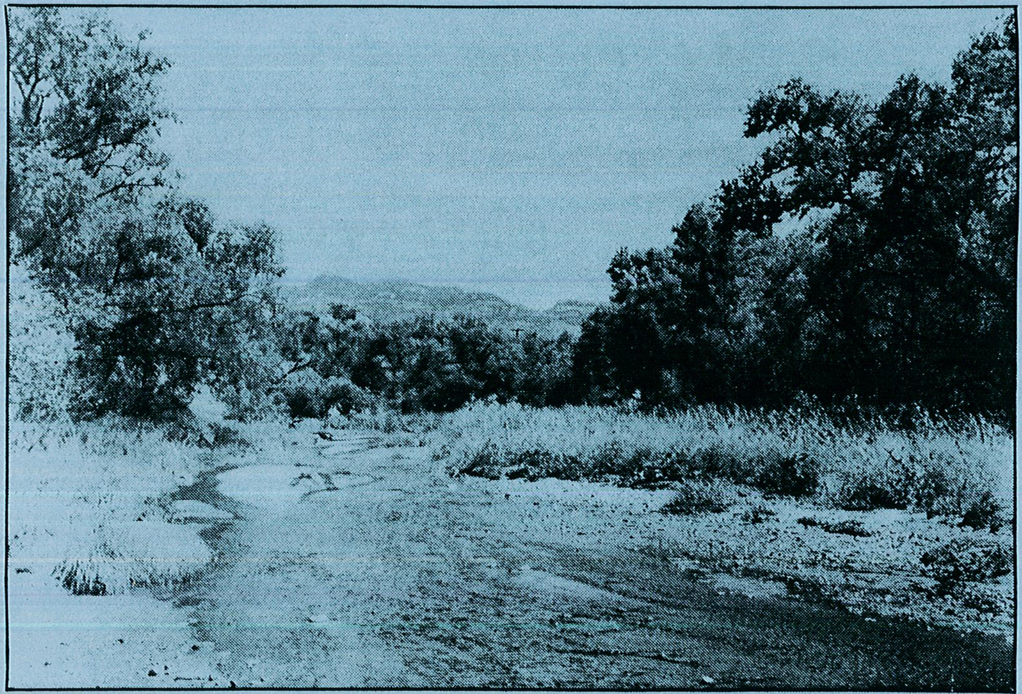
UNIQUE WATERS
FINAL NOMINATION REPORT
FOR
CIENEGA CREEK NATURAL PRESERVE
PIMA COUNTY, ARIZONA



Prepared for
Arizona Department of Environmental Quality
Water Quality Standards Unit

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EXECUTIVE SUMMARY

This report presents data supporting designation of a portion of Cienega Creek as a Unique Water of the State of Arizona. Cienega Creek is one of two remaining perennial streams in the Tucson area. In order to protect the stream, interagency water quality management studies were undertaken by Pima County Department of Transportation and Flood Control District, Pima Association of Governments and the Arizona Department of Environmental Quality to support a Unique Waters nomination. Unique Waters status offers additional water quality protection to the stream reach because only short-term waivers permitting water quality degradation may be permitted in surface waters which have been classified as Unique Waters or which have been proposed for classification as a Unique Water. Additionally, more stringent water quality standards may be set for Unique Waters.

In order to receive the Unique Waters designation, the stream segment must meet at least one of the following criteria:

1) outstanding public resource due to the surface water's geology, flora, fauna, size, archaeology, aesthetic value or wilderness characteristics (R18-11-108D.1)

2) essential habitat for species of national or state significance (R18-11-108D.2)

3) existing water is consistently better than state surface water quality criteria or the economic and technical capability exists for the surface water to exceed prescribed surface water quality criteria (R18-11-108D.3).

The nominated stream reach meets Unique Waters criteria because: 1) the water quality of the stream is consistently better than state standards, and 2) the reach is a rare ecological, recreational and educational resource within the Tucson metropolitan area. The nominated reach extends from a sub-surface dam structure located near Vail, Arizona, upstream to the Interstate Highway 10 bridge crossing. Studies conducted for the nomination included groundwater level monitoring, surface water discharge measurements, water quality analyses of surface water, groundwater and sediment, and preliminary land use and biological assessments.

Studies by other researchers, summarized in this report, indicate that the nominated reach is a rare ecological, recreational and educational resource. The stream reach supports 570 acres of mesquite and cottonwood-willow woodland and a population of native fish. The stream segment is one of only two public recreational areas near Tucson which offer lush riparian woodlands and year-round running water. The stream is also used for geological, ornithological and botanical research and education. At this time, it is not known whether the stream provides essential habitat for species of national or state significance. Future biological monitoring studies will determine whether federally or state-listed species are present.

Results of our studies show that the base flow water quality of the nominated stream is consistently better than state surface water quality standards. The base flows are sustained by discharges of a calcium-sulfate groundwater. Although existing water quality is good, existing and planned land uses have the potential to degrade both groundwater and surface water quality. The nominated reach is particularly vulnerable to water quality degradation due to proximity of a major interstate highway and two railroad corridors.

A water quality management plan has been developed to reduce the potential for pollution and to support the Unique Waters classification. The water quality management recommendations include mitigating the potential for highway spills to enter Cienega Creek, development of an emergency response plan for railroad spills, and protection of existing surface quality water uses.

CHAPTER I

INTRODUCTION

Unique Waters Program

On March 19, 1987, following Pima Association of Government's Regional Council recommendation, the Pima County Board of Supervisors (Board) requested that the Arizona Department of Environmental Quality (ADEQ) consider a portion of Cienega Creek for the State's Unique Waters designation. The Cienega Creek Natural Preserve contains one of Pima County's few perennial streams (Arizona State Parks, 1989).

The Unique Waters Program is administered by ADEQ to give selected surface waters special water quality protection under the State's antidegradation regulations. The designation provides that the high-quality waters will undergo no additional degradation, except as ADEQ may allow under a short-term waiver. In addition, more stringent site-specific water quality standards may be set. Current draft regulations require that the applicant demonstrate that the stream segment meets one of the three criteria discussed below (Appendix A).

The Board's primary intent in participating in the Unique Waters program is to protect the existing water quality of the Cienega Creek Natural Preserve (Preserve) from being degraded by human activities, a goal which is consistent with the federal Clean Water Act. Protecting water quality will benefit both the aquatic and nonaquatic life in the Preserve, as well as assuring continuation of a high-quality drinking water source derived from natural recharge to the Tucson basin aquifer.

Purpose and Organization

The purpose of this report is to demonstrate that Cienega Creek Natural Preserve meets at least one of the following Unique Waters nomination criteria:

1) outstanding public resource due to the surface water's geology, flora, fauna, size, archaeology, aesthetic value or wilderness characteristics (R18-11-108D.1)

2) essential habitat for species of national or state significance (R18-11-108D.2)

3) existing water is consistently better than state surface water quality criteria or the economic and technical capability exists for the surface water to exceed prescribed surface water quality criteria (R18-11-108D.3).

Chapter II of the report describes the study area. Chapters III and IV present water quality data for the nominated stream reach and compare the results to state standards, thus addressing criterion R18-11-108D.3. Chapter V addresses the public resource criterion (R-18-11-108D.1). Chapter VI describes the susceptibility of the stream reach to pollution as a basis for a water quality management plan. Chapter VII of the report includes a water quality management plan, even though a management plan is not required under ADEQ's proposed surface water quality standards rules. Cienega Creek is being considered in tandem with the surface water quality rule changes (see Appendix A).

The applicant has already submitted to ADEQ a preliminary management analysis showing that the nominated stream segment can be managed as a Unique Water (PCDOT, 1988). That analysis was undertaken to determine if there were any major obstacles to achieving the management criterion prior to committing agency resources to water quality sampling. The management criterion was mandatory under ADEQ's former surface water quality standards rules, which were in effect at the time the Board of Supervisors nominated Cienega Creek. Under proposed rules, the management criterion is deleted.

CHAPTER II

DESCRIPTION OF STUDY AREA

Location

The Cienega Creek Natural Preserve is located in Pima County, 25 miles southeast of Tucson, Arizona (Figure II-1). The Preserve lies upstream of the community of Vail at Colossal Cave Road and downstream of the Interstate 10/Cienega Creek bridge (Figure II-2). Marsh Station Road and the Southern Pacific Railroad bisect the Preserve. The stream segment nominated for Unique Waters designation is contained within the Pima County Flood Control District's Cienega Creek Natural Preserve. The segment extends 9.5 channel miles from the Interstate Highway 10 bridge crossing downstream to a subsurface dam in Section 14, Township 16 South, Range 16 East. The reach includes a spring in Section 34, Township 16 South, Range 17 East.

Watershed Characteristics

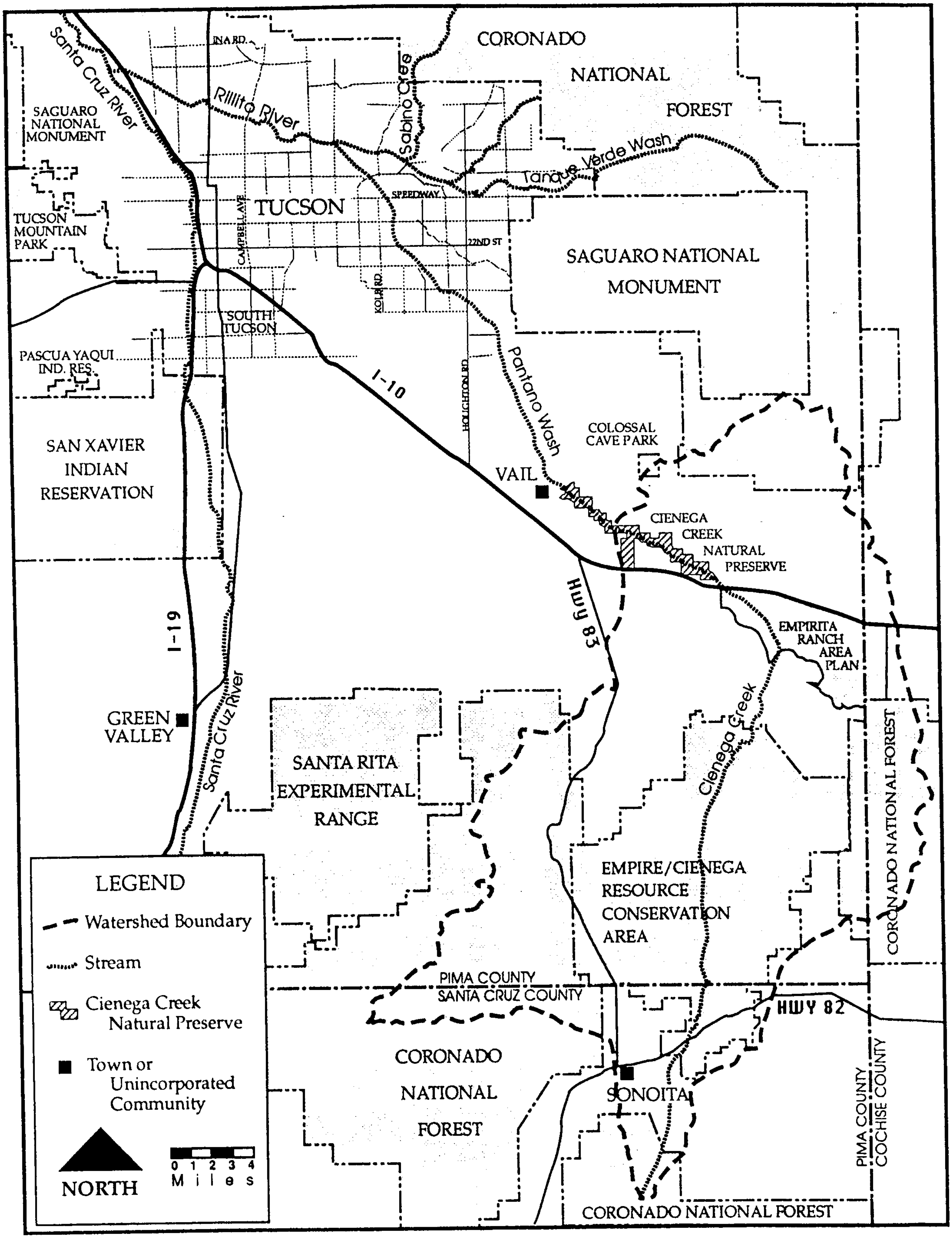
Cienega Creek collects runoff from mountain and valley terrain typical of the Basin and Range Province of southeastern Arizona. Elevations in the watershed vary from as much as 9,453 feet in the Santa Rita Mountains to 3,200 feet at the dam. Watershed area upstream of the dam is 457 square miles (Figure II-1). The Cienega Creek watershed is tributary to the Santa Cruz River via Rillito Creek and Pantano Wash.

The Cienega Creek groundwater basin upgradient from the nominated reach is smaller in area than the watershed contributing surface water runoff to the nominated reach (Figure II-3). This is because much of the watershed consists of bedrock. Basin fill alluvium, bounded by bedrock features, comprises the Cienega Creek groundwater basin (Kennard, et al., 1988). The Cienega Creek basin is subdivided at "The Narrows" into lower and upper sub-basins. The Narrows is located just upgradient of the 3900-foot groundwater contour of Figure II-3. The nominated stream segment lies in the lower sub-basin. Both the watershed of the nominated stream segment and the groundwater basin include areas within the Tucson Active Management Area (TAMA).

Upland vegetation, occurring on rolling hills above the Cienega Creek floodplain, consists of Sonoran desertscrub, Chihuahuan desertscrub and semi-desert grassland with pine and oak woodland in the upper portions of the watershed. Information regarding upland vegetation in the study area is found in Bergthold and others (1978) and Smith and Unangst (1987). Riparian vegetation is discussed in Chapter V.

Climate

Average annual precipitation in the Cienega Creek watershed ranges from 12 to 30 inches. The higher amounts of precipitation correlate with the higher elevations of the Santa Rita Mountains, while lesser rainfall amounts characterize the Preserve. Average monthly temperatures in the Preserve vary seasonally from 45 °F in January to 80 °F in July (Sellers et al., 1985).



Location Map

Figure II - 1

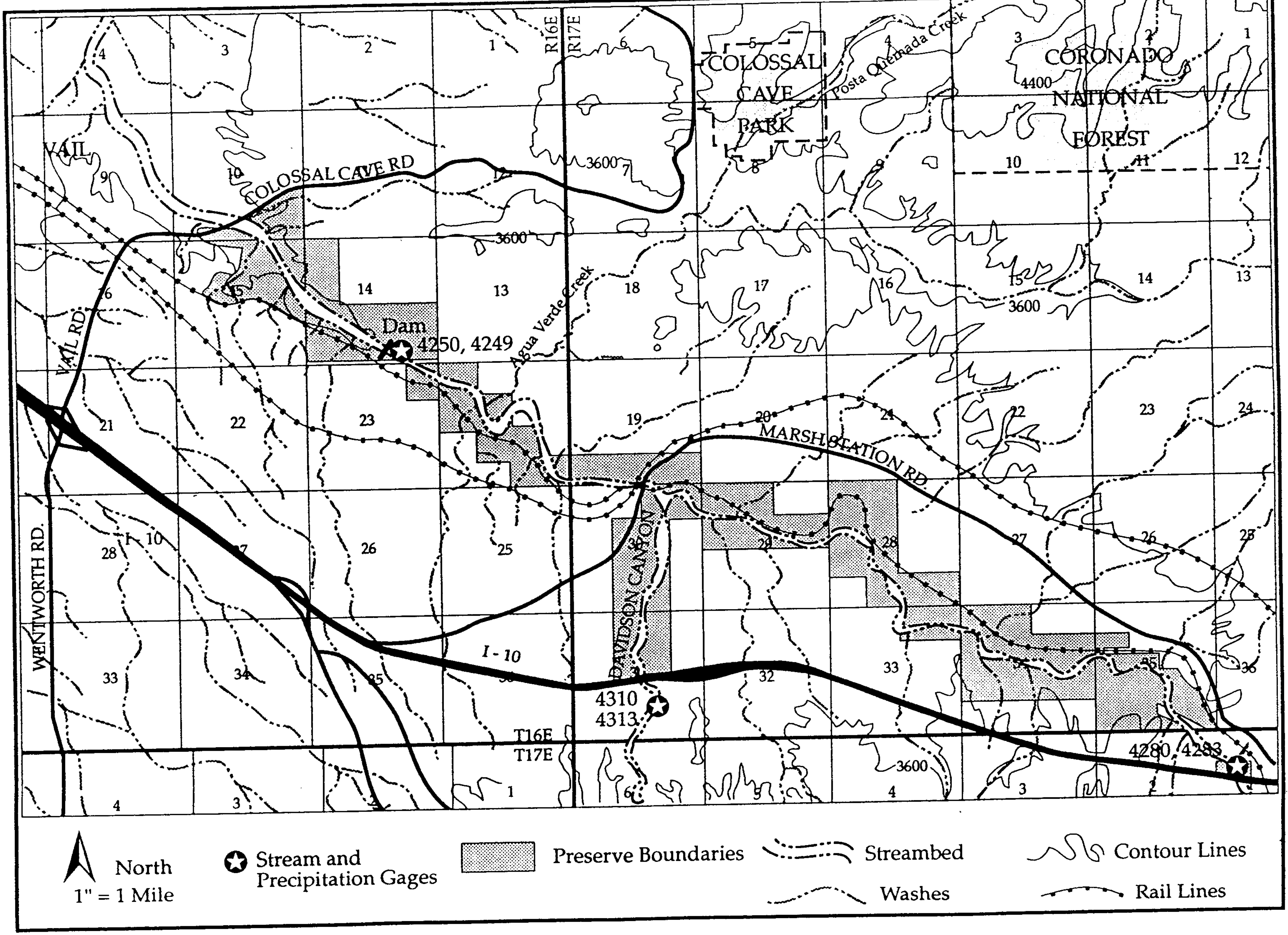
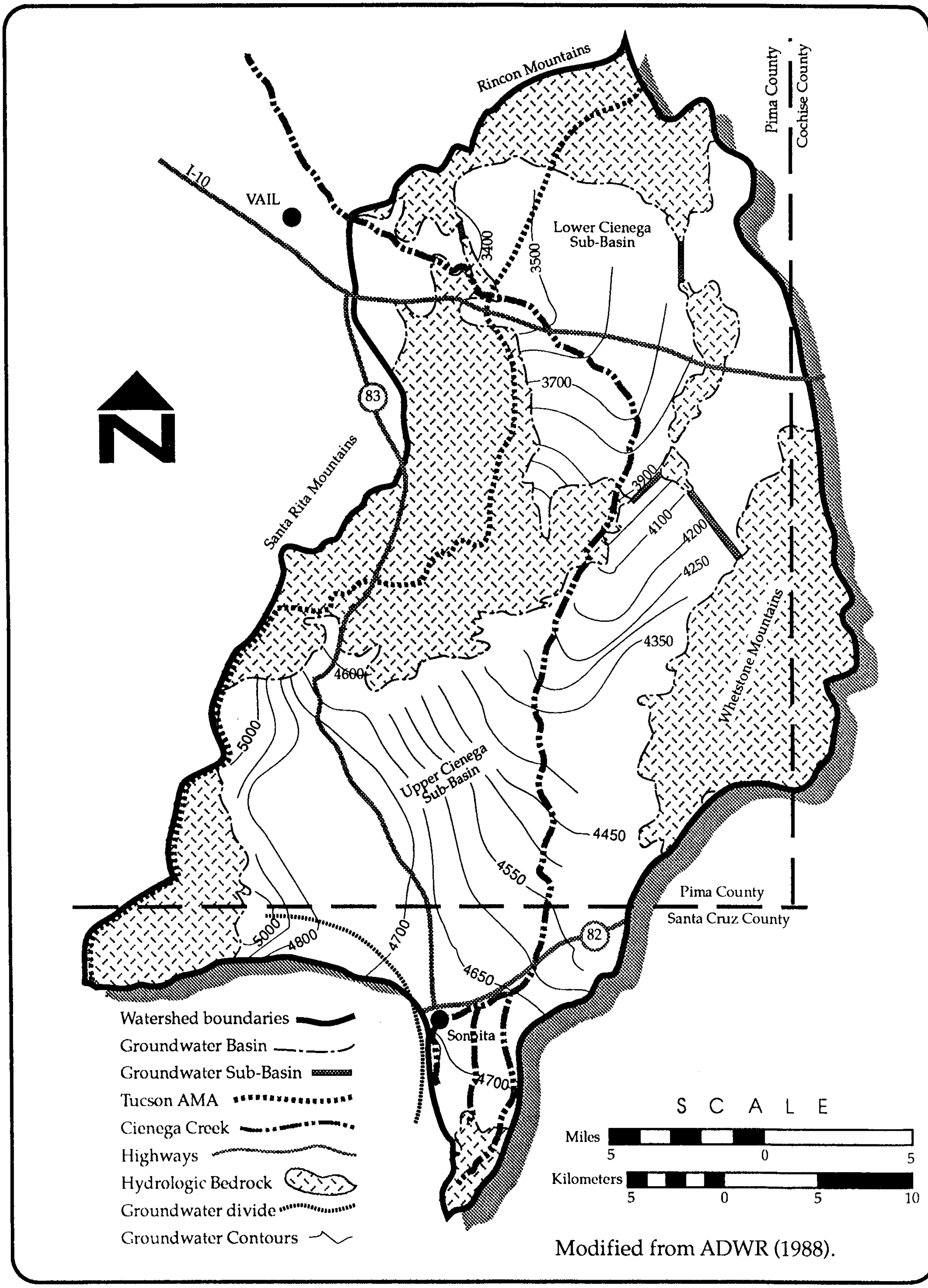


Figure II - 2 CIENEGA CREEK NATURAL PRESERVE



Cienega Creek Watershed

Figure II - 3

Precipitation is bimodally distributed in the Preserve with the majority of rainfall occurring in the summer (July, August and September) and fall/winter months (October to January). Average rainfall is 14 inches within the Preserve (Sellers and Hill, 1974). Rainfall measured at Pima County precipitation stations in and near the Preserve was 16 inches in 1988 and an average of 6 inches in 1989 (Figure II-2 and Table II-1).

TABLE II-1

PRECIPITATION IN LOWER CIENEGA CREEK WATERSHED[1]

Year	1988	1989	1989	1989	1990	1990	1990
Gage	4310	4250	4280	4310	4250	4280	4310
Month							
January	1.26	0.00	0.67	1.26	0.71	0.67	1.10
February	0.44	0.00	0.20	0.32	1.02	1.10	1.93
March	0.28	0.08	0.87	1.18	0.24	0.08	0.59
April	1.45	0.00	0.00	0.00	0.08	0.12	0.12
May	0.00	0.00	0.43	0.28	0.04	0.04	0.12
June	0.52	0.00	0.00	0.00	0.00	0.00	0.08
July	3.47	1.30	2.33	0.56	6.04	6.38	6.42
August	3.32	0.56	1.38	0.16			
September	0.83	0.31	1.02	0.16			
October	2.67	1.46	2.05	0.36			
November	1.49	0.12	0.08	0.12			
December	0.24	0.47	0.12	0.35			
	15.97	4.30	9.15	4.75			

[1]All values reported in inches.

Surface Water Hydrology

Historically, the entire length of Cienega Creek was a cienega (marsh) characterized by year-round water (Hendrickson and Minckley, 1985).

Arroyo-cutting along Cienega Creek began in the 1880's (Smith, 1910; Vail, n.d) eventually resulting in a channel incised 10 to 25 feet into the former floodplain. The incision led to a lowering of the water table, as evidenced by the elevation of present-day groundwater discharges compared to former cienega and stream locations ((U.S. General Land Office, 1874) and the almost complete disappearance of discharging springs that were noted by historic accounts (Potter, 1902; Vail, n.d.). Topographic surveys indicate that the channel had assumed dimensions similar to today's by 1936 (Soil Conservation Service, 1936). Over an a arroyo-cutting period no longer than 56 years, a minimum of 4,000,000 tons of sediment was removed from the study reach.

The draining of the cienegas and incision of the former floodplain undoubtedly had profound effects upon flood hydrographs along the stream. A large amount of natural flood storage capacity was lost when the floodplain was narrowed by incision, resulting in flashier storm discharges and higher flood peaks.

Today the only perennial reaches are within the Preserve and at he Narrows. The nominated stream segment is characterized primarily by perennial stream flow, interrupted by short reaches of intermittent or ephemeral stream flow. In general, stream flow is perennial where the volume of young alluvium is restricted by the hydrogeologic bedrock. Where the width or depth of young alluvium increases, stream flow may be intermittent or ephemeral.

Stream flows consist of base and storm flows. Base flows are produced by discharges from the groundwater aquifer, while storm flows result from precipitation and runoff. Pima County maintains stream and precipitation gages on Cienega Creek at the upper and lower ends of the nominated reach (Figure II-2). Gage 4249 is a float-type sensor is located in D-16-16-14dca, just upstream of an at-grade dam. Upstream gage 4283 is a pressure transducer located in D-16-17-35bca. These gages do not typically measure base flows.

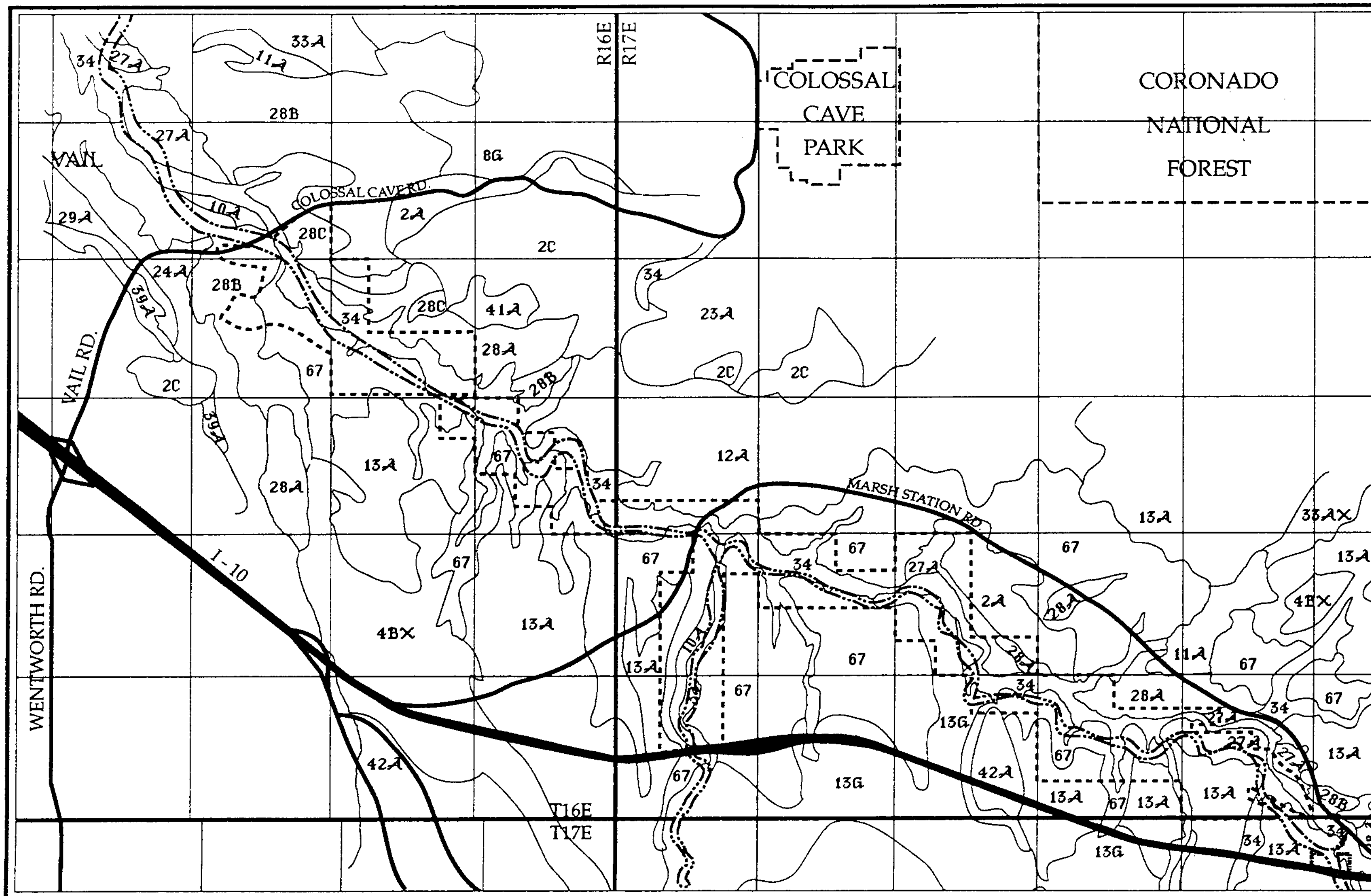
Storm flows follow seasonal precipitation patterns. Historic floods along the Cienega Creek correspond with summer thunderstorms during late June through September and tropical disturbances in September and October. The greatest flood of record occurred on August 11, 1958. The estimated flow of 38,000 cubic feet per second (cfs) is based upon high-water marks at the Vail United States Geological Survey (USGS) gage site (D-16-16-14dca).

Major tributaries to the nominated segment are Davidson Canyon, which enters Cienega Creek in Township 16 South, Range 16 East, Section 30 and Agua Verde Creek, which joins Cienega Creek in Township 16 South, Range 16 East, Section 24 (Figure II-2). Davidson Canyon is gaged at location D-16-17-31dcb with a precipitation gage (4310) and a float sensor (4313) in a stilling well.

Geomorphology and Soils

The stream regime and water quality are affected by the geomorphology and geologic history of the area surrounding the stream. The Cienega Creek floodplain defines the most recent areas of erosion and deposition (Figure II-4). At the same time the Creek cuts through the older soil deposits which are briefly summarized below in Table II-2. This geologic perspective is important to understand in that it provides the context which affects possible transmissivity of pollutants, rate of permeability of surface water to groundwater, and potential sediment hazards to the stream.

The soils of the Preserve exhibiting calcium carbonate accumulations (caliche) are the Anklam-Pantano Complex, Pantano Rock Outcrop Complex, Pinaleno-Nickel Complex, and Pinaleno-Nickel-Palos Verdes Complex.



UNIT #	SOIL NAME
2A	Anklam-Pantano Complex
2C	Pantano-Rock Outcrop Complex
4BX	Sasabe-Caralampi Complex
7A	Cave gravelly fine sandy loam
10A	Tanque
11A	Continental gravelly loam
13A	Powerline-Monterosa Complex
13G	Deloro-Rock Complex
13H	Deloro-Andrada Complex
27A	Riveroad & Tierranegre
28A	Pinaleno very sandy loam
28B	Pinaleno-Nickel Complex
28C	Pinaleno-Nickel-Palos Verd. Complex
33AX	Diaspar sandy loam
34	Arizo-Riverwash Complex
39A	Riggs clay loam
41A	St. Thomas-Rock Outcrop Complex
42A	Nolam-Gallen Complex
67	Redington

North

Cienega Creek Natural Preserve Boundaries

13H Soil Unit

Streambed

SOURCE: Adapted From Soil Conservation Service Maps (1985) on USGS 7.5 Minute Quads.

FIGURE II - 4 SOIL MAP

TABLE II-2

SOILS IN CIENEGA CREEK NATURAL PRESERVE

Unit No.	2A	2C	10A	13A	13G
Soil Name	Anklam-Pantano Complex	Pantano-Rock Outcrop Complex	Tanque	Powerline-Monterosa Comp.	Deloro-Rock Complex
Slope	5-25%	25-60%	0-2%	10-35%	15-60%
Location	Rolling to hilly peds.	Steep hills to to mtn. slopes	Instream & fan terraces	Hillslopes of old alluvium	Steep hillsides to mountain slopes
Soil Order	Haplargids and Calciorthids	Calciorthids	N/A	N/A	N/A
Texture 1	Ank: grv-sl	Pan: grx-l	sl	Pow: grv-sl	Del: chx-l
Texture 2	Pan: grx-l	Rock: rock	gr-cos;gr-l-cos	Mon: grx-l	Roc: rock outcrop
Depth	Shallow	Shallow	Deep	Mod. deep	Shallow
Drainage	Well	Well	Excessive	Well	Well
Permeab.	Mod. Slow	Moderate	Rapid	Moderate	Slow
Erosion	Slight	Slight	Slight	Slight	Slight
Flooding	None	None	None-rare	None	None

Unit No.	27A	28B	28C	34	67
Soil Name	River Road & Tierranegre	Pinaleno-Nickel Comp.	Pinaleno-Nickel-Palos Verd. Comp.	Arizo-Riverwash Complex	Redington
Slope	0-2%	5-16%	10-35%	0-2%	30-55%
Location	Level low	Strong. sloping	Fan & stream	Floodplains &	Steep val.
walls &	fan terraces stream terraces	Terraces	channel bottoms	terrace escarp.	
Soil Order	Camborthids Calciorthids	Haplargids and orthids, Duragids	Haplargids,Calci-	Torriorthent	N/A
Texture 1	Riv: cl	Pin: cov-sl	Pin: cov-sl	Ari: f-sl	cov-ls
Texture 2	Tie: l,sl	Nic: grv-sl	Nic: grv-sl	Riv: s, si, gr	gr-ls, s
Depth	Deep	Deep	Deep	Deep	Shallow
Drainage	Well	Well	Well	Excessive	Excessive
Permeab.	Mod.-Mod.Slow	Mod. slow	Mod. slow	Very Rapid	Rapid
Erosion	High	Slight	Slight	Very High	Severe
Flooding	None-Rare?	None	None	Frequent, brief	None

Note: Complex groups have Texture 1 & 2 divided between the two main soils in the complex, while a single soil has surface and subsurface textures corresponding to 1 & 2.

TABLE II-2 (Continued)

Soil Definitions

Soil Orders, Suborders

Haplargids	-	Typical Aridisol with argillic (clay) horizon.
Durargids	-	Aridisol (arid desert soils) with argillic horizon and cemented layer.
Calciorthids	-	Aridisol without argillic horizon but with CaCO3 present.
Camborthids	-	Aridisol without argillic layer but with incompletely weathered layer of primary minerals
Torriorthent	-	Typical entisol (undeveloped or little profile development) in a torric (hot and dry) moisture regime.

Texture Key

gr = gravelly; rock fragments 2mm - 3 inches in diameter
s = sand; rock or mineral fragments .05 - 2mm in dia.
si = silt; mineral particles .002 - .05mm in dia.
c = clay; mineral particles < .002 in dia.
l = loam; soil with 7-28% clay, 22-52% sand and 30-50% silt
v = very
x = extremely
co = coarse
f = fine
ch = channery

Interpretation Key

Depth	-	depth to bedrock.
Very shallow	-	5 to 10 (inches)
Shallow	-	5,10 to 20,30
Mod. shallow	-	20 to 50
Mod. deep	-	>20 to 50
Deep	-	<60
Very deep	-	>60

Drainage

Well - Water is removed readily but not rapidly; textures from fine sandy loam to silt.
Excessive - water is removed rapidly; sand or similarly porous.

TABLE II-2 (Continued)

Soil Definitions

Permeability Class Ranges

Very slow	-	< 0.06 (in inches per hour)
Slow	-	0.06 to 0.2
Mod. slow	-	0.2 to 0.6
Moderate	-	0.6 to 2.0
Mod. rapid	-	2.0 to 6.0
Rapid	-	6.0 to 20
Very rapid	-	> 20

Erosion Potential: Related to Universal Soil Loss Equation (USLE) and susceptibility of soil to accelerated erosion resulting from disturbance of vegetation. Texture, length and degree of slope are primary factors.

Flooding Hazard:
None - no reasonable possibility
Rare - unlikely but possible
Frequent - more often than once in 2 years
Brief - 2 to 7 days duration of flood

(Adapted from Soil Conservation Service, 1985)

CHAPTER III

METHODS

Surface Water Sampling

A sampling plan was developed and implemented by technical staff from Pima County Department of Transportation and Flood Control District (PCDOT), Arizona Department of Environmental Quality (ADEQ), and Pima Association of Governments (PAG). Pima County Wastewater Management Department also participated in early discussions. This chapter describes the plan.

