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

2015

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

Lower Williamson Valley Wash
3/4/2015

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

Contents

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).

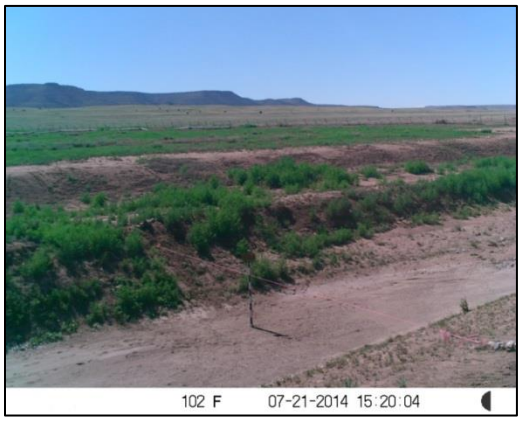


Figure 1. Upper Big Chino Wash tagline reference.

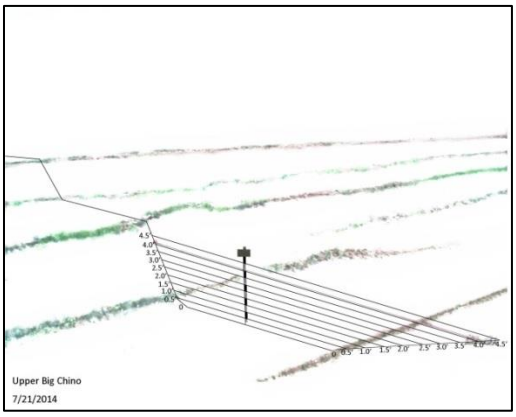


Figure 2. Upper Big Chino Wash stage level overlay.

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.

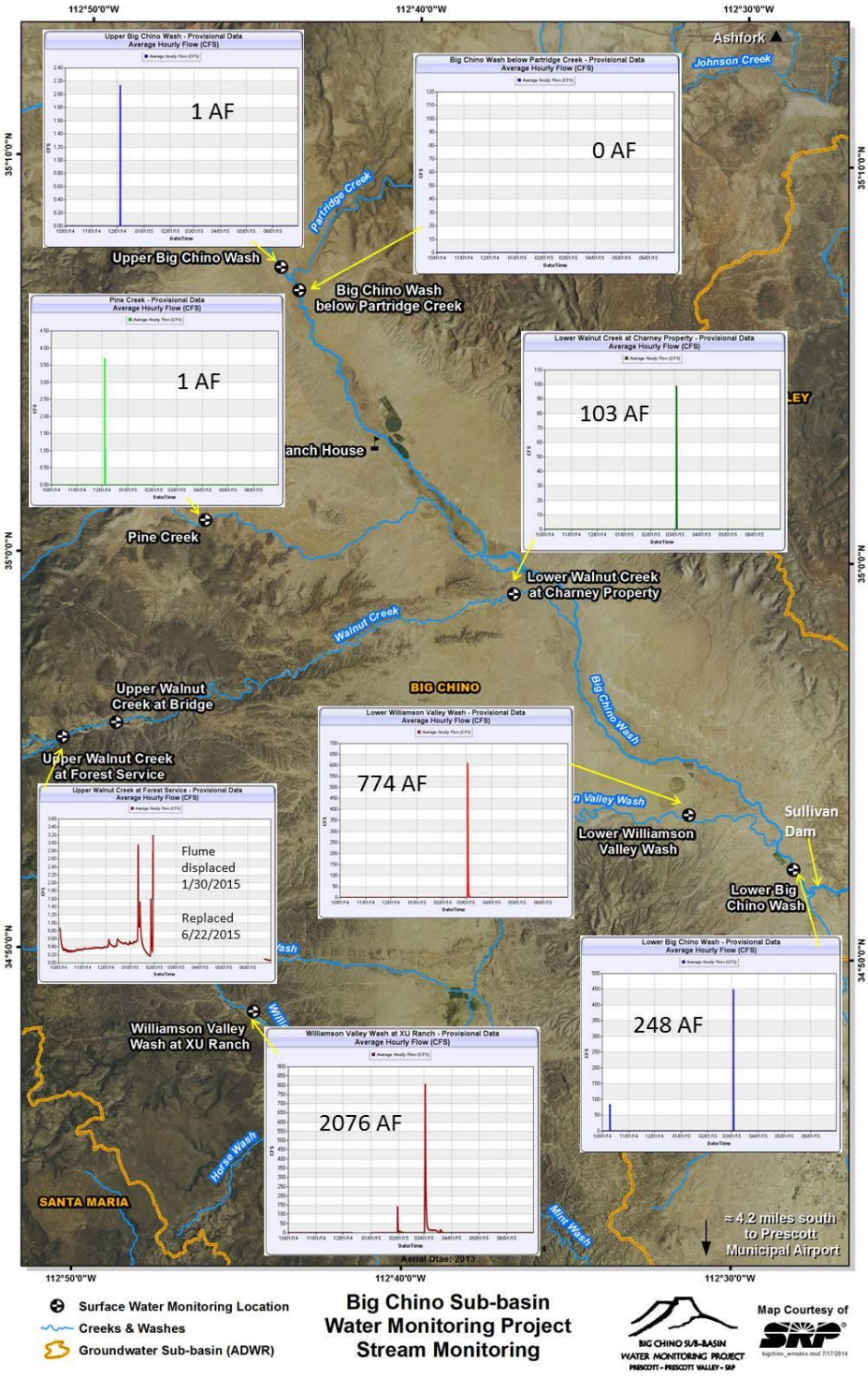
A total volume of 248 AF was estimated to flow through the Lower Big Chino Wash (LBCW) location just upstream of Sullivan Dam during two flow events (10/9/2014 and 3/2/2015). Sullivan Dam was not monitored during the 2014-2015 Winter/Spring season therefore it was not determined whether water spilled 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.

