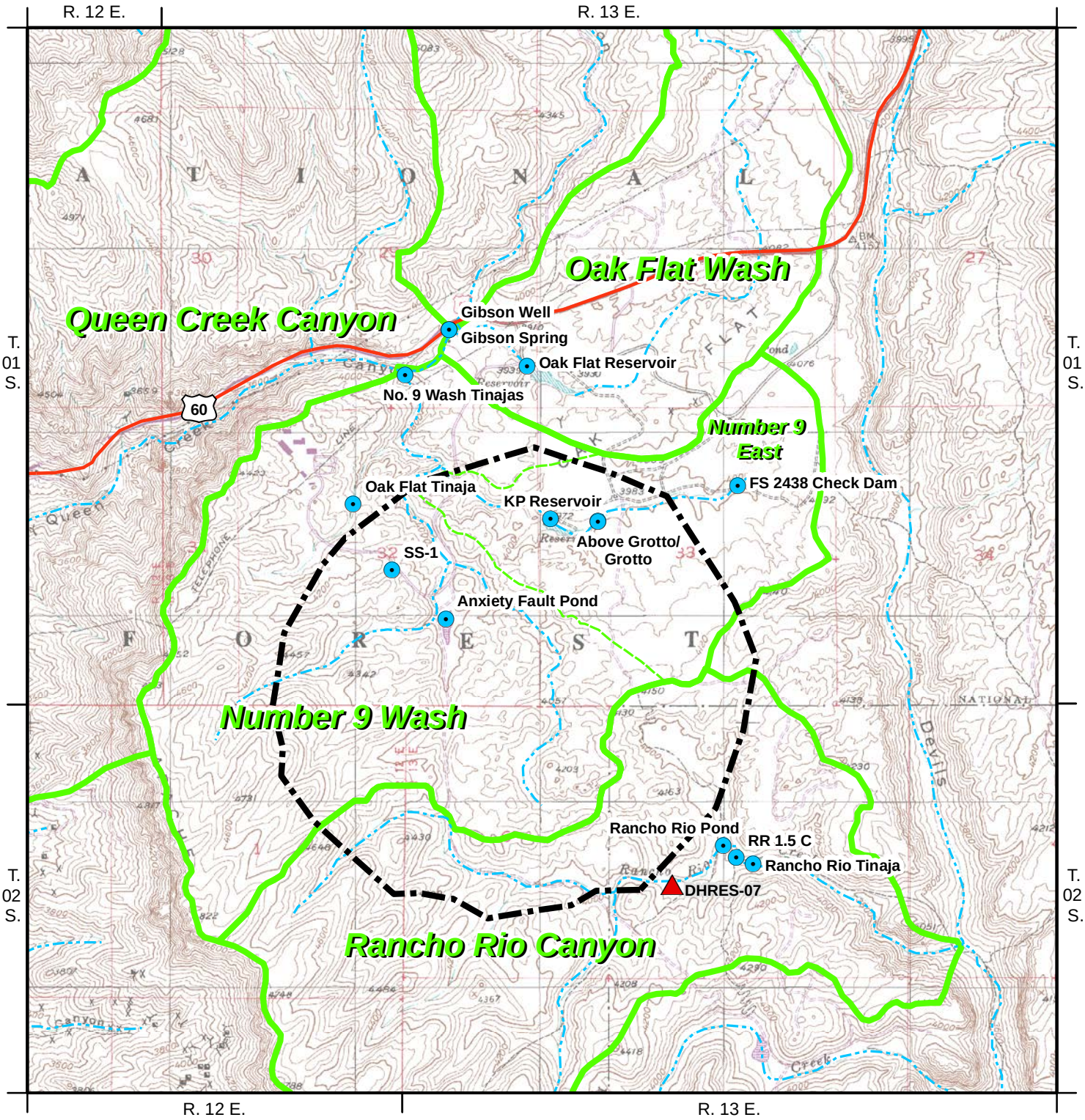
--- = not applicable

* = edited after review of field data

Table 11c Gibson Well

Feature ID	Metric	Date				
		3/24/2017	4/19/2017	6/24/2017	8/3/2017	9/21/2017
Well	Flowing/ Pooled/ Wet/ Damp/ Dry	pooled	pooled	dry	pooled	damp
	Length (m)	NM	1.0	0.0	1.0	0.0
	Width (m)	NM	1.0	0.0	1.0	0.0
	Depth of water in well (m)	1.71	1.48	0.0	1.77	0.0
Drainage/ Spring	Flowing/ Pooled/ Wet/ Damp/ Dry	flowing	flowing (trickle)	dry	flowing	dry
	Length (m)	NM	24	0.0	>24	0.0
	Average Width (m)	NM	2.0	0.0	3.0	0.0
	Average Depth (m)	NM	0.2	0.0	0.4	0.0
Entire Site	Invertebrate Observations	NO	*Ilybiosoma lugens*	insufficient water	no ecologically informative species	insufficient water
	Vertebrate Observations	NO	NO	NO	tadpoles	NO
	Vegetation Observations	NO	NO	depth from top of well masonry to the bottom of the well = 2.47m. Vegetation density, composition is similar to that observed during the previous visit. Some vegetation (moss, locust) has dried out. Yellow leaves on the locust.	grasses and locust are greener than during previous visit.	Locust, deergrass, bullgrass, and cocklebur appear healthy. Bright green foliage. Soil at the bottom of the well is damp. Soil at the adjacent drainage bottom is dry.

*** NM indicates "no measurement." This refers to situations in which the site was visited but no water feature dimension measurements were recorded.**
*** NO indicates "no observation." This refers to situations in which the site was visited but no noteworthy observations were recorded, e.g. no invertebrate samples collected, no wildlife species observed, or no noticeable changes in vegetative characteristics.**



EXPLANATION

- SS-1 — Monitoring Site
- DHRES-07 — Rain Gauge
- Maximum Projected Mine Collapse Zone
- Sub-Basin Boundary
- Stream Channel

0 3,000 Feet

N

FIGURE 1. 2017 OAK FLAT MONITORING SITE MAP

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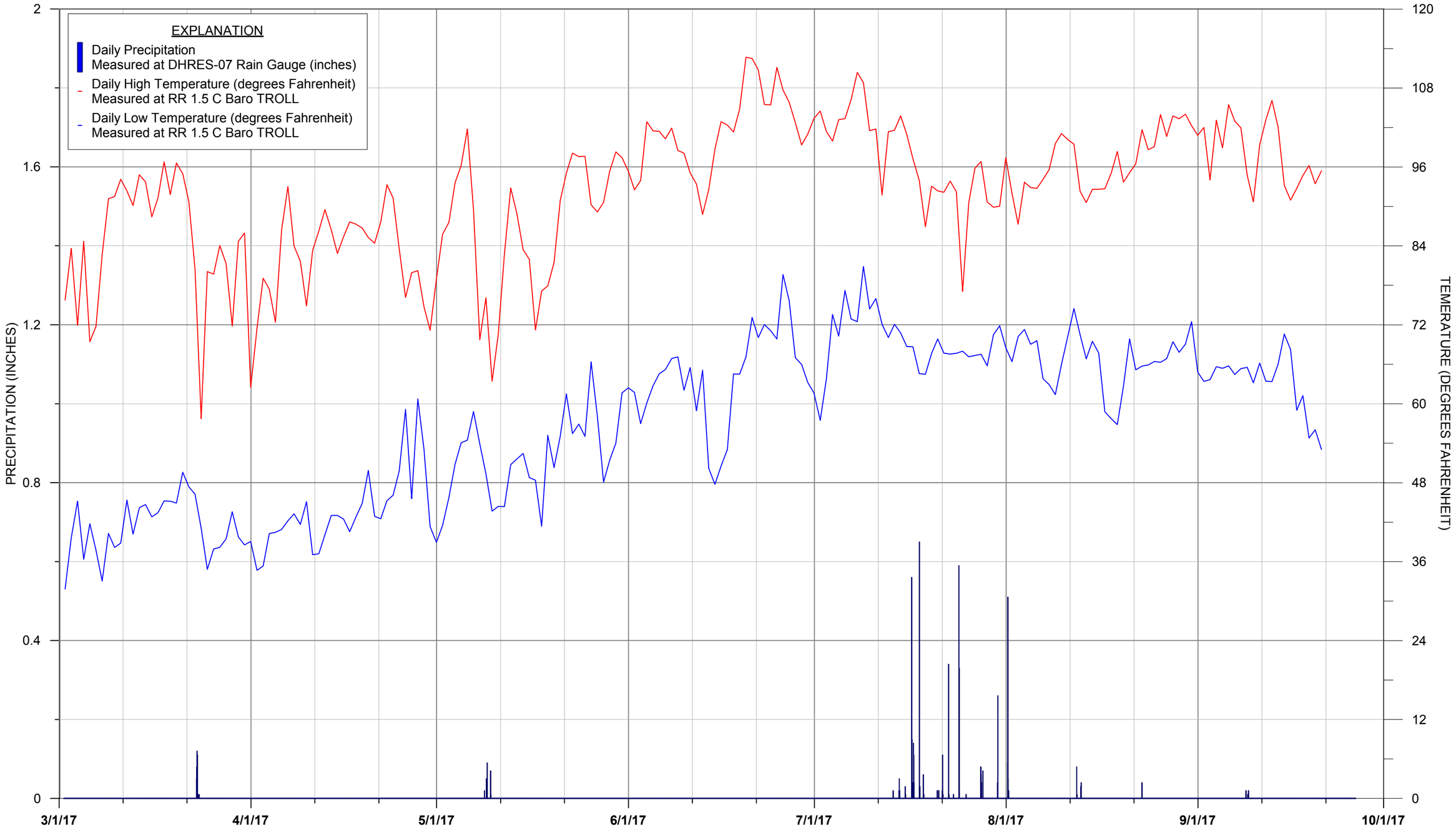