The purpose of the surface-water sampling plan was to guide the collection of data to determine whether baseline water quality conditions are consistently better than state surface water quality criteria (Unique Waters Criterion R18-11-108D.3). The sample plan also details the sampling rationale behind the type, frequency, location and duration of sampling. Under such a plan, constituents present in the water are evaluated for probable source and quality assurance/quality control during the sample collection in the field and in laboratory analyses. From the analytical results, a measure of the magnitude of constituents was estimated to help assess water quality standard exceedances and create new limits for existing or proposed protected uses. Table III-1 summarizes the type, frequency, duration, and location of samples that were taken.

TABLE III-1

WATER QUALITY
LABORATORY ANALYSES SCHEDULE

LOW FLOWS

Three locations (SC-7, SC-8, SC-9), Sampled in May, July, September, November 1989, January, March 1990:

NUTRIENTS (total only)
Phosphorus
Total Kjeldahl Nitrogen
Total Nitrogen (Nitrate and Nitrite)

MAJOR IONS (total only)

Calcium	Magnesium
Sodium	Potassium
Carbonate	Bicarbonate
Sulfate	Chloride
Fluoride	Hydroxide

TRACE SUBSTANCES (total and dissolved)

Arsenic	Nickel
Boron	Thallium
Cadmium	Beryllium
Chromium	Antimony
Copper	Barium
Lead	Strontium
Manganese	Mercury
Selenium	Silver
Zinc	Iron

MISCELLANEOUS
Hardness
Turbidity
Total Suspended Solids
Total Dissolved Solids
Alkalinity (total and phenol.)

BIOLOGICAL (July, November, March only)
Fecal coliform
Fecal streptococcus

TABLE III-1

WATER QUALITY
LABORATORY ANALYSES
(Continued)

Site SC-7 low flow, September (combined w/one of bi-monthly samples):

Purgeable halocarbons (EPA Method 601)
Total cyanide
Phenols (EPA Method 420.1)
Total sulfides

Middle (SC-7) or upstream site (SC-8) low flow, one time, to coincide with cattle and human use (combined w/one of regularly scheduled bi-monthly samples):

Giardia & other parasites
Human enteric viruses

HIGH FLOWS

Site in (D-16-16-10dcb), at least one event

Nutrients
Major ions
Trace substances (total & dissolved)
Biological
Miscellaneous

SEDIMENT

Sites in (D-17-17-1)

Antimony	Arsenic
Beryllium	Cadmium
Chromium	Copper
Lead	Mercury
Nickel	Selenium
Silver	Thallium
Zinc	

Sampling Plan

The sampling plan emphasized obtaining data for the constituents of low flows in the perennial stream segments of the Cienega Creek Natural Preserve (base flows). The bias towards base-flow water quality protection was chosen for the following reasons:

1) existing aquatic life is dependent on perennial base flows;

2) perennial stream flow in a low desert riparian area is a rare natural resource in Pima County;

3) future land uses, including recreation, have the potential to degrade base flows (Pima County Department of Transportation and Flood Control District, 1988); and

4) the base flow has a low pollution attenuation potential.

One storm flow was to be sampled. Storm-flow sampling was considered desirable to examine how concentrations of constituents vary with discharge change. Since base flows were thought to represent discharges of groundwater, it was expected that storm-flow quality would be distinctly different than base flow water quality.

Safety considerations dictated that storm flow samples be taken at somewhat different locations than the base-flow samples. Potential sampling locations included the Interstate Highway 10 bridge at Cienega Creek (D-17-17-1bca), the Interstate Highway 10 bridge at Davidson Canyon (D-16-17-31dcb), the Marsh Station Road bridge at Cienega Creek (D-16-17-19dcc), or the Colossal Cave Road bridge at Pantano Wash (D-16-16-10dcb). The type of sample was to be a grab sample of flow and sediment. An estimate of the discharge and sampling time relative to the hydrograph was to be obtained from stream flow gage records.

Emphasis was given to sampling at Colossal Cave Road bridge in order to analyze the largest possible contributing watershed. However, it was thought possible that the stream flow may infiltrate upstream of this location, in which case a site upstream would be chosen. Another constraint was the length of available cables or ropes. The Marsh Station Road bridge, for instance, would require at least 70 feet of cable.

Locations

ADEQ began monitoring water quality on Cienega Creek at Marsh Station Road on October 15, 1987. Additional sampling sites were chosen to assess variation of water quality along the nominated stream segment.

The upstream sampling location is within the bedrock walls of the channel and lies at an elevation of 3480 feet above sea level at D-16-17-34add (ADEQ Station SC-8). It was chosen for the following reasons (Figure III-1):

1) bedrock walls and floor provides a stable cross-section for measurement of base flows;

2) perennial stream flow begins near this location; and

3) because of its proximity to the upstream proposed Empirita Ranch development, water quality impacts due to reduction in stream flow or future effluent discharges might be evident here before other locations.

An intermediate sampling location is just upstream of the Marsh Station Road bridge crossing of Cienega Creek and lies at an elevation of 3300 feet above sea level at location D-16-17-19dcc (Figure III-1, ADEQ Station SC-7). This site was chosen for the following reasons:

1) established Arizona Department of Environmental Quality sampling point with historic data;

2) bedrock walls present in most places, providing a relatively stable cross-section;

3) downstream of a tributary, Davidson Canyon, along which land uses might be contributing pollutants;

4) lower end of the primary perennial stream reach; and

5) site is grazed by livestock and attracts more people than the other sites due to its proximity to Marsh Station Road.

The downstream sampling site is adjacent to a bend in the Southern Pacific Railroad. The elevation above sea level at the site is 3220 feet at location D-16-16-24bbc (Figure III-1; ADEQ Station SC-9). The site was chosen for the following reasons:

1) downstream of a tributary, Agua Verde Creek, along which land uses might be contributing pollutants;

2) site is perennial or possibly intermittent. Based on field inspection, it was believed to have a wider variation in base-flow discharge than the other two sites; and

3) site was needed to support extension of the unique waters stream reach downstream of Marsh Station Road.

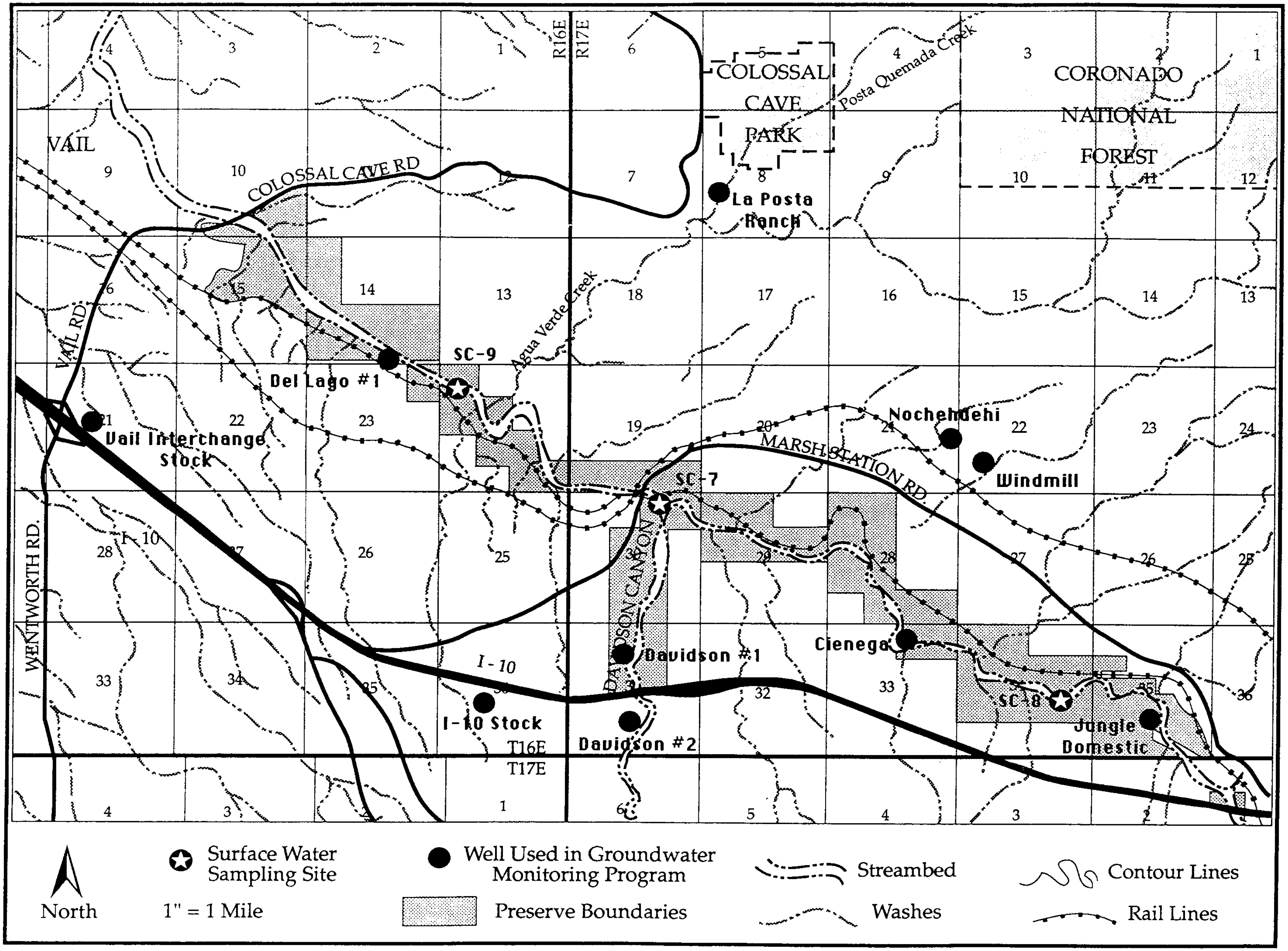


Figure III-1 MONITORING SITES

Duration

The duration of the surface-water sampling plan was one year from the time of the first concurrent sampling of all three sites, which was May 23, 1989. A duration of one year was chosen for the following reasons:

1) financial and personnel resources of the participants were limited;

2) natural variations in discharge, temperature and plant growth occur on an annual cycle;

3) because base flows are derived from groundwater forced upward by impermeable rock strata, the water quality of the base flows is expected to change more from season to season than from year-to-year, assuming no changes in land uses and climate;

4) some existing land uses (grazing, recreation) vary on an annual basis; and

5) preliminary data indicated low variability in water quality over time the year.

The sampling period for storm flows was extended into summer 1990 due to the lack of sustained storm flows in 1989.

Constituents

Constituent analyses were chosen for either one of two reasons: to determine compliance with existing water quality standards, or to provide baseline data against which future water quality results may be compared. Constituent choice was also guided by the types of constituents associated with the identified land-uses in the study area, and in up-gradient areas. Existing and future land uses have been previously described in the Preliminary Management Analysis (PCDOT, 1988).

Frequency

All three base flow sampling sites were sampled once every two months (bi-monthly). For efficiency and ease of comparison, all three sites were sampled on the same day. A bi-monthly sampling frequency was chosen for the following reasons:

1) financial and personnel resources of the participants were limited; and

2) a frequency of at least once every two months was necessary to discern water quality changes due to seasonal variations in discharge, leaf fall, grazing, and recreation use.

One of the sampling periods was chosen to coincide with a livestock grazing period.

Methods

Samples were collected at each site according to the procedures described in Section 10 of ADEQ's <u>Quality Assurance Project Plan December 1988</u> and the U.S.G.S. <u>Field Guidelines for Collection and Treatment and Analysis of Water Samples, Arizona District</u> by L. R. Kister and W. B. Garrett, Nov. 1984. Inorganic chemsets supplied by the laboratory were used for transporting the samples. A churn-splitter was used for all width-integrated composite sampling beginning with the September 24, 1989 sampling period. Sterile plastic bags preserved with sodium thiosulfate were used to collect bacteria samples. Observations of weather, degree of algal and plant growth, substrate and floodplain conditions, and type of aquatic life were recorded. Personnel made field measurements of temperature (water and air), pH, flow, dissolved oxygen and percent saturation, and electrical conductivity corrected to 25° Centigrade. In situations where poorly mixed waters were suspected, an electrical conductivity transect across the stream was used to determine the degree of mixing. Flow was measured using a Marsh-McBirney flowmeter and a measuring tape stretched across the stream flow. No corrections for tape sag were applied due to the narrow stream width. Data was recorded in field books. Photos were taken of the sites each time they were sampled. Simple calculations were done in the field, and the rest were done upon return to the office.

Aquatic Life Sampling

As a contingency plan, in the event that sediment or water quality analyses indicate that unusual types and concentrations of organic or other compounds were present, provision was made to include aquatic life sampling. Another contingency which could have triggered aquatic life sampling was if a toxic materials spill occurred during the study period. This contingency was not invoked.

During the course of the sampling program, ADEQ became interested in the information available through biological assessments. To document some baseline conditions for the present aquatic uses of the stream, aquatic invertebrates were collected from sites SC-7 and SC-8 on May 2, 1990 and were identified by Jim Boggs, ADEQ Environmental Health Specialist I, and Carl Olson, Associate Curator of Entomology, Museum of Natural History, University of Arizona.

Aquatic organisms (macroinvertebrates and fish) were surveyed from Cienega Creek at Marsh Station Road and at a site near Vail. Organisms were qualitatively collected using an aquatic kick net by disturbing substrate (ie. gravel, sand, leaves, decaying organic matter) from all habitat types (ie. riffles, runs, pools, instream vegetation) present. Specimens were immediately preserved in 70 percent ethanol for subsequent identification to the lowest taxonomic level possible (usually family). Identification was performed with the assistance of Carl Olson. Collected specimens are archived at the Museum of Natural History.

Sediment Sampling

A sample of sediment from Cienega Creek located downstream of Interstate Highway 10 (D-17-17-1bca) was to be analyzed for lead. The purpose of this analysis was to determine the contribution of roadways to pollution via deposition of aerosols. Upon further discussion with ADEQ, the sample purpose changed to test the contribution of roadway runoff from trucking accidents to water pollution, since some concern existed about the higher number of spills that could have degraded water quality. The emphasis was placed upon analysis of priority pollutant metals in fine-grained surficial sediments. The transect approximately 50 feet downstream of the bridge including sampling of fines located near the highway runoff outfalls. For comparative purposes, an upstream transect site was selected 1200 feet from the bridge to reflect background conditions.

Sediment sampling for organics was suggested by ADEQ, but was not undertaken because it was thought that sampling the "first flush" of roadway pollutants would be difficult logistically due to the personnel travel time involved. Major flows would tend to transport roadway pollutants away from the bridge, and gentle rains would tend to cause the pollutants to infiltrate. Instead, groundwater sample analyses would be tested for organic constituents; the results would indicate if organic pollutants had infiltrated into the channel bed aquifer.

The sampling plan included additional sediment sampling, if during the one-year sampling period a spill of toxic materials were to occur within the immediate area.

Groundwater Sampling

A groundwater monitoring plan was developed and implemented for the Cienega Creek Natural Preserve by PAG. PCDOT provided final review and approval of the groundwater quality and groundwater level monitoring plan.

The plan's goals and objectives were to:

1) develop baseline groundwater data within the Preserve;

2) determine if groundwater/surface water interactions occur;

3) complement the Empirita Ranch Groundwater Monitoring Program;

4) document seasonal variations from land uses and climate;

5) determine if groundwater parameters exceeded drinking water standards and potential contamination sources.

Sampling Plan

Locations

Figure III-1 shows the two sites sampled within Cienega Creek Natural Preserve which both met the monitoring plan's goals and objectives. These well sites were also selected on the basis of well construction data and the locations of the surface water sampling sites. Historical groundwater quality data within the study area were also used to review potential sites. The historical groundwater quality information is discussed in Chapter IV.

Frequency and Duration

Wells were sampled once during the winter and once during the summer for a one year period to determine if any water quality seasonal fluctuations existed.

Constituents

Water quality parameters analyzed in the groundwater samples were the same as for the surface water samples (Table III-1) with the exception of the biological parameters for the high flow sampling period. Microbes were expected to be absent since percolating water is filtered through the vadose zone materials and thus were not included in the sampling plan.

Sample Methods

The same sample preservation techniques were used as in the surface water monitoring plan. A static groundwater level was first determined before water quality sampling began. All field equipment was calibrated and logged on a field sheet prior to pumping of the well.

Wells were pumped until the electrical conductivity, pH and temperature of the discharged water was constant, or until three to five well volumes could be obtained to ensure proper purging. Wells not equipped with pumps were sampled with a hand bailer or thief sampler when a portable pump was not available. Samples collected in this manner were noted in the results. Winter samples were collected by bailing and installing a pump. Del Lago Well #1 was collected with a bailer. Tucson Water provided personnel and equipment for this task. A private pump contractor installed a submersible pump at the Cienega well for winter and summer samples.

Groundwater Level Monitoring Plan

Locations

Figure III-1 shows sites used in the Cienega Creek Natural Preserve Groundwater Level Monitoring Program. Appendix B presents information on well locations and well construction. Historical groundwater level information within the study area is also contained on the table. This table was used in selecting the wells in the water level monitoring network. This information was developed from field surveys by PAG, ADWR and USGS well files.

Frequency and Duration

Groundwater level monitoring was conducted for one year. Measurements were collected at one month intervals during the first week of each month to be consistent with the Empirita Ranch Monitoring Program.

Measurement Procedure

The well was noted on a field form if it was unused for a sufficient period of time to allow well water to be at static level prior to measurement. An electric sounder was used to make the measurements.

Quality Assurance/Quality Control

Quality assurance/quality control procedures were developed by ADEQ (Woodwick, 1989). Using a random number generator, duplicate samples were selected to be taken at the farthest upstream surface-water site during the first and third visits. Duplicate samples were not selected for the other two surface-water sites. Obtaining two duplicates from a total of 18 samples equates to 11 percent duplication. A 10 percent duplication was considered to be adequate for quality control purposes. Duplicate samples were taken at SC-8 on May 23, 1989 and September 24, 1989, and at SC-7 on November 21, 1989. A blank was used on the September 24, 1989 sampling date.

Those parameters only sampled once (purgeable halocarbons, phenols, and sulfides) were sampled at the time a duplicate was taken. Collection of duplicate samples during high-flow events was left at the discretion of the sampling team. No duplicates or blanks were planned for sediment sampling and groundwater sampling due to the small number of samples collected and the higher importance of quality assurance in the surface water monitoring collection.

Quality assurance of laboratory analyses was conducted according to procedures specified in Quality Assurance Program for Analytical Chemistry Services (ADHS) or Quality Assurance Plan Complete Analytical Services Provided for ADEQ-RFP #807 by Analytical Technologies, Inc.. Sample splits were labeled without a time or place so that the laboratory did not know which site was so treated.

Sample contamination by transport was checked by carrying a blank with the purgeable halocarbon samples. No travel blanks were used for inorganics and metals samples. Samples were usually transported to the laboratory via UPS or Greyhound. Chain-of-custody forms were used even though the samples were not being taken for enforcement purposes. Chain-of-custody forms documented the possession of samples from the time that they were collected until they were received by the laboratory. The holding times and preservation techniques used for all parameters were found in Standard Methods for Examination of Water and Wastewater 16th Edition (1985).

The data was checked using a LOTUS 1-2-3 spreadsheet developed by ADEQ. The spreadsheet performs the following checks:

1) compares field pH to laboratory pH;

2) compares field EC to laboratory EC;

3) calculates TDS/EC;

4) calculates evaporated TDS/calculated TDS (sum of cations and anions); and

5) calculates cation-anion balance.

An additional LOTUS 1-2-3 worksheet called "Perdiff.wk1" has been developed by ADEQ to compare split sample analyses. Whenever QA/QC measures indicated a problem, every effort was made to locate and correct the problem, including test reruns by the lab. Upon receipt of the laboratory results, PAG checked the accuracy of the data by: (1) comparing results to the previous analyses of the same or a similar sampling point; and (2) performed the same quality control checks.

Laboratory Selection

The primary laboratory selected for use was Analytical Technologies, Inc. located in Tempe, Arizona. The secondary laboratory selected was Arizona Department of Health Services, located in Phoenix, Arizona. ADEQ contracts both laboratories for analyses (contract number 6-C-1). Turner Laboratories in Tucson, Arizona was selected for analyses of sediment, high-flow, and groundwater samples on the basis of cost and convenience. All were state-certified laboratories.

Institutional Responsibilities

Pima County Department of Transportation and Flood Control District (PCDOT)

PCDOT was responsible for coordinating the sampling program. PCDOT personnel assisted ADEQ's Point Source and Monitoring Unit in base-flow sampling. PCDOT was to be responsible for obtaining, installing and maintaining automated high-flow samplers, if any were installed. PCDOT was responsible for collection and funding of analyses of high-flow event samples and sediment samples, and for funding of the groundwater samples. PCDOT maintained the stream and precipitation gages.

Arizona Department of Environmental Quality Point Source and Monitoring Unit (PSMU)

PSMU was responsible for sample collection and funding of base-flow, organics, viral/giardia, and aquatic life collection. PSMU would assist PCDOT personnel for sampling collection for high-flow samples and sediment samples, when possible. PSMU entered base-flow results in STORET and assisted in development of the sample plan. PSMU was responsible for implementing QA/QC procedures for surface-water samples. PSMU analyzed and interpreted the laboratory results, and informed program participants in any exceedances of standards.

Arizona Department of Environmental Quality Water Quality Standards Unit (WQSU)

WQSU supervised and coordinated the Unique Waters designation process. WQSU reviewed the nominated stream segment for the manageability criterion of the Unique Waters designation. WQSU developed the quality assurance/quality control procedures for the sampling plan and reviewed the water quality sampling plan results for adequacy.

Pima Association of Governments (PAG)

PAG was responsible for monthly monitoring of groundwater levels at three sites in the Preserve and other adjacent wells during the study period. In addition, PAG collected the groundwater samples and transported them to the laboratory. PAG reviewed the analytical results of groundwater, surface water and sediment analyses and advised PCDOT if any errors or potential errors existed.

CHAPTER IV

RESULTS

Surface Water

Surface Water Quality Standards

In order to meet criterion R18-11-108D.3 of the Unique Waters program (Appendix A), the nominated stream segment must meet or exceed or have the capability to meet or exceed state surface water quality standards.

The ADEQ develops surface water quality standards as required by the federal Clean Water Act and the State's Environmental Quality Act. Arizona surface water quality standards are currently being updated through the CWA triennial review process by ADEQ. However, ADEQ has directed that proposed standards will be applicable to the Cienega Creek Unique Waters Nomination.

Surface water standards for streams in Arizona are based on existing or attainable stream uses. Generally, the protected use having the highest susceptibility to a chemical has the most stringent standard for that pollutant.

Surface water quality parameters regulated in Arizona (Appendix C) are divided into several groups: physical (discharge, sediment, dissolved oxygen, and turbidity), inorganic (major ions, metals and nutrients), biologic (fecal coliform, fecal streptococci), and organic. Standards can be set for total or dissolved inorganic chemicals. Dissolved standards are more stringent because they do not include both the dissolved and undissolved components of the parameter.

Present surface water uses for the Cienega Creek Natural Preserve are Incidental Human Contact (IHC), Aquatic and Wildlife (A&W), Agricultural Livestock Watering (AgL), Drinking Water Source (DWS) and Full-Body Contact (FBC). The surface water use having the majority of most stringent parameters on Cienega Creek is Aquatic and Wildlife protection. Analytical results for each parameter grouping on Appendix C are discussed under "Quality" and compared to the applicable standards.

Surface-water quality results are summarized below for the sampling period May 23, 1989 to March 27. 1990, supplemented where possible with historic data.

Physical Parameters

The lowest measured base flow during the sampling period at SC-7 (Marsh Station Road) was 0.7 cfs on September 24, 1989 and July 25, 1989. Winter base flows ranged from 1.1 to 2.0 cfs. Measured base flows at SC-8 and SC-9 were lower, varying from a spring maximum of 0.6 cfs (SC-9 on March 27, 1989) to a minimum of 0.09 cfs (SC-9 on September 24, 1989, Appendix D).

Two historic samples taken during 1988 may be storm-flow related. The discharge value of 10.7 cfs measured on July 20, 1988 far exceeds base flow values. A second measurement, taken August 21, 1988, showed a discharge value in the range of normal base-flow values, but the water quality may have been influenced by storm flow on Davidson Canyon. A stream-flow gage at Davidson Canyon, approximately 2 miles upstream of SC-7, indicated that a stream flow occurred on the tributary during the night of August 20/21. Stream flow had waned to nongageable levels by 5:00 a.m. Stream flow again peaked and waned on Davidson Canyon four hours before a sample was collected at SC-7.

Figure IV-1 (in pocket) summarizes the extent of stream flow within the Cienega Creek Natural Preserve for the period 1974 to 1989. These observations are based upon inspection from aerial overflights and interpretation from aerial photographs and maps. Aerial photo interpretation and U.S.G.S. map information may be less reliable than the large-scale photographics collected by aerial overflights for Empirita Ranch Monitoring Program by Errol Montgomery and Associates (1985, 86, 87, 88, 89 and 90). Small-scale photographs are deemed less reliable than large-scale photographs.

In general, the stream is well-aerated, with supersaturated dissolved oxygen contents common much of the year (Appendix D). Dissolved oxygen content decrease below the standard of 6.0 mg/l after algae had been removed by summer storm flows, as occurred in the July 25, 1989 measurements at SC-7 and SC-9. Water temperature ranges between 10°C and 26°C for the study period. Water temperatures exceed air temperatures during the months of November through January. Air temperatures exceed water temperatures from February to October.

Results of the sediment analyses show that levels of cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc increased downstream of the Interstate 10 bridge over Cienega Creek relative to a site upstream of the bridge (Table IV-1). Antimony, arsenic, beryllium, and thallium registered no measurable change. In general, however, the results show no values above hazardous concentration levels. Copper, lead and zinc registered the highest concentrations of all metals sampled. Sources of copper, lead and zinc in urban runoff studied by Striegl (1987) originated primarily from traffic-related sources. The lack of mining, construction or other downstream sources to cause the differences between sampling sites suggests that highway runoff from motor vehicles is the likely source for increased levels of these metals.

Measured turbidities and total suspended solids (TSS) values for base flows were very low at all three sites, usually less than 1 NTU for turbidity and 5 mg/l for TSS. On July 20, 1988, turbidity was 526 NTU for a sample collected during the waning limb of a storm flow on Cienega Creek. The state standard is 50 NTU. The TSS value for this event was 2440 mg/l.

Electrical conductivity (EC) corrected to 25°C varied little between samples at a site. EC values were slightly lower and displayed less variability at SC-7, which also has a higher base flow discharge than the other two sites. Corrected field EC values from all three sites varied from 382 to 1026 umhos/cm^2 but generally varied between 900 and 1000 umhos/cm^2. Corrected field EC values dropped to 382 during the July 1988 storm flow event at SC-7. The low EC value corresponded to the highest flow rate (10.7 cfs), the lowest laboratory EC and the lowest levels of total dissolved solids. Laboratory EC values were generally higher than field EC values for all samples.

Measured field pH generally ranged between 7.5 and 8.5, well within state standards of 6.5 to 9.0. Laboratory pH varied between 8.0 and 8.3. The lowest measured field pH of 5.20 occurred on April 5, 1988 at SC-7 but corresponded to a laboratory pH of 8.1. This value may be the result of a faulty field meter. The cation-anion balance for this analysis is 16 percent. An acceptable error is 10 percent.

TABLE IV-1

SEDIMENT ANALYSIS RESULTS (6-18-89)
PRIORITY POLLUTANT METALS

	Locations			
Parameter	Downstream of I-10	Upstream of I-10	Percent Increase	ADEQ HGBL Guidelines
Antimony	<5.6	<5.6	0%	60
Arsenic	0.20	0.02	900%	1,000
Beryllium	<0.40	0.40	0%	0.14
Cadmium	1.16	0.60	93%	100
Chromium	3.30	1.70	94%	2,000
Copper	27.6	5.60	393%	26,000
Lead	24.3	7.00	247%	400
Mercury	0.24	0.18	33%	40
Nickel	7.90	5.00	58%	2,000
Selenium	0.05	0.04	25%	900
Silver	0.40	0.40	0%	1,000
Thallium	>2.2	>2.2	0%	10
Zinc	62.4	17.4	259%	100,000

All data reported in parts per million.

Inorganic Chemicals

Nutrient levels are below drinking water standards. Nitrogen (measured as $NO_2 + NO_3$) varied from a high value of 0.29 mg/l to below detection levels. Nitrogen levels were often higher at SC-8 than at other sites. Phosphorus and ammonia levels do not vary significantly between sites. There are currently no nutrient standards for protected uses on Cienega Creek.

Surface water at all three sites has a calcium-sulfate composition (Figure IV-2). Calcium ion concentrations from all sites were an average of 125 mg/l. Sulfate ion concentrations averaged 313 mg/l. The cause of the high sulfate levels is thought to be from dissolution of naturally occurring gypsum deposits in the Pantano Formation. Sodium and chloride concentrations increase slightly in a downstream direction. Fluoride levels are well below the drinking water standard of 4.0 mg/l.

SURFACE WATER QUALITY CHANGES IN CIENEGA CREEK NATURAL PRESERVE

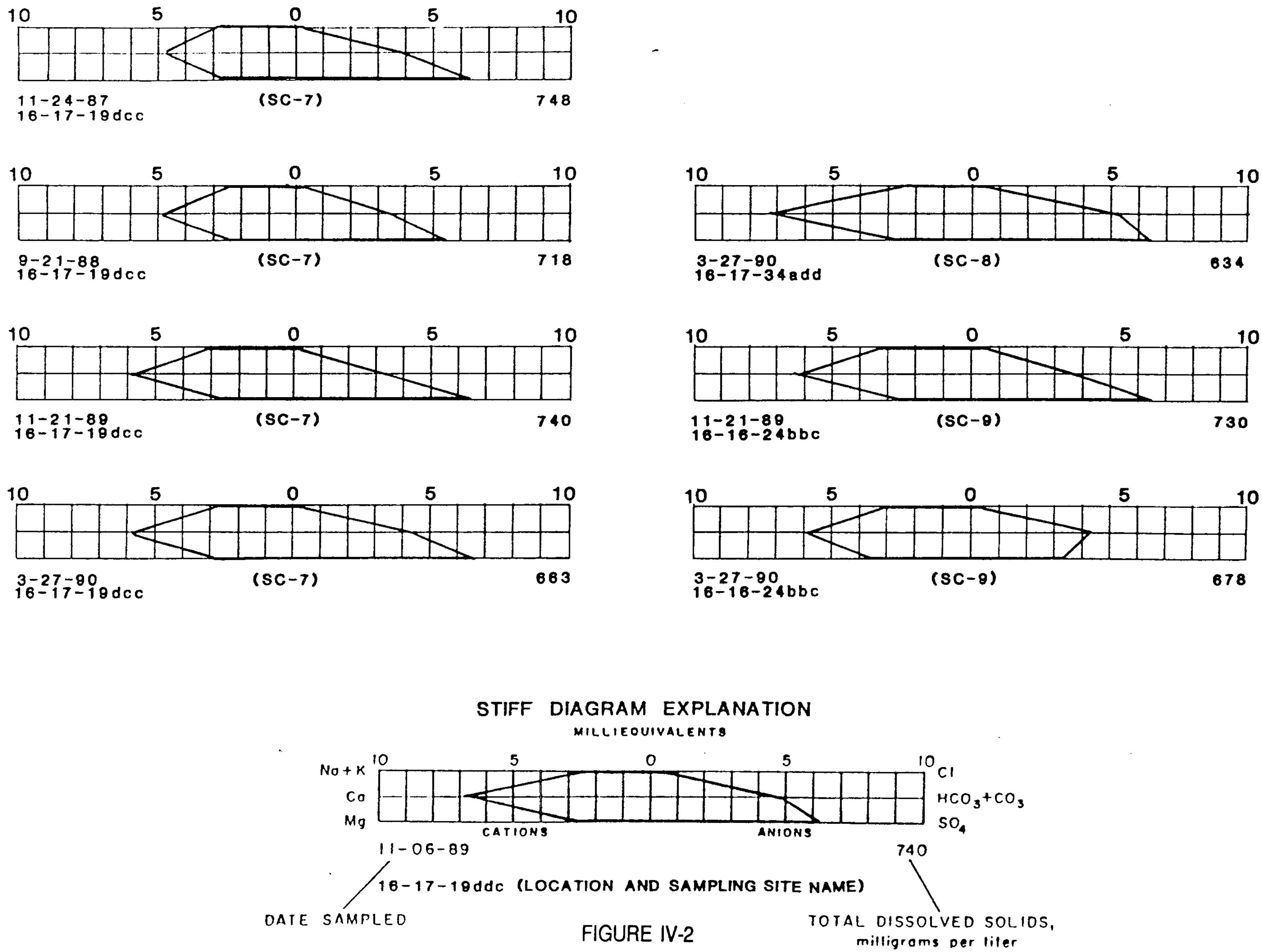


FIGURE IV-2

Calculated hardness is very hard, varying between 426 and 520 mg/l during the sampling period. The lowest hardness (319 mg/l) was measured from the storm flow discharge at SC-7 of July 20, 1988, but the cation-anion balance of 70.6 percent suggests that the value is not reliable.

Metals were uniformly low during the sampling period. No exceedances were indicated for metals during normal base flow conditions. Total arsenic, barium, chromium, copper, iron, manganese, and lead levels were elevated in the July 20, 1988, storm event, however the cation-anion balance of 70.6 percent suggests these values are not reliable.

Samples were taken at SC-7 for total and dissolved metals on September 24, 1989. Lab results indicated slightly higher values of barium, mercury and strontium in the dissolved sample due to a contaminated filter. A travel blank taken the same day did not show evidence for contamination by these metals. Total chromium in sample split dated November 21, 1989 was six times larger than the control sample.

Biological Constituents

Extremely high levels of fecal streptococcus were found for SC-7 in 1988 (Table IV-2). The low fecal coliform/fecal streptococcus ratio suggested a warm-blooded animal source rather than a domestic sewage source. Since it was known that approximately 90 cows had grazed the creek bottom upstream of SC-7 from March 12 to April 3 of that year, it was surmised that grazing as a source of bacteria should be further evaluated.

Samples taken November 21, 1989 indicated very low levels of bacteria. The quality control sample indicated no analytical problems existed.

Samples for fecal coliform and fecal streptococcus were collected at all three sites on July 25, 1989 and March 27, 1990. The July 25, 1989 samples showed high bacterial levels, particularly at SC-7. The highest value of 3000 colony-forming units per 100 milliliters (CFU/100 ml) does not exceed state standards for the proposed aquatic and wildlife uses. The ratio of fecal coliform to fecal streptococcus exceeds 2:1, indicating the potential for human contamination by sewage (Novotny and Chesters, 1981). The March 30 sampling followed a brief period of grazing upstream of SC-7 and SC-9, but downstream of SC-8. All March 1990 bacterial levels were lower than the July 1989 levels, and below single-sample state standards for fecal coliform. Paradoxically, bacterial levels at SC-8 (which is located upstream of the grazed area) were an order of magnitude higher than at downstream sites SC-7 and SC-9.

Since fecal streptococci analyses include several species and subspecies of bacteria other than enterococci, no assessment can be made of compliance with the proposed enterococci standard for full-body contact.