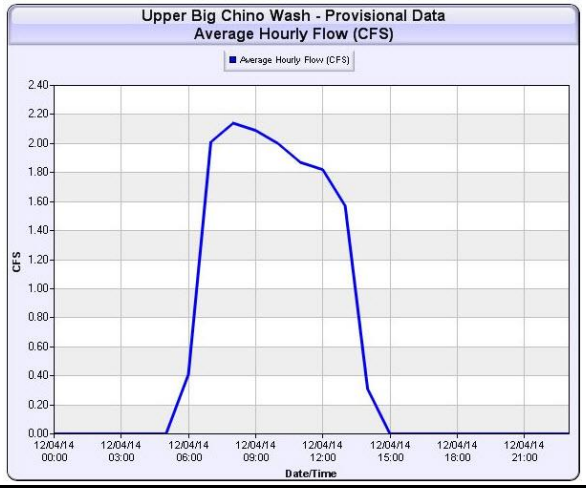
Table 2: Upper Big Chino Wash – 2014-2015 Winter/Spring Flow Events

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

12/4/2014 Flow Event (Peak Discharge = 2.1 CFS)



12/4/2014 Flow Event (peak discharge = 2.1 CFS)

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.

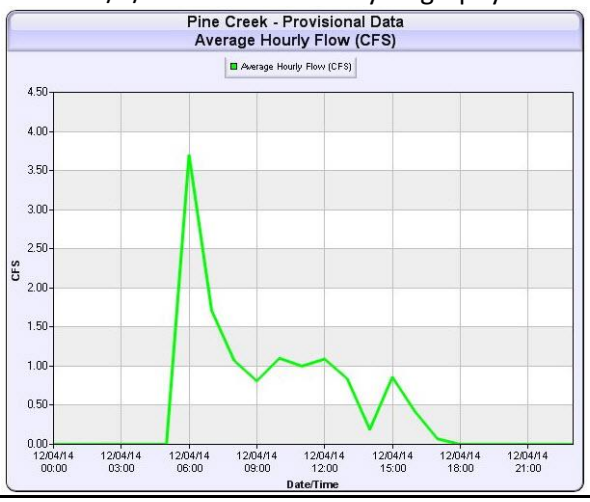
Table 3: Pine Creek - 2014 Winter/Spring Flow Events

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

12/4/2014 Flow Event Hydrography



12/4/2014 Flow Event (peak discharge = 5.7 CFS)

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 flowtography 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 flowtography 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 Flowtography Images

Prior to Event on 1/29/2015 at 17:25

Near Peak Flow on 1/30/2015 at 14:54

Near Peak Flow on 3/2/2015 at 10:15

Recession of Flow on 3/4/2015 at 16:56

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

Channel Prior to Installation

After Installation of Flume looking downstream

Close-up of Low-Flow Flume

Flowtography Camera View

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.

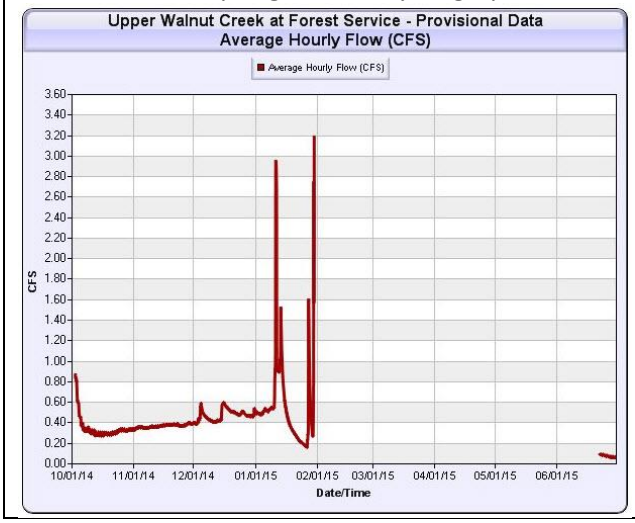
Table 4: Upper Walnut Creek Forest Service – 2014-2015 Winter/Spring Flow Events