FIGURE 2. TEMPERATURE AT RR 1.5 C BAROMETER AND PRECIPITATION AT DHRES-07 RAIN GAUGE, OAK FLAT, PINAL COUNTY, ARIZONA

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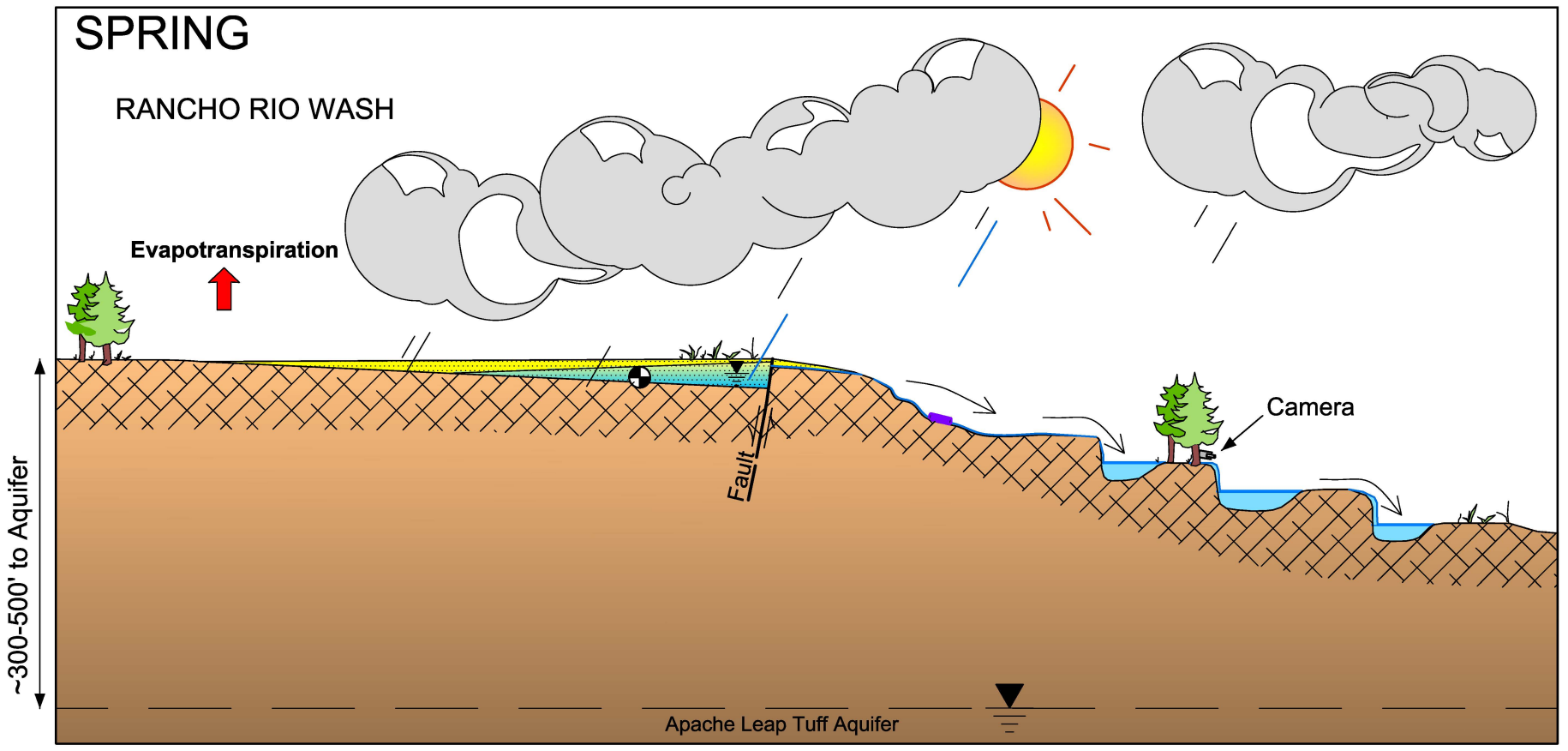

