Water Quality Studies
Within The
Cienega Creek Natural Preserve

Prepared by: David Scalero, Principal Hydrologist, and Frank Postillion, Chief Hydrologist, Pima County Regional Flood Control District, Water Resources Division, April 10, 2009
Contributions by: Claire Zucker and Mead Mier, Pima Association of Governments, and Julia Fonseca, Pima County Department of Conservation Science

Introduction and Background

Cienega Creek and the tributary Davidson Canyon Wash contain a unique mixture of desert and riparian habitats influenced by the presence of perennial and intermittent water flows. The occurrence of perennial water at such low elevations and in close proximity to urbanization makes these two streams exceptionally rare within the semi-arid region of Southeastern Arizona. These two streams are significant sources for Hydro- and Meso-riparian ecosystems and serve as excellent wildlife migration corridors between the Whetstone, Empire and Santa Rita Mountains to the south and the Rincon Mountains to the north.

Cienega Creek and Davidson Canyon (nomination) are classified as Outstanding Waters of Arizona by the Arizona Department of Environmental Quality based on the characteristics described in A.A.C. R18-11-112 and summarized below:

1. The surface water is a perennial water;
2. The surface water is in free-flowing condition;
3. The surface water has good water quality;
4. The surface water meets one or both of the following conditions:
    a. The surface water is of exceptional recreational or ecological significance because of unique attributes.
    b. Threatened or endangered species are known to be associated with the surface water and existing water quality essential to the maintenance and propagation of threatened or endangered species or the surface water provides critical habitat for threatened or endangered species.

The Outstanding Waters program provides a level of protection to assure that the outstanding waters will not be degraded long-term (PAG, 2005). The Antidegradation Rule and Unique (Outstanding) Water Rule are provided in **Appendix A**.

Several mining activities have been proposed or are currently in operation within the Cienega Creek and Davidson Canyon watersheds. Annual sampling and testing of the perennial waters along both creeks should be conducted to evaluate the effects of mining and other land use activities on the quality of the waters found along these two streams.

Purpose

The purpose of this report is to summarize the current water quality for Davidson Canyon and Cienega Creek and to develop a monitoring program for identifying any future degradation of the two streams. Water analyses from previous years will be reviewed and compared to standards developed by the Environmental Protection Agency (EPA). The current water quality summary will serve as a baseline for evaluating the effects of mining and other land use activities on the two streams. The monitoring program will be designed to adequately analyze the waters for a suite of metals, inorganics and general water chemistry (i.e., turbidity, pH, TDS, etc.) that could be affected by land use activities, especially mining.

Existing Water Quality

The quality of recent water samples taken along Cienega Creek and Davidson Canyon compare favorably to drinking water standards developed by the Environmental Protection Agency (Tables 1 and 2). Primary Maximum Contaminant Levels (MCLs) were not exceeded in any of the reaches sampled along both creeks. Secondary MCLs for Sulfate and Total Dissolved Solids (TDS) were, however, exceeded in the majority of the samples collected. Secondary MCLs are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (skin or tooth discoloration) or aesthetic effects such as taste, odor or color (EPA, 2009). Iron was slightly over the Secondary MCL in the sample collected at "Tilted Beds", Cienega Creek. Manganese was over the Secondary MCL in the sample collected at "Tilted Beds" in October 2008 (Errol Montgomery & Associates) and the sample collected in Middle Davidson Canyon in September 2008 (Pima Association of Governments).

Based on the high concentrations of sulfate (> 300 mg/l) and TDS (> 800 mg/l) reported in 2008, it would appear that the waters in Lower Davidson Canyon and Cienega Creek are similar, perhaps suggesting a mixing of subsurface flows along both creeks. However, samples collected along Lower Davidson Canyon between June 2002 and January 2003 showed vastly different results, with sulfate levels less than 100 mg/l and TDS not exceeding 520 mg/l (PAG, 2003a). The results from 2003 indicate more of a similarity in the waters at both sites in Davidson Canyon as opposed to an influence by Cienega Creek subsurface flows.

Change in subsurface geology could be reflected in the water quality recently recorded at the two Davidson Canyon sites. The Pantano formation occurs all along lower Cienega Creek and in lower Davidson Canyon up to Interstate 10, whereas bedrock within Davidson Canyon south of the Interstate mostly consists of granitic rocks (PAG, 2003b). The Cienega Basin Source Water Study (PAG, 2000) compared waters from Cienega Creek with those of another tributary, Posta Quemada Spring, which has bedrock consisting of granitic rocks similar to the Middle Davidson Canyon site. Samples from the study showed levels of sulfate, sodium, magnesium, calcium and total dissolved solids in Posta Quemada that are similar to recent samples collected by PAG at Middle Davidson Canyon, which are significantly lower than recent samples collected along Cienega Creek and in Lower Davidson Canyon.