TABLE IV-2

BACTERIOLOGICAL DATA

Location	Date	Fecal Coliform CFU/100 ml	Fecal Streptococcus CFU/100 ml
SC-7	04-05-88	2	TNTC
	05-04-88	30	TNTC
	07-25-89	3000	1110
	11-21-89	30	30
	11-21-89	4	30
	03-27-90	13	1
SC-8	07-25-89	700	900
	03-27-90	280	180
SC-9	07-25-89	700	600
	03-27-90	13	10

TNTC = too numerous to count
CFU = colony forming units

Organics

An unfiltered sample taken at SC-8 on September 24, 1989 and analyzed using EPA Method 601 showed no evidence of contamination by volatile halocarbons except for methylene chloride (Appendix E). However, the laboratory analysis reagent was the likely source of the methylene chloride, as indicated by a reagent blank. Total phenolics in the sample were less than 0.02 mg/l. Cyanide is less than 0.01 mg/l and total sulfide is less than 1 mg/l. Additional testing would be needed to determine whether total sulfide values are below the new standard of 0.1 mg/l (chronic) for A&W use.

Surface Water Quality Summary

Base-flow water quality conditions appear to meet or exceed state standards for designated uses, thus fulfilling Unique Waters Criterion R18-11-108D.3. If full-body contact (FBC) were added as a designated use, the potential would exist for periodic base flow exceedances of FBC standards for fecal coliform. Surface water quality sampling results indicate state standards for A&W may be exceeded during or immediately after storm flow events for dissolved oxygen, pH, turbidity and metals.

Aquatic Life

Preliminary sampling of aquatic macroinvertebrates reveals a number of insect taxonomic groups, as well as snails and fish inhabit the creek's waters (Table IV-3). This information is incomplete to identify all aquatic taxonomic groups since it represents a small sampling of Cienega Creek. However, this information does demonstrate a diversity of trophic levels (ie. herbivores, filterers, collectors, predators) within the aquatic community as well as a potential food base for predacious birds (Great Blue Herons, kingfishers, sandpipers, passeriform birds) and mammals (raccoons).

TABLE IV-3

AQUATIC ORGANISMS

CLASS	ORDER	FAMILY
Insecta	Diptera	Tabanidae Simuliidae
	Coleoptera	Dytiscidae Hydrophilidae Elmidae Dryopidae
	Odonata	Coenargrionidae Gomphidae Libellulidae
	Ephemeroptera	Baetidae
	Hemiptera	Belostomatidae Corixidae Nepidae
	Megaloptera	Coryalidae
	Lepidoptera	Pyralidae
Gastropoda (snails)		
Osteicthyes (fish)		Long Fin Dace

Groundwater

Hydrogeology

Cienega Creek Natural Preserve lies in a hydrogeologically complex stratigraphic and structural area. The most permeable units are youngest (alluvial deposits) and least permeable are oldest (bedrock complex). The youngest deposits are unindurated sediments found along Cienega Creek, its terrace, and along its major tributaries. The older basin-fill deposits are weakly indurated, poorly sorted gravels deposited by Quaternary and possible Tertiary fans. The basin-fill deposits are extensive and widely distributed. Bedrock in the Preserve includes the Tertiary Pantano Formation, Tertiary volcanics, Cretaceous conglomerates, and Permo-Pennsylvanian limestones and granites (Drewes, 1977). Bedrock is exposed in the uplands and along the channel bottom.

Groundwater is found primarily in basin-fill and recent alluvial deposits, although in some areas groundwater is also found in the Pantano Formation (Kennard, et al., 1988). In the study area, the recent alluvial deposits receive recharge from the streambed infiltration during stormflow events and receive discharges from the basin-fill deposits.

The upstream Empirita Ranch Area lies in primarily basin-fill deposits, but contains a significant portion of the Cienega Creek alluvial deposits within the lower Cienega Creek sub-basin. The Narrows is the upgradient groundwater discharge point into the lower sub-basin due to the outcropping of the bedrock complex.

Principal structural features within Cienega Creek Natural Preserve were mapped by Creasey (1967), Finnell (1971) and Drewes (1977 and 1980). Several faults are adjacent to the Preserve and trend north, northwest and northeast. Concealed faults in the bedrock are believed to divide the bedrock into structural blocks. These fracture openings are thought to control groundwater movement in the bedrock. Relative displacement of the structural blocks is also believed to be the controlling factor of the thickness of overlying basin-fill deposits.

Groundwater first discharges to the surface in the Preserve in the vicinity of the outcropping Pantano Formation and bedrock complex in Section 35, Township 16 South, Range 17 East. Discharge from the Pantano Formation and recent alluvial deposits continues downstream because they are the predominant outcropping units and overlie the bedrock complex which is considered to be an aquitard (Montgomery and Associates, 1985).

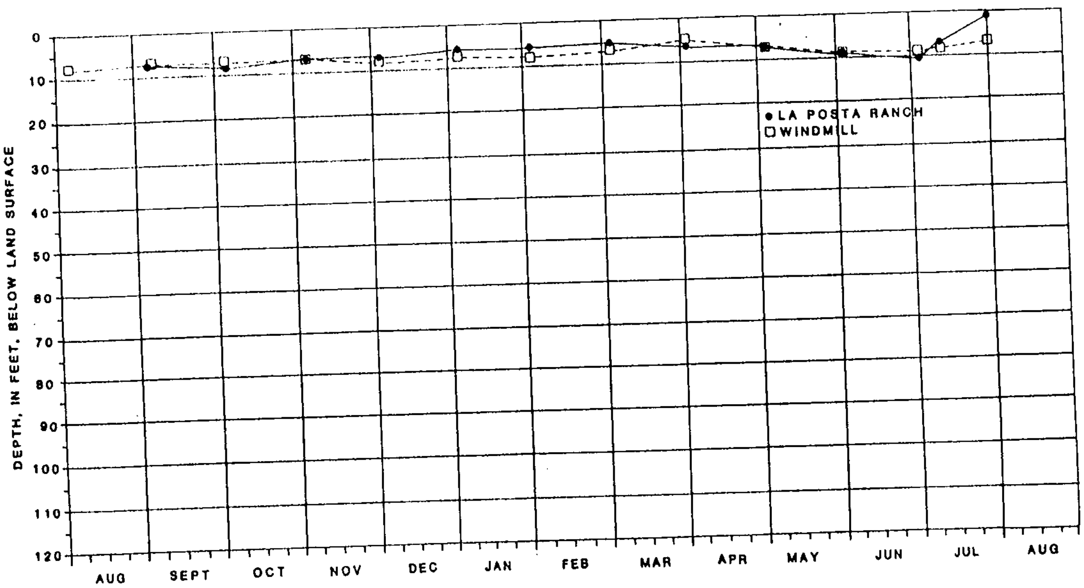
Depth-to-Water

Current Levels

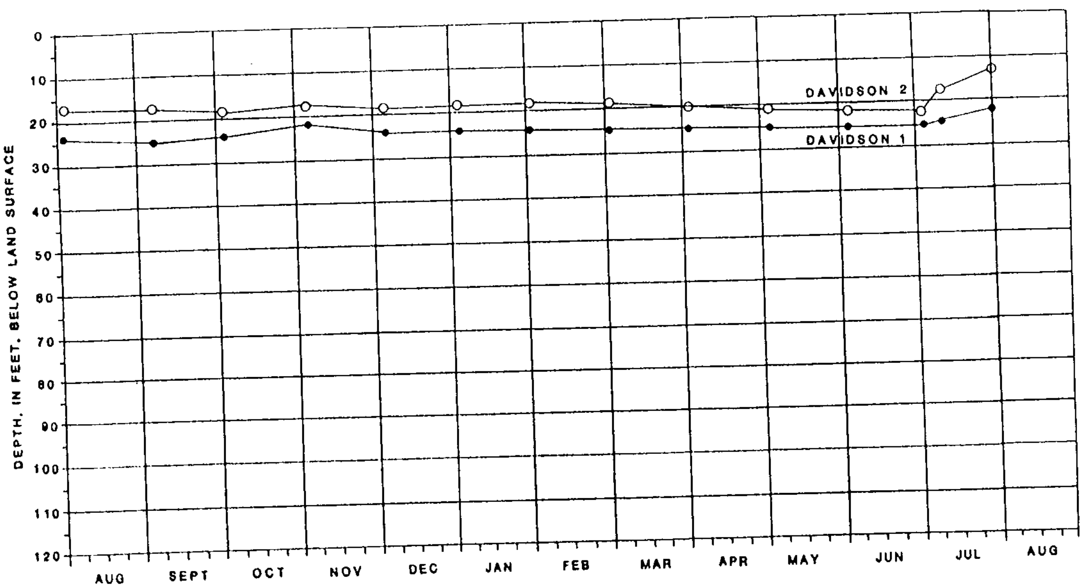
Depth-to-water measurements (in feet) were collected by PAG between August 1989 and August 1990. Results are presented on Appendix B. Appendix B also lists historic groundwater level records for the study area.

Average annual depth-to-water for the study period, ranged from 8 feet to 529 feet. Groundwater was shallowest along Cienega Creek tributaries and has shown both seasonal and regional depth-to-water variations of three to nine feet of rise. Depths-to-water along watercourses in the Agua Verde Creek and Posta Quemada Creek areas averaged 8 feet (Figure IV-3).

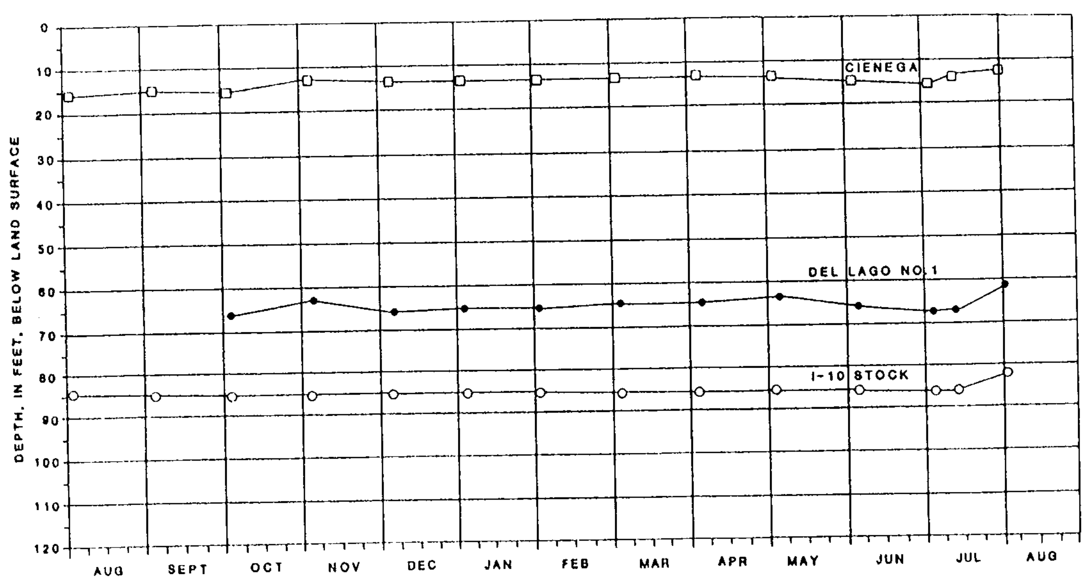
Wells along Davidson Canyon had deeper average depths-to-water. Davidson #1 had an average depth-to-water of 23 feet. Davidson #2 average depth-to-water was 19 feet. Annual net change ranged from a one foot rise in Davidson #1 well, to a 3.5 foot rise at Davidson #2 well. The closer proximity of Davidson #1 well to year-round recharge from Cienega



WATER LEVELS FOR WELLS NORTH OF THE PRESERVE



WATER LEVELS AT DAVIDSON CANYON



WATER LEVELS FOR WELLS IN CIENEGA CREEK NATURAL PRESERVE

FIGURE IV-3

Creek may account for the large water level rise between October and December than in Davidson #2. However, Davidson #2 had a nine foot rise between July and August, while Davidson #1 only rose about two feet.

The shallowest groundwater (averaging 15 feet) along Cienega Creek is in the upper reach of the Preserve at Cienega well. Del Lago #1 well lies in the lower portion of the Preserve reach and has a greater average depth-to-water of 65 feet. The increasing depth-to-water between the two wells corresponds with the thickening of alluvial deposits to the west and increasing depth to bedrock. Neither well shows uniform seasonal water level changes along the creek (Table IV-4). The Del Lago #1 well had greater recoveries in fall, early spring and summer, and larger declines in November and late spring. The rises in water levels at Del Lago #1 well (5 feet) appear to be from flood recharge events on Cienega Creek or Agua Verde Creek or pumpage declines after storm events. After summer storms in July and August, the Cienega well showed a recovery of three feet while water levels rose nearly six feet at Del Lago #1. Water level changes between the wells for the months of February, March, April, June and July, were all essentially equal in magnitude. Streamflow and precipitation records indicate normal base flows were present which probably led to the uniform water level changes.

TABLE IV-4

WATER LEVEL CHANGES ALONG CIENEGA CREEK

Time Period	Del Lago #1	Change	Cienega Well	Change
Oct - Nov 89	4.1	---	+2.2	
Oct - Dec 89	-0.3	-4.4	+1.6	-0.6
Oct - Jan 90	0.0	+0.3	+1.5	-0.1
Oct - Feb 90	+1.1	+1.1	+1.4	-0.1
Oct - Mar 90	+1.7	+0.6	+1.8	+0.4
Oct - Apr 90	+2.2	+0.5	+2.1	+0.3
Oct - Mar 90	+2.7	+0.5	+1.6	-0.5
Oct - Jun 90	+0.4	-2.3	+0.3	-1.3
Oct - Jul 90	-0.6	-1.0	-0.7	-1.0
Oct - Jul 90	-0.6	0.0	+1.2	+1.9
Oct - Aug 90	+5.1	+5.7	+2.2	+1.0
Oct - Sep 90	+4.4	-0.7	+0.6	-1.6

The deepest average depth to water in the study area is 529 feet and occurs at the western portion of the Preserve, which coincides with the eastern margin of the Tucson basin.

Historic Levels

Three sets of annual groundwater level measurements were available to analyze long-term regional trends. The Arizona Department of Water Resources (Remick, 1990; Santos, 1990) and U.S. Geological Survey (1988; 1989) measured groundwater levels in Water Years 1982 and 1988 within the study area. On Table IV-5, these data are compared to measurements collected by PAG for Water Year 1990.

TABLE IV-5

WATER LEVEL CHANGES IN LOWER CIENEGA BASIN

Well Location	Water Level Change 88/82 (feet)	Water Level Change 90/82 (feet)	Water Level Change 90/88 (feet)
16-16-08AAB	+10.70		
09DCD2			
10ACA	+19.60		
10DCB2	+17.10		
11ACC	+44.20		
13DBD	+ 4.92		
14DDC			
15CBB	+23.30		
21BDC		+43.1	
36ABC	+64.00		
36CAB	+12.79	+0.94	-11.65
16-17-08CBD	+ 8.70		
16ADD	+29.31		
22CBD	+ 1.38	+1.58	+ 0.20
31DCA	- 4.92	-2.45	- 2.47
33ABB	- 0.30	+0.73	+ 1.03

Only two of the wells did not have a rise in water level between Water Years 1982 and 1988. Groundwater levels rose at least 10 feet in eight of the twelve measured wells. Raised water levels are most likely linked to recharge of the aquifer from streamflow events and mountain front recharge. Lowered water levels in the two wells penetrating young channel alluvium (D-16-17-31dca and D-16-17-33abb) probably reflect more rapid response times to drier climatic conditions prevailing since 1985.

Flow Directions

Groundwater flow movement beneath Cienega Creek within the Preserve is from southeast to northwest along the streamcourse (Figure IV-4). Flow directions are north-northeast on the southern portion of the Preserve. Groundwater moves to the southwest away from the Rincon Mountain foothills in the northeastern half of the Cienega Creek Preserve. Flow directions in the Pistol Hill area at the northwest portion of the Preserve is to west, southwest and southeast.

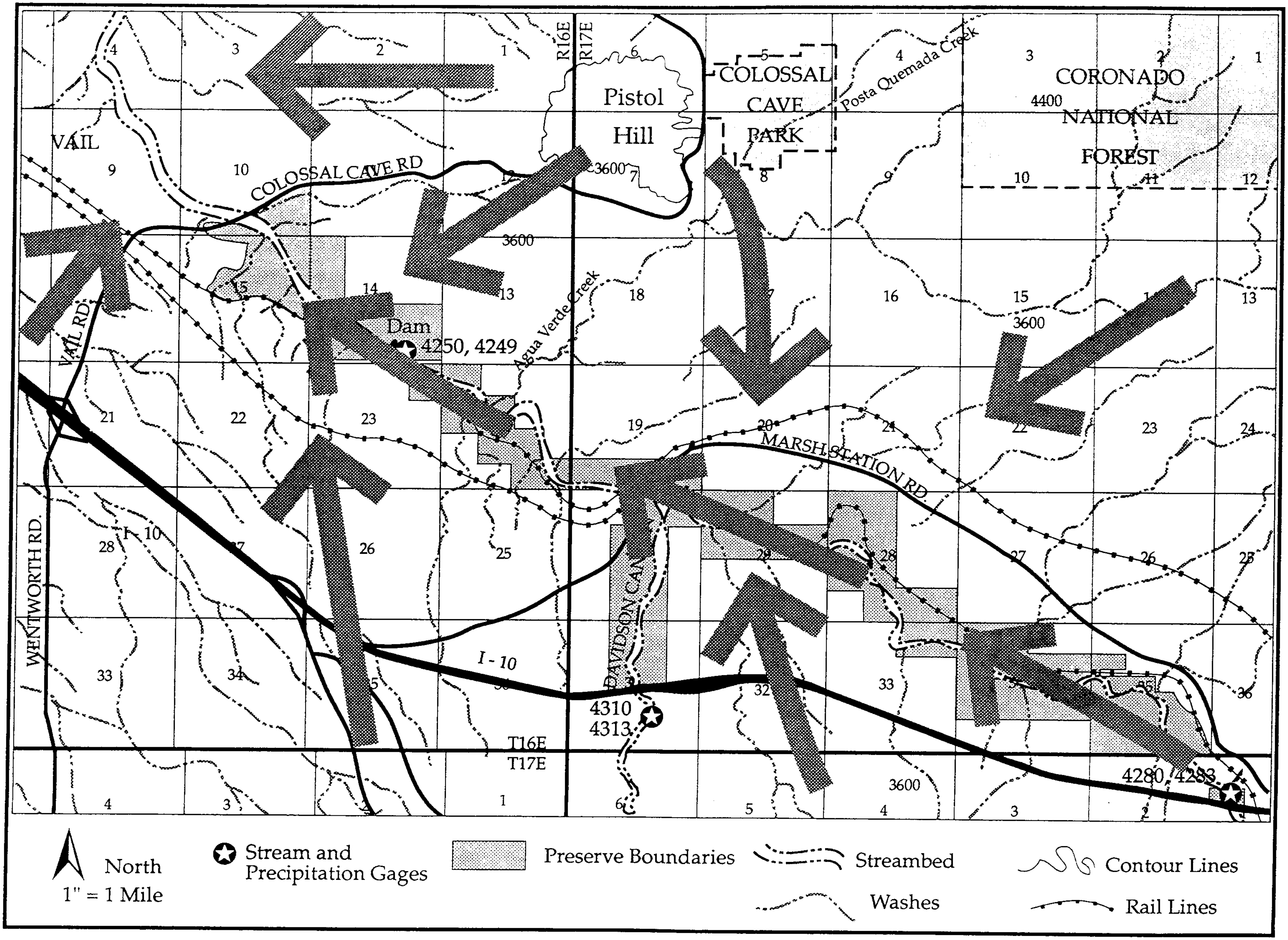


Figure IV - 4 GROUNDWATER FLOW DIRECTIONS

Groundwater Quality

Standards

Groundwater quality in Arizona is evaluated in reference to drinking water standards in Appendix F. The Environmental Protection Agency's (EPA) Primary Drinking Water Maximum Contaminant Levels (MCLs) were adopted as Arizona's first numeric Aquifer Water Quality Standards. MCLs are the current legal, enforceable drinking water standard as promulgated by the EPA.

Federal Secondary Maximum Contaminant Levels (SMCLs) were developed by EPA as guidelines for constituents in groundwater that affect aesthetic qualities of drinking water. These recommended limits are not commonly used by federal and state governments as enforceable standards.

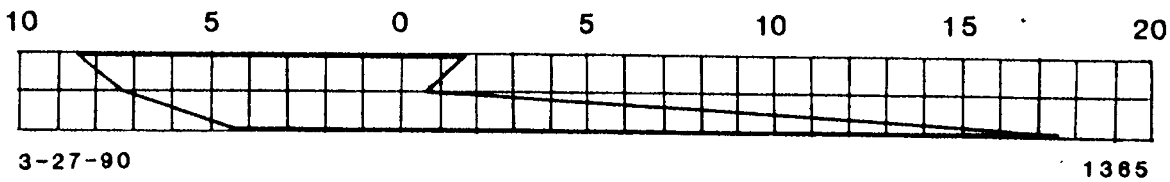
Action Levels (ALs) are advisory or guidance levels for drinking water developed by the State of Arizona in 1985. These criteria were based on health risk data as well as analytical capabilities and certain risk management criteria for 30 constituents that were updated in February 1989 and now are referred to as Health Based Guidelines (HBGLs). The update established HBGLs for 138 constituents. Both ALs and HBGLs are guidance levels and have no legal authority, but can be used to alert ADEQ of future or potential water quality contaminant problems.

Inorganic Chemicals

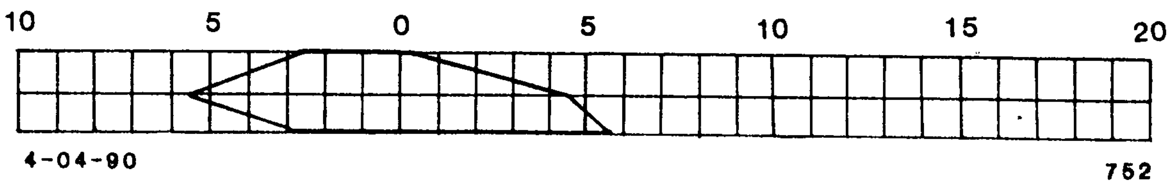
Both Cienega well and Del Lago #1 were far below the drinking water standard of 10 mg/l for nitrate-nitrogen. A combined nitrogen of less than 1 mg/l was calculated for each sample from summing the individual nitrogen forms (Total Kjeldahl nitrogen, nitrite, nitrate and ammonia) (Appendix G). There is no ammonia or phosphate standard or limit set for groundwaters. Historical data near Vail indicates nitrogen concentrations in groundwater were low and generally less than 2 mg/l. No historical nutrient data was found for Cienega well and Del Lago #1. The Jungle well had nitrate concentrations between 1.0 and 1.5 mg/l in 1989 (Appendix H)

The predominant cation at Cienega well is calcium at 52 percent with equal remaining amounts (about 24 percent) of magnesium and sodium plus potassium. Del Lago #1 has sodium and potassium as the predominant cation (42 percent), followed closely by calcium at 38 percent and lesser amounts of magnesium (21 percent). The lithology of the aquifer media at the two well sites is different enough to account for these cation exchanges. Alluvial deposits are intercepted by the Cienega well, while Del Lago #1 occurs in the Pantano Formation.

A pronounced shift in anions also occurs between the Cienega well site and Del Lago #1 site (Figure IV-5). Sulfate predominates (55 percent) at the Cienega well with lesser amounts of bicarbonate (43 percent) and trace amount of chloride at three percent. Del Lago #1 also predominates in sulfate but at higher levels of 88 percent. Chloride is next at 8 percent and bicarbonate is at 3 percent. The Pantano Formation is known to have gypsiferous beds and is likely the source of the increased sulfate.



16-16-14 ddc (Del Lago #1)



16-17-33 abb (Cienega)

Groundwater Quality Changes in
Cienega Creek Natural Preserve

FIGURE IV-5

Historic cation-anion data was available from year 1959 at Del Lago #1 (Appendix G). The results are nearly identical with the exception of lower concentrations of bicarbonate in the recent sample. Insufficient bailing of the well may account for this difference. Calcium sulfate bicarbonate water predominated in 1989 at the Jungle well.

Total dissolved solids (TDS) at both wells are higher than the federal secondary maximum contaminant levels (SMCL) of 500 mg/l. Cienega well had a TDS content of 752 mg/l and Del Lago #1 was at 1,365 mg/l. The elevated concentration at Del Lago #1 may also be due to insufficient bailing during sampling to obtain groundwater representative of the aquifer. No historic TDS data is available at these wells to confirm these results. The Jungle well site has an average TDS content of 640 mg/l and lies in similar hydrogeology as the Cienega well.

Sulfate levels exceed the SMCL of 250 mg/l at the two sampled wells. Cienega well has a sulfate concentration of 272 mg/l, while Del Lago #1 is much higher at 833 mg/l. The Jungle well site has slightly lower sulfate levels at 220 mg/l and is below the drinking water limit.

Fluoride levels at both wells are lower than the drinking water standard of 4.0 mg/l. Fluoride concentrations were less than 0.70 mg/l at the wells. Historic data shows the same concentration levels at Del Lago #1 and Jungle well.

Metal concentrations at both wells were below drinking water standards except for lead at Del Lago #1. The exceedance may be due to stagnant casing water or naturally occurring mineralization. Exceedance of secondary MCL's at Del Lago #1 for iron and manganese which are common casing materials tends to support the former premise. On the other hand, leachate from abandoned lead and zinc smelting operations upgradient from this site could be contributing to the elevated levels. Historic data on iron in the area shows it commonly exceeded the SMCL in the past.

Thallium levels may be above the HGBL in either well. The detection limit is a source of uncertainty regarding true thallium levels. A second set of more sensitive analyses would help evaluate whether thallium guidelines are exceeded.

Bacteria

Cienega well was sampled August 28, 1990 for bacteria. Less than two colony-forming units per 100 milliliters were found for both fecal coliform and total coliform and fecal streptococcus. The well is not used for drinking water. Additional sampling would be required to demonstrate that the well water would meet the drinking water standard of less than one colony-forming unit for total coliform.

Organics

Cienega well was sampled August 28, 1990 for chlorinated herbicides using EPA Method 8150. The sample showed no detectable contamination (Appendix E)

Groundwater-Surface Water Relationships

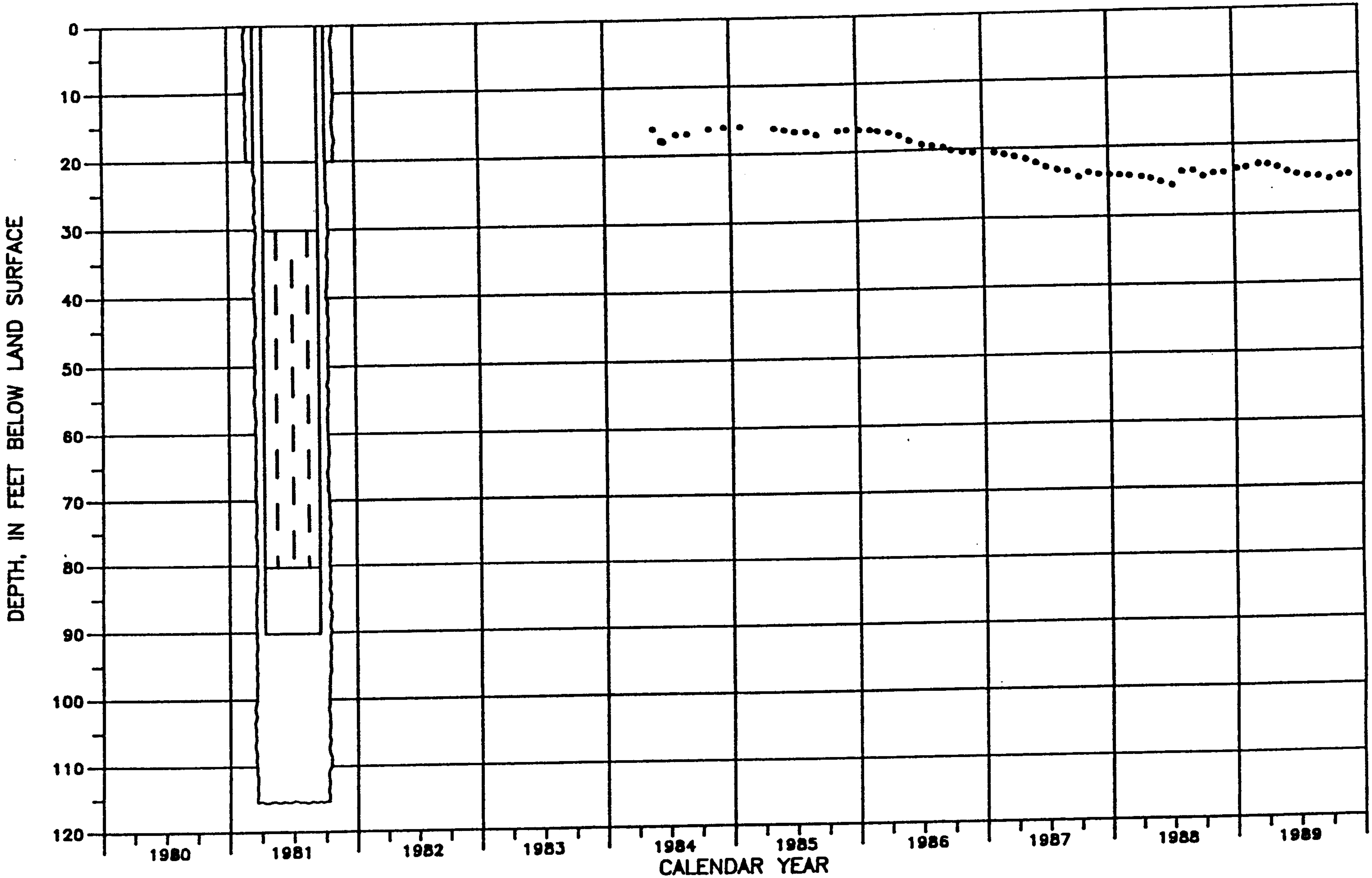
Data collected during the course of this study and previous to this study indicate that the groundwater and surface water systems of the lower Cienega Creek basin and the Cienega Creek watershed are highly interconnected.

Rapid response of water levels in monitoring wells to storm flows in Cienega Creek indicate that the alluvial deposits in the geologic floodplain are efficient infiltration media, and that abundant recharge to the deposits occurs during stormflows. During the fourth day of a five-day pump test conducted by Montgomery and Associates at wells D-16-17-35dbc3 and D-16-17-35aaa, the ephemeral reach of Cienega Creek that lies east of the site was observed to flow during a rainstorm. Water levels in the wells responded within about two hours after surface flow began (Montgomery and Associates, 1985). The monitoring wells are perforated in the alluvial channel deposits.

The extent of stream flow rapidly responds to changes in groundwater levels. Measurements of stream flow length for 1984-1989 indicate progressive declines in the length of channel having stream flow (Figure IV-1 in pocket). These declines correspond to declines in measured groundwater levels over the period 1984-1988 (Appendix 3 and Figure IV-6).

Corresponding to the general decline in groundwater levels since 1984 is a progressive change in groundwater quality for the Jungle domestic well at D-16-17-35dbc2 and surface water quality in Cienega Creek downstream from the Jungle site (Appendix H and Figures IV-7 and IV-8). Over the period January 25, 1984 to November 1989, total dissolved solids have increased from 640 mg/l to 760 mg/l. TDS and chemical composition of surface water and groundwater at the Jungle site after 1987 are equivalent. The water quality changes may reflect a shift in the temporal and/or spatial characteristics of the groundwater source; for instance, from recently recharged groundwater to groundwater that has been in storage for a longer time, or from the alluvial deposits aquifer to the Pantano Formation or basin fill aquifer.

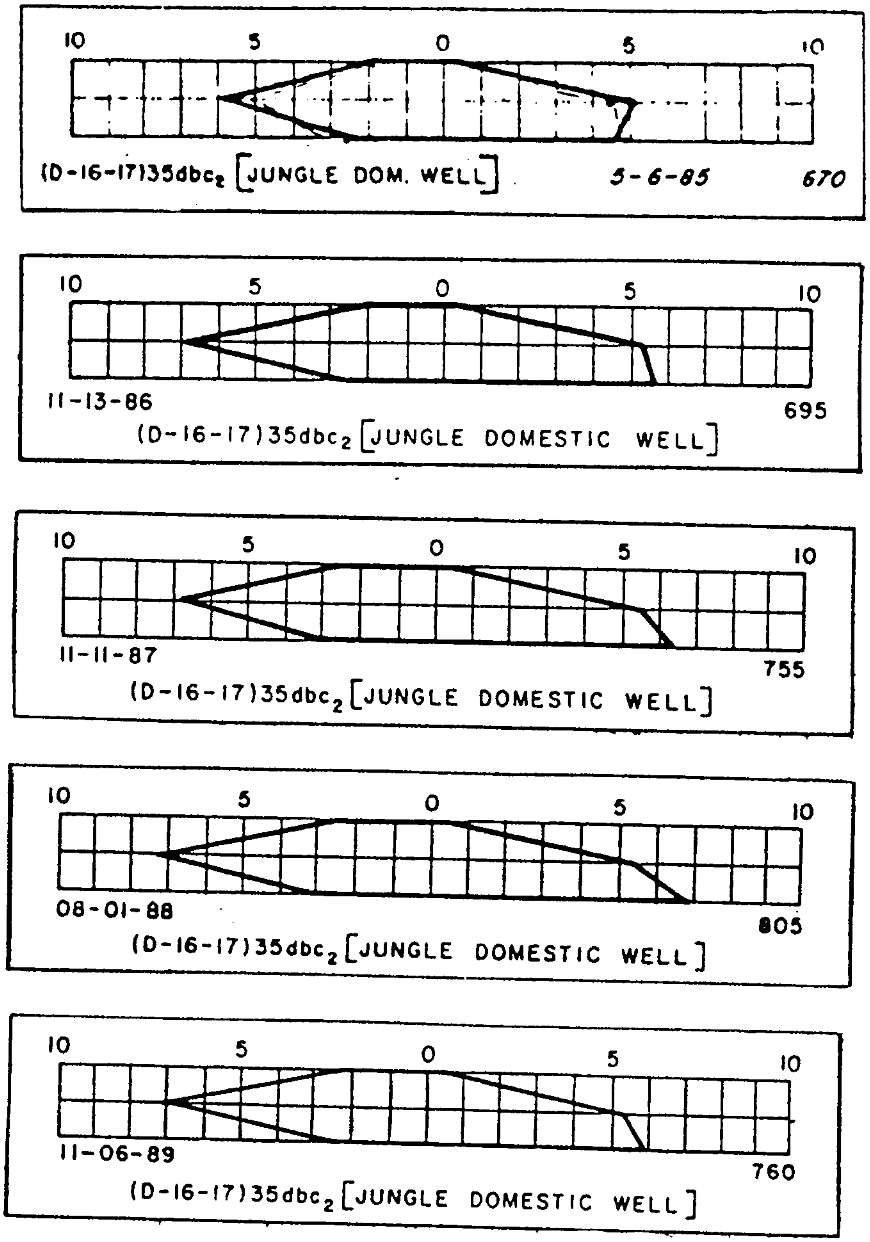
Information regarding changes in surface water quality and its relationship to groundwater recharge will be important in assessing the cause of any observed changes. Future changes in basic water quality parameters must be evaluated carefully to determine their origin, whether natural or man-made. The quality of base flows cannot be regarded as a static phenomenon. Furthermore, the close relationship between water in the alluvial deposits aquifer and the surface flows means that polluted surface flows could quickly and rapidly contaminate the alluvial deposits aquifer, and therefore the drinking water supply for several nearby residents.