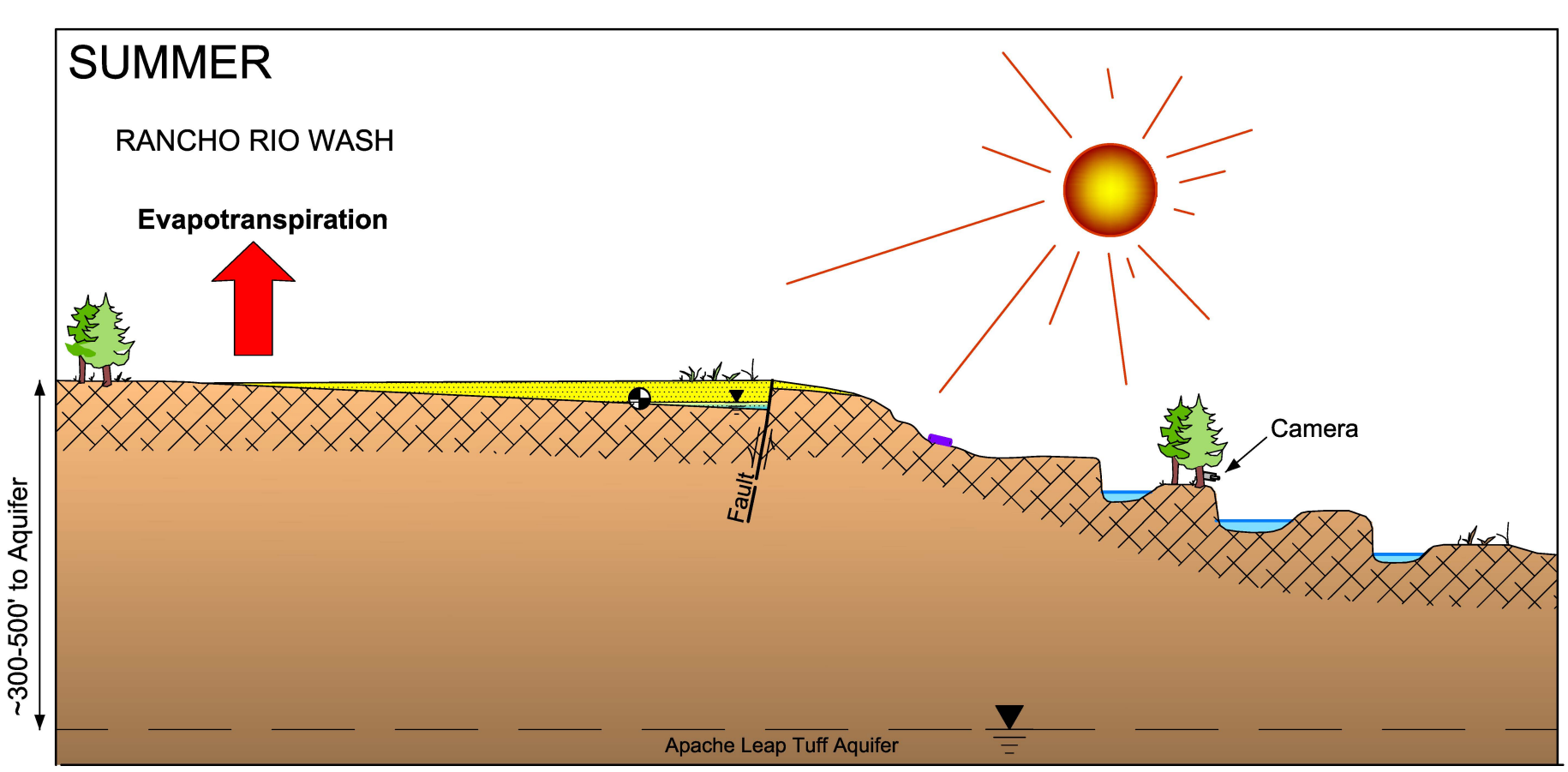

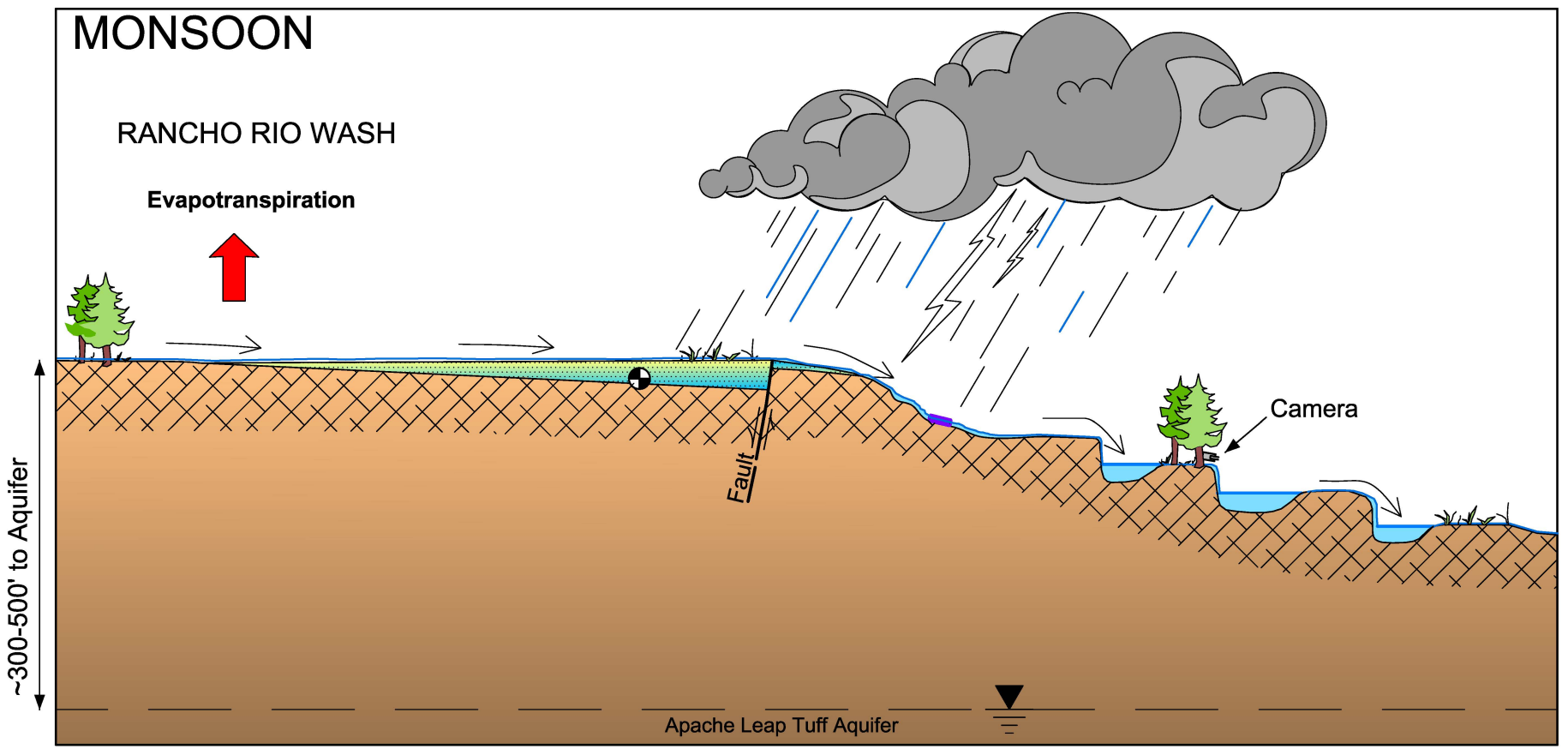

NOT TO SCALE

EXPLANATION

- Transducer
- Aqua TROLL (RR 1.5 C)
- Water
- Alluvium
- Bedrock

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SCHEMATIC OF RANCHO RIO CANYON MONITORING SITES

2017

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FIGURE 3

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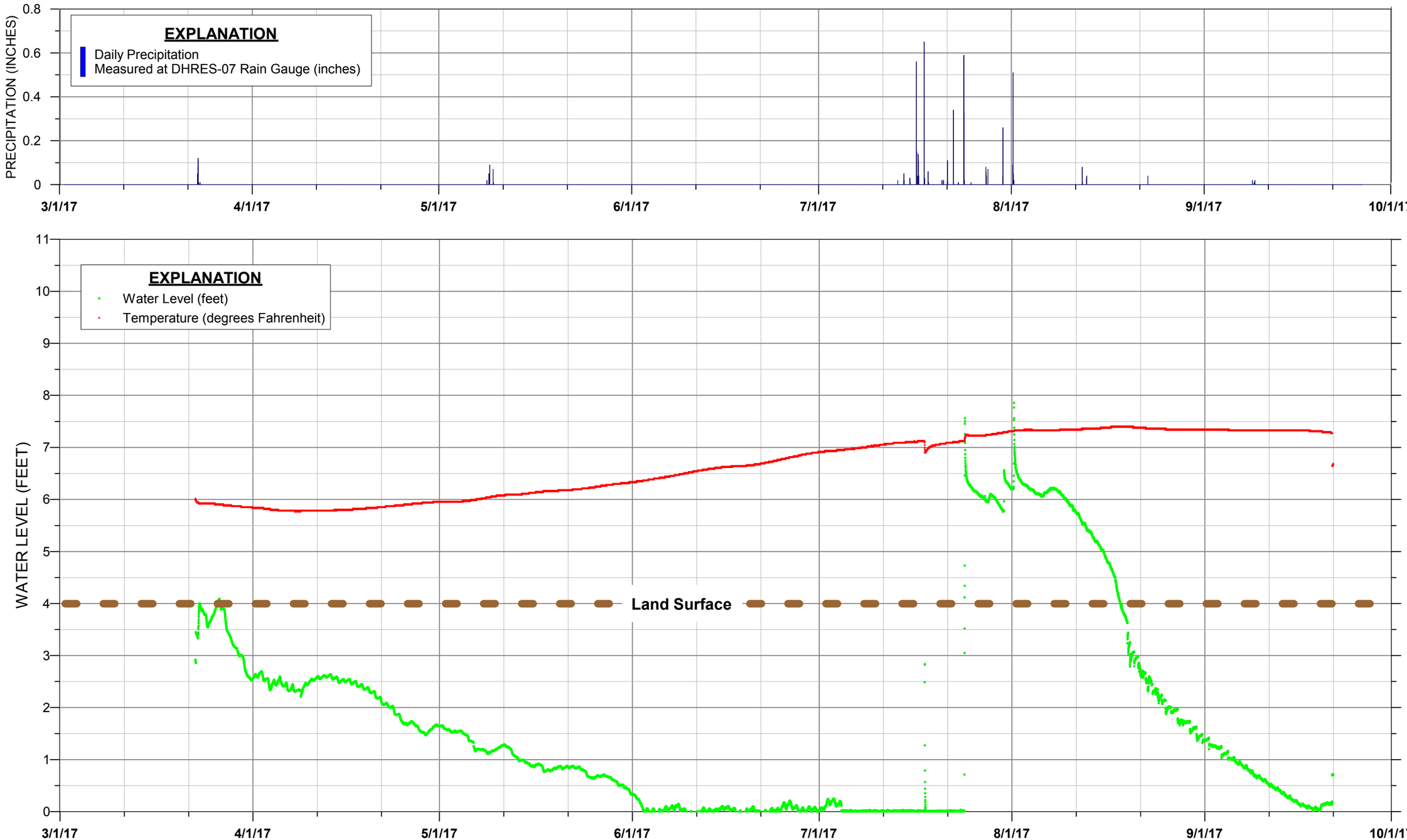

FIGURE 4. WATER LEVEL AND TEMPERATURE IN ALLUVIUM AT RANCHO RIO POND, AND PRECIPITATION AT DHRES-07 RAIN GAUGE, OAK FLAT, PINAL COUNTY, ARIZONA

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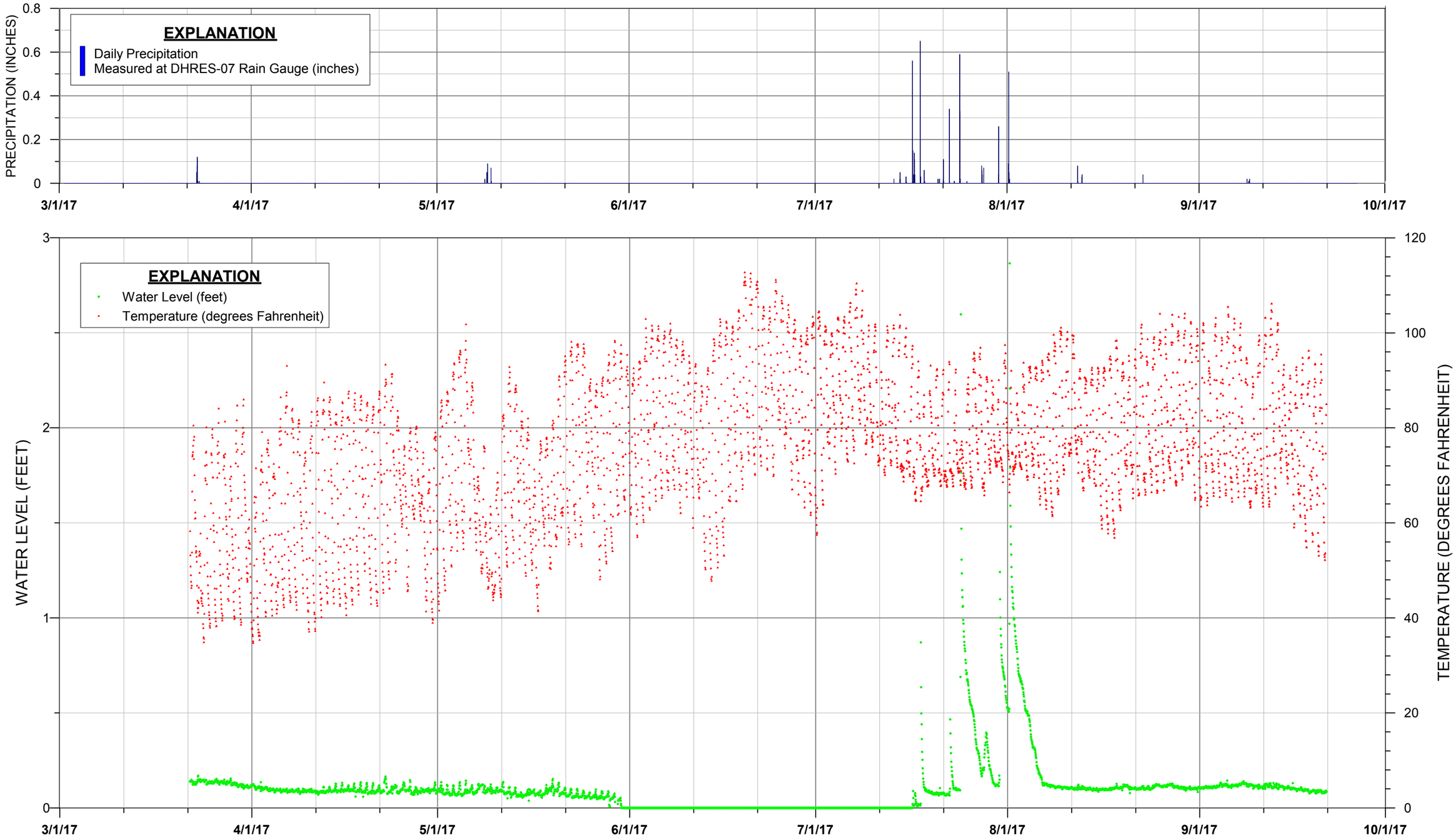
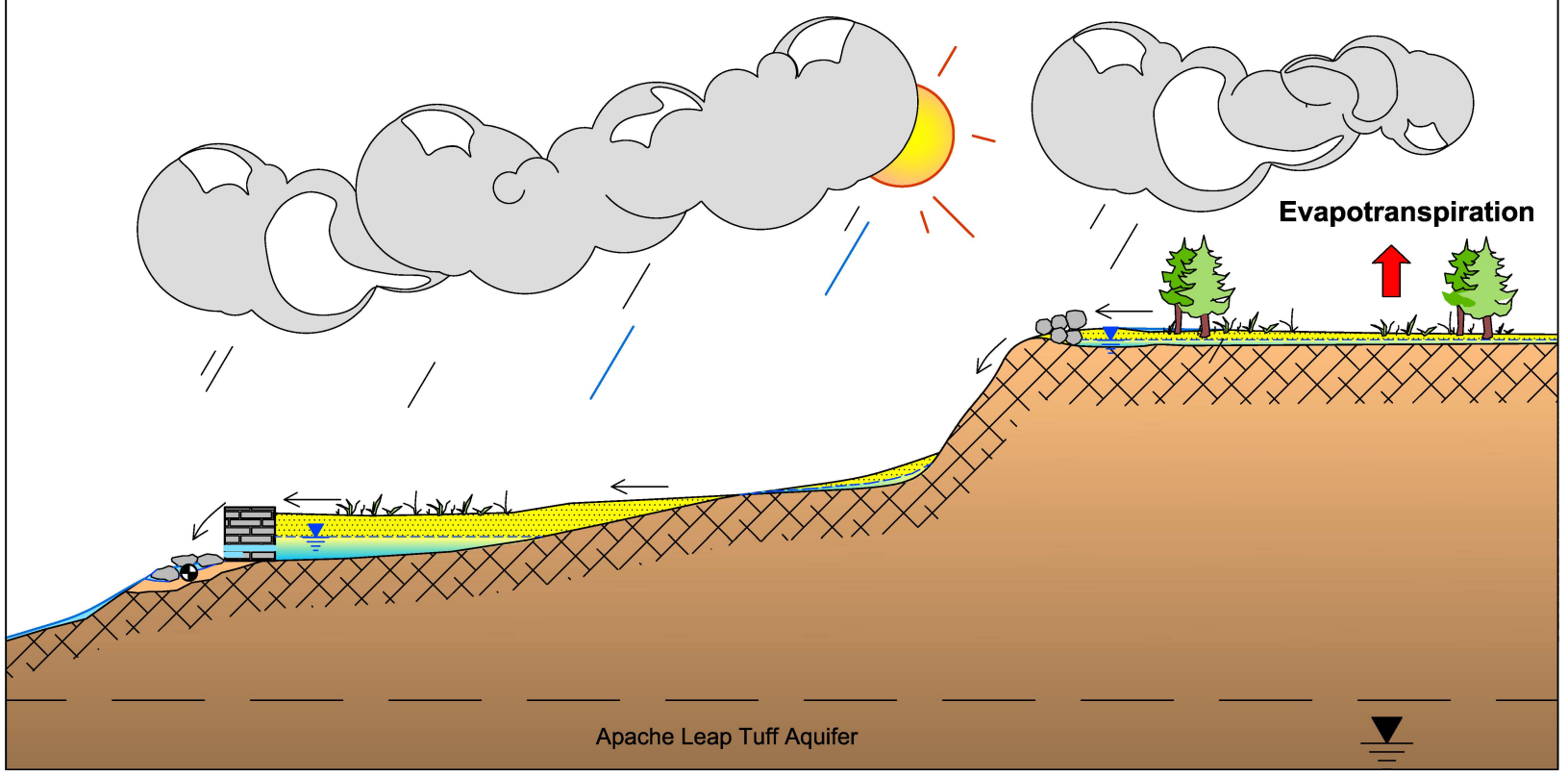
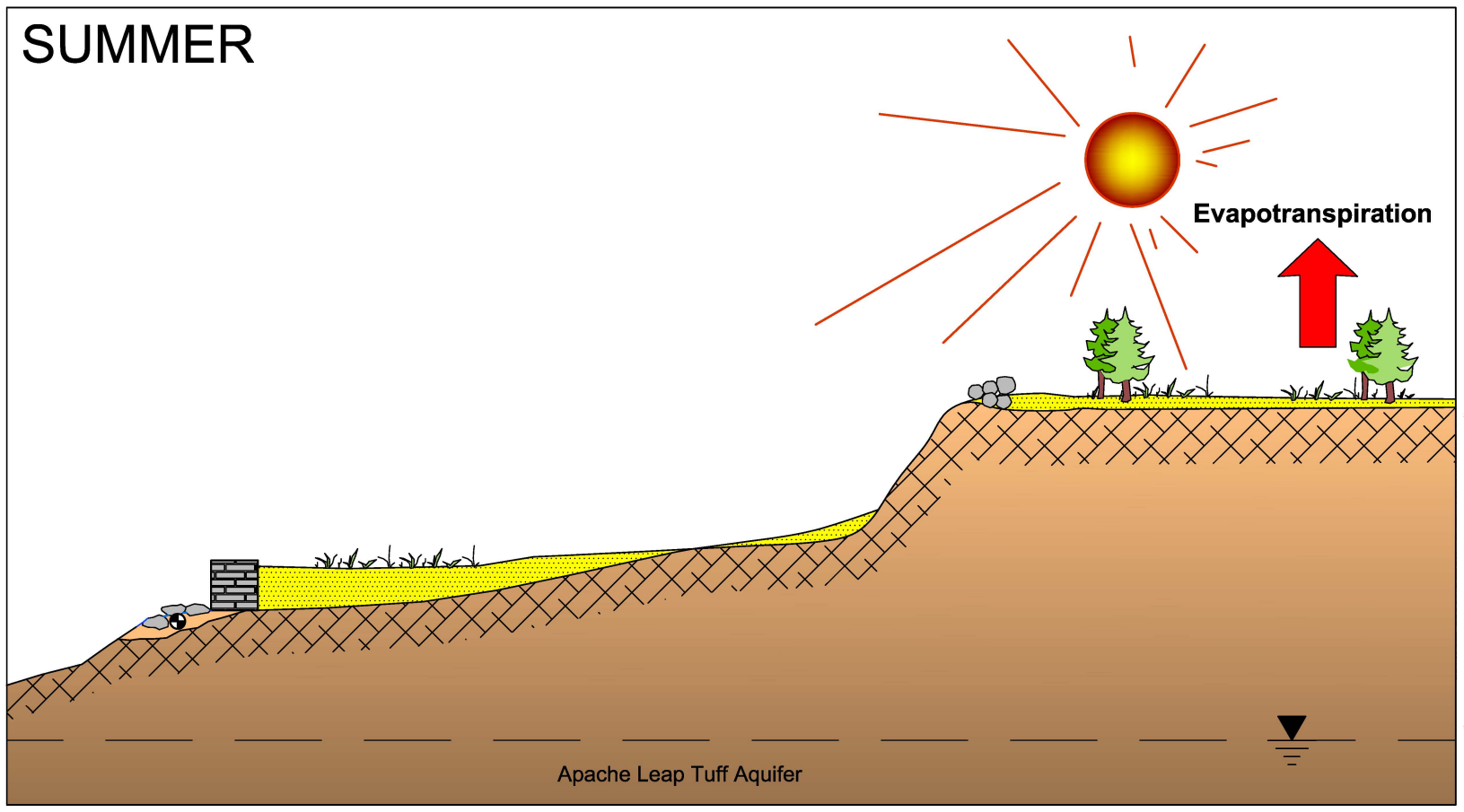