Monitoring Recommendations

Tables 1 and 2 provide a "snapshot" of the recent water quality in Cienega Creek and Davidson Canyon. Quarterly samples should be taken and analyzed along these two creeks for the next couple of years to better develop a baseline for analyzing the effects of future mining activities in the area. Once a baseline has been established, monitoring can be conducted less frequently until there are noticeable changes.

Table 3 provides a list of the metals and inorganics that can be affected by mining activities along with the associated costs for testing. Total cost for the suite of analyses is $344.25 per pricing obtained from TestAmerica Laboratories, Inc. in Calendar Year 2008. Using the laboratory run by Pima County Regional Water Reclamation Department may reduce these costs or at least keep funding internally within the Pima County system.

If funding is limited to the point where quarterly sampling of the full suite of analytes is not possible, the sampling plan should be modified as follows:

- Quarterly sampling of key analytes including Calcium, Magnesium, Sodium, Potassium, Bicarbonate (HCO_3), Chloride, Sulfate (SO_4), Nitrate-Nitrite as Nitrogen, Iron, aluminum, selenium, molybdenum, pH, TDS and Turbidity
- Annual sampling for the remaining metals and inorganics to be conducted at different quarters each year (Quarter 2 in Year 1, Quarter 3 in Year 2, Quarter 4 in Year 3, Quarter 1 in Year 4, etc.).

This would reduce the yearly costs from $1,377.00 to $923.25, while maintaining seasonal data that is most desirable for monitoring purposes.

Based on the amount of mining activity or proposed mining activity within both watersheds, it is recommended that both Cienega Creek and Davidson Canyon be sampled and analyzed for the suite of metals and inorganics listed in Table 3. Specific locations for the sampling should be those areas that have been consistently perennial over the last several years and appear to represent the Outstanding Waters quality of the stream, which have been Lower Cienega Creek upstream of the confluence with Davidson Canyon and Middle Davidson Canyon upstream of Interstate 10. These locations (CIEN1 and DAV3) are marked on a map provided by Pima Association of Governments (Figure 1). Significant changes in the water quality at one or both of these sites may warrant the need for monitoring at locations in downstream areas to determine the extent of water quality degradation.

Due to their familiarity with the sampling sites, it is recommended that Pima Association of Governments (PAG) conduct the sampling along both creeks. Procedures for sampling should follow the same as those provided in the sampling plan produced by PAG in February 2005 and highlighted in **Appendix B** of this report.

References

Environmental Protection Agency (EPA). 2009. Drinking Water Contaminants: National Secondary Drinking Water Regulations. Cited from webpage updated on March 18, 2009 http://www.epa.gov/safewater/contaminants/index.html

Pima Association of Governments (PAG). 2000. Lower Cienega Basin Source Water Study: Final Project Report. Prepared for the Pima County Flood Control District. October 2000.

Pima Association of Governments (PAG). 2003a. Contributions of Davidson Canyon to base flows in Cienega Creek. Prepared for the Pima County Flood Control District. November 2003.

Pima Association of Governments (PAG). 2003b. Geologic influences on the hydrology of Cienega Creek. Prepared for the Pima County Flood Control District. December 2003.

Pima Association of Governments (PAG). 2005. Unique Waters Nomination for Davidson Canyon. Prepared for the Pima County Regional Flood Control District's nomination of Davidson Canyon as a State of Arizona Unique Water.