WATER LEVEL HYDROGRAPH FOR WELL (D-16-17)35dbc3 [JUNGLE MONITOR WELL EM-3]

FIGURE IV-6

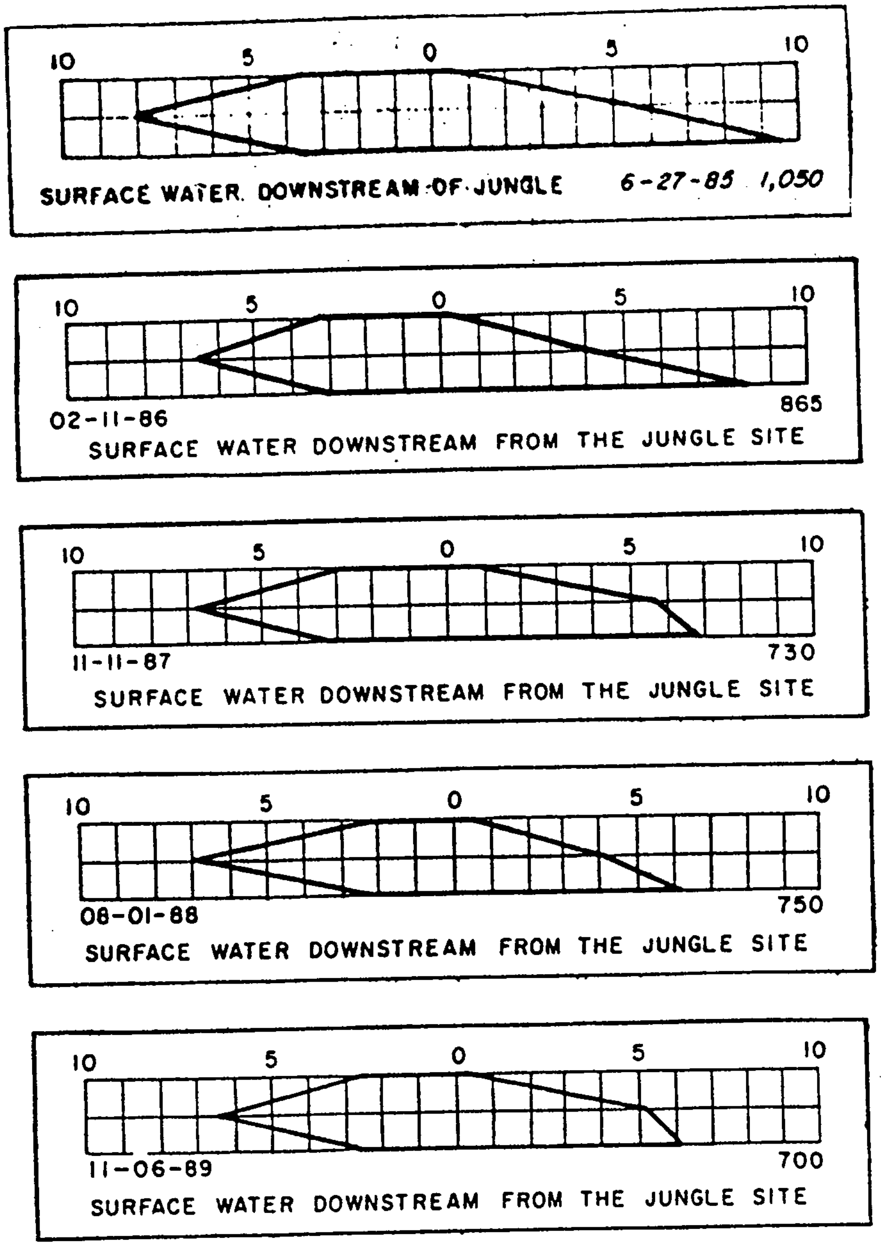
ERROL L. MONTGOMERY & ASSOCIATES, INC
TUCSON, ARIZONA



GROUNDWATER QUALITY CHANGES AT THE JUNGLE DOMESTIC WELL

FIGURE IV-7

Adapted from Montgomery and Associates (1985,86,88,89 and 90)



SURFACE WATER QUALITY CHANGES AT THE JUNGLE SITE

FIGURE IV-8

Adapted from Montgomery and Associates (1985,86,87,88,89 and 90)

CHAPTER V

PUBLIC AND NATURAL RESOURCES CRITERIA

The nominated segment is clearly an outstanding public resource due to the existence of perennial stream flow and the flora, fauna, and recreational opportunities supported by the stream (R18-11108D.1).

Recreation

The Preserve is one of only two public recreational areas near Tucson which offer lush riparian woodlands and year-round running water. The other is Sabino Canyon National Recreational Area in Coronado National Forest. Although the terrain is less rugged than Sabino Canyon, the Preserve provides more opportunities for solitude. Recreational activities allowed along the nominated segment include hiking, bird-watching, wading, hunting and horseback riding. Swimming opportunities are limited due to the generally shallow nature of the stream, but walking and wading in the water are popular recreational pastimes. Prohibited recreational activities include use of motorized vehicles. Recreational activities are regulated in the nominated segment through a permitting system operated by Pima County Parks and Recreation Department and patrol by park rangers. Cienega Creek's bird life has attracted University of Arizona's ornithology class for a number of years. Its flood deposits have been the subject of recent University studies, and its riparian plants have attracted a U.S. Environmental Protection Agency educational seminar on the delineation of Southwestern wetlands.

Vegetation

The floristic focal point of the Preserve is the riparian woodland that flanks both the perennial and ephemeral reaches of the stream. The presence of riparian and aquatic plant communities nearly double the number of plant species found on the Cienega Creek Natural Preserve (Baldwin and Fonseca, 1987) and therefore greatly increases its capabilities of supporting a wide diversity of wildlife compared with adjacent desertscrub habitats. Based on a 1985 aerial photographic base, the total acreage supporting riparian woodland within the Preserve is 570 acres. This estimate does not include areas undergoing natural revegetation which were formerly riparian habitat. Dominant riparian trees includes velvet mesquite (Prosopis velutina), Goodding willow (Salix gooddingii), Arizona ash (Fraxinus velutina), hackberry (Celtis reticulata) and cottonwood (Populus fremontii). There are local streamside occurrences of three-square bulrush (Scirpus americana), cattail (Typha sp.) and several species of sedges (Carex), monkey-flower (Mimulus), and watercress (Rorippa sp.).

Wildlife

The importance of riparian vegetation and permanent flowing water in the desert cannot be overemphasized. The water-, food- and cover-dependent bird species have been documented by Bergthold and Caldwell (1978) and by Smith and Unangst (1987). Only 12 bird species of the 80 on the list for this area are classified as nonriparian and actual numbers are expected to increase as more on-site studies are conducted. The mesquite woodlands along the stream almost certainly provide habitat for the Northern Beardless Tyrranulet (Camptostoma imberbe), (Smith and Unangst, 1987). The bird is listed in Group 3 of the threatened natural wildlife of Arizona (a state designation).

Raccoons and skunks are quite common along the stream as evidenced by tracks in the soft streamside soil (Smith and Unangst, 1987). Game animals which use the stream include javelina, mule and possibly white-tailed deer, cottontail and jack rabbit. Top predators include coyotes, mountain lions and possibly black bear.

The nominated reach is not proven to provide essential habitat for species having national and state significance (Unique Waters criterion R18-11-108D.2). The waters of Cienega Creek host thriving populations of an Arizona native fish known as the long-fin dace (Agosia crysogaster). Individual dace are known to survive water temperatures as high as 33.1°C and depths as shallow as 1 cm, although such conditions result in declining populations (Minckley and Barber, 1971). Spawning most often occurs in 5- to 20- cm waters with slight currents over sandy bottoms. The stream may also harbor the Gila Chub (Gila intermedia) and the endangered Gila topminnow (Poeciliopsis occidentalis) following floods which carry these fishes downstream from the Empire Ranch, but no self-sustaining populations are known to be present in the Preserve (Minckley, pers. comm.). Historically, the nominated stream segment probably contained these less tolerant fish species. Arizona Game and Fish Department has identified a small discharging spring adjacent to the stream reach with Gila topminnow as a suitable site for extending the species current range through reintroduction (AGFD, 1990).

The riparian and upland areas will be inventoried for species of national or state significance as part of the Cienega Creek Management Plan. Thus, better assessment of whether the area provides essential habitat (R18-11-108D.2) can be made at a later date.

CHAPTER VI

POLLUTION POTENTIAL ANALYSIS

In order to address Unique Waters report requirement R18-11-108C.5, identification of potential threats to maintaining or enhancing water quality, the stream's pollution potential must be examined. Assessment of pollution potential includes examining physical and land use parameters which affect susceptibility and describing existing and future activities which may contribute pollutants to the watershed.

Pollution Attenuation

Pollution attenuation occurs in the environment naturally and can serve as a buffering mechanism in the transmission of a contaminant and as a detoxifier of the contaminant by dilution or conversion to less harmful forms. However, there are limits to the attenuation of contaminants as all environments have pollutant loading limits which are complex and vary with, for example, changing climate conditions. In a hydrologic system, attenuation occurs in the surface water, the saturated zone and the unsaturated or vadose zone. In each part of the system, the attenuation mechanisms are different as are their relative importance. Generally, attenuation is related to transit time through the system; with a faster transit time there is less of a likelihood for pollutant reduction.

Surface Water

Surface water will have the least likelihood of a high buffering or attenuation capacity. Surface water attenuation is primarily controlled by the ratio of flow volume to the contaminant (dilution), volatilization of contaminants due to mixing and vapor pressure differences, and to photo-decay (sunlight-induced) reactions. Due to the low volume of base flows, Cienega Creek surface water has a low attenuation capacity. High flow events can redistribute upstream contaminants into the Preserve as discussed in Chapter IV.

Saturated Zone

Pollutant attenuation in the saturated zone is primarily due to dilution. Mechanisms of lesser influence are particle surface reactions, microbial degradation and filtration. Pollution attenuation in groundwater is of some but limited importance and mostly can be thought of as affecting the speed and extent of dispersion rather than serving to actually eliminate the contaminant from the environment. Pollutants in the saturated zone would move downgradient toward the dam at D-16-16-14 where some would be intercepted by an underground gravity-fed pipeline by the Del Lago Water Company or infiltrate further downstream and recharge the Tucson basin aquifer.

Vadose Zone

Attenuation mechanisms in the reduction zone are relatively more important than those of the surface water and saturated zones. These reduction mechanisms may include precipitation, surface reactions and specific adsorption with the soil particles, chemical degradation, pH effects, oxidation-reduction, volatilization, microbial degradation, plant uptake, filtration, and dilution. Of these, specific adsorption of pollutants onto the surfaces of soils and the role of microorganisms in promoting adsorption and other attenuation processes are probably the most important factors in the removal of potential ground-water pollutants from percolating waters (Wilson, 1981).

TABLE VI-1

POLLUTION ATTENUATION MECHANISMS

(PAG, 1983)

Specific Pollutant Affected By:

Pollutant Categories	Specific Adsorption	Soil Organisms
Major Inorganics	Ammonium and Potassium	Nitrogen and Sulfate
Trace/Minor Inorganics	Manganese, Copper, Zinc, Cobalt and Chromium	Arsenic, Molybdenum, Cyanide, Mercury, Selenium
Organics	Pesticides: Carbaryl, Maration Parathion, Picloran, Malthion, Malthion, Paraquat, Diquat, DDT 2-4-D, Polychlor. Biphenyls	Large Group of Herbicides and Insectices
Microorganisms	Virus held by van der Waals forces	Variable

Specific adsorption entails the binding of a pollutant to the surface structure of a solid in such a way that the pollutant cannot be displaced by common cations and anions. Adsorbents include clay minerals, hydrous oxides (aluminum, iron, manganese and silica), humates, fulvates, bioremnants, calcium carbonates, iron and sulfates. Adsorption tends to form more insoluble forms with time. The clay and silt fractions of the soil are the primary mineral grains that attenuate pollutants through specific adsorption. Attenuation, however, is dependent upon the pollutant. Local research has documented that Southwest soils absorb small quantities of organics, but high levels of metals (Gerba and Bitton, 1984). Recharging streamflow events can mobilize microbes great distances in the aquifer. Trace organics probably will not be adsorbed, while metals will. Phenols may be restricted in movement by reactions with iron oxides. Bacteria and virus movement will be restricted but not deactivated solely by adsorption.

Soil organisms take up pollutants as a process of their biological activity and convert these pollutants to less harmful or to elemental forms. Biological organisms included are bacteria, fungi, protozoa, actinomycetes and worms.

Soils in the Preserve having the greatest potential for pollutant attenuation would be the River Road and Tierranegre Soils (Figure IV-1 and Table II-2). However, since these soils are prone to erosion, attenuated pollutants would likely be transported as sediment downstream as a result of flooding events.

In general, vadose zone attenuation in the eastern Preserve area is limited by the shallow depth to groundwater.

Erosion Potential

The highest soil erosion potential occurs along the stream channels, on steep slopes having fine to medium grained silty sands, and in areas historically overgrazed (PAG, 1989a).

Murphy and Moore (1980) provide a qualitative guide for the relative potential for erosion to occur based upon factors of topography, soil texture, and permeability. The Murphy and Moore study divides a site into areas of lowest, moderate and highest erosion potential which roughly correlated to the soil units of the Preserve as follows on Table VI-2.

In summary, the younger soils along the creek are highly transmissive of pollutants, while the older deposits are much less so. Calcium carbonate accumulations in some of the old soils may limit vertical percolation, influence background levels of calcium carbonate in surface and groundwater, and serve as a pollutant attenuator (Machette, 1985).

TABLE VI-2

POTENTIAL SOIL EROSION

Erosion Rating	Slope	Geomorph. Character.	Vertical Permeab.	Preserve Soils
Lowest	0-10%	Flat-gentle topo, Gullies & rills scarce, Overland Flow localized as sheet flow	0.6-20.0 inches/hour Moderate to High Perm.	None in this category
Moderate	Up to 45%	Gentle-steep slopes, Channels & sheet flow, Prevalent surface indicators of erosion	0.6-2.0 inches/hour Moderate permeability	Anklam-Pantano, Pantano Rock Outcrop, Pinaleno Nickel, Powerline-Monterosa, Deloro Rock, Nickel Palos Verdes Complexes, Tanque Soil
Highest	Variable slopes	Steep slopes, gullies unstable walls cut by side flow	0.6-2.0 inches/hour Mod. slow to v. slow	River Road and Tierranegre Soils (in/near Creek), Redington Soil (very steep slopes).

(Adapted from Murphy and Moore, 1980)

The stream slope in both lower and upper sub-basins is gentle at approximately one percent. Arroyo cutting has produced incised channels which have increased the potential for erosion of streambanks during flood events. These confined channels also concentrate pollutants in groundwater recharge areas during low stream flows and mobilize pollutants downstream during high flow events.

Channel bed substrate for all three base-flow sampling sites consisted of coarse sand. Gravelly bars are common, but not present as substrate for the surface water and sediment sampling sites. Silt, clay, limestone, conglomerate, and andesite are also found on the stream bottom. The substrate is generally coarser than the material which comprises the channel bank walls.

Sedimentation and erosion processes are extremely active during storm flows. Channel bank erosion during floods removes fine-grained sediment from the 20-foot high banks that line most of the floodplain. This young alluvium is also subject to piping or cavitation from overland flows during storms. After storm flows, collapse of oversteepened channel walls may occur, creating localized obstructions to flow. Flooding also deposits and removes sediment from the channel bottom.

After a flood on September 24, 1987, alluvium was locally removed from the channel bed, exposing bedrock and creating large pools. A flood on July 29/30, 1988 filled the pools up. Large pools of water formed again along the study reach during July 24, 1990 flooding.

These pools were completely filled by a flow event that occurred after July 24 but before August 5, 1990. Headcutting along tributaries is another process that contributes to sediment loads during flooding.

Land Uses

Land uses within Cienega Creek Basin include mining, agriculture, grazing, recreation, transportation and utility corridors, and residences (Table VI-3). Land ownership is divided into federal, state, county and private. The largest landowner in the basin is the federal government. County ownership is the smallest percentage. Grazing, recreation, utility corridors, and transportation corridors comprise at least 80 percent of the land uses within the basin. Private lands have the widest variety of land uses but occur on less than 20 percent of the land in the Cienega Creek Basin.

TABLE VI-3
LAND OWNERS AND ASSOCIATED LAND USES WITHIN CIENEGA CREEK BASIN

Land Owner/Manager	Area (mi)	Percent of Total	Land Uses
Federal Forest Service	129	29	Grazing, Recreation, Utility Corridors, Mining, Highways
BLM	113	25	Grazing, Recreation Utility Corridors, Highways
State	115	25	Grazing, Utility Corridors, Recreation, Highways, Railroads, Abandoned Wells
County	4	1	Grazing Recreation, Utilizing corridors, Retired Agriculture
Private	89	20	Grazing, Utility Corridors, Mining, Highways, Railroads, Wildcat Dumps, Domestic Septage, Retired Agriculture, Underground Storage Tanks, Industry, Construction, Hydrologic/Habitat Modification, Abandoned Wells Residence
TOTAL	450	100	

Data Sources: Pima County Transportation and Flood Control District, (1988); Pima Association of Governments (1989b)

Based on existing documentation, there are few land uses directly affecting water quality in the Preserve, although there are several activities which do have the potential to degrade water quality. Future development may add additional pollutant sources or increase pollutant loads. Pollutant sources can be described in terms of point sources and non-point sources. Table VI-4 summarizes potential pollution sources and contaminants.

TABLE VI-4

POTENTIAL POLLUTION SOURCES AND CONTAMINANTS
ON THE CIENEGA CREEK NATURAL PRESERVE

Pollution Source	Potential Contaminant
Natural	Elevated sulfate and TDS from evaporite minerals, sediment
Hydrologic/Habitat Modification	Sediment, temperature
Highway runoff	Hydrocarbons, metals, toxics from spills, sediment
Railroad runoff	Hydrocarbons, metals, toxics from spills, sediment
Recreation	Nitrates, microbiological, sediment
Grazing	Nitrates, sediment
Abandoned wells	Nitrates, metals, toxics, microbiological
Utility Corridors	Sediment, toxic spills
Wildcat Dumps	Nitrates, metals, toxics, microbiological
Construction	Sediment
Underground Storage Tanks	Hydrocarbons
Industry	Hazardous waste spills
Domestic Septage	Nitrates, microbiological, toxics
Retired Agriculture	Nitrates, pesticides, sediment
Mines	Sediment, metals

Point Sources

During the course of the study, a well located in D-16-17-35aca was found to present a potential hazard to groundwater quality and human health. The well consists of an open pipe casing approximately five feet in diameter, having a metal ladder attached to the inside surface. The well was housed in an unlocked shelter. Arizona Department of Water Resources (ADWR) staff contacted the lessee, who repaired the shelter and provided a locked door to prevent easy access to the well. Other uncapped wells were reported to ADWR for capping to prevent chemical disposal.

A dump located in D16-17-35cbb was removed by the Operations Division of Pima County Department of Transportation and Flood Control District. The dump contained wood and metal debris, old batteries, empty oil containers, paper, and livestock remains. Because the dump was located in a gully upstream of a spring which contributes flow to Cienega Creek, it was thought to be a potential hazard to water quality.

No underground storage tanks are known to occur on the property. A former irrigation well (D-16-17-35dbc) has become contaminated with motor oil (Montgomery and Associates, 1990), due to accidental spillage during removal of the pump (Neal Hanna, pers. comm., 1990). There are no wastewater treatment facilities which discharge into Cienega Creek. However, none of the dwellings within the watersheds of the nominated segment are connected to Pima County's existing regional metropolitan wastewater system. If urban development of the magnitude permitted by the 1959 Posta-Quemada Zoning Plan or the 1987 Empirita Ranch Area Plan occurs, wastewater treatment facilities would have to be provided. The Vail-Posta Quemada Plan accommodates approximately 116,000 people, with an average net density of 7.1 units per acre. The Empirita Ranch Area Plan provides for a population of roughly 20,000. The latter plan specifically requires that nondischarging wastewater treatment facilities and effluent re-use.

Non-Point Sources

Interstate Highway 10 crosses Cienega Creek upstream of the nominated segment. Inspection of ADOT accident records suggest that the Interstate Highway 10 bridge is a high-risk area, at least during inclement weather [Fonseca, unpub. data]. The situation at the bridge is complicated by an interchange located just east of the bridge, localized ponding of water near the bridge, and substandard roadway conditions. Any material which spills in the vicinity of the bridge can enter the stream by way of highway drainage conduits or by flowing directly through the bridge weep holes. A Department of Public Safety officer confirmed two diesel tanker truck accidents at the bridge. One of the spills supposedly resulted in diesel entering into stormwaters flowing under the bridge.

Accidental chemical spills along the highway represent a high threat during rainstorm events. During the term of the study, a chlorine spill occurred along Interstate 10 near a tributary watercourse. The chlorine spill presented no hazard to wildlife or human life because the tablet-form chlorine was encased in plastic containers.

Arizona Department of Transportation (ADOT) is aware of roadway problems in this area and plans to construct new drainage structures and a highway overpass over Southern Pacific Railroad (SPRR), widen the bridge deck, and resurface the road during fiscal year 1993-1994.

Based on sediment analyses, normal highway runoff is thought to contribute to some pollutants to the streambed, but not to such a degree to cause concern.

Arizona Department of Transportation staff were contacted regarding their vegetation management practices. Maintenance of the right-of-way includes spot applications of herbicides. A test for organic chemicals in surface water quality found no herbicides (Appendix E). ADOT was also contacted regarding the need to prevent degradation of water quality from construction debris, since the roadway surface was removed and replaced with asphaltic concrete during May 1990. A subsequent field check indicated no construction debris in the channel.

Special management needs are posed by the potential for leakages or accidental spills from the Southern Pacific Railroad, which crosses the nominated segment in two locations in section 19 (Figure 1). One of the tracks parallels the river channel and is upgradient for the entirety of the segment, passing within several hundred feet of the channel in several locations. Several train derailments occurred along the railroads between Vail and Benson during September and October 1990, but no liquid material was known to have been discharged to Cienega Creek or its tributaries. While the potential for accidental spills can be mitigated by proper safety precautions, an element of spill risk cannot be eliminated. However, pollution impacts can be minimized by rapid emergency response of cleanup efforts.

Along stream reaches in D-16-16-19 and D-16-17-29, the railroad track is located within 100 feet of the active channel. Bank erosion of the railroad fill could prompt Southern Pacific railroad to place fill and revetment works in the channel. These activities have the potential to directly affect water quality. Care should be taken as to the type of fill used, such as not using smelter slag or tailings. Existing locations of tailings that have been used as fill may contribute to elevated levels of metals during flooding.

Normal railroad maintenance introduces foreign materials to the floodplain of Cienega Creek, including castoff batteries, railroad ties, railroad fill material, oil and grease for track oiling and empty canisters. In February 1990, and again in April, the Southern Pacific Railroad was contacted regarding materials which had fallen into the flowing stream. As of November 1990, SPRR had not responded.

Recreational activities in the nominated segment are regulated through a permitting system and ranger patrol operated by Pima County Parks and Recreation Department. The Pima County Parks and Recreation Department restricts the number of persons permitted access to the Preserve to a number "consistent with the goals of protection and maintenance of the riparian ecosystem of the area."

Surface water quality data collected do not indicate that periodic grazing practices in the Preserve contribute to elevated turbidity or total suspended solids at this time. Livestock are thought to contribute to elevated fecal coliform levels; however, other sources such as domestic septage and rail car flushing may exist.

Upstream clay mines in D-16-17-21, -29, and -35 potentially contribute to elevated turbidity during storm flows. However, there is no documentation indicating that there is any water quality problem caused by existing mining practices or abandoned mine areas. Excess clay mine tailings have encroached the channel of one tributary stream in Section 28, Township 16 South, Range 16 East. Some of the clay may have swept downstream by storm flows in summer 1990 as evidenced by erosion of the fill slopes (PCDOT Drainage Complaint 90-35).

Upstream gravel mining in D-17-17-12 and D-17-18-4 could result in discharges of fine-grained sediment-laden water into Cienega Creek or its tributaries, thereby posing a threat to the turbidity of water and aquatic organisms in the nominated reach. At present there is no reason to believe that upstream gravel mines located affect Cienega Creek's water quality. Because the perennial reach is entirely within Pima County's ownership and no discharges of wash water are now present, no further management steps need be taken, other than continuing the aerial monitoring of sand and gravel operations and permitting activities normally undertaken by the Pima County Flood Control District, Arizona Department of Environmental Quality, and the U. S. Army Corps of Engineers. This task can be accomplished through internal directives.

Electric and gas line corridors are not indicated as a source of water quality degradation by the sampling program. However, field observations indicate that the corridors are used as access for off-road recreational vehicles (ORVs). ORVs have been observed to compact soil, divert water, crush vegetation, and increase erosion. Pima County Parks and Recreation is attempting to control ORV use through posting of signs and patrolling access points.

Septic tanks serve residential developments in the area. The closest septic tank is that serving a mobile home in D-16-17-35, upstream of SC-8. Septic tanks located in the fine-grained young alluvium could potentially contribute nitrate and microbial contaminants downstream. The sampling program did not indicate exceedances that could be attributed to this source. Since much of the area surrounding the Preserve will not be serviced by regional wastewater treatment plants, there is potential for increased quantities of domestic septage to contribute to surface water and groundwater quality problems.

The sampling program indicated no exceedances that could be attributed to retired agriculture. Abandoned agricultural areas may continue to elevate nitrate levels in groundwater for domestic well D-16-17-35dbc2 after recharge events. Data collected by Montgomery and Associates (1984; 1985; 1986). indicate that nitrate concentrations (as N) dropped from an average of 2.2 mg/l NO_3-N in 1984 to an average of 0.9 mg/l NO_3-N in 1988. Decreasing nitrate levels also correspond to water level declines at the well. The higher values could be from leaching of nitrates from past agricultural activities. An alternative source may be domestic septage from an adjacent household. Agricultural pesticides were not detected downgradient of retired agricultural land.

No sources of urban runoff exist in the vicinity. However, existing and conditional zoning provide for large areas of commercial, industrial and high-residential use adjacent to the Preserve. The Vail-Posta Quemada Zoning Plan, which includes the nominated segment, was adopted on April 21, 1959 with the intention of providing a satellite community of 116,000 people centered on a proposed manufacturing and industrial corridor. Urban runoff and waste storage for future industrial facilities could present water quality threats, if inadequate zoning restrictions or no NPDES stormwater permit exists.

Other than highway road-surface reconstruction, no construction adjacent to the channel occurred during the study period. Isolated areas along tributaries were graded for mobile home placement. These activities did not appear to affect water quality of base flows. Construction for high-density residential, commercial and industrial uses per the Posta Quemada Zoning Plan could result in higher turbidities in storm flows.

No modifications of the streambed within the Preserve are anticipated. Repair or modification of the damsite in D-16-16-14 could locally increase turbidity for the short-term. Because the dam structure serves as a grade control for the upstream channel reach, removal of the dam structure would cause significant long-term channel-bed degradation in the nominated reach.

CHAPTER VII

WATER QUALITY MANAGEMENT PLAN

This water quality management plan suggests management actions needed to maintain or improve water quality characteristics in the nominated reach. No institutional barriers have been identified which would prevent management of the nominated stream segment. However, action is needed by the following agencies: Pima County Department of Transportation and Flood Control District (PCDOT) and other County departments, the State Land Department, Arizona Department of Environmental Quality (ADEQ), the Arizona Department of Transportation (ADOT), the Southern Pacific Railroad (SPRR), the U.S. Forest Service, and the Bureau of Land Management. Pima Association of Governments (PAG) is the appropriate forum for such coordination.

Local Administration

1. Include policies which prevent water quality degradation in new area, community, neighborhood, specific and zoning plans which replace the Vail-Posta Quemada Zoning Plan. According to Pima County Planning and Development Services (PDS) Department, the zoning plan conflicts with the adopted Comprehensive Plan and should be deleted. PDS and PCDOT are entities responsible for seeing that any new plans contain policies which prevent water quality degradation.

2. Designate PAG's Environmental Planning Advisory Committee (EPAC) as the review body for the Empirita Ranch Monitoring Program. The Empirita Ranch Area Plan states, "A water level and quality monitoring program, to be incorporated into the Program established in 1984 by the developer, shall be developed and implemented, to be reviewed by appropriate agencies for the Cienega Creek Natural Preserve prior to approval of any community plans, neighborhood plans or rezonings."

3. Review and approve any proposed additions or deletions to the nominated stream segment through PAG Regional Council. Should the community wish to extend or delete Unique Waters protection, the proposal should be reviewed and approved by the same procedure that produced this nomination.

4. Develop revegetation standards. Mitigation of sediment generation caused by construction, mining and maintenance of utility and transportation corridors should be addressed through revegetation as a non-point pollution control mechanism. Revegetation is also desirable for regrowth of roads and retired agricultural lands which are not designated for hiking trails and pedestrian/equestrian access. Standards should be developed as part of Pima County's management plan for Cienega Creek Natural Preserve. PCDOT and Pima County Department of Parks and Recreation are responsible.

5. Conduct biological inventories of aquatic plants, fish and macroinvertebrates and riparian plants and animals. The diversity of aquatic and riparian species is dependent on the quality and quantity of surface water flows. Additional biological inventories will provide a baseline for assessments of changes in the health of the ecosystem. Pima County Parks and Recreation Department and PCDOT are responsible for implementation, either through

the inventory phase of the Cienega Creek management plan or through encouraging research efforts which would provide this information.

6. Update the Water Quality Management Plan when new water quality regulations are implemented or the area-wide development occurs. The plan will also be reviewed for consistency with PAG's 208 Plan. PCDOT and PAG are responsible.

7. Submit an annual status report to PCDOT by PAG based on water resources and pollution source data collected in the Preserve.

State Administration

8. Designate surface water quality uses for the nominated stream segment. Full Body Contact (FBC) is a present use, albeit one that is dependent upon flood events scouring the channel to form pools of sufficient size and depth to allow swimming. Cienega Creek is a source of downstream drinking water through groundwater recharge. There are also a few active domestic wells (Southern Pacific, Jungle Domestic and Thompson) intercepting water from the river's alluvial channel deposits. Domestic Water Source (DWS), FBC, A&W, and AgL use designations would be appropriate protected uses for inclusion into ADEQ's surface water quality standards for the reach between Interstate Highway 10 and the dam in D-16-16-14.

9. Review available data to determine whether site-specific surface water quality standards should be proposed to insure continual water quality protection for base flows in Cienega Creek Natural Preserve. No standards exist for nutrients nitrogen, phosphate and phosphorus. There are no standards for two metals (nickel and beryllium). Total zinc and manganese concentrations are far below the existing standards for each constituent. The physical parameter turbidity is also adequately below the standard level of 10 turbidity units. ADEQ's Water Quality Standards Unit is responsible. Any site-specific standards proposed by ADEQ will be reviewed by EPAC.

Monitoring

10. Monitor water quality monitoring. Quarterly surface water sampling at Marsh Station Road should continue as proposed by ADEQ. This will provide additional information to support any site-specific standards, as well as providing a check on water quality standards compliance. Entercocci sampling would be needed by PCDOT and ADEQ to determine full-body contact compliance. Periodic groundwater and surface water quality analyses should continue by Montgomery and Associates (1990).

11. Monitor surface water flows and groundwater levels. PCDOT will continue to maintain flood gaging stations on Cienega Creek and its tributaries as part of its flood-warning system. Additional gages may be added to its tributaries or upstream of the Preserve if finances permit. PCDOT is also likely to continue monitoring base flows if necessary to obtain an instream flow permit from Arizona Department of Water Resources. Empirita Ranch should continue to conduct monthly groundwater level monitoring of wells upstream of and within the Preserve as indicated in the Empirita Ranch Area Plan. PCDOT should monitor water levels at the Del Lago #1 and Cienega wells.

Remediation

12. Mitigate the potential for roadway spill runoff to enter Cienega Creek at Interstate Highway 10. Ideally, runoff should be collected and disposed outside of the 100-year floodplain. Given the topographic constraints, this will not be possible. An alternative is to provide an area that could be easily blocked off to provide emergency retention of roadway spills. Responsible entities are ADOT (reconstruction of the drainage system), PCDOT (review of roadway drainage plans and provision of additional land, if necessary), and Arizona Department of Environmental Quality (ADEQ) (review of roadway drainage plans).

13. Remove oil from contaminated well (D-16-17-35dbc). Pima County Department of Transportation and Flood Control District, as the owner of the property, is responsible for removing the oil. Pima County DEQ will review any plan to remove the oil.

14. Develop maintenance and emergency response plans for Southern Pacific Railroad. Remediation of SPRR dumping and follow-up surveillance along SPRR right-of-way by ADEQ is needed. The potential for continued poor waste management and slow response to correct problems by SPRR will require continued effort by ADEQ. Southern Pacific Railroad, PCDOT, and Pima County Emergency Services are responsible for development of the emergency response plan. PAG is preparing a grant proposal for funding preparation of the plan. PAG EPAC will review any plans.

CHAPTER VIII

CONCLUSIONS

The portion of Cienega Creek lying downstream of Interstate Highway 10 and upstream of the underground dam structure in Township 16 South, Range 16 East, Section 14 should be designated as a Unique Water of the State of Arizona to provide enhanced water quality protection. The reach includes the perennial portions of the stream that lie within the Cienega Creek Natural Preserve. The nominated stream reach meets Unique Waters criteria because: 1) the water quality of the stream is consistently better than state standards, and 2) the reach is a rare ecological and recreational resource within the Tucson metropolitan area.

The nominated stream is of exceptional recreational and ecological significance because it is one of two remaining low-desert perennial streams in the Tucson area. Free-flowing water is a focal point for recreational activities in the Cienega Creek Natural Preserve. The stream flow and shallow groundwater table along the stream promote outstanding examples of mesquite bosques and cottonwood-willow gallery forest.

Available information indicates that existing water quality of base flows in the nominated reach is consistently better than state standards. Based on ADEQ's revised draft standards dated October 26, the water quality meets or exceeds aquatic and wildlife (warm-water) and full-body contact standards. However, since enterococci were sampled in combination with other species of fecal streptococci, a final determination whether the water quality meets the full-body contact standard cannot be made. At the time the sampling for this study was done, there was no entercocci standard for full body contact.

At this time, it is not known whether the stream provides essential habitat for species of national or state significance (a third Unique Waters criterion). Future biological monitoring studies will determine whether federally or state-listed species are present.

Although existing water quality is good, existing and planned land uses have the potential to degrade surface water quality. The nominated reach is particularly vulnerable to water quality degradation due to proximity of a major interstate highway and two railroad corridors. Due to the source-sink relationship between the alluvial deposits aquifer and the stream, pollution of surface flows could lead to contamination of groundwater and vice versa.

Implementation of the water quality management plan could reduce the potential for pollution. The water quality management recommendations include mitigating the potential for highway spills to enter Cienega Creek, development of an emergency response plan for railroad spills, and protection of existing surface quality water uses.

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APPENDIX A

UNIQUE WATERS STANDARDS

R18-11-109. Unique waters.

A. The classification of a navigable water as a unique water shall be by rule.

B. The Director may adopt, by rule, site-specific water quality standards to maintain and protect existing water quality in a unique water pursuant to R18-11-113. Pending adoption of site-specific water quality standards, a unique water shall be protected by the antidegradation provisions applicable to unique waters in R18-11-102.C, the narrative water quality standards prescribed in R18-11-103, and the numeric water quality standards prescribed in R18-11-104.

C. Any person may nominate a navigable water for classification as a unique water by filing a petition for rule adoption with the Department. A petition for rule adoption to classify a navigable water as a unique water shall include:

1. A map and a description of the navigable water;

2. A written statement in support of the nomination, including specific reference to the applicable criteria for unique waters classification as prescribed in Subsection D of this Section;

3. Supporting evidence demonstrating that one or more of the applicable unique waters criteria prescribed in Subsection D of this Section has been met; and

4. Available water quality data.

D. A navigable water may be classified as a unique water by the Director upon a finding that the navigable water meets one of the following criteria:

1. The navigable water constitutes an outstanding public resource because it is of exceptional recreational or ecological significance because of its unique attributes, including but not limited to, attributes related to the geology, flora, fauna, size, location, aesthetic values or wilderness characteristics of the navigable water.

