

Comprehensive Agreement No. 1

Second Annual Report

FY15
(July 1, 2014 – June 30, 2015)



BIG CHINO SUB-BASIN
WATER MONITORING PROJECT
PRESCOTT - PRESCOTT VALLEY - SRP

Prepared by:



October 2015

**Comprehensive Agreement #1
SRP/Prescott/Prescott Valley
Monitoring/Modeling Committee
FY15 Annual Report
(July 1, 2014 – June 30, 2015)**

Background

This is the second annual report of the Comprehensive Agreement #1 (CA#1) contract. The background for the overall project is further described in this section.

In a joint meeting of the City of Prescott and the Town of Prescott Valley on September 19, 2012, their Councils unanimously approved a comprehensive water monitoring and groundwater modeling agreement with Salt River Project and the Salt River Valley Water Users' Association (SRP) regarding the City's Big Chino Water Ranch Project. The agreement CA#1, was authorized by SRP's Board on September 10, 2012.

CA#1 evolved over two years of discussions among Prescott, Prescott Valley and SRP to implement a plan consistent with the February 11, 2010, Agreement in Principle among the same parties. The Agreement in Principle resolved longstanding differences pertaining to water rights in the Big Chino sub-basin, set forth a framework for future agreements, and ended litigation regarding plans to pump groundwater from the Big Chino Sub-basin as authorized by Arizona state law.

CA#1 set forth a program for enhanced water monitoring and modeling of groundwater flows in the Big Chino, confirmed the parties' rights to water arising from within the Prescott Active Management Area, and achieved a mutual agreement by all parties not to challenge those rights. CA#1 is a long term commitment to construct, implement and maintain the monitoring and modeling program, with the parties sharing in the long term cost.

The goals of data collection and monitoring plan are to:

- Improve the understanding of the hydrologic relationship between groundwater and surface water in the Upper Verde River area.
- Act as an early warning system for the Upper Verde Springs.

- Collect data that may be used to distinguish groundwater pumping from the Big Chino Water Ranch from the impacts of groundwater pumping by others, and natural system variability.
- Develop the ability to relate regional groundwater and surface water observations to future groundwater model calibration and verification.
- Determine if additional data are needed.
- Provide data for development of a numerical groundwater flow model.

Summary of Annual Accomplishments

Meetings

- Monthly meetings of the Monitoring and Modeling Committee
- Multi-agency meeting – 7/9/2014
- USGS Cooperator’s Meeting – 6/26/2015

Executed Documents or Coordinated Activities

- Collected and analyzed crop survey data in the Big Chino sub-basin (USGS, through an ADWR contract) for May and August, 2015.
- Coordination with Yavapai County Flood Control District to locate, install and maintain a weather station in Limestone Canyon. Station to be installed fall 2015.
- Coordination with Yavapai County Flood Control District to locate, install and maintain a radar stage gage on Williamson Valley Road Bridge over Walnut Creek. Stage gage installed 6/05/2015.
- Executed Special Use Permit Amendment (7/18/14) with Prescott National Forest for three gage sites.
- Executed Amendment Two to Independent Contractor Agreement for Big Chino Sub-Basin Ephemeral Stream flow Monitoring Contract with SRP (6/9/15)
- Executed Amendment No. 1 to Joint Funding Agreement with the USGS for Geophysical investigations and Gravity Monitoring (6/23/2015)
- Received land access agreement from Arizona State Land Department for USGS personnel to conduct geophysical investigations (2014).

Contract Requirements

- All parties made agreed monetary contributions for the Monitoring Plan for FY 2014

Public Information

- Presentations
 - Citizens Water Advocacy Group – Kornrumph (3/14/15)
 - Prescott Valley Citizens Academy – Munderloh (4/13/15)
 - Upper Verde River Watershed Protection Coalition – Graser/Munderloh (1/28/15)

- Arizona Hydrologic Society Meeting – Lee Ester (9/16/15)
- Verde River Basin Partnership – Lee Ester (12/17/15)
- City of Prescott website – continual updates

Status Reports Completed

- Big Chino Sub-basin Water Monitoring Project, Monsoon Season Report, July 1 – September 30, 2014.
- Big Chino Sub-basin Water Monitoring Project Winter/Spring Report: October 1, 2014 – June 30, 2015
- FY 14 Annual Report, Comprehensive Agreement #1, October 2012-June 30, 2014 SRP/Prescott/Prescott Valley Monitoring/Modelling Committee

Accounting/Budget

In accordance with CA#1, in particular Exhibit 5, the parties funded the project with initial startup contributions and then yearly contributions. The budget for the period of this annual report is shown in Table 1.

**Table 1 – Contract Budget
Including monitoring contributions for WAC equipment**

Entity	Startup Contribution	Year 1 Contribution	Year 2 Contributions ²		
			Monitoring	Modeling	WAC equipment ³
City of Prescott	\$4,296	\$239,097	256,359	156,380	22,061
Town of Prescott Valley	\$3,644	\$202,857	217,502	132,677	21,496
Salt River Project	\$351,550 ¹	\$250,000	286,931	144,529	0

¹ Per contract, the SRP contributed “catch-up” monies related to monitoring expenses already incurred by the other parties at start up. SRP contributions will be reduced in future years accordingly.

² Per contract, Exhibit 5, the parties began funding the modeling portion of the project.

³ Prescott and Prescott Valley were members of the former Yavapai County Water Advisory Committee (WAC) which had contracted with USGS for equipment in the Big Chino. The parties agreed to assume the equipment after verifying its continued importance to the CA#1; Prescott and Prescott Valley assumed the costs in Year 2.

Starting July 1, 2014, the CA#1 funding including monies for modeling, two separate accounts are in operation at the City of Prescott. The monitoring project account balance and expenditures as of June 30, 2015, were \$1,622,065.26 and \$182,895.31, respectively. The modeling project account balance and expenditure as of June 30, 2015 were 433,586.00 and zero, respectively. A detail of expenditures is shown in Table 2. At the date of this annual report, the parties are in the second year of the work plan which requires preparation for drilling of both shallow and deep monitor wells (see CA#1, Exhibit 4). Monitor well drilling along with the commencement of modeling activities will significantly drawdown the total balance of the capital account which is not explicitly shown.

Table 2 – Contract Expenditures

Description	Amount	Payment Date(s)
New Stream Gages	\$166,905.91	2/2/2015, 2/25/2015, 3/18/2015, 5/21/2015
Existing Stream Gage	6,760.18	2/2/2015, 3/18/15, 5/21/2015
Exiting Well Monitoring	3,729.22	2/2/2015, 3/18/2015, 5/21/2015
USGS Services	\$5,500	9/19/2014
Total	\$182,895.31	

CA #1 Monitoring Projects

CA#1 was executed with the knowledge of existing monitoring in the sub-basin, and new equipment required for groundwater modeling purposes. Although not all data collection to date is reflected in this annual report, basic information is provided for equipment that was identified as existing/new and related to CA#1 for budget purposes.

Established Monitoring Efforts

Groundwater Level Monitoring

From December 2005 to May 2007, the drilling of six (6) wells was attempted; five (5) were completed successfully. These new wells and one (1) existing well were intended for water level monitoring (Table 3). Both ADWR and USGS monitor these wells with either continuous data recorders or with a less frequent manual well sounder. The hydrographs for these wells are shown in Map 1. Since 2008, SRP has maintained a continuous recording transducer in the Gipe well located north of Paulden (Table 3). The hydrograph for this well is also shown in Map 1.

Table 3 –Monitoring Wells Established Under CA#1

Name	Cadastral Location	Completion Date	Comments
WMW-1	B-20-04 19CBA	1956	<u>Data collection by either ADWR or USGS</u>
WMW-2	B-20-04 33CBD2	2006	<u>Data collection by either ADWR or USGS</u>
WMW-3	B-19-04 10CCB2	2006	<u>Data collection by either ADWR or USGS</u>
BMW-3	B-18-04 01ACA2	2007	<u>Data collection by ADWR</u>
BMW-1	B-18-04 11ACC	2003	<u>Data collection by ADWR</u>
BCMW-1	B-18-04 25AAA2	2006	<u>Data collection by ADWR</u>
Gipe Well	B-18-01 17AAA	2008	Installed by SRP with cooperative funding from the Drake Mine

Streamflow Monitoring

In April 2005 SRP, in cooperation with Arizona Game and Fish Commission, installed the Campbell Ranch Low-flow gage. The data can be viewed at http://www.watershedmonitor.com/siteDetail.aspx?dbNm=stratos&statn_id=VerdeHeadWtr&kw=WW_MidVerde. The location of the Campbell Ranch gage is displayed on Map 2 and the annual hydrograph is provided in Map 4.

Because of the variable nature of stream flow in ephemeral streams, the CA #1 Committee accelerated the plan to install additional stream gages in the Big Chino Sub-basin. Stream gages identified in the CA#1 Hydrologic Monitoring Plan were primarily installed between June and October 2014, with some later additions due to site characteristics or land access issues. These stream flow monitoring sites are summarized in Table 4 and with the general locations shown on Map 2. The annual hydrographs are displayed in Maps 3 and 4.

Table 4 – Stream-flow Monitoring Sites Established Under CA#1

Name	Completion Date	Comments
Campbell Ranch Low-flow gage	4/2005	
Williamson Valley Wash Near Paulden	1965-1985 2002-Current	USGS Gage 09502800
Big Chino Wash below Partridge Creek	6/26/2014	
Lower Big Chino Wash	5/21/2014	
Lower Walnut Creek at Charney Property	6/10/2014	
Lower Williamson Valley Wash	5/22/2014	
Pine Creek	5/19/2014	
Upper Big Chino Wash	1/16/2014	
Upper Walnut Creek at Bridge	6/26/2014	
Upper Walnut Creek at Forest Service	10/1/2014	Displaced and reinstalled
Williamson Valley Wash at XU Ranch	6/12/2014	
Upper Walnut Creek at Bridge	6/05/2015	Yavapai County Flood Control District

New Monitoring Sites/Data Collection Efforts

Walnut Creek Flume

On October 1, 2014, SRP personnel completed the installation of the Walnut Creek Flume near the Walnut Creek Research Center. This reach of Walnut Creek and the upstream tributary of Apache Creek are rare examples of perennial flow in the Big

Chino Sub-basin. The flume was installed to provide an accurate measurement of smaller, consistent flows.



Walnut Creek Flume after installation, looking upstream (October, 2014) and after storm damage, looking upstream (January, 2015).

On January 30, 2015, a high-flow event significantly damaged the flume. The flume was reinstalled on 6/22/2015 with earthen, rather than metal, wing walls. This design feature allows the earthen wing walls to be eroded by high flows and pass around the flume rather than push the flume along with the wing walls. Following a large event in the future, the flume can be easily reinstalled.

Upper Walnut Creek at Bridge

Yavapai County Flood Control District (YCFCD) worked with the CA#1 Monitoring Committee to provide future stage measurements at the Walnut Creek Bridge. A missing component of the stream flow monitoring network has been the ability to monitor high flows on Upper Walnut Creek. As described above, the low-flow flume at Upper Walnut Creek is not capable of monitoring larger flows, and the site is not conducive to a typical Flowtopography installation due to channel characteristics. Land access issues prevented the installation of Flowtopography equipment elsewhere on Upper Walnut Creek. However, Yavapai County Flood Control District operates a pressure transducer stage gage at the Williamson Valley Road Bridge over Walnut Creek and recently added a radar stage gage at that site (installed on 6/05/2015). SRP also installed a Flowtopography camera on the bridge site that will provide supporting information to the radar stage data. According to YCFCD, the elevation of the channel floor at this location increases or decreases channel depths depending on specific flow event characteristics. The down-looking radar installation will be more effective at recording flow stage compared to a pressure transducer buried in the floor of a channel with variable depths of cover. The USGS

will assist in providing high flow measurements from the bridge upon request. These measurements will assist in developing the stage-discharge relationship.

Weather Stations

The CA#1 Monitoring Committee also worked to establish additional weather stations in the Big Chino Sub-basin. The original monitoring plan identified possible locations on Big Black Mesa, in the floor of the Big Chino Sub-basin and in the mountains on the west side of the Sub-basin. After careful consideration, the CA#1 Monitoring Committee decided that the intent of the plan was to gather data sufficient to determine Evapotranspiration (ET) rates at a variety of elevations in the Sub-basin and to monitor precipitation rates throughout the basin. YCFCD, the National Weather Service and the USGS currently operate fifteen (15) precipitation and weather stations throughout the Big Chino Sub-basin. Map 5 shows the weather stations located in the central portion of the Big Chino Sub-basin, other stations within the basin are outside of the map extent. A listing of the weather stations is included in Table 5.

Table 5 - Existing Weather Stations in the Big Chino Sub-basin

Station Name	Responsible Agency	Data Collected
Granite Basin	YCFCD	Precipitation
Walnut Creek	YCFCD	Precipitation/Stage
Big Chino Wash @ SR 89	YCFCD	Precipitation/Stage
CYFD @ Outer Loop Rd	YCFCD	Precipitation
Hyde Mountain	YCFCD	Precipitation
Williamson Valley FD	YCFCD	Precipitation
Seligman Airport	YCFCD	Precipitation/Weather
Ash Fork Draw @ I-40	YCFCD	Precipitation/Stage
Partridge Creek @ I-40	YCFCD	Precipitation/Stage
Crookton	YCFCD	Precipitation
Big Chino Water Ranch ¹	YCFCD	Precipitation/Weather
Williamson Valley Wash	USGS	Precipitation/Stage/Flow
Verde River near Paulden	USGS	Precipitation/Stage/Flow
Camp Wood nr Bagdad CPWA3	National Weather Service	Precipitation
Ashfork 12 NW ASFA3	National Weather Service	Precipitation

¹Big Chino Water Ranch was installed in 2014 but is considered one of the new sites discussed below.

The CA#1 Committee decided that the existing precipitation monitoring network was sufficient for most parts of the basin but lacking in the Big Black Mesa area and that

weather stations appropriate for calculating ET rates needed to be established at the low and high elevation parts of the Sub-basin. At the request of the CA#1 Monitoring Committee, YCFCD agreed to install, operate and maintain two of the identified sites at no cost to the CA#1 Program. YCFCD installed a full-service weather station on the Big Chino Water Ranch on 10/29/2014 and incorporated the station data into their flood warning network. YCFCD also agreed to install, operate and maintain a precipitation station on Big Black Mesa (Limestone Canyon). This station is currently waiting for access approval from the Prescott National Forest (PNF).

The CA#1 Monitoring Committee identified a high elevation location for a full-service weather station on the southwestern flank of Juniper Mesa at George Wood Canyon. Installation and operation of this site was contracted with SRP in Amendment Two to the Independent Contractor Agreement. This site will also incorporate a “Snowtopography” gage to help monitoring snow conditions on the watershed. Snow condition data will provide critical information for estimating runoff characteristics after a precipitation event. This data will inform the CA#1 Committee and SRP Field Services personnel about the possibility of sustained runoff conditions and opportunities for making direct stream measurements. A land access agreement is currently waiting for approval from the Prescott National Forest. The equipment is in storage and ready to be installed pending approval of the agreement. Table 6 lists information on these new sites and Map 5 shows their location.

Table 6 – New Climatic Monitoring Equipment

Name	Installed (Y/N)	Completion Date	Comments	Data Collected
Big Chino Water Ranch	Y	10/29/2014	YCFCD operated	Wind, Precipitation Barometric Pressure, Temp., Rh, Dewpoint
Big Black Mesa (AKA Limestone Canyon)	N	Fall, 2015	YCFCD operated – pending access from PNF	Precipitation
George Wood Canyon	N	Fall, 2015	SRP Operated - pending access from PNF	Wind, Precipitation. Snow Depth, Barometric Pressure, Rh, Temp

Yavapai County Water Advisory Committee Data Collection Efforts

Before the start of the CA#1 monitoring program, the Yavapai County Water Advisory Committee (WAC) maintained a number of monitoring sites within the Big Chino Sub-basin under a Joint Funding Agreement with the USGS. The WAC was dissolved by action of the Yavapai County Board of Supervisors on July 7, 2014. Prescott and Prescott Valley, as charter members of the WAC, agreed to continue the WAC's data collection efforts within the Big Chino sub-basin with some of the funding that would typically have been used for WAC membership dues. This data collection effort involved eleven (11) aquifer storage monitoring sites that utilize both gravity and water level measurements (See Map 6). Two of these site are located outside (south) of the map extent. Also included in the WAC's data collection efforts were the USGS stream gage on Williamson Valley Wash (USGS 09502800 Williamson Valley Wash near Paulden, AZ), continuous water level monitoring at five (5) wells (B-18-03 26BDB1, B-20-04 33CBD2, B-20-04 19CBA, B-19-04 10CCB2 and B-19-04 05ABA) and limited isotope and/or noble gas sampling. The WAC's contract period with the USGS expired on September 30, 2014. In this report period, the CA#1 Committee evaluated the usefulness of this data collection effort and agreed to continue the "WAC Monitoring Program" by adding those elements to the existing contract with USGS in Amendment No. 1, approved by Prescott City Council on June 23, 2015. Funding for this continued effort was provided through additional contributions to the fund from Prescott and Prescott Valley. The "WAC Monitoring Program" will simply be absorbed into the overall CA#1 monitoring effort.

Aquifer Storage Monitoring Sites

During the reporting period, the USGS completed the installation of seventeen (17) new aquifer storage monitoring sites (See Map 6) and began data collection efforts at these sites, including collecting groundwater levels at various wells associated with the aquifer storage monitoring sites. In total, 28 aquifer storage monitoring sites are now in place and being monitored by the USGS.

Geophysical Surveys

In April 2015 the USGS began geophysical surveys of Phase 1 as defined by the USGS Work Plan under Contract No. 2014-160 with the City of Prescott. Soon after surveys were initialized the USGS proposed an additional geophysical survey line in the Upper Verde Springs area near King Spring. This additional line was added to the USGS Contract in Amendment No. 1. Initial survey work in that area revealed possible faulting and groundwater conduits in that area that could have important

consequences on the future groundwater model and in locating future monitoring wells.

The USGS completed approximately half of the geophysical survey efforts in Phase #1 as outlined in the contract. The geophysical survey profiles are shown in Map 6.

Analytical Results and Data Collected

The results of the data collection efforts are being reported by the various agencies within a variety of reporting formats. One of the duties of the CA#1 Monitoring Committee is to coordinate and monitor these efforts so that the results are useful for the groundwater modeling and monitoring purposes outlined in CA#1. An explanation of how these various efforts are reported or recorded is provided below:

Groundwater Monitoring

Groundwater level monitoring efforts are being completed both under contract with the CA#1 program (e.g. aquifer storage monitoring and continuous water level monitoring under the USGS contract) and through traditional water level monitoring efforts conducted by the Arizona Department of Water Resources.

Efforts by the USGS

The USGS will produce a data report for the CA#1 program on the aquifer storage monitoring results (gravity data combined with water level data) near the end of the contract period (estimated summer 2017). Data that is collected in the interim is provided to the CA#1 Committee in regular presentations by the USGS and housed electronic format by the CA#1 Monitoring Committee and by the USGS.

Efforts by ADWR

ADWR collects annual water level data at 101 index wells in the Big Chino Sub-basin (including 9 automated telemetry sites) and tries to conduct water level “sweeps” of a larger number of wells approximately every five years. ADWR projects that their next water level sweep of the Big Chino Sub-basin will occur in 2017 and their last sweep occurred in 2009. ADWR maintains this information in the Groundwater Site Index (GWSI) data base that is hosted on-line at www.azwater.gov.

Streamflow Monitoring

Streamflow monitoring efforts in the Big Chino Sub-basin are conducted by SRP and by the USGS under contracts with the CA#1 Program. The USGS also maintains another stream gage outside of the CA#1 Contract and flow stage data is collected by YCFCD for flood control purposes.

Efforts by SRP

SRP Field Services conducts the majority of the stream gaging data in the Big Chino Sub-basin under contract with the CA#1 Program. Two interim reports were completed during the reporting period to document the results of the flow monitoring program. The reports document monitoring activities during the summer monsoon season and the rest of the year. The following reports are included in Attachment 1 and 2: The annual hydrographs combining stream flows from both reports are shown in Maps 3 and 4.

Big Chino Sub-basin Water Monitoring Project Monsoon Season Report: July 1 – September 30, 2014

Big Chino Sub-basin Water Monitoring Project Winter/Spring Report: October 1, 2014 – June 30, 2015

Efforts by USGS

The USGS operates two stream gages in the Big Chino Sub-basin. The Williamson Valley Wash near Paulden gage is funded through the CA#1 Program and the Verde River near Paulden gage is funded through a separate program with SRP, the U.S. Forest Service and the USGS. Stream flow records for these sites are maintained by the USGS in their on-line database: <http://waterdata.usgs.gov/az/nwis/rt>

Efforts by Yavapai County Flood Control District

YCFCD collects flow stage data at four locations in the Big Chino Sub-basin; Ashfork Draw at I-40, Partridge Creek at I-40, Big Chino Wash at Highway 89, and Walnut Creek at Walnut Creek Bridge. The CA#1 Committee and SRP Field Service evaluated these sites for their usefulness in converting flood stage data into stream flow records. Of the listed sites only the Walnut Creek Bridge stage data will be used for calculating stream flow.

Climatic Data

Climatic data collected by various agencies are stored on their respective websites as shown in Table 7. Most of the information can be obtained in real time and is useful for predicting runoff characteristics for stream gaging. The accumulated climatic data will be used for groundwater modelling and estimates of soil evaporation and plant transpiration from the sub-basin.

Table 7 – Climatic Data Sites in the Big Chino Sub-basin

Agency Name	Data Portal
YCFCD	http://weather.ycflood.com/
USGS	http://waterdata.usgs.gov/az/nwis/rt
NWS-HADS (Camp Wood – CPWA3, Ashfork – ASFA3)	http://www.nws.noaa.gov/oh/hads/
Historic Climatic Data	http://www.wrcc.dri.edu/summary/climsmaz.html

Efforts by SRP

SRP Field Services will operate the weather station in George Wood Canyon and maintain the data once this station is installed (predicted installation in fall 2015). This station will provide the only snow accumulation information within the Big Chino Sub-basin. The data will be reported in the seasonal stream gaging reports provided by SRP.

Crop Surveys and Estimated Crop Water Use

The USGS, under contract with ADWR, conducted crop surveys in the Big Chino Sub-basin in May and August, 2014. The results are shown in Table 8 and 9, and depicted in Maps 7 and 8. Approximately 53% of the irrigable lands that were surveyed were being cropped in 2014 (1,908 acres in August). The USGS estimated that the total water withdrawal by crops on these lands was 3,230 acre-feet for summer 2014. This represents a total withdrawal of 1.7 acre-feet per acre. The USGS methodology for calculating crop consumptive use and irrigation efficiency should be examined and local climatic data such as that collected at the new station on the Big Chino Water Ranch should be incorporated in consumptive use estimates before these values are used in a groundwater model.

Table 8– 2014 Crop Survey – Acres Irrigated May 2014

Crop	Map Area				Total
	Upper Big Chino	Paulden	Williamson Valley	Walnut Creek	
Alfalfa	18.0	0.0	8.2	0.0	26.1
Corn	324.9	0.0	0.0	0.0	324.9
Grass	0.0	127.2	586.2	63.9	777.2
Oats	0.0	0.0	0.0	0.0	0.0
Sod	0.0	91.8	0.0	0.0	91.8
Timothy Grass	120.0	0.0	0.0	0.0	120.0
Total	462.9	219.0	594.3	63.9	877.2
No Crop Evident	1288.1	223.3	489.5	252.8	965.7

Table 9 – 2014 Crop Survey – Acres Irrigated August 2014

Crop	Map Area				Total
	Upper Big Chino	Paulden	Williamson Valley	Walnut Creek	
Alfalfa	18.0	0.0	8.2	0.0	26.1
Corn	275.7	61.6	0.0	0.0	337.3
Grass	127.4	245.1	688.1	256.0	1316.5
Oats	0.0	0.0	0.0	0.0	0.0
Sod	0.0	108.3	0.0	0.0	108.3
Timothy Grass	120.0	0.0	0.0	0.0	120.0
Total	541.2	414.9	696.2	256.0	1908.3
No Crop Evident	1209.8	27.3	387.6	60.7	1685.5