FIGURE 5. WATER LEVEL AND TEMPERATURE AT RR 1.5 C AQUATROLL, AND PRECIPITATION AT DHRES-07 RAIN GAUGE, OAK FLAT, PINAL COUNTY, ARIZONA

SPRING



SUMMER



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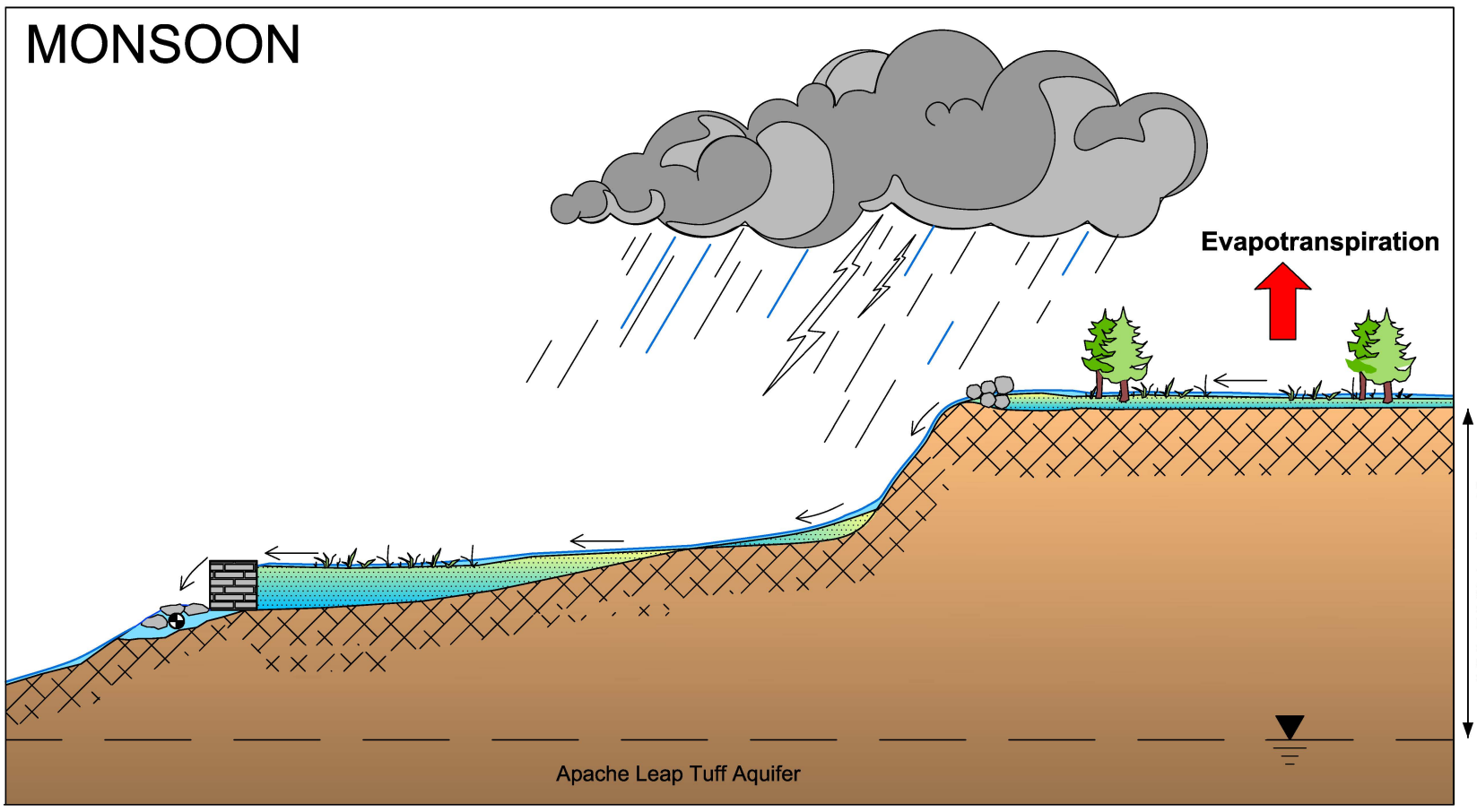

NOT TO SCALE

EXPLANATION

- Transducer
- Water
- Alluvium
- Bedrock

RESOLUTION COPPER

SCHEMATIC OF CHECK DAM AND RESERVOIR

2017

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FIGURE 6

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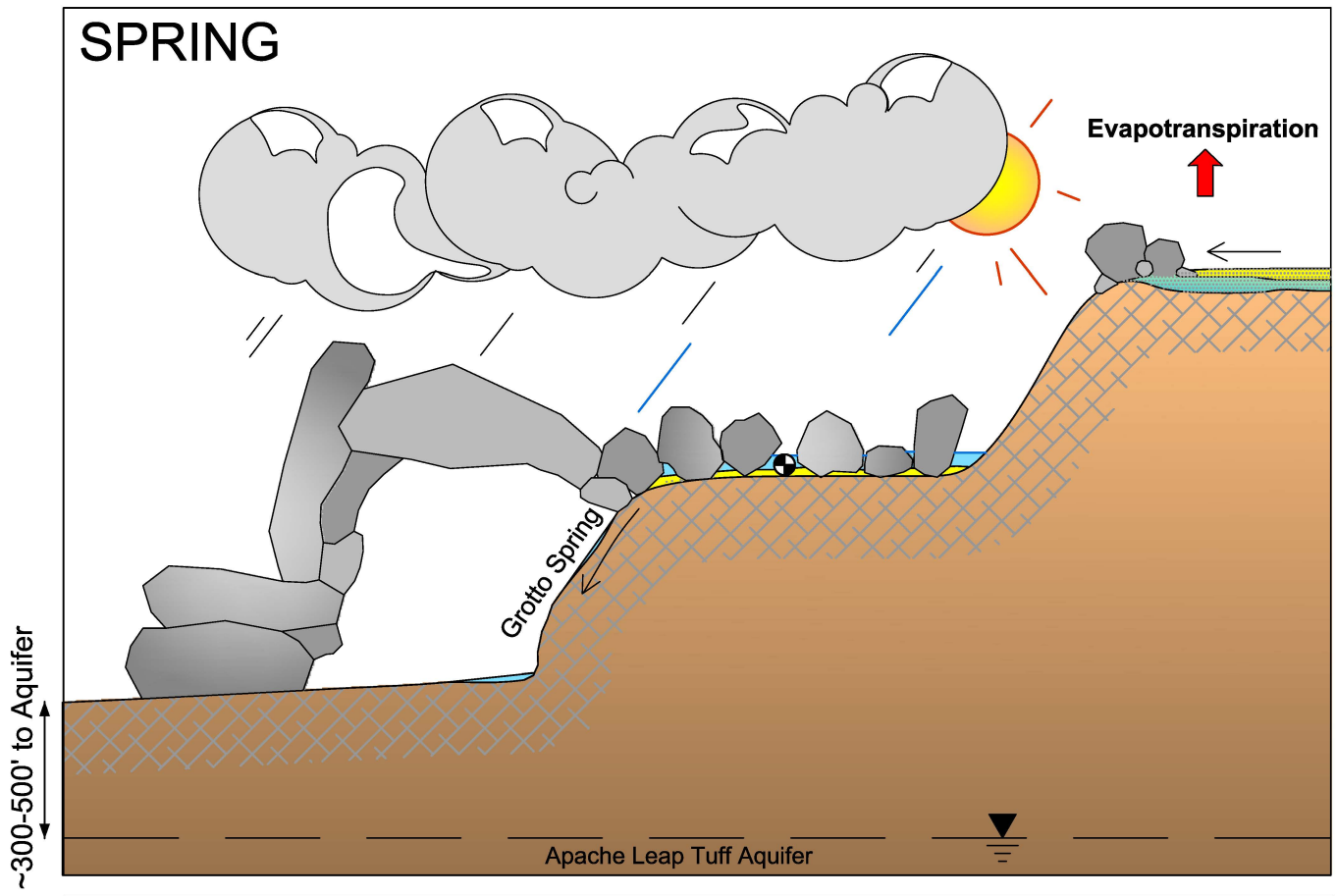