Threatened or endangered species are known to be associated with the navigable water and the existing water quality is essential to the maintenance and propagation of the threatened or endangered species, or the navigable water provides critical or essential habitat for a threatened or endangered species. Endangered or threatened species may be recognized through state or federal actions, including but not limited to, actions taken pursuant to the Migratory Bird

Treaty Act as amended, 16 U.S.C. §701 et seq; the Endangered Species Act as amended, 16 U.S.C. §1531 et seq; actions taken by the Arizona Game and Fish Commission in placing a species on the list of "Threatened Native Wildlife of Arizona," (July 21, 1988) (and no future editions), which is incorporated by reference and on file with the Secretary of State and with the Department; and actions taken by the Commission of Agriculture and Horticulture by including a species for protection under the Arizona Native Plant Laws as prescribed in A.A.C. R3-1-615 and A.A.C. R3-1-616.

3. The existing water quality of the navigable water is consistently better than the water quality criteria prescribed by this Article to maintain and protect the aquatic and wildlife and full body contact designated uses.

E. The following navigable 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. Peeple's Canyon Creek, tributary to Santa Maria River;

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

5. Francis Creek, Mohave and Yavapai counties;

6. Bonita Creek, tributary to the upper Gila River;

7. Cienega Creek, from I-10 bridge to Colossal Cave Road, Pima County.

APPENDIX B

GROUNDWATER LEVELS IN CIENEGA CREEK NATURAL PRESERVE

GROUNDWATER LEVELS IN CIENEGA CREEK NATURAL PRESERVE

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level
D-16-16-03BCC					3,155	2.0		HISP	A	12/08/87		V		2,706.1	448.90
D-16-16-09AAB		Ab		914	3,178	1.0		ACTB	A	03/09/82		V		2,678.5	499.50
									A	12/08/87		V		2,689.2	488.80
D-16-16-09DCD2	Vail School	Active-Mun		759	3,235	1.0		ACTB, S	A	12/05/85		V		2,697.3	537.70
									A	05/28/86		V		2,695.3	539.70
									A	12/09/86		V		2,693.6	541.40
									A	06/03/87		V		2,691.6	543.40
									A	12/08/87		V		2,688.6	546.40
									A	12/08/87		V		2,688.6	546.40
									A	06/08/88		V		2,687.3	547.70
									A	12/08/88		V		2,686.2	548.80
D-16-16-10ACA		Ab		856	3,235	1.0		ACTB	A	03/09/82		V		2,718.5	516.50
									A	12/08/87		V		2,738.1	496.90
D-16-16-10DCB2		Ab		769	3,138	1.0		ACTB, S	A	03/09/82		V		2,723.3	414.70
									A	12/08/87		V		2,740.4	397.60
D-16-16-11ACA					3,355	1.5		HISP	A	12/08/87		V		3,145.1	209.90
D-16-16-11ACC		Active-Dom		750	3,345	0.5		HISP	A	12/23/81		V		2,919.5	425.50
									A	12/09/87		V		2,965.7	379.30
D-16-16-12DDA					3,680	2.0		HISP	A	12/09/87		V		3,568.6	111.40
D-16-16-13DBD					3,369	2.0		TCA	A	12/30/81		S		3,227.3	141.70
									A	12/09/87		S		3,232.2	136.78
D-16-16-14DDC	Del Lago #1	Unused-Mun	16	308	3,241	2.0	3,243.00	TCA		07/20/59		S		3,162.8	78.23
									PAG	10/27/88	10:28	V	54.83	3,178.2	52.83
										08/01/89					0.00
										09/01/89					0.00
									PCTFCD	10/03/89	14:51	V	68.49	3,174.5	66.49
									PAG	11/06/89	09:29	V	54.40	3,178.5	52.40
									PAG	12/06/89	14:41	V	68.78	3,174.2	66.78
									PAG	01/03/90	13:50	V	68.51	3,174.5	66.51
									PAG	02/01/90	12:34	V	67.40	3,175.6	65.40
									PAG	03/01/90	12:41	V	66.83	3,176.2	64.83
									PAG	04/04/90	08:18	V	66.26	3,176.7	64.26
									PAG	05/03/90	13:16	V	65.76	3,177.2	63.76
									PAG	06/04/90	13:47	V	68.12	3,174.9	66.12
									PAG	07/03/90	11:51	V	69.04	3,174.0	67.04
									PAG	07/11/90	10:37	V	69.08	3,173.9	67.08
									PAG	08/01/90	11:15	V	63.40	3,179.6	61.40
									PAG	09/05/90	12:14	V	64.06	3,178.9	62.06
									PAG	10/04/90	10:14	V	66.58	3,176.4	64.58
									PAG	11/01/90	07:59	V	67.67	3,175.3	65.67

GROUNDWATER LEVELS IN CIENEGA CREEK NATURAL PRESERVE

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level
D-16-16-15CBB	Del Lago #2	Active	16	604	3,265	1.5	3,266.50	ACTB, N	A	03/09/82		S		2,912.1	352.90
									A	12/08/87		V		2,935.4	329.60
									PAG	09/07/89	14:55	V	336.50	2,930.0	335.00
D-16-16-16ABA					3,230	1.0		HISP	A	12/09/87		V		2,682.0	548.00
D-16-15-21BDC	Vail Interchange Stock	Ab	6	629	3,262	0.5	3,262.50	TCA		12/26/46		S		2,685.5	576.47
										03/00/48		S		2,686.4	575.65
										08/19/48		S		2,686.0	575.99
										03/08/49		S		2,685.8	576.20
										03/19/56		S		2,680.0	582.03
										07/12/57		S		2,679.8	582.17
										03/10/58		S		2,679.2	582.83
										03/26/59		S		2,675.7	586.33
										04/20/60		S		2,672.6	589.40
										04/05/61		S		2,662.4	599.57
										03/29/62		S		2,662.0	600.05
										03/28/63		S		2,667.8	594.20
										08/21/63		S		2,671.9	590.08
										03/25/64		S		2,676.3	585.74
										04/01/65		S		2,679.2	582.77
										04/18/66		S		2,671.6	590.42
										03/09/67		S		2,677.3	584.71
										03/29/68		S		2,679.2	582.78
										03/13/69		S		2,686.5	575.53
										03/12/70		S		2,680.0	582.00
										03/02/71		S		2,678.4	583.62
										02/00/72				2,680.6	581.40
										11/08/72		V		2,671.1	590.90
										01/15/73		S		2,701.3	560.70
										02/07/74		S		2,680.1	581.90
										02/19/75		S		2,679.5	582.49
										02/00/76		S		2,678.4	583.65
										02/00/77		S		2,677.2	584.85
										02/00/78		S		2,672.3	589.70
										02/00/79		S		2,671.2	590.75
									A	12/08/87		V		2,690.0	572.00
										08/00/89					
										09/00/89					
										10/00/89					
										11/00/89					
									PAG	12/06/89	13:38	V	529.58	2,732.9	529.08
									PAG	01/03/90	13:19	V	529.81	2,732.7	529.31
									PAG	02/01/90	12:08	V	529.88	2,732.6	529.38
									PAG	03/01/90	12:04	V	530.00	2,732.5	529.50
										04/04/90					

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level
D-16-16-36ABC		Stock		NA	3,552	2.0		TCA		11/22/61		S		3,408.6	143.40
										03/29/62		S		3,409.6	142.44
										04/09/63		S		3,411.6	140.40
										03/25/64		S		3,412.7	139.30
									A	12/30/81		V		3,348.4	203.60
									A	12/08/87		V		3,412.8	139.60
D-16-16-36CAB	I-10 Stock	Ab	12	NA	3,527	1.5	3,528.5	TCA		12/22/81		S		3,440.8	86.19
									A	12/02/87		V		3,453.6	73.40
									PAG	08/01/89	08:35	V	86.42	3,442.1	84.92
									PAG	09/07/89	10:17	V	86.50	3,442.0	85.00
									PAG	10/04/89	10:19	V	87.00	3,441.5	85.50
									PAG	11/06/89	10:51	V	86.58	3,441.9	85.08
									PAG	12/06/89	10:16	V	86.75	3,441.8	85.25
									PAG	01/03/90	10:01	V	86.72	3,441.8	85.22
									PAG	02/01/90	09:12	V	86.75	3,441.8	85.25
									PAG	03/01/90	09:16	V	86.83	3,441.7	85.33
									PAG	04/04/90	09:36	V	86.95	3,441.6	85.45
									PAG	05/03/90	09:37	V	87.08	3,441.4	85.58
									PAG	06/05/90	10:35	V	87.18	3,441.3	85.68
									PAG	07/03/90	08:20	V	87.25	3,441.3	85.75
									PAG	07/11/90	07:33	V	87.25	3,441.3	85.75
									PAG	08/01/90	07:50	V	83.87	3,444.6	82.37
									PAG	09/05/90	09:15	V	87.18	3,441.3	85.68
D-16-17-08CBD		Domestic		155	3,418	1.0		HISP	A	12/23/81		V		3,404.4	13.60
									A	12/09/87		V		3,413.1	4.90
										08/01/89					
D-16-17-08CBD	La Posta Ranch	Ab	72	NA	3,408	1.0	3,409.00	TCA	PAG	09/07/89	13:58	V	10.12	3,398.9	9.29
									PAG	10/04/89	12:10	V	10.30	3,398.7	9.47
									PAG	11/06/89	09:55	V	8.93	3,400.1	8.10
									PAG	12/06/89	14:46	V	8.95	3,400.1	8.12
									PAG	01/03/90	14:22	V	8.59	3,400.4	7.76
									PAG	02/01/90	12:59	V	8.59	3,400.4	7.59
									PAG	03/01/90	13:07	V	8.46	3,400.5	7.46
									PAG	04/04/90	08:53	V	8.79	3,400.2	7.79
									PAG	05/03/90	13:47	V	9.54	3,399.5	8.54
									PAG	06/04/90	14:20	V	10.89	3,398.1	9.89
									PAG	07/03/90	12:23	V	11.45	3,397.6	10.45
									PAG	07/11/90	11:05	V	9.22	3,399.8	8.22
									PAG	08/01/90	11:51	V	1.08	3,407.9	0.08
									PAG	09/05/90	11:44	V	0.88	3,408.1	(0.12)
D-16-17-15DAB					3,565				A	12/09/87		V		3,481.1	83.90
D-16-17-15ADD		Ab		700	3,525				A	01/07/82		S		3,468.2	56.81
									A	12/09/87		V		3,497.5	27.50
D-16-17-20ADD					3,500				A	12/10/87		V		3,242.1	257.90

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level
D-16-17-20DAA	Nochehdehi #1 (South)	Unused	6	500	3,465	2.5	3,467.50	TCA	PAG	08/01/89	12:55	V	207.17	3,260.3	204.67
									PAG	09/07/89	15:17	V	202.50	3,265.0	200.00
									PAG	10/04/89	14:34	V	203.50	3,264.0	201.00
									PAG	11/06/89	13:30	V	189.37	3,278.1	186.87
		Unused Inactive		800	3,465	2.0	3,467.00	TCA	PAG	12/06/89	12:55	V	203.33	3,263.7	201.33
									PAG	01/03/90	12:48	V	238.72	3,228.3	236.72
									PAG	02/01/90	11:45	-	-	-	
										03/01/90					
D-16-17-22CBD	Windmill	Active		NA	3,535	0.0	3,535.00	TCA	A	01/06/82		S		3,525.0	9.96
									A	12/09/87		S		3,526.4	8.58
									PAG	08/03/89	10:33	V	9.17	3,525.8	9.17
									PAG	09/08/89	15:39	V	9.08	3,525.9	9.08
									PAG	10/04/89	14:12	V	8.92	3,526.1	8.92
									PAG	11/06/89	13:06	V	8.14	3,526.9	8.14
									PAG	12/06/89	12:27	V	9.08	3,525.9	9.08
									PAG	01/03/90	12:24	V	9.08	3,525.9	9.08
									PAG	02/01/90	11:26	V	8.72	3,526.3	8.72
									PAG	03/01/90	10:57	V	7.81	3,527.2	7.81
									PAG	04/04/90	13:54	V	6.99	3,528.0	6.99
									PAG	05/03/90	11:45	V	8.07	3,526.9	8.07
									PAG	06/04/90	13:02	V	9.35	3,525.7	9.35
									PAG	07/03/90	11:11	V	9.61	3,525.4	9.61
									PAG	07/11/90	09:56	V	8.53	3,526.5	8.53
									PAG	08/01/90	10:28	V	5.90	3,529.1	5.90
									PAG	09/05/90	11:35	V	6.20	3,528.8	6.20
D-16-17-31BDD	Davidson #1	Ab	12	150	3,400	2.0	3,402.00	TCA	PAG	08/01/89	09:26	V	25.58	3,376.4	23.58
									PAG	09/07/89	11:12	V	27.25	3,374.8	25.25
									PAG	10/04/89	09:39	V	25.45	3,376.6	23.45
									PAG	11/06/89	11:35	V	23.56	3,378.4	21.56
									PAG	12/05/89	11:01	V	25.32	3,376.7	23.32
									PAG	01/03/90	10:43	V	25.35	3,376.7	23.35
									PAG	02/01/90	10:00	V	25.42	3,376.6	23.42
									PAG	03/01/90	09:56	V	25.46	3,376.5	23.46
									PAG	04/04/90	14:53	V	25.45	3,376.6	23.45
									PAG	05/03/90	10:23	V	25.68	3,376.3	23.68
									PAG	06/04/90	11:32	V	26.04	3,376.0	24.04
									PAG	07/03/90	08:30	V	26.11	3,375.9	24.11
									PAG	07/11/90	08:18	V	25.19	3,376.8	23.19
									PAG	08/01/90	08:40	V	24.37	3,377.6	22.37
									PAG	09/05/90	10:06	V	23.52	3,378.5	21.52
D-16-17-31DCB	Davidson #2	Ab	16	NA	3,457	0.8	3,457.80	TCA		12/22/81		S		3,441.2	15.80
										12/03/87		S		3,436.3	20.72
									PAG	08/01/89	08:32	V	18.17	3,439.6	17.37
									PAG	09/07/89	10:37	V	18.88	3,438.9	18.08
									PAG	10/04/89	09:05	V	19.75	3,438.1	18.95
									PAG	11/06/89	11:08	V	18.67	3,439.1	17.87
									PAG	12/05/89	10:36	V	19.25	3,438.6	18.45

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level
									PAG	01/03/90	10:17	V	19.36	3,438.4	18.56
									PAG	02/01/90	09:34	V	19.79	3,438.0	18.99
									PAG	03/01/90	09:30	V	19.83	3,438.0	19.03
									PAG	04/04/90	14:25	V	20.96	3,436.8	20.16
									PAG	05/03/90	09:57	V	22.00	3,435.8	21.20
									PAG	06/04/90	10:58	V	23.12	3,434.7	22.32
									PAG	07/03/90	07:54	V	23.62	3,434.2	22.82
									PAG	07/11/90	07:48	V	18.86	3,438.9	18.06
									PAG	08/01/90	08:07	V	14.63	3,443.2	13.83
									PAG	09/05/90	09:36	V	12.96	3,444.8	12.16
									PAG	10/04/90	08:52	V	16.38	3,441.4	15.58
D-16-17-33ABB	Cienega	Unused	12	80	3,428	1.5	3,429.50	TCA	A	01/07/82		S		3,412.9	15.14
									A	12/09/87		S		3,412.6	15.44
									PAG	08/01/89	10:59	V	17.08	3,412.4	15.58
									PAG	09/07/89	18:14	V	16.92	3,412.6	15.42
									PAG	10/04/89	13:44	V	17.52	3,412.0	16.02
									PAG	11/06/89	12:32	V	15.27	3,414.2	13.77
									PAG	12/06/89	11:57	V	15.94	3,413.6	14.44
									PAG	01/03/90	11:43	V	16.01	3,413.5	14.51
									PAG	02/01/90	10:52	V	16.07	3,413.4	14.57
									PAG	03/01/90	11:23	V	15.75	3,413.8	14.25
									PAG	04/04/90	10:21	V	15.42	3,414.1	13.92
									PAG	05/03/90	11:12	V	15.92	3,413.6	14.42
									PAG	06/04/90	12:26	V	17.19	3,412.3	15.69
									PAG	07/03/90	10:45	V	18.30	3,411.2	16.80
									PAG	07/11/90	09:32	V	16.37	3,413.1	14.87
									PAG	08/01/90	09:50	V	15.28	3,414.2	13.78
									PAG	08/28/90	08:48	V	16.62	3,412.9	15.12
									PAG	09/05/90	11:10	V	16.90	3,412.6	15.40
									PAG	10/04/90	09:27	V	17.33	3,412.2	15.83
									PAG	11/01/90	08:39	V	17.19	3,412.3	15.69
D-17-16-10AAA		Ab		825	3,560					12/21/81		S		3,537.6	22.36
									A	12/02/87		S		3,535.9	24.08
D-17-16-14BBD		Ab		NA	3,704					11/07/72		V		3,650.8	53.20
									A	12/21/81		S		3,664.2	39.80
									A	04/01/82		S		3,663.5	40.50
									A	12/02/87		V		3,661.1	42.90

FOOTNOTES:

(1) - Ab: Abandoned well; non-equipped and sometimes uncapped
Unused-Mun: Unused municipal; non-equipped

(2) - Land surface elevation from USGS topographic maps, USGS and ADWR database files

GROUNDWATER LEVELS IN CIENEGA CREEK NATURAL PRESERVE

Well Location	Well Name	Status (1)	Casing Diameter	Well Depth	Land Surface Elevation (2)	Measuring Point Height (3)	Measuring Point Elevation	Measuring Point Description (4)	Measured By (5)	Water Level Date Measurement (M/D/YR)	Time (HRS/MIN)	Measured With (6)	Depth to Water at Measuring Point	Elevation of Static Water Level	Depth to Static Water Level

(3) - ADWR GWSI database file

(4) - Source of information was ADWR Basic Data Section
HISP: Hole in submersible cap plate
TCA: Top of casing

(5) - A: Arizona Department of Water Resources
PAG: Pima Association of Governments
PCTFCD: Pima County Transportation and Flood Control District

(6) - V: Electric sounder
S: Steel tape

APPENDIX C

SURFACE WATER QUALITY STANDARDS

R18-11-104. Numeric water quality standards

A. The water quality criteria prescribed in this Section apply to all navigable waters except effluent dominated waters.

B. The ambient water quality criteria for pollutants prescribed in Appendix A shall not be exceeded. Concentrations are expressed in micrograms per liter (µg/l) except where otherwise indicated.

C. The following ambient water quality criteria for microbiological pollutants, expressed in colony forming units per 100 milliliters of water (cfu/100ml), shall not be exceeded:

1. Fecal Coliform	DWS	IHC,A&W(all),AgI,AgL
Geometric mean (5 sample minimum)	20	1000
Single sample maximum	90	4000

2. Enterococci	FBC	Other uses
Geometric mean (5 sample minimum)	20	NS
Single sample maximum	90	NS

D. The following ambient water quality criteria for pH, expressed in standard units, shall not be exceeded:

pH	DWS	A&W(all)	AgI	AgL
Maximum	9.0	9.0	9.0	9.0
Minimum	5.0	6.5	4.5	6.5
Maximum change due to discharge	NS	0.5	NS	NS

E. The following maximum allowable increase in ambient water temperature, expressed in degrees Celsius, shall not be exceeded:

Temperature	A&W(w)	A&W(c)	Other uses
Maximum increase due to discharge	3.0	1.0	NS

F. The following ambient water quality criteria for turbidity, expressed in nephelometric turbidity units (NTU), shall not be exceeded:

Turbidity	FBC,IHC,A&W(w)	A&W(c)	Other uses
Streams, canals and other flowing waters	50	10	NS
Lakes, reservoirs and ponds	25	10	NS

G. The following are the ambient water quality criteria for dissolved oxygen (O_2), expressed in milligrams per liter (mg/l). The dissolved oxygen concentration in a navigable water shall not fall below the following minimum concentration:

Dissolved O_2	A&W(w)	A&W(c)	Other uses
Minimum concentration	6.0	7.0[1]	NS

[1] Or 90% saturation whichever is greater

H. The following ambient water quality criteria for total phosphorus and total nitrogen, expressed in milligrams per liter (mg/l), shall not be exceeded:

	Annual mean	90th percentile	Single Sample Maximum
Verde River and its tributaries from headwaters to Bartlett Lake			
Total phosphorus	0.10	0.30	1.00
Total nitrogen	1.00	1.50	3.00
White River, Black River,Tonto Creek and their tributaries			
Total phosphorus	0.10	0.20	0.80
Total nitrogen	0.50	1.00	2.00
Salt River and its tributaries, except Pinal Creek, from the confluence of the White and Black Rivers to Theodore Roosevelt Lake			
Total phosphorus	0.12	0.30	1.00
Total nitrogen	0.60	1.20	2.00

R18-11-103. Narrative water quality standards

A. All navigable waters shall be free from pollutants that:

1. Settle to form bottom deposits that adversely affect aquatic life, impair recreational uses or are unsightly;.

2. Cause off-taste or odor in the water or off-flavor in aquatic organisms or waterfowl;

3. Are present in amounts or in combinations that are toxic to humans, animals, plants or other organisms;

4. Cause excessive or nuisance growth of algae or aquatic plants;

5. Cause or contribute to a violation of an aquifer water quality standard as prescribed in A.A.C. R18-11-405 or A.A.C. R18-11-406; or

6. Produce objectionable color in the water.

B. All navigable waters shall be free from oil, grease and other floating pollutants that are unsightly, cause a deposit on a shoreline or bank, cause a film or iridescent appearance on the surface of the water, adversely affect aquatic life, or that impair recreational uses.

PARAMETER	DWS (ug/l)	DWS/FC (ug/l)	FC (ug/l)	FBC (ug/l)	IHC (ug/l)	A&Wc ACUTE[1] (ug/l)	A&Wc CHRONIC[2] (ug/l)	A&Ww ACUTE[1] (ug/l)	A&Ww CHRONIC[2] (ug/l)	EPH A&W ACUTE[1] (ug/l)	EPH A&W CHRONIC[2] (ug/l)	AgI (ug/l)	AgL (ug/l)
2-methyl-4,6-dinitrophenol	1370	1300	20000	55000	NS	69	19	69	19	940	260	NS	NS
2-sec-butyl-4,6-dinitrophenol	7.0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
4-chloro-3-methylphenol	NS	NS	NS	NS	NS	9	2.49	9	2.5	28600	7900	NS	NS
Acenaphthene	NS	NS	NS	NS	8400	510	140	510	140	12400	3400	NS	NS
Acenaphthylene	0.003	0.001	0.002	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Acrolein	550	260	480	1300	1300	20	5.6	20	5.6	20	6	NS	NS
Acrylonitrile (c)	0.06	q	0.41	2.6	1400	2300	630	2300	630	2300	630	NS	NS
Aldrin (c)	0.002	q	0.0001	0.08	4.2	3	NS	2	NS	2.0	NS	NS	NS
Ammonia	NS	NS	NS	NS	NS	a	a	a	a	NS	NS	NS	NS
Anthracene	0.003	0.0008	0.001	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Antimony	14	13	140	56	56	88 D	30 D	88 D	30 D	1000 D	290 D	NS	NS
Arsenic (c)	50 D	0.02 D	1.5 D	0.80 D	2800 D	360 D	190 D	340 D	140 D	440 D	230 D	2000 T	200 T
Arsenic V	NS D	NS D	NS D	NS D	2800 D	260 D	71 D	260 D	71 D	260 D	71 D	NS	NS
Asbestos	30,000 f/l	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Barium	1000 D	NS D	NS D	1000 D	NS D	NS	NS	NS	NS	NS	NS	NS	NS
Benzene (c)	5.0	q	93	48	470	1590	440	6600	1800	90000	24900	NS	NS
Benzidine (c)	0.0001	q	0.0004	0.006	420	750	210	750	210	6000	1660	NS	NS
Benzo (a) anthracene	0.003	0.0004	0.0004	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzo (a) pyrene (c)	0.003	q	0.001	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzo (ghi) perylene	0.003	0.00001	0.00001	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzo (k) fluoranthene	0.003	0.00003	0.00003	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Benzofluoranthene-3,4	0.003	0.003	NS	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Beryllium (c)	0.008	q	0.13	0.33	700	39 D	5.3 D	39 D	5.3 D	340 D	93 D	NS	NS
BHC-alpha (c)	0.006	q	0.01	0.22	NS	30	8.3	30	8.3	30	8.3	NS	NS
BHC-beta (c)	0.019	q	0.02	0.78	NS	950	260	950	260	950	260	NS	NS
BHC-delta	NS	NS	NS	NS	NS	950	260	950	260	950	260	NS	NS
BHC-gamma(lindane) (c)	0.03	q	0.006	1.0	2500	2	0.08	4	0.32	1.0	0.08	NS	NS
Bis(2-chloroethoxy) methane	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Bis(2-chloroethyl) ether (c)	0.03	q	0.89	1.3	NS	71400	5700	71400	5700	71400	19800	NS	NS
Bis(2-chloroisopropyl) ether	1400	1300	24000	5600	5600	NS	NS	NS	NS	NS	NS	NS	NS
Bis-(2-ethylhexyl) phthalate (c)	2.5	1.2	2.4	100	280000	400	360	400	360	27	7.4	NS	NS
Boron	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1000 T	NS
Bromoform	5.7	5.7	NS	230	2800	8800	2400	8800	2400	14000	3900	NS	NS
Bromophenyl phenyl ether-4	NS	NS	NS	NS	NS	110	30	110	30	110	30	NS	NS
Butyl benzyl phthalate	7000	2200	3200	28000	28000	990	66	990	66	5600	1500	NS	NS
Cadmium (c)	10 T	NS	NS	NS	70 T	b D	b D	b D	b D	b D	b D	50 T	50 T
Carbon tetrachloride (c)	5.0	q	3.6	11	8000	10600	2900	10600	2900	10600	2900	NS	NS
Chlordane (c)	0.03	q	0.0007	1.1	111	2.4	0.0043	0.67	0.0043	1.5	0.0043	NS	NS
Chlorobenzene	NS	NS	NS	NS	2800	5900	1600	5900	1600	NS	NS	NS	NS
Chlorodibromomethane	5.7	5.3	77	230	2800	NS	NS	NS	NS	NS	NS	NS	NS
Chloroethane	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chloroethyl vinyl ether-2	NS	NS	NS	NS	NS	106000	29400	106000	29400	NS	NS	NS	NS

PARAMETER	DWS (ug/l)	DWS/FC (ug/l)	FC (ug/l)	FBC (ug/l)	IHC (ug/l)	A&Wc ACUTE[1] (ug/l)	A&Wc CHRONIC[2] (ug/l)	A&Ww ACUTE[1] (ug/l)	A&Ww CHRONIC[2] (ug/l)	EPH A&W ACUTE[1] (ug/l)	EPH A&W CHRONIC[2] (ug/l)	AgI (ug/l)	AgL (ug/l)
Chloroform (c)	5.7	q	350	230	1400	8700	2400	8700	2400	8700	2400	NS	NS
Chloronapthalene-2	NS	NS	NS	NS	11200	NS	NS	NS	NS	NS	NS	NS	NS
Chlorophenol-2	175	150	1400	700	700	1300	360	1300	360	1300	360	NS	NS
Chlorophenyl phenyl ether-4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chromium III	50 D	35000 D	NS D	140000 D	140000 D	d D	d D	d D	d D	d D	d D	NS	NS
Chromium VI (c)	175 D	? D	54000 D	700 D	700 D	16 D	11 D	15 D	1.5 D	14 D	10 D	1000 T	1000 T
Chromium III + VI	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Chrysene	0.003	0.0001	0.0002	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Copper	1000 D	NS D	NS D	NS D	5200 D	e D	e D	e D	e D	e D	e D	5000 T	500 T
Cyanide (Free)	700	700	210000	3100	3100	22	5.2	46	6.7	32	7.4	NS	0.2
Dalapon	200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DDD (c)	0.15	q	NS	5.8	NS	1.1	0.001	0.7	0.009	0.47	0.01	NS	NS
DDE (c)	0.1	q	NS	4.1	NS	1.1	0.001	0.7	0.009	0.47	0.01	NS	NS
DDT (c)	0.1	q	0.0003	4.1	700	1.1	0.001	0.7	0.009	0.47	0.01	NS	NS
Dibenzo (ah) anthracene	0.003	0.00002	0.00002	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dichlorobenzene-1,2	3150	2000	5400	12600	12600	470	130	730	200	730	200	NS	NS
Dichlorobenzene-1,3	470	330	1200	12600	12600	1500	420	1500	420	8400	2300	NS	NS
Dichlorobenzene-1,4	4.0	410	3100	NS	12600	340	93	1200	330	3300	910	NS	NS
Dichlorobenzidine-3,3	0.02	0.01	0.02	0.83	NS	NS	NS		NS	NS	NS	NS	NS
Dichlorobromomethane	5.7	5.3	77	230	2800	NS	NS	NS	NS	NS	NS	NS	NS
Dichloroethane-1,1	NS	NS	NS	NS	14000	NS	NS	NS	NS	NS	NS	NS	NS
Dichloroethane-1,2 (c)	5.0	q	120	15	10400	35400	9800	35400	9800	65400	18100	NS	NS
Dichloroethylene-1,1 (c)	7.0	q	1.1	2.3	1260	9100	2500	9100	2500	9100	2500	NS	NS
Dichloroethylene-1,2-trans	700	680	19000	2800	2800	40500	11200	40500	11200	NS	NS	NS	NS
Dichlorophenol-2,4	105	87	520	420	420	600	170	600	170	780	220	NS	NS
Dichlorophenoxyacetic acid	100	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dichloropropane-1,2	NS	NS	NS	NS	200	15800	4400	15800	4400	15800	4400	NS	NS
Dichloropropene-1,3 (c)	0.19	q	12	7.8	60	1800	73	1800	73	1800	510	NS	NS
Dieldrin (c)	0.002	q	0.0001	0.09	7	2.5	0.0019	1.84	0.0019	0.35	0.082	NS	NS
Diethyl phthalate	28000	20000	74000	112000	112000	15600	4300	15600	4300	15600	4300	NS	NS
Dimethyl phthalate	350000	290000	1900000	14000000	NS	9900	2700	9900	2700	9900	2700	NS	NS
Dimethylphenol-2,4	NS	NS	NS	NS	NS	640	180	640	180	640	180	NS	NS
Dinitrophenol-2,4	70	68	2700	280	280	190	51	190	51	1300	360	NS	NS
Dinitrotoluene-2,4	0.009	0.006	0.01	0.38	NS	9300	2600	9300	2600	10500	2900	NS	NS
Dinitrotoluene-2,6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		NS	NS
Dioxin	0.0000002	0.000000003	0.000000003	NS	NS	0.003	0.000002	0.072	0.000002	0.06	0.005	NS	NS
Diphenylhydrazine-1,2 (c)	0.04	q	0.16	1.8	NS	81	22	81	22	1200	340	NS	NS
Diquat	20	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Di-n-butyl phthalate	3500	100	100	14000	14000	280	78	280	78	630	170	NS	NS
Di-n-octyl phthalate	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Di-(ethylhexyl) adipate	500	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Endosulfan sulfate	NS	NS	NS	NS	NS	0.22	0.056	0.28	0.071	0.17	0.087	NS	NS

PARAMETER	DWS (ug/l)	DWS/FC (ug/l)	FC (ug/l)	FBC (ug/l)	IHC (ug/l)	A&Wc ACUTE[1] (ug/l)	A&Wc CHRONIC[2] (ug/l)	A&Ww ACUTE[1] (ug/l)	A&Ww CHRONIC[2] (ug/l)	EPH A&W ACUTE[1] (ug/l)	EPH A&W CHRONIC[2] (ug/l)	AgI (ug/l)	AgL (ug/l)
Endosulfan-alpha	1.8	0.40	0.51	70	NS	0.22	0.056	0.28	0.071	0.17	0.087	NS	NS
Endosulfan-beta	1.8	0.40	0.51	70	NS	0.22	0.056	0.28	0.071	0.17	0.087	NS	NS
Endothall	100	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Endrin	0.2	1.8	2.2	40	40	0.18	0.0023	0.16	0.079	0.16	0.08	NS	NS
Endrin aldehyde	11	10	NS	420	NS	0.18	0.0023	0.16	0.079	0.16	0.08	NS	NS
Ethylbenzene	3500	3300	72000	63600	63600	13600	130	13600	130	22500	6200	NS	NS
Fluoranthene	200	30	35	5600	5600	1200	330	1200	330	16300	4500	NS	NS
Fluorene	0.003	0.001	0.002	0.12	5600	NS	NS	NS	NS	NS	NS	NS	NS
Fluoride	4000	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Glyphosate	700	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Heptachlor epoxide (c)	0.004	q	0.00008	0.15	2	0.52	0.0038	0.31	0.036	0.45	0.051	NS	NS
Heptachlor (c)	0.008	q	0.0002	0.31	20	0.52	0.0038	0.31	0.036	0.45	0.051	NS	NS
Hexachlorobenzene	0.02	0.002	0.003	0.83	100	1.8	0.3	6	3.7	2.1	0.58	NS	NS
Hexachlorobutadiene (c)	0.45	q	0.01	18	280	27	7.5	27	7.5	63	17	NS	NS
Hexachlorocyclopentadiene	250	180	640	1000	1000	2	0.6	2	0.6	14	4	NS	NS
Hexachloroethane (c)	2.5	q	2.3	100	140	290	81	290	81	510	140	NS	NS
Indeno (1,2,3-cd) pyrene	0.003	0.00003	0.00003	0.12	NS	NS	NS	NS	NS	NS	NS	NS	NS
Isophorone	7000	6800	310000	28000	28000	35100	9700	35100	9700	35100	9700	NS	NS
Lead (c)	50 D	NS	NS	NS	NS	f D	f D	f D	f D	f D	f D	10000 T	100 T
Manganese	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	10000	NS
Mercury	2.0 T	0.97 T	1.1 T	42 T	42 T	2.4 T	0.012 T	2.2 T	0.012 T	1.3 T	0.67 T	NS	10 T
Methoxychlor	100	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Methyl bromide	49	48	3000	200	200	3300	910	3300	910	NS	NS	NS	NS
Methyl chloride	5.7	5.7	590	230	2800	165000	45700	165000	45700	67200	18600	NS	NS
Methylene chloride (c)	4.7	q	NS	190	26500	58000	16000	58000	16000	NS	NS	NS	NS
Naphthalene	NS	NS	NS	NS	560	690	190	2000	550	2600	710	NS	NS
Nickel	700 D	170 D	220 D	2800 D	2800 D	g D	g D	g D	g D	g D	g D	NS	NS
Nitrate	10000	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrobenzene	17	17	380	70	70	8100	2200	8100	2200	8100	2200	NS	NS
Nitrophenol-2	NS	NS	NS	NS	NS	1300	360	1300	360	1300	360	NS	NS
Nitrophenol-4	NS	NS	NS	NS	NS	2500	690	2500	690	4100	1100	NS	NS
N-nitrosodimethylamine (c)	0.007	q	NS	0.27	NS	NS	NS	NS	NS	NS	NS	NS	NS
N-nitrosodiphenylamine (c)	7.1	q	7.9	290	NS	1800	490	1800	490	2300	640	NS	NS
N-nitrosodi-n-propylamine (c)	0.005	q	0.26	0.20	NS	NS	NS	NS	NS	NS	NS	NS	NS
Oxamyl	200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PCBs (c)	0.004	q	0.0004	0.18	NS	2	0.014	0.43	0.014	1.0	0.23	NS	NS
Pentachlorophenol	1000	870	5100	2000	2000	h	h	h	h	h	h	NS	NS
Phenanthrene	0.003	0.0003	0.0003	0.12	NS	30	6.3	29	4.8	32	0.36	NS	NS
Phenol	21000	21000	6500000	84000	84000	3100	850	4200	1200	4200	1200	NS	NS
Pichloram	500	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Pyrene	0.003	0.001	0.002	0.12	4200	NS	NS	NS	NS	NS	NS	NS	NS
Selenium	10 D	NS D	NS D	NS D	420 D	20 D	2 D	11 D	2 D	33 D	2.0 D	20 T	50 T