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**			

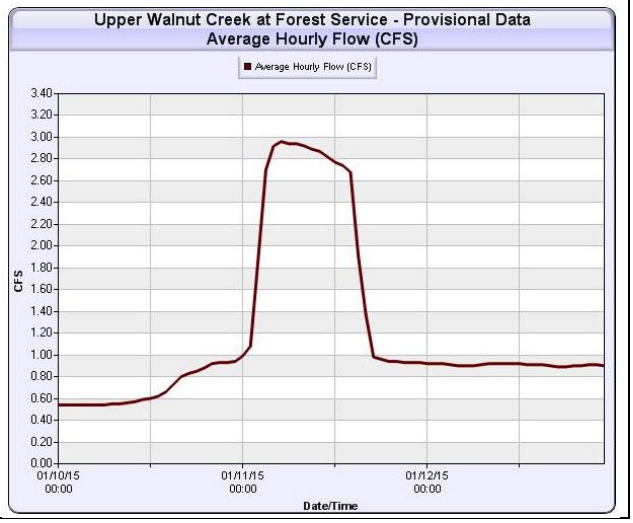
* Start times are approximate within 15 minutes and events may continue into the following days

Figure 8 – Upper Walnut Creek Forest Service Hydrographs

UWCFS Winter/Spring Season Hydrograph



UWCFS flow event on 1/11/2015



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:

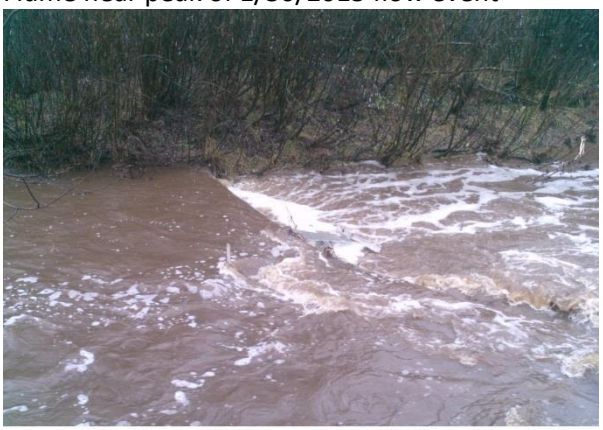
- 10/2/2014 – Flume Installation, CMM conducted
- 10/17/2014 – Inspection of flume and equipment calibration
- 1/7/2015 – Reset camera to collect daytime images only to prevent freezing
- 2/10/2015 – Inspect damaged flume from 1/30/2015 event
- 3/25/2015 – Inspect damaged flume from 3/2/2015 event
- 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

Flume near peak of 1/11/2015 flow event

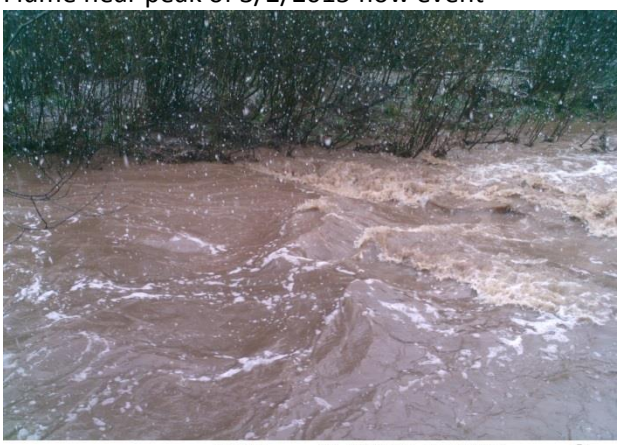
Flume after flow event - 1/12/2015 14:47

Flume near peak of 1/30/2015 flow event



Flume during flow recession on 1/31/2015

Flume near peak of 3/2/2015 flow event



Flume following winter/spring 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

Channel after removal during CMM on 5/27/2015

Channel after reinstallation on 6/22/2015

Close up of new Flume, event gage, staff gage

Flowtography camera view after 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.