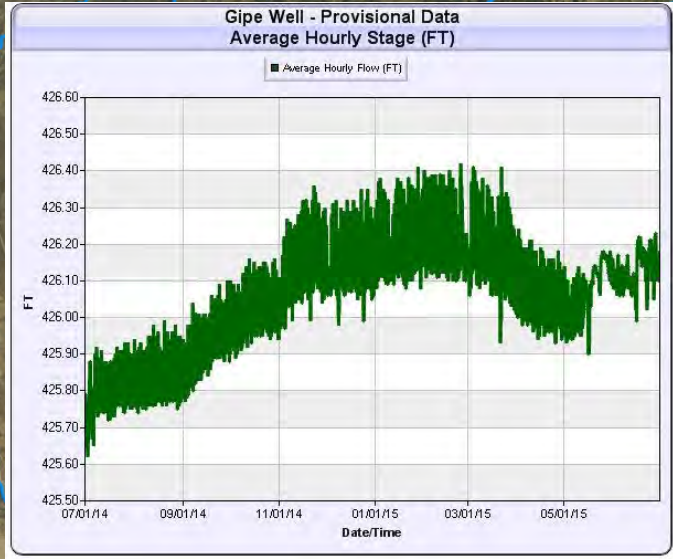
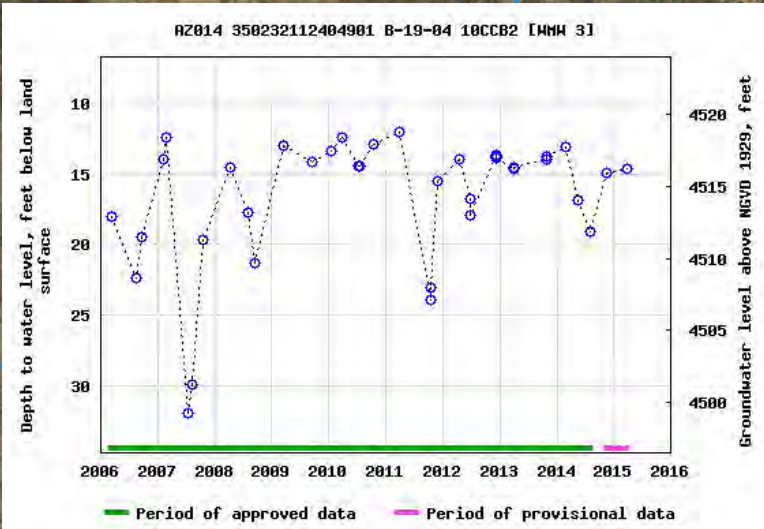
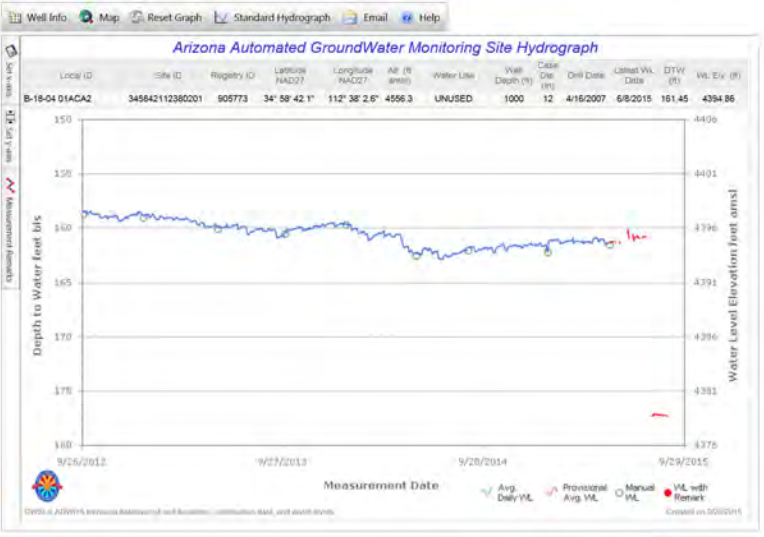
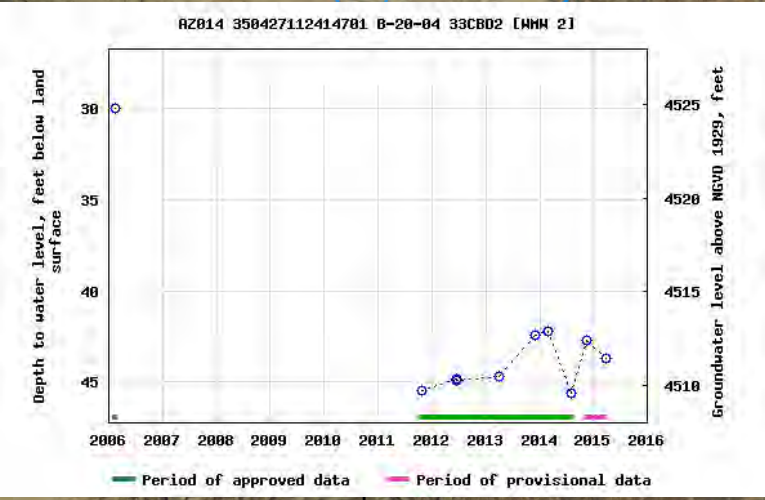
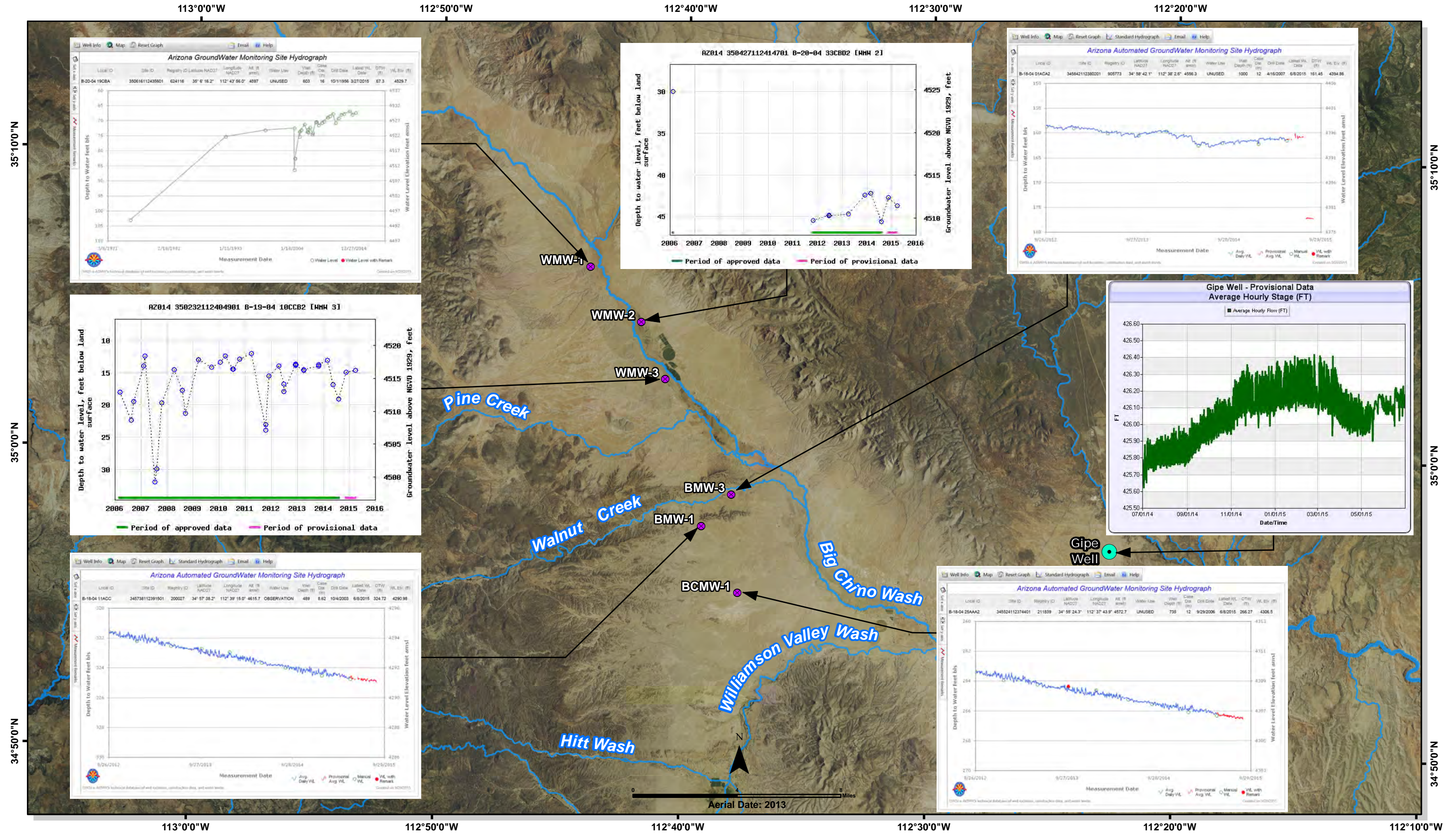
Conclusions

During FY15/16, the Monitoring Committee will move forward with developing requests for proposal to drill shallow monitor wells, monitor the progress of the USGS geophysical study, assist with access permits for gravity stations and geophysical surveys as necessary, maintain the various ephemeral stream flow gages and the gage on Walnut Creek, and provide seasonal summaries of stream flow data.

The project remains within budget and on schedule, and is generating data. It is important to note that the schedule has been reviewed carefully to effectively and efficiently sequence and deploy equipment. The ephemeral streamflow installations

were moved up in the 8-year period to provide a longer period of record for modeling uses. The Committee will similarly adjust the Monitoring Plan as technology improves, new knowledge is gained, and where additional cost efficiencies can be achieved.

On June 26, 2015, the CA#1 Committee began the groundwater modelling phase of the project. This started with the creation of the CA#1 Modelling Committee in addition to the Monitoring Committee. Both committees are composed of the same individuals appointed by the CA#1 partners and both monthly meetings and other efforts are closely coordinated to avoid duplication of effort. Over the next year the CA#1 Modelling Committee plans to create a plan of study for the modelling effort and produce a request for proposals from qualified organizations to begin the modelling effort.

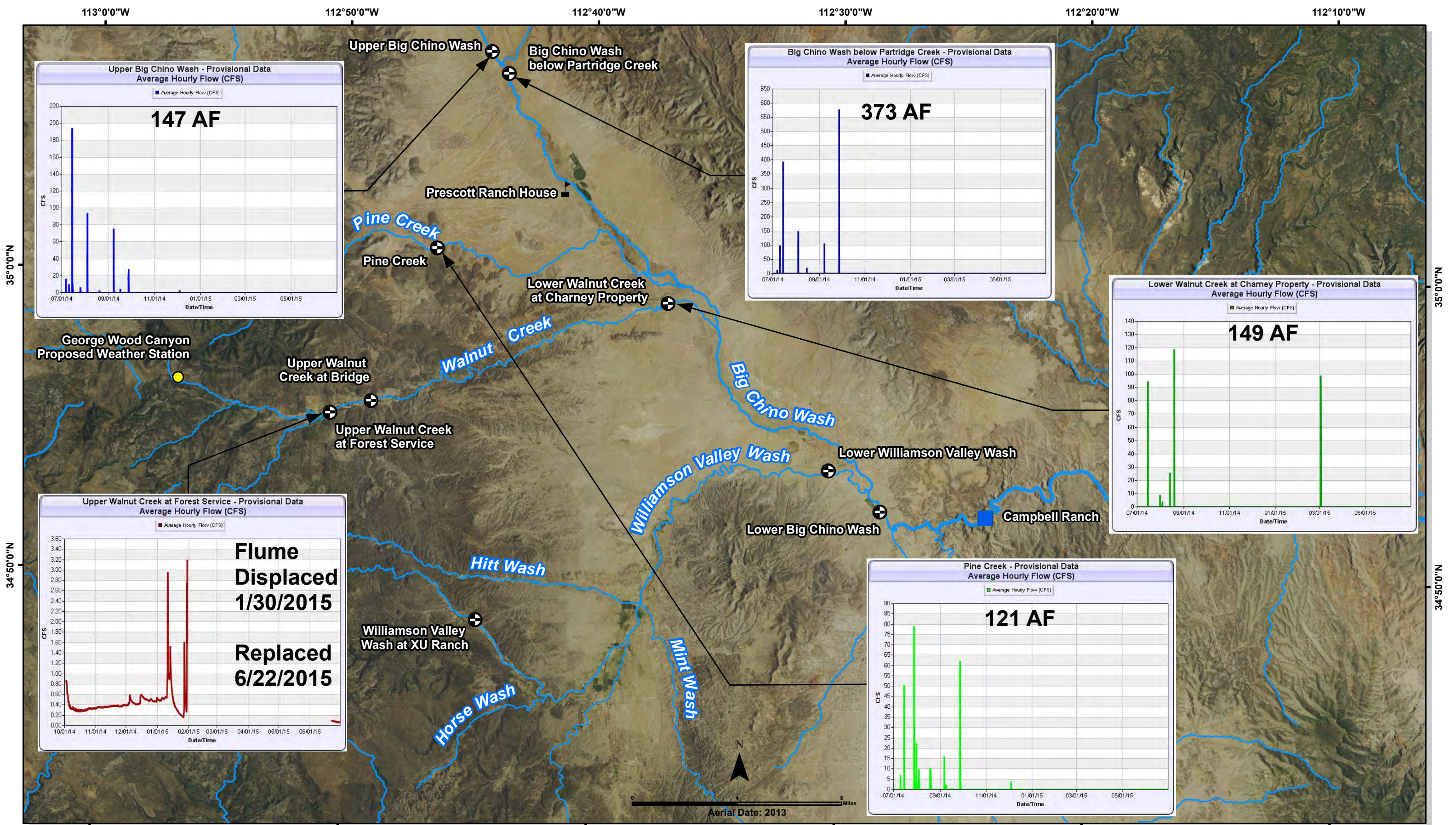






- Existing Monitor Well
- Gipe Well

Map 1
Big Chino Water Ranch/Gipe Well
Existing Monitor Wells

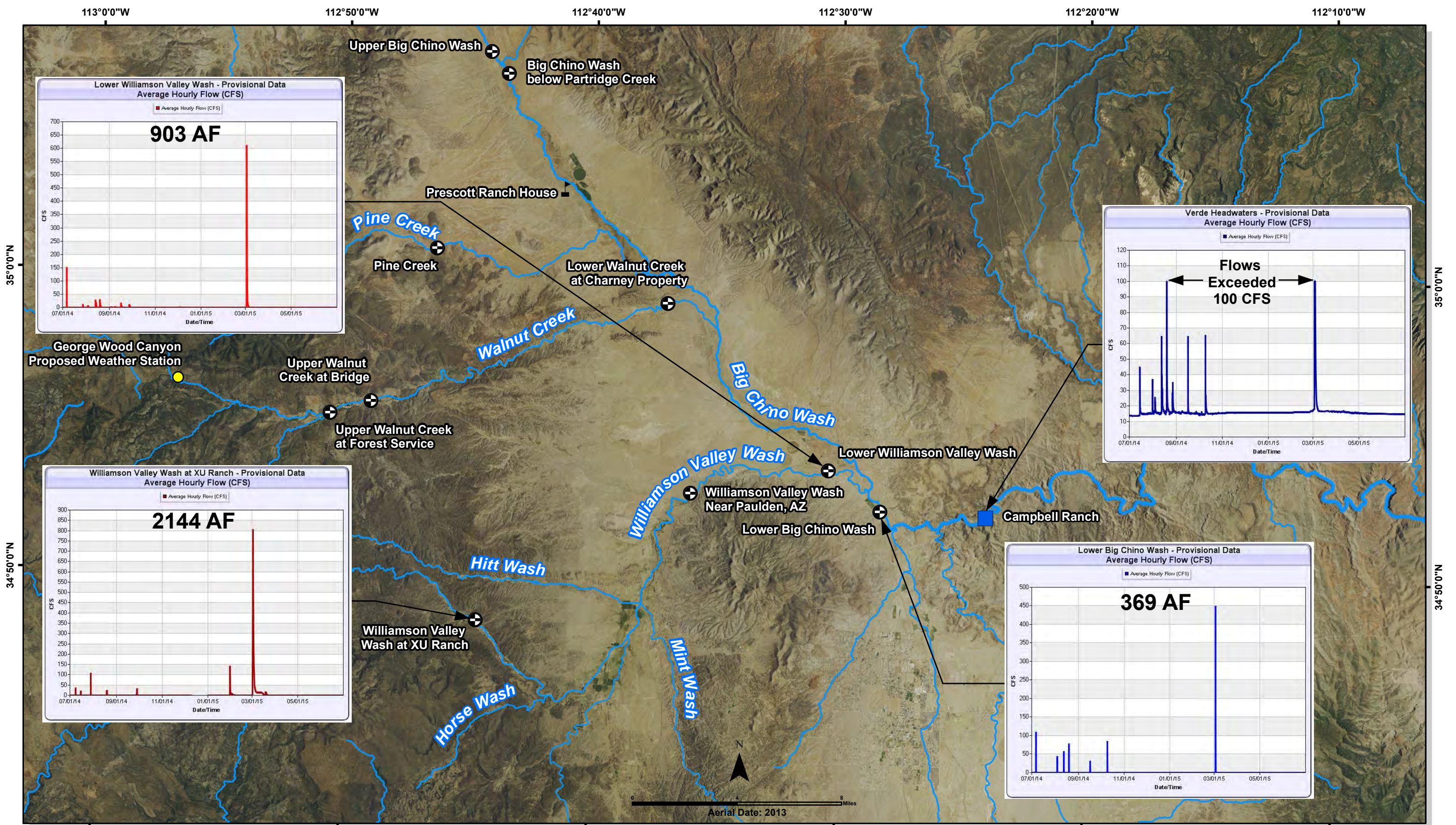


Map 2
Big Chino Sub-basin - Stream Monitoring
 (existing flowtography, camera only sites, George Wood weather, Campbell Ranch and Gipe)



-  Creeks & Washes
-  Surface Water Monitoring Location
-  Campbell Ranch
-  Proposed Weather Station

Map 3
Big Chino Sub-basin – Stream Monitoring
Northern Hydrographs



- Creeks & Washes
- Surface Water Monitoring Location
- Campbell Ranch
- Proposed Weather Station

Map 4
Big Chino Sub-basin – Stream Monitoring
Southern Hydrographs



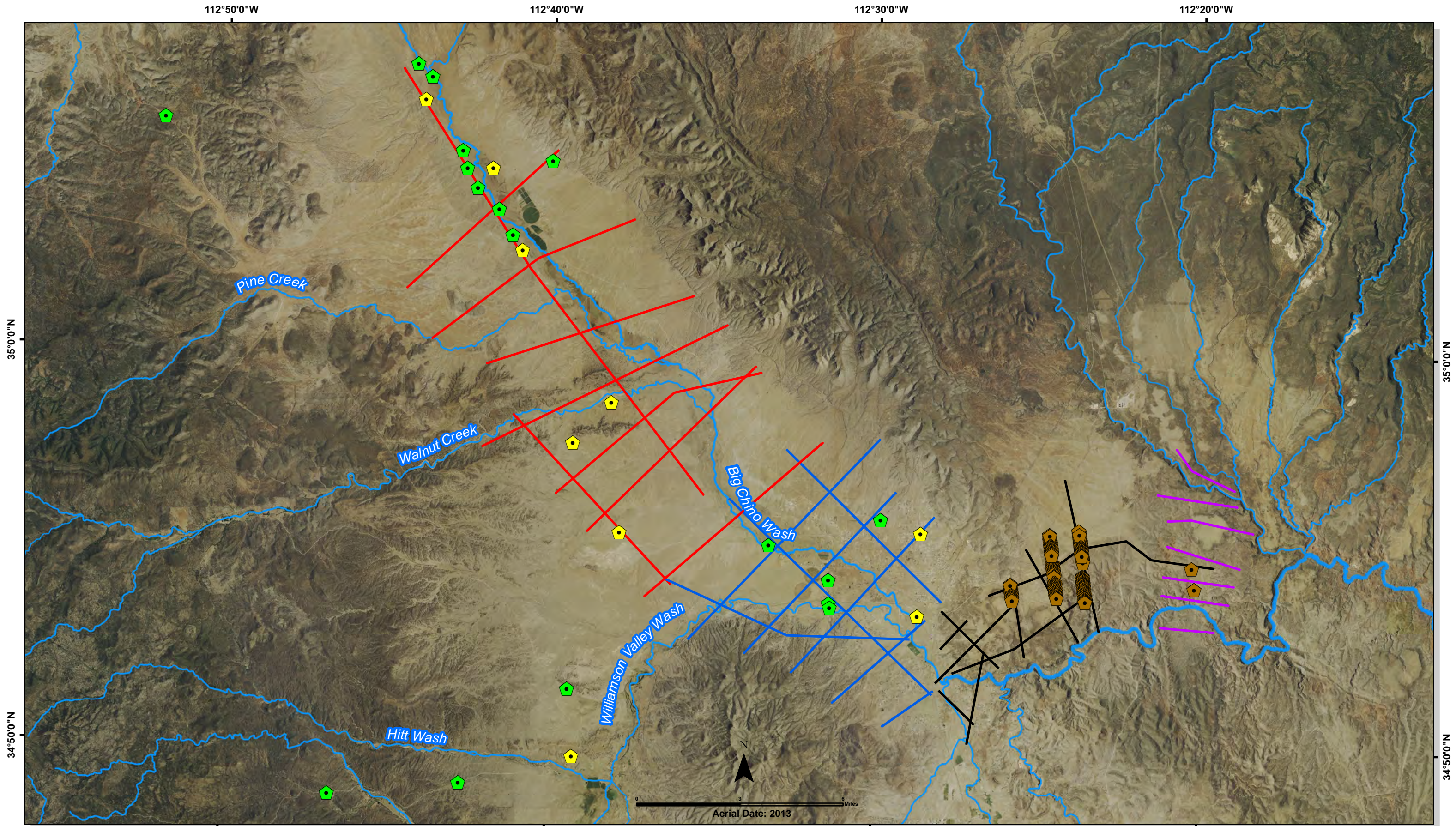
- Yavapai County Flood Control District Weather Station
- National Weather Service Hydrometeorological Automated Data System Station
- USGS Weather Station
- Proposed Weather Station

Map 5
Big Chino Area
Weather Stations






Map Courtesy of

 big_chino_weather_stations.mxd 9/30/2015



USGS Gravity Sites

-  New Gravity Sites
-  Water Advisory Committee Existing Gravity Sites
-  Completed Profiles in Phase 1

Geophysical Profiles

-  Phase 1
-  Phase 2
-  Phase 3
-  King Spring

Map 6
Big Chino Sub-basin Water Monitoring Project
USGS Gravity Sites and Geophysical Profiles



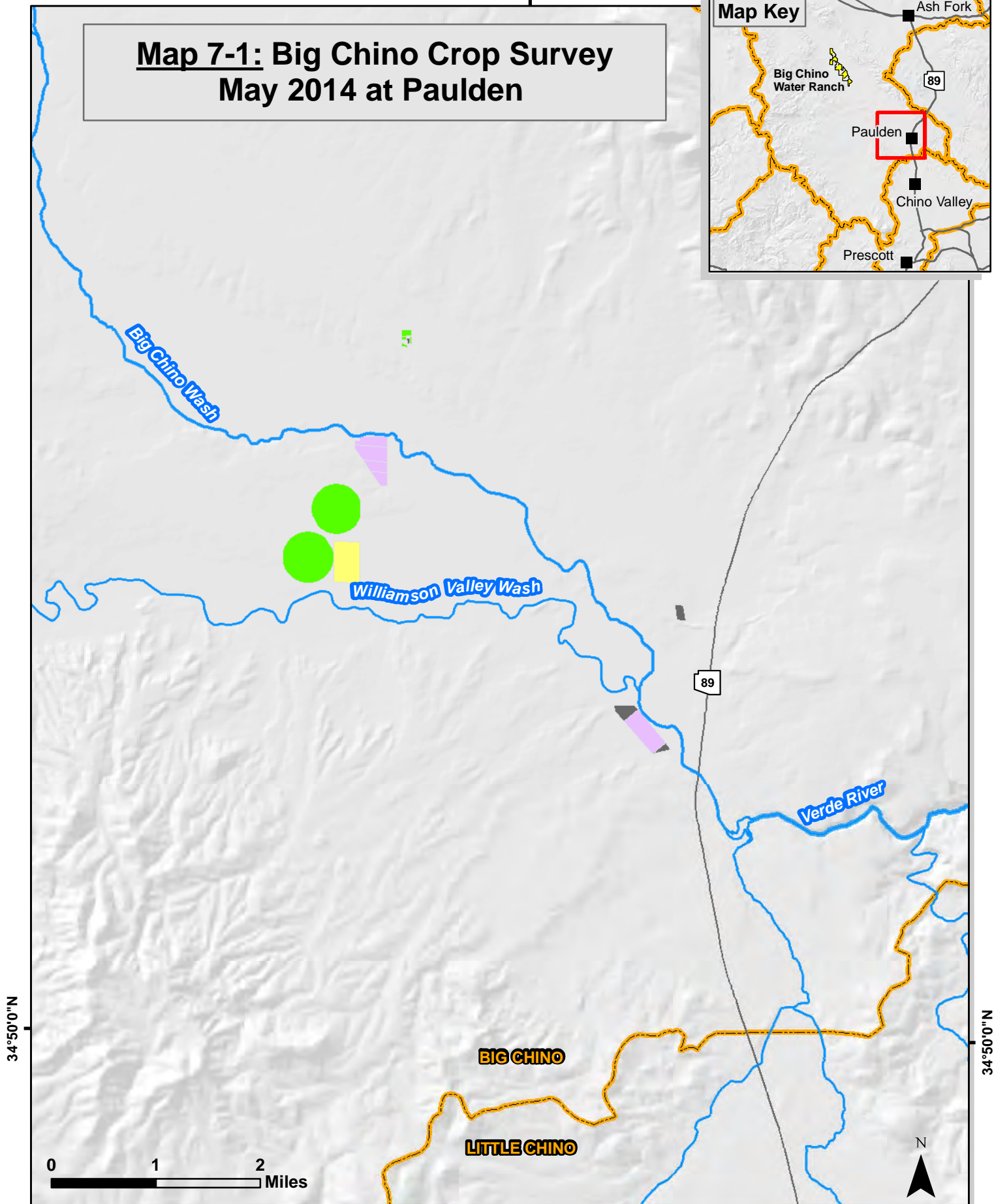
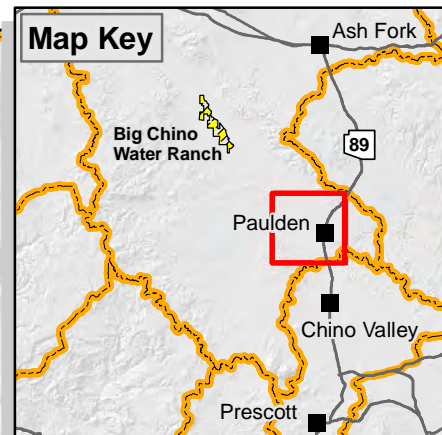
Map Courtesy of



bigchino_gravity_geophysical.mxd 10/1/2015

112°30'0"W

Map 7-1: Big Chino Crop Survey May 2014 at Paulden



- Alfalfa
- Grass
- Timothy Grass
- Corn
- Sod
- No Crop Evident (Abandoned/Fallow)

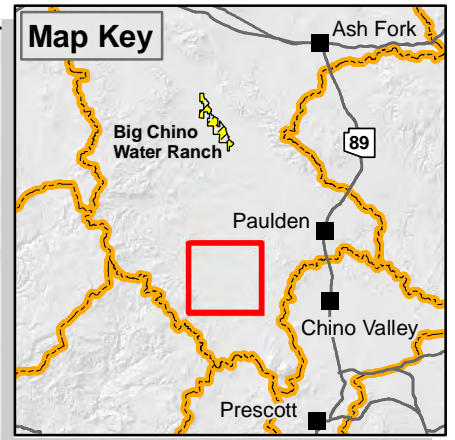
112°30'0"W

Groundwater Sub-basin (ADWR)