PARAMETER	DWS (ug/l)	DWS/FC (ug/l)	FC (ug/l)	FBC (ug/l)	IHC (ug/l)	A&Wc ACUTE[1] (ug/l)	A&Wc CHRONIC[2] (ug/l)	A&Ww ACUTE[1] (ug/l)	A&Ww CHRONIC[2] (ug/l)	EPH A&W ACUTE[1] (ug/l)	EPH A&W CHRONIC[2] (ug/l)	AgI (ug/l)	AgL (ug/l)
Silver	50 D	95 D	1000 D	420 D	420 D	0.92 D	0.12 D	0.9 D	0.11 D	1.1 D	0.14 D	NS	NS
Simazene	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sulfides	NS	NS	NS	NS	NS	0.1 T	NS T	0.1 T	NS T	0.1 T	NS T	NS	NS
Tetrachloroethane-1,1,2,2 (c)	0.17	q	11	7.0	450	2800	770	2800	770	2800	770	NS	NS
Tetrachloroethylene	0.88	0.79	8.0	35	4000	1600	440	3900	1100	5300	1500	NS	NS
Thallium	19000 D	19000 D	NS D	10 D	10 D	420 D	17 D	420 D	17 D	420 D	120 D	NS	NS
Toluene	10000	9400	87000	42000	42000	5300	1500	5300	1500	41100	11400	NS	NS
Toxaphene (c)	5.0	q	0.0006	1.3	1000	0.73	0.0002	0.71	0.017	0.65	0.015	NS	NS
Trichlorobenzene-1,2,4	NS	NS	NS	NS	2800	450	130	1000	280	NS	NS	NS	NS
Trichloroethane-1,1,1	200	3100	160000	12600	12600	15800	4400	15800	4400	159000	44000	NS	NS
Trichloroethane-1,1,2 (c)	0.6	q	31	25	560	10800	3000	10800	3000	10800	3000	NS	NS
Trichloroethylene (c)	5.0	2.6	50	110	NS	12200	3400	12200	3400	13500	3700	NS	NS
Trichlorophenol-2,4,5	10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trichlorophenol-2,4,6 (c)	3.2	q	3.2	130	NS	96	27	96	27	1800	490	NS	NS
Uranium	35 D	NS D	NS D	NS D	NS D	NS	NS	NS	NS	NS	NS	NS	NS
Vinyl chloride	2.0	2.0	620	81	NS	NS	NS	NS	NS	NS	NS	NS	NS
Zinc	5000 D	NS D	NS D	NS D	28000 D	i D	i D	i D	i D	i D	i D	10000 T	25000 T

Ammonia

A&Wc Acute[1]

Ammonia mg-N/liter (or mg NH3-N/liter)

pH	Temperature in C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30 and above	pH
6.5	29	28	28	27	27	27	27	26	26	26	25	25	25	25	25	24	24	24	24	24	24	16.6	11.8	6.5
6.6	28	27	27	27	26	26	26	25	25	25	25	24	24	24	24	24	24	23	23	23	23	16.2	11.4	6.6
6.7	27	27	26	26	26	25	25	25	24	24	24	24	23	23	23	23	23	23	23	22	22	15.6	11.1	6.7
6.8	26	25	25	25	24	24	24	24	23	23	23	23	23	22	22	22	22	22	22	22	21	15.0	10.6	6.8
6.9	25	24	24	24	23	23	23	22	22	22	22	22	21	21	21	21	21	21	21	21	20	14.3	10.1	6.9
7.0	23	23	22	22	22	22	21	21	21	21	20	20	20	20	19.9	19.7	19.6	19.5	19.4	19.3	19.2	13.4	9.5	7.0
7.1	22	21	21	21	20	20	19.9	19.6	19.5	19.3	19.1	18.9	18.8	18.6	18.5	18.4	18.3	18.2	18.1	18.0	17.9	12.5	8.9	7.1
7.2	19.8	19.6	19.2	19.0	18.8	18.5	18.4	18.1	17.9	17.8	17.6	17.5	17.3	17.2	17.0	16.9	16.8	16.7	16.7	16.6	16.5	11.6	8.2	7.2
7.3	18.0	17.8	17.5	17.3	17.1	16.9	16.7	16.5	16.3	16.2	16.0	15.9	15.8	15.6	15.5	15.4	15.3	15.2	15.2	15.1	15.0	10.6	7.5	7.3
7.4	16.2	16.0	15.7	15.5	15.3	15.1	15.0	14.8	14.6	14.5	14.4	14.3	14.1	14.0	13.9	13.8	13.8	13.7	13.6	13.6	13.5	9.5	6.7	7.4
7.5	14.3	14.1	13.9	13.7	13.6	13.4	13.3	13.1	13.0	12.8	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.1	12.1	12.0	8.4	6.0	7.5
7.6	12.5	12.3	12.2	12.0	11.9	11.7	11.6	11.5	11.4	11.2	11.2	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.5	7.4	5.3	7.6
7.7	10.8	10.7	10.5	10.4	10.3	10.1	10.0	9.9	9.8	9.7	9.6	9.6	9.5	9.5	9.3	9.3	9.2	9.2	9.2	9.1	9.1	6.4	4.6	7.7
7.8	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.9	7.8	7.8	5.5	4.0	7.8
7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.2	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.7	6.7	6.7	6.6	6.6	4.7	3.4	7.9
8.0	6.5	6.4	6.4	6.3	6.2	6.1	6.1	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.6	4.0	2.9	8.0
8.1	5.2	5.1	5.1	5.0	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6	4.6	4.6	4.6	4.5	4.5	4.9	4.5	4.5	4.5	3.2	2.3	8.1
8.2	4.2	4.1	4.0	4.0	4.0	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	2.6	1.89	8.2
8.3	3.3	3.3	3.2	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.1	1.55	8.3
8.4	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.4	1.71	1.27	8.4
8.5	2.1	2.1	2.1	2.0	2.0	2.0	1.98	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.90	1.90	1.90	1.90	1.90	1.91	1.92	1.41	1.05	8.5
8.6	1.68	1.66	1.65	1.63	1.61	1.60	1.59	1.58	1.57	1.56	1.55	1.55	1.54	1.54	1.54	1.54	1.54	1.55	1.55	1.56	1.57	1.16	0.88	8.6
8.7	1.35	1.33	1.32	1.31	1.30	1.29	1.28	1.27	1.26	1.26	1.25	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.27	1.28	1.29	0.96	0.74	8.7
8.8	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.05	1.06	1.07	0.81	0.63	8.8
8.9	0.87	0.86	0.86	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.84	0.84	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.69	0.55	8.9
9.0	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.69	0.69	0.70	0.70	0.71	0.72	0.73	0.74	0.75	0.59	0.48	9.0

A&Wc Chronic[2]

Ammonia mg-N/liter (or mg NH3-N/liter)

pH	Temperature in C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30 and above	pH
6.5	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	1.64	1.51	1.42	1.31	1.22	0.85	0.79	6.5
6.6	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	1.64	1.52	1.42	1.31	1.22	0.85	0.79	6.6
6.7	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	1.64	1.53	1.42	1.31	1.22	0.85	0.80	6.7
6.8	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.80	1.78	1.77	1.64	1.53	1.41	1.32	1.22	0.85	0.80	6.8
6.9	2.1	2.0	2.0	2.0	1.97	1.94	1.91	1.89	1.88	1.85	1.84	1.82	1.81	1.80	1.78	1.77	1.64	1.53	1.42	1.32	1.22	0.85	0.80	6.9
7.0	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.89	1.88	1.86	1.84	1.83	1.81	1.79	1.78	1.77	1.65	1.53	1.41	1.31	1.22	0.85	0.80	7.0
7.1	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.89	1.88	1.86	1.84	1.83	1.81	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23	0.86	0.80	7.1
7.2	2.1	2.1	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.85	1.83	1.81	1.80	1.78	1.77	1.65	1.53	1.42	1.32	1.23	0.86	0.80	7.2
7.3	2.1	2.1	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.85	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23	0.86	0.81	7.3
7.4	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.90	1.88	1.86	1.85	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23	0.86	0.81	7.4
7.5	2.1	2.1	2.0	2.0	1.97	1.95	1.92	1.91	1.88	1.86	1.85	1.83	1.82	1.81	1.79	1.78	1.65	1.54	1.43	1.33	1.23	0.86	0.81	7.5
7.6	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.91	1.89	1.87	1.85	1.84	1.82	1.81	1.80	1.79	1.66	1.54	1.43	1.33	1.23	0.87	0.82	7.6
7.7	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.91	1.89	1.87	1.85	1.84	1.82	1.82	1.79	1.79	1.66	1.54	1.43	1.33	1.24	0.87	0.82	7.7
7.8	1.78	1.75	1.73	1.71	1.69	1.67	1.65	1.63	1.61	1.60	1.58	1.57	1.57	1.55	1.54	1.53	1.42	1.32	1.23	1.14	1.07	0.75	0.71	7.8
7.9	1.50	1.48	1.46	1.44	1.42	1.41	1.39	1.38	1.36	1.35	1.34	1.34	1.32	1.32	1.30	1.30	1.21	1.12	1.04	0.97	0.90	0.64	0.46	7.9
8.0	1.26	1.24	1.22	1.21	1.19	1.18	1.17	1.15	1.14	1.14	1.13	1.12	1.11	1.10	1.10	1.09	1.01	0.94	0.88	0.82	0.76	0.54	0.39	8.0
8.1	1.00	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.92	0.91	0.90	0.89	0.89	0.88	0.88	0.87	0.81	0.81	0.70	0.66	0.61	0.44	0.32	8.1
8.2	0.80	0.78	0.77	0.77	0.76	0.75	0.74	0.73	0.73	0.72	0.72	0.71	0.71	0.71	0.70	0.70	0.65	0.61	0.56	0.53	0.49	0.35	0.26	8.2
8.3	0.64	0.63	0.62	0.61	0.60	0.60	0.59	0.59	0.58	0.58	0.58	0.57	0.57	0.57	0.56	0.56	0.52	0.49	0.45	0.42	0.40	0.29	0.21	8.3
8.4	0.51	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.45	0.42	0.39	0.37	0.34	0.32	0.23	0.17	8.4
8.5	0.40	0.40	0.40	0.39	0.39	0.38	0.38	0.38	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.34	0.32	0.30	0.28	0.26	0.19	0.14	8.5
8.6	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.28	0.26	0.24	0.23	0.21	0.16	0.12	8.6
8.7	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.23	0.21	0.20	0.19	0.18	0.13	0.10	8.7
8.8	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.19	0.17	0.16	0.15	0.15	0.11	0.09	8.8
8.9	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.14	0.14	0.13	0.12	0.09	0.07	8.9
9.0	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.13	0.12	0.11	0.11	0.10	0.08	0.07	9.0

A&W Acute[1]

Ammonia mg-N/liter (or mg NH3-N/liter)

pH	Temperature in C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30 and above	pH
6.5	29	28	28	27	27	27	27	26	26	26	25	25	25	25	25	24	24	24	24	24	24	23	16.6	6.5
6.6	28	27	27	27	26	26	26	25	25	25	25	24	24	24	24	24	24	23	23	23	23	23	16.1	6.6
6.7	27	27	26	26	26	25	25	25	24	24	24	24	23	23	23	23	23	23	23	22	22	22	15.6	6.7
6.8	26	25	25	25	24	24	24	24	23	23	23	23	23	22	22	22	22	22	22	22	21	21	15.0	6.8
6.9	25	24	24	24	23	23	23	22	22	22	22	22	21	21	21	21	21	21	21	21	20	20	14.3	6.9
7.0	23	23	22	22	22	22	21	21	21	21	20	20	20	20	20	20	20	20	19.4	19.3	19.2	19.0	13.4	7.0
7.1	22	21	21	21	20	20	20	20	19.5	19.3	19.1	18.9	18.8	18.6	18.5	18.4	18.3	18.2	18.1	18.0	17.9	17.7	12.6	7.1
7.2	20	20	19.2	19.0	18.8	18.5	18.4	18.1	17.9	17.8	17.6	17.5	17.3	17.2	17.0	16.9	16.8	16.7	16.7	16.6	16.5	16.3	11.6	7.2
7.3	18.0	17.8	17.5	17.3	17.1	16.9	16.7	16.5	16.3	16.2	16.0	15.9	15.8	15.6	15.5	15.4	15.3	15.2	15.2	15.1	15.0	14.9	10.6	7.3
7.4	16.2	16.0	15.7	15.5	15.3	15.1	15.0	14.8	14.6	14.5	14.4	14.3	14.1	14.0	13.9	13.8	13.8	13.7	13.6	13.6	13.5	13.4	9.5	7.4
7.5	14.3	14.1	13.9	13.7	13.6	13.4	13.3	13.1	13.0	12.8	12.7	12.6	12.5	12.4	12.4	12.3	12.2	12.1	12.1	12.1	12.0	11.9	8.5	7.5
7.6	12.5	12.3	12.2	12.0	11.9	11.7	11.6	11.5	11.4	11.2	11.2	11.1	11.0	10.9	10.8	10.8	10.7	10.6	10.6	10.5	10.5	10.5	7.4	7.6
7.7	10.8	10.7	10.5	10.4	10.3	10.1	10.0	9.9	9.8	9.7	9.6	9.6	9.5	9.5	9.3	9.3	9.2	9.2	9.2	9.1	9.1	9.1	6.5	7.7
7.8	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.9	7.8	7.8	7.8	5.6	7.8
7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.2	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.7	6.7	6.7	6.6	6.6	6.6	4.8	7.9
8.0	6.5	6.4	6.4	6.3	6.2	6.1	6.1	6.0	5.9	5.9	5.8	5.8	5.8	5.7	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6	4.0	8.0
8.1	5.2	5.1	5.1	5.0	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6	4.6	4.6	4.6	4.5	4.5	4.9	4.5	4.5	4.5	4.5	3.3	8.1
8.2	4.2	4.1	4.0	4.0	4.0	3.9	3.9	3.8	3.8	3.8	3.7	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.7	2.7	8.2
8.3	3.3	3.3	3.2	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	2.2	8.3
8.4	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.4	2.4	1.80	8.4
8.5	2.1	2.1	2.1	2.0	2.0	2.0	1.98	1.96	1.95	1.94	1.93	1.92	1.91	1.90	1.90	1.90	1.90	1.90	1.90	1.91	1.92	1.99	1.49	8.5
8.6	1.68	1.66	1.65	1.63	1.61	1.60	1.59	1.58	1.57	1.56	1.55	1.55	1.54	1.54	1.54	1.54	1.54	1.55	1.55	1.56	1.57	1.63	1.24	8.6
8.7	1.35	1.33	1.32	1.31	1.30	1.29	1.28	1.27	1.26	1.26	1.25	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.27	1.28	1.29	1.36	1.05	8.7
8.8	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.14	0.90	8.8
8.9	0.87	0.86	0.86	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.84	0.84	0.84	0.85	0.85	0.86	0.87	0.88	0.89	0.97	0.77	8.9
9.0	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.69	0.69	0.70	0.70	0.71	0.72	0.73	0.74	0.75	0.83	0.68	9.0

A&W Chronic[2]

Ammonia mg-N/liter (or mg NH3-N/liter)

pH	Temperature in C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	25	30 and above	pH
6.5	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	2.32	2.14	2.00	1.85	1.73	1.20	0.85	6.5
6.6	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	2.32	2.14	2.00	1.85	1.72	1.20	0.85	6.6
6.7	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.79	1.78	1.77	2.31	2.15	2.00	1.85	1.72	1.21	0.85	6.7
6.8	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.90	1.88	1.86	1.84	1.82	1.81	1.80	1.78	1.77	2.32	2.16	2.00	1.86	1.72	1.20	0.85	6.8
6.9	2.1	2.0	2.0	2.0	1.97	1.94	1.91	1.89	1.88	1.85	1.84	1.82	1.81	1.80	1.78	1.77	2.32	2.15	2.00	1.86	1.73	1.21	0.85	6.9
7.0	2.1	2.0	2.0	2.0	1.97	1.94	1.92	1.89	1.88	1.86	1.84	1.83	1.81	1.79	1.78	1.77	2.32	2.16	2.00	1.86	1.73	1.21	0.86	7.0
7.1	2.1	2.0	2.0	2.0	1.96	1.94	1.92	1.89	1.88	1.86	1.84	1.83	1.81	1.80	1.79	1.78	2.33	2.16	2.00	1.86	1.73	1.21	0.86	7.1
7.2	2.1	2.1	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.85	1.83	1.81	1.80	1.78	1.77	2.32	2.16	2.01	1.86	1.73	1.21	0.86	7.2
7.3	2.1	2.1	2.0	2.0	1.97	1.94	1.92	1.90	1.88	1.86	1.85	1.83	1.82	1.80	1.79	1.78	2.33	2.16	2.01	1.87	1.73	1.22	0.86	7.3
7.4	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.90	1.88	1.86	1.85	1.83	1.82	1.80	1.79	1.78	2.33	2.16	2.01	1.87	1.74	1.22	0.87	7.4
7.5	2.1	2.1	2.0	2.0	1.97	1.95	1.92	1.91	1.88	1.86	1.85	1.83	1.82	1.81	1.79	1.78	2.34	2.17	2.02	1.88	1.74	1.22	0.87	7.5
7.6	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.91	1.89	1.87	1.85	1.84	1.82	1.81	1.80	1.79	2.34	2.17	2.02	1.88	1.74	1.23	0.87	7.6
7.7	2.1	2.1	2.0	2.0	1.97	1.95	1.93	1.91	1.89	1.87	1.85	1.84	1.82	1.82	1.79	1.79	2.35	2.18	2.03	1.88	1.76	1.24	0.88	7.7
7.8	1.78	1.75	1.73	1.71	1.69	1.67	1.65	1.63	1.61	1.60	1.58	1.57	1.57	1.55	1.54	1.53	2.36	2.19	2.03	1.89	1.77	1.25	0.89	7.8
7.9	1.50	1.48	1.46	1.44	1.42	1.41	1.39	1.38	1.36	1.35	1.34	1.34	1.32	1.32	1.30	1.30	2.37	2.21	2.05	1.90	1.77	1.26	0.90	7.9
8.0	1.26	1.24	1.22	1.21	1.19	1.18	1.17	1.15	1.14	1.14	1.13	1.12	1.11	1.10	1.10	1.09	1.43	1.33	1.24	1.15	1.08	0.76	0.55	8.0
8.1	1.00	0.99	0.98	0.96	0.95	0.94	0.93	0.92	0.92	0.91	0.90	0.89	0.89	0.88	0.88	0.87	1.15	1.15	0.99	0.93	0.86	0.62	0.45	8.1
8.2	0.80	0.78	0.77	0.77	0.76	0.75	0.74	0.73	0.73	0.72	0.72	0.71	0.71	0.71	0.70	0.70	0.92	0.86	0.80	0.74	0.69	0.50	0.36	8.2
8.3	0.64	0.63	0.62	0.61	0.60	0.60	0.59	0.59	0.58	0.58	0.58	0.57	0.57	0.57	0.56	0.56	0.74	0.69	0.64	0.60	0.56	0.40	0.30	8.3
8.4	0.51	0.50	0.49	0.49	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.45	0.60	0.56	0.52	0.48	0.45	0.33	0.24	8.4
8.5	0.40	0.40	0.40	0.39	0.39	0.38	0.38	0.38	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.48	0.45	0.42	0.39	0.37	0.27	0.20	8.5
8.6	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.39	0.37	0.34	0.32	0.30	0.22	0.17	8.6
8.7	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.32	0.30	0.28	0.26	0.25	0.19	0.14	8.7
8.8	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.26	0.25	0.23	0.22	0.21	0.16	0.12	8.8
8.9	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.22	0.20	0.19	0.18	0.17	0.13	0.11	8.9
9.0	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.18	0.17	0.16	0.15	0.14	0.11	0.09	9.0

APPENDIX D

SURFACE WATER QUALITY IN THE CIENEGA CREEK NATURAL PRESERVE

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-90
FILE NAME: CRUZ.WK1

Field Parameters

Site ID	Date (yymmdd)	Time (hrs)	No.	STORET No.	Basin	HUC (#)	Agency	Air (oC)	H2O (oC)	DO (mgO2/l)	Sat. (%)	Fld EC (uS/cm)	EC@25C (uS/cm)	Fld pH (SU)	Staff (ft)	Width (ft)	Depth (ft)	Velocity (ft/sec)
				SC7 CIENEGA CR. AT MARSH STATION ROAD							(.88)							
SC7	870529	1120		SC-SC7	SCR	15050301	ADEQ	35	23	8.4	112.0%	900	936	8.05		6	0.3	0.5
SC7	870821	1120		SC-SC7	SCR	15050301	ADEQ	27	21.5	6.9	89.0%	720	770	7.81				
SC7	871015	1650		SC-SC7	SCR	15050301	ADEQ	23	19.5	7.1	88.0%	800	896	7.38		10	0.2	1
SC7	871124	1005		SC-SC7	SCR	15050301	ADEQ	11	17	9.0	106.0%	800	944	7.49		3	0.4	1.6
SC7	880118	1450		SC-SC7	SCR	15050301	ADEQ	5	14	7.3	81.0%	720	914	7.16		5	0.4	1.5
SC7	880405	1005		SC-SC7	SCR	15050301	ADEQ	25	17.5	8.6	102.0%	720	842	5.20		5	0.2	1.3
SC7	880504	1125		SC-SC7	SCR	15050301	ADEQ	27.5	19	8	98.0%	800	904	8.06				
SC7	880720	0940		SC-SC7	SCR	15050301	ADEQ	26	22	6.3	82.0%	360	382	7.52		12.5	0.4	2.4
SC7	880921	0940		SC-SC7	SCR	15050301	ADEQ	30.7	23.5			850	876	8		5.8	0.3	1
SC7	881122	1035		SC-SC7	SCR	15050301	ADEQ	14	17	8.4	99.0%	830	979	7.75		11.1	0.3	0.9
SC7	890125	0920		SC-SC7	SCR	15050301	ADEQ	5	13	9.5	103.0%	680	884	8.13		11.6	0.2	0.6
SC7	890330	1130		SC-SC7	SCR	15050301	ADEQ	26	19	8.7	106.8%	900	1017	8.08		7.5	0.3	1.3
SC7	890523	1110		SC-SC7	SCR	15050301	ADEQ	36	23	8.28	109.9%	950	988	8.15		5.8	0.3	0.9
SC7	890725	0950		SC-SC7	SCR	15050301	ADEQ	31.5	25	5.32	73.4%	950	950	7.53		5.4	0.16	1.16
SC7	890924	0930		SC-SC7	SCR	15050301	ADEQ	26	21	9.53	121.7%	800	864	8.3		5.8	0.16	0.74
SC7	891121	1030		SC-SC7	SCR	15050301	ADEQ	15	17.5	10.1	119.0%	800	936	8.21		7.1	0.185	1.001
SC7 (QC1)	891121	1030		SC-SC7	SCR	15050301	ADEQ	15	17.5	10.1	119.0%	800	936	8.21		7.1	0.185	1.001
SC7	900131	1145		SC-SC7	SCR	15050301	ADEQ	11	14.5	8.88	91.6%	760	950	8.15		7	0.16	1.24
SC7	900327	1215		SC-SC7	SCR	15050301	ADEQ	28	20	9.6	114.3%	810	899	8.64		5	0.25	1.27
SC7	900530	1045		SC-SC7	SCR	15050301	ADEQ	26	21.5	8.72	125.8%	870	931	8.75		3.8	0.24	1.04
SC7	900710	1400		SC-SC7	SCR	15050301	ADEQ	32	27.5	5.58	78.4%	1010	960	8.39		5.2	0.14	1.149
SC7	901001	1505		SC-SC7	SCR	15050301	ADEQ	20	19	7.65	93.9%	850	961	7.87		4.5	0.241	1.34
				SC8 CIENEGA CR. AT TILTED BED SITE														
SC8	890330	0940		806001002000649	SCR	15050301	ADEQ	20	18.5	9.05	109.9%	900	1026	8.02		4.8	0.2	0.5
SC8	890523	0955		806001002000649	SCR	15050301	ADEQ	31.5	26	7.5	105.3%	1000	980	8.15		5.8	0.2	0.3
SC8(QC)	890523	0955	(QC)	806001002000649	SCR	15050301	ADEQ	31.5	26	7.5	105.3%	1000	980	8.15		5.8	0.2	0.3
SC8	890725	0850		806001002000649	SCR	15050301	ADEQ	27.5	25	7	96.5%	970	970	8.04		2.9	0.21	0.7
SC8	890924	0815		806001002000649	SCR	15050301	ADEQ	20.5	18.5	9.22	111.9%	805	917.7	8.24		2.6	0.11	0.77
SC8(QC)	890924	0815	(QC)	806001002000649	SCR	15050301	ADEQ	20.5	18.5	9.22	111.9%	805	917.7	8.24		2.6	0.11	0.77
SC8	891121	915		806001002000649	SCR	15050301	ADEQ	11	13.5	9.15	107.8%	730	934	8.29		3	0.134	0.735
SC8	900131	930		806001002000649	SCR	15050301	ADEQ	11	10	10.6	109.4%	660	924	8.62		3	0.18	0.98
SC8	900327	1030		806001002000649	SCR	15050301	ADEQ	22	17	9.13	108.7%	800	944	8.6		2.8	0.19	1.79
				SC9 CIENEGA CR. NR. AGUA VERDE WASH														
SC9	890523	1210		806001002000314	SCR	15050301	ADEQ	34	23	8.47	112.4%	910	946	7.54		5.5	0.2	0.5
SC9	890725	1045		806001002000314	SCR	15050301	ADEQ	31.5	24	4.5	60.9%	980	1000	7.63		3.5	0.13	0.6
SC9	890924	1020		806001002000314	SCR	15050301	ADEQ	28	21.5	7.6	98.0%	885	947	8.05		5.6	0.09	0.15
SC9	891121	1145		806001002000314	SCR	15050301	ADEQ	16	19	7.57	89.2%	790	893	7.64		4.6	0.271	0.298
SC9	900131	1315		806001002000314	SCR	15050301	ADEQ	13	14.5	8.54	88.1%	740	925	8.01		4.5	0.11	0.515
SC9	900327	1345		806001002000314	SCR	15050301	ADEQ	24.5	19.5	9.38	111.7%	860	963	8.24		4	0.12	0.91

ADEQ FSN DATA & QA/QC
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FILE NAME: CRUZ.WK1

Site ID	Date (yymmdd)	Time (hrs)	Discharge (ft3/sec)	Lab EC (uS/cm)	Lab pH (SU)	Hardness EDTA (mg/l)	TDS Evap (mg/l)	TSS (mg/l)	Turbidity (NTU's)	Cations Ca (mg/l)	Cations Mg (mg/l)	Cations Na (mg/l)	Cations K (mg/l)	Anions OH (mg/l)	Anions CO3 (mg/l)	Anions HCO3 (mg/l)	Anions SO4 (mg/l)	Anions Cl (mg/l)
SC7	870529	1120	1		8.10		731	6		109	32.4	56.8	6		0	227	216	13
SC7	870821	1120																
SC7	871015	1650	2	1045	8.00		731	4		61.4	24.4	58.1	4.9		0	235	306	20.7
SC7	871124	1005	1.92	1037	8.00		748	13		92.1	29.5	62.7	4.5		0	233	300.5	17.5
SC7	880118	1450	3	944	8.19		697	4	3.3	123	32.5	60	5.77		0	279	311	17.8
SC7	880405	1005	1.62	1033	8.10		776	4	0.3	101.5	30.89	50.1	3.9		0	225	361	17.96
SC7	880504	1125																
SC7	880720	0940	10.7	620	8.2	319	320	2440	526	70	35	27.3	17.8		0	138	108	6.7
SC7	880921	0940	1.74	812	8.2	339	718	5	0.38	93	25.9	50.1	3.9	0.5	0.5	220	268	15.8
SC7	881122	1035	2.04	971	8.1	370	684	5	0.84	106	26.9	50.5	4.4	0.5	0.5	206	304	16
SC7	890125	0920	1.8	1032	8.3	416	720	5	0.44	115	31.4	56.2	3.6	0.5	0.5	229	296	18.5
SC7	890330	1130	2.04	1030	8.3	392	760	4	0.36	107	30.3	56.7	3.8	0.5	0.5	224	308	17.8
SC7	890523	1110	1.11	1020	8.3	466	750	5	0.4	129	35	64.6	4.4	0.5	0.5	232	327	17.8
SC7	890725	0950	0.72	1050	8.3	455	740	5	4.9	130	31.7	67.8	4.8	0.5	0.5	238	320	18
SC7	890924	0930	0.67	970	8.2	453	710	5	0.48	126	33.2	65.1	4.3	0.5	0.5	222	350	17.2
SC7	891121	1030	1.065	934	8.3	426	740	5	2.7	115	33.6	69.5	3.7	0.5	0.5	227	310	19.3
SC7 (QC1)	891121	1030	1.065	941	8.3	426	710	20	0.52	116	33.2	66.9	3.5	0.5	0.5	229	320	19.3
SC7	900131	1145	1.98	963	8.14	447	745	2	0.64	119	31.9	62.1	6.5		1	261	349	15.6
SC7	900327	1215	1.7	968	8.28	426	663	2	0.2	117	31.7	64.5	3.8		1	255	314	14.1
SC7	900530	1045	1.034	1000	8.4	445	760	10	0.18	123	33.4	61.3	3.8	0.5	4	213	380	16
SC7	900710	1400	1.383	910	8.3	458	820	36	9	130	32.5	60.6	5.4	0.5	0.5	232	280	16
SC7	901001	1505	1.79															
SC8	890330	0940	0.38	1025	8	449	760	5	0.8	130	30.3	52.6	3.3	0.5	0.5	223	307	12.9
SC8	890523	0955	0.28	1010	8.1	502	710	5	0.52	116	34.6	59.6	3.8	0.5	0.5	222	298	12.5
SC8(QC)	890523	0955	0.28	982	8.1	520	740	5	0.5	116	35.4	59.4	3.9	0.5	0.5	220	325	12.8
SC8	890725	0850	0.36	1000	8.2	473	760	5	4.2	141	29.3	61.7	5.7	0.5	0.5	236	330	12
SC8	890924	0815	0.26	952	8.1	458	670	5	1.5	128	33.5	57.8	4	0.5	0.5	226	350	11.6
SC8(QC)	890924	0815	0.26	945	8	458	700	5	1.1	128	33.5	58.9	3.9	0.5	0.5	225	220	11.5
SC8	891121	915	0.399	755	8	446	740	5	1.1	124	33.2	59.1	3.7	0.5	0.5	244	300	14.5
SC8	900131	930	0.518	982	8.14	480	746	9	0.77	132	31	52.6	5.2		1	307	320	10.7
SC8	900327	1030	0.514	985	8.24	484	634	2	2	143	33.9	57.6	3.3		1	306	308	10.3
SC9	890523	1210	0.45	1010	8.2	476	690	5	0.19	135	33.7	70.8	4.8	0.5	0.5	212	326	18.8
SC9	890725	1045	0.22	1080	8.3	462	780	5	4.4	133	31.5	75.7	5.1	0.5	0.5	240	350	21
SC9	890924	1020	0.09	996	8	450	710	5	0.33	125	33.6	69.9	4.8	5	0.5	228	350	18.4
SC9	891121	1145	0.148	997	8.1	442	730	5	0.3	123	32.7	70.6	4.3	0.5	0.5	225	300	26
SC9	900131	1315	0.34	973	7.96	452	737	10	2.4	117	30.9	64.6	7.8		1	244	344	18
SC9	900327	1345	0.61	989	8.1	429	678	2	0.35	119	34.3	69.5	4.7		1	245	155	17.1

ADEQ FSN DATA & QA/QC
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Site ID	Date (yymmdd)	Time (hrs)	Alk, T (mg/l)	Alk, P (mg/l)	F (mg/l)	TKN (mgN/l)	NO2+NO3 (mgN/l)	Ammonia (mgN/l)	TP (mgP/l)	Bacteria: FC (cfu/100ml)	Bacteria: FS (cfu/100ml)	Trace Metals: Ag, T (ug/l)	Trace Metals: Ag, D (ug/l)	Trace Metals: As, T (ug/l)	Trace Metals: As, D (ug/l)	Trace Metals: Ba, T (ug/l)
SC7	870529	1120	227	0			0.01 K		0.08			3 K		5 K		100 K
SC7	870821	1120														
SC7	871015	1650	235	0	0.8	2 K	0.54		0.07			4 K		9		50 K
SC7	871124	1005	233	0	1.1		0.51		0.01 K			4 K		5 K		240
SC7	880118	1450	229	0	0.71	0.5 K	0.1 K	0.1 K	0.05 K			5 K		20 K		100 K
SC7	880405	1005	225	0	1.14		0.1 K	0.4	0.23	2	TNTC	2 K		10 K		50 K
SC7	880504	1125								30	TNTC					
SC7	880720	0940	138	0	0.31	0.3 K	0.63	0.06	0.05 K			10 K		55		1200
SC7	880921	0940	220	0.5	0.73	0.6 K	0.26	0.07	0.066			10 K		5 K		80
SC7	881122	1035	206	0.5	0.69	1	0.06 K	0.05 K	0.05 K					5 K		80
SC7	890125	0920	229	0.5	0.56	1	0.06 K		0.05 K			10 K		5 K		60
SC7	890330	1130	224	0.5	0.72	0.4	0.06 K	0.04	0.05 K			10 K		5 K		60
SC7	890523	1110	232	0.5	0.82	0.1 K	0.06 K	0.05	0.05 K			10 K	10 K	5 K	5 K	60
SC7	890725	0950	238	0.5	0.77	0.1 K	0.15	0.4	0.05 K	3000	1110	10 K		5 K		110
SC7	890924	0930	222	0.5	0.71	0.1	0.08	0.03 K	0.05 K			10 K	10 K	5 K	5 K	70
SC7	891121	1030	227	0.5	0.74	0.1 K	0.06 K	0.03 K	0.05 K	30	30	10 K		5 K		63
SC7 (QC1)	891121	1030	229	0.5	0.75	0.1	0.06 K	0.08	0.05 K	4	30	10 K		5		63
SC7	900131	1145	214	1	0.72	0.1 K	0.1 K	0.2	0.05 K			1 K	1 K	10 K	10 K	100 K
SC7	900327	1215	209	1	0.64	0.1 K	0.1 K	0.05 K	0.05 K	13	1	1 K		10 K		100 K
SC7	900530	1045	217	2	0.69	0.1 K	0.06 K	0.03	0.05 K			10 K	10 K	5 K	7	60
SC7	900710	1400	232	0.5	0.62	0.3	0.06 K	0.03 K	0.09	240	560	10 K		6 K		105
SC7	901001	1505								12	64					
SC8	890330	0940	223	0.5	0.77	0.4	0.19	0.07	0.05 K			10 K		5 K		70
SC8	890523	0955	222	0.5	0.84	0.1	0.06 K	0.07	0.05 K			10 K		5 K		80
SC8(QC)	890523	0955	220	0.5	0.88	0.1	0.06 K	0.09	0.05 K			10 K		5 K		80
SC8	890725	0850	236	0.5	0.83	0.1	0.12	0.11	0.05 K	700	900	10 K		5 K		140
SC8	890924	0815	226	0.5	0.74	0.1	0.23	0.03 K	0.05 K			10 K		5 K		120
SC8(QC)	890924	0815	225	0.5	0.73	0.3	0.24	0.11	0.05 K			10 K		5 K		120
SC8	891121	915	244	0.5	0.72	0.2	0.26	0.03 K	0.05 K			10 K		5 K		89
SC8	900131	930	252	1	0.69	0.1 K	0.29	0.1 K	0.05 K			1 K		10 K		100 K
SC8	900327	1030	251	1	0.64	0.1 K	0.1 K	0.05 K	0.05 K	280	180	1 K		10 K		100 K
SC9	890523	1210	212	0.5	0.73	0.1 K	0.06 K	0.06	0.05 K			10 K		5 K		60
SC9	890725	1045	240	0.5	0.69	0.1 K	0.06 K	0.07	0.06	700	600	10 K		5 K		110
SC9	890924	1020	228	0.5	0.71	0.1	0.14	0.03 K	0.05 K			10 K		5 K		60
SC9	891121	1145	225	0.5	0.68	0.1 K	0.16	0.03 K	0.05 K			10 K		5 K		62
SC9	900131	1315	200	1	0.59	0.21	0.1 K	0.1 K	0.05 K			1 K		10 K		100 K
SC9	900327	1345	201	1	0.59	0.1 K	0.1 K	0.05 K	0.05 K	13	10	1 K		10 K		100 K