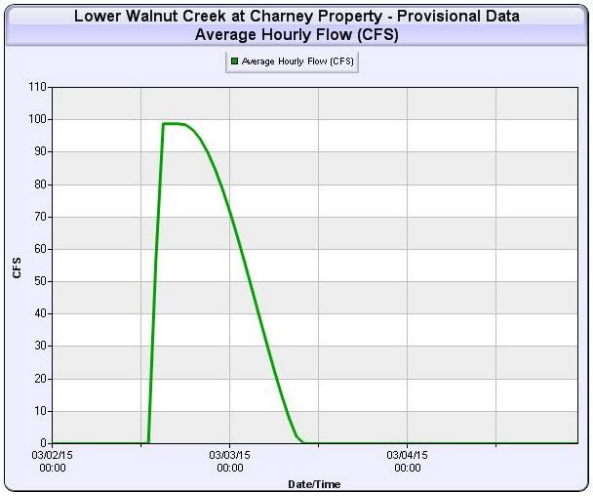
Table 5: Lower Walnut Creek at Charney Property – 2014 Winter/Spring Flow Events

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

3/2/2015 Flow Event Hydrograph



3/2/2015 Flow Event (peak discharge = 98.7 CFS)

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**

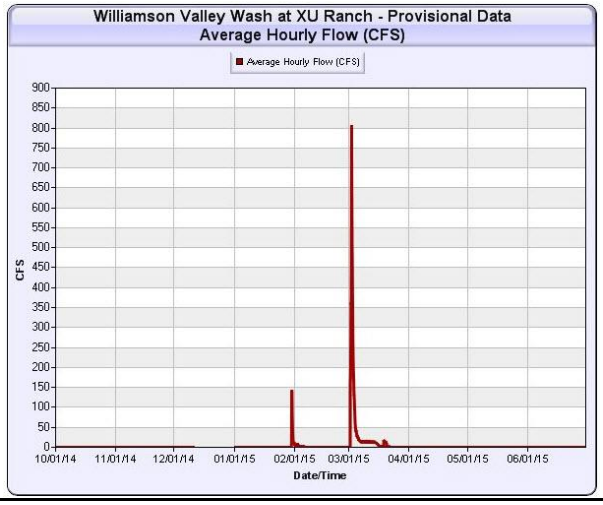
* Start times are approximate within 15 minutes and events may continue into the following days

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:

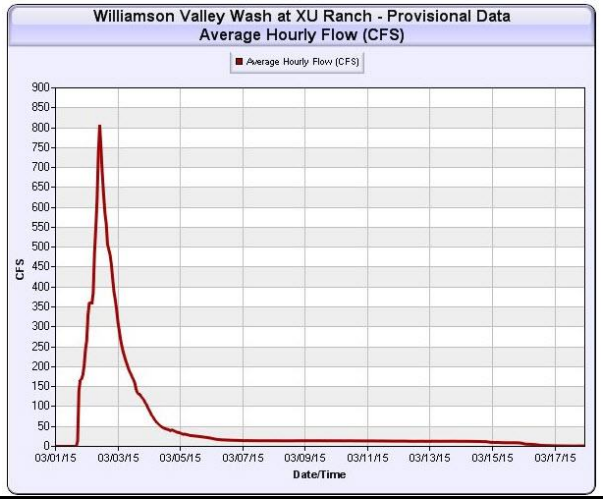
- 1/27/2015 - Resurveyed the channel at the event gage locations and reset Drone Cameras to collect daytime images only to prevent freezing
- 3/4/2015 – Conducted CMM and Float test, observation/measurement during flow event
- 3/25/2015 – Reset camera to collect images back to 24 hour operation at 15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

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

2014-2015 Winter/Spring Flow Events (3 total)



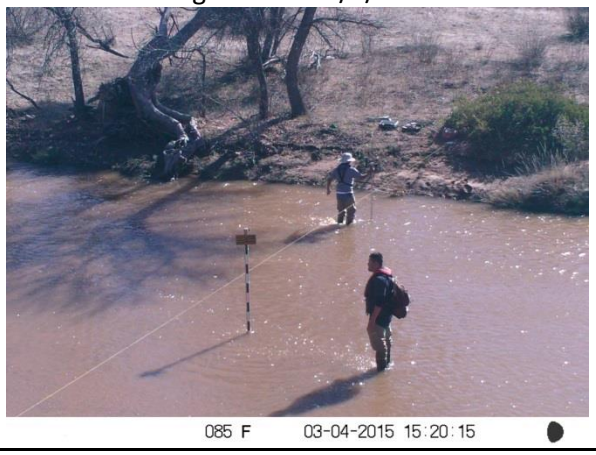
3/2/2015 Flow Event (peak discharge = 895 CFS)



Start of Event on 3/1/2015 at 17:20

Peak of Event on 3/2/2015 at 11:00 (895 CFS)