Table 1. Comparison of Water Quality in Cienega Creek to EPA Standards

Analyte	MCL	Unit	Lower Cienega Creek		Cienega Creek @ Tilted Beds (October 2008)
			June 2008	October 2008	
Metals					
Aluminum	0.5 – 2.0	mg/l	< 0.03	< 0.03	< 0.01
Antimony	0.006	mg/l	0.0005	< 0.0004	0.0004
Arsenic	0.05	mg/l	0.0035	0.0030	0.0083
Barium	2.0	mg/l	0.054	0.060	0.278
Beryllium	0.004	mg/l	< 0.0001	< 0.0001	< 0.0001
Cadmium	0.005	mg/l	< 0.0001	< 0.0001	0.0002
Calcium	--	mg/l	186	148	186
Chromium	0.1	mg/l	< 0.01	< 0.02	< 0.01
Copper	1.3	mg/l	< 0.01	< 0.02	< 0.01
Iron	0.3[a]	mg/l	< 0.02	0.02	0.34
Lead	0.015	mg/l	< 0.0001	< 0.0001	0.0003
Magnesium	--	mg/l	50.1	40.7	33.4
Manganese	0.05[a]	mg/l	0.017	0.09	1.11
Mercury	0.002	mg/l	< 0.0002	< 0.0002	< 0.0002
Molybdenum	--	mg/l	< 0.01	0.03	0.02
Nickel	--	mg/l	< 0.01	< 0.01	< 0.01
Potassium	--	mg/l	4.8	4.5	5.4
Selenium	0.05	mg/l	< 0.0001	0.0001	0.0001
Silver	0.1		--	< 0.02	< 0.01
Sodium	--	mg/l	71.5	65.0	47.5
Thallium	0.002	mg/l	< 0.0001	< 0.0001	0.0001
Zinc	5.0[a]	mg/l	< 0.01	0.01	0.11
Wet Chemistry					
Alkalinity as CaCO3	--	mg/l	275	278	294
Bicarbonate Alkalinity as CaCO3	--	mg/l	323	315	346
Carbonate Alkalinity as CaCO3	--	mg/l	6	12	6
Chloride	250[a]	mg/l	12.2	12.2	8.4
Cyanide (total)	0.2	mg/l	<0.005	< 0.005	< 0.005
Fluoride	4.0	mg/l	0.6	0.6	0.5
Nitrate/Nitrite as N	10.0	mg/l	0.03	0.68	3.71
pH	6.5 – 8.5		6.23	6.86	6.40
Sulfate	250[a]	mg/l	486	365	379
Total Dissolved Solids (TDS)	500[a]	mg/l	1050	840	890
Turbidity	0.5 – 1.0	NTU	No Sample	No Sample	No Sample

[a] Secondary Maximum Contaminant Level

Table 2. Comparison of Water Quality in Davidson Canyon to EPA Standards

Analyte	MCL	Unit	Lower Davidson Cyn (ELM&A, October 2008)	Middle Davidson Cyn DAV 3 (PAG, September 2008)
Metals				
Aluminum	0.5 – 2.0	mg/l	< 0.03	< 0.20
Antimony	0.006	mg/l	0.0012	< 0.003
Arsenic	0.05	mg/l	0.0026	0.0026
Barium	2.0	mg/l	0.158	0.23
Beryllium	0.004	mg/l	< 0.0001	< 0.001
Cadmium	0.005	mg/l	<0.0001	< 0.001
Calcium	--	mg/l	101	86
Chromium	0.1	mg/l	< 0.01	< 0.001
Copper	1.3	mg/l	< 0.01	0.0022
Iron	0.3[a]	mg/l	0.04	0.081
Lead	0.015	mg/l	< 0.0001	< 0.001
Magnesium	--	mg/l	25.9	14
Manganese	0.05[a]	mg/l	0.032	0.074
Mercury	0.002	mg/l	< 0.0002	< 0.0002
Molybdenum	--	mg/l	0.07	< 0.01
Nickel	--	mg/l	< 0.01	0.0021
Potassium	--	mg/l	3.5	5.4
Selenium	0.05	mg/l	0.0022	< 0.002
Silver	0.1		< 0.01	< 0.01
Sodium	--	mg/l	51.4	28
Thallium	0.002	mg/l	< 0.0001	No Sample
Zinc	5.0[a]	mg/l	< 0.01	< 0.05
Wet Chemistry				
Alkalinity as CaCO3	--	mg/l	332	300
Bicarbonate Alkalinity as CaCO3	--	mg/l	366	300
Carbonate Alkalinity as CaCO3	--	mg/l	19.2	< 6.0
Chloride	250[a]	mg/l	36.3	6.5
Cyanide (total)	0.2	mg/l	< 0.005	No Sample
Fluoride	4.0	mg/l	0.8	0.53
Nitrate/Nitrite as N	10.0	mg/l	0.81	0.36
pH	6.5 – 8.5			7.82
Sulfate	250[a]	mg/l	327	42
Total Dissolved Solids (TDS)	500[a]	mg/l	860	370
Turbidity	0.5 – 1.0	NTU	No Sample	No Sample