ADEQ FSN DATA & QA/QC
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FILE NAME: CRUZ.WK1

Site ID	Date (yymmdd)	Time (hrs)	Ba, D (ug/l)	B, T (ug/l)	B, D (ug/l)	Be, T (ug/l)	Be, D (ug/l)	Cd, T (ug/l)	Cd, D (ug/l)	Cr, T (ug/l)	Cr, D (ug/l)	Cu, T (ug/l)	Cu, D (ug/l)	Fe, T (ug/l)	Fe, D (ug/l)	Hg, T (ug/l)
SC7	870529	1120						2		10		15 K		150 K		2 K
SC7	870821	1120														
SC7	871015	1650		190				46		12		10		770		2 K
SC7	871124	1005		390				1 K		31		9		290		2 K
SC7	880118	1450		230				1 K		10 K		18		130		0.5 K
SC7	880405	1005		210				2 K		12		18		90		
SC7	880504	1125														
SC7	880720	0940		60 K		5 K		5		42		125		45050		0.2 K
SC7	880921	0940		30 K		5 K		3 K		20 K		10 K		52		0.2 K
SC7	881122	1035		200 K		5 K		3 K		20 K		16		145		0.2 K
SC7	890125	0920		200 K		5 K		3 K		20 K		12		10 K		0.2 K
SC7	890330	1130		100 K		5 K		3 K		20 K		10 K		10 K		0.2 K
SC7	890523	1110	50	100 K	100 K	5 K	5 K	5 K	5 K	20 K	20 K	10 K	10 K	10 K	10 K	0.2 K
SC7	890725	0950		180		5 K		5 K		20 K		10 K		16		0.2 K
SC7	890924	0930	80	140	120	5 K	5 K	5 K	5 K	20 K	20 K	28	10 K	433	10 K	0.2
SC7	891121	1030		140		5 K		5 K		10 K		20 K		17		0.2 K
SC7 (QC1)	891121	1030		180		5 K		5 K		60		20 K		238		0.2 K
SC7	900131	1145	100 K	100 K	100 K	0.5 K	0.5 K	1 K	1 K	10 K	10 K	10 K	10 K	100 K	100 K	0.5 K
SC7	900327	1215		100 K		0.5 K		0.5 K		10 K		10 K		100 K		0.5 K
SC7	900530	1045	57	10 K	10 K	5 K	5 K	5 K	5 K	10 K	10 K	20 K	20 K	43	10	0.2 K
SC7	900710	1400		130		5 K		5 K		10 K		20 K		980		0.2 K
SC7	901001	1505														
SC8	890330	0940		100 K		5 K		3 K		20 K		10 K		34		0.2 K
SC8	890523	0955		100 K		5 K		5 K		20 K		10 K		10 K		0.2 K
SC8(QC)	890523	0955		100 K		5 K		1 K		20 K		10 K		10 K		0.2 K
SC8	890725	0850		160		5 K		5 K		20 K		10		11		0.2 K
SC8	890924	0815		110		5 K		5 K		20 K		30		37		0.4
SC8(QC)	890924	0815		100 K		5 K		5 K		20 K		30		37		0.8
SC8	891121	915		160		5 K		5 K		10 K		20 K		94		0.2 K
SC8	900131	930		100 K		0.5 K		1 K		10 K		10 K		120		0.5 K
SC8	900327	1030		100 K		0.5 K		0.5 K		10 K		10 K		240		0.5 K
SC9	890523	1210		100 K		5 K		5 K		20 K		10 K		10 K		0.2
SC9	890725	1045		150		5 K		5 K		20 K		10 K		34		0.2 K
SC9	890924	1020		120		5 K		5 K		20 K		26		27		0.3
SC9	891121	1145		130		5 K		5 K		10 K		20 K		25		0.2 K
SC9	900131	1315		100 K		0.5 K		1 K		10 K		10 K		160		0.5 K
SC9	900327	1345		100 K		0.5 K		0.5 K		10 K		10 K		100 K		0.5 K

ADEQ FSN DATA & QA/QC
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Site ID	Date (yymmdd)	Time (hrs)	Hg, D (ug/l)	Mn, T (ug/l)	Mn, D (ug/l)	Ni, T (ug/l)	Ni, D (ug/l)	Pb, T (ug/l)	Pb, D (ug/l)	Sb, T (ug/l)	Sb, D (ug/l)	Se, T (ug/l)	Se, D (ug/l)	Sr, T (ug/l)	Sr, D (ug/l)	Tl, T (ug/l)
SC7	870529	1120		4				13								
SC7	870821	1120														
SC7	871015	1650		43				5 K				3 K				
SC7	871124	1005		10				5 K				3 K				
SC7	880118	1450		50 K				20 K				5 K				
SC7	880405	1005		5 K				5 K				10 K				
SC7	880504	1125														
SC7	880720	0940		1975		42		52		20 K		5 K				5 K
SC7	880921	0940		90		30 K		2 K		20 K		5 K				5 K
SC7	881122	1035		51		48		3 K				5 K		1620		5 K
SC7	890125	0920		10 K		30 K		2 K		20 K		5 K		17100		5 K
SC7	890330	1130		10 K		30 K		2 K		10 K		5 K		1670		5 K
SC7	890523	1110	0.2 K	10 K	10 K	30 K	30 K	2 K	2 K	10 K	10 K	5 K	5 K	1880	1840	5 K
SC7	890725	0950		126		30 K		2		10 K		5 K		1700		5 K
SC7	890924	0930	0.6	16	14	30 K	30 K	2 K	2 K	10 K	10 K	5 K	5 K	1153	1700	5 K
SC7	891121	1030		10		20 K		2 K		50 K		5 K		1600		5 K
SC7 (QC1)	891121	1030		10 K		20 K		2 K		50 K		5 K		1610		5 K
SC7	900131	1145	0.5 K	50 K	50 K	50 K	50 K	10 K	10 K	5 K	5 K	5 K	5 K	2200	1900	5 K
SC7	900327	1215		50 K		50 K		10 K		5 K		5 K		1750		5 K
SC7	900530	1045	0.2 K	10 K	10 K	20 K	20 K	2 K	2 K	50 K	50 K	25 K	25 K	1810	1750	5 K
SC7	900710	1400		522		20 K		2 K		50 K		5 K		1540		5 K
SC7	901001	1505														
SC8	890330	0940		22		30 K		2 K		10 K		5 K		1990		5 K
SC8	890523	0955		44		30 K		2 K		10 K		5 K		2120		5 K
SC8(QC)	890523	0955		41		30 K		2 K		10 K		5 K		2180		5 K
SC8	890725	0850		196		30 K		2 K		10 K		5 K		1940		5 K
SC8	890924	0815		57		30 K		2 K		10 K		5 K		1820		5 K
SC8(QC)	890924	0815		41		30 K		2 K		10 K		5 K		1820		5 K
SC8	891121	915		90		20 K		2 K		50 K		5 K		1190		5 K
SC8	900131	930		70		50 K		10 K		5 K		5 K		2270		5 K
SC8	900327	1030		110		50 K		10 K		5 K		5 K		2100		5 K
SC9	890523	1210		10 K		30 K		2 K		10 K		5 K		1620		5 K
SC9	890725	1045		282		30 K		2 K		10 K		5 K		1680		5 K
SC9	890924	1020		32		30 K		2 K		10 K		5 K		1440		5 K
SC9	891121	1145		19		20 K		2 K		50 K		5 K		1420		5 K
SC9	900131	1315		50 K		50 K		10 K		5 K		5 K		1570		5 K
SC9	900327	1345		50 K		50 K		10 K		5 K		5 K		1490		5 K

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-
FILE NAME: CRUZ.WK1

QA/QC

Site ID	Date (yymmdd)	Time (hrs)	Tl, D (ug/l)	Zn, T (ug/l)	Zn, D (ug/l)	Lab Turnaround Time: Lab	Lab No.	Submit	Report	Rec'd	Total (days)	Ratios: F/L EC Ratio	F/L pH Ratio	TDS/EC Ratio	Hardness: EDTA (mg/l)	Calc. (mg/l)
SC7	870529	1120		7 K		U OF A						ERR	0.994	ERR	0	406
SC7	870821	1120										ERR	ERR	ERR	0	0
SC7	871015	1650		10		U OF A						0.857	0.923	0.700	0	254
SC7	871124	1005		5 K		U OF A						0.910	0.936	0.721	0	351
SC7	880118	1450		50 K		ADHS						0.968	0.874	0.738	0	441
SC7	880405	1005		17		U OF A						0.815	0.642	0.751	0	381
SC7	880504	1125				ADHS										
SC7	880720	0940		204		ATI						0.616	0.917	0.516	319	319
SC7	880921	0940		10 K		ATI,TUR	809144	880922	881201	881208		1.079	0.976	0.884	339	339
SC7	881122	1035		15		ATI,TUR	811606	881122	890103	890307		1.008	0.957	0.704	370	375
SC7	890125	0920		22		ATI,TUR	901610	890127	890223	890224		0.857	0.980	0.698	416	416
SC7	890330	1130		10 K		ATI,TUR	904506	890403	890502	890510		0.987	0.973	0.738	392	392
SC7	890523	1110	5 K	10 K	10 K	ATI,TUR	905674	890525	890705	890707		0.969	0.982	0.735	466	466
SC7	890725	0950		10 K		ATI,TUR	907678	890727	890831	890914		0.905	0.907	0.705	455	455
SC7	890924	0930	5 K	11	10	ATI	909706	890927	891026	891108		0.891	1.012	0.732	453	451
SC7	891121	1030		11		ATI	911754	891122	900130	900131		1.002	0.989	0.792	426	425
SC7 (QC1)	891121	1030		24		ATI	911754	891122	900130	900131		0.995	0.989	0.755	426	426
SC7	900131	1145	5 K	50 K	50 K	ATI,ADHS	19093	900201	900417	900419		0.987	1.001	0.774	447	428
SC7	900327	1215		50 K		ATI,ADHS	20464	900330	900808	900810		0.929	1.043	0.685	426	423
SC7	900530	1045	5 K	5	5 K	ATI	5816	900531	900804	900817		0.931	1.042	0.760	445	445
SC7	900710	1400		14		ATI	7655	900713	900815	900831		1.055	1.011	0.901	458	458
SC7	901001	1505														
SC8	890330	0940		31		ATI,TUR	904506	890403	890502	890510		1.001	1.003	0.741	449	449
SC8	890523	0955		10 K		ATI,TUR	905674	890525	890705	890707		0.970	1.006	0.703	502	432
SC8(QC)	890523	0955		10 K		ATI,TUR	905674	890525	890705	890707		0.998	1.006	0.754	520	435
SC8	890725	0850		10 K		ATI,TUR	907678	890727	890831	890914		0.970	0.980	0.760	473	473
SC8	890924	0815		14		ATI	909706	890927	891026	891108		0.964	1.017	0.704	458	458
SC8(QC)	890924	0815		11		ATI	909706	890927	891026	891108		0.971	1.030	0.741	458	458
SC8	891121	915		10 K		ATI	911754	891122	900130	900131		1.238	1.036	0.980	446	446
SC8	900131	930		50 K		ATI,ADHS	19094	900201	900412	900419		0.941	1.059	0.760	480	457
SC8	900327	1030		50 K		ATI,ADHS	20465	900330	900816	900822		0.958	1.044	0.644	484	497
SC9	890523	1210		10 K		ATI,TUR	905674	890525	890705	890707		0.937	0.920	0.683	476	476
SC9	890725	1045		10 K		ATI,TUR	907678	890727	890831	890914		0.926	0.919	0.722	462	462
SC9	890924	1020		11		ATI	909706	890927	891026	891108		0.951	1.006	0.713	450	450
SC9	891121	1145		10 K		ATI	911754	891122	900130	900131		0.895	0.943	0.732	442	442
SC9	900131	1315		50 K		ATI,ADHS	19091	900201	900412	900420		0.951	1.006	0.757	452	419
SC9	900327	1345		50 K		ATI,ADHS	20466	900330	900820	900831		0.974	1.017	0.686	429	438

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-
FILE NAME: CRUZ.WK1

Site ID	Date (yymmdd)	Time (hrs)	E/C	TDS Evap (mg/l)	TDS Sum (mg/l)	E/S	Cations Ca (mg/l)	Cations Mg (mg/l)	Cations Na (mg/l)	Cations K (mg/l)	Anions OH (mg/l)	Anions CO3 (mg/l)	Anions HCO3 (mg/l)	Anions SO4 (mg/l)	Anions Cl (mg/l)	Cation Ca (meq/l)
SC7	870529	1120	0.000	731	660	1.107	109	32.4	56.8	6	0	0	227	216	13	5.44
SC7	870821	1120	ERR	0	0	ERR	0	0	0	0	0	0	0	0	0	0.00
SC7	871015	1650	0.000	731	711	1.029	61.4	24.4	58.1	4.9	0	0	235	306	20.7	3.06
SC7	871124	1005	0.000	748	740	1.011	92.1	29.5	62.7	4.5	0	0	233	300.5	17.5	4.60
SC7	880118	1450	0.000	697	829	0.841	123	32.5	60	5.77	0	0	279	311	17.8	6.14
SC7	880405	1005	0.000	776	790	0.982	101.5	30.89	50.1	3.9	0	0	225	361	17.96	5.06
SC7	880504	1125														
SC7	880720	0940	1.000	320	403	0.794	70	35	27.3	17.8	0	0	138	108	6.7	3.49
SC7	880921	0940	1.001	718	678	1.059	93	25.9	50.1	3.9	0.5	0.5	220	268	15.8	4.64
SC7	881122	1035	0.986	684	715	0.957	106	26.9	50.5	4.4	0.5	0.5	206	304	16	5.29
SC7	890125	0920	0.999	720	751	0.959	115	31.4	56.2	3.6	0.5	0.5	229	296	18.5	5.74
SC7	890330	1130	1.000	760	749	1.015	107	30.3	56.7	3.8	0.5	0.5	224	308	17.8	5.34
SC7	890523	1110	1.000	750	811	0.925	129	35	64.6	4.4	0.5	0.5	232	327	17.8	6.44
SC7	890725	0950	1.000	740	811	0.912	130	31.7	67.8	4.8	0.5	0.5	238	320	18	6.49
SC7	890924	0930	1.004	710	819	0.867	126	33.2	65.1	4.3	0.5	0.5	222	350	17.2	6.29
SC7	891121	1030	1.001	740	779	0.950	115	33.6	69.5	3.7	0.5	0.5	227	310	19.3	5.74
SC7 (QC1)	891121	1030	0.999	710	789	0.900	116	33.2	66.9	3.5	0.5	0.5	229	320	19.3	5.79
SC7	900131	1145	1.043	745	846	0.881	119	31.9	62.1	6.5	0	1	261	349	15.6	5.94
SC7	900327	1215	1.008	663	801	0.828	117	31.7	64.5	3.8	0	1	255	314	14.1	5.84
SC7	900530	1045	1.001	760	835	0.910	123	33.4	61.3	3.8	0.5	4	213	380	16	6.14
SC7	900710	1400	0.999	820	758	1.083	130	32.5	60.6	5.4	0.5	0.5	232	280	16	6.49
SC7	901001	1505														
SC8	890330	0940	0.999	760	760	1.000	130	30.3	52.6	3.3	0.5	0.5	223	307	12.9	6.49
SC8	890523	0955	1.162	710	748	0.950	116	34.6	59.6	3.8	0.5	0.5	222	298	12.5	5.79
SC8(QC)	890523	0955	1.194	740	774	0.957	116	35.4	59.4	3.9	0.5	0.5	220	325	12.8	5.79
SC8	890725	0850	1.001	760	817	0.931	141	29.3	61.7	5.7	0.5	0.5	236	330	12	7.04
SC8	890924	0815	1.001	670	812	0.825	128	33.5	57.8	4	0.5	0.5	226	350	11.6	6.39
SC8(QC)	890924	0815	1.001	700	682	1.027	128	33.5	58.9	3.9	0.5	0.5	225	220	11.5	6.39
SC8	891121	915	0.999	740	780	0.949	124	33.2	59.1	3.7	0.5	0.5	244	300	14.5	6.19
SC8	900131	930	1.050	746	860	0.868	132	31	52.6	5.2	0	1	307	320	10.7	6.59
SC8	900327	1030	0.975	634	863	0.735	143	33.9	57.6	3.3	0	1	306	308	10.3	7.14
SC9	890523	1210	1.000	690	802	0.860	135	33.7	70.8	4.8	0.5	0.5	212	326	18.8	6.74
SC9	890725	1045	1.001	780	857	0.910	133	31.5	75.7	5.1	0.5	0.5	240	350	21	6.64
SC9	890924	1020	0.999	710	835	0.850	125	33.6	69.9	4.8	5	0.5	228	350	18.4	6.24
SC9	891121	1145	1.001	730	783	0.933	123	32.7	70.6	4.3	0.5	0.5	225	300	26	6.14
SC9	900131	1315	1.078	737	827	0.891	117	30.9	64.6	7.8	0	1	244	344	18	5.84
SC9	900327	1345	0.979	678	646	1.050	119	34.3	69.5	4.7	0	1	245	155	17.1	5.94

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-
FILE NAME: CRUZ.WK1

Site ID	Date (yymmdd)	Time (hrs)	s (meq/l) Mg (meq/l)	Na (meq/l)	K (meq/l)	Anions (meq/l) OH (meq/l)	CO3 (meq/l)	HCO3 (meq/l)	SO4 (meq/l)	Cl (meq/l)	Sum (meq/l) Cations (meq/l)	Anions (meq/l)	C/A	Cations (%meq/l) Ca (%meq/l)	Mg (%meq/l)	Na+K (%meq/l)
SC7	870529	1120	2.67	2.47	0.15	0.00	0.00	3.72	4.50	0.37	10.73	8.58	1.250	50.69%	24.85%	24.46%
SC7	870821	1120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ERR	ERR	ERR	ERR
SC7	871015	1650	2.01	2.53	0.13	0.00	0.00	3.85	6.37	0.58	7.72	10.81	0.715	39.66%	25.99%	34.34%
SC7	871124	1005	2.43	2.73	0.12	0.00	0.00	3.82	6.26	0.49	9.87	10.57	0.933	46.58%	24.61%	28.81%
SC7	880118	1450	2.67	2.61	0.15	0.00	0.00	4.57	6.48	0.50	11.57	11.55	1.002	53.05%	23.12%	23.83%
SC7	880405	1005	2.54	2.18	0.10	0.00	0.00	3.69	7.52	0.51	9.89	11.71	0.844	51.23%	25.71%	23.05%
SC7	880504	1125														
SC7	880720	0940	2.88	1.19	0.46	0.00	0.00	2.26	2.25	0.19	8.02	4.70	1.706	43.58%	35.93%	20.49%
SC7	880921	0940	2.13	2.18	0.10	0.03	0.02	3.61	5.58	0.45	9.05	9.68	0.935	51.27%	23.55%	25.18%
SC7	881122	1035	2.21	2.20	0.11	0.03	0.02	3.38	6.33	0.45	9.81	10.20	0.962	53.91%	22.56%	23.53%
SC7	890125	0920	2.58	2.44	0.09	0.03	0.02	3.75	6.16	0.52	10.86	10.48	1.036	52.84%	23.79%	23.36%
SC7	890330	1130	2.49	2.47	0.10	0.03	0.02	3.67	6.41	0.50	10.40	10.63	0.978	51.36%	23.98%	24.66%
SC7	890523	1110	2.88	2.81	0.11	0.03	0.02	3.80	6.81	0.50	12.24	11.16	1.097	52.59%	23.53%	23.88%
SC7	890725	0950	2.61	2.95	0.12	0.03	0.02	3.90	6.66	0.51	12.17	11.12	1.095	53.31%	21.44%	25.25%
SC7	890924	0930	2.73	2.83	0.11	0.03	0.02	3.64	7.29	0.49	11.96	11.46	1.044	52.56%	22.84%	24.59%
SC7	891121	1030	2.76	3.02	0.09	0.03	0.02	3.72	6.45	0.54	11.62	10.77	1.080	49.38%	23.79%	26.83%
SC7 (QC1)	891121	1030	2.73	2.91	0.09	0.03	0.02	3.75	6.66	0.54	11.52	11.01	1.047	50.25%	23.72%	26.04%
SC7	900131	1145	2.63	2.70	0.17	0.00	0.03	4.28	7.27	0.44	11.43	12.02	0.951	51.95%	22.96%	25.09%
SC7	900327	1215	2.61	2.81	0.10	0.00	0.03	4.18	6.54	0.40	11.35	11.15	1.018	51.44%	22.98%	25.58%
SC7	900530	1045	2.75	2.67	0.10	0.03	0.13	3.49	7.91	0.45	11.65	12.02	0.970	52.68%	23.59%	23.72%
SC7	900710	1400	2.67	2.64	0.14	0.03	0.02	3.80	5.83	0.45	11.94	10.13	1.178	54.35%	22.41%	23.24%
SC7	901001	1505														
SC8	890330	0940	2.49	2.29	0.08	0.03	0.02	3.65	6.39	0.36	11.35	10.46	1.086	57.14%	21.96%	20.90%
SC8	890523	0955	2.85	2.59	0.10	0.03	0.02	3.64	6.20	0.35	11.33	10.24	1.106	51.11%	25.14%	23.75%
SC8(QC)	890523	0955	2.91	2.58	0.10	0.03	0.02	3.61	6.77	0.36	11.39	10.78	1.056	50.84%	25.59%	23.57%
SC8	890725	0850	2.41	2.68	0.15	0.03	0.02	3.87	6.87	0.34	12.28	11.12	1.104	57.31%	19.64%	23.05%
SC8	890924	0815	2.76	2.51	0.10	0.03	0.02	3.70	7.29	0.33	11.76	11.36	1.035	54.31%	23.44%	22.25%
SC8(QC)	890924	0815	2.76	2.56	0.10	0.03	0.02	3.69	4.58	0.32	11.81	8.64	1.367	54.10%	23.35%	22.55%
SC8	891121	915	2.73	2.57	0.09	0.03	0.02	4.00	6.25	0.41	11.59	10.70	1.083	53.41%	23.58%	23.01%
SC8	900131	930	2.55	2.29	0.13	0.00	0.03	5.03	6.66	0.30	11.56	12.03	0.961	56.98%	22.07%	20.95%
SC8	900327	1030	2.79	2.51	0.08	0.00	0.03	5.02	6.41	0.29	12.52	11.75	1.065	57.02%	22.29%	20.69%
SC9	890523	1210	2.77	3.08	0.12	0.03	0.02	3.47	6.79	0.53	12.71	10.84	1.173	52.99%	21.82%	25.19%
SC9	890725	1045	2.59	3.29	0.13	0.03	0.02	3.93	7.29	0.59	12.65	11.86	1.067	52.45%	20.49%	27.06%
SC9	890924	1020	2.76	3.04	0.12	0.29	0.02	3.74	7.29	0.52	12.17	11.85	1.026	51.27%	22.73%	26.00%
SC9	891121	1145	2.69	3.07	0.11	0.03	0.02	3.69	6.25	0.73	12.01	10.71	1.121	51.11%	22.41%	26.49%
SC9	900131	1315	2.54	2.81	0.20	0.00	0.03	4.00	7.16	0.51	11.39	11.70	0.973	51.26%	22.32%	26.42%
SC9	900327	1345	2.82	3.02	0.12	0.00	0.03	4.02	3.23	0.48	11.90	7.76	1.534	49.88%	23.71%	26.41%

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-
FILE NAME: CRUZ.WK1 Anions (%meq/l) Management Report

Site ID	Date (yymmdd)	Time (hrs)	Alk (%meq/l)	SO4 (%meq/l)	Cl (%meq/l)	Date Entered	Initials	Date Checked	Initials	Date to STORET	Initials
SC7	870529	1120	43.34%	52.39%	4.27%					88----	TJA
SC7	870821	1120	ERR	ERR	ERR					890801	MKL
SC7	871015	1650	35.64%	58.95%	5.40%					88----	TJA
SC7	871124	1005	36.13%	59.20%	4.67%					88----	TJA
SC7	880118	1450	39.59%	56.06%	4.35%					88----	TJA
SC7	880405	1005	31.49%	64.18%	4.33%					88----	TJA
SC7	880504	1125								890801	MKL
SC7	880720	0940	48.13%	47.85%	4.02%	880831	TJA			88----	TJA
SC7	880921	0940	37.74%	57.66%	4.61%	890131	MKL			890721	MKL
SC7	881122	1035	33.54%	62.03%	4.42%					890721	MKL
SC7	890125	0920	36.24%	58.78%	4.98%	890302	MKL	890302	MKL	890721	MKL
SC7	890330	1130	34.96%	60.31%	4.72%					890721	MKL
SC7	890523	1110	34.49%	61.01%	4.50%	890719	MKL	890719	MKL		
SC7	890725	0950	35.50%	59.93%	4.57%	890918	MKL	890918	MKL		
SC7	890924	0930	32.16%	63.60%	4.24%	891119	JFB				
SC7	891121	1030	34.99%	59.95%	5.06%	900209	JB				
SC7 (QC1)	891121	1030	34.52%	60.53%	4.95%	900209	JB				
SC7	900131	1145	35.87%	60.47%	3.66%	900423	JB				
SC7	900327	1215	37.79%	58.64%	3.57%	900823	JB	901022	MKL		
SC7	900530	1045	30.40%	65.85%	3.76%	900823	JB				
SC7	900710	1400	37.99%	57.55%	4.46%	900928	JB	900928	MKL		
SC7	901001	1505									
SC8	890330	0940	35.39%	61.13%	3.48%					890812	MKL
SC8	890523	0955	35.98%	60.58%	3.44%	890719	MKL	890719	MKL	890812	MKL
SC8(QC)	890523	0955	33.88%	62.77%	3.35%	890719	MKL	890719	MKL	890812	MKL
SC8	890725	0850	35.19%	61.77%	3.04%	890918	MKL	890918	MKL		
SC8	890924	0815	33.00%	64.12%	2.88%	891119	JFB				
SC8(QC)	890924	0815	43.22%	53.02%	3.76%	891119	JFB				
SC8	891121	915	37.80%	58.37%	3.82%	900209	JB				
SC8	900131	930	42.10%	55.39%	2.51%	900423	JB				
SC8	900327	1030	42.96%	54.57%	2.47%	900822	JB	901022	MKL		
SC9	890523	1210	32.48%	62.62%	4.89%	890719	MKL	890719	MKL	890812	MKL
SC9	890725	1045	33.56%	61.45%	5.00%	890918	MKL	890918	MKL		
SC9	890924	1020	34.15%	61.48%	4.38%	891119	JFB				
SC9	891121	1145	34.85%	58.30%	6.85%	900209	JB				
SC9	900131	1315	34.46%	61.20%	4.34%	900423	JB				
SC9	900327	1345	52.19%	41.60%	6.22%	900924	JB				

ADEQ FSN DATA & QA/QC
CIENEGA CREEK - WY 1987-
FILE NAME: CRUZ.WK1

Site ID	Date (yymmdd)	Time (hrs)	Remarks
SC7	870529	1120	
SC7	870821	1120	
SC7	871015	1650	
SC7	871124	1005	
SC7	880118	1450	
SC7	880405	1005	
SC7	880504	1125	
SC7	880720	0940	
SC7	880921	0940	
SC7	881122	1035	
SC7	890125	0920	
SC7	890330	1130	
SC7	890523	1110	LAB HAD DIFFICULTY BALANCING IONS
SC7	890725	0950	FIELD TURBIDITY = 0.56 NTU
SC7	890924	0930	X-CONT Ba(D), Hg(D), Sr(D),
SC7	891121	1030	
SC7 (QC1)	891121	1030	
SC7	900131	1145	TKN BY ATI, LAB# FOR FILT MET 19092
SC7	900327	1215	TKN BY ATI
SC7	900530	1045	XCONT(As)
SC7	900710	1400	QA/QC OFF
SC7	901001	1505	
SC8	890330	0940	
SC8	890523	0955	LAB HAD DIFFICULTY BALANCING IONS
SC8(QC)	890523	0955	LAB HAD DIFFICULTY BALANCING IONS
SC8	890725	0850	FIELD TURBIDITY = 0.60 NTU
SC8	890924	0815	
SC8(QC)	890924	0815	
SC8	891121	915	
SC8	900131	930	TKN BY ATI
SC8	900327	1030	TKN BY ATI
SC9	890523	1210	LAB HAD DIFFICULTY BALANCING IONS
SC9	890725	1045	FIELD TURBIDITY = 0.40 NTU
SC9	890924	1020	
SC9	891121	1145	
SC9	900131	1315	TKN BY ATI
SC9	900327	1345	TKN BY ATI, QA/QC OFF

APPENDIX E

ORGANICS IN SURFACE WATER AND GROUNDWATER AT CIENEGA CREEK NATURAL PRESERVE

Analytical Technologies, Inc.

GAS CHROMATOGRAPHY - RESULTS

ATI I.D. : 90970601

TEST : VOLATILE HALOCARBONS (EPA METHOD 601)

CLIENT	: DEPT. OF ENVIRONMENTAL QUALITY	DATE SAMPLED	: 09/24/89
PROJECT #	: (NONE)	DATE RECEIVED	: 09/27/89
PROJECT NAME	: SFSN-SNTA CR	DATE EXTRACTED	: N/A
CLIENT I.D.	: SC-8(UNFILTERED)	DATE ANALYZED	: 09/27/89
SAMPLE MATRIX	: AQUEOUS	UNITS	: UG/L
		DILUTION FACTOR	: 1

COMPOUNDS	RESULTS
BROMODICHLOROMETHANE	<0.2
BROMOFORM	<0.2
BROMOMETHANE	<0.2
CARBON TETRACHLORIDE	<0.2
CHLOROBENZENE	<0.5
CHLOROETHANE	<0.2
CHLOROFORM	<0.2
CHLOROMETHANE	<0.2
DIBROMOCHLOROMETHANE	<0.2
1,3-DICHLOROBENZENE	<0.5
1,4 & 1,2-DICHLOROBENZENE	<0.5
DICHLORODIFLUOROMETHANE	<0.2
1,1-DICHLOROETHANE	<0.2
1,2-DICHLOROETHANE	<0.2
1,1-DICHLOROETHENE	<0.2
1,2-DICHLOROETHENE(TOTAL)	<0.2
1,2-DICHLOROPROPANE	<0.2
CIS-1,3-DICHLOROPROPENE	<0.2
TRANS-1,3-DICHLOROPROPENE	<0.2
METHYLENE CHLORIDE	<2.0
1,1,2,2-TETRACHLOROETHANE	<0.2
TETRACHLOROETHENE	<0.2
1,1,1-TRICHLOROETHANE	<0.2
1,1,2-TRICHLOROETHANE	<0.2
TRICHLOROETHENE	<0.2
TRICHLOROFLUOROMETHANE	<0.5
VINYL CHLORIDE	<0.2
TRICHLOROTRIFLUOROETHANE	<0.2
2-CHLOROETHYL VINYL ETHER	<0.2

SURROGATE PERCENT RECOVERIES

BROMOCHLOROMETHANE (%)	97

AnalyticalTechnologies, inc

GAS CHROMATOGRAPHY - RESULTS

ATI I.D. : 90970615

TEST : VOLATILE HALOCARBONS (EPA METHOD 601)

CLIENT	: DEPT. OF ENVIRONMENTAL QUALITY	DATE SAMPLED	: 09/25/89
PROJECT #	: (NONE)	DATE RECEIVED	: 09/27/89
PROJECT NAME	: (NONE)	DATE EXTRACTED	: N/A
CLIENT I.D.	: BLANKS	DATE ANALYZED	: 09/27/89
SAMPLE MATRIX	: AQUEOUS	UNITS	: UG/L
		DILUTION FACTOR	: 1

COMPOUNDS	RESULTS
BROMODICHLOROMETHANE	<0.2
BROMOFORM	<0.2
BROMOMETHANE	<0.2
CARBON TETRACHLORIDE	<0.2
CHLOROBENZENE	<0.5
CHLOROETHANE	<0.2
CHLOROFORM	<0.2
CHLOROMETHANE	<0.2
DIBROMOCHLOROMETHANE	<0.2
1,3-DICHLOROBENZENE	<0.5
1,4 & 1,2-DICHLOROBENZENE	<0.5
DICHLORODIFLUOROMETHANE	<0.2
1,1-DICHLOROETHANE	<0.2
1,2-DICHLOROETHANE	<0.2
1,1-DICHLOROETHENE	<0.2
1,2-DICHLOROETHENE(TOTAL)	<0.2
1,2-DICHLOROPROPANE	<0.2
CIS-1,3-DICHLOROPROPENE	<0.2
TRANS-1,3-DICHLOROPROPENE	<0.2
METHYLENE CHLORIDE	12 B
1,1,2,2-TETRACHLOROETHANE	<0.2
TETRACHLOROETHENE	<0.2
1,1,1-TRICHLOROETHANE	<0.2
1,1,2-TRICHLOROETHANE	<0.2
TRICHLOROETHENE	<0.2
TRICHLOROFLUOROMETHANE	<0.5
VINYL CHLORIDE	<0.2
TRICHLOROTRIFLUOROETHANE	<0.2
2-CHLOROETHYL VINYL ETHER	<0.2

SURROGATE PERCENT RECOVERIES

BROMOCHLOROMETHANE (%)	96

Analytical Technologies, inc

GAS CHROMATOGRAPHY - RESULTS

REAGENT BLANK

TEST : VOLATILE HALOCARBONS (EPA METHOD 601)

CLIENT : DEPT. OF ENVIRONMENTAL QUALITY
PROJECT # : (NONE)
PROJECT NAME : (NONE)
CLIENT I.D. : REAGENT BLANK

ATI I.D. : 909706
DATE EXTRACTED : 09/27/89
DATE ANALYZED : 09/27/89
UNITS : UG/L
DILUTION FACTOR : N/A

COMPOUNDS	RESULTS
BROMODICHLOROMETHANE	<0.2
BROMOFORM	<0.2
BROMOMETHANE	<0.2
CARBON TETRACHLORIDE	<0.2
CHLOROBENZENE	<0.5
CHLOROETHANE	<0.2
CHLOROFORM	<0.2
CHLOROMETHANE	<0.2
DIBROMOCHLOROMETHANE	<0.2
1,3-DICHLOROBENZENE	<0.5
1,4 & 1,2-DICHLOROBENZENE	<0.5
DICHLORODIFLUOROMETHANE	<0.2
1,1-DICHLOROETHANE	<0.2
1,2-DICHLOROETHANE	<0.2
1,1-DICHLOROETHENE	<0.2
1,2-DICHLOROETHENE(TOTAL)	<0.2
1,2-DICHLOROPROPANE	<0.2
CIS-1,3-DICHLOROPROPENE	<0.2
TRANS-1,3-DICHLOROPROPENE	<0.2
METHYLENE CHLORIDE	2.5
1,1,2,2-TETRACHLOROETHANE	<0.2
TETRACHLOROETHENE	<0.2
1,1,1-TRICHLOROETHANE	<0.2
1,1,2-TRICHLOROETHANE	<0.2
TRICHLOROETHENE	<0.2
TRICHLOROFLUOROMETHANE	<0.5
VINYL CHLORIDE	<0.2
TRICHLOROTRIFLUOROETHANE	<0.2
2-CHLOROETHYL VINYL ETHER	<0.2

SURROGATE PERCENT RECOVERIES

BROMOCHLOROMETHANE (%)	95

AnalyticalTechnologies, Inc

GENERAL CHEMISTRY - QUALITY CONTROL

CLIENT : DEPT. OF ENVIRONMENTAL QUALITY
PROJECT # : (NONE)
PROJECT NAME : SFSN-SNTA CR   ATI I.D. : 909706

PARAMETER	UNITS	ATI I.D.	SAMPLE RESULT	DUP. RESULT	RPD	SPIKED SAMPLE	SPIKE CONC	% REC
CARBONATE	MG/L	90970101	<1	<1	NA	NA	NA	NA
BICARBONATE	MG/L		74	72	3	NA	NA	NA
HYDROXIDE	MG/L		<1	<1	NA	NA	NA	NA
TOTAL ALKALINITY	MG/L		74	72	3	NA	NA	NA
CHLORIDE	MG/L	90970601	11.6	11.5	1	32.4	20.0	104
CYANIDE, TOTAL	MG/L	90972001	<0.01	<0.01	NA	0.25	0.25	100
CONDUCTIVITY(UMHOS/CM)		90970610	623	614	1	NA	NA	NA
FLUORIDE	MG/L	90971201	0.35	0.37	6	0.77	0.40	105
AMMONIA AS NITROGEN	MG/L	90970612	<0.03	<0.03	NA	0.18	0.20	90
AMMONIA AS NITROGEN	MG/L	90970608	13.84	13.15	5	27.80	15.00	93
NITRITE/NITRATE-N (TOT	MG/L	90970615	<0.06	<0.06	NA	1.83	2.00	92
PHENOLPHTHALEIN ALKALI	MG/L	90974105	4	4	0	NA	NA	NA
PH	UNITS	90970101	8.3	8.3	0	NA	NA	NA
PHENOLICS, TOTAL	MG/L	90972001	<0.02	<0.02	NA	0.25	0.25	100
SULFIDE, TOTAL	MG/L	90966402	<1	<1	NA	9.7	10.8	90
SULFATE	MG/L	90970612	250	250	0	850	625	96
TOTAL DISSOLVED SOLIDS	MG/L	90970612	610	620	2	NA	NA	NA
TOTAL KJELDAHL NITROGE	MG/L	90970612	0.1	0.4	120	1.1	1.0	100
PHOSPHOROUS,TOTAL	MG/L	90970610	0.40	0.40	0	0.79	0.40	98
TOTAL SUSPENDED SOLIDS	MG/L	90970612	<10	<10	NA	NA	NA	NA
TURBIDITY	NTU	90970610	2.4	2.4	0	NA	NA	NA

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative Percent Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

COLUMBIA ANALYTICAL SERVICES, INC.