CMM during Event on 3/4/2015 at 15:20



Recession of Event on 3/7/2015 at 16:05

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**

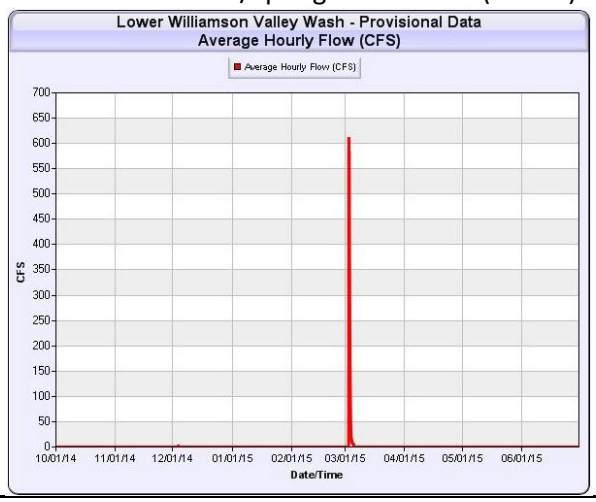
* Start times are approximate within 15 minutes and events may continue into the next day

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:

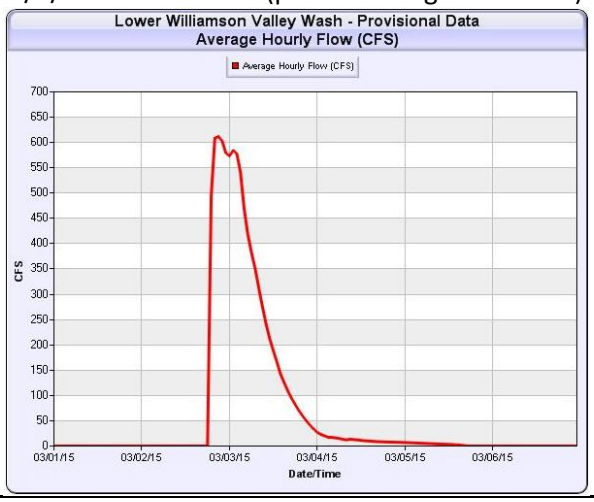
- 12/2/2014 – Camera malfunction due to cold temperatures. Reset camera and drone
- 1/7/2015 – Camera malfunction due to cold temperatures. Reset camera and drone, replaced battery, and set camera to collect daytime images only to prevent freezing
- 2/10/2015 – Resurveyed the channel at the event gage 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 – Flowtography pole and camera were removed from upstream location and installed downstream in a position to collect flowtography 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

2014-2015 Winter/Spring Flow Events (2 total)



3/2/2015 Flow Event (peak discharge = 634 CFS)



Prior to Event on 3/2/2015 at 17:48

During Event on 3/3/2015 at 9:00 (294 CFS)

Event during CMM on 3/4/2015 at 16:28

Scouring after Event on 3/9/2015 at 15:42

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**

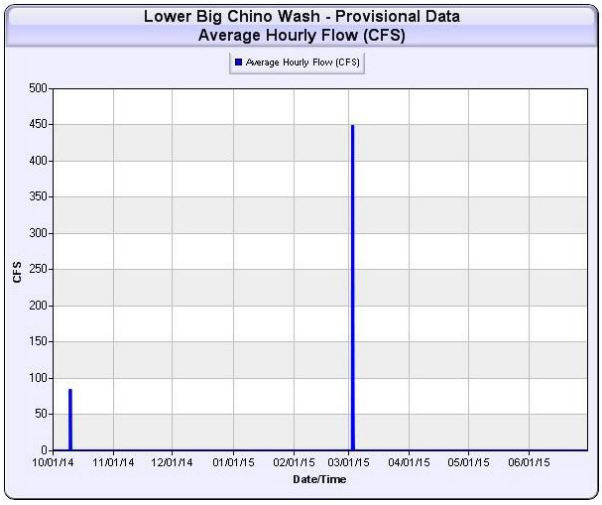
* Start times are approximate within 15 minutes and events may continue into the next day

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:

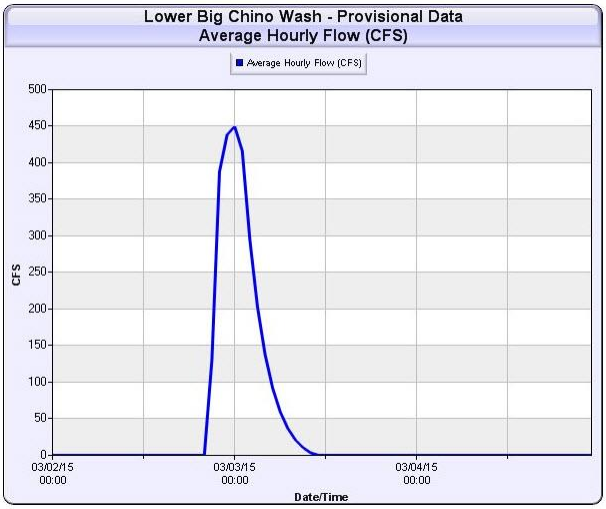
- 10/3/2014 – Camera was inoperative and reset to normal operation
- 10/7/2014 – Camera was inoperative, Replaced camera and power cord, reset drone
- 11/19/2014 – Camera was inoperative, replaced data card and reset to normal operation
- 12/2/2015 - Camera was inoperative, replaced data card and reset 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 Flowtography Flow Event Images