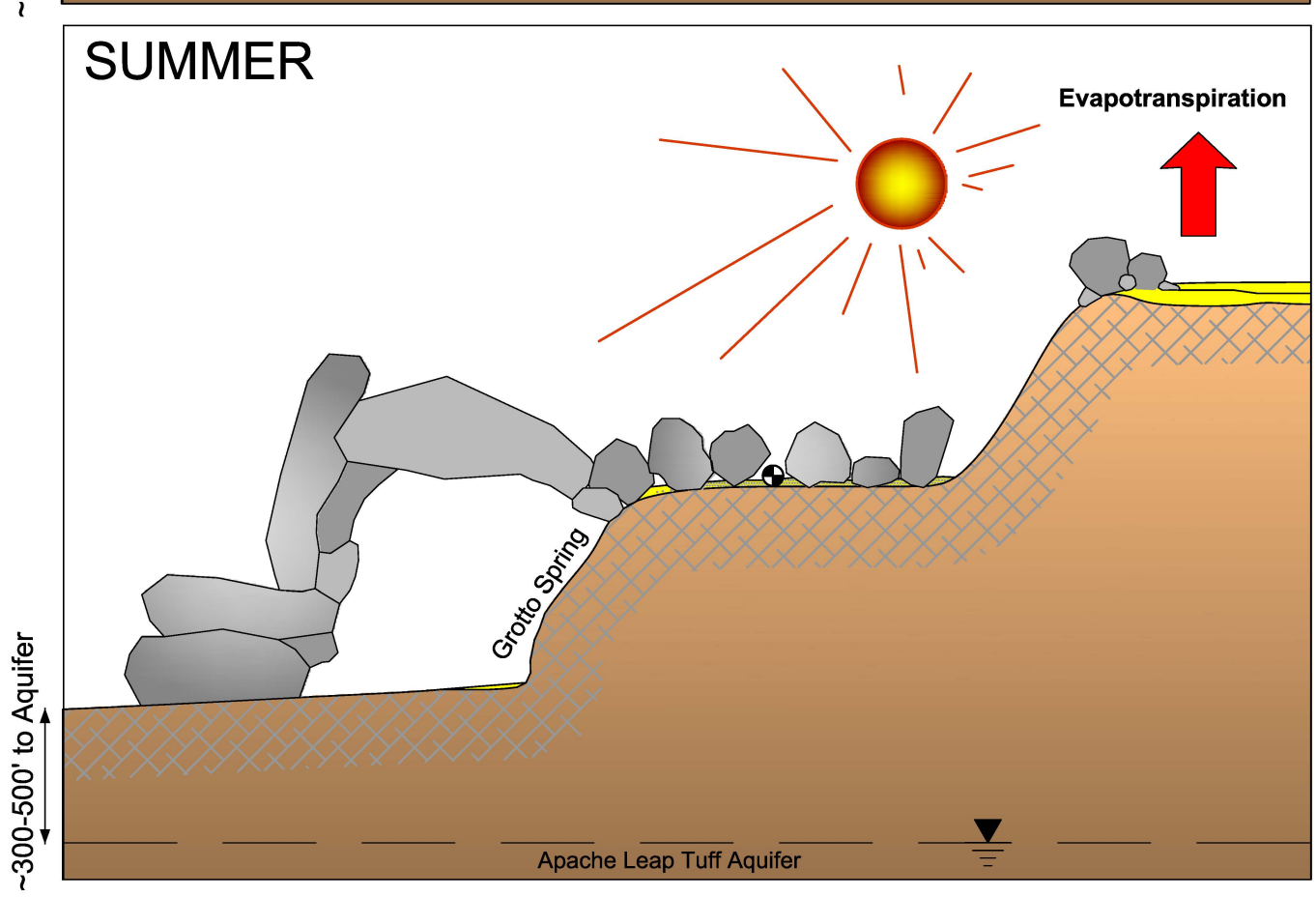

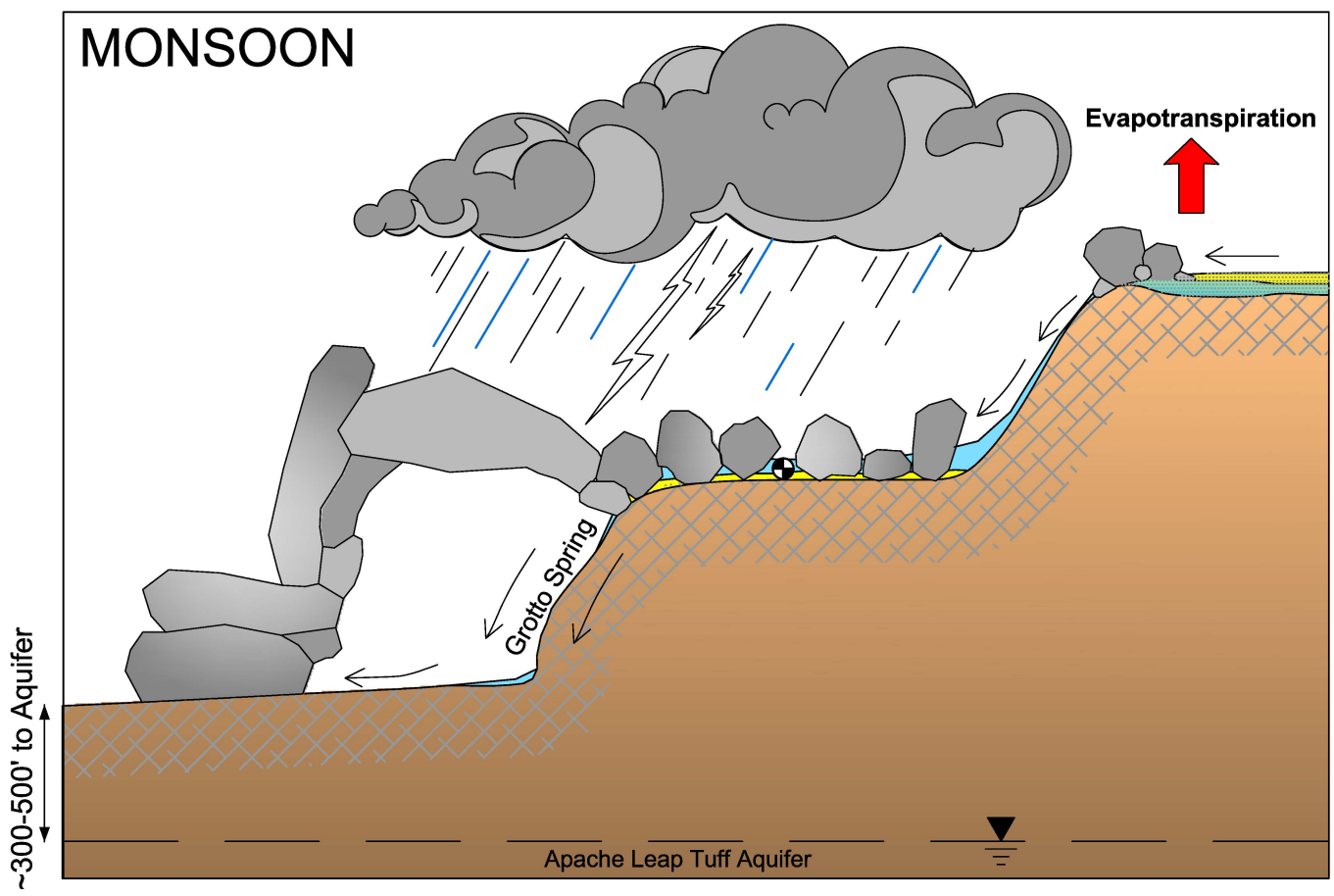

EXPLANATION

- Transducer
- Water
- Alluvium
- Bedrock

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SCHEMATIC OF GROTTO FEATURE

2017

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FIGURE 7

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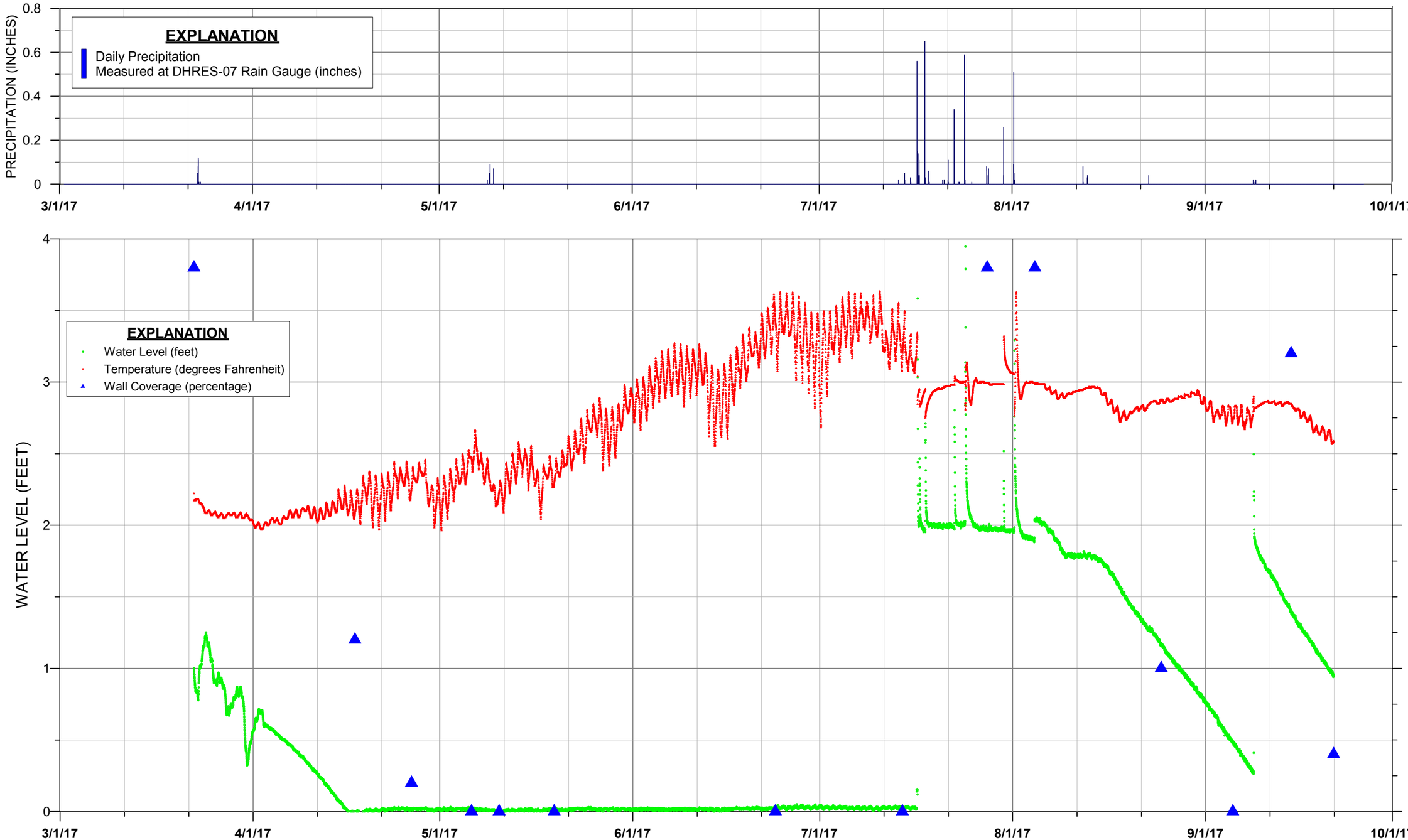

