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MEMORANDUM

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CC: Amy Loughner
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FROM: Mead Mier

SUBJECT: **Cienega Creek Natural Preserve Surface Water and Groundwater Monitoring Annual Report for the 2007-2008 Fiscal Year**

DATE: August 11, 2009

Enclosed is the Fiscal Year 2007-2008 year-end technical memorandum for the Cienega Creek Natural Preserve Monitoring Project. This report summarizes PAG's groundwater and surface-water monitoring between July 2007 and June 2008.

If you have any questions and/or would like any additional information, please feel free to call me at 792-1093.

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Pima County's Cienega Creek Natural Preserve
Surface Water and Groundwater Monitoring Project
Annual Report: Fiscal Year July 2007 - June 2008

Submitted August 11, 2009

Pima Association of Governments

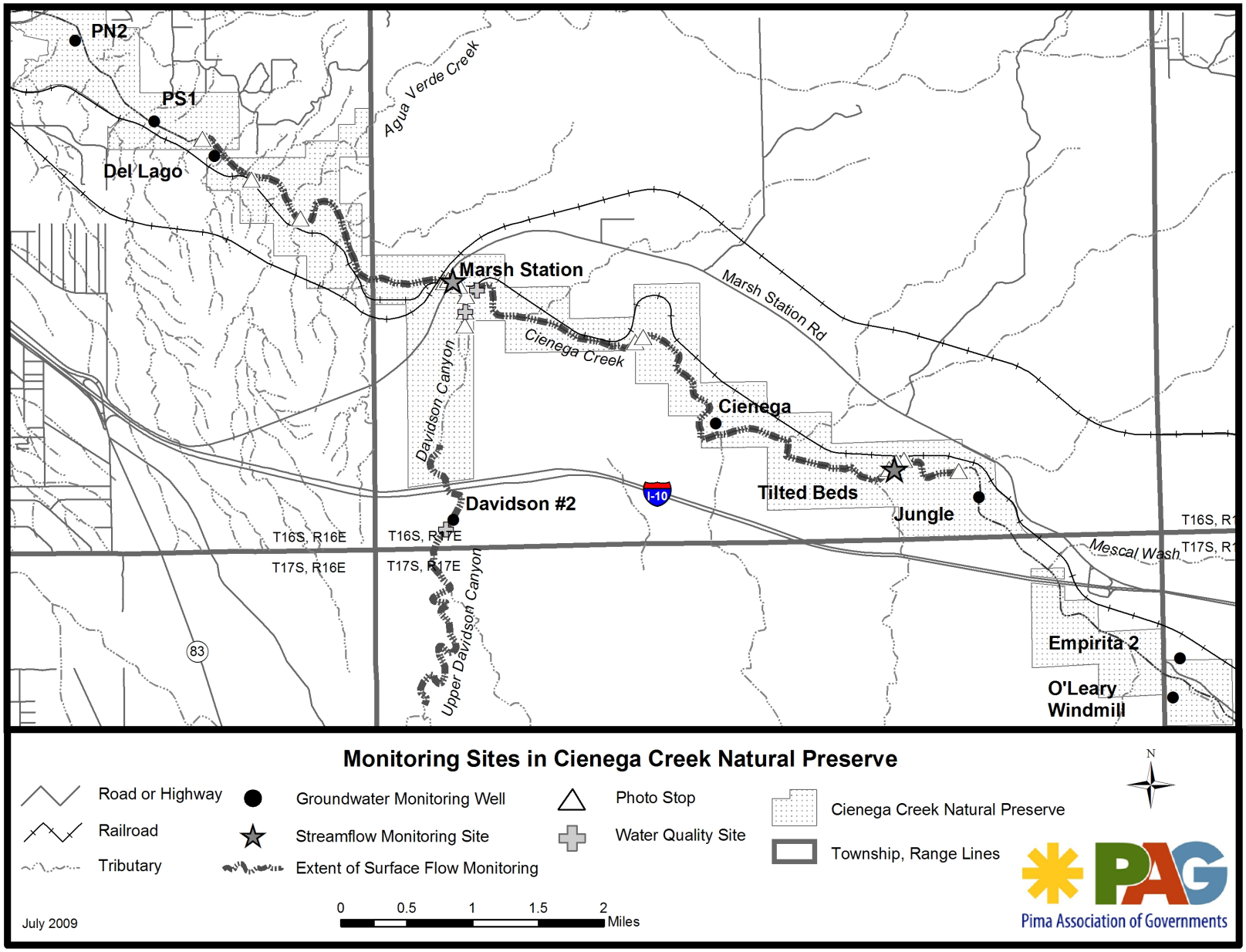
Introduction

This memo describes work completed under Pima Association of Governments' (PAG) 2007-2008 Overall Work Program, which includes monitoring in Cienega Creek and Davidson Canyon, both of which have priority aquatic and riparian resources as specified in the Sonoran Desert Conservation Plan. PAG has monitored the hydrology of the Cienega Creek Natural Preserve since 1989, as part of the PAG Overall Work Program in coordination with the Pima County Regional Flood Control District (PCRFCD). PAG staff continued to monitor surface water and groundwater at the Preserve during the 2007-2008 Fiscal Year (FY), which spans from July 2007 to June 2008. The data tables and figures showing results from the 2007-2008 monitoring year are included, with some data from previous years for comparison purposes.

During FY 07-08, monitoring methods and locations remained essentially the same as in past years, with any exceptions for this year explained in this memo. The specific methodology is described for each aspect of monitoring throughout this report. PAG staff generally conducts its portion of the monitoring during the middle of each month, with exceptions for weather (explained in detail in the streamflow section below). PAG has further documentation for protocols, forms and metadata available in-house, as well as in reports from previous years. The reach of Cienega Creek between Interstate 10 and a diversion dam east of Vail, Arizona, is the focus of this monitoring program. The Cienega Creek Natural Preserve, which is owned by PCRFCD, includes most of this part of Cienega Creek. The locations of the monitoring sites are shown in Figure 1.

The purpose of the monitoring is to firmly establish baseline hydrologic conditions for comparison purposes, in the event that future groundwater development occurs in the vicinity of the creek. Cienega Creek is an important water, recreation, and wildlife resource in the Santa Cruz River watershed. It is one of the few low-elevation streams in Pima County that exhibit significant perennial flow. Perennial reaches of Cienega Creek support native fish and the surrounding riparian vegetation provides habitat for a diversity of wildlife. In recognition of its value to the state of Arizona, the reach of Cienega Creek downstream from Interstate 10 to Del Lago Dam has been designated by the Arizona Department of Environmental Quality (ADEQ) as an "Outstanding Water," (R18-11-112) which qualifies it for site-specific water quality standards established to maintain and protect the existing water quality. The certificate of in-stream flow rights was granted by the Arizona Department of Water Resources (ADWR) to Pima County Flood Control District in December 1993 (No. 89090.0000). Monthly monitoring of groundwater levels, streamflow extent and stream discharge in the preserve are conducted so that long-term trends are firmly established and conditions documented.

Figure 1. Monitoring Sites in Cienega Creek Natural Preserve



Streamflow Quantity (Discharge)

Methods

Throughout Fiscal Year 2007-2008, PAG took monthly streamflow measurements at two sites using a USGS Pygmy Flow Meter and calculated the discharge in cubic feet per second (CFS). The sites are Marsh Station Road Bridge, which is downstream from the Cienega/Davidson confluence and Tilted Beds, which is located several miles upstream from Marsh Station (Figure 1).

The hydrologic monitoring program is designed to collect streamflow data during baseflow conditions. Baseflows are produced by discharges from the aquifer into the stream channel without the direct influence from surface runoff. If a significant rainfall event occurs within three days prior to a scheduled field event, the sampling is postponed until drier conditions prevail and runoff no longer has a direct influence on stream flow in the canyon. Baseflow is determined through County gages on the PC ALERT Web site, http://alert.rfcd.pima.gov/scripts/pima.pl. We refer to the rain gages 4280, 4310, 4220 and 4250, and stream gages 4283 (Cienega at I-10), 4313 (Davidson Canyon) and 4253 (Pantano at Vail). Field staff does not conduct field monitoring under hazardous conditions, such as during flood flows or lightning storms. Based on standard guidelines, measurements are taken at a location along the stream where the channel is relatively straight and streamflow is fairly uniform. When possible, points of converging and diverging flow paths are avoided.

Results

Annual average streamflow remained generally consistent with last year's level at the Marsh Station site, whereas flow was identified for the first time in many years at Tilted Beds. Streamflow data for this fiscal year are shown in Table 1, while Figure 2 graphically presents the streamflow trends for the past two fiscal years. To provide a longer term perspective on flow trends, Figure 3 shows discharge data from 1993 to the present.