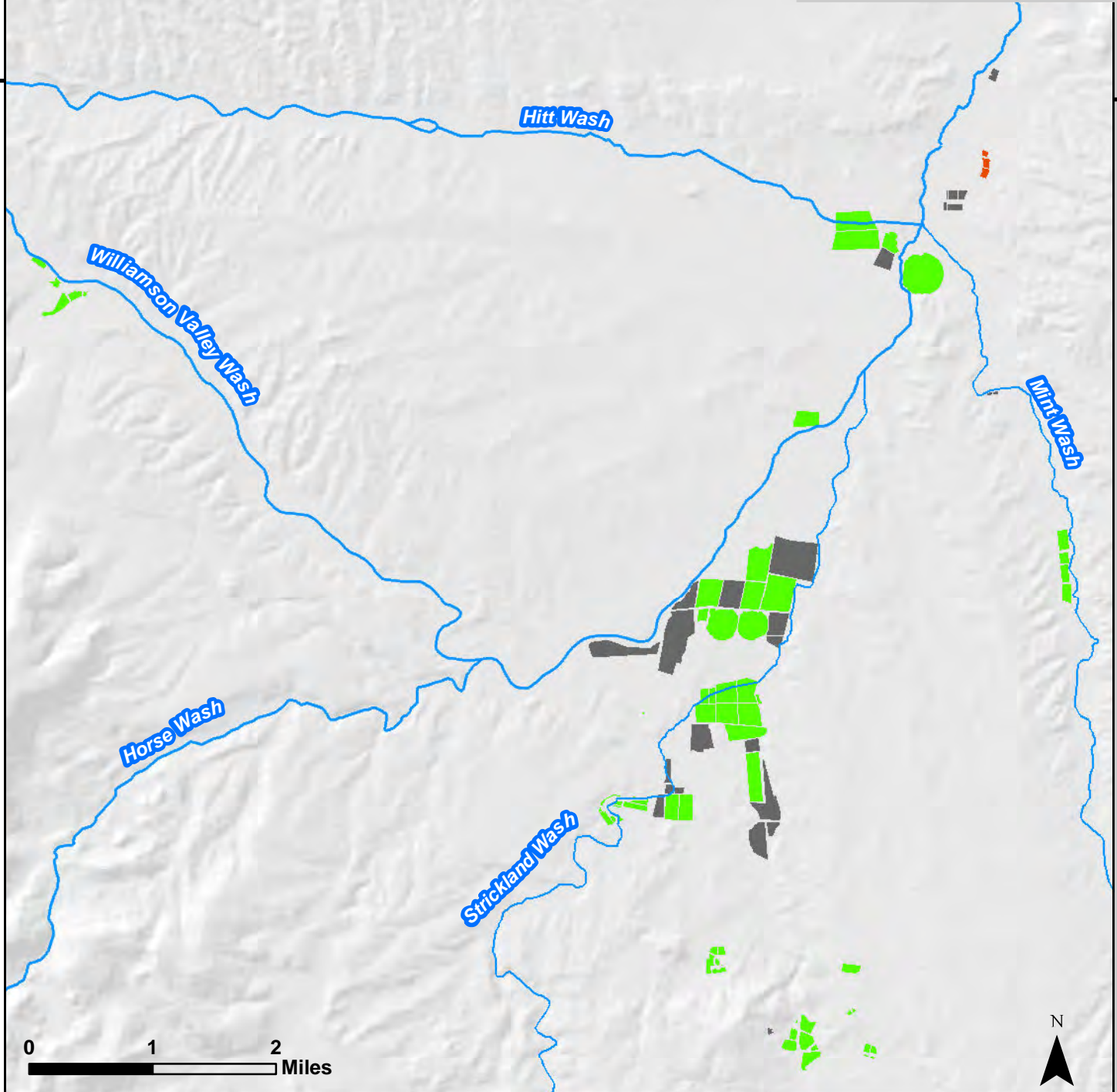
112°40'0"W

Map 7-2: Big Chino Crop Survey May 2014 at Williamson Valley



34°50'0"N

34°50'0"N



0 1 2 Miles



112°40'0"W

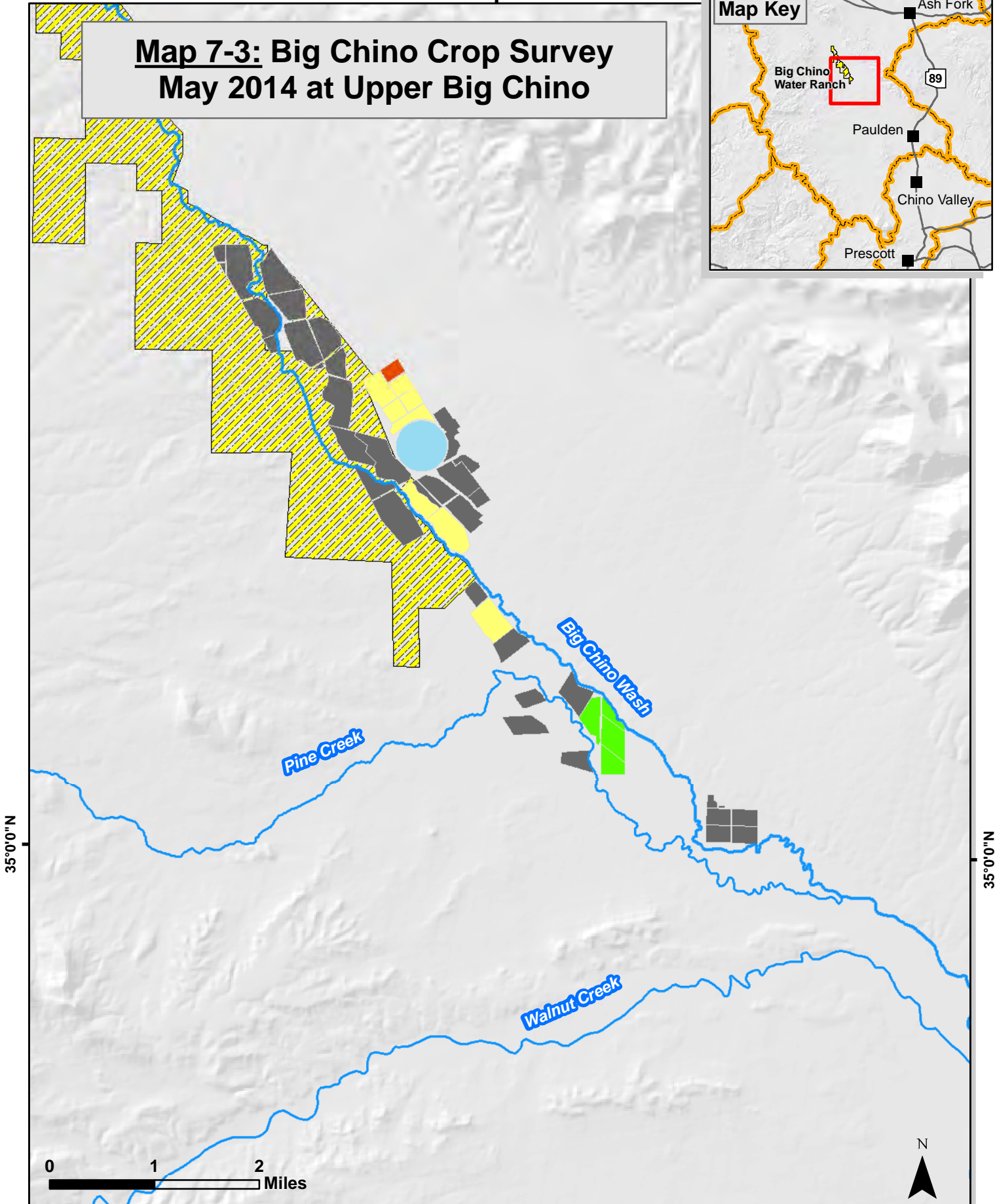
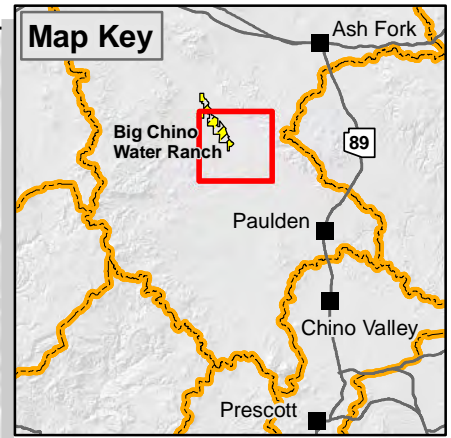
- Alfalfa
- Grass
- Timothy Grass
- Corn
- Sod
- No Crop Evident (Abandoned/Fallow)

Groundwater Sub-basin (ADWR)



112°40'0"W

Map 7-3: Big Chino Crop Survey May 2014 at Upper Big Chino




0 1 2 Miles

35°0'0"N

35°0'0"N

112°40'0"W

-  Alfalfa
-  Grass
-  Timothy Grass
-  Corn
-  Sod
-  No Crop Evident (Abandoned/Fallow)

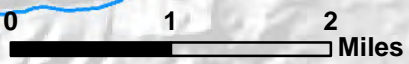
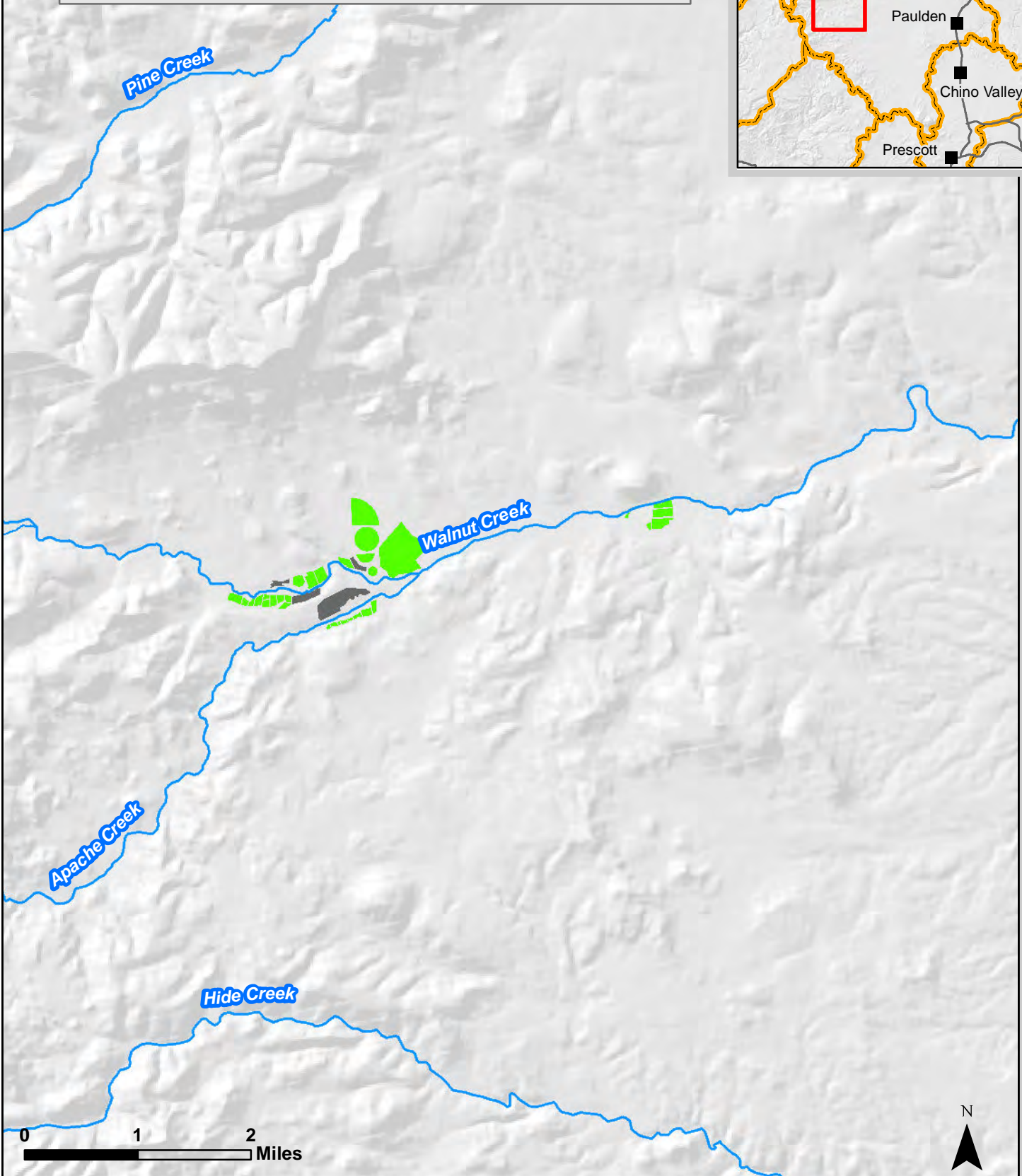
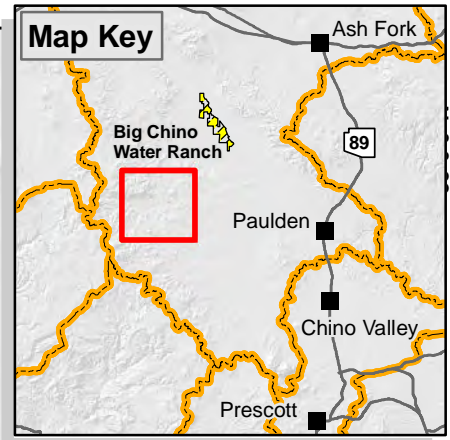
 Groundwater Sub-basin (ADWR)



112°50'0"W

35°0'0"N

Map 7-4: Big Chino Crop Survey May 2014 at Walnut Creek



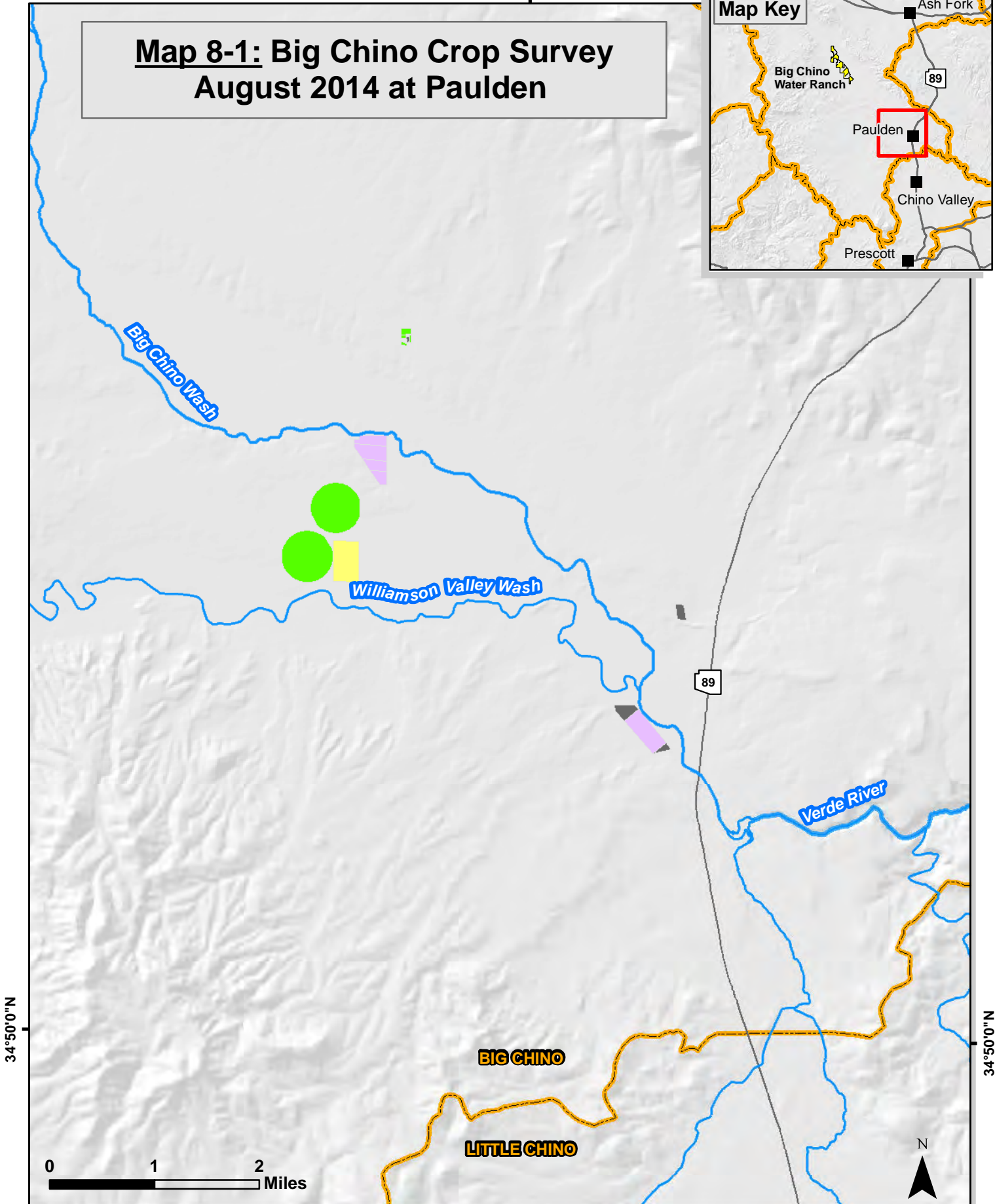
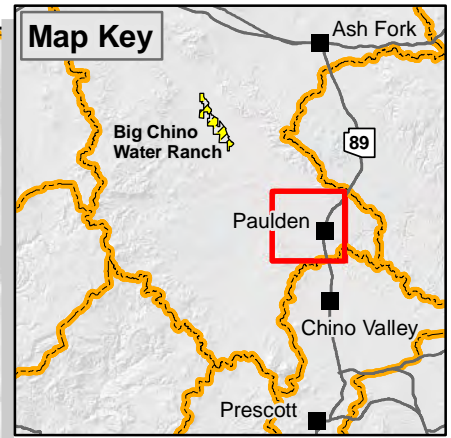
112°50'0"W

- Alfalfa
- Grass
- Timothy Grass
- Corn
- Sod
- No Crop Evident (Abandoned/Fallow)
- Groundwater Sub-basin (ADWR)



112°30'0"W

Map 8-1: Big Chino Crop Survey August 2014 at Paulden



34°50'0"N

34°50'0"N

112°30'0"W

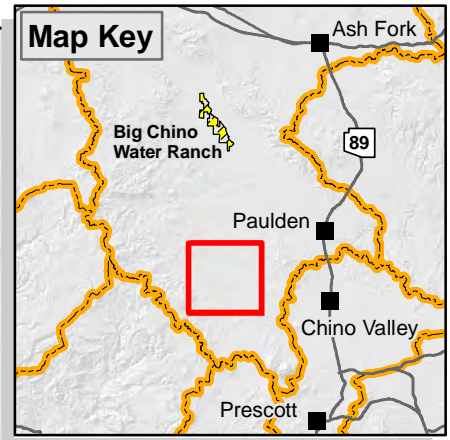
- Alfalfa
- Grass
- Timothy Grass
- Corn
- Sod
- No Crop Evident (Abandoned/Fallow)

Groundwater Sub-basin (ADWR)

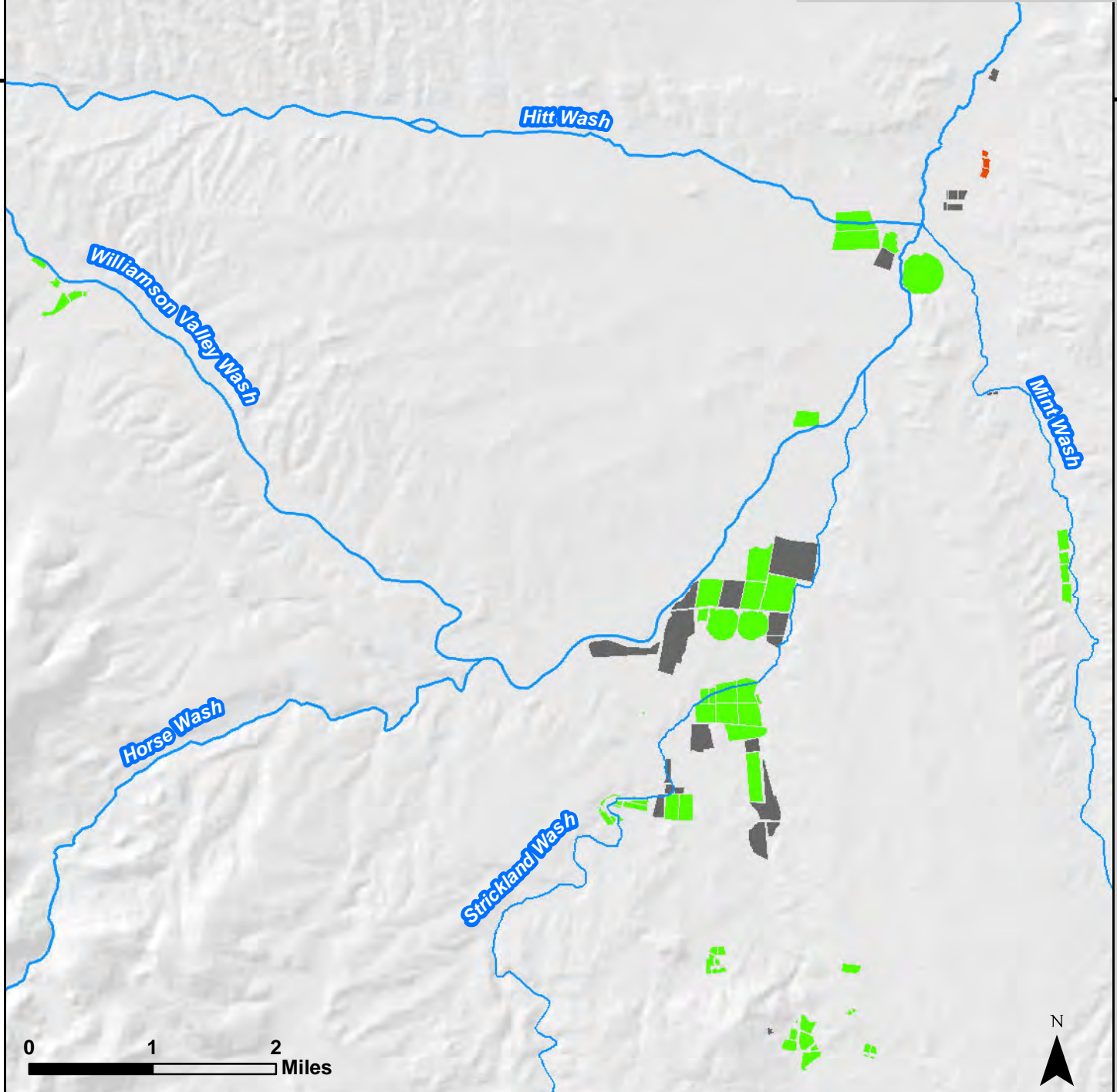


112°40'0"W

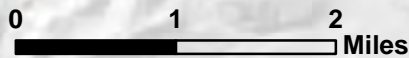
Map 8-2: Big Chino Crop Survey August 2014 at Williamson Valley



34°50'0"N




34°50'0"N



112°40'0"W

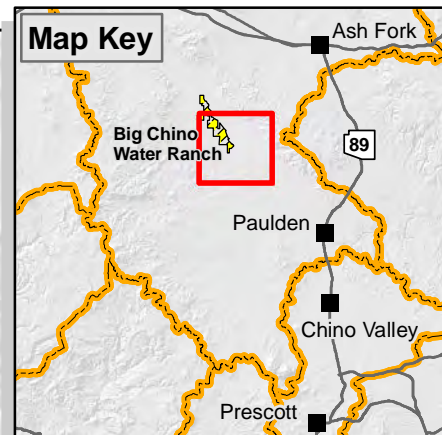
-  Alfalfa
-  Grass
-  Timothy Grass
-  Corn
-  Sod
-  No Crop Evident (Abandoned/Fallow)

 Groundwater Sub-basin (ADWR)



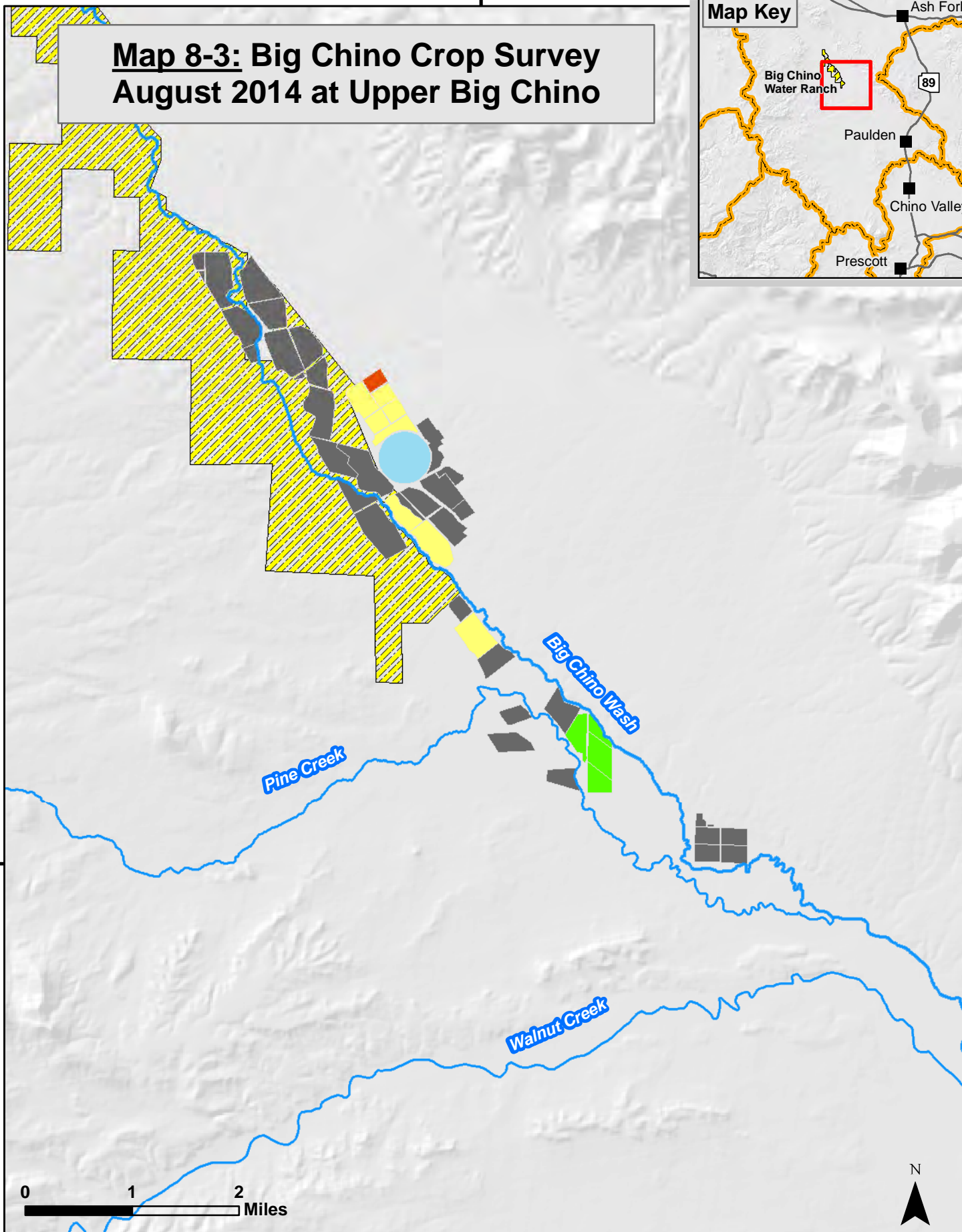
112°40'0"W

Map 8-3: Big Chino Crop Survey August 2014 at Upper Big Chino



35°0'0"N

35°0'0"N




0 1 2 Miles



112°40'0"W

-  Alfalfa
-  Grass
-  Timothy Grass
-  Corn
-  Sod
-  No Crop Evident (Abandoned/Fallow)

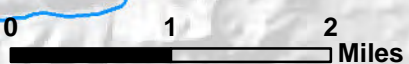
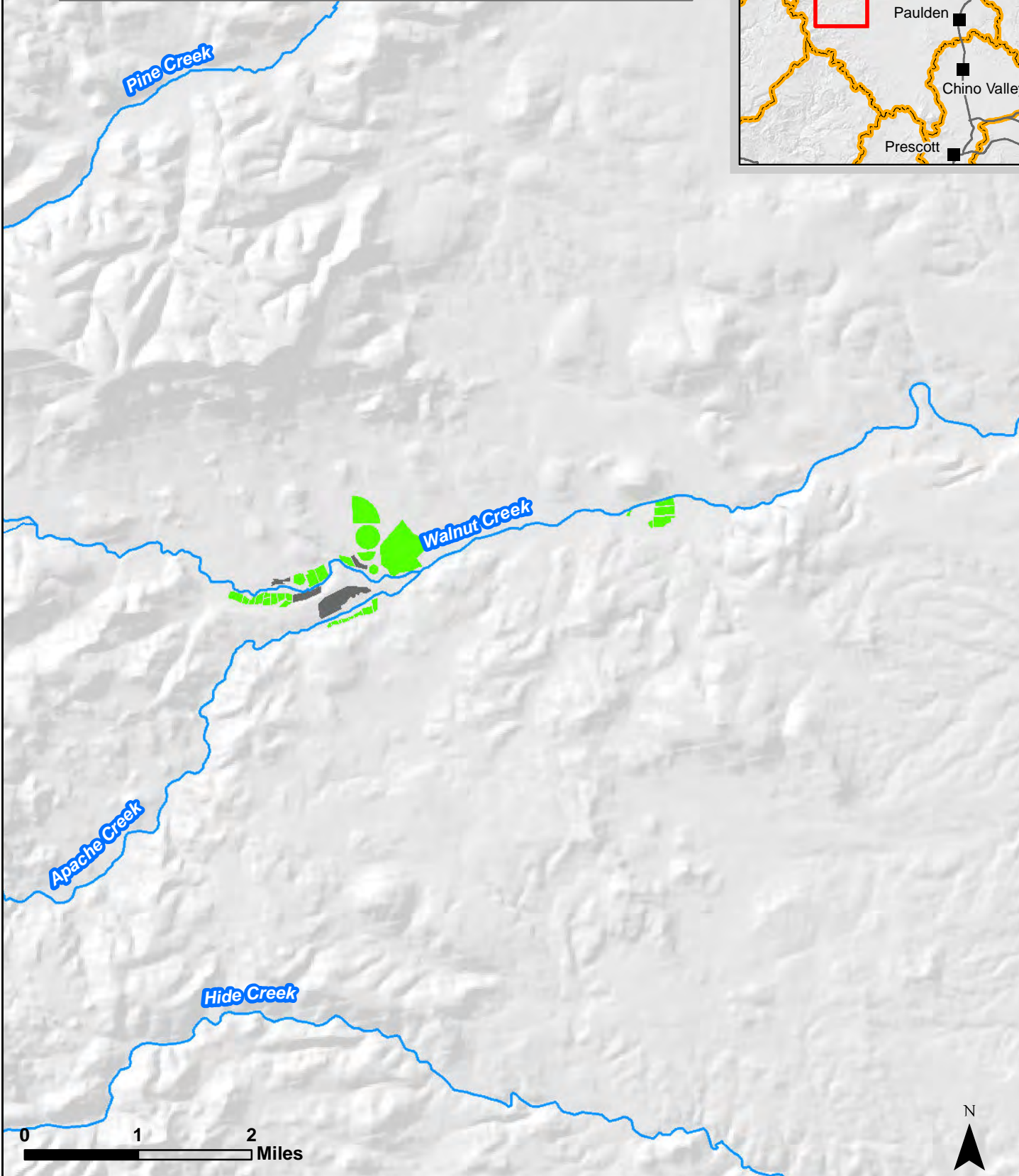
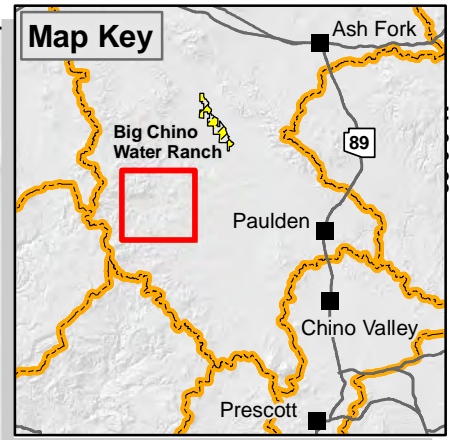
 Groundwater Sub-basin (ADWR)



112°50'0"W

35°0'0"N

Map 8-4: Big Chino Crop Survey August 2014 at Walnut Creek



112°50'0"W

- Alfalfa
- Grass
- Timothy Grass
- Corn
- Sod
- No Crop Evident (Abandoned/Fallow)
- Groundwater Sub-basin (ADWR)



bigchino_cropsurvey14.mxd 10/1/2015

Attachment #1

Big Chino Sub-basin Water Monitoring Project Monsoon Season Report: July 1 – September 30, 2014



2014

Big Chino Sub-basin Water Monitoring Project Monsoon Season Report: July 1 – September 30



Upper Big Chino Wash – 7/14/2014



Prepared by: Stephen P. Flora, R.G.
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and SRP Water Measurement Field Staff

Prepared for: CA1 Monitoring Committee
(Prescott, Prescott Valley, SRP)

4/1/2015

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Introduction

The purpose of the Big Chino Sub-Basin Ephemeral Stream Flow Monitoring Project is to collect additional surface water hydrologic data for use in the development of a numerical groundwater flow model. The streamflow data is part of a larger long-term data collection program. This monsoon season report is being developed for the CA1 Monitoring Committee as part of the Big Chino Sub-basin Water Monitoring Project in collaboration with the City of Prescott, Town of Prescott Valley, and Salt River Project (SRP). Under an independent contractor's agreement approved in 2013, SRP Water Measurement was selected to provide the installation, maintenance, and data collection at nine stream-flow sites within the Big Chino Sub-basin. A summary of flow events recorded during the 2014 monsoon season (July 1 to September 30, 2014) at each location are documented within this report.