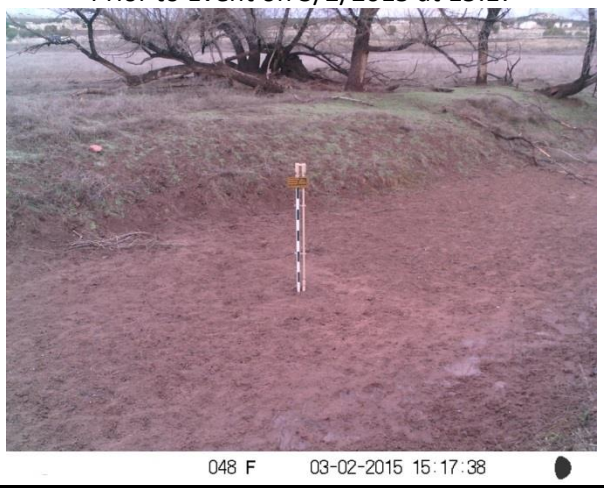
2014-2015 Winter/Spring Flow Events (2 total)



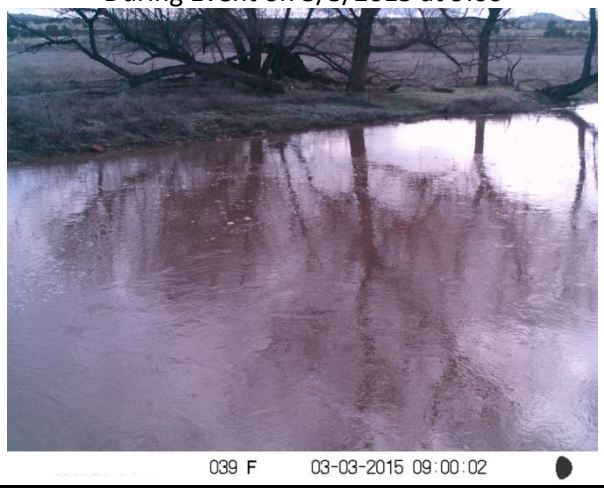
7/6/2014 Flow Event (peak discharge = 113 cfs)



Prior to Event on 3/2/2015 at 15:17



During Event on 3/3/2015 at 9:00



Pooled Water during Visit on 3/4/2015 at 14:35

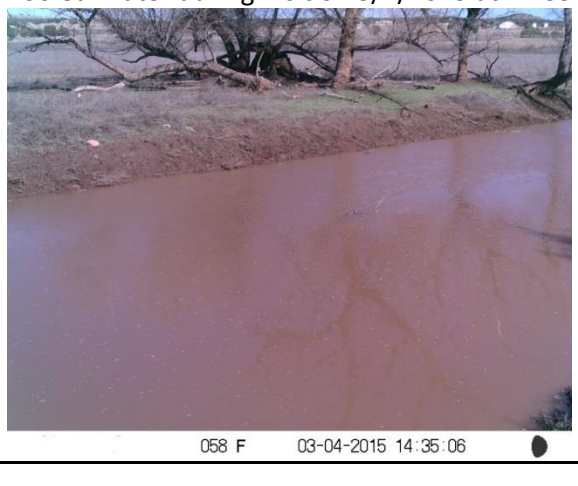


Image on 3/24/2015 at 16:17

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

UBCW Transducer Relocation	BCWPC Transducer Access Box	LBCW modified event gage
		

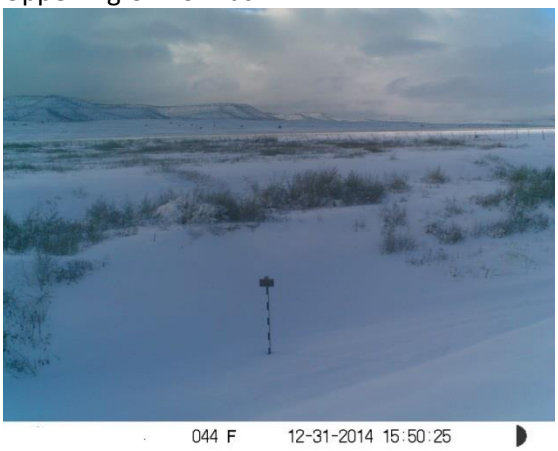
At LWVW, the flowtography camera was relocated to the downstream event gage on 4/8/2015 due to scouring that occurred at the upstream location during the flow event on 3/2/2015. Additionally, camera malfunctions occurred at several locations due to extreme cold conditions in December. Cameras at all locations were set to collected 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 measureable 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