FIGURE 8. WATER LEVEL, TEMPERATURE, AND OBSERVED PERCENTAGE OF WALL SATURATION AT GROTTO LOCATION, AND PRECIPITATION AT DHRES-07 RAIN GAUGE, OAK FLAT, PINAL COUNTY, ARIZONA

RESOLUTION COPPER

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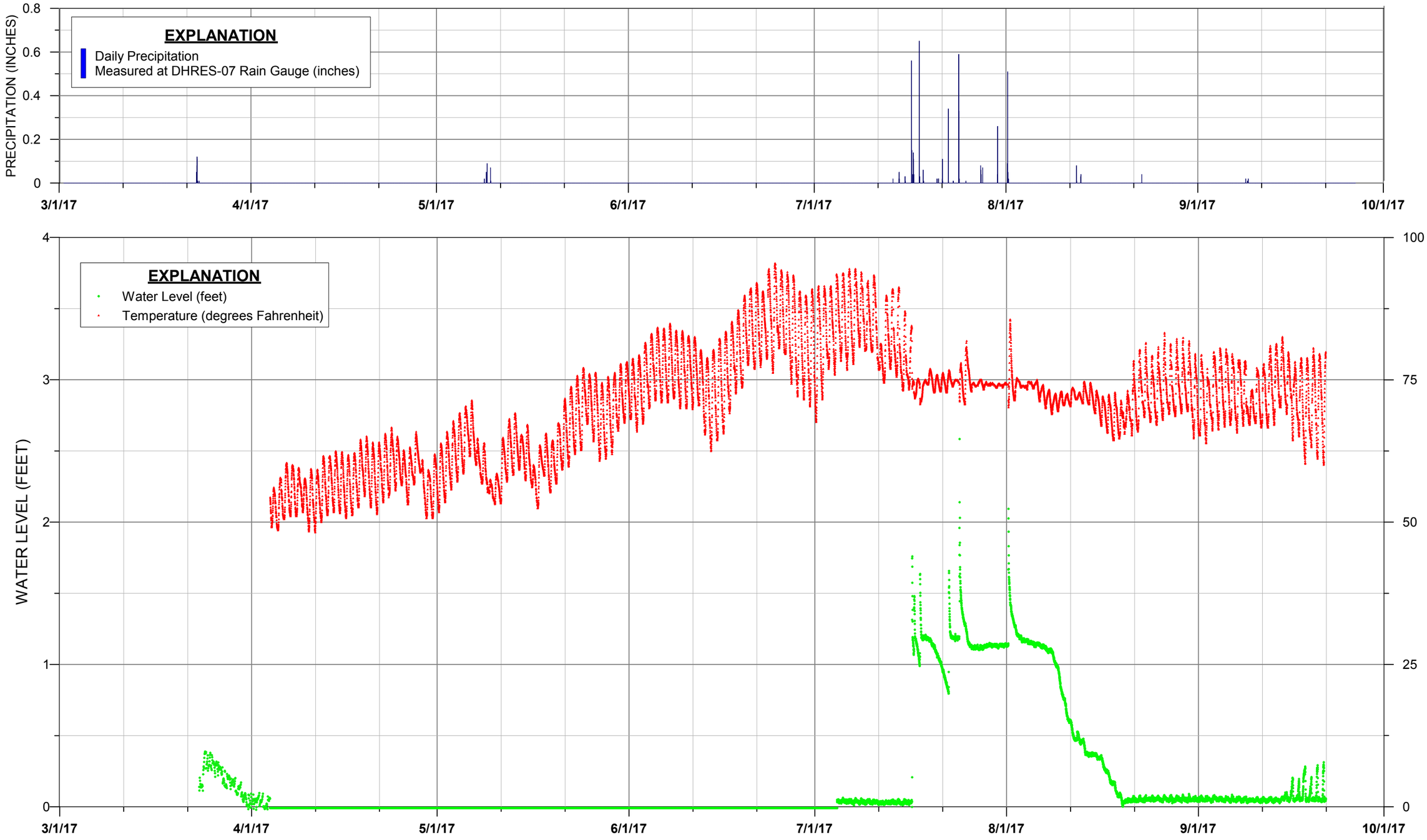

FIGURE 9. WATER LEVEL AND TEMPERATURE AT KP RESERVOIR, AND PRECIPITATION AT DHRES-07 RAIN GAUGE OAK FLAT, PINAL COUNTY, ARIZONA

RESOLUTION COPPER

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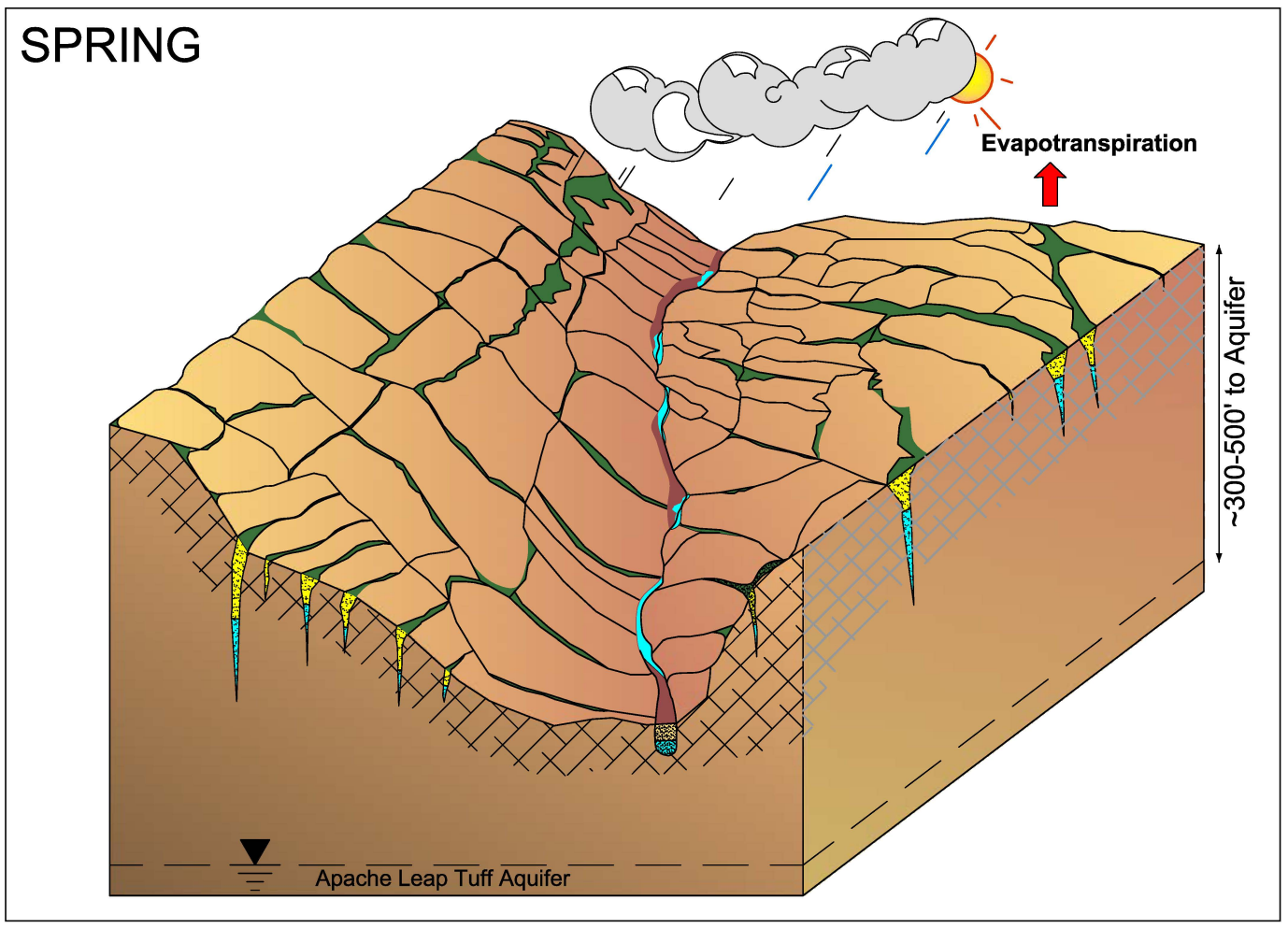