Two additional stream gages located in the Big Chino Sub-basin are not detailed in this report. Williamson Valley Wash near Paulden gage is operated and maintained by the USGS with funding contributions from the CA1 Monitoring Committee. Prior to October 2014 this gage was funded by the Yavapai County Water Advisory Committee through member contributions, including from Prescott and Prescott Valley. This site has a period of record ranging from 3/26/1965 to 9/30/1985 and from 8/03/2001 to present. The other gage is Verde Headwaters located on the Verde River at Campbell Ranch installed and operated by SRP to measure low flows since 4/13/2005. Operation and maintenance of this gage is also now funded by the CA1 Monitoring Committee and is briefly discussed in this report for general comparison purposes with stream-flow sites within the Big Chino Sub-basin.

Background and Rating Development

As part of this monitoring effort, SRP Flowtography™ equipped stream-flow monitoring locations were installed between December 2013 and June 2014. SRP Flowtography™ is a system of hardware combined with back-office processes that improves knowledge of hydrologic and operation site information. The system utilizes time-lapse high resolution photography coupled with a fixed event gage within the frame of the image collected and specific to the condition being monitored. Standard configuration at most monitoring locations include upstream and downstream event gages equipped with pressure transducers (to collect stage values) and a flowtography camera mounted on the stream bank that records images of the upstream event gage. Surveys were conducted to determine the channel cross sections for event gages at each monitoring location. Using the Slope-Area Method and preliminary survey data collected in the field, an illustrative detailed estimate of flow prediction was calculated for channel stages. The collected survey information was further used by inputting into Hec-Ras. A rating table, a rating curve and a rating equation were generated using the Hec-Ras model for the upstream and downstream cross sections.

Site Maintenance and Data Processing

A number of site visits were required to perform routine maintenance and non-routine servicing. Routine maintenance included collection of upstream and downstream transducer data, collection of flowtography images from cameras, general cleaning of each site, and verification of general site operation. Several non-routine servicing (break-fix events) were also required and included replacing transducers and event gages damaged by flash flood events, troubleshooting camera issues and wireless

modern operation, debris removal, and additional survey and site investigation required for data processing. Specifics on site visits for each location are discussed in the Location Summaries section.

Data processing of stage values and rating curves were completed using Aquarius (version 3.5) time series software. Stage values (feet) collected from the upstream transducer serve as the primary data source (downstream transducer serve as secondary). Offsets to stage values were applied based on the depth of the transducer below stream channel and then compared with visual determination of stage values from flowtopography images. For instances when the event gage was obstructed or missing from the flowtopography images, stage level overlays were created using a tag line reference at each location (see Figure 1 and Figure 2).

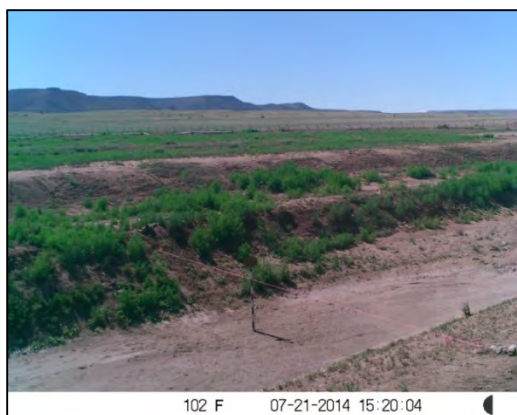


Figure 1. Upper Big Chino Wash tagline reference.

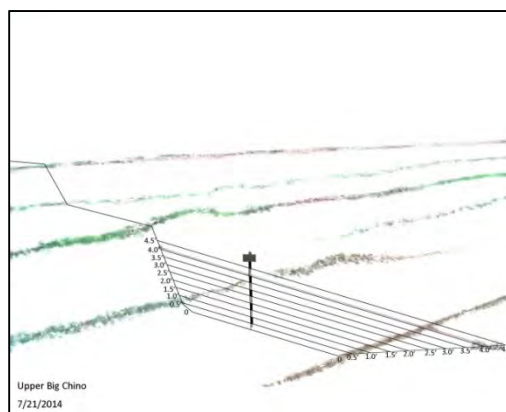


Figure 2. Upper Big Chino Wash stage level overlay.

The developed ratings were used to generate discharge values in cubic-feet per second (CFS) for each stage value. The hourly mean CFS was used to calculate the total volume of water in acre-feet (AF) for each flow event. Data and images are stored and maintained by SRP and are available to the CA1 monitoring committee via a secure SRP hosted web portal.

Seasonal Flow Events Summary

During the 2014 monsoon season, July 1 through September 30, 2014, a total of 17 storm events resulting in surface water flow were recorded in the Big Chino Sub-basin. The number of sites with flow, magnitude of flow, and duration of flow during these events varied throughout the sub-basin. Monsoon season flow event totals (AF) at each location are outlined in Table 1 and Figure 3.

Pine Creek and Lower Williamson Valley Wash recorded the highest number of events (10) while Lower Big Chino Wash and Lower Walnut Creek at Charney Property recorded the fewest events (5). The average duration of flow events and overall flow time of events at each location varied throughout the sub-basin. The highest average duration of events and total duration of flow during the monsoon season occurred at Lower Williamson Valley Wash (21.6 hours per event, 216 total hours of flow). The longest duration event at Lower Williamson Valley Wash lasted 53 hours and yielded 27.9 AF of water for the entire event. The shortest average duration of events and total duration of flow occurred at Lower Walnut Creek at Charney Property (2.3 hours per event, 11.5 total hours of flow).

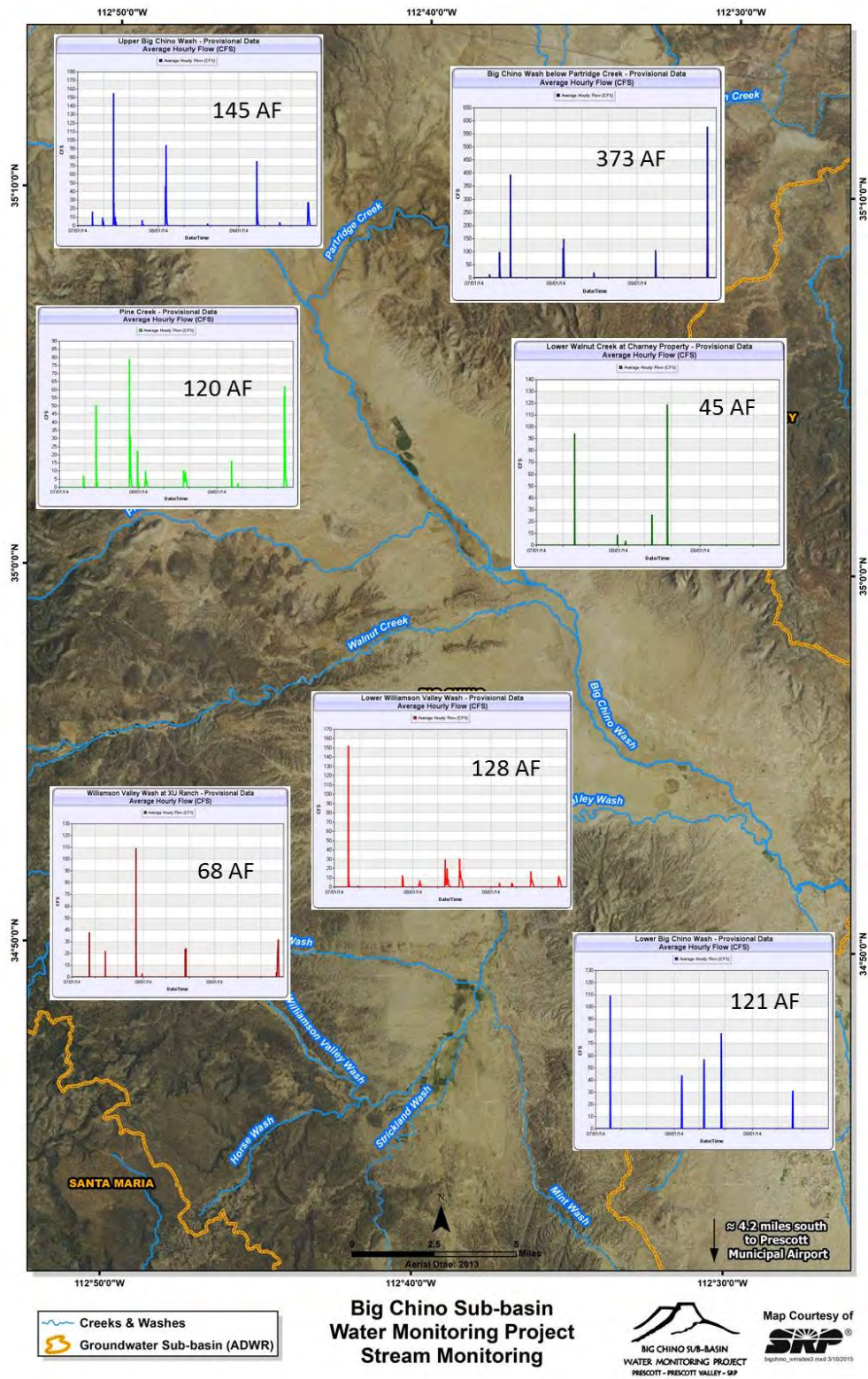
Big Chino Wash below Partridge Creek recorded the highest single event flow and total highest flow throughout the monsoon season. Maximum peak discharge recorded at the site was 640 CFS on 9/27/2014 resulting in 174.47 AF for the event. A total of 373.64 AF of water flowed through the Big Chino Wash below Partridge Creek location during the monsoon season. It should be noted that flow at the Upper Big Chino Wash location would most likely also contribute to the Big Chino Wash below Partridge Creek location in addition to flow contributions from Partridge Creek. The lowest total volume of water to flow through a site during the 2014 monsoon season was 45.46 AF at the Lower Walnut Creek at Charney Property location. A total volume of 121.79 AF was estimated to flow through the Lower Big Chino Wash location just upstream of Sullivan Dam. Sullivan Dam was not monitored during the 2014 monsoon season therefore it was not determined whether water spilled to the Verde River Canyon.

Table 1: Big Chino Sub-basin Locations - 2014 Monsoon Season Flow Event Totals in acre-feet (AF)

Start Date*	Upper Big Chino Wash	Big Chino Wash below Partridge Creek	Pine Creek	Lower Walnut Creek at Charney Property	Williamson Valley Wash at XU Ranch	Lower Williamson Valley Wash	Lower Big Chino Wash
7/6/2014	3.86	3.39	0	0	0	25.09	28.87
7/8/2014	0	0	0	0	4.2	0	0
7/10/2014	4.52	25.33	2.09	0	0	0.16	0
7/14/2014	48.77	64.98		0	0	0	0
7/15/2014	0	0	10.97	14.71	3.31	0	0
7/25/2014	2.48	0	0	0		0	0
7/28/2014	0	0	27.62	0	20.43	6.34	0
7/31/2014	0	0	6.26	0.82	0.31	0	0
8/3/2014	38.55	72.05	6.76	0.47	0	5.31	22.65
8/13/2014	0	0	0	0	0	27.97	24.98
8/15/2014	0	4.49	0	3.82	0	0	0
8/19/2014	0.78	0	15.94	25.64	8.81	28.10	31.17
9/4/2014	0	0	0	0	0	1.33	0
9/7/2014	22.84	28.93	3.46	0	0	0	0
9/9/2014	0	0	0.83	0	0	3.1	0
9/16/2014	1.17	0	0.05	0	0	15.14	14.12
9/27/2014	22.85	174.47	46.49	0	31.61	15.88	0
	145	373	120	45	68	128	121

*Note: Flow events may continue into the next day or start just prior to indicated date in some instances

**Figure 3: Big Chino Sub-basin SRP Flowtography™ Stream-flow Monitoring Locations
2014 Monsoon Season Flow Events – July 1 to September 30, 2014**



Location Summaries

Upper Big Chino Wash (UBCW)

A total of 9 flow events were recorded at Upper Big Chino Wash during the period from July 1, 2014 through September 30, 2014. Peak discharge ranged from 2.75 CFS on 8/19/2014 to 319 CFS on 7/14/2014. Total volume of each event ranged from 0.78 AF to 48.77 AF, respectively. A total volume of 145.82 AF was estimated to flow through the UBCW location during the 2014 monsoon season.

Total duration of the events ranged from 5.75 hours on 9/16/2014 to 31.25 hours on 7/14/2014. Average event flow duration was 18.69 hours and total flow duration was 168.25 hours for the 2014 monsoon season. Table 2 below summarizes the flow events at the UBCW location and Figure 4 displays hydrographs and flowtopography images of flow events.

Table 2: Upper Big Chino Wash - 2014 Monsoon Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/6/2014	15:30	13.5	1	29.4	3.86
7/10/2014	13:30	10.25	0.62	13.8	4.52
7/14/2014**	16:45	31.25	3.53	319	48.77
7/25/2014	14:30	21	0.64	7.18	2.48
8/3/2014	17:00	27.25	2.31	125	38.55
8/19/2014***	10:00	13.25	0.32	2.75	0.78
9/7/2014	21:00	23	2.08	109	22.84
9/16/2014	15:45	5.75	0.29	4.97	1.17
9/27/2014	11:15	23	1.06	32.6	22.85
Average		18.69	1.31	71.52	16.20
Total		168.25			145.82

* Start times are approximate within 15 minutes and events may continue into the next day

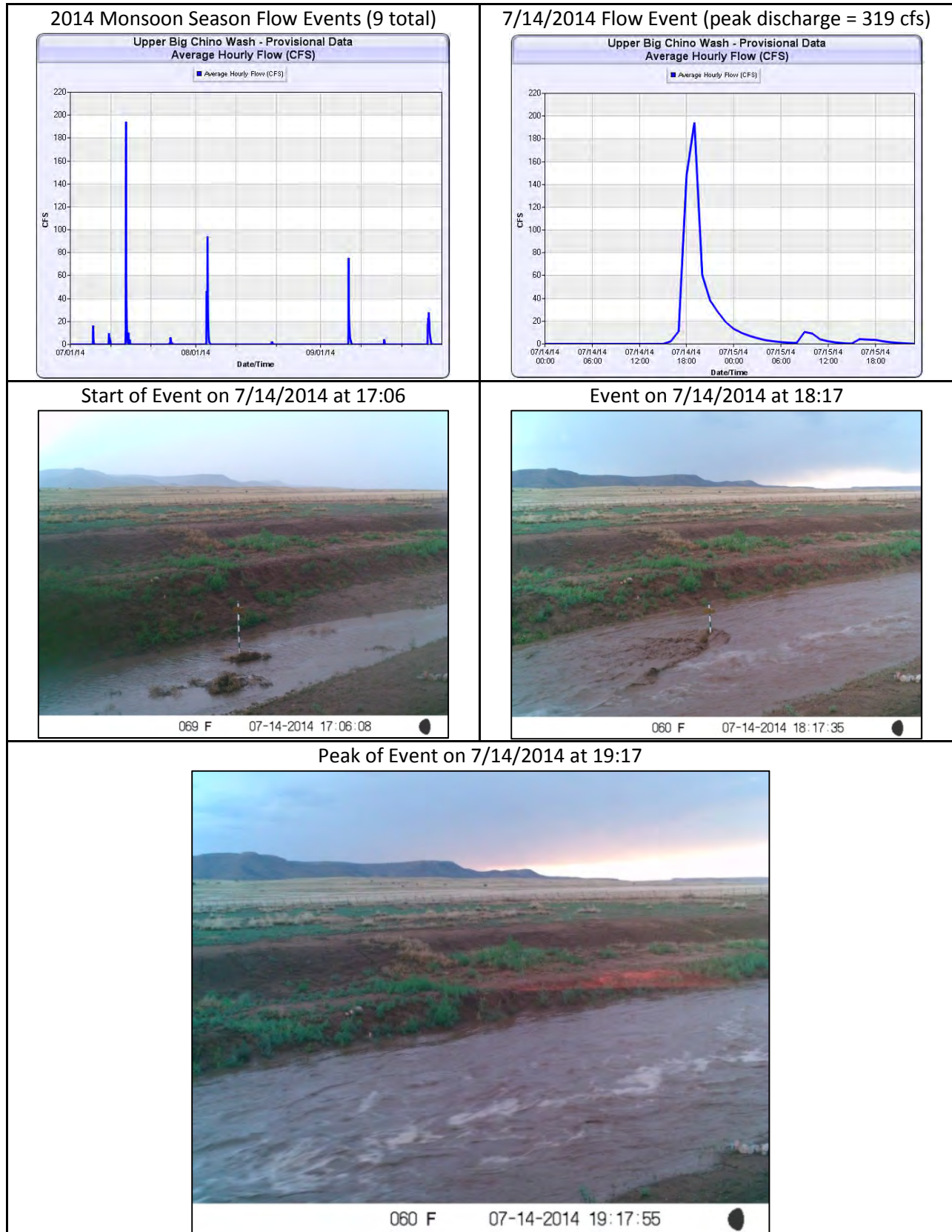
**Event gage damaged during flow event

*** Duration only when flowing. Period of no flow within event.

The UBCW location was visited a total of three times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Repaired and replaced the two event gages that were knocked over during the 7/14/2014 flow event
- Replaced filter screen on upstream event gage and cleared vegetation from banks that obstruct flowtopography view
- Took photos with tagline (reference) to determine stage level in images without event gage or with obstructed view of event gage

Figure 4: Upper Big Chino Wash Hydrographs and Flowtography Flow Event Images



Big Chino Wash below Partridge Creek (BCWPC)

A total of 7 flow events were recorded at Big Chino Wash below Partridge Creek (BCWPC) during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 12.3 CFS on 7/06/2014 to 640 CFS on 9/27/2014. Total volume of each event ranged from 3.39 AF to 174.47 AF, respectively. Flow measured at the BCWPC location includes both portions of flow measured at the UBCW location and additional flow contributions from Partridge Creek. When compared with flows at UBCW, estimated flow contributions from Partridge Creek can be inferred. For example during the 9/27/2014 flow event total 174.47 AF of water at BCWPC, only 22.85 AF of water was measured at UBCW, indicating the majority of flow occurred from Partridge Creek during this flow event.

A total volume of 373.64 AF was estimated to flow through the BCWPC location during the 2014 monsoon season. Total duration of the events ranged from 5.5 hours on 7/14/2014 to 11 hours on 8/3/2014. Average event flow duration was 8.14 hours and total flow duration was 57 hours for the 2014 monsoon season. Note that flow duration and volume estimated at this location does not include pooled or static water that collects at the site and only physical flow is used in calculations (water flowing past the downstream control). Table 3 below summarizes the flow events at BCWPC location and Figure 5 displays hydrographs and flowtography images of flow events.

Table 3: Big Chino Wash below Partridge Creek – 2014 Monsoon Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/6/2014	22:00	5.75	1.28	12.3	3.39
7/10/2014**	14:30	10.5	3	123	25.33
7/14/2014	18:30	5.5	4.8	420	64.98
8/3/2014	17:45	11	3.27	155	72.05
8/15/2014	10:45	6	1.69	26.9	4.49
9/7/2014	21:30	9	2.86	108	28.93
9/27/2014	12:15	9.25	5.63	640	174.47
Average		8.14	3.22	212.17	53.38
Total		57			373.64

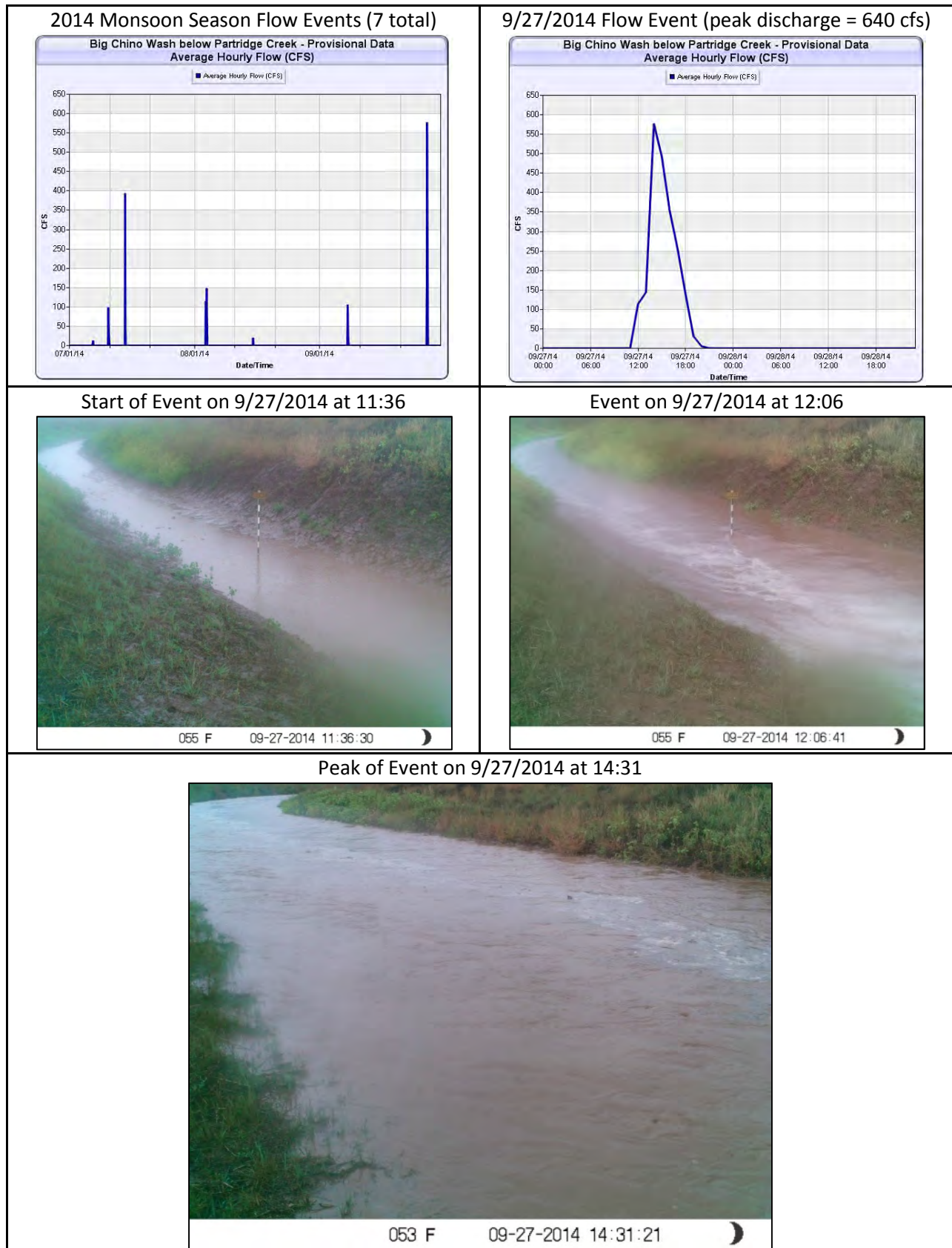
* Start times are approximate within 15 minutes and events may continue into the next day

**Event gage damaged during flow event

The BCWPC location was visited a total of four times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Replaced the two event gages that were damaged during the 7/10/2014 flow event
- Replaced transducers and cleared vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images
- Investigated and surveyed downstream of event gage in order to adjust rating equation

Figure 5: Big Chino Wash below Partridge Creek Hydrographs and Flowtopgraphy Flow Event Images



Pine Creek (PC)

A total of 10 flow events were recorded at Pine Creek (PC) location during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 0.51 CFS on 9/16/2014 to 84.7 CFS on 9/27/2014. Total volume of each event ranged from 0.05 AF to 46.49 AF, respectively. A total volume of 120.47 AF was estimated to flow through the PC location during the 2014 monsoon season.

Total duration of the events ranged from 1.75 hours on 9/16/2014 to 27.75 hours on 7/28/2014. Average event flow duration was 17.35 hours and total flow duration was 173.5 hours for the 2014 monsoon season. Table 4 below summarizes the flow events at PC location and Figure 6 displays hydrographs and flowtography images of flow events.