The annual average base discharge at Marsh Station was only slightly lower than the previous year's average by 0.07 (Table 1), but still 0.28 cfs higher than the average two years prior. Since 1993, annual average flow is overall on a downward trend (Figure 4) but the past three years show this average increasing toward 1995-2000 levels. Figure 3 shows that FY 07-08 streamflow patterns are consistent with long term seasonal patterns. As shown in Figure 2, stream discharge at the Marsh Station site ranged from less than 0.23 cfs (in July 2007) to 1.79 cfs (in August 2007). July was also the low month in previous years, but the high flow month (August) came one month earlier than last year's high flow month (September in FY 06-07).

Long term data (Figure 3) show that the Tilted Beds site flows ephemerally and generally during the winter months. During this fiscal year, the Tilted Beds site flowed from December through May. This was the first time it had measurable flow since April 2003, marking the end of a three year dry spell. This was the longest dry spell in our records.

Table 1. Cienega Creek Discharge, July 2007 – June 2008

DATE	FLOW (cfs) Marsh Station	FLOW (cfs) Tilted Beds
July 2007	0.230	0
August 2007	1.790	0
September 2007	1.160	0
October 2007	0.860	0
November 2007	0.780	0
December 2007	1.060	0.060
January 2008	0.990	0.180
February 2008	1.330	0.190
March 2008	1.460	0.180
April 2008	1.140	0.140
May 2008	0.780	0.040
June 2008	0.320	0
2006-2007 AVERAGE	1.06	0
2007-2008 AVERAGE	0.99	0.07
CHANGE [1]	- 0.07	+ 0.07

PAG measured all flows with USGS Pygmy Flow Meter.
[1] Difference between 2007-2008 average and 2006-2007 average
"+" = increase in discharge
"-" = decrease in discharge

Figure 2. Cienega Creek Streamflow Quantity, July 2006 – June 2008

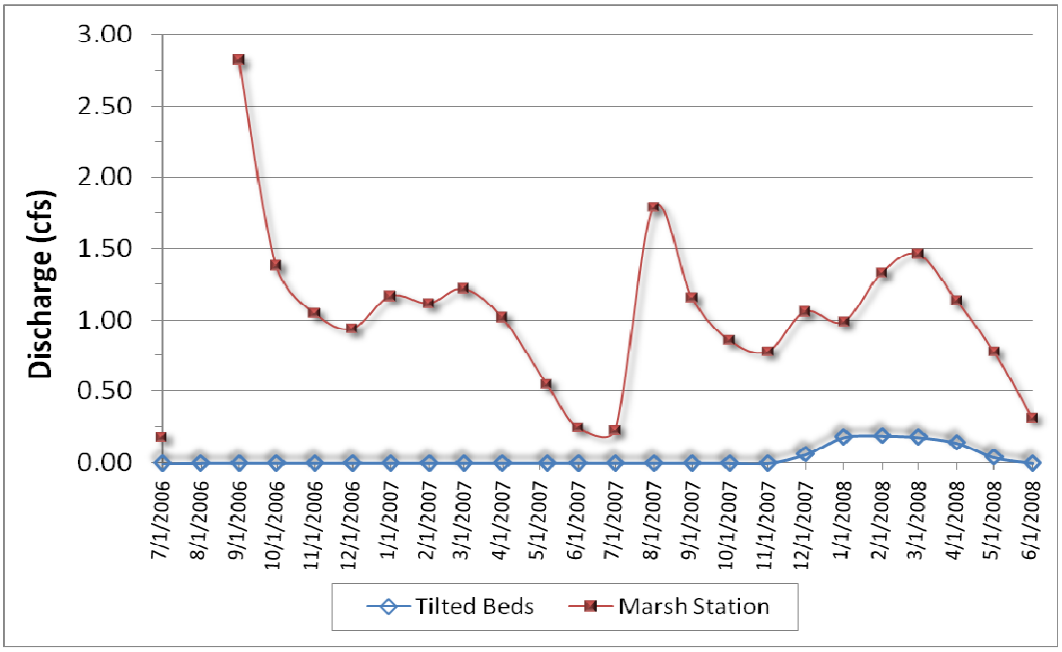


Figure 3. Cienega Creek Streamflow Quantity, July 1993 – July 2008

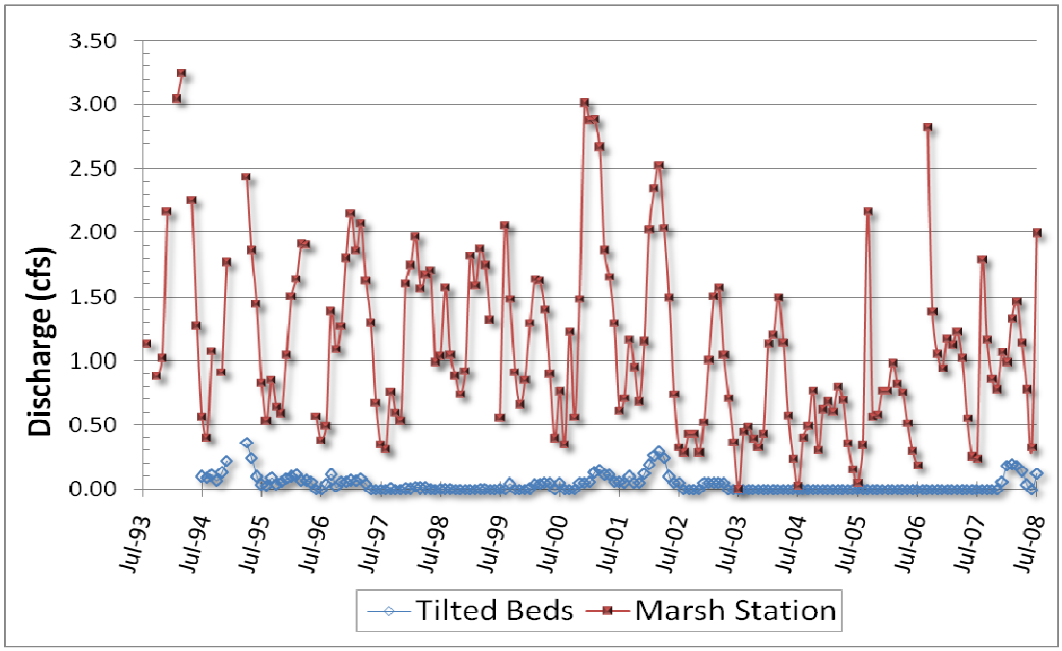
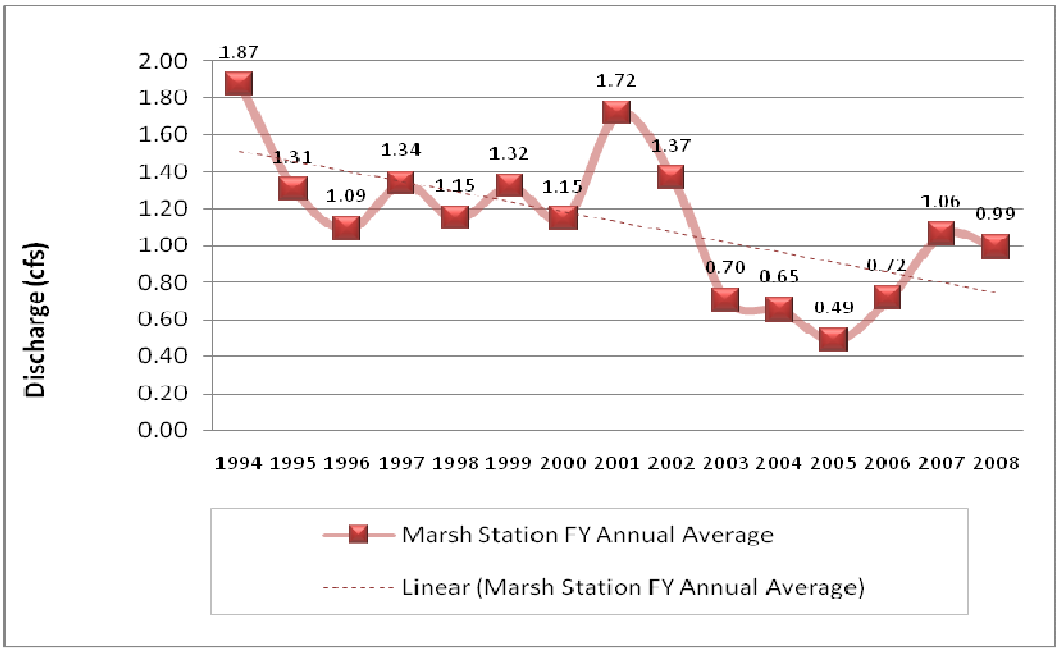


Figure 4: Marsh Station Annual Fiscal Year Average Flow Trends



Groundwater Levels

Methods

Depths to groundwater were measured at eight wells with a Solinst Water Level Meter or by in site transducers. The eight wells are distributed throughout the preserve length and are named (East to West) Empirita 2, O'Leary Windmill, Jungle, Cienega, Davidson 2, Del Lago 1, PS-1, and PN-2. On a monthly basis, PAG monitored the Jungle, Cienega, and Del Lago 1 wells. Davidson 2 continued to be monitored on a quarterly schedule and due to access issues, the Empirita 2 and O'Leary Windmill were also switched to a quarterly schedule. The PS-1 and PN-2 wells are monitored hourly by ADWR transducers. Any monitor dates that fell outside this schedule are noted in Table 2. Wells with inconsistent data were excluded from calculations of average water levels, including the O'Leary well which had a pump installed in June 2007, which likely influenced subsequent water levels.