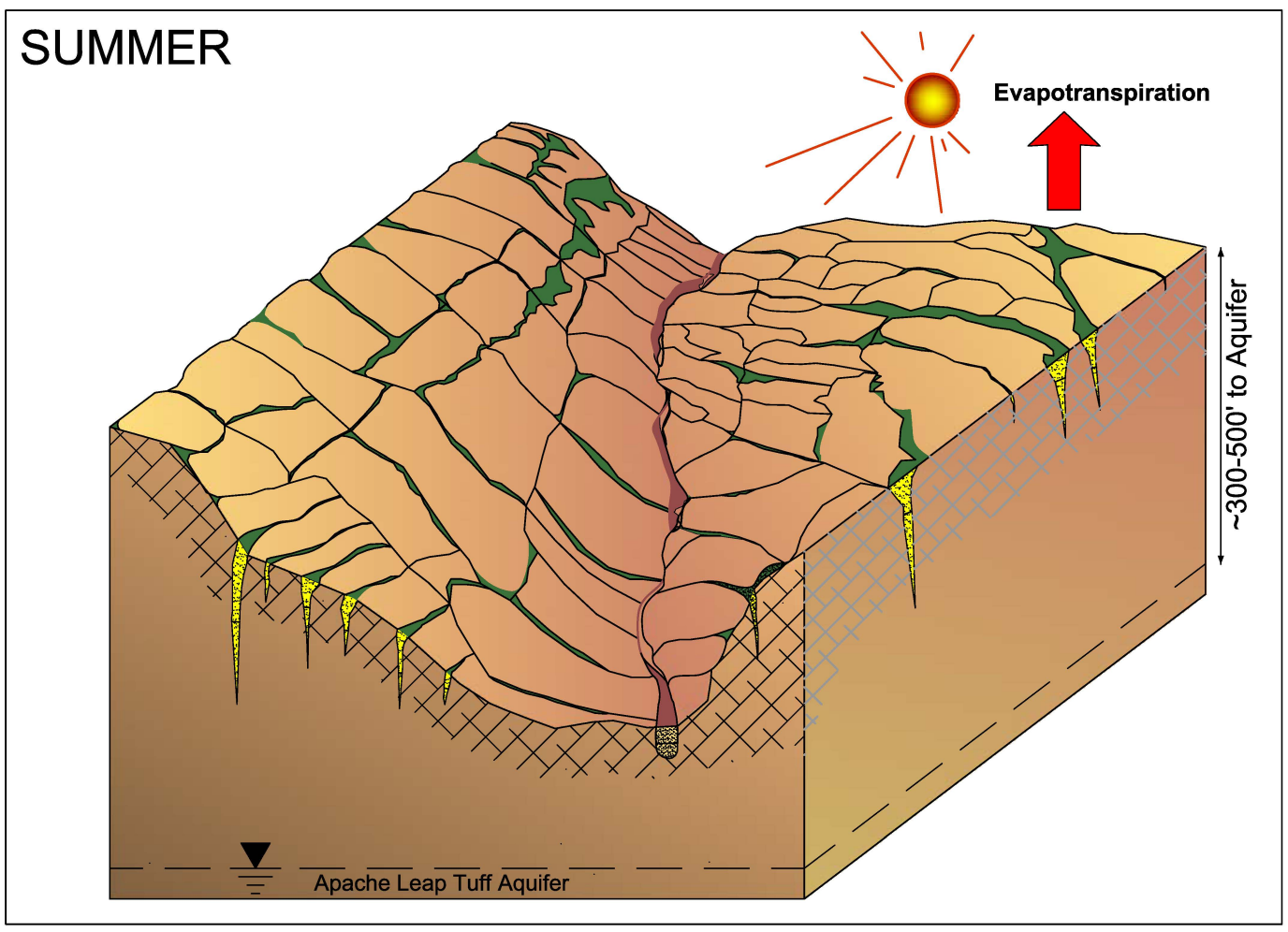

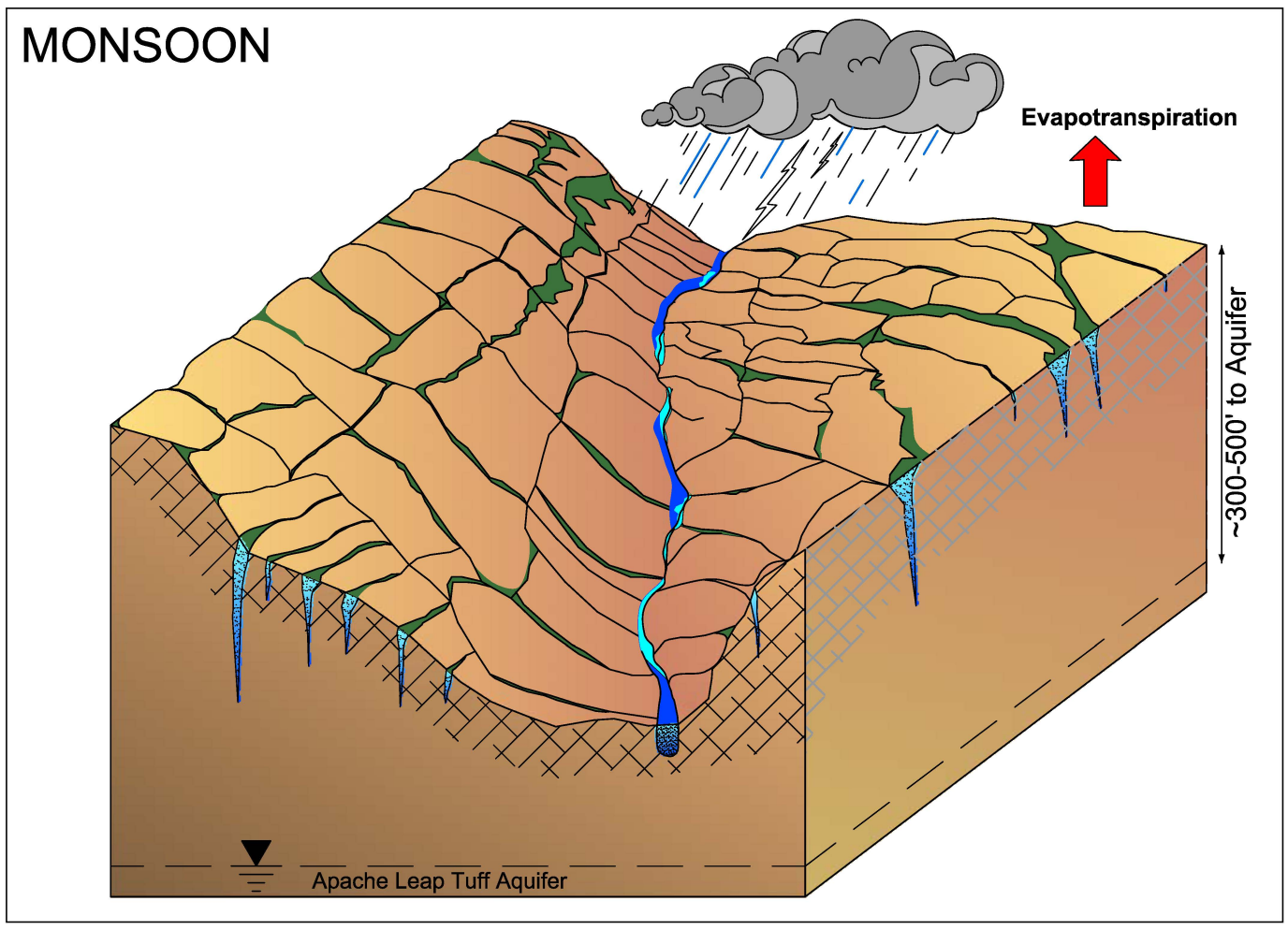

RESOLUTION COPPER

SCHEMATIC OF JOINT CAPTURE/RELEASE SYSTEM

2017

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FIGURE 10

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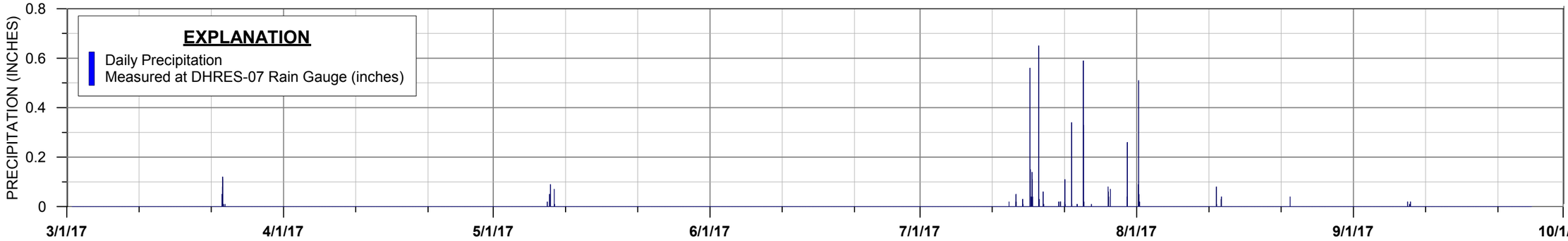

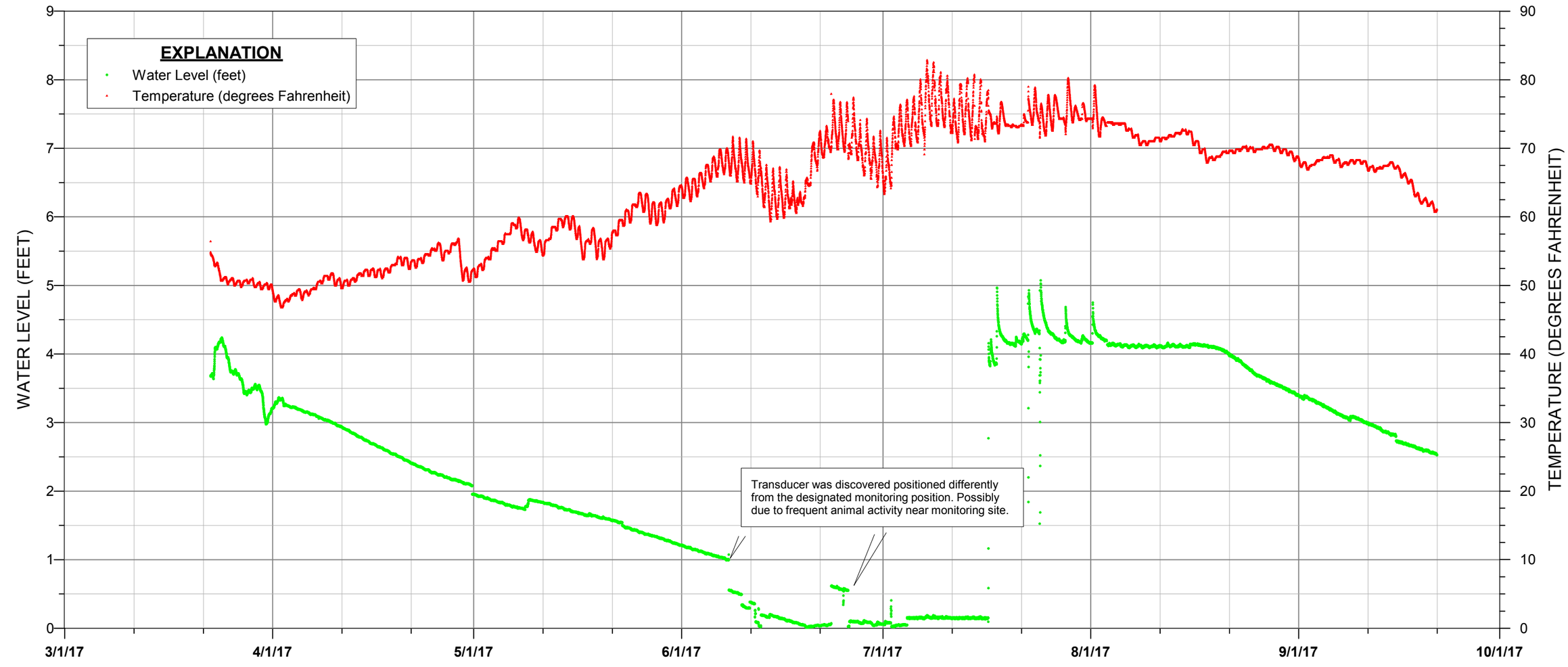

FIGURE 11. WATER LEVEL AND TEMPERATURE AT OAK FLAT TINAJA, AND PRECIPITATION AT DHRES-07 RAIN GAUGE OAK FLAT, PINAL COUNTY, ARIZONA