Table 4: Pine Creek - 2014 Monsoon Flow Events

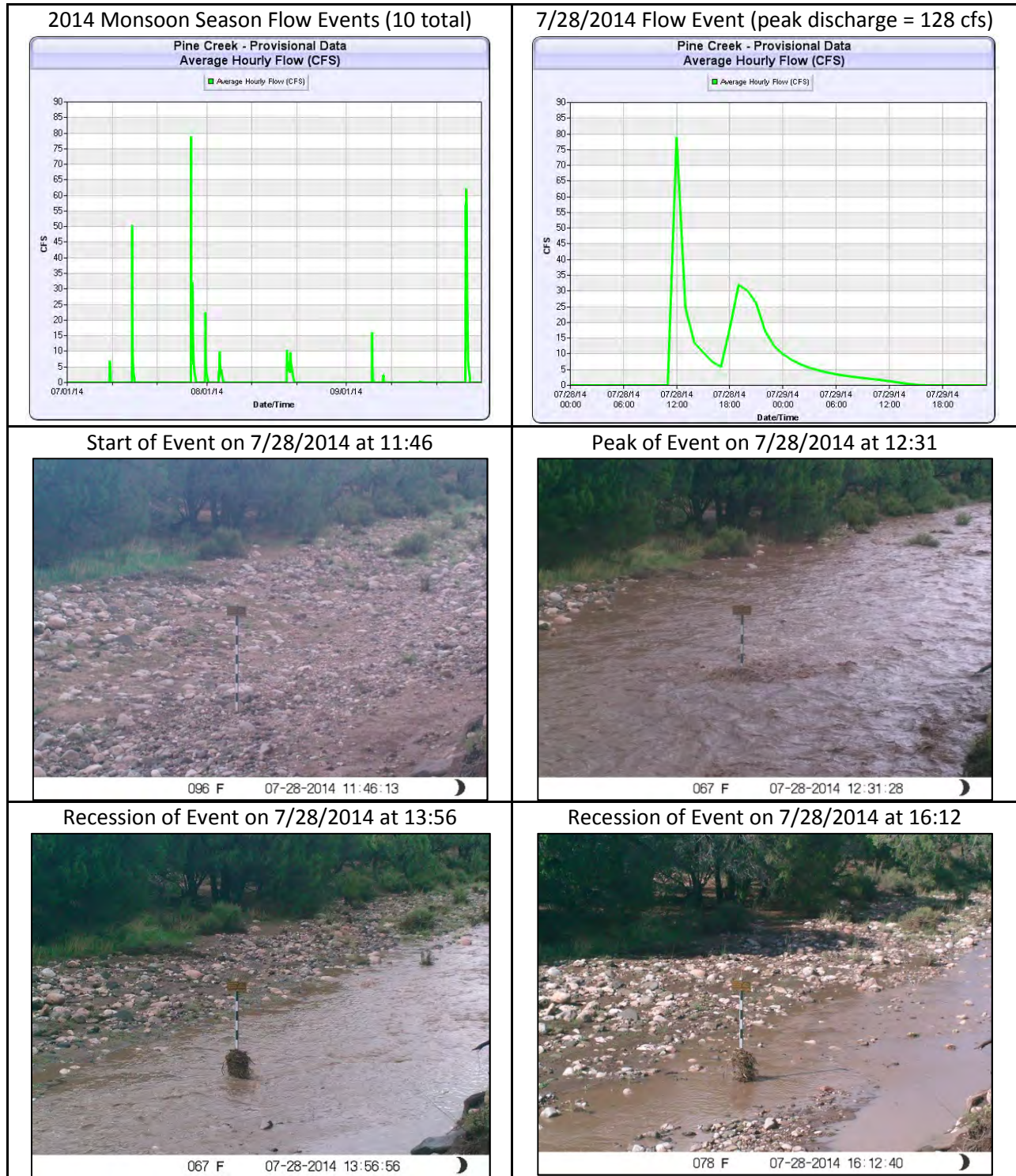
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/10/2014	10:45	5.25	0.3	8.43	2.09
7/15/2014	10:00	13.75	1.22	82.3	10.97
7/28/2014	12:15	27.75	1.5	128	27.62
7/31/2014	15:45	17	0.71	30.5	6.26
8/3/2014	15:45	25	0.39	12.3	6.76
8/18/2015	18:15	41	0.37	11.37	15.94
9/6/2014	16:30	9.5	0.73	31.5	3.46
9/9/2014	3:15	7.75	0.11	2.64	0.83
9/16/2014	9:45	1.75	0.02	0.51	0.05
9/27/2014	11:00	24.75	1.23	84.7	46.49
Average		17.35	0.66	39.23	12.05
Total		173.5			120.47

* Start times are approximate within 15 minutes and events may continue into the next day

The PC location was visited a total of four times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Cleaned debris from event gages and removed vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images with obstructed gage

Figure 6: Pine Creek Hydrographs and Flowtopgraphy Flow Event Images



Lower Walnut Creek at Charney Property (LWCCP)

A total of 5 flow events were recorded at Lower Walnut Creek at Charney Property (LWCCP) location during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 8.35 CFS on 8/3/2014 to 219 CFS on 8/19/2014. Total volume of each event ranged from 0.47 AF to 25.64 AF, respectively. A total volume of 45.46 AF was estimated to flow through the LWCCP location during the 2014 monsoon season.

Total duration of the events ranged from 1 hour on 8/3/2014 to 4.25 hours on 8/19/2014. Average event flow duration was 2.3 hours and total flow duration was 11.5 hours for the 2014 monsoon season. Table 5 below summarizes the flow events at LWCCP location and Figure 7 displays hydrographs and flowtography images of flow events.

Table 5: Lower Walnut Creek at Charney Property – 2014 Monsoon Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/15/2014	11:30	3	1.26	191	14.71
7/31/2014	16:00	1.75	0.28	22.5	0.82
8/3/2014***	15:15	1	0.12	8.35	0.47
8/15/2015	18:30	1.5	0.46	43.6	3.82
8/19/2014	13:30	4.25	1.37	219	25.64
Average		2.30	0.70	96.89	9.09
Total		11.5			45.46

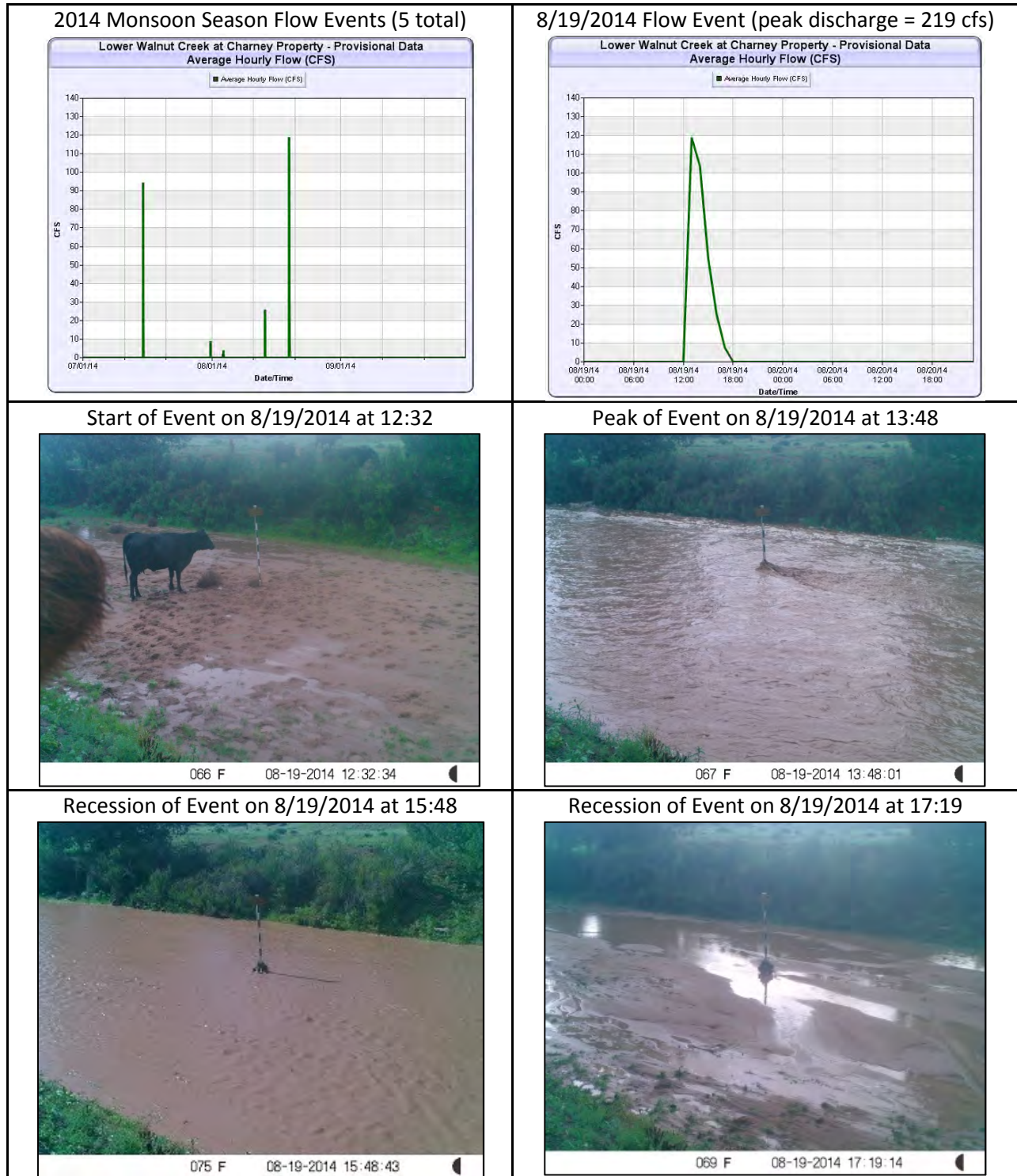
* Start times are approximate within 15 minutes and events may continue into the next day

*** Period(s) of no flow within event. Duration of event indicates only time with flow

The LWCCP location was visited a total of three times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Cleaned debris from event gages and removed vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images with obstructed gage
- Replaced damaged event gages and transducers (possibly loosened due to cows rubbing against the event gage)
- Base of event gages were scoured out and filled with sand and rocks

Figure 7: Lower Walnut Creek at Charney Property Hydrographs and Flowtophography Flow Event Images



Williamson Valley Wash at XU Ranch (WVWXU)

A total of 6 flow events were recorded at Williamson Valley Wash at XU Ranch (WVWXU) location during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 8.12 CFS on 7/31/2014 to 179 CFS on 7/28/2014. Total volume of each event ranged from 0.31 AF on 7/31/2014 to 31.61 AF on 9/27/2014. A total volume of 68.67 AF was estimated to flow through the WVWXU location during the 2014 monsoon season.

Total duration of the events ranged from 0.75 hour on 7/31/2014 to 27.25 hours on 9/27/2014. Average event flow duration was 8.63 hours and total flow duration was 51.75 hours for the 2014 monsoon season. Table 6 below summarizes the flow events at WVWXU location and Figure 8 displays hydrographs and flowtography images of flow events.

Table 6: Williamson Valley Wash at XU Ranch – 2014 Monsoon Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/8/2014	14:30	2.5	0.72	85.7	4.2
7/15/2014	12:30	2.5	0.48	43.1	3.31
7/28/2014	19:45	10.25	1.1	179	20.43
7/31/2014	12:00	0.75	0.16	8.12	0.31
8/19/2015***	5:30	8.5	0.56	55.5	8.81
9/27/2014	19:45	27.25	0.39	31.9	31.61
Average		8.63	0.57	67.22	11.45
Total		51.75			68.67

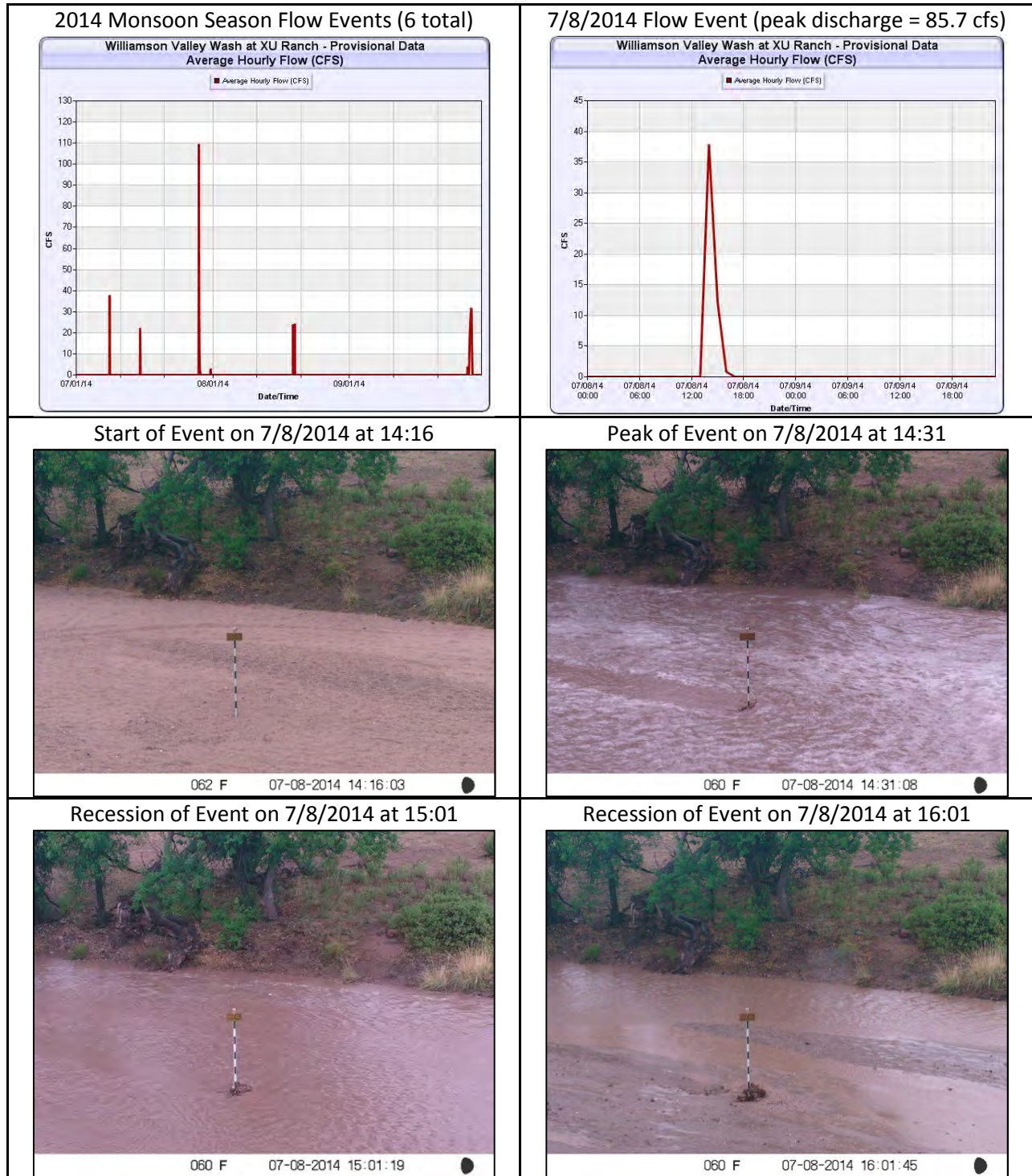
* Start times are approximate within 15 minutes and events may continue into the next day

*** Period(s) of no flow within event. Duration of event indicates only time with flow

The WVWXU location was visited a total of four times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Cleaned debris from event gages and removed vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images with obstructed event gage

Figure 8: Williamson Valley Wash at XU Ranch Hydrographs and Flowtopography Flow Event Images



Lower Williamson Valley Wash (LWVW)

A total of 10 flow events were recorded at Lower Williamson Valley Wash (LWVW) during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 4.07 CFS on 7/10/2014 to 281 CFS on 7/6/2014. Total volume of each event ranged from 0.16 AF on 7/10/2014 to 28.1 AF on 8/19/2014. A total volume of 128.23 AF was estimated to flow through the LWVW location during the 2014 monsoon season.

Total duration of the events ranged from 1.0 hour on 7/10/2014 to 53 hours on 8/13/2014. Average event flow duration was 21.6 hours and total flow duration was 216 hours for the 2014 monsoon season. Table 7 below summarizes the flow events at LWVW location and Figure 9 displays hydrographs and flowtography images of flow events.

Table 7: Lower Williamson Valley Wash – 2014 Monsoon Flow Events

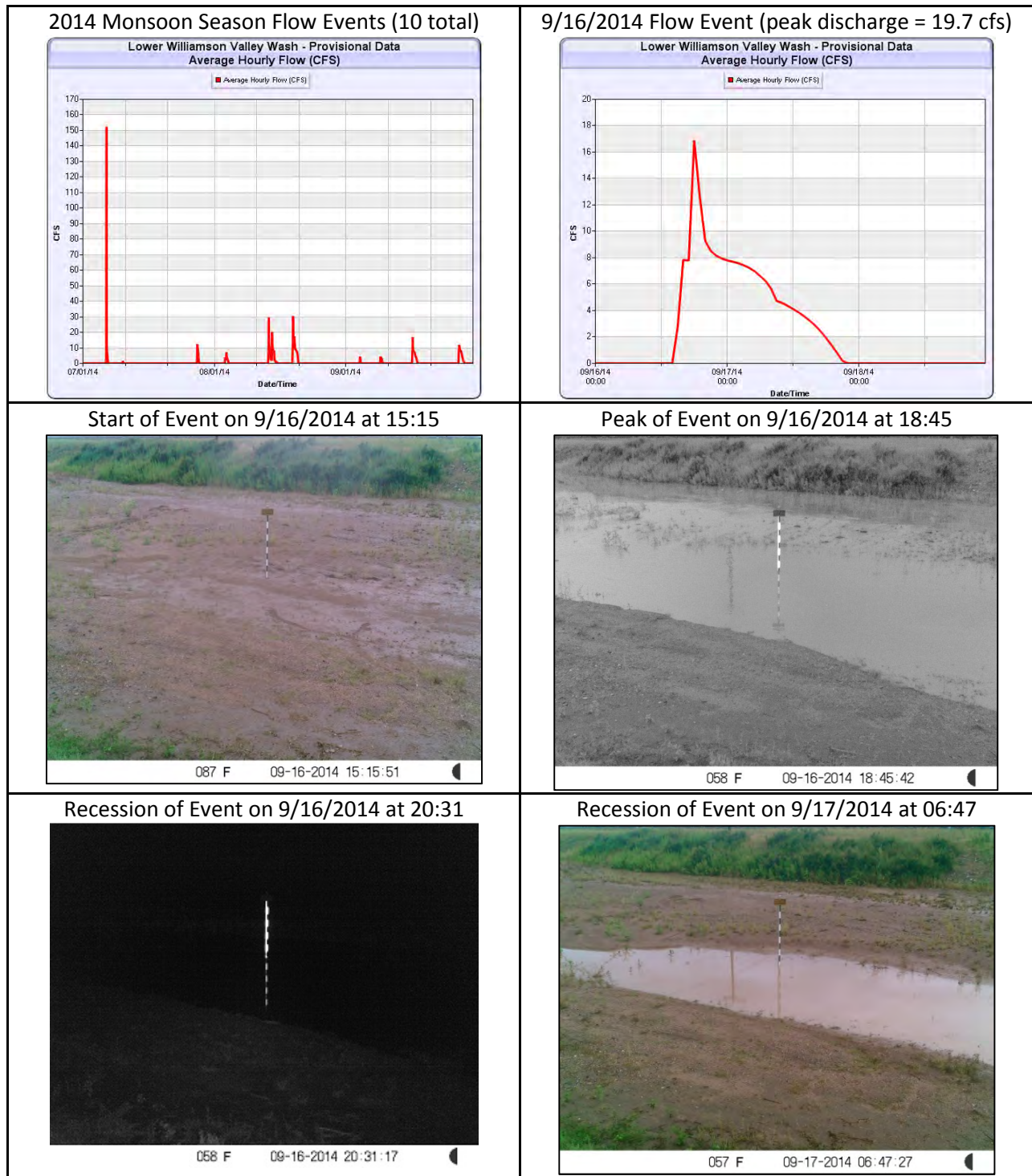
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/6/2014	13:00	15	1.8	281	25.09
7/10/2014	11:00	1	0.1	4.07	0.16
7/27/2014	23:00	11	0.66	12.8	6.34
8/3/2014	12:45	20.5	0.31	7.41	5.31
8/13/2014	17:30	53	0.99	39.2	27.97
8/19/2015	10:45	32.5	1.0	42.9	28.10
9/4/2014	7:00	5.75	0.11	4.50	1.33
9/9/2014	3:15	13	0.11	4.53	3.10
9/16/2014	15:46	30	0.79	19.7	15.14
9/27/2014	14:30	34.5	0.65	12.5	15.88
Average		21.6	0.52	42.8	12.8
Total		216			128.23

* Start times are approximate within 15 minutes and events may continue into the next day

The LWVW location was visited a total of three times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Cleaned debris from event gages and removed vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images with obstructed event gage

Figure 9: Lower Williamson Valley Wash Hydrographs and Flowtopgraphy Flow Event Images



Lower Big Chino Wash (LBCW)

A total of 5 flow events were recorded at Lower Big Chino Wash (LBCW) during the period from July 1, 2014 through September 30, 2014. Peak discharge during events ranged from 31.4 CFS on 9/16/2014 to 113 CFS on 7/6/2014. Total volume of each event ranged from 14.12 AF on 9/16/2014 to 31.17 AF on 8/19/2014. A total volume of 121.79 AF was estimated to flow through the Lower Big Chino Wash location during the 2014 monsoon season.

Total duration of the events ranged from 5.5 hours on 7/6/2014 to 18.5 hours on 8/12/2014. Average event flow duration was 9.5 hours and total flow duration was 47.5 hours for the 2014 monsoon season. Note that flow duration and volume estimated at this location does not include pooled or static water that collects at the site and only physical flow is used in calculations (water flowing past the downstream control). Table 8 below summarizes the flow events at Lower Big Chino Wash location and Figure 10 displays hydrographs and flowtography images of flow events.

Table 8 - Lower Big Chino Wash - 2014 Monsoon Flow Events

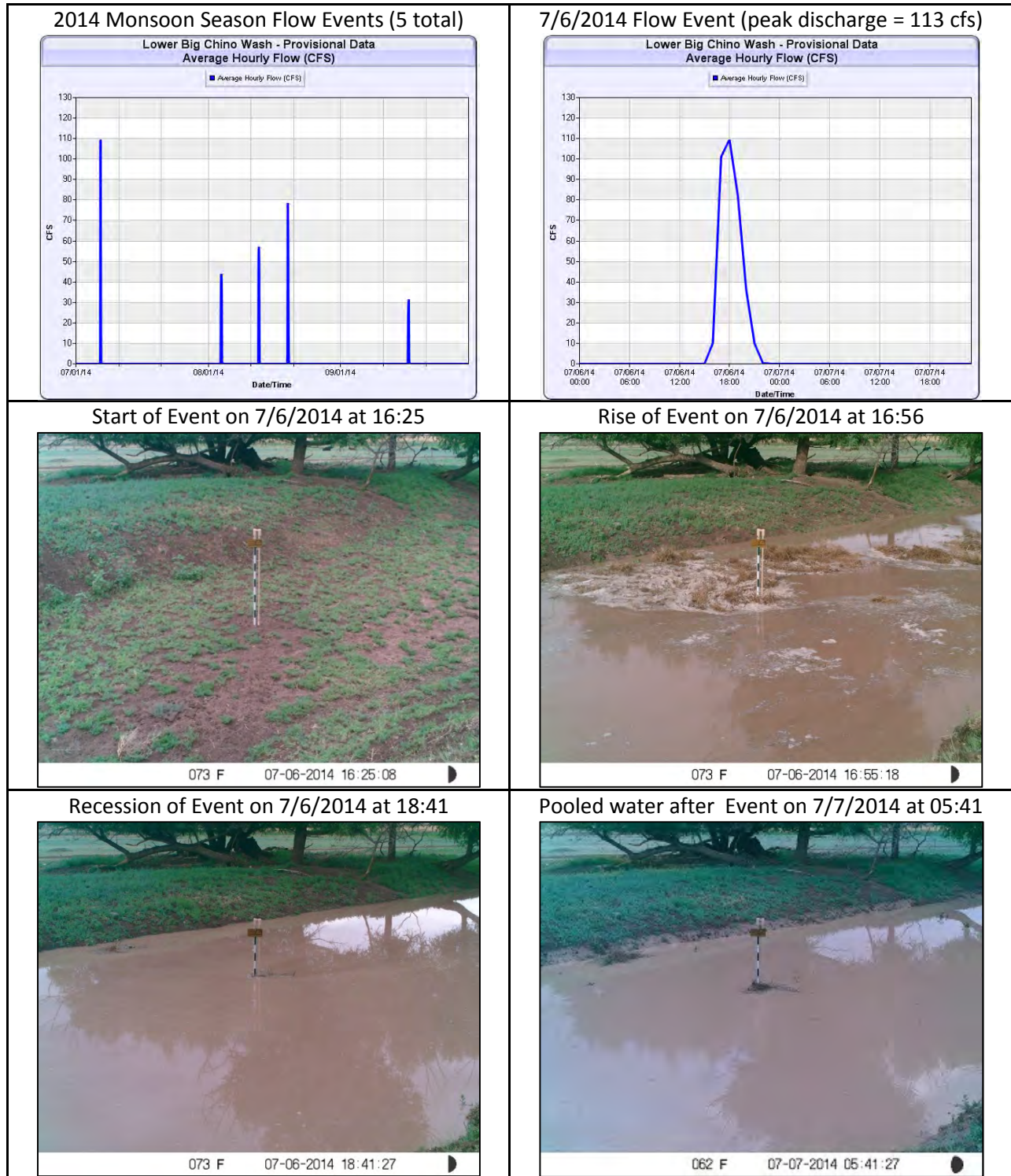
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
7/6/2014	16:45	5.5	2.65	113	28.87
8/3/2014	21:30	7.75	1.9	44.1	22.65
8/12/2015	17:15	18.5	2.07	57.5	24.98
8/19/2014	12:30	8.5	2.35	81.8	31.17
9/16/2014	18:15	7.25	1.71	31.4	14.12
Average		9.5	1.73	65.56	24.35
Total		47.5			121.79

* Start times are approximate within 15 minutes and events may continue into the next day

The LBCW location was visited a total of three times during the monsoon season with additional visits for post monsoon related activities. In addition to routine maintenance and collection, the following adjustments were required at the site:

- Cleaned debris from event gages and removed vegetation from banks that obstruct flowtography view
- Took photos with tagline (reference) to determine stage level in images with obstructed gage
- Troubleshoot and repair camera issues
- Investigated and surveyed downstream of event gage in order to adjust rating equation to account for pooled water due to downstream control toward Sullivan Lake.

Figure 10: Lower Big Chino Wash Hydrographs and Flowtopgraphy Flow Event Images

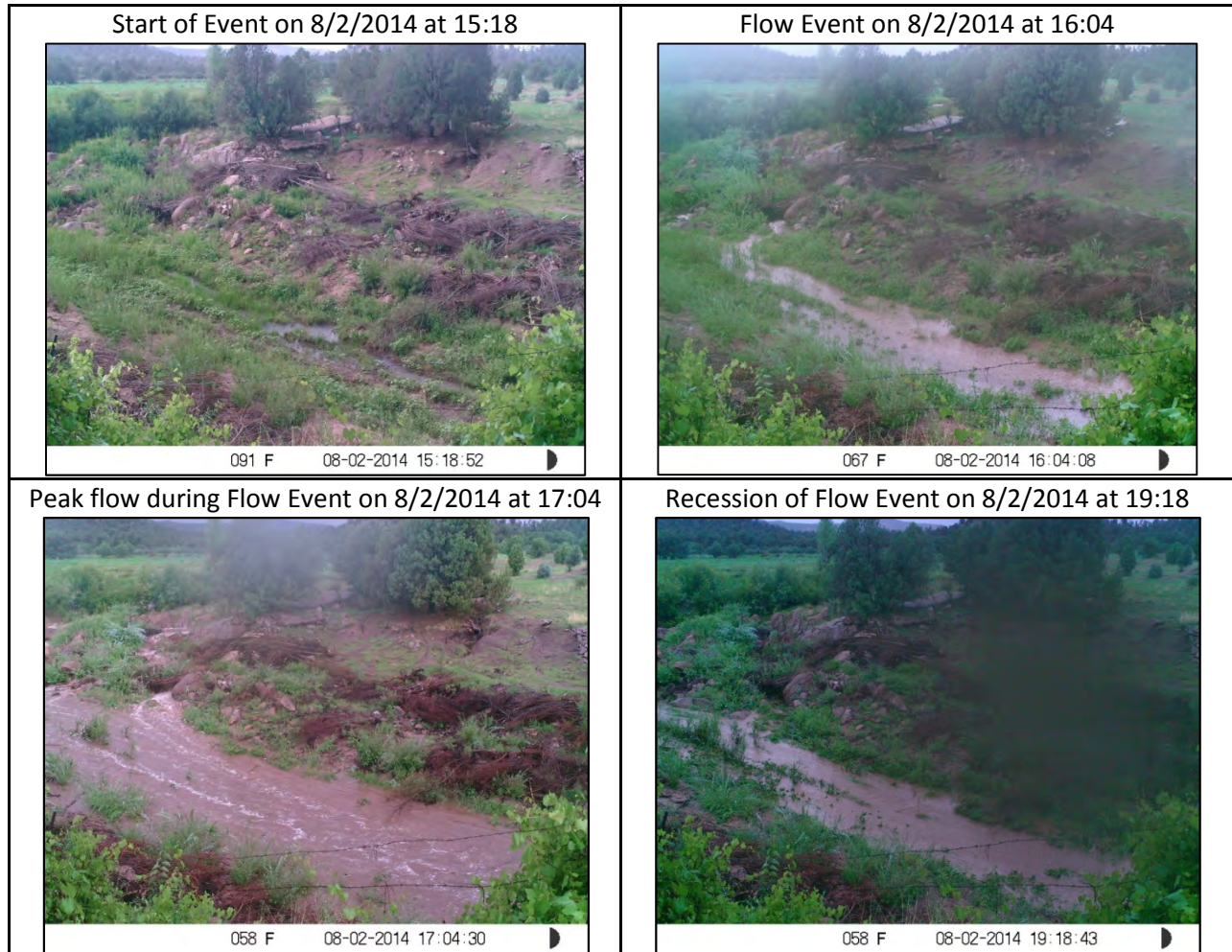


Upper Walnut Creek at Bridge (UWCB)

A total of 6 flow events were recorded at the Upper Walnut Creek at Bridge (UWCB) location during the 2014 Monsoon Season. The UWCB location is only equipped with a flowtography camera. No transducer or event gages exist, therefore stage and discharge data are not available for this location. No flow measurements were made at the UWCB location during the 2014 monsoon season.