Results

Annual Variation:

In two thirds of the wells that had consistently available data, water levels declined during Fiscal Year 2007-2008 (Table 2). In contrast, water levels were up at every well in the previous fiscal year, 06-07. The Empirita 2 and O'Leary wells are excluded from the discussion on comparative averages due to the irregular accessibility of the sites' water level data. Despite declines at most wells, this year's average water level slightly increased, primarily because of the large rise in water at PN-2. The increase in average water levels in Fiscal Year 2006-2007 was a change from yearly declines exhibited since 2001. Figure 5 graphically represents water level data for this monitoring year and the previous fiscal year, whereas Figure 6 shows water level data from 1994 to the present, exhibiting the longer term trends.

Seasonal Variation:

Seasonal variations in water levels were observed at most monitoring wells during this year (Figure 4). As is typical, groundwater levels rose most dramatically between July 07 and August 07 with additional smaller increases between December 07 and January 08 at most wells. The Jungle and Empirita 2 wells experience the most gradual seasonal changes, whereas the two wells downstream of the dam, PS-1 and PN-2, had the largest seasonal response, followed by the O'Leary and Del Lago wells. In contrast to past years, throughout 2003-2006, the Del Lago well site had a fairly stable water table level with minimal seasonal responses. That time period (2003-2006) also coincides with the drop in water levels most apparent at Empirita, O'Leary and Jungle wells, as well as with the dry period at the Tilted Beds streamflow site, all three of which currently show higher water levels.

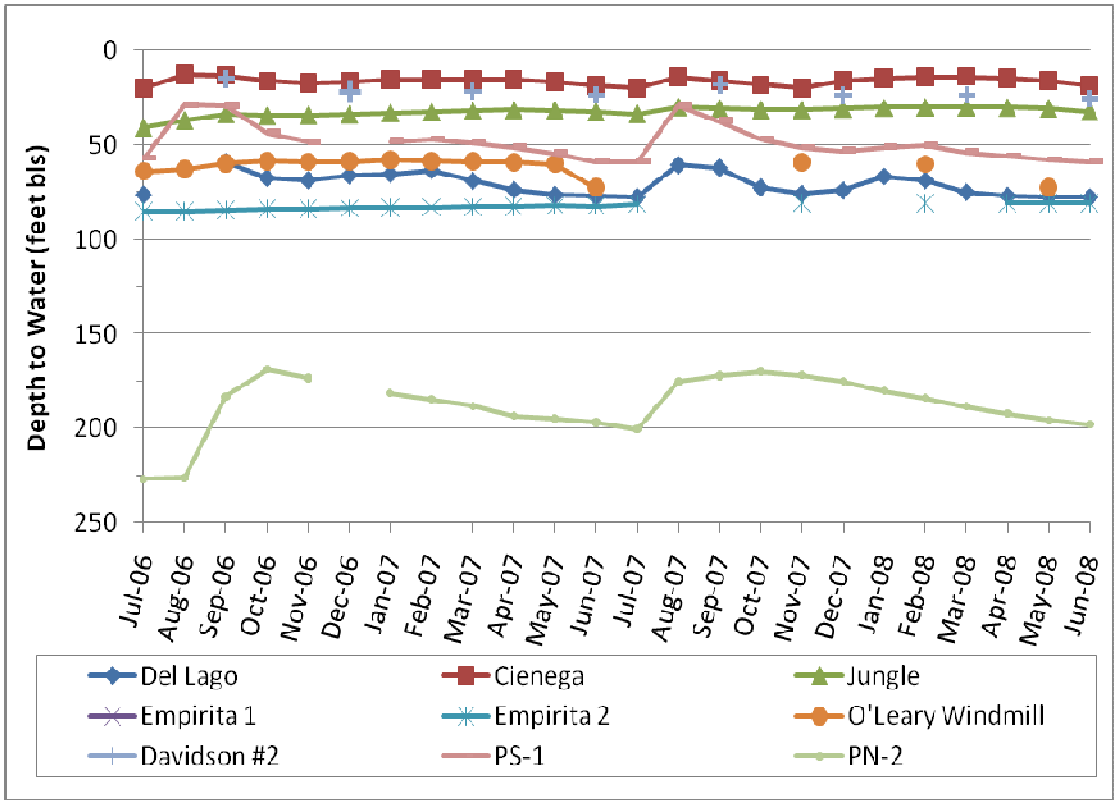
Table 2. Depths to Water in Cienega Creek Natural Preserve Monitor Wells, July 2007 – June 2008

DATE	DEL LAGO 1 (feet)	CIENEGA (feet)	JUNGLE (feet)	EMPIRITA 2 (feet)	O'LEARY WINDMILL (feet)	DAVIDSON #2[1] (feet)	PS-1[2] (feet)	PN-2[2] (feet)
7/13/07	77.65	19.70	33.62	81.18	-[3]		58.66	200.45
8/17/07	60.71	14.20	30.00	-[4]	-[4]		29.44	175.46
9/11/07	62.23	15.84	30.79	-[4]	-[4]	17.82	37.32	172.17
10/12/07	72.68	18.08	31.37	-[4]	-[4]		46.97	170.21
11/14/07	76.00	19.58	31.45	81.04	59.15		51.33	171.79
12/13/07	74.24	16.10	30.90	-[4]	-[4]	23.58	53.09	175.13
1/18/08	66.78	14.70	30.20	-[4]	-[4]		51.19	180.30
2/14/08	68.78	14.25	30.10	80.90	60.18		50.38	184.02
3/19/08	75.10	13.75	30.06	-[4]	-[4]	23.46	53.62	188.49
4/21/08	77.06	14.80	30.30	80.75	-[5]		55.87	192.12
5/6/08	77.46[6]	15.70	30.69	80.74	72.63		57.78[6]	195.77[6]
6/17/08	77.77	18.50	32.29	80.88	-[7]	25.35	58.85	197.93
2006-2007 AVERAGE	69.47	15.95	33.99	83.66	60.93	20.30	46.88	192.50
2007-2008 AVERAGE	72.21	16.27	30.98	80.92	63.99	22.55	50.38	183.65
CHANGE [8]	-2.74	-0.32	+3.01	+2.74	-3.06	-2.25	-3.50	+8.85

Note: *All depths are feet below land surface*
[1] Measured quarterly
[2] Monitored by ADWR
[3] Pump installed in June 2007 could not be turned off to obtain a water depth measurement
[4] Inaccessible during this month of monitoring
[5] Measurement obtained is not valid: pump was turned off for over 20 minutes, but never recovered to the usual depth
[6] Measurement obtained on a separate field day (5/27/08) due to time constraints
[7] Due to fluctuation in well water depth levels from pumping, we are no longer monitoring this well
[8] Difference between 2007-2008 average and 2006-2007 average