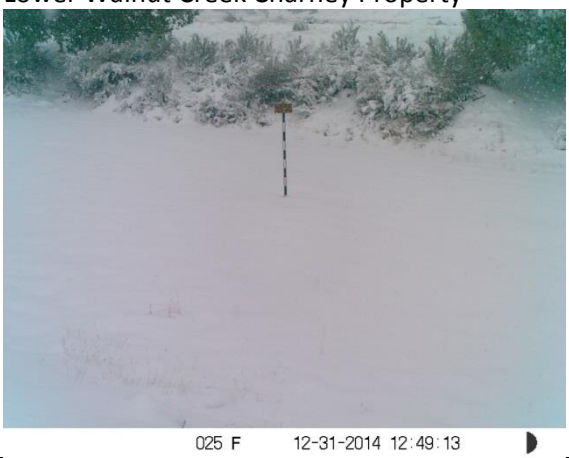
Upper Big Chino Wash



Pine Creek

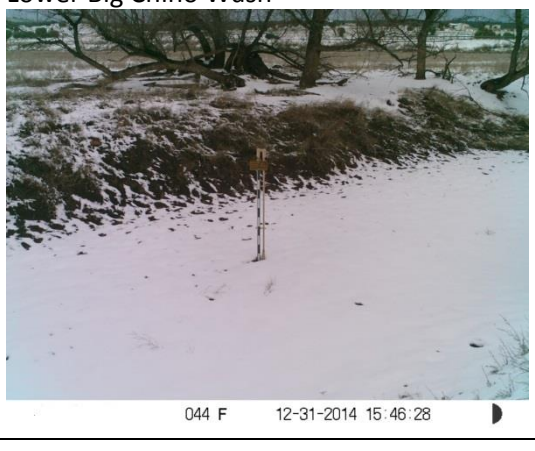
Upper Walnut Creek at Forest Service

Lower Walnut Creek Charney Property



Williamson Valley Wash at XU Ranch

Lower Big Chino Wash



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 flowtography 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