Flow events occurred on the following dates and durations: 7/28/2014 (2.25 hours), 8/1/2014 (4 hours), 8/2/2014 (19.25 hours), 8/3/2014 (26 hours), 8/19/2014 (2 hours), and 9/27/2014 (7.5 hours). Average event flow duration was 17.4 hours and total flow duration was 61 hours for the 2014 monsoon season. The UWCB location was not visited during the 2014 monsoon season but was visited before (6/26/2014) and after (10/2/2014) for routine maintenance and flowtography image collection. Figure 11 shows flowtography images during a flow event recorded on 8/2/2014.

Figure 11 – Upper Walnut Creek at Bridge Flow Event Flowtography Images



Upper Walnut Creek at Forest Service (UWCFS)

The Upper Walnut Creek at Forest Service (UWCFS) location monitoring equipment was not installed prior to the 2014 monsoon season and the site was not visited during this period. Installation of a low flow flume (rated for 2.0 CFS max) and flowtography camera at the site occurred on October 2, 2014. Details on the flume installation and data collected at the UWCFS location will be detailed in the 2014/2015 Winter Season Report. Figure 12 shows the UWCFS location on June 5, 2014.

Figure 12 –Upper Walnut Creek at Forest Service Location

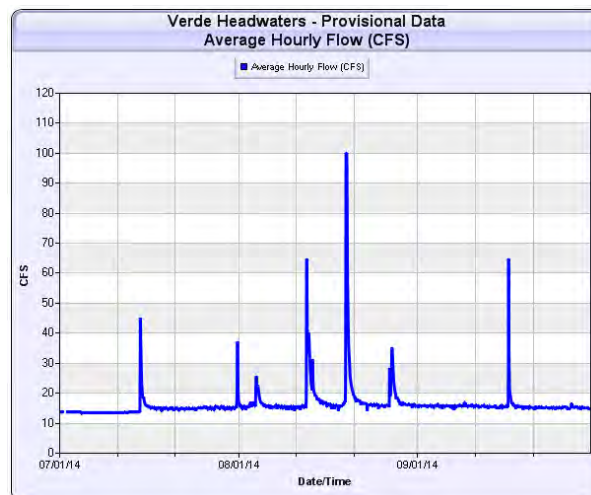


Conclusion

Flow events during the 2014 Monsoon season were typical of summer monsoon flash floods consisting of high flows with a short duration with some sites recording smaller flows. Peak discharge reached as high as 640 CFS (BCWPC) and flows varied by location. Stream stage of approximately four feet (or less due to tumbleweeds stuck on gage) were observed to damage (knock over or loosen) event gages at UBCW, BCWPC, and LWCCP. Several of these sites required additional non-routine maintenance and repair due to damage from monsoon flood events, faulty cameras or weak cellular signals, and damage by animals (i.e. cows at LWCCP). Additionally, due to the short duration and flash flood nature of the flow events, conditions were not conducive to current meter measurements during this period. While stage values are typically accurate during flow events, discharge values are based on estimated ratings developed from the modeled cross sections. Direct current meter measurements of flow would be needed to improve accuracy of discharge values in the future. Shifts to rating equations only occurred at UBCW during periods where channel fill were observed above the zero stage level of the event gage.

During the 2014 Monsoon season a total of 1,000 AF were recorded to flow at the seven SRP Flowtography™ equipped stream flow monitoring locations recording stage levels within the Big Chino Sub-basin (UWCFS and UWCB excluded). A total of approximately 121 AF were recorded to flow through the LBCW location just upstream of Sullivan Dam near the headwaters of the Verde River. Sullivan Dam was not monitored during this period; therefore it was not determined whether any water recorded at LBCW spilled to the Verde River Canyon (approximately 3 miles upstream of the Verde Headwaters gage location) during the 2014 Monsoon Season. For the five flow events recorded at LBCW, spikes in flow at Verde Headwaters were observed during four of these events on 8/3/2014, 8/12/2014, 8/19/2014, and 9/16/2014 (Figure 13). Without monitoring of Sullivan Dam and Granite Creek, the contributing source of flow seen at Verde Headwaters during events is uncertain. If water did not spill over Sullivan Dam during flow events, it is assumed that surface water flow contributing to spikes in discharge seen at Verde Headwaters would be from Granite Creek and localized runoff below Sullivan Dam.

Figure 13 – Verde Headwaters Hydrograph: 2014 Monsoon Season Flow Events (7 total)



Based on the initial observations from data collected at the current Big Chino Sites during the 2014 monsoon season several additional flowtography (camera only) locations (similar to UWCB) are being proposed to the CA1 committee to be installed to better understand the surface water flow and recharge at various locations within the sub-basin. Potential new flowtography sites include:

- Location at Sullivan Dam to visually record any periods of spill to the Verde River Canyon and potential contributions to the Verde Headwaters gage.
- Location along Granite Creek to visually record periods of potential contribution to the Verde Headwaters gage.
- Location along Big Chino Wash at southern end of Prescott Water Ranch property to visually record amount of surface water exiting the property downstream.
- Locations along Big Chino Wash at or near major confluences (Partridge Creek, Walnut Creek, and Williamson Valley Wash) to visually record flow contributions and provide additional information for downstream gages where pooling occurs (BCWPC and LBCW).

SRP Water Measurement continues to maintain current sites and process transducer data and flowtography images collected at the monitoring locations. Other beneficial uses of flowtography images have also been seen throughout monitoring of the locations such as capturing daytime and night time flow conditions, wildlife and animal activity, and recording of snow depths. The data presented within this report is provisional in nature and is reflective of the best available data at the time this report was written. Results of Winter/Spring flow events (October 1, 2014 – June 30, 2015) will be detailed in the 2014-2015 Winter/Spring Season Report.

Attachment #2

**Big Chino Sub-basin Water Monitoring Project
Winter/Spring Report: October 1, 2014 – June 30,
2015**



2015

Big Chino Sub-basin Water Monitoring Project Winter/Spring Report: October 1, 2014 – June 30, 2015



Prepared by: Stephen Flora and Mark Hubble

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Lower Williamson Valley Wash
3/4/2015

Prepared for: CA1 Monitoring Committee
(Prescott, Prescott Valley, SRP)
9/15/2015

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Table of Acronyms

AF	Acre Feet	SRP	Salt River Project
BCWPC	Big Chino Wash Partridge Creek	UBCW	Upper Big Chino Wash
CFS	Cubic Feet per Second	USGS	United States Geological Survey
CMM	Current Meter Measurement	UWCB	Upper Walnut Creek Bridge
GW	Gipe Well	UWCFS	Upper Walnut Creek Forest Service
LBCW	Lower Big Chino Wash	VRCR	Verde River at Campbell Ranch
LWCCP	Lower Walnut Creek Charney Property	WM	Water Measurement
LWVW	Lower Williamson Valley Wash	WVWXU	Williamson Valley Wash at XU
PC	Pine Creek	YCFCD	Yavapai County Flood Control District

Introduction

The purpose of the Big Chino Sub-Basin Ephemeral Stream Flow Monitoring Project is to collect additional surface water hydrologic data for use in the development of a numerical groundwater flow model within the Big Chino Sub-basin. This Winter/Spring report is being developed for the CA1 Monitoring Committee as part of the Big Chino Sub-basin Water Monitoring Project in collaboration with the City of Prescott, Town of Prescott Valley, and Salt River Project (SRP). Under an independent contractor's agreement approved in 2013, SRP Water Measurement (WM) was selected to provide the installation, maintenance, and data collection at nine stream-flow sites within the Big Chino Sub-basin. A summary of flow events recorded during the 2014-2015 Winter/Spring reporting period (October 1, 2014 to June 30, 2015) is contained within this report.

Two additional stream gages located in the Big Chino Sub-basin are also briefly discussed in this report. The Williamson Valley Wash near Paulden (WVWP) gage is operated and maintained by the United States Geological Survey (USGS) with funding contributions from the CA1 Monitoring Committee. Prior to October 2014, this gage was funded by the Yavapai County Water Advisory Committee. This site has a period of record ranging from 3/26/1965 to 9/30/1985 and from 8/03/2001 to present. The other gage is located approximately 3 miles downstream of Sullivan Dam on the Verde River at Campbell Ranch (VRCR), installed and operated by SRP to measure low flows since 4/13/2005. Operation and maintenance of this gage is also now funded by the CA1 Monitoring Committee.

Background and Rating Development

As part of this monitoring effort, SRP Flowtography™ (flowtography) equipped stream-flow monitoring locations were installed between December 2013 and June 2014. Flowtography is a system of hardware combined with data processing that improves knowledge of the hydrologic conditions and site operation. The system utilizes time-lapse high resolution photography of a stationary event gage within the frame of the image to capture real time images of flow conditions. Standard configuration at most monitoring locations include upstream and downstream event gages equipped with pressure transducers (to collect stage values) and a flowtography camera mounted on the stream bank that records images of the upstream event gage. Surveys determined the channel cross sections for event gages at each monitoring location. Using the Slope-Area Method and preliminary survey data collected in the field, an illustrative detailed estimate of flow prediction was calculated for channel stages. The collected survey information was analyzed through HEC-RAS modeling software to develop a rating table and equation for both the upstream and downstream cross sections.

Site Maintenance and Data Processing

A number of site visits were required to perform routine and non-routine maintenance. Routine maintenance included the collection of upstream and downstream transducer data, flowtography images, general cleaning, and verification of site operation. Several non-routine break-fix events were required and included replacing transducers and event gages, modification of site configuration to bring transducer cables out of the channel, troubleshooting camera issues, and additional site investigation/surveying required for data processing. Specifics on site visits for each location are discussed in the Location Summaries section.

Data processing of stage values and rating curves were completed using Aquarius (version 3.5) time series software. Stage values (feet) collected from the upstream transducer serve as the primary data source (downstream transducer is secondary). Offsets to stage values were applied based on the depth of the transducer below the stream channel and then compared with the visual determination of stage values from flowtography images. For instances when the event gage was obstructed or missing from the flowtography images, stage level overlays were created using a tag line reference at each location (see Figure 1 and Figure 2).

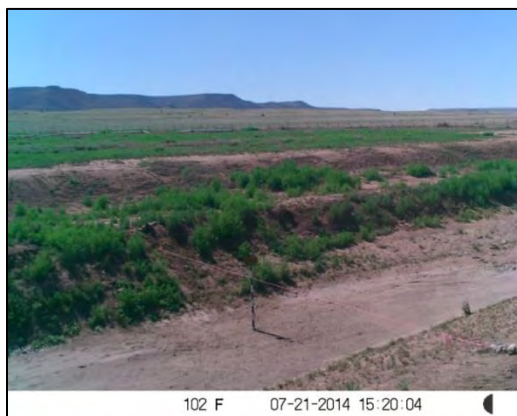


Figure 1. Upper Big Chino Wash tagline reference.

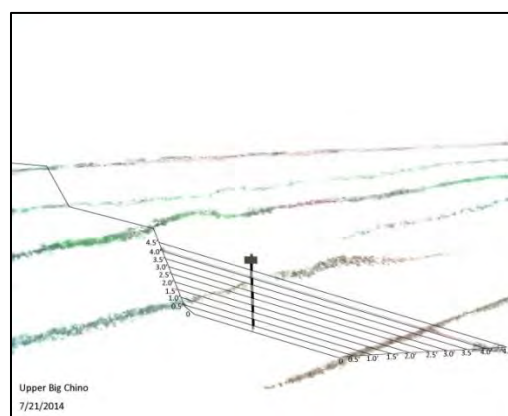


Figure 2. Upper Big Chino Wash stage level overlay.

The developed ratings are used to generate discharge values in cubic-feet per second (CFS) for each stage value. The hourly mean CFS values are used to calculate the total volume of water in acre-feet (AF). Data and images are stored and maintained by SRP and are available to the CA1 monitoring committee via a secure SRP hosted web portal.

Seasonal Flow Events Summary

During the 2014-2015 Winter/Spring reporting period, a total of 7 storm events resulting in surface water flow were recorded in the Big Chino Sub-basin. The number of locations with flow, magnitude of flow, and duration of flow during these events varied throughout the sub-basin. Williamson Valley Wash at XU Ranch (WVWXU) recorded the highest number of events (3) while Big Chino Wash below Partridge Creek (BCWPC) recorded the fewest events (0). The highest total duration of flow during the Winter/Spring reporting period occurred at WVWXU (668 total hours of flow). The shortest total duration of flow occurred at Upper Big Chino Wash (UBCW) (8 total hours of flow). Winter/Spring flow event totals (AF) at each location are outlined in Table 1 and Figure 3.

One storm event (3/2/2015) was of sufficient duration (multiple days) and flow to allow staff to perform current meter measurements (CMMs) at two of the southern sub-basin locations. The largest flow within the sub-basin occurred during this event at WVWXU location. The maximum peak discharge was 895 CFS resulting in a total of 1,862 AF for the entire event lasting 412 hours (17.1 days). The two downstream locations; LWVW and LBCW; resulted in a total of 774 AF and 222 AF, respectively.

During the same event, moderate flow occurred at LWCCP (up to 99 CFS resulting in a total of 103 AF) and Upper Walnut locations UWCFS and UWCB (visually observed only, no measurement of discharge), but no flow was recorded at the upper sub-basin locations (UBCW, BCWPC, and PC). The only flow event recorded in the upper portion of the sub-basin was on 12/4/2014 with approximately 2 AF of total water measured in less than 12 hours duration at two locations (UBCW and PC).

It should also be noted that snow accumulation was observed at multiple locations throughout the sub-basin on 12/31/2015. Maximum snow depths measured at the event gages ranged from 0.2 to 0.7 feet. Snow was present at the various sites for approximately 5 to 10 days, but no measureable flow was recorded or observed at any locations as a result of snowmelt.

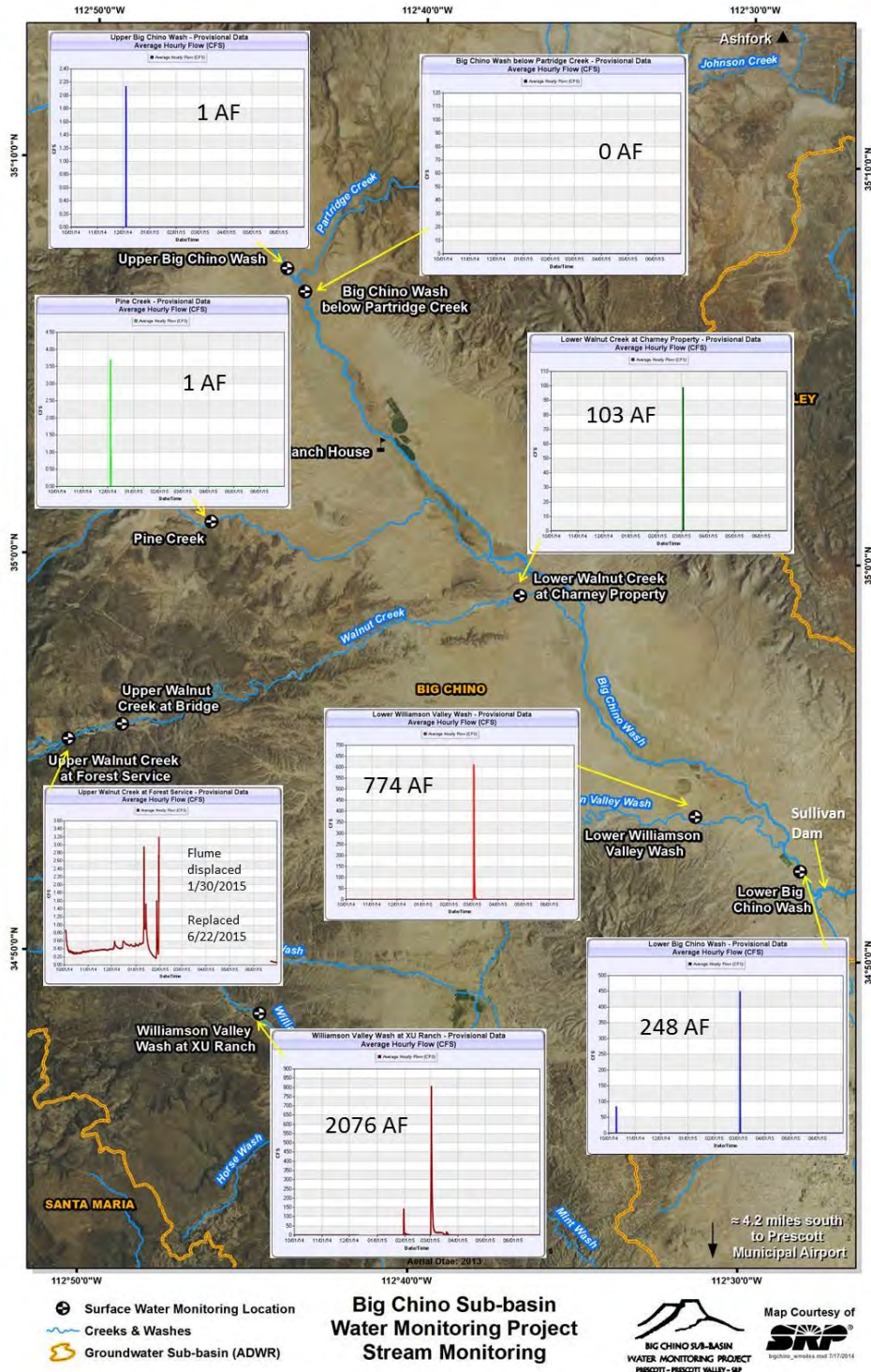
A total volume of 248 AF was estimated to flow through the Lower Big Chino Wash (LBCW) location just upstream of Sullivan Dam during two flow events (10/9/2014 and 3/2/2015). Sullivan Dam was not monitored during the 2014-2015 Winter/Spring season therefore it was not determined whether water spilled to the Verde River Canyon, but increases in flow were measured at the VRCR gage during the two corresponding flow events at LBCW.

Table 1: Big Chino Sub-basin 2014-2015 Winter/Spring Flow Event Totals in acre-feet (AF)

Start Date*	Upper Big Chino Wash (UBCW)	Big Chino Wash below Partridge Creek (BCWPC)	Pine Creek (PC)	Upper Walnut Creek at Forest Service (UWCFS)	Lower Walnut Creek at Charney Property (LWCCP)	Williamson Valley Wash at XU Ranch (WVWXU)	Lower Williamson Valley Wash (LWVW)	Lower Big Chino Wash (LBCW)
10/9/2014	0	0	0	n/a	0	0	0	26
12/4/2014	1	0	1	<1	0	0	<1	0
12/31/2014	snow	snow	snow	snow	snow	snow	Snow	snow
1/11/2015	0	0	0	>4	0	0	0	0
1/30/2015	0	0	0	>4	0	167	0	0
3/2/2015	0	0	0	>4	103	1862	774	222
3/18/2015	0	0	0	n/a	0	47	0	0
	1	0	1	n/a	103	2076	774	248

*Note: Flow events may start just prior to date indicated or continue into the following days

Figure 3: Big Chino Sub-basin SRP Flowtography™ Stream-flow Monitoring Location Hydrographs with Total Estimated Water Volumes in Acre-Feet (AF) 2014-2015 Winter/Spring Flow Events – October 1, 2014 to June 30, 2015



Location Summaries

Upper Big Chino Wash (UBCW)

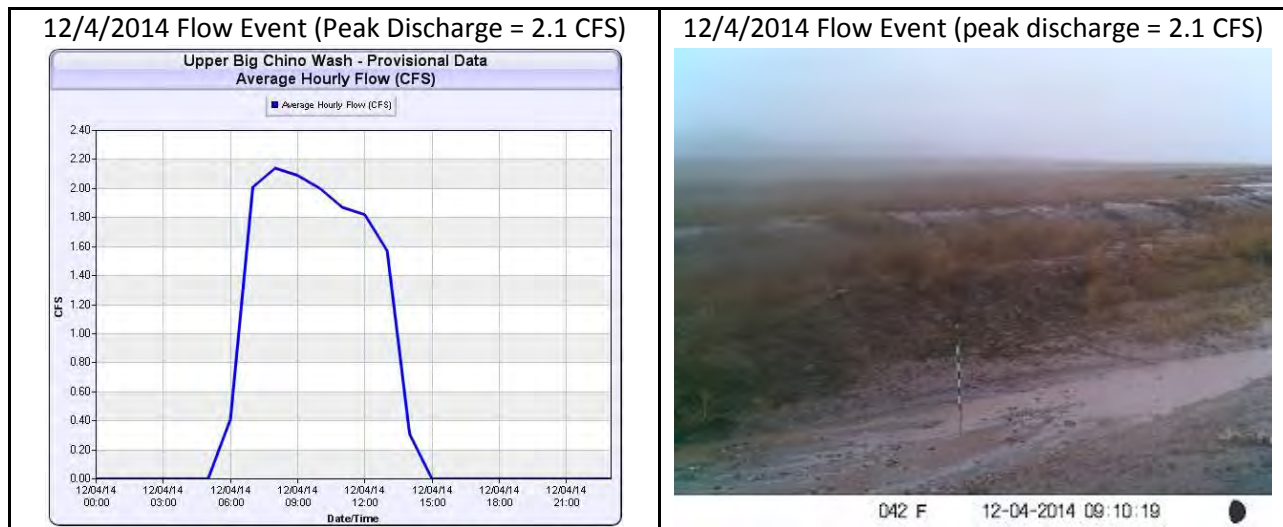
One flow event was recorded at Upper Big Chino Wash (UBCW) during the period from October 1, 2014 through June 30, 2015. Total duration of the event on 12/4/2014 was 8 hours. Peak discharge for the event was 2.1 CFS resulting in a total volume of 1 AF (Table 2 and Figure 4). Several additional precipitation events were noted at the location throughout this period but none resulted in any measureable flow at the event gage.

Table 2: Upper Big Chino Wash – 2014-2015 Winter/Spring Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
12/4/2014	06:45	8	0.15	2.1	1
Total		8			1

* Start times are approximate within 15 minutes and events may continue into the next day

Figure 4: Upper Big Chino Wash Hydrographs and Flowtography Flow Event Images



The UBCW location was visited a total of eight times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare location for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 1/7/2015 – Reset Drone Cameras to collect daytime images only to resolve freezing issue.
- 1/27/2015 – Resurveyed the channel cross section at the event gages
- 4/13/2015 – Pressure transducers access moved from stream channel to bank. New access box, extended cable, and flexible conduit. Reset camera to collect images at daily every 15 minutes
- 6/3/2015 – Repaired damaged camera box

Big Chino Wash below Partridge Creek (BCWPC)

No flow events were recorded at Big Chino Wash below Partridge Creek (BCWPC) during the period from October 1, 2014 through June 30, 2015. Flow occurred at UBCW on 12/4/2014, but was not seen downstream at BCWPC.

The BCWPC location was visited a total of nine times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare location for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 10/2/2015 – Repair event gage poles from monsoon event damage
- 10/31/2015 – Replaced both upstream and downstream event gages due to damage from monsoon flow event.
- 11/5/2015 – Replaced transducers at both event gages
- 1/7/2015 – Investigated and surveyed downstream of event gage in order to adjust rating equation due to pooling at the site. Also noted pooling upstream from location near confluence of Big Chino Wash and Partridge Creek. Reset Drone Cameras to collect daytime images only to prevent freezing.
- 2/10/2015 - Resurveyed the channel cross section at the event gages
- 3/25/2015 - Reset camera to collect images back to 24 hour operation at 15 minute intervals.
- 4/13/2015 - Pressure transducers access was moved out of the stream channel and onto the bank. Each included a new access box, extended cable and flexible conduit.

Pine Creek (PC)

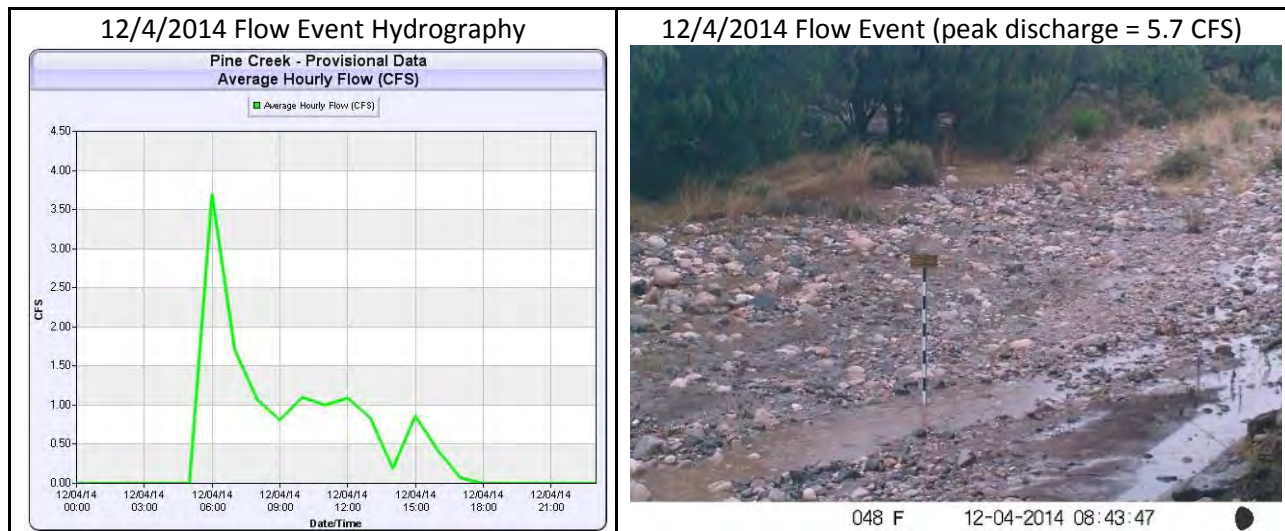
One flow event was recorded at Pine Creek (PC) during the period from October 1, 2014 through June 30, 2015. Total duration of the event on 12/4/2014 was 8 hours. Peak discharge was 5.7 CFS resulting in a total volume of 1 AF (Table 3 and Figure 5). Several additional precipitation events were noted at the location throughout this period but none resulted in any measureable flow at the event gage.

Table 3: Pine Creek - 2014 Winter/Spring Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
12/4/2014	06:15	12.0	0.22	5.7	1
Total		12.0			1

* Start times are approximate within 15 minutes and events may continue into the next day

Figure 5: Pine Creek Hydrographs and Flowtography Flow Event Images



The PC location was visited six times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare sites for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 1/07/2015 – Reset Drone Cameras to collect daytime images only to resolve freezing issue
- 1/27/2015 – Resurveyed the channel at the event gage locations
- 3/25/2015 – Replaced downstream pressure transducer (malfunctioned), Reset camera to collect images back to 24 hour operation at 15 minute intervals.

Upper Walnut Creek at Bridge (UWCB)

Two high flow events were recorded at the Upper Walnut Creek at Bridge (UWCB) location between October 1, 2014 and June 30, 2015. The UWCB location is equipped with a flowtopography camera only. No transducer or event gages exist, therefore stage and discharge data are not available for this location. No flow measurements were made at UWCB location during the winter/spring reporting period. Yavapai County Flood Control District (YCFCD) installed a radar stage gage on the Walnut Creek Bridge on 6/5/2015 and SRP will attempt to build a stage-discharge relationship for this site in the future.

High flow events occurred on 1/30/2015 and 3/2/2015 (Figure 6), with duration of approximately 72 to 96 hours, respectively. The UWCB location was visited a total of nine times during the 2014-2015 winter/spring reporting period for routine maintenance and flowtopography image collection. Site visits on 1/7/2015, 2/10/2015, 3/25/2015, and 4/27/2015 also required replacement or repair of batteries or camera due to being inoperative.