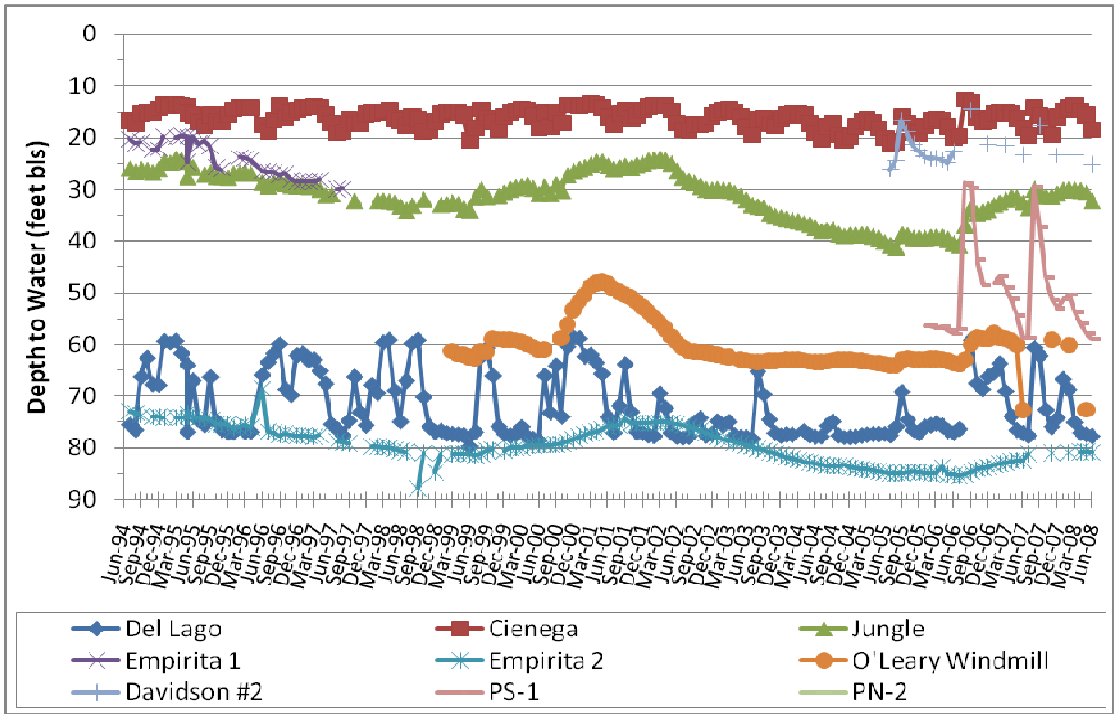
"+" = rise in water level
"-" = drop in water level

Figure 5. Depths to Groundwater in Cienega Creek Natural Preserve, July 2006 – June 2008



Data are not available for some months due to inaccessibility.

Figure 6. Depths to Groundwater in Cienega Creek Natural Preserve, June 1994 – June 2008



PN-2 is not featured due to scale. See Figure 5 for information on this well.

Extent of Surface Flow (Wet/ Dry Mapping Walk-Throughs)

Methods

The extent of surface flow was mapped by walking the length of the creek channels and marking the location of the flows. Annual wet/dry mapping was conducted during the month of June from 1999 to 2001; the current quarterly schedule for the wet/dry program began during the FY 01-02 monitoring year. Quarterly mapping is conducted during the months of September, December, March, and June. Cienega Creek Preserve walk-throughs begin at the ephemeral reach at Jungle Road and continues to the Pantano (Del Lago/Vail Water) diversion dam, a distance of about 8 miles. Lower Davidson Canyon mapping has been conducted near its confluence with Cienega Creek since fiscal year 01-02 and in Upper Davidson Canyon, south of Interstate 10 on the County's Bar V property, since FY 05-06. Walk-through extents are delineated on Figure 1.

Until FY 07-08, wet/dry mapping was completed on hardcopy aerial photography maps in the field, followed by hand digitization in GIS (ArcMap) to clip a streamflow shapefile line into corresponding flowing segments. This year, we began using a GPS (Trimble) Unit to mark points at the beginning and end of intermittent flow. We continue to use GIS to clip the same Cienega streamflow shapefile line for consistency of comparative length of flow through the years. This shapefile line is a rough creek line that follows the general incision of the creek. It does not necessarily follow the small meanders, braids or actual stream path in detail due to changes every year in this path. This shapefile template is from the Pima County Land Information System and was created at a 1:200,000 scale.

The length of streamflow for each quarterly walk-through is calculated by totaling the sum of the flowing segments. As is consistent with historical records, we consider the total length of creek channel within the preserve to be 9.5 miles. This includes the section of creek that begins at the I-10 crossing and flows north-west to the dam, but we do not walk the first 1.5 miles since it is known to be dry. The mapping results are mapped in Figure 7. All stream lengths within the Preserve, including lower Davidson Canyon, are included in the total sum of flow length. Located outside the Preserve, the sum of flow length for Upper Davidson Canyon (Figure 1) is calculated and presented separately. The data are evaluated for trends of average annual total streamflow length, seasonal variation, intermittency of segments, and minimal perennial flow trends.

Results

Cienega Flow Length:

The annual average of total streamflow length in the Cienega Creek Preserve since 1975 has decreased over time (Table 4). To illustrate, the average flowing length annually since 2001 was 4.0 miles, whereas from 1989 to 1999, it was 7.7 miles. The time period since 2001 is generally considered to be a drought period, which our data supports. In the short term (Figure 7), there has been less change, which can be illustrated by comparing this year's data to last year's data, which is down 0.1 miles this year in total streamflow length.

Since 1975, we had been seeing increasing seasonal variation of total streamflow length (Figure 8); but in recent years, the seasonal difference has stayed similar. Seasonal variation in the fiscal year is evaluated by taking the difference between the quarterly walk-through with the greatest total streamflow length and the walk-through with the least total streamflow length. This seasonal difference was 2.97 miles (Table 3) which is similar to last fiscal year, which had a range of 3.1 miles. The seasons were also similar to last year in that each of the values corresponding to those months with greatest and least amount of streamflow length was very close to last year's values (within .1 to .3 miles).

The documentation of seasonal variation helps to identify ephemeral and perennial reaches. The month with the greatest total flow length was March, which is consistent with every past year's results except for FY 06-07 when September had the longest total flow length. Wetter seasons have fewer numbers of flowing segments, but have greater length of continuous flow because ephemeral segments connect the perennial reaches (Figure 6 and Table 3). The largest change in streamflow extent generally occurs as a decline between the months of March and June, which coincides with the time period when evapo-transpiration rates increase and recharge rates decrease. As seen in Figure 8, the total length of streamflow in the Preserve is consistently lowest in the summer (June). Mapping streamflow during this time of the year conservatively identifies the perennial reaches in the Preserve. In addition to shorter total streamflow length, drier years and drier seasons also generally have more intermittent segments and shorter length stream reaches, as seen in Figure 7 and Table 3.

Summer streamflow extents have declined substantially since the 1980s (Table 4). In July 1984, the creek flowed continuously from I-10 to the Pantano Dam; a distance of 9.5 miles (Montgomery & Associates 1993). In contrast, in June 2008, the creek flowed for 2.87 miles and was segmented into several short flowing reaches composing 30% of the creek length, separated by dry reaches. However, streamflow extent in June was longer this year than in any June from 1999-2006, with 2001 as an exception (Figure 9). This year, June's flow was 0.6 miles more than the average since 1999. The average percentage of dry creek since 1999 has been 72 %.

The extent of streamflow has varied considerably over time in Lower Davidson Canyon near the confluence with Cienega Creek since 2001, when mapping began. In 2007, Lower Davidson Canyon only flowed in a single quarter, September (Table 3); the prior fiscal year (FY 06-07) had flow year-round and the fiscal year previous to that (FY 05-06) had no flow year round.

Upper Davidson Canyon Flow Length:
The flowing reaches of Upper Davidson Canyon are located at a spring next to a bedrock outcrop south of the I-10 crossing (as seen on the map in Figure 7). The extent of June streamflow length in Upper Davidson Canyon has declined substantially since 2007 (Table 4), and no flow was found during June this year. The greatest flowing lengths in Upper Davidson Canyon were found in September 2007 when it flowed for 5,505 feet (Table 3). This is the third year that these surface flows were systematically mapped, but these streamflows along this reach were also noted during earlier PAG studies. Pools of considerate size, between one to three feet deep, remain along this channel, but no fish have been seen since the summer of 2005.

Outreach and Coordination
We continued to coordinate with the Bureau of Land Management (BLM) and The Nature Conservancy (TNC) on methods of surface flow mapping to ensure that our hydrologic monitoring programs are consistent with the upper reaches of Cienega Creek within the Las Cienegas National Conservation Area. We work with Arizona NEMO, who maps the Gila River and the Agua Fria River; with The Nature Conservancy, Community Watershed Alliance, BLM, and CONANP (Comision Nacional de Areas Naturales Protegidas), who map the San Pedro River, and with The Nature Conservancy, who maps Sonoita Creek, to coordinate a single week for Arizona rivers mapping.

Outside agency staff and other interested individuals are invited to accompany PAG staff on quarterly walk-throughs to provide them an opportunity to learn about Cienega Creek and become more familiar with some of the management issues of the Preserve and the surrounding region.

The invited agencies include Pima County Regional Flood Control District, Pima County Natural Resources, Arizona Game and Fish Department, Arizona Department of Environmental Quality, U.S. Fish and Wildlife Service, The Nature Conservancy, Sonoran Institute, University of Arizona, Cienega Watershed Partnership, Arizona Department of Water Resources, Sky Island Alliance, Empire-Fagan Coalition, the Sustainability of semi-Arid Hydrology and Riparian Areas center, Tucson Audubon Society, NEMO, USDA Agricultural Research Center, Rincon Institute, Watershed Management Group, Colossal Cave Park, Tucson Electric Power, Arizona State University, Congresswoman Giffords Office, and the Master Watershed Stewards program.