[a] Secondary Maximum Contaminant Level

Table 3. Test Analyses Prices per Suite of Analytes to be Sampled at Davidson Canyon

Analyte	**Method**	**Cost**[1]
Antimony Arsenic Barium Cadmium Chromium Copper Lead Nickel Selenium Thallium	EPA 200.8, 6020	$ 78.75
Aluminum Beryllium Calcium Iron Magnesium Manganese Molybdenum Potassium Silver Sodium Zinc	EPA 200.7, 6010	$ 67.50
Mercury	EPA 200.7, 6010	$ 22.50
Bicarbonate Alkalinity (HCO3)	SM2320B	$ 15.00
Chloride	SM2320B	$ 15.00
Cyanide (total)	EPA 300.0	$ 15.75
Fluoride	SM4500-CN,G	$ 56.25
Nitrate/Nitrite as N	EPA 300.0/SM4500-F,C	$ 15.75
Sulfate	EPA 300.0	$ 15.75
Total Dissolved Solids (TDS)	EPA 300.0	$ 15.75
Turbidity	SM 2540C	$ 15.00
Total	EPA 180.1	$ 11.25
		$ 344.25

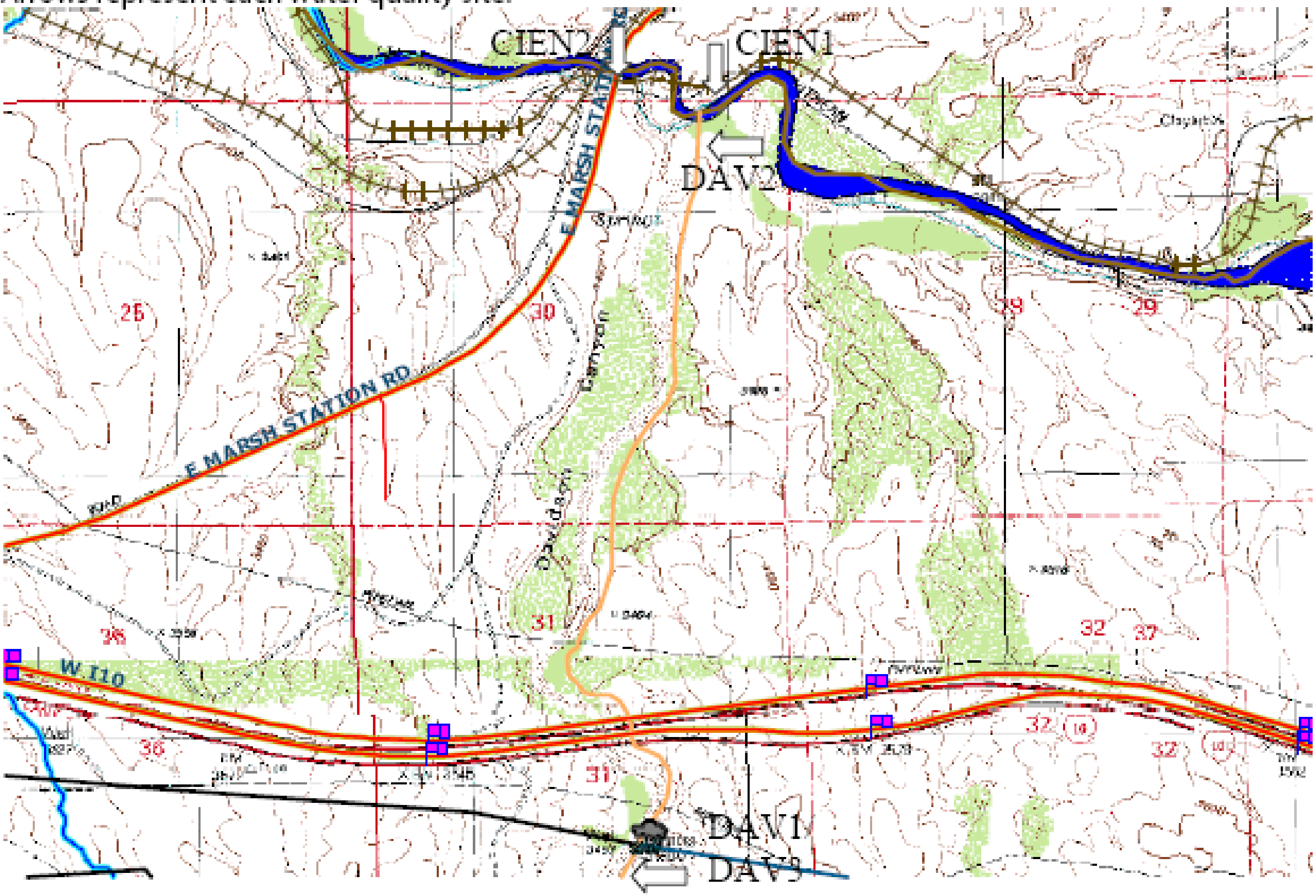
[1] Cost is based on contract with TestAmerica through June 30, 2009

Figure 1

MAP

Davidson Canyon is represented by an orange line

Arrows represent each water quality site.