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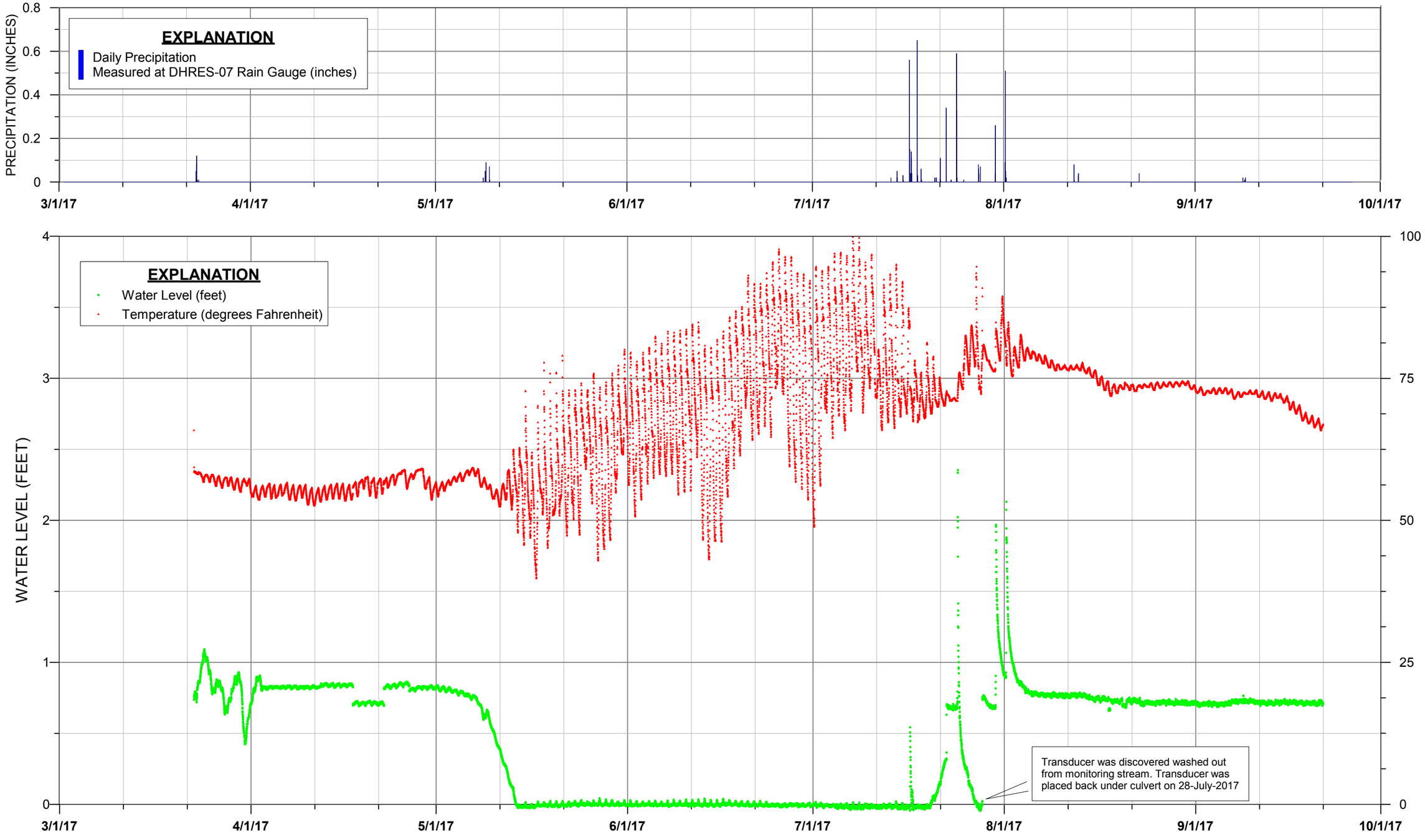

FIGURE 12. WATER LEVEL AND TEMPERATURE IN CULVERT BELOW OAK FLAT RESERVOIR DAM, AND PRECIPITATION AT DHRES-07 RAIN GAUGE, OAK FLAT, PINAL COUNTY, ARIZONA

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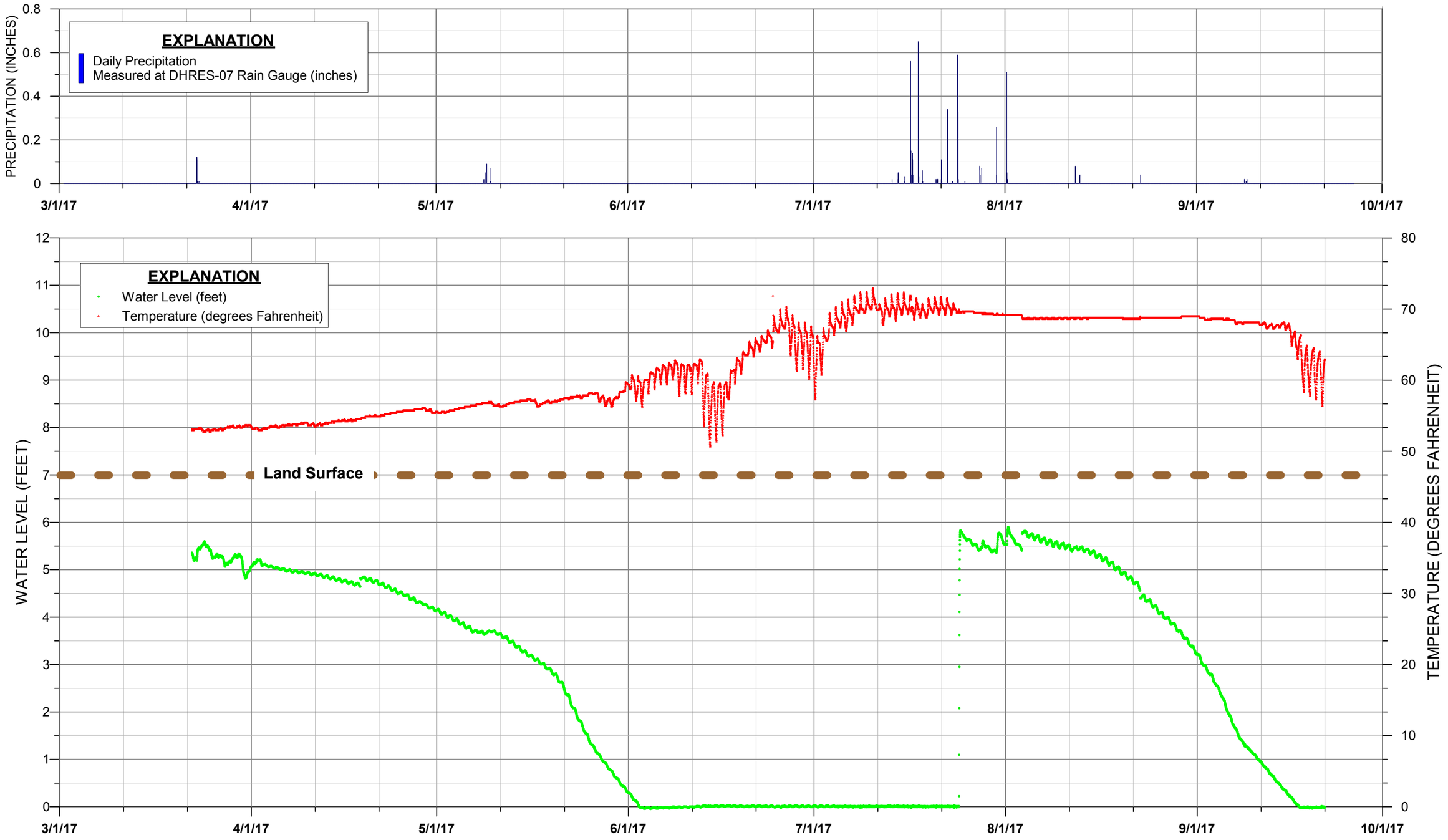

FIGURE 13. WATER LEVEL AND TEMPERATURE IN GIBSON WELL, AND PRECIPITATION AT DHRES-07 RAIN GAUGE OAK FLAT, PINAL COUNTY, ARIZONA

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Appendix A

Monitoring Site Photos (on flash drive)

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LETTER TO FILE

RECORD #: 0002599

DOCUMENT DATE: 11/13/2017

DOCUMENT TITLE: Appendix A - Field Photographs

AUTHOR: WestLand Resources Inc.

RECIPIENT:

SUMMARY: Locations [dates]: Above Grotto [3/22/17; 4/17/17; 4/26/17; 5/5/17; 5/11/17; 5/19/17; 6/5/17; 6/22/17; 7/14/17; 7/27/17; 8/4/17; 8/24/17; 9/5/17; 9/14/17; 9/21/147]. Anxiety Fault Pond [similar dates]. FS 2438 Check dam [similar dates]. Gibson Well [similar dates]. Grotto [similar dates]. KP Reservoir [similar dates]. Number 9 Wash Tinajas [similar dates]. Oak Flat Reservoir [similar dates]. Oak Flat Tinaja [3/22/17; 4/19/17; 6/24/17; 8/3/17; 9/22/17]. Rancho Rio [similar dates]. SS-1 [similar dates].

OTHER NOTES:

RESOLUTION COPPER EIS
LETTER TO FILE

RECORD #: 0002599

DOCUMENT DATE: 11/13/2017

DOCUMENT TITLE: Attachments

AUTHOR: Montgomery and Associates

RECIPIENT:

SUMMARY: Attachment 1: 2 videos of Rancho Rio. Attachment 2: 2 videos of FS 2438. Attachment 3: 2 videos of SS-1. Attachment 4: 2 videos of Oak Flat Tinaja.

OTHER NOTES:

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November 14, 2017

US Forest Service
Supervisor's Office
2324 East McDowell Road
Phoenix, AZ 85006-2496

Subject: Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – Baseline Surface Water Information

Dear Ms. Rasmussen,

Enclosed for your review and consideration, please find copies of the following baseline surface water report listed below:

Document Title	Document Date	Author (Organization)	File Key
2017 Oak Flat Surface Water Monitoring Program	NOV 2017	M&A	2017Oak Flat Monitoring Program.pdf

Should you have any questions or require further information please do not hesitate to contact me.

Sincerely,

Vicky Peacey,
Senior Manager, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining, LLC

Cc: Ms. Mary Morissette; Senior Environmental Specialist; Resolution Copper Company

Enclosure(s): Resolution Copper Mining, LLC – Mine Plan of Operations and Land Exchange – Baseline Surface Water Information