Repeat Photography

PAG continued photographing 17 established photo stops in FY 07-08 during quarterly walk-throughs. The site locations, acquired by GPS, are shown in Figure 1. Photos are stored digitally at PAG and documentation of the locations is stored with each photo. In FY 08-09, we will do an analysis of the effectiveness of these efforts and show a comparison of the photo sites over time.

Table 3. Lengths of Flowing Reaches in Cienega Creek Natural Preserve and Upper Davidson Canyon, Measured Quarterly, September 2007– June 2008

	Length of Flowing Reach (feet)			
Flowing Reach	**September**	**December**	**March**	**June**
	9/27/2007	12/18/2007	3/18/2008	6/12/2008
Cienega Creek Reach A	655	11529	11855	326
Cienega Creek Reach B	203	2792	10897	450
Cienega Creek Reach C	613	5276	997	2935
Cienega Creek Reach D	5415	4640	4057	939
Cienega Creek Reach E	969	3046	3055	4605
Cienega Creek Reach F	4484			4292
Cienega Creek Reach G	5479			441
Cienega Creek Reach H	653			460
Cienega Creek Reach I	1485			709
Cienega Creek Reach J	3478			
Lower Davidson Canyon Reach	908	dry, no pools	dry, no pools	dry, no pools
TOTAL (ft)	**24342**	**27283**	**30861**	**15157**
(miles)	**4.61**	**5.17**	**5.84**	**2.87**
	9/11/2007	12/13/2007	3/19/2008	6/19/2008
Upper Davidson Canyon Reach A	3001	278	236	moist soil at old spring pool
Upper Davidson Canyon Reach B	1651	218	39	
Upper Davidson Canyon Reach C	853	34		
Upper Davidson Canyon Reach D		48		
TOTAL (ft)	**5505**	**578**	**275**	**0**
(miles)	**1.04**	**0.11**	**0.05**	**0.00**

Reaches are not numbered in sequence; they are not associated with any one fixed portion on the creek. A lower total number of reaches generally indicates less interrupted flow.
Upper Davidson Canyon reaches mapped on different dates than Cienega Creek and Lower Davidson Canyon reaches due to the length of time required to complete both streams.

Table 4. Total Lengths of Flow in Cienega Creek Natural Preserve and Upper Davidson Canyon, Summer months, 1984 – 2007

Year	Length of Cienega Creek	Length of Upper Davidson	Source
Jul-84	50,000 ft. (9.5 miles)	No data	Errol L. Montgomery & Associates, Inc.
May-85	50,000 ft. (9.5 miles)		
May-86	43,140 ft. (8.2 miles)		
May-87	43,200 ft. (8.2 miles)		
May-88	41,500 ft. (7.9 miles)		
May-89	34,640 ft. (6.6 miles)		
May-90	37,400 ft. (7.1 miles)		
May-91	42,160 ft. (8.0 miles)		
May-92	37,740 ft. (7.1 miles)		
No data 1993-1998			
Jun-99	14,290 ft. (2.7 miles)	No data	PAG
Jun-00	14,590 ft. (2.8 miles)		
Jun-01	24,950 ft. (4.7 miles)		
Jun-02	17,220 ft. (3.3 miles)		
Jun-03	10,630 ft. (2.0 miles)		
Jun-04	8,145 ft. (1.5 miles)		
Jun-05	7,865 ft. (1.5 miles)		
Jun-06	12,025 ft. (2.3 miles)	170 ft. (.03 miles)	
Jun-07	15,860 ft. (3.0 miles)	483 ft. (.09 miles)	
Jun-08	14,831 ft. (2.8 miles)	0 ft. (0 miles)	

Length of Cienega Creek channel from Interstate 10 to Pantano Dam equals 50,000 ft. (9.5 miles) and includes 1,100 ft. (0.21 miles) of Lower Davidson near the confluence with Cienega in this calculation. Upper Davidson includes 22,700 ft. of creek channel (4.3 miles) from the springs south of the I-10 crossing down to the beginning of the Lower Davidson Reach. Data was collected by Errol L. Montgomery & Associates from 1984 to 1993. Data were not collected from 1993 through 1998.

Figure 7. Extents of Flowing Stream Reaches in Cienega Creek Natural Preserve and Davidson Canyon, September 2007 – June 2008