APPENDIX A
Anti-degradation Rule and Unique (Outstanding) Water Rule
Arizona Department of Environmental Quality

R18-11-107. Antidegradation

A. The Director shall determine whether there is degradation of water quality in a surface water on a pollutant-by-pollutant basis.

B. Tier 1: The level of water quality necessary to protect existing uses shall be maintained and protected. No degradation of existing water quality is permitted in a surface water where the existing water quality does not meet the applicable water quality standard.

C. Tier 2: Where existing water quality in a surface water is better than the applicable water quality standard, the existing water quality shall be maintained and protected. The Director may allow limited degradation of existing water quality in the surface water, provided that the Department holds a public hearing on whether degradation should be allowed under the general public hearing procedures prescribed at R18-1-401 and R18-1-402 and the Director makes all of the following findings:

1. The level of water quality necessary to protect existing uses is fully protected. Water quality shall not be lowered to a level that does not comply with applicable water quality standards.
2. The highest statutory and regulatory requirements for new and existing point sources are achieved.
3. All cost-effective and reasonable best management practices for nonpoint source pollution control are implemented.
4. Allowing lower water quality is necessary to accommodate important economic or social development in the area where the surface water is located.

D. Tier 3: Existing water quality shall be maintained and protected in a surface water that is classified as a unique water under R18-11-112. The Director shall not allow limited degradation of a unique water under subsection (C).

E. The Department shall implement this Section in a manner consistent with § 316 of the Clean Water Act [33 U.S.C. § 1326] if a potential water quality impairment associated with a thermal discharge is involved.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1).

R18-11-112. Unique Waters

A. The Director shall classify a surface water as a unique water by rule. The Director shall consider nominations to classify a surface water as a unique water during the triennial review of water quality standards for surface waters.

B. The Director may adopt, by rule, site-specific water quality standards to maintain and protect existing water quality in a unique water.

C. Any person may nominate a surface water for classification as a unique water by filing a nomination with the Department. The nomination to classify a surface water as a unique water shall include:

1. A map and a description of the surface water;
2. A written statement in support of the nomination, including specific reference to the applicable criteria for unique water classification prescribed in subsection (D);
3. Supporting evidence demonstrating that the applicable unique water criteria prescribed in subsection (D) are met; and

4. Available water quality data relevant to establishing the baseline water quality of the proposed unique water.

D. The Director may classify a surface water as a unique water upon finding that the surface water is an outstanding state resource water based upon the following criteria:
   1. The surface water is a perennial water;
   2. The surface water is in a free-flowing condition. For purposes of this subsection, "in a free-flowing condition" means that a surface water does not have an impoundment, diversion, channelization, rip-rapping or other bank armor, or another hydrological modification within the reach nominated for unique water classification;
   3. The surface water has good water quality. For purposes of this subsection, "good water quality" means that the surface water has water quality that meets or exceeds applicable surface water quality standards. A surface water that is listed as impaired under § 303(d) of the Clean Water Act (33 U.S.C. § 1313) is ineligible for unique waters classification; and
   4. The surface water meets one or both of the following conditions:
      a. The surface water is of exceptional recreational or ecological significance because of its unique attributes, including but not limited to, attributes related to the geology, flora, fauna, water quality, aesthetic values, or the wilderness characteristics of the surface water.
      b. Threatened or endangered species are known to be associated with the surface water and the existing water quality is essential to the maintenance and propagation of a threatened or endangered species or the surface water provides critical habitat for a threatened or endangered species. Endangered or threatened species are identified in Endangered and Threatened Wildlife and Plants, 50 CFR § 17.11 and § 17.12 (revised as of October 1, 2000) which is incorporated by reference and on file with the Department and the Office of the Secretary of State. This incorporation by reference contains no future editions or amendments.