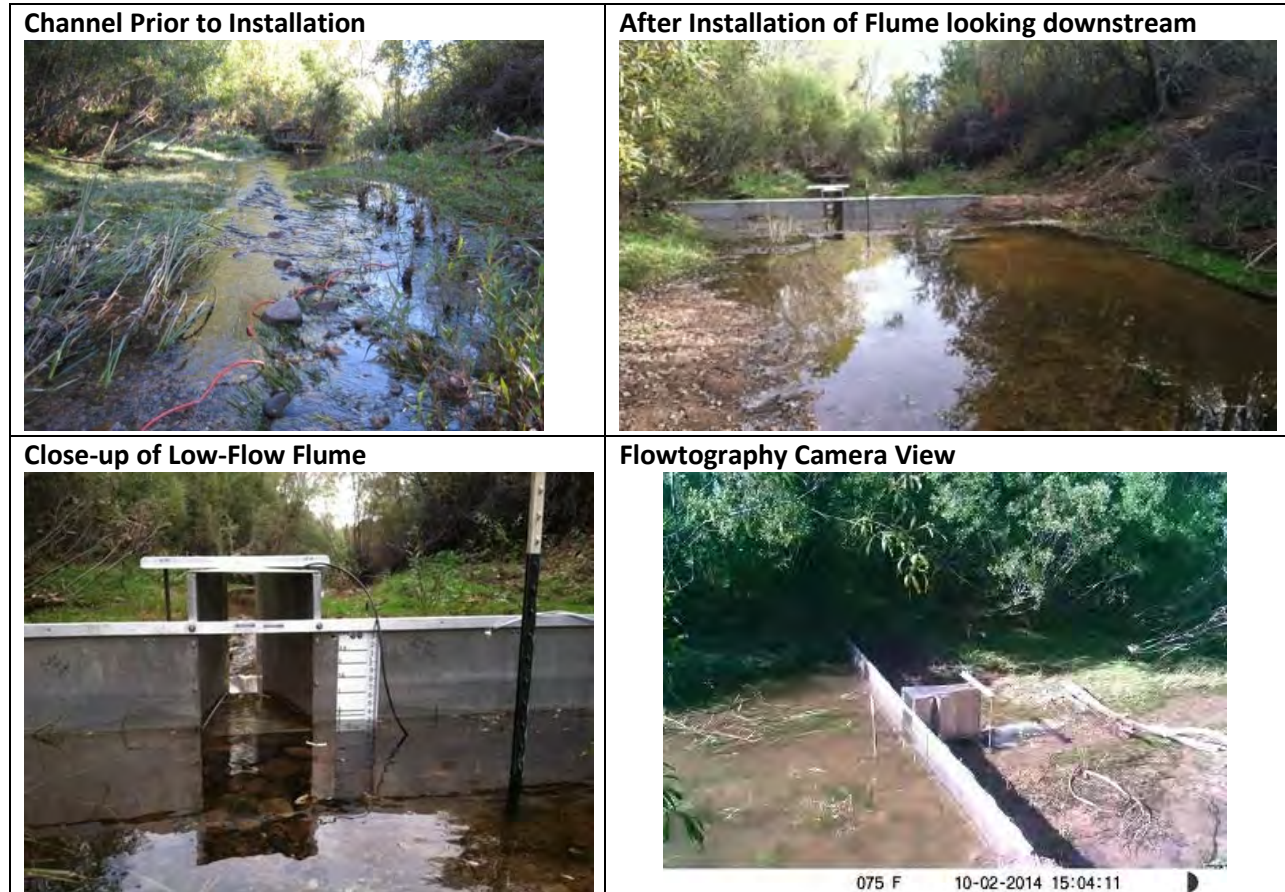
Figure 6 – Upper Walnut Creek at Bridge Flow Event Flowtopography Images



Upper Walnut Creek at Forest Service (UWCFS)

On October 2, 2014, a modified parshall low flow flume (rated for up to 2.0 CFS max) was installed in the channel with wing walls installed to each bank to guide water through the flume (Figure 7). A camera was attached to a tree on the right bank in order to collect 15 minute flowtography images of the flume and event gage.

Figure 7 –Upper Walnut Creek at Forest Service Installation



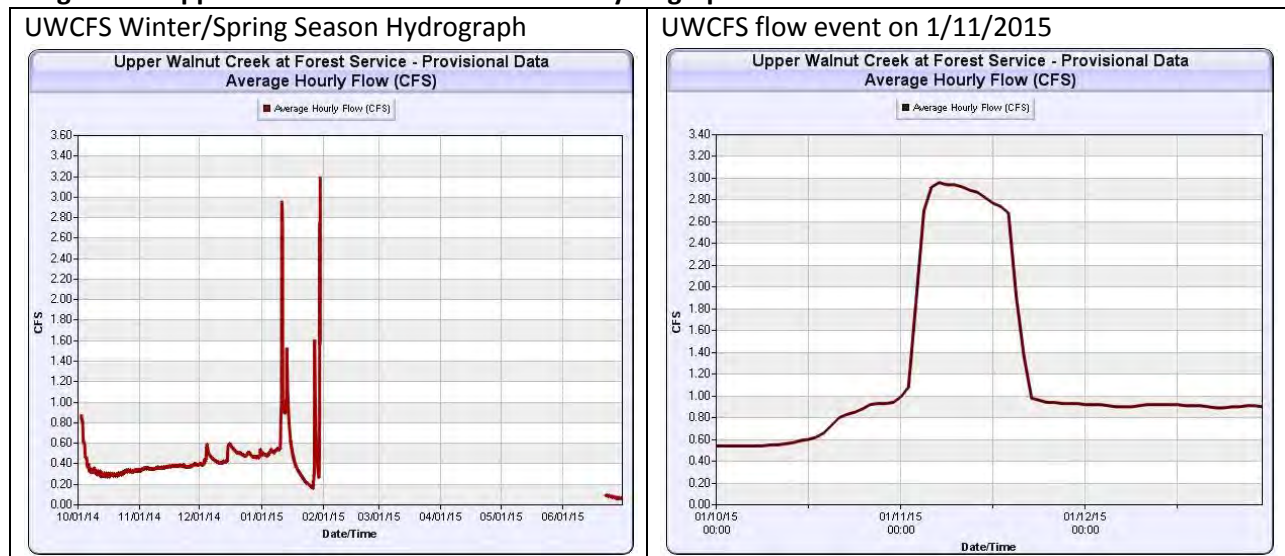
A total of 3 high flow events occurred at the Upper Walnut Creek Forest Service (UWCFS) location between October 1, 2014 and June 30, 2015 (Table 4 and Figure 8). The first event occurred on 1/11/2015 and reached a peak discharge of approximately 3 CFS but did not exceed the flume capacity. The events on 1/30/2015 and 3/2/2015 both exceeded the flume capacity and the flume equipment was dislodged from its position in the channel. As a result, peak flows during these events and low flows following 1/30/2015 were not measured. Figure 9 shows flowtography images during three flow events. Small increases in low flow (tenths of a CFS) were also noted on 12/4/2014, 12/15/2014, 12/31/2014, 1/13/2015, and 1/27/2015. Low flow between installation and the first high flow event on 1/11/2015 steadily increased from a low of 0.27 CFS (0.6 AF/day) on 10/2/2014 to a high of 0.54 CFS (1 AF/day) on 1/10/2015 with small increases in flow as noted above. Approximately 102 AF were estimated to flow through the UWCFS location between 10/2/2014 and 1/29/2015 prior to it being dislodged.

Table 4: Upper Walnut Creek Forest Service – 2014-2015 Winter/Spring Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
1/11/2015	2:00	15	1.26	>2 CFS	N/A
1/30/2015	3:45	96	1.37	>2 CFS	N/A
3/1/2015	21:30	192	3.33	>2 CFS	N/A
Total		303			

* Start times are approximate within 15 minutes and events may continue into the following days

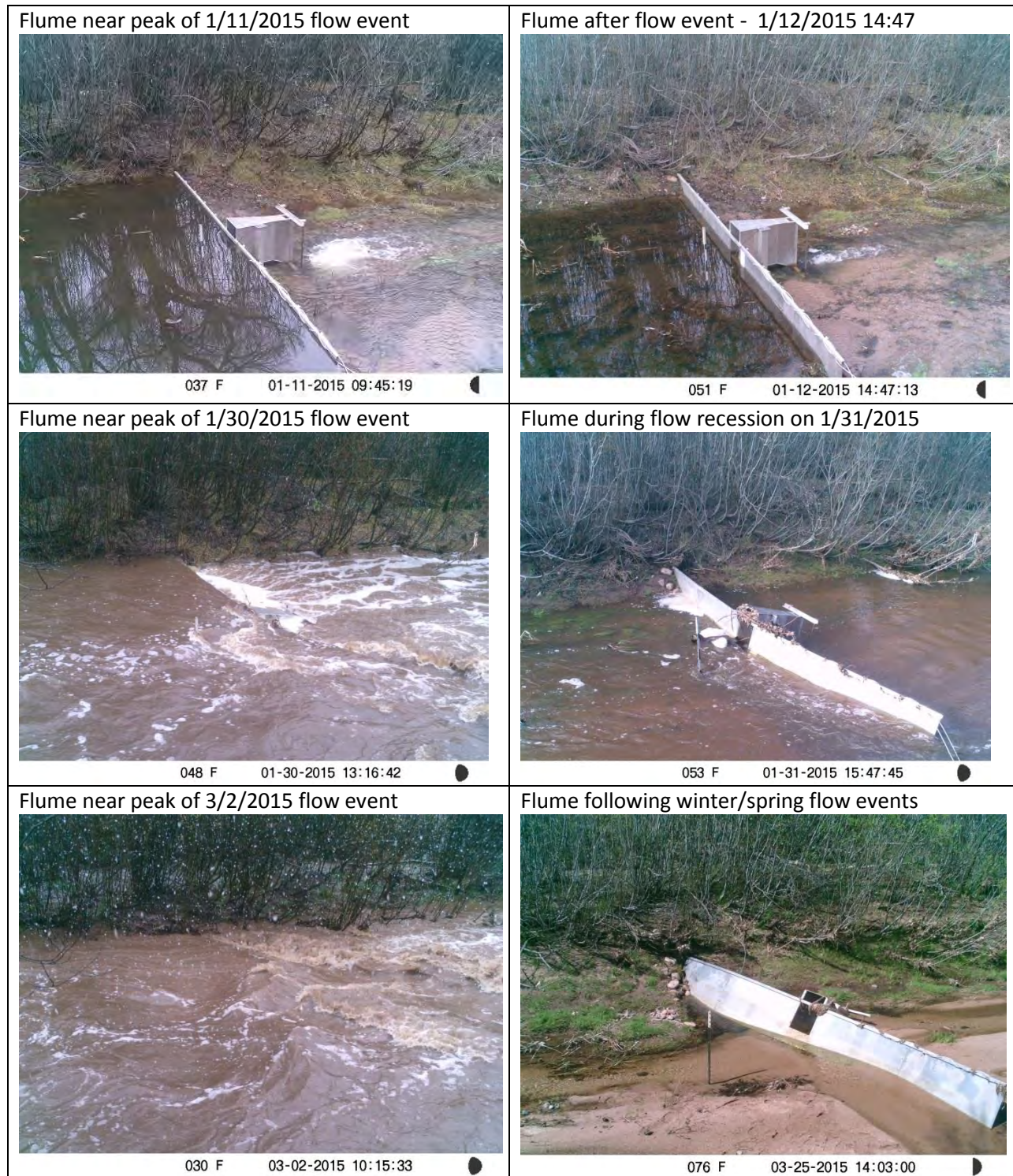
Figure 8 – Upper Walnut Creek Forest Service Hydrographs



The UWCFS location was visited a total of nine times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare for the monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 10/2/2014 – Flume Installation, CMM conducted
- 10/17/2014 – Inspection of flume and equipment calibration
- 1/7/2015 – Reset camera to collect daytime images only to prevent freezing
- 2/10/2015 – Inspect damaged flume from 1/30/2015 event
- 3/25/2015 – Inspect damaged flume from 3/2/2015 event
- 3/27/2015 – Removal of flume equipment, CMM conducted
- 5/27/2015 – CMM conducted in channel at flume location
- 6/22/2015 – Reinstallation of low flow flume only (no wings), CMM conducted

Figure 9 – Upper Walnut Creek Forest Service Flow Events



Due to damage from high flow events, the flume was removed from the channel on 3/27/2015 and the site was restored to the natural state. A new pressure transducer and event gage was installed in the channel that could be used to support flowtography image processing during a flow event. CMMs were

completed at the UWCFS location during site visits on 5/27/2015 and 6/22/2015. Discharges measured on these dates were 0.42 CFS and 0.13 CFS respectively. A simplified version of the low flow flume was reinstalled on 6/22/2015 approximately 6 feet upstream of the previous flume location in order to measure low flow in the channel. The pressure transducer was moved to the flume stilling well and calibrated to record stage level in the flume. The wing walls that previously crossed the entire channel were not reinstalled in order to allow higher flows to flow around the low flow flume to minimize impact to the site and equipment. Figure 10 shows images of the reinstalled flume at the UWCFS location.

Figure 10 – Upper Walnut Creek Forest Service Flume Reinstallation



Lower Walnut Creek at Charney Property (LWCCP)

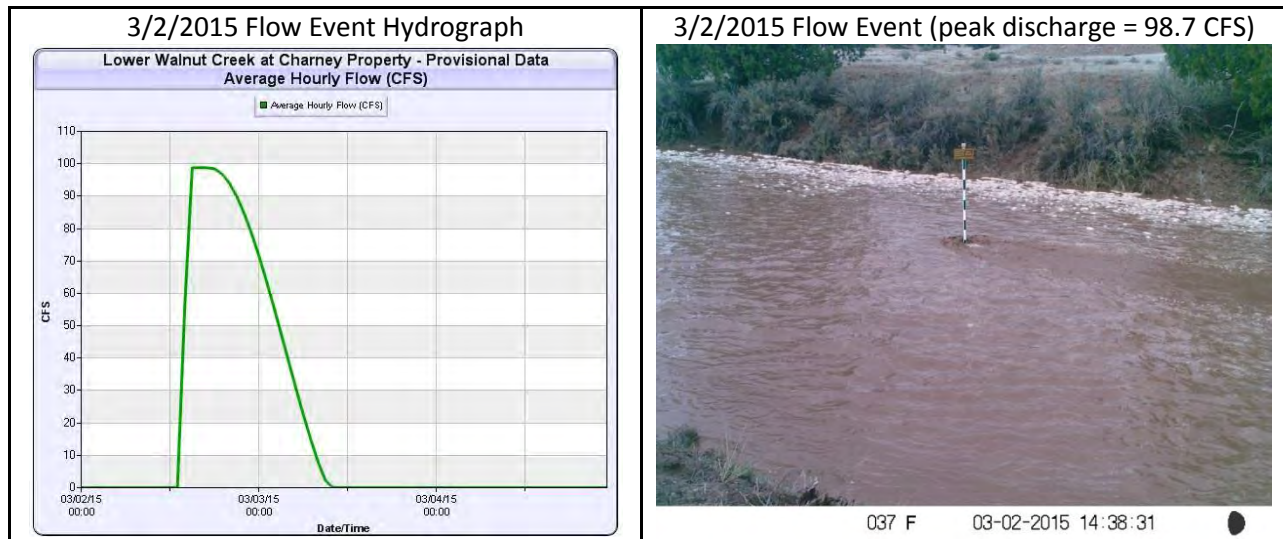
One flow event was recorded at Lower Walnut Creek at Charney Property (LWCCP) during the period from October 1, 2014 through June 30, 2015. Total duration of the flow event on 3/2/2015 was 21 hours. Peak discharge for the event was 98.7 CFS resulting in a total volume of 103 AF (Table 5 and Figure 11). Several additional precipitation events were noted at the location throughout this period but none resulted in any measureable flow at the event gage.

Table 5: Lower Walnut Creek at Charney Property – 2014 Winter/Spring Flow Events

Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
3/2/2015	14:30	21	0.82	98.7	103
Total		21			103

* Start times are approximate within 15 minutes and events may continue into the next day

Figure 11: Lower Walnut Creek at Charney Property Hydrographs/Flowtography Flow Event Images



The LWCCP location was visited eight times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare location for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 1/7/2015 – Reset Drone Cameras to collect daytime images only to prevent freezing
- 1/27/2015 – Resurveyed the channel at the event gage locations
- 4/13/2015 – Reset camera to collect images back to 24 hour operation at 15 minute intervals

Williamson Valley Wash at XU Ranch (WVWXU)

Three flow events were recorded at Williamson Valley Wash at XU Ranch (WVWXU) during the period from October 1, 2014 through June 30, 2015 (Table 6 and Figure 12). Peak discharge during events ranged from 17.9 CFS on 3/18/2015 to 895 CFS on 3/2/2015. Total volume of each event ranged from 47 AF to 1,862 AF, respectively. A total volume of 2,076 AF was estimated to flow through the WVWXU location during the 2014-2015 winter/spring reporting period.

Individual events ranged in duration from 87 hours beginning 3/18/2015 to 412 hours beginning 3/1/2015, with a total duration of 668 hours. Due to the longer duration of the flow event starting on 3/1/2015, WM staff traveled to WVWXU on 3/4/2015 at 15:00 to conduct a CMM at the event gage. A discharge of 41.8 CFS was measured using a Pygmy meter, top set rod, and AquaCalc Pro Plus. Discharge recorded at the same time using the corrected pressure transducer stage data and modeled rating equation was 43.6 CFS.

Table 6: Williamson Valley Wash at XU Ranch – 2014-2015 Winter/Spring Flow Events

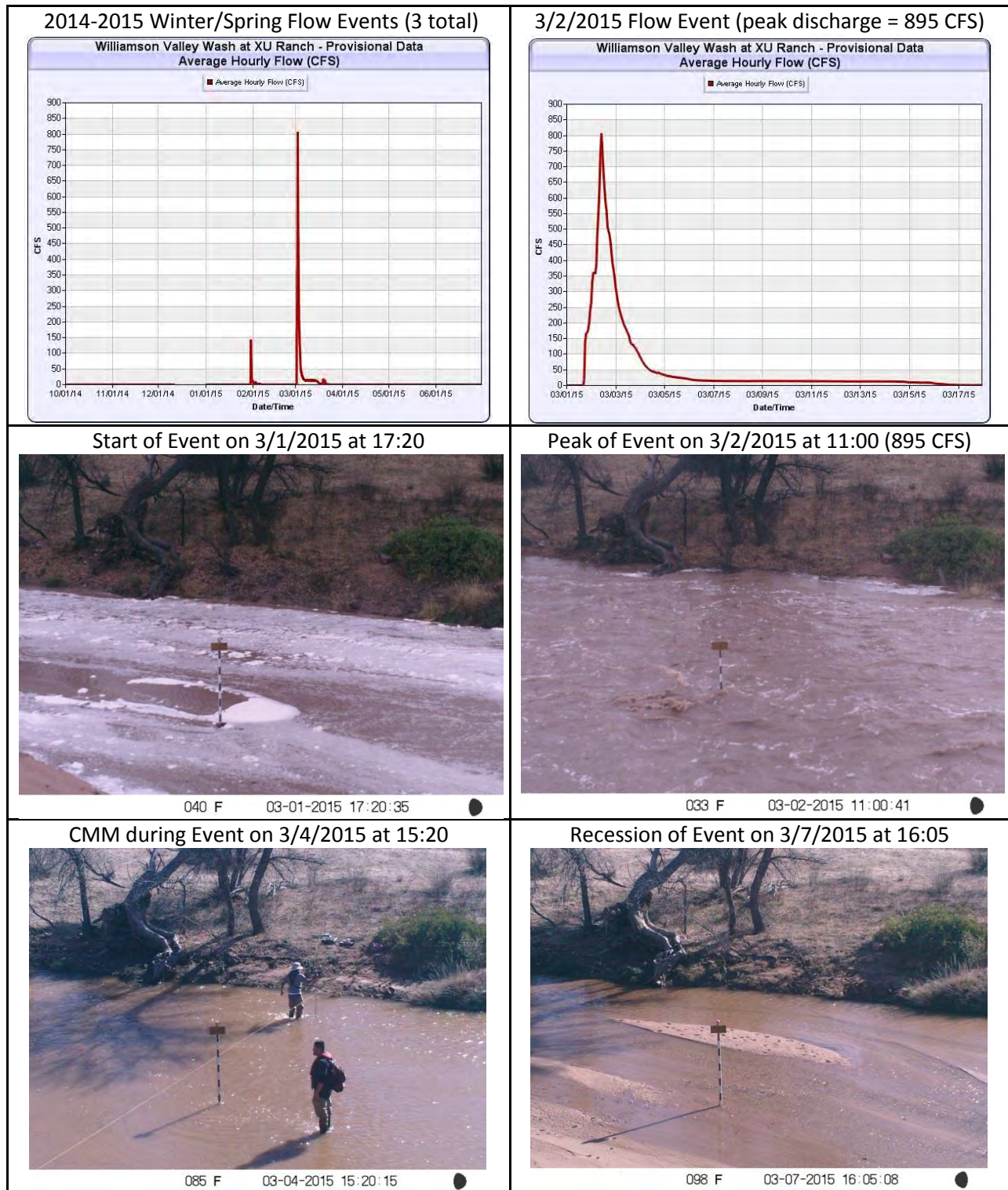
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
1/30/2015	11:15	169	0.97	145	167
3/1/2015	17:30	412	2.59	895	1,862
3/18/2015	21:45	87	0.28	17.9	47
Total		668			2,076

* Start times are approximate within 15 minutes and events may continue into the following days

The WVWXU location was visited a total of six times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare location for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 1/27/2015 - Resurveyed the channel at the event gage locations and reset Drone Cameras to collect daytime images only to prevent freezing
- 3/4/2015 – Conducted CMM and Float test, observation/measurement during flow event
- 3/25/2015 – Reset camera to collect images back to 24 hour operation at 15 minute intervals

Figure 12: Williamson Valley Wash at XU Ranch Hydrographs and Flowtography Flow Event Images



Lower Williamson Valley Wash (LWVW)

Two flow events were recorded at Lower Williamson Valley Wash (LWVW) during the period from October 1, 2014 through June 30, 2015 (Table 7 and Figure 13). Peak discharge during events ranged from 4.8 CFS on 12/3/2014 to 634 CFS on 3/2/2015. Total volume of each event ranged from <1 AF to 774 AF, respectively. A total volume of 774 AF was estimated to flow through the LWVW location during the winter/spring season, which was almost entirely a result of the 3/2/2015 flow event.

Total duration of the events ranged from 1.0 hour on 12/3/2014 to 71 hours on 3/2/2015. Total flow duration was 72 hours for the winter/spring reporting period, almost entirely as a result of the 3/2/2015 flow event. Due to the longer duration of the flow event starting on 3/2/2015, WM staff traveled to LWVW on 3/4/2015 at 16:15 to conduct a CMM at the event gage. A discharge of 21.3 CFS was measured using a Pygmy meter, top set rod, and AquaCalc Pro Plus. Discharge recorded at the same time using the corrected pressure transducer stage data and modeled rating equation was 10.3 CFS. It should be noted that scouring occurred during this event which may have resulted in slightly higher discharges at low stage values than what was estimated using the modeled rating equation.

Table 7: Lower Williamson Valley Wash – 2014 Winter/Spring Flow Events

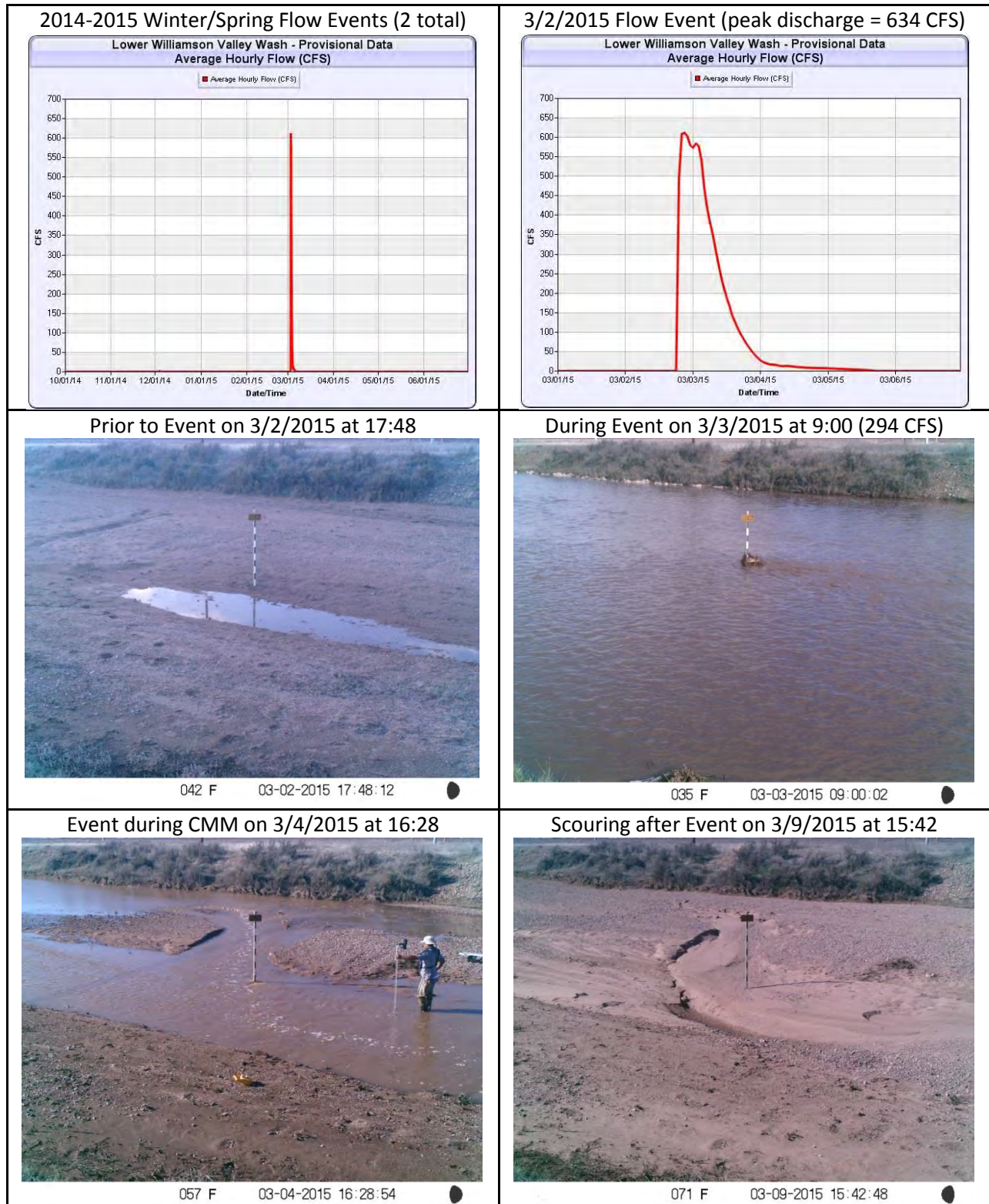
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
12/3/2014	22:00	1.0	0.12	4.8	<1
3/2/2015	19:00	71	2.24	634	774
Total		72			774

* Start times are approximate within 15 minutes and events may continue into the next day

The LWVW location was visited twelve times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare location for monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 12/2/2014 – Camera malfunction due to cold temperatures. Reset camera and drone
- 1/7/2015 – Camera malfunction due to cold temperatures. Reset camera and drone, replaced battery, and set camera to collect daytime images only to prevent freezing
- 2/10/2015 – Resurveyed the channel at the event gage locations
- 3/4/2015 – Conducted CMM and Float test, observation and measurement during flow event at location
- 3/25/2015 – Site investigation and resurvey of channel at event gages due to scouring of channel at upstream gage. Replaced downstream transducer.
- 4/8/2015 – Flowtopography pole and camera were removed from upstream location and installed downstream in a position to collect flowtopography images of the downstream event gage
- 4/27/2015 – Replaced inoperative camera with new one

Figure 13: Lower Williamson Valley Wash Hydrographs and Flowtography Flow Event Images



Lower Big Chino Wash (LBCW)

Two flow events were recorded at Lower Big Chino Wash (LBCW) during the period from October 1, 2014 through June 30, 2015 (Table 8 and Figure 14). Peak discharge during events ranged from 96.8 CFS on 10/9/2014 to 459 CFS on 3/2/2015. Total volume of each event ranged from 26 AF to 222 AF, respectively, for a total volume of 248 AF estimated to flow through the LBCW location during the 2014-2015 winter/spring reporting period.