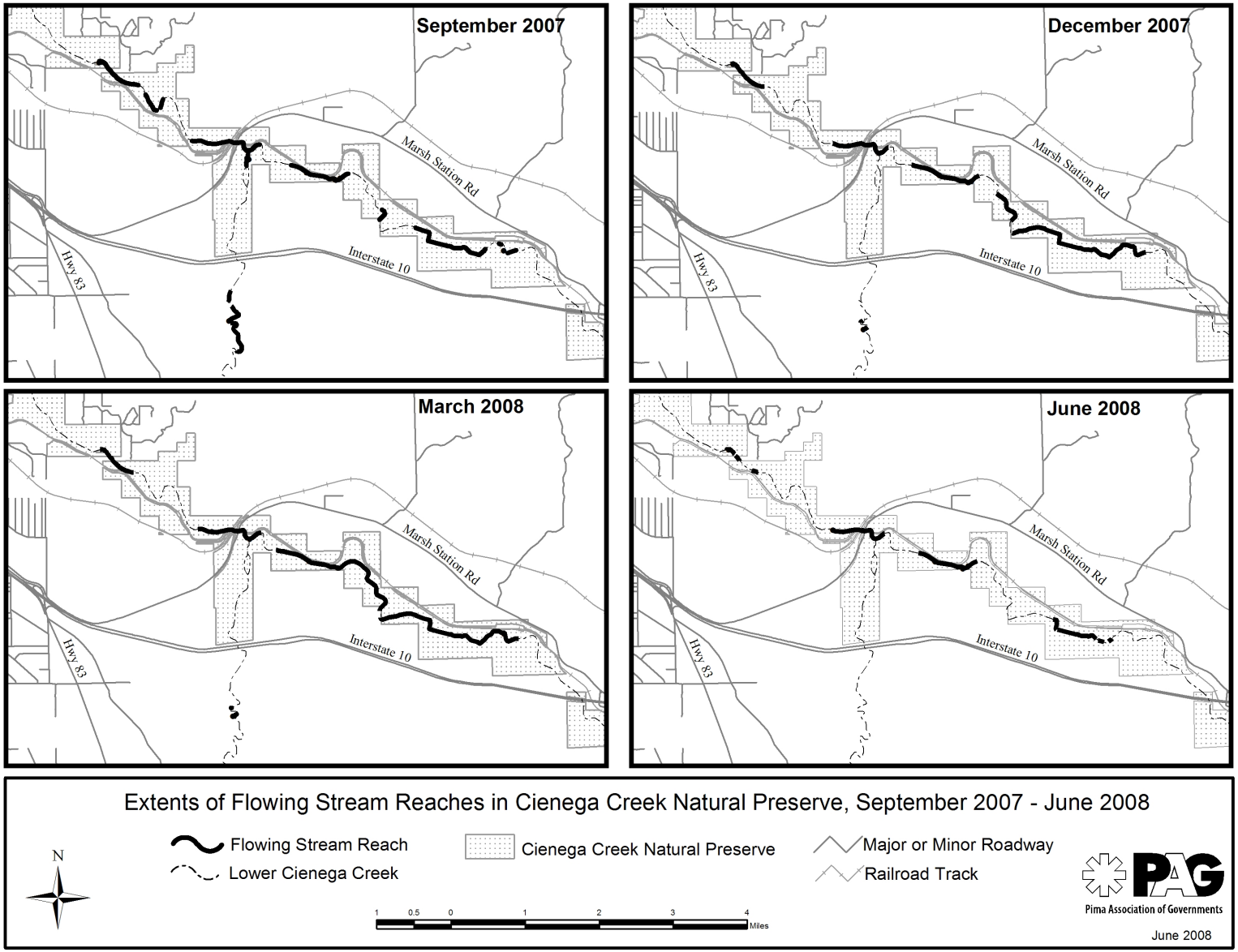


Figure 8. Lengths of Streamflow in Cienega Creek Natural Preserve, 1999-2008

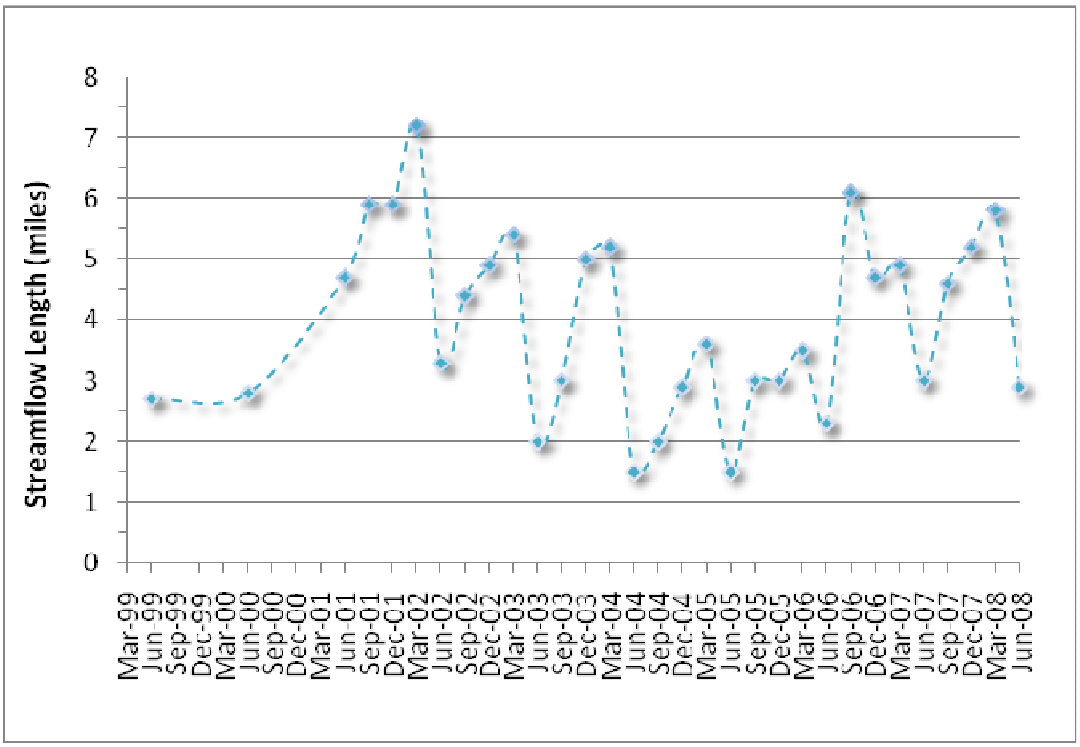
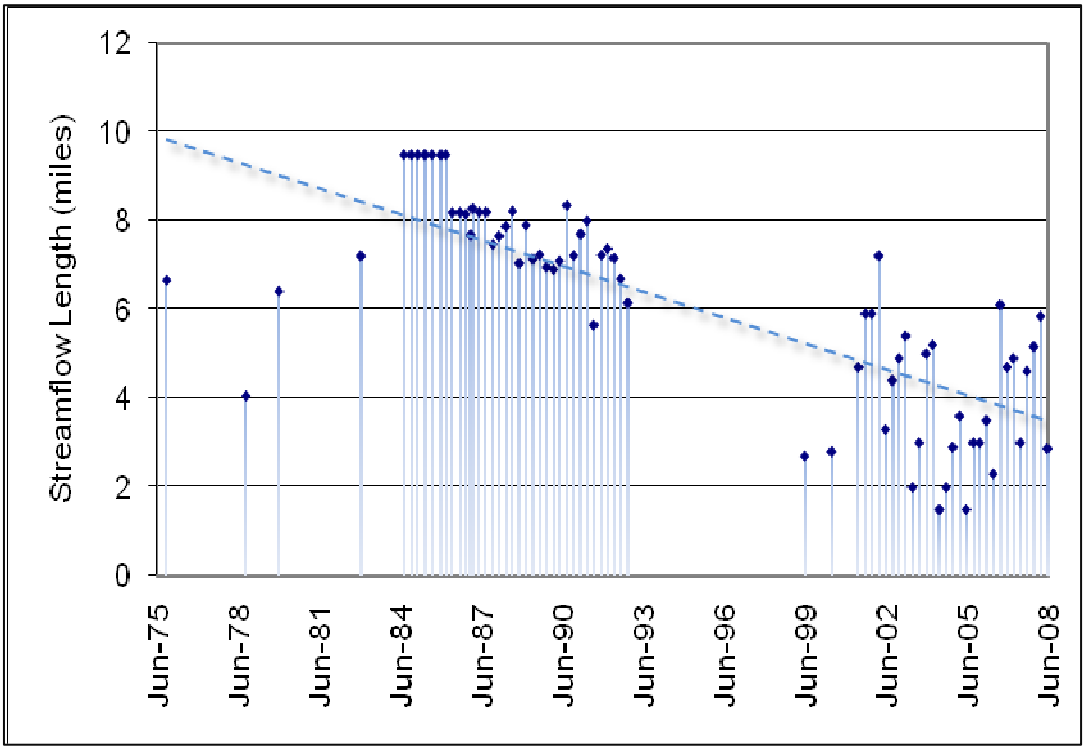
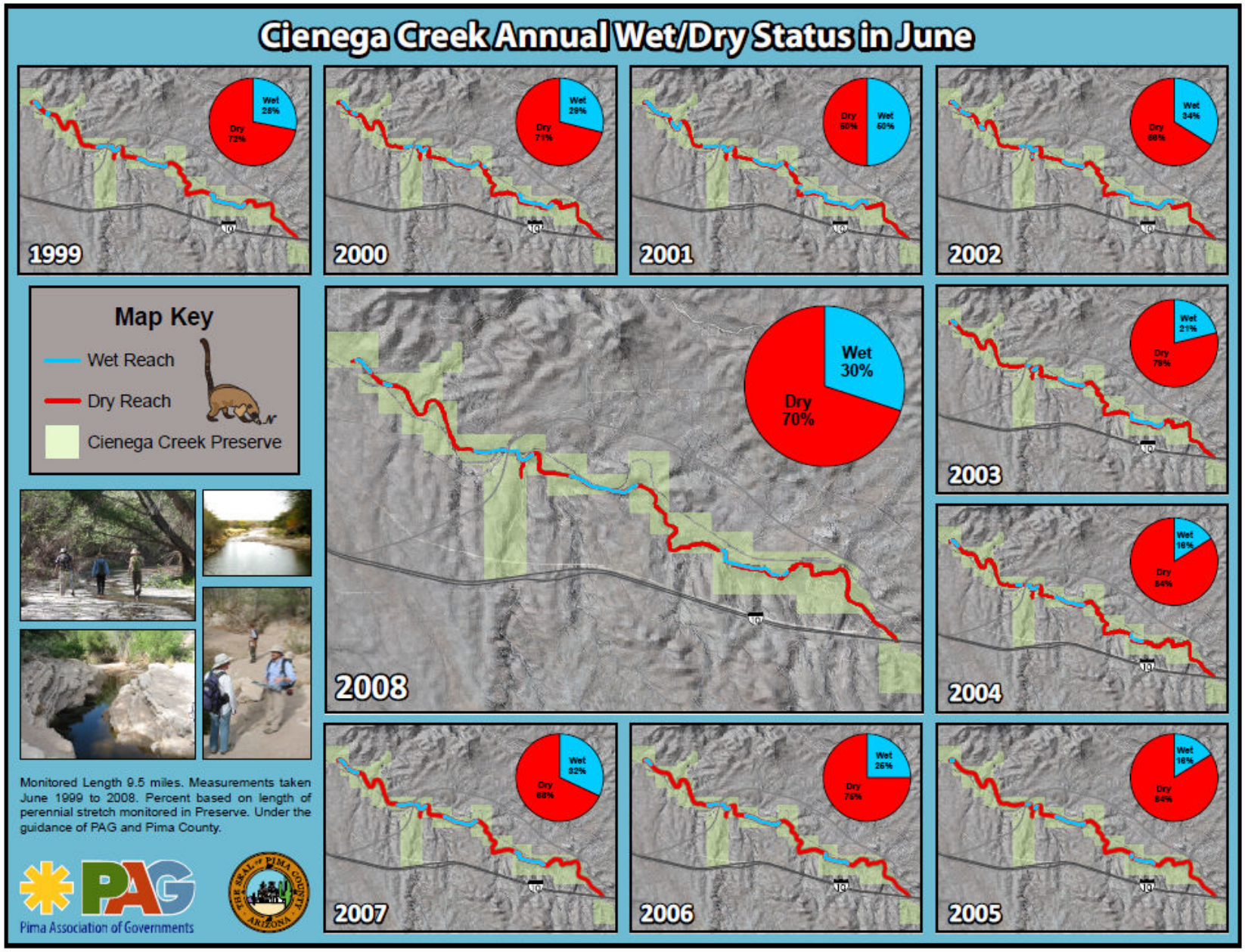


Figure 9. Lengths of Streamflow in Cienega Creek Natural Preserve, 1975-2008



Data prior to 1993 is from Errol L. Montgomery & Associates, (Montgomery &Associates 1993). Length was not measured from1993-1998.