E. The following surface waters are classified as unique waters:
   1. The West Fork of the Little Colorado River, above Government Springs;
   2. Oak Creek, including the West Fork of Oak Creek;
   3. Peoples Canyon Creek, tributary to the Santa Maria River;
   4. Burro Creek, above its confluence with Boulder Creek;
   5. Francis Creek, in Mohave and Yavapai counties;
   6. Bonita Creek, tributary to the upper Gila River;
   7. Cienega Creek, from confluence with Gardner Canyon and Spring Water Canyon at R18E T17S to USGS gaging station at 32°02'09" / 110°40'34", in Pima County;
   8. Aravaipa Creek, from its confluence with Stowe Gulch to the downstream boundary of Aravaipa Canyon Wilderness Area;
   9. Cave Creek and the South Fork of Cave Creek (Chircahua Mountains), from the headwaters to the Coronado National Forest boundary;
   10. Buehman Canyon Creek, from its headwaters (Lat. 32°24'55.5" N, Long. 110°39'43.5"W) to approximately 9.8 miles downstream (Lat. 32°24'31.5" N, Long. 10°32'08" W);
   11. Lee Valley Creek, from its headwaters to Lee Valley Reservoir;
   12. Bear Wallow Creek, from its headwaters to the boundary of the San Carlos Indian Reservation;
   13. North Fork of Bear Wallow Creek, from its headwaters to Bear Wallow Creek;
   14. South Fork of Bear Wallow Creek, from its headwaters to Bear Wallow Creek;

15. Snake Creek, from its headwaters to its confluence with Black River;
17. Hay Creek, from its headwaters to its confluence with the West Fork of the Black River;
18. Stinky Creek, from the Fort Apache Indian Reservation boundary to its confluence with the West Fork of the Black River; and
19. KP Creek, from its headwaters to its confluence with the Blue River.

F. The Department shall hold at least one public meeting in the local area of a nominated unique water to solicit public comment on the nomination.

G. The Director may consider the following factors when making a decision whether to classify a nominated surface water as a unique water:
1. Whether there is the ability to manage the unique water and its watershed to maintain and protect existing water quality;
2. The social and economic impact of Tier 3 antidegradation protection;
3. The public comments in support or opposition to a unique waters classification;
4. The support or opposition of federal and state land management and natural resources agencies to a nomination;
5. Agency resource constraints;
6. The timing of the unique water nomination relative to the triennial review of surface water quality standards;
7. The consistency of a unique water classification with applicable water quality management plans (for example, § 208 water quality management plans); and
8. Whether the nominated surface water is located within a national or state park, national monument, national recreation area, wilderness area, riparian conservation area, area of critical environmental concern, or it has another special use designation (for example, Wild and Scenic River designation).

H. The following water quality standards apply to the listed unique waters. Water quality standards prescribed in this subsection supplement the water quality standards prescribed by this Article.

1. The West Fork of the Little Colorado River, above Government Springs:

Parameter	Standard
pH (standard units)	No change due to discharge
Temperature	No increase due to discharge
Dissolved oxygen	No decrease due to discharge
Total dissolved solids	No increase due to discharge
Chromium (as Cr)(D)	10 µg/L

2. Oak Creek, including the West Fork of Oak Creek:

Parameter	Standard
pH (standard units)	No change due to discharge
Nitrogen (T)	1.00 mg / L (annual mean)
	1.50 mg / L (90th percentile)
	2.50 mg / L (single sample max.)
Phosphorus (T)	0.10 mg/L (annual mean)
	0.25 mg/L (90th percentile)
	0.30 mg/ L (single sample max.)
Chromium (as Cr) (D)	5 µg/L

Turbidity change due to discharge	3 NTUs

3. Peoples Canyon Creek, tributary to the Santa Maria River:

Parameter	Standard
Temperature	No increase due to discharge
Dissolved oxygen	No decrease due to discharge
Turbidity change due to discharge	5 NTUs
Arsenic (T)	20 µg/L
Manganese (T)	500 µg/L

4. Burro Creek, above its confluence with Boulder Creek:

Parameter	Standard
Manganese (T)	500 µg/L

5. Francis Creek, in Mohave and Yavapai counties:

Parameter	Standard
Manganese (T)	500 µg/L

6. Cienega Creek, from its confluence with Gardner Canyon and Spring Water Canyon at R18E T17S to Del Lago Dam, in Pima County:

Parameter	Standard
pH	No change due to discharge
Temperature	No increase due to discharge
Dissolved oxygen	No decrease due to discharge
Total dissolved solids	No increase due to discharge
Turbidity	10 NTUs

7. Bonita Creek, tributary to the Upper Gila River:

Parameter	Standard
pH	No change due to discharge
Temperature	No increase due to discharge
Dissolved oxygen	No decrease due to discharge
Total dissolved solids	No increase due to discharge
Turbidity	15 NTUs

Abbreviations:
"(D)" means dissolved fraction
"(T)" means total recoverable
"NTUs" means nephelometric turbidity units
"mg / L" means milligrams per liter
"µg / L" means micrograms per liter

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Added "water quality standards" to R18-11-112, previously omitted in error (Supp. 96-3). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1).

APPENDIX B
Sampling Plan for Cienega Creek and Davidson Canyon

<u>Target Condition for Sampling</u>
The sampling program is designed to collect representative surface water samples from Davidson Canyon during baseflow conditions. Baseflows are produced by discharges from the aquifer into the stream channel. For the purposes of this program, baseflows are considered to by flows without the direct influence from surface runoff. Samples will not be collected during or immediately after a significant rainfall event. If rainfall occurs during or immediately prior to a scheduled sampling event, the sampling event will be postponed until drier conditions prevail and runoff no longer has a direct influence on stream flow. Field staff will not collect samples under hazardous conditions, such as during flood flows or lightning storms.

Sampling will occur at a location along the main channel of the flowing reach where flow appears to represent the majority of the flowing reach in depth, width, velocity, and channel bed roughness. Samples will not be collected from standing water, eddies, or unmeasurable flow. Streamflow will be measured immediately before water samples are collected. Therefore, based on basic guidelines for streamflow measurements, surface water samples will be collected at a location along the stream where the channel is relatively straight and streamflow is fairly uniform.

<u>Types of Samples to be Collected</u>
Surface water grab samples will be collected for water chemistry analysis.

<u>Water Analysis</u>
The water samples will be analyzed by an ADEQ-accepted laboratory that uses EPA-approved methods for water analysis.

<u>Field Equipment</u>
Water quality measurements to be taken in the field include pH, temperature, and electrical conductivity. These parameters will be measured using a Myron L Ultrameter 6P meter, or a comparable instrument. The meter will be used in accordance to its instructions and documented accuracy. The meter will be calibrated on the day of the sampling event.

Streamflow will be measured using a USGS Pygmy flow meter, or comparable flow meter, or a flume. The USGS Pygmy Meter is designed to measure flow velocity as low as 0.1 foot per second, which is roughly equivalent to 0.10 cfs (given a depth of 1 inch and a width of 18 inches). If flows are too low to measure with a flow meter, flow will be measured suing a portable Free Flow B-notch Flume, or a comparable flume. The Free Flow Flume is capable of measuring flows as low as 0.10 cubic feet per second. The mid-section method will to utilized when measuring streamflow with a slow meter.

Sampling and Field Protocols

Surface water grab samples will be collected from streamflow in the channel. Clean, unpreserved sample bottles will be obtained from the laboratory prior to the sampling event and will remain sealed until used in the field. The samples will be filtered and acidified by the laboratory after the samples have been collected and delivered to the lab; therefore the bottles should be free of any preservative. In accordance with ADEQ sampling protocol for collection of surface water grab samples, the samples will be collected form the middle of the channel at a location where streamflow and stream channel characteristics are representative of the entire flowing reach. Powderless, disposable latex gloves will be worn during the sampling to prevent potential contamination of the water sample. If streamflow is too shallow to collect the sample directly with the sample bottle, a plastic beaker will be used to collect and transfer the sample into the sample bottle. The plastic beaker will be cleaned prior to the sampling event and rinsed three times with sample water prior to collection. After collection, the water samples will be immediately put on ice for transport to the lab. The samples will be dropped off a the lab on the same day that the samples are collected.

Sample Identification and Custody Protocol

Prior to collecting a water sample, the bottle will be labeled (using water-proof ink) with the site name, sample date, sample time, sample type, and "collected by". Chain of custody forms will be taken into the field with the sample bottles, filled out by the sampling field crew, and submitted to the laboratory along with the samples. A copy of the chain of custody form will be kept on record by the sampler. The laboratory will keep the water samples for 30 days, after which the samples will be discarded unless otherwise specified.

Quality Control Protocols

One duplicate sample will be collected during each sampling event. Laboratory quality assurance and quality control procedures are available from the lab.