Total duration of the events ranged from 36 hours on 3/2/2015 to 60 hours on 10/9/2014 for a total flow duration of 96 hours during the 2014-2015 winter/spring reporting period. Note that flow duration and volume estimated at this location does not include pooled or static water that collects at the site. LBCW was visited on 3/4/2015 but no CMM was conducted due to pooled water at the event gage.

Table 8 - Lower Big Chino Wash - 2014 Winter/Spring Flow Events

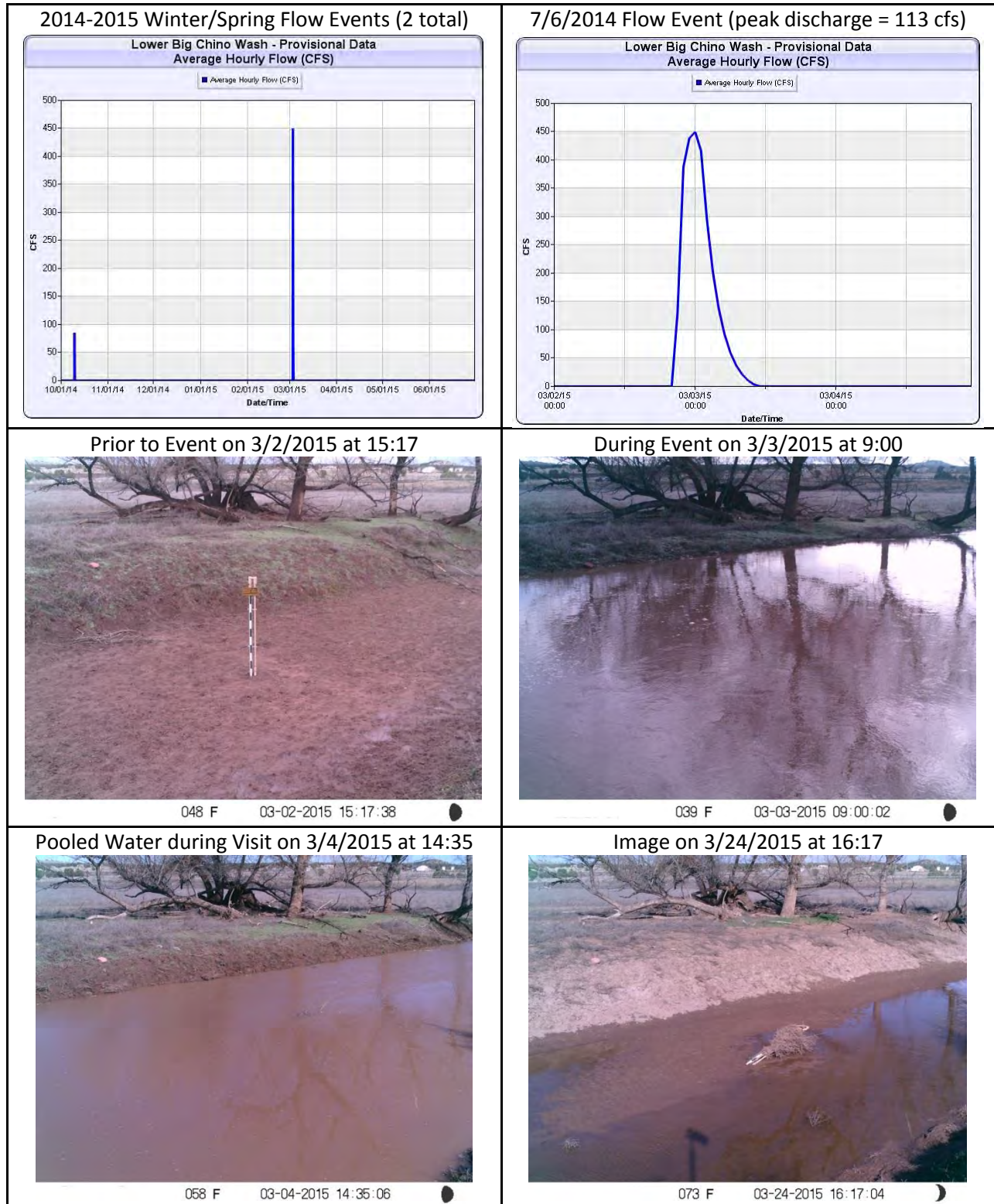
Start Date	Start Time*	Duration (hours)	Peak Stage (feet)	Peak Discharge (CFS)	Total Volume (AF)
10/9/2014	18:30	60	2.14	96.8	26
3/2/2014	21:30	36	4.74	459	222
Total		96			248

* Start times are approximate within 15 minutes and events may continue into the next day

The LBCW location was visited thirteen times during the winter/spring reporting period with an additional visit on July 8, 2015 to collect data and prepare for the monsoon season. In addition to routine maintenance and collection, the following adjustments were required at the site:

- 10/3/2014 – Camera was inoperative and reset to normal operation
- 10/7/2014 – Camera was inoperative, Replaced camera and power cord, reset drone
- 11/19/2014 – Camera was inoperative, replaced data card and reset to normal operation
- 12/2/2015 - Camera was inoperative, replaced data card and reset to normal operation
- 12/11/2015 – Surveyed the Lower Big Chino Wash profile from the upstream event gage to approximately 2000 feet downstream at high control point that results in pooled water at site
- 2/10/2015 – Reset camera, replaced battery, and replaced data card to return camera to operational function, reset camera to collect daytime images only to prevent freezing
- 3/4/2015 – Observation of site during event, CMM not possible due to pooled water
- 3/25/2015 – Repaired event gages and reset camera to collect images back to 24 hour operation at 15 minute intervals
- 4/8/2015 – Downstream pressure transducer access was moved out of the stream channel and onto the bank and included a new access box, extended cable and flexible conduit.

Figure 14: Lower Big Chino Wash Hydrographs and Flowtopography Flow Event Images



Additional Activities and Observations

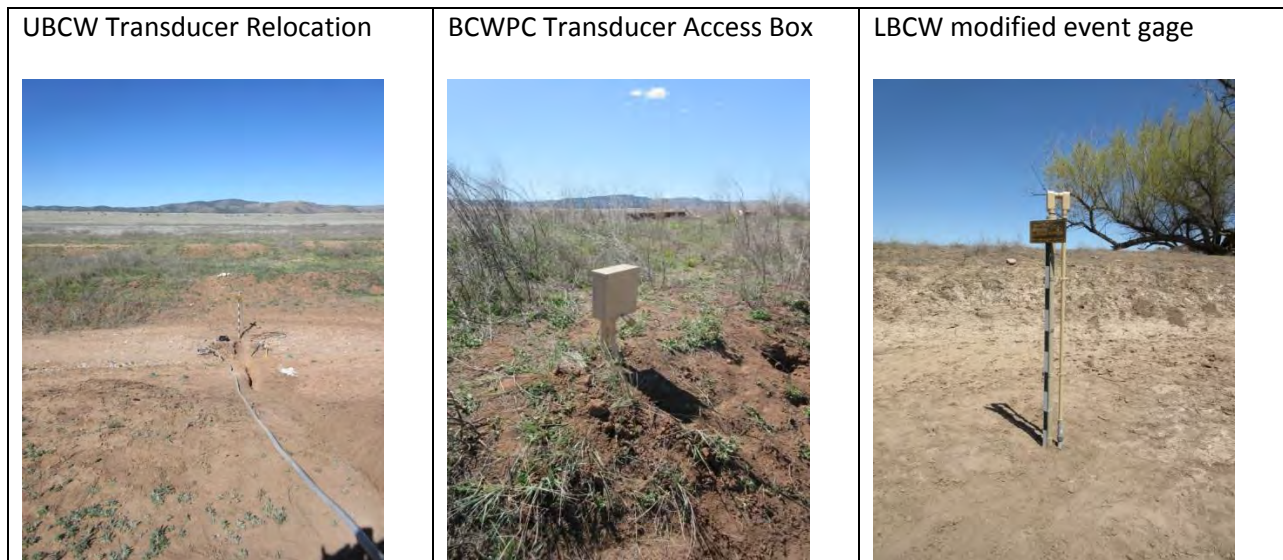
In addition to routine maintenance, data collection, and processing for each location, the following activities and observations were completed during the winter/spring reporting period:

- Completed equipment modifications to cameras and/or pressure transducers to maintain operation and safe working conditions at several locations
- Captured snow accumulations in flowtography images at multiple locations
- Conducted CMMs for the first time at two locations along Williamson Valley Wash
- Observed water spilling over Sullivan Dam into the Verde Canyon during a site visit following a flow event seen at LBCW and VRCR gage
- Investigated three new potential flowtography locations and three new potential weather station locations within the Big Chino sub-basin.

Maintenance and Equipment Modifications

Equipment modifications were necessary at a few of the flowtography stations during the 2014-2015 winter/spring reporting period. Pressure transducer access was moved out of the stream channel and onto the bank at UBCW, BCWPC, and LBCW (downstream) in order to safely retrieve data at the sites due to muddy conditions. Transducer cables were extended through flexible conduit from the top of the event gage to an access box at the stream bank (Figure 15).

Figure 15 – Equipment modifications at UBCW, BCWPC, and LBCW

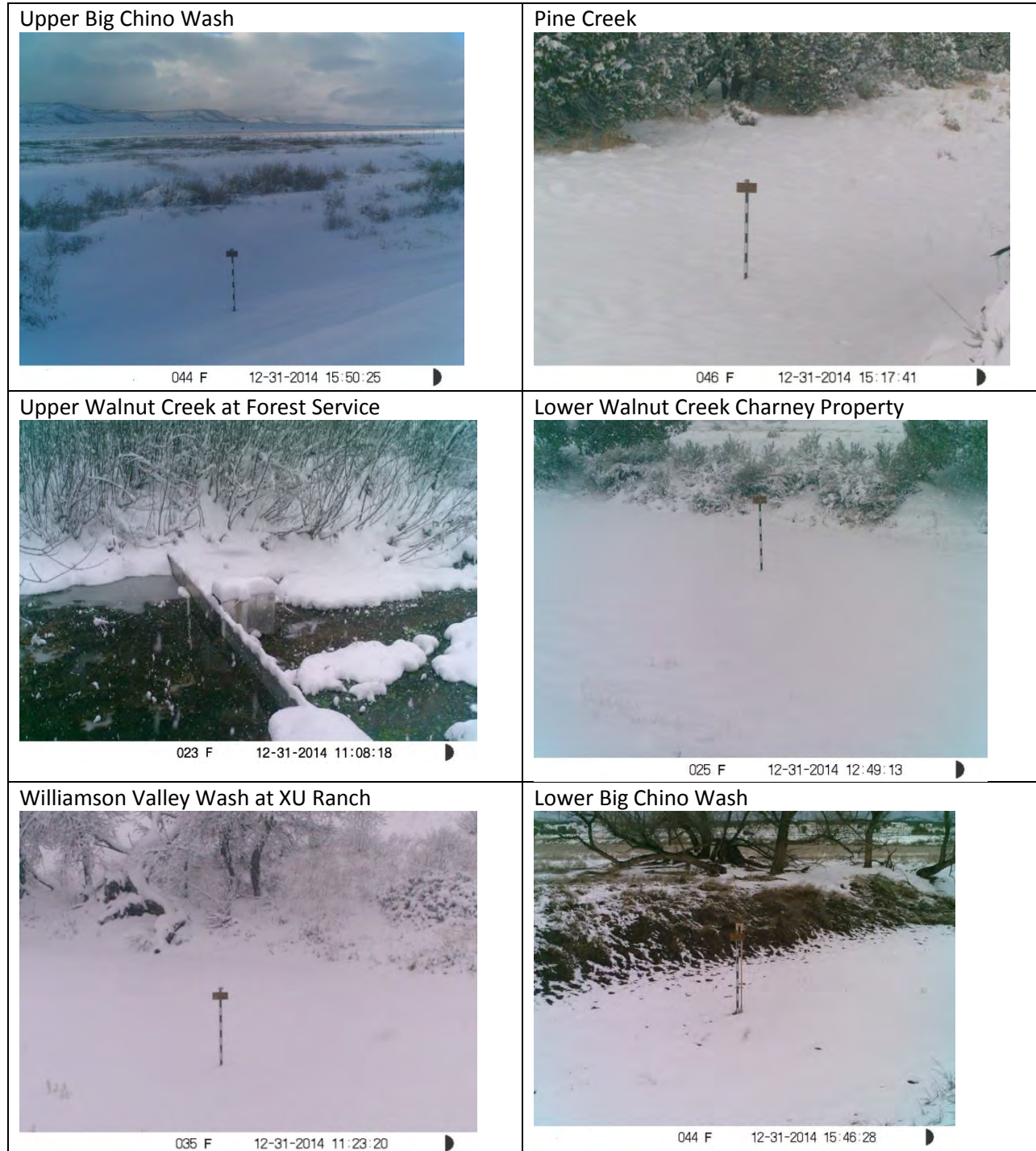


At LWVW, the flowtography camera was relocated to the downstream event gage on 4/8/2015 due to scouring that occurred at the upstream location during the flow event on 3/2/2015. Additionally, camera malfunctions occurred at several locations due to extreme cold conditions in December. Cameras at all locations were set to collect daytime only images during the winter months (January through March) to prevent camera from locking up due to the cold temperatures.

Snow Accumulation Observations

Snow accumulation was observed at multiple locations throughout the sub-basin on 12/31/2015 (Figure 16). Maximum snow depths measured at the event gages ranged from 0.2 (LBCW) to 0.7 feet (PC and WVWXU). Snow was present at the various sites for approximately 5 to 10 days, but no measurable flow was recorded at any locations as a result of snowmelt.

Figure 16 – Flowtography images capturing snow depths at various Big Chino locations on 12/31/2015



Williamson Valley Wash CMMs

The storm event on 3/2/2015 resulted in substantial flows along Williamson Valley Wash in the southwestern portion of the Big Chino sub-basin. Figure 17 shows the hydrographs for the two flowtopography locations (WVWXU and LWVW) and USGS 09502800 Williamson Valley Wash near Paulden, AZ gaging station (USGS WVWP) located approximately 15 miles downstream of WVWXU and 9 miles upstream of LWVW. Comparison of the three stream flow monitoring locations (Figure 17) show progressively lower discharge, duration, and total volume for the flow event from upstream to downstream locations. The total volume of water estimated to flow through each location (Table 9) from upstream to downstream location was 1,862 AF (WVWXU), 940 AF (USGS WVWP), and 774 AF (LWVW) indicating the occurrence of channel recharge and infiltration resulting directly from the channel flows as they moved downstream. This estimate does not include an analysis of additional flow that could have occurred from a number of large unmonitored tributary washes between the WVWXU and USGS WVWP gage locations.

Figure 17 – Hydrograph of discharge at locations along Williamson Valley Wash

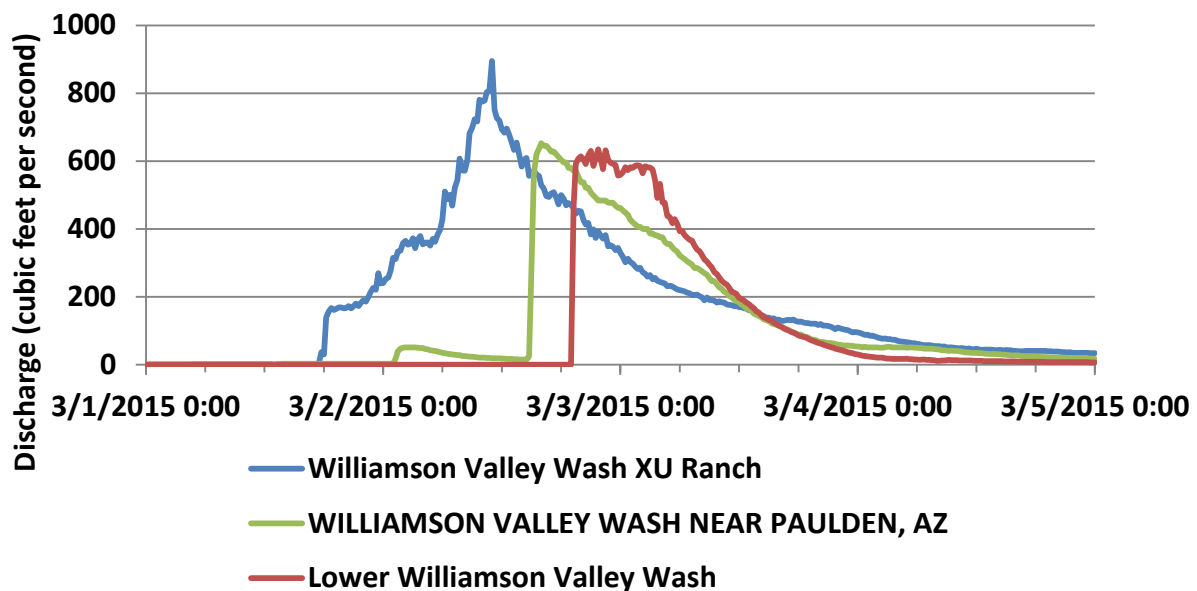


Table 9 – Williamson Valley Wash (WVW) Flow Events

Location	Start Date of Event	Start Time of Event*	Time at Peak Discharge 3/2/2015	Peak Discharge (CFS)	Measured Q on 3/4/2015 (15:00 to 17:00)	Estimated Volume of Event (AF) thru 3/4/2015
WVWXU	3/1/2014	17:30	11:00	895	42	1535
USGS WVWP	3/2/2014	15:00	16:00	653	26	940
LWVW	3/2/2014	19:00	21:00	634	21	774

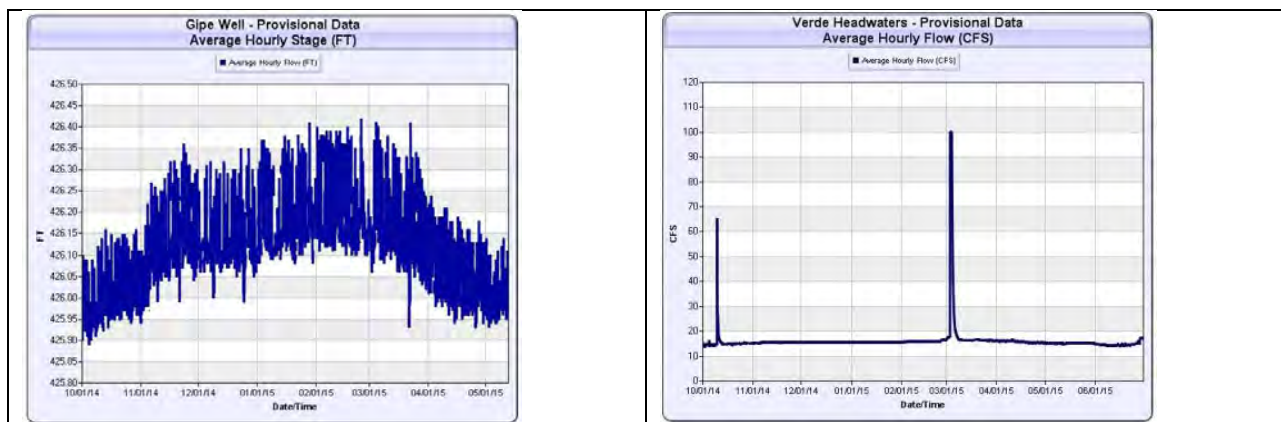
* Start times are approximate within 15 minutes and events may continue into the next day

On 3/4/2015, WM conducted CMMs at WVWXU and LWVW locations and the USGS completed a CMM at the USGS WVWP location. All three CMMs were completed between 15:00 and 17:00 on 3/4/2015 during the recession of the flow event and resulted in progressively lower discharges measured downstream (Table 9). The discharge measured at WVWXU (41.8 CFS) was similar to the discharge calculated from the modeled rating equation (43.6 CFS). At LWVW the discharge measured (21.3 CFS) was higher than the discharge calculated from the rating equation (10.3 CFS). This may be attributed to the scouring that occurred at the upstream event gage (see Figure 13) resulting in lower stage values to have an underestimated discharge. Following this event, the flowtopography camera was moved to the downstream event gage and the modeled rating equation for the downstream cross section was used starting on 4/8/2015.

Verde River at Campbell Ranch (VRCR) and Gipe Well (GW)

Two additional locations, Verde River at Campbell Ranch (VRCR) and Gipe Well (GW) were monitored as part of the project. GW records the depth to water (stage in feet below land surface) and is located in the southeastern portion of the sub-basin approximately 7 miles northeast of Sullivan dam. Groundwater levels remain stable at approximately 426 feet below land surface with minor daily and seasonal fluctuations (Figure 18). The pressure transducer at GW malfunctioned on 5/13/2015 and a new transducer was installed in July 2015.

Figure 18 – Gipe Well (depth to water in feet) and Verde River at Campbell Ranch (CFS) Hydrographs

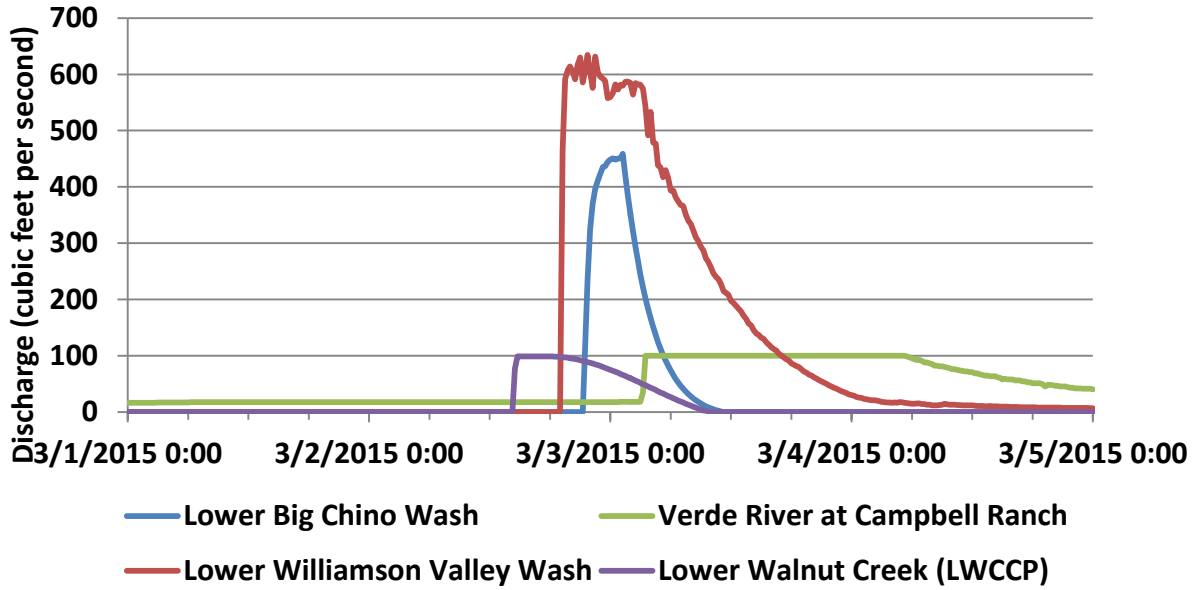


VRCR gage measures low flow (<100 CFS) along the Verde River approximately 3 miles downstream of Sullivan Dam. Flow during the Winter/Spring reporting period remained relatively stable at approximately 15 CFS (+/- 1 CFS fluctuations) with the exception of two high flow events (Figure 18). A total of approximately 248 AF were recorded to flow through the LBCW location just upstream of Sullivan Dam. For the two flow events recorded at LBCW, spikes in flow at VRCR were observed during both of these events on 10/9/2014 and 3/2/2015.

On the 10/9/2014 flow event, spikes in flow were seen at the same time at both locations. If water did not spill over Sullivan Dam during the 10/9/2015 flow event, it is assumed that surface water flow contributing to the discharge seen at VRCR would be from Granite Creek and localized runoff.

For the flow event on 3/2/2015, increases in flow at VRCR were seen approximately 6 hours following the start of the flow event seen at LBCW (Figure 19). Note that VRCR gage is designed to measure low flow only (<100 CFS) and during the event, flows exceeded the maximum discharge rating (hydrograph flattens at 100 CFS indicating flows exceeded 100 CFS during this period).

Figure 19 – Hydrograph of LBCW, LWVW, VRCR, and LWCCP locations for flow event on 3/2/2015.



Sullivan Dam was not monitored during this period; but a site visit on 3/4/2015 confirmed that water from Sullivan Lake spilled to the Verde River Canyon as a result of the 3/2/2015 flow event (Figure 20) indicating surface water contributions to the Verde River from the Big Chino sub-basin. Without monitoring of Sullivan Dam and Granite Creek, the contributing amount of flow seen at the VRCR location during events is uncertain.

Figure 20 – Sullivan Lake Spill on 3/4/2015



Additional Proposed Site Locations

Based on the initial observations from data collected at the current Big Chino Sites during the 2014 monsoon season and portions of the 2014-2015 winter/spring season, additional flowtography (camera only) locations (similar to UWCB) were proposed to the CA1 committee to be installed to better understand the surface water flow and recharge at various locations within the sub-basin. Three proposed flowtography (camera only) locations have been approved by the CA1 Monitoring Committee at the following locations:

- Along Big Chino Wash at southern end of Prescott Water Ranch property to visually record amount of surface water exiting the property downstream
- Along Big Chino Wash at or near confluence of Walnut Creek to visually record flow contributions to downstream locations.
- Location at Sullivan Dam to visually record any periods of spill to the Verde River Canyon and potential contributions to the VRCR gage.

Property owner approval is still being pursued and new equipment will be installed when (and if) approval of property owners is obtained. Additionally, three new weather station locations were proposed to be installed within or just outside the Big Chino Sub-basin at the following locations:

- **George Wood Canyon** - Western portion of sub-basin near Upper Walnut Creek
- **Iron King** – Northern portion of sub-basin near Pine Creek and Upper Big Chino Wash
- **Limestone Canyon** – Eastern edge of sub-basin

One weather station location (George Wood Canyon) was approved for installation. The weather station will include a WXT520 Vaisala Weather Transmitter providing barometric pressure, relative humidity, precipitation, air temperature, and wind speed and direction. Also, a flowtography station will be set up to collect snow depths at an event gage located near the weather station. The installation of a weather station at the Limestone Canyon site will be pursued by the YCFCD.

Conclusions

Flow events during the 2014-2015 Winter/Spring reporting period (October 1, 2014 through June 30, 2015) ranged from a few regional large storm events with long duration and high flows at several locations to a few small isolated storm events with short duration and minimal flows. Peak discharge reached as high as 895 CFS at WVWXU. Sites in the northern portion of the sub-basin had little to no flow during the entire 2014-2015 winter/spring reporting period. A few regional storm events resulted in high flow events at flowtopography locations in the southern and western portions of the sub-basin.

A total of 3,203 AF were recorded to flow at the seven SRP Flowtopography™ equipped stream flow monitoring locations recording stage levels within the Big Chino Sub-basin (UWCFS and UWCB excluded). One flow event on 3/2/2014, resulted in approximately 90% of the total volume of water measured at all the flowtopography locations in the Big Chino Sub-basin during the 2014-2015 winter/spring reporting period. Due to the long duration of flow (several days) of this event, CMMs were conducted at WVWXU and LWVW locations on 3/4/2015. Shifts to rating equations did not occur during this period but the primary rating equation for LWVW was modified to the channel section at the downstream event gage due to the relocation of the flowtopography camera on 4/8/2015.

SRP WM continues to maintain the sites and process pressure transducer data and flowtopography images collected at the monitoring locations. Additional activities will be detailed in future reports. While stage values are typically more accurate during flow events, discharge values are based on estimated ratings and impacted by changes in the channel cross sections. Additional direct current meter measurements of flow would be needed to improve accuracy of discharge values in the future. The data presented within this report is provisional in nature and is reflective of the best available data at the time this report was written.