Figure 10. Extents of Flowing Stream Reaches in June in Cienega Creek Natural Preserve, 1999-2008



Water Chemistry

Methods

PAG began regular water quality monitoring in January 2007 at four monitoring sites that have a history of monitoring in past PAG studies. PAG resumed water quality monitoring partially due to ADEQ's inclusion of Davidson Canyon in their proposal for Outstanding Arizona Waters. This monitoring will serve as additional baseline data, should the creek become impacted by copper or limestone mining development. For example, limestone mines can affect pH and if calcium and sulfate combine, the resulting gypsum may show up in TDS readings.

The locations of the monitoring sites for water chemistry are displayed in Figure 1. Davidson 1 was located south of I-10, upstream of the PC ALERT stream gage. Davidson 3 functions as a replacement for Davidson 1 which is now dry. Davidson 3 is an ephemeral site just downstream of the fence crossing and spring. Davidson 2 has ephemeral flow and is located in Davidson Canyon within 1000 feet of the Cienega confluence. Cienega 1 is on Cienega Creek within a few hundred feet upstream of the Davidson Canyon confluence and is a perennial site. Cienega 2 is downstream at Marsh Station Bridge at the perennial streamflow monitoring site where ADEQ had over 10 years of data.

All sites are measured quarterly during walk-throughs. In addition, Cienega 2, the site below the confluence on Cienega Creek is measured during monthly streamflow monitoring. We use an Ultrameter to measure Total Dissolved Solids, temperature, conductivity, and pH at the four sites. The water quality Ultrameter is maintained by monthly calibration. Field notes also include date and time of sampling, a description of the weather, the names of the field crew, the site name, and any calibration observations. Water quality measurements are only gathered during baseflow conditions when clear, non-storm runoff water is flowing in the creek. Samples and readings are not collected from standing water, eddies, or immeasurable flow.

Results

Our data shows the seasonal changes and differences between water chemistry sites but we did not detect any significant long term trends in the changes of data. In examining seasons of FY 07-08, total dissolved solids (TDS) consistently dropped in the fall after monsoons and fluctuated about 200 parts per million from the highest to lowest point in the year (figure 11). On average, Davidson Canyon sites had lower average conductivity and TDS than Cienega Creek, possibly contributing to lower conductivity at the Cienega site downstream of the Davidson confluence (figure 12). When comparing the past two year's data with 2002-2003 data, we found that conductivity increased slightly at all sites, except for a light decrease at Davidson 2 (figures 15). By contrasting site data we see that conductivity data are similar at the two Davidson Canyon sites whereas pH and temperature where most similar at Lower Davidson and on Cienega 2 below the confluence (figures 12, 13 and 14). The pH and temperature data were found to be highest at these sites.

Further sampling and water chemistry data is available from the following sources:

- Errol L. Montgomery & Assoc. (EMA) in June 2008 at Cienega 1, Davidson 2 and Davidson 3 and in October 2008 at Cienega 1, Davidson 2 and Tilted Beds
- PAG sampling results (Test America Lab Work) taken at Davidson 3 in September 2008
- PAG Quarterly samples were taken in 2002-2003 and a single sample in 2005 for the Unique Waters study and in 2005 for the Davidson Unique Waters Plan more metals were sampled.
- PAG 2002-2003 quarterly samples for isotopes, chemistry and constituent sampling in the Davidson Cienega Study

Figure 11. Total Dissolved Solids in the Cienega Watershed (Jan. 2007- June 2008)

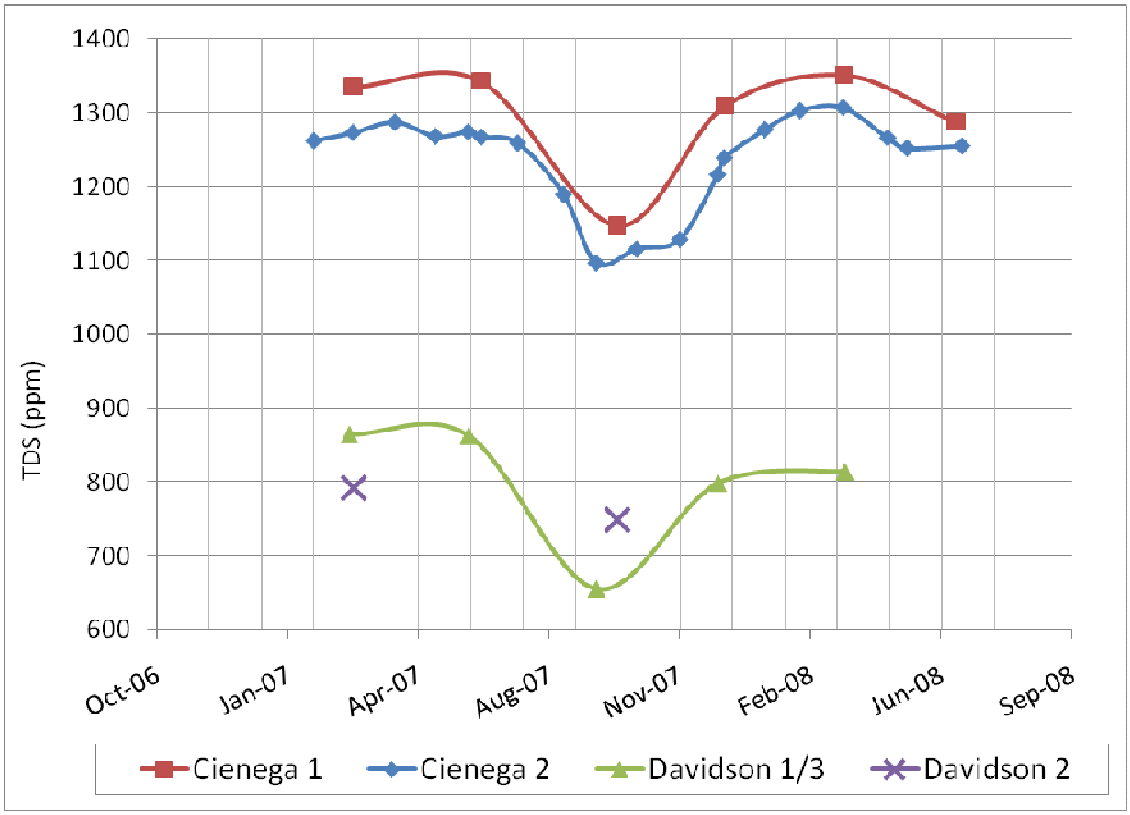
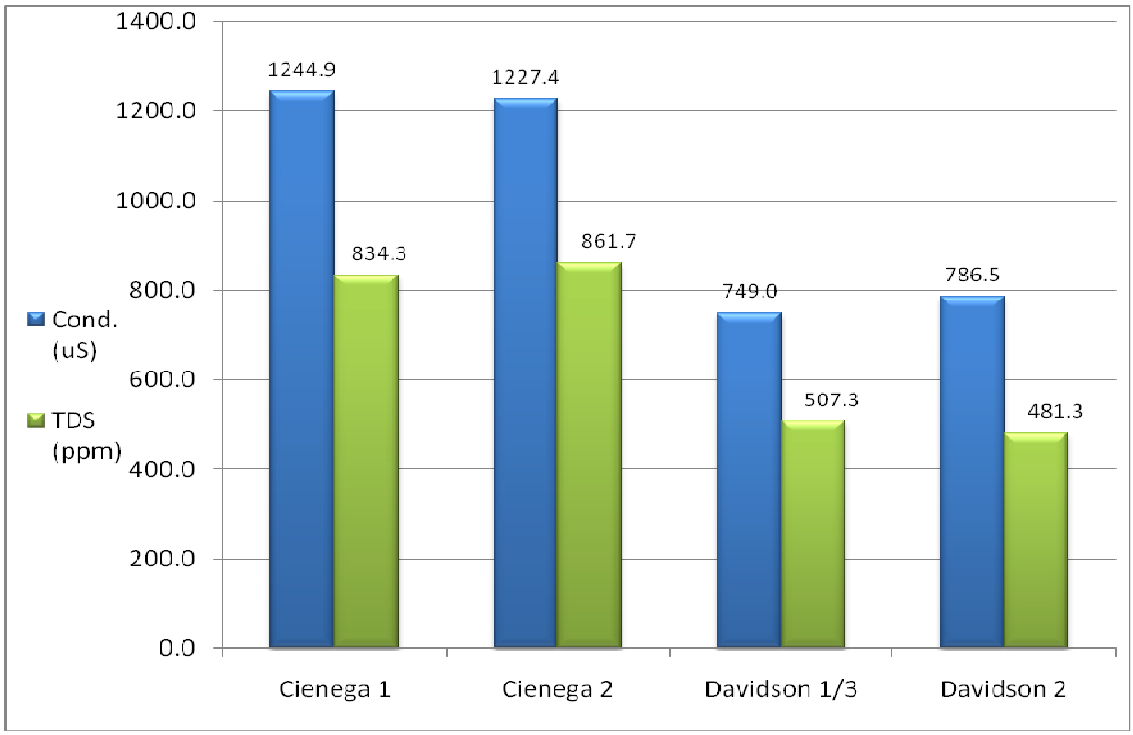


Figure 12. Average Specific Conductivity and Total Dissolved Solids 2002- 2008



Davidson 3 serves as a replacement for the Davidson 1 site since March 2007. Depending on the site, readings were measured every 1-3 months, when sites had available flow. No data was collected from 2004-2006.