Procedures for Maintaining Equipment

The water quality meter will be calibrated on the day of the sampling event. Calibration will be conducted in accordance to the instructions included in the meter's user manual. The meter will be cleaned and inspected after each sampling event and will be inspected again prior to each sampling event. Calibrating and inspecting the meter prior to the sampling event is especially important if the meter is used infrequently (ie, less than once a month).

The flow meter will be cleaned and inspected after each sampling event and will be inspected again prior to the sampling event. Inspection will include conducting a "spin test", which determines whether or not the bucket-wheel is spinning freely and is producing the proper electrical signal for flow measurement.

Field Notes

Field notes will be written in pen. At a minimum, field notes will consist of the following:

- Names of sampler and field crew;

- Project name;
- Date and time of sampling;
- Description of the weather;
- Description of sample location along flowing reach and why location was chosen;
- Duplicate sample information (time and location);
- Sample type;
- Description of streamflow (instantaneous, flow measurement sheet);
- Calibration observations (ie, any complications, drifting, etc.);
- Field observations of watershed activities;
- Bank conditions;
- Remarks on any photographs taken; and
- Other pertinent information to assist in data interpretation.

Data Review and Management

The analytical results will be mailed to the Pima County Regional Flood Control District by the laboratory. RFCD staff will then forward the data results to the sampler, who will keep a copy on file. Results from the duplicate sample will be reviewed to test the validity of the sample results.

Water Quality Monitoring Management

Pima County RFCD personnel will oversee the overall management of the program and be responsible for fiscal activities. The following is a list of specific personnel and their tasks for this sampling program:

- Frank Postillion (Chief Hydrologist) – overall program manager

- David Scalero (Principal Hydrologist) – program oversight, data management, fiscal activities; assist with field activities when needed

Sampling Plan for Cienega Creek and Davidson Canyon
Health and Safety Plan

Health and Safety Considerations:

Concern	Hazard Potential	Precautions
Explosion	Low	Access to DAV1 site is by gas utility road. Line is examined by the utility; field personnel will avoid areas with evidence of gas leaks.
Oxygen deficiency	Low	
Radiation	Low	
Toxic gasses	Low	
Skin/Eye contact	Low	Unpreserved sample bottles; latex gloves will be worn during sampling.
Heat/Cold stress	Medium - High	Field personnel will carry water and take appropriate measures (wear sunscreen, hats, and sunglasses)
Falling objects	Low – Medium	Falling objects from canyon walls and railroad bridge. Field personnel will be aware of surroundings and will avoid crossing under railroad bridge when train is present.
Falls	Medium – High	Access to sites on foot could involve traversing steep and/or rough terrain. Field personnel will access sites using the safest routes possible.
Confined spaces	Low	
Mechanical	Low	
Electrical	Low	

Extra Precautions Taken by Field Crew:
Field personnel will carry a mobile phone while in the field. A first aid kit will be available in the vehicle.

Exposure to Harmful Compounds:
Surface waters in Cienega Creek and Davidson Canyon have shown no evidence of hazardous chemicals. Therefore, it is expected that hazardous compounds, if present, are al low concentrations and will not pose a health risk at exposure frequency and duration anticipated.

Nearest Hospital with Emergency Room:
Kino Community Hospital
2800 E. Ajo Way
Tucson

Directions: Interstate 10 west (towards Tucson) to Kino Blvd. exit; right onto Ajo Way; pass ballparks; hospital is just east of main TEP ballpark on the right side of Ajo Way.

Proccess for collecting surface water samples for Cienega Creek and Davidson Canyon:

Preparation:

1. Schedule sampling event (coordinate field crew, check weather, etc.)
2. Obtain sample bottles from laboratory and inform them of scheduled sampling date;
3. Assemble and check field equipment: WQ parameter meter, flow meter, beakers;

Sampling:

4. Calibrate WQ parameter meter (can be done in field or in office);
5. Select representative location along stream reach;
6. Measure WQ parameters: pH, temperature, electrical conductivity;
7. Measure streamflow;
8. Label sample bottles;
9. Collect water samples;
10. Complete field notes;
11. Complete chain of custody form;
12. Put samples on ice;
13. Repeat stems 5-12 at other site

After Sampling:

14. Deliver samples and chain of custody to laboratory;
15. Put field notes, a copy of chain of custody, and other pertinent information on file in office;
16. Calculate streamflow;
17. Clean and inspect field equipment;
18. Inform Pima County of any interesting observations or concerns.