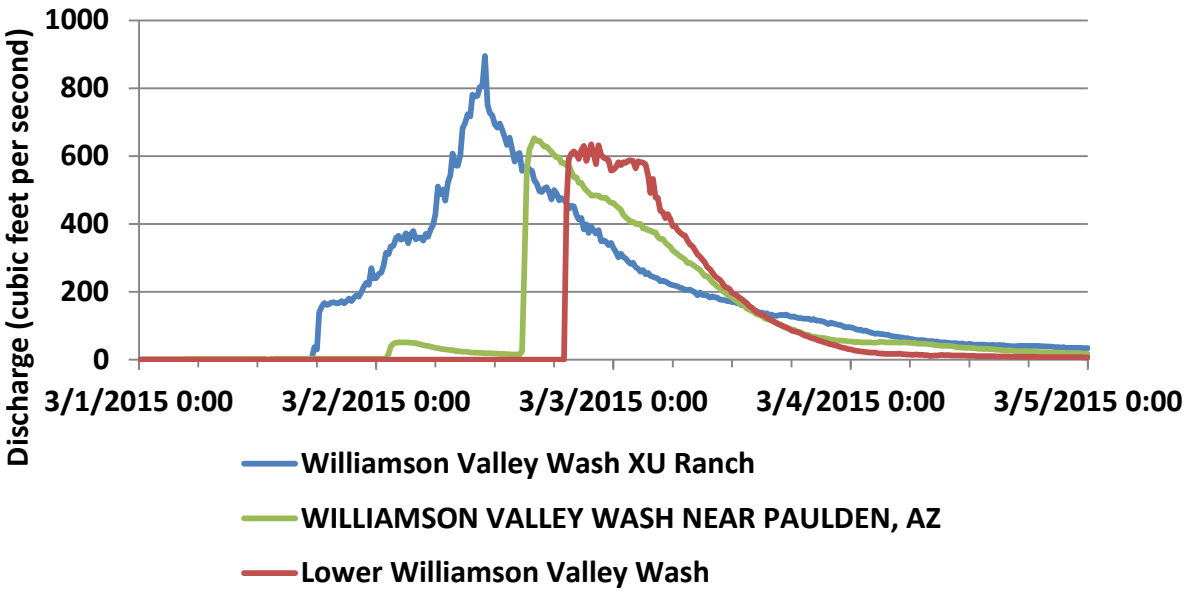


Table 9 – Williamson Valley Wash (WVW) Flow Events

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

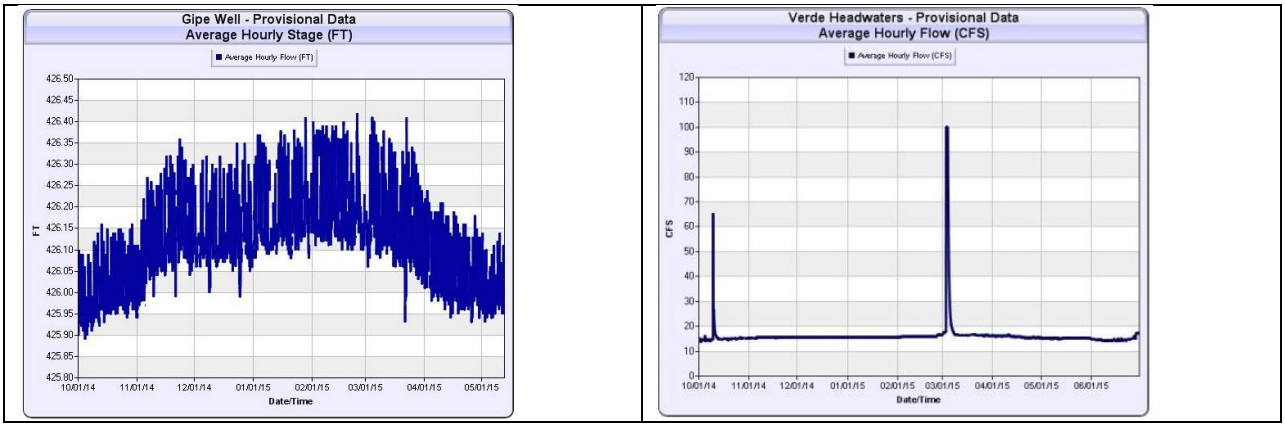
* Start times are approximate within 15 minutes and events may continue into the next day

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 flowtography 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

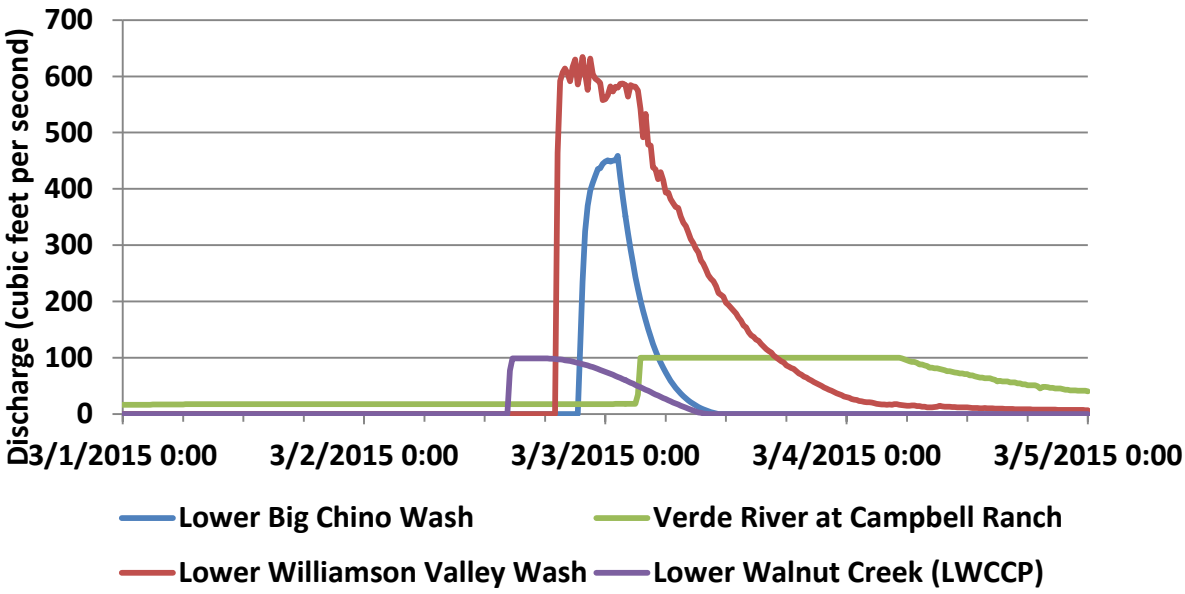


VRCR gage measures low flow (<100 CFS) along the Verde River approximately 3 miles downstream of Sullivan Dam. Flow during the Winter/Spring reporting period remained relatively stable at approximately 15 CFS (+/- 1 CFS fluctuations) with the exception of two high flow events (Figure 18). A total of 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

Sullivan Lake area on 3/4/2015

Water Spilling over Sullivan Dam 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 flowtography 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 Flowtography™ 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 flowtography 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 flowtography camera on 4/8/2015.

SRP WM continues to maintain the sites and process pressure transducer data and flowtography 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.