Figure 13. 2002-2008 Baseline pH Averages per Site

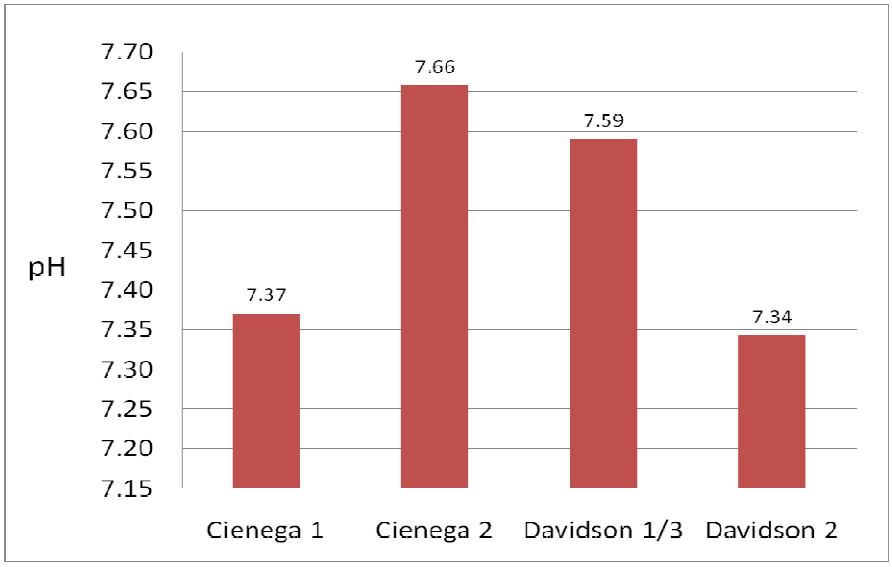


Figure 14. 2002-2008 Baseline Temperature Averages per Site

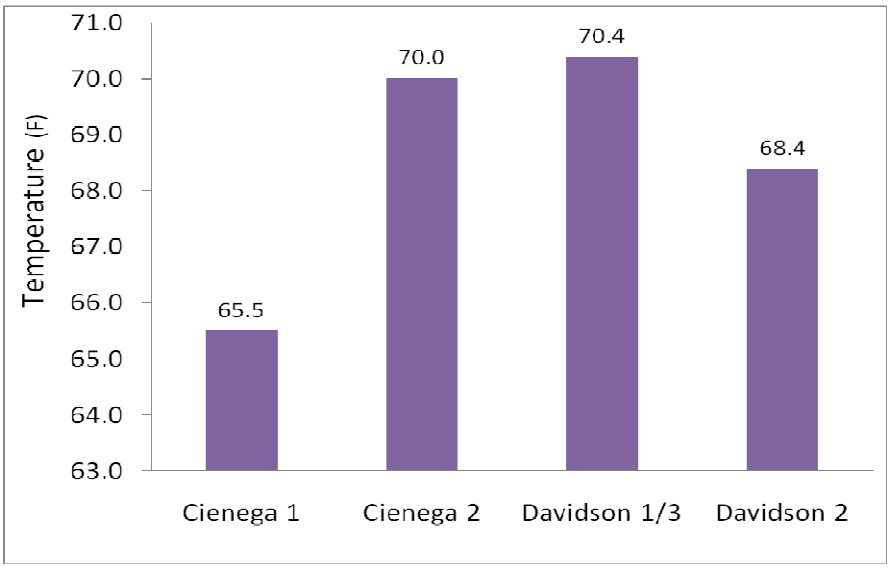
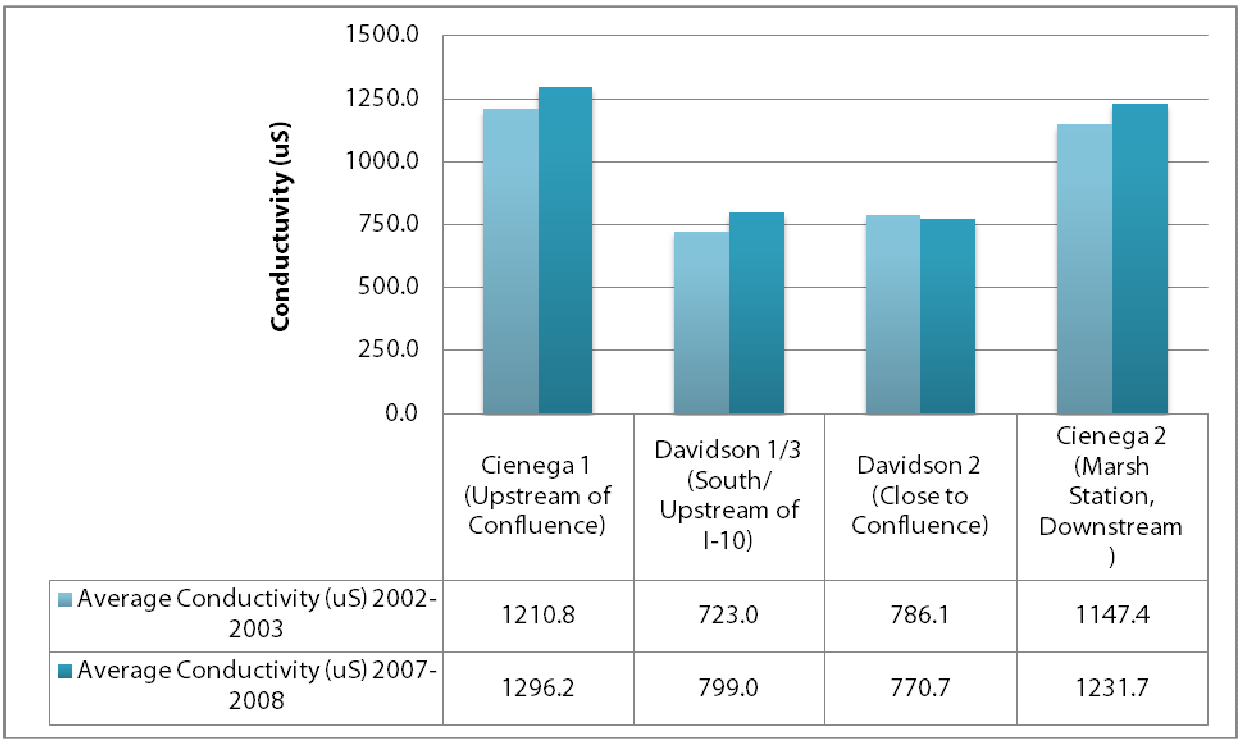


Figure 15. Comparison of Historic Conductivity



	Cienega 1 (Upstream of Confluence)	Davidson 1/3 (South/ Upstream of I-10)	Davidson 2 (Close to Confluence)	Cienega 2 (Marsh Station, Downstream)
Average Conductivity (uS) 2002-2003	1210.8	723.0	786.1	1147.4
Average Conductivity (uS) 2007-2008	1296.2	799.0	770.7	1231.7

Headcut Study

The headcut at the railroad horseshoe is being studied through a two year Arizona Water Protection Fund Grant (AWPF Grant No. 07-144). PAG is monitoring groundwater levels through two piezometers, measuring headcut entrenchment, taking repeat photography, monitoring two streamflow sites and assessing habitat through riffle/pool distribution. Reports will be completed in 2010.

Wildlife Observations

Pools were present at various locations along Cienega Creek during each quarterly walk-through this year. Native fish and frogs were commonly seen in most flowing stream reaches and pools including Gila Topminnow, chub, Longfin dace, and Lowland leopard frog.

Possible Implications

The presence of flow at Tilted Beds is likely correlated to sedimentation history. The reason for PN-2 being the fastest declining well, with its depth to water lower than all other wells, may be due to bedrock surface elevation. The gradual drying trend in Cienega flow lengths since 1984 (Table 4) is probably due in part to the current drought. This drought period appears to be a possible contributor to seasonal stability in water levels at Del Lago well.