Analytical Report

CLIENT: Turner Laboratories
SUBMITTED BY: Tom Graf
PROJECT: #16198-PCFC
SAMPLE DESCRIPTION: Water

DATE RECEIVED: 08/29/90
DATE EXTRACTED: 09/05/90
DATE ANALYZED: 09/10/90
WORK ORDER #: K903109

Chlorinated Herbicides
EPA Method 8150
μg/L (ppb)

Sample Name:		16198	Method Blank
Lab Code:		3109-1	3109-MB
Compound	MRL		
Dalapon	5	ND	ND
Dicamba	0.5	ND	ND
MCPA	200	ND	ND
MCPP	200	ND	ND
Dichloroprop	0.6	ND	ND
2,4-D	1	ND	ND
Silvex	0.2	ND	ND
2,4,5-T	0.2	ND	ND
2,4-DB	2	ND	ND
Dinoseb	2	ND	ND

MRL means Method Reporting Limit
ND means None Detected at or above the MRL

Approved by Athie Spielman Date 9/14/90

COLUMBIA ANALYTICAL SERVICES, INC.

CLIENT: Turner Laboratories
SUBMITTED BY: Tom Graf
PROJECT: #16198-PCFC
SAMPLE DESCRIPTION: Water

DATE RECEIVED: 08/29/90
WORK ORDER #: K903109

QA/QC Report
Surrogate Recovery Summary
Chlorinated Herbicides
EPA Method 8150

Sample Name	Lab Code	Percent Recovery
16198	3109-1	64.4
Method Blank	3109-MB	49.4
CAS Acceptance Criteria		16-128

Approved by Abbie Spielman Date 9/19/90

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APPENDIX F

GROUNDWATER QUALITY STANDARDS

ARIZONA GROUNDWATER QUALITY STANDARDS

Water Qlty Var.Group*	Water Quality Variable	MCL	SMCL	HBGL	AL	UNITS
BTX	Benzene	5.0000	--------	1.3000	5.0000	ug/l
	Ethylbenzene	--------	--------	680.0000	680.0000	ug/l
	m-Xylene	--------	--------	440.0000	440.0000	ug/l
	o/p-Xylene	--------	--------	440.0000	440.0000	ug/l
	o-Xylene	--------	--------	440.0000	440.0000	ug/l
	p-Xylene	--------	--------	440.0000	440.0000	ug/l
	Toluene	--------	--------	2.0000	2.0000	mg/l
	Xylene /Total (1)	--------	--------	440.0000	440.0000	ug/l
ION	Chloride	--------	250.0000	--------	--------	mg/l
	Cyanide /Total	--------	--------	220.0000	160.0000	ug/l
	Fluoride	4.0000	2.0000	4.0000	--------	mg/l
	Fluoride /Dissolved	4.0000	2.0000	4.0000	--------	mg/l
	Sulfate	--------	250.0000	--------	--------	mg/l
	Total Dissolved Solids	--------	500.0000	--------	--------	mg/l
MET	Aluminum	--------	--------	0.0730	--------	mg/l
	Aluminum /Dissolved	--------	--------	0.0730	--------	mg/l
	Antimony	--------	--------	0.0140	--------	mg/l
	Antimony /Dissolved	--------	--------	0.0140	--------	mg/l
	Arsenic	50.0000	--------	50.0000	--------	ug/l
	Arsenic /Dissolved	50.0000	--------	50.0000	--------	ug/l
	Arsenic /Total	50.0000	--------	50.0000	--------	ug/l
	Barium	1.0000	--------	1.5000	--------	mg/l
	Barium /Dissolved	1.0000	--------	1.5000	--------	mg/l
	Barium /Total	1.0000	--------	1.5000	--------	mg/l
	Beryllium	--------	--------	0.0070	--------	ug/l
	Beryllium /Dissolved	--------	--------	0.0070	--------	ug/l
	Cadmium	10.0000	--------	5.0000	--------	ug/l
	Cadmium /Dissolved	10.0000	--------	5.0000	--------	ug/l
	Cadmium /Total	10.0000	--------	5.0000	--------	ug/l
	Chromium	50.0000	--------	120.0000	--------	ug/l
	Chromium /Dissolved	50.0000	--------	120.0000	--------	ug/l
	Chromium /Hexavalent	50.0000	--------	120.0000	--------	ug/l
	Chromium /Total	50.0000	--------	120.0000	--------	ug/l
	Cobalt	--------	--------	0.7000	--------	ug/l
	Cobalt /Dissolved	--------	--------	0.7000	--------	ug/l
	Copper	--------	1.0000	1.3000	--------	mg/l
	Copper /Dissolved	--------	1.0000	1.3000	--------	mg/l
	Copper /Total	--------	1.0000	1.3000	--------	mg/l
	Iron	--------	300.0000	--------	--------	ug/l
	Iron /Dissolved	--------	300.0000	--------	--------	ug/l
	Iron /Total	--------	300.0000	--------	--------	ug/l

1) Total Xylenes are comprised of m-Xylene, o-Xylene, o/p-Xylene, and p-Xylene. The combined total must not exceed 440 ug/l though 440 ug/l is given as the MCL for each individual Xylene.

*Standards presented are only those for constituents that appear in the ADEQ Groundwater Database. For a complete list of Water Quality Variables tested for see Table 13.

Water Qlty Var.Group*	Water Quality Variable	MCL	SMCL	HBGL	AL	UNITS
MET	Lead	50.0000	--------	20.0000	--------	ug/l
	Lead /Dissolved	50.0000	--------	20.0000	--------	ug/l
	Lead /Total	50.0000	--------	20.0000	--------	ug/l
	Manganese	--------	50.0000	--------	--------	ug/l
	Manganese /Dissolved	--------	50.0000	--------	--------	ug/l
	Manganese /Total	--------	50.0000	--------	--------	ug/l
	Mercury	2.0000	--------	3.0000	--------	ug/l
	Mercury /Dissolved	2.0000	--------	3.0000	--------	ug/l
	Mercury /Total	2.0000	--------	3.0000	--------	ug/l
	Nickel	--------	--------	150.0000	--------	ug/l
	Nickel /Dissolved	--------	--------	150.0000	--------	ug/l
	Selenium	10.0000	--------	45.0000	--------	ug/l
	Selenium /Dissolved	10.0000	--------	45.0000	--------	ug/l
	Selenium /Total	10.0000	--------	45.0000	--------	ug/l
	Silver	50.0000	--------	50.0000	--------	ug/l
	Silver /Dissolved	50.0000	--------	50.0000	--------	ug/l
	Silver /Total	50.0000	--------	50.0000	--------	ug/l
	Thallium	--------	--------	13.0000	--------	ug/l
	Thallium /Dissolved	--------	--------	13.0000	--------	ug/l
	Vandium	--------	--------	7.0000	--------	ug/l
	Vandium /Dissolved	--------	--------	7.0000	--------	ug/l
	Zinc	--------	5.0000	5.0000	--------	mg/l
	Zinc /Dissolved	--------	5.0000	5.0000	--------	mg/l
	Zinc /Total	--------	5.0000	5.0000	--------	mg/l
NUT	Nitrate	10.0000	--------	10.0000	--------	mg/l
	Nitrite/Nitrate /Dissolved	10.0000	--------	10.0000	--------	mg/l
	Nitrite/Nitrate /Total	10.0000	--------	10.0000	--------	mg/l
PEST	2,4,5-TP (Silvex)	10.0000	--------	35.0000	--------	ug/l
	2,4-D	100.0000	--------	70.0000	--------	ug/l
	Aldicarb	--------	--------	9.0000	9.0000	ug/l
	Aldrin	--------	--------	0.0020	--------	ug/l
	DDT	--------	--------	0.1000	--------	ug/l
	Dibromochloropropane	--------	--------	0.0250	--------	ug/l
	Dieldrin	--------	--------	0.0010	--------	ug/l
	Dinoseb	--------	--------	3.5000	3.5000	ug/l
	Endrin	0.2000	--------	0.3200	--------	ug/l
	Ethylene Dibromide	--------	--------	0.0005	0.0100	ug/l
	Heptachlor	--------	--------	0.0080	0.0500	ug/l
	Heptachlor Epoxide	--------	--------	0.0040	--------	ug/l
	Lindane	4.0000	--------	0.2000	--------	ug/l
	Methomyl	--------	--------	180.0000	175.0000	ug/l
	Methoxychlor	100.0000	--------	340.0000	--------	ug/l
	Toxaphene	5.0000	--------	0.0300	--------	ug/l
PHY	pH	--------	8.5000	--------	--------	StdUnt
	pH /Lab	--------	8.5000	--------	--------	StdUnt
	Turbidity	1.0000	--------	--------	--------	NTU

Water Qlty Var.Group*	Water Quality Variable	MCL	SMCL	HBGL	AL	UNITS
VOC	1,1,1,2-Tetrachloroethane	--------	--------	--------	0.5000	ug/l
	1,1,1-Trichloroethane	200.0000	--------	200.0000	200.0000	ug/l
	1,1,2,2-Tetrachloroethane	--------	--------	0.1700	--------	ug/l
	1,1,2-Trichloroethane	--------	--------	0.6100	1.0000	ug/l
	1,1-Dichloroethene	7.0000	--------	7.0000	--------	ug/l
	1,1-Dichloropropene	--------	--------	87.0000	--------	ug/l
	1,2,3-Trichloropropane	--------	--------	42.0000	--------	ug/l
	1,2,4-Trichlorobenzene	--------	--------	140.0000	--------	ug/l
	1,2-Dibromo-3-Chloropropane	--------	--------	0.0250	--------	ug/l
	1,2-Dibromoethane	--------	--------	0.0050	--------	ug/l
	1,2-Dichlorobenzene	--------	--------	620.0000	620.0000	ug/l
	1,2-Dichloroethane	5.0000	--------	0.3800	5.0000	ug/l
	1,2-Dichloropropane	--------	--------	0.5600	1.0000	ug/l
	1,3-Dichlorobenzene	--------	--------	620.0000	--------	ug/l
	1,4-Dichlorobenzene	75.0000	--------	75.0000	75.0000	ug/l
	Bromodichloromethane	100.0000	--------	0.1900	--------	ug/l
	Bromoform	100.0000	--------	0.1900	--------	ug/l
	Bromomethane	--------	--------	0.1900	2.5000	ug/l
	Carbon Tetrachloride	5.0000	--------	0.2700	5.0000	ug/l
	Chlorobenzene	--------	--------	60.0000	--------	ug/l
	Chloroform	100.0000	--------	0.1900	3.0000	ug/l
	Chloromethane	--------	--------	0.1900	0.5000	ug/l
	CIS-1,2-Dichloroethane	--------	--------	70.0000	--------	ug/l
	CIS-1,3-Dichloropropene	--------	--------	87.0000	--------	ug/l
	Dibromochloromethane	100.0000	--------	0.1900	--------	ug/l
	Dichlorodifluoromethane	--------	--------	1400.0000	1.0000	ug/l
	Methylene Chloride	--------	--------	4.7000	4.7000	ug/l
	Styrene	--------	--------	140.0000	140.0000	ug/l
	Tetrachloroethene	--------	--------	0.6700	3.0000	ug/l
	Trichloroethene	5.0000	--------	3.2000	--------	ug/l
	Trichlorofluoromethane	--------	--------	2100.0000	1.0000	ug/l
	Trihalomethane (2)	100.0000	--------	0.1900	--------	ug/l
	Trihalomethane /Total	100.0000	--------	0.1900	--------	ug/l
	t-1,3-Dichloropropene	--------	--------	87.0000	--------	ug/l
	Vinyl Chloride	2.0000	--------	0.0150	1.0000	ug/l

BTX - Aromatic Hydrocarbons
ION - Major Cations and Anions
MET - Metals
NUT - Nutrients
PEST- Pesticides
PHY - Physical
VOC - Volatile Organic Compounds

(2) Trihalomethanes are comprised of Bromodichloromethane, Bromoform, Chlorodibromomethane and Chloroform. The combined total must not exceed 100 ug/l though 100 ug/l is given as the MCL for each individual Trihalomethane.

MCL	Maximum Contaminant Levels
SMCL	Secondary Maximum Contaminant Levels
HBGL	Health Based Guidance Levels
AL	Arizona Action Levels

* Arizona Action Levels are presented for reference though not included in the report analyses.

From Arizona Department of Environmental Quality (1989)

APPENDIX G

GROUNDWATER QUALITY IN THE CIENEGA CREEK NATURAL PRESERVE

Groundwater Quality in Cienega Creek Preserve   File: CNGA.WK1 Disk: PIMA SPECIAL
LOTUS QA&QC Worksheet (Revised)   Printed:5/30/90

LOCATION	Well Name	Date (yymmdd)	Time (hh:mm)	ADWR Regis#	Basin	Well Use	Sampling Agency/ DataSource	Field Parameters Air (C)	H2O (C)	DO (mgO2/l)	Sat. (%)	Fld EC (uS/cm)	Fld pH (SU)	Depth (ft)	PerfInt (ft)	Cased Depth	Casing Diam	DateDrill (yymmdd)	Lab Lab EC (uS/cm)	Lab pH (SU)	Hardness EDTA (mg/l)	TDS Evap (mg/l)	TSS (mg/l)
16-16-03	Valley Water #1	800801	10:00				ATL													7.6		740	
16-16-09dcd	Vail School	590210																					
16-16-09dcd	Vail School	661104				PS	ADHS							610					769	7.3		500	
16-16-09dcd	Vail School	710423				PS	ADHS												833	7.8		525	
16-16-09dcd	Vail School	710920				PS	ADHS							650					769	8.1		500	
16-16-09dcd	Vail School	720420				PS	ADHS							650					571	8.0		370	
16-16-09dcd	St. Rita Church	710920				PS	ADHS							750					625	8.3		400	
16-16-10dcb	Del-Lago	410327					USGS							500					1160				
16-16-10dcb	Del-Lago	590210					USGS																
16-16-14ddc	Del-Lago #1	590710					USGS																
16-16-14ddc	Del-Lago #1	900327	09:13			U	PAG		21			1520	7.05	308			16			7.5	211	1365	10
16-16-16dcd	Del-Lago #3	810309	08:30			M	STORET													7.5		460	
16-16-16dcd	Del-Lago #3	840126	11:00			M	ATL/STORET													8.1		470	
16-16-16dcd	Del-Lago #3	840928	14:30			M	STORET		29											7.3		426	
16-16-16dcd	Del-Lago #3	840928	15:10			M	STORET		22											7.1		501	
16-16-16dcd	Del-Lago #3	861216	11:00			M	ATL													7.7		650	
16-16-17	Vail Jr. High School	670000				PS	ADHS												385			245	
16-16-17	Vail Jr. High School	671004				PS	ADHS												333			210	
16-16-26ccc		410328					USGS							251					523				
16-16-27aac	Del-Lago #2	600510																					
16-16-27aac	Del-Lago #2	610310																					
16-16-27aac	Del-Lago #2	640000					ADHS												733				
16-16-27aac	Del-Lago #2	650000				M	ADHS							868					714				
16-16-27aac	Del-Lago #2	690106				M	ADHS												685			435	
16-16-27aac	Del-Lago #2	720218	08:00			M	ADHS												680	8.3		430	
16-16-27aac	Del-Lago #2	750130				M	ATL												667	8.1		425	
16-16-27aac	Del-Lago #2	780213	08:00			M	ATL												704	7.2		451	
16-16-27aac	Del-Lago #2	810309	08:30			M	ATL													7.5		460	
16-16-27aac	Del-Lago #2	840710	11:20			M	ATL													7.9		400	
16-17-08b	Colossal Cave	651102				PS	ADHS												588			380	
16-17-08b	Colossal Cave	690000				PS	ADHS												580			375	
16-17-08b	Colossal Cave	720103				PS	ADHS																
16-17-08b	Colossal Cave	760315	10:30			PS	ADHS													7.5		266	
16-17-08b	Colossal Cave	760518	11:30			SPS	ADHS												629	7.1		422	
16-17-08b	Colossal Cave	790606	14:15			PS	ADHS												571	7.5		436	
16-17-33abb	Cienega	900404	13:04			U	TURNER		18			850	6.95							7.8			22
17-16-10abb	Santa Rita #1	800813	11:00			PS	STORET													8.2		350	
17-16-10abb	Santa Rita #1	820625	10:30			PS	STORET													7.2		405	
17-16-10abb	Santa Rita #1	850123	07:00			PS	STORET		16											7.8		368	
17-17-01	Pantano Rest Area	761028	16:30			PS	ADHS	15.5	20					101.5						7.6		655	
17-17-01	Pantano Rest Area	761030	17:30			PS	ADHS	20	20					101.5						7.7		646	

Groundwater Quality in Cienega Creek Preserve
LOTUS QA&QC Worksheet (Revised)

				Cations				Anions												Bacteria	
LOCATION	Well Name	Date (yymmdd)	Turbidity (NTU)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	OH (mg/l)	CO3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	Cl (mg/l)	Alk, T (mg/l)	Alk, P (mg/l)	F (mg/l)	TKN (mgN/l)	NO2+NO3 (mgN/l)	Ammonia (mgN/l)	TP (mgP/l)	FC (cfu/100ml)	FS (cfu/100ml)
16-16-03	Valley Water #1	800801		118	26	83				263	360	24	216	0	0.3		2.1				
16-16-09dcd	Vail School	590210		91	29					305	170	10									
16-16-09dcd	Vail School	661104		85	26	45				293	136	10	240	0	0.5					1 K	
16-16-09dcd	Vail School	710423		32	13	127				271	150	13	222	0	0.49		2.2				
16-16-09dcd	Vail School	710920	<5	91	19	40				273	125	12	224	0	0.49		1.8				
16-16-09dcd	Vail School	720420	<5	60	18	72				236	134	11	194	0	0.42		2.7				
16-16-09dcd	St. Rita Church	710920	<5	67	15	46				256	95	14	210	0	0.53		1.4				
16-16-10dcb	Del-Lago	410327		134	42				0	448	280	21			1.0						
16-16-10dcb	Del-Lago	590210		154	40				0	373	330	42									
16-16-14ddc	Del-Lago #1	590710		166	50	196	0		0	217	780	38			0.6						
16-16-14ddc	Del-Lago #1	900327	28	151	50	187	8.14	0	0	48	833	58	48	0	0.3	0.24	0.1	0.2	0.04		
16-16-16dcd	Del-Lago #3	810309		33	14	111				261	137	26	214		0.6		0.9				
16-16-16dcd	Del-Lago #3	840126		79	28	45				244	160	8	200		1.0		0.5				
16-16-16dcd	Del-Lago #3	840928		127						236			194								
16-16-16dcd	Del-Lago #3	840928		210						262			215								
16-16-16dcd	Del-Lago #3	861216		114	41	54				251	270	26	206		0.9		0.4				
16-16-17	Vail Jr. High School	670800													0.3		2.5				
16-16-17	Vail Jr. High School	671004													0.3		2.7				
16-16-26ccc		410328		46	16				0	225	46	27									
16-16-27aac	Del-Lago #2	600510		34	11				0	276	173	32									
16-16-27aac	Del-Lago #2	610310		30	10				2	230	110	28			0.7						
16-16-27aac	Del-Lago #2	640000		27	14	131				284	116	26	228	0	2.5		0.2 K				
16-16-27aac	Del-Lago #2	650000																			
16-16-27aac	Del-Lago #2	690106		22	13	121				268	105	22	220	0	0.3		0.2 K				
16-16-27aac	Del-Lago #2	720218	<5	33	8	110				266	98	26	218	0	0.8		0.2 K				
16-16-27aac	Del-Lago #2	750130	<5	34	8	102				268	96	24	220	0	0.6		0.2 K				
16-16-27aac	Del-Lago #2	780213		91	14	66			4.9	438	80	22	359	<2.4	0.71		0.1				
16-16-27aac	Del-Lago #2	810309		33	14	111				261	137	26	214		0.6		0.2				
16-16-27aac	Del-Lago #2	840710		44	17	78				222	120	20	182		1.7		0.3				
16-17-08b	Colossal Cave	651102		98	13	17				378	14	7	310	0	0.5		0.2 K				
16-17-08b	Colossal Cave	690800		111	11	23				366	25	10	300	0	0.19		0.2 K				
16-17-08b	Colossal Cave	720103													0.4						
16-17-08b	Colossal Cave	760315	<5	71	8	19				334	22	7	274	0	0.31		0.2 K				
16-17-08b	Colossal Cave	760518	<5	130	2	16				427	23	7	350	0	0.29		0.2				
16-17-08b	Colossal Cave	790606		91	11	25				305	38	39	250	0	0.43		0.1 K				
16-17-33abb	Cienega	900404	4.4	111	32	55	3.08	0	0	269	272	10	269	0	0.68	0.25 K	0.8	0.09			
17-16-10abb	Santa Rita #1	800813		38	13	75				254	77	14	208	0	0.5		0.4				
17-16-10abb	Santa Rita #1	820625		27	13	44				504	76	30	413		0.38		0.4				
17-16-10abb	Santa Rita #1	850123		126						264			217								
17-17-01	Pantano Rest Area	761028	<5	138	20	43				310	240	10	254	0	0.71		0.4				
17-17-01	Pantano Rest Area	761030	<5	128	28	41				305	246	10	250	0	0.71		0.2 K				

Groundwater Quality in Cienega Creek Preserve
LOTUS QA&QC Worksheet (Revised)   Trace Metals

LOCATION	Well Name	Date (yymmdd)	Ag, T (ug/l)	Ag, D (ug/l)	As, T (ug/l)	As, D (ug/l)	Ba, T (ug/l)	Ba, D (ug/l)	B, T (ug/l)	B, D (ug/l)	Be, T (ug/l)	Be, D (ug/l)	Cd, T (ug/l)	Cd, D (ug/l)	Cr, T (ug/l)	Cr, D (ug/l)	Cu, T (ug/l)	Cu, D (ug/l)	Fe, T (ug/l)	Fe, D (ug/l)
16-16-03	Valley Water #1	800801	20 K		10 K		200 K						5 K		10 K		50 K		210	
16-16-09dcd	Vail School	590210																		
16-16-09dcd	Vail School	661104											10 K		10 K		50 K		50 K	
16-16-09dcd	Vail School	710423													10 K					
16-16-09dcd	Vail School	710920			10 K										10 K		50 K		50 K	
16-16-09dcd	Vail School	720420	10 K		10 K								10 K		10 K		50 K		50 K	
16-16-09dcd	St. Rita Church	710920			10 K										10 K		50 K			
16-16-10dcb	Del-Lago	410327																		
16-16-10dcb	Del-Lago	590210																		
16-16-14ddc	Del-Lago #1	590710																		
16-16-14ddc	Del-Lago #1	900327	10 K		1 K		47 K		600		20 K		10 K		40 K		20 K		7970	
16-16-16dcd	Del-Lago #3	810309	20 K		10 K		200 K						5 K		5 K		50 K		1100	
16-16-16dcd	Del-Lago #3	840126	20 K		10 K		500 K						5 K		10 K		94		610	
16-16-16dcd	Del-Lago #3	840928																		
16-16-16dcd	Del-Lago #3	840928																		
16-16-16dcd	Del-Lago #3	861216	20 K		10 K		500 K						5 K		10 K		50 K		1700	
16-16-17	Vail Jr. High School	670800																		
16-16-17	Vail Jr. High School	671004																		
16-16-26ccc		410328																		
16-16-27aac	Del-Lago #2	600510																		
16-16-27aac	Del-Lago #2	610310																		
16-16-27aac	Del-Lago #2	640800													10 K		50 K		200	
16-16-27aac	Del-Lago #2	650800																		
16-16-27aac	Del-Lago #2	690106			10 K										10 K				50 K	
16-16-27aac	Del-Lago #2	720210	10 K		10 K								10 K		10 K		50 K		50 K	
16-16-27aac	Del-Lago #2	750130	10 K		10 K								10 K		10 K		50 K		290	
16-16-27aac	Del-Lago #2	780213	20 K		1 K		200 K						5 K		30 K		40 K		200 K	
16-16-27aac	Del-Lago #2	810309	20 K		10 K		200 K						5 K		10 K		50 K		1100	
16-16-27aac	Del-Lago #2	840710	20 K		10 K		500 K						5 K		10 K		50 K		1500	
16-17-08b	Colossal Cave	651102													10 K		50 K		50 K	
16-17-08b	Colossal Cave	690800			10 K										10 K					
16-17-08b	Colossal Cave	720103	10 K		10 K								10 K		10 K					
16-17-08b	Colossal Cave	760315	10 K		10 K								10 K		10 K		50 K		50 K	
16-17-08b	Colossal Cave	760510	10 K		10 K								10 K		10 K		50 K		70	
16-17-08b	Colossal Cave	790606	10 K		5 K		100 K						5 K		10 K		50 K		50	
16-17-33abb	Cienega	900404			1 K		33 K		30 K		20 K		10 K		30 K		20 K		940	
17-16-10abb	Santa Rita #1	800813	20 K		10 K		200 K						5 K		10 K		50 K		3100	
17-16-10abb	Santa Rita #1	820625	20		5 K		100 K						10 K		50 K		10 K		100	
17-16-10abb	Santa Rita #1	850123																		
17-17-01	Pantano Rest Area	761028	10 K		5 K								5 K		10 K		50 K		50 K	
17-17-01	Pantano Rest Area	761030	10 K		6 K								5 K		10 K		50 K		70	

Groundwater Quality in Cienega Creek Preserve
LOTUS QA&QC Worksheet (Revised)

LOCATION	Well Name	Date (yymmdd)	Hg, T (ug/l)	Hg, D (ug/l)	Mn, T (ug/l)	Mn, D (ug/l)	Ni, T (ug/l)	Ni, D (ug/l)	Pb, T (ug/l)	Pb, D (ug/l)	Sb, T (ug/l)	Sb, D (ug/l)	Se, T (ug/l)	Se, D (ug/l)	Sr, T (ug/l)	Sr, D (ug/l)	Tl, T (ug/l)	Tl, D (ug/l)	Zn, T (ug/l)
16-16-03	Valley Water #1	800801	1 K		50 K				20 K				5 K						2400
16-16-09dcd	Vail School	590210																	
16-16-09dcd	Vail School	661104			50 K		100 K		10 K										100 K
16-16-09dcd	Vail School	710423																	
16-16-09dcd	Vail School	710920			50 K				50 K										
16-16-09dcd	Vail School	720420	0.5 K		50 K				50 K				10 K						300
16-16-09dcd	St. Rita Church	710920			50 K				50 K										
16-16-10dcb	Del-Lago	410327																	
16-16-10dcb	Del-Lago	590210																	
16-16-14ddc	Del-Lago #1	590710																	
16-16-14ddc	Del-Lago #1	900327	1 K		120		70 K		130				1 K				140 K		40
16-16-16dcd	Del-Lago #3	810309	1 K		120				20 K				5 K						50 K
16-16-16dcd	Del-Lago #3	840126	1 K		50 K				20 K				5 K						50 K
16-16-16dcd	Del-Lago #3	840928																	
16-16-16dcd	Del-Lago #3	840928																	
16-16-16dcd	Del-Lago #3	861216	1 K		50 K				20 K				5 K						50 K
16-16-17	Vail Jr. High School	670000																	
16-16-17	Vail Jr. High School	671004																	
16-16-26ccc		410328																	
16-16-27aac	Del-Lago #2	600510																	
16-16-27aac	Del-Lago #2	610310																	
16-16-27aac	Del-Lago #2	640000																	
16-16-27aac	Del-Lago #2	650000																	
16-16-27aac	Del-Lago #2	690106																	
16-16-27aac	Del-Lago #2	720218	0.5 K		50 K				50 K				10 K						50 K
16-16-27aac	Del-Lago #2	750130	0.5 K		50 K				50 K				10 K						50 K
16-16-27aac	Del-Lago #2	780213	0.5 K		20 K				20 K				5 K						90
16-16-27aac	Del-Lago #2	810309	1 K		120				20 K				5 K						50 K
16-16-27aac	Del-Lago #2	840710	1 K		50 K				20 K				5 K						50 K
16-17-08b	Colossal Cave	651102																	
16-17-08b	Colossal Cave	690000																	
16-17-08b	Colossal Cave	720103	0.5 K						50 K				10 K						
16-17-08b	Colossal Cave	760315	0.5 K		50 K				50 K				10 K						60
16-17-08b	Colossal Cave	760518	0.5 K		50 K				50 K				10 K						860
16-17-08b	Colossal Cave	790606	0.5 K		50 K				20 K				5 K						80
16-17-33abb	Cienega	900404	1 K		20 K		13 K		12 K		21 K		1 K				60 K		90
17-16-10abb	Santa Rita #1	800813	1 K		110				20 K				5 K						1100
17-16-10abb	Santa Rita #1	820625	1 K		50 K				40 K				5 K						40
17-16-10abb	Santa Rita #1	850123																	
17-17-01	Pantano Rest Area	761028	0.5 K		210				20 K				5 K						70
17-17-01	Pantano Rest Area	761030	0.5 K		50 K				20 K				5 K						50 K

Groundwater Quality in Cienega Creek Preserve — QA/QC
LOTUS QA&QC Worksheet (Revised)

LOCATION	Well Name	Date (yymmdd)	Zn, D (ug/l)	Lab.	Lab No.	Lab Turnaround Time: Submit Date	Report Date	Date Rec'd	Total (days)	Ratios: F/L EC Ratio	F/L pH Ratio	TDS/EC Ratio	Hardness: EDTA (mg/l)	Calc. (mg/l)	E/C Ratio	TDS: Evap (mg/l)	Sum (mg/l)	E/S Ratio	Cations: Ca (mg/l)	Mg (mg/l)
16-16-03	Valley Water #1	800801		ATL	711400	08/05	08/18			ERR	0.000	ERR		401.66	0.00	740.00	874.00	0.85	118.00	26.00
16-16-09dcd	Vail School	590210								ERR	ERR	ERR		346.59	0.00		605.00	0.00	91.00	29.00
16-16-09dcd	Vail School	661104		ADHS	12547	11/04	12/02			0.000	0.000	0.650		319.26	0.00	500.00	595.00	0.84	85.00	26.00
16-16-09dcd	Vail School	710423		ADHS	53517	04/29	05/05			0.000	0.000	0.630		133.41	0.00	525.00	606.00	0.87	32.00	13.00
16-16-09dcd	Vail School	710920		ADHS	15603	09/23	10/01			0.000	0.000	0.650		305.43	0.00	500.00	560.00	0.89	91.00	19.00
16-16-09dcd	Vail School	720420		ADHS	55540	05/03	06/12			0.000	0.000	0.648		223.91	0.00	370.00	531.00	0.70	60.00	18.00
16-16-09dcd	St. Rita Church	710920		ADHS	15601	09/23	10/23			0.000	0.000	0.640		229.04	0.00	400.00	493.00	0.81	67.00	15.00
16-16-10dcb	Del-Lago	410327								0.000	ERR	0.000		507.47	0.00		925.00	0.00	134.00	42.00
16-16-10dcb	Del-Lago	590210								ERR	ERR	ERR		549.18	0.00		939.00	0.00	154.00	40.00
16-16-14ddc	Del-Lago #1	590710								ERR	ERR	ERR		620.30	0.00		1447.00	0.00	166.00	50.00
16-16-14ddc	Del-Lago #1	900327		TURNER	14647	03/27	04/03	04/09	14	ERR	0.940	ERR	211.00	582.85	0.36	1365.00	1335.14	1.02	151.00	50.00
16-16-16dcd	Del-Lago #3	810309								ERR	0.000	ERR		140.03	0.00	460.00	582.00	0.79	33.00	14.00
16-16-16dcd	Del-Lago #3	840126		ATL	470900	01/27	02/17			ERR	0.000	ERR		312.51	0.00	470.00	564.00	0.83	79.00	28.00
16-16-16dcd	Del-Lago #3	840928								ERR	0.000	ERR		316.37	0.00	426.00	362.70	1.17	126.70	0.00
16-16-16dcd	Del-Lago #3	840928								ERR	0.000	ERR		523.62	0.00	501.00	471.70	1.06	209.70	0.00
16-16-16dcd	Del-Lago #3	861216		ATL	96100	12/17	01/16			ERR	0.000	ERR		453.41	0.00	650.00	756.00	0.86	114.00	41.00
16-16-17	Vail Jr. High School	670000		ADHS	21240		01/27	01/09		0.000	ERR	0.636		0.00	ERR	245.00	0.00	ERR	0.00	0.00
16-16-17	Vail Jr. High School	671004		ADHS	11519		11/01	10/13		0.000	ERR	0.631		0.00	ERR	210.00	0.00	ERR	0.00	0.00
16-16-26ccc		410328								0.000	ERR	0.000		180.72	0.00		360.00	0.00	46.00	16.00
16-16-27aac	Del-Lago #2	600510								ERR	ERR	ERR		130.17	0.00		526.00	0.00	34.00	11.00
16-16-27aac	Del-Lago #2	610310								ERR	ERR	ERR		116.07	0.00		410.00	0.00	30.00	10.00
16-16-27aac	Del-Lago #2	640000		ADHS	22496	05/07	06/08			0.000	ERR	0.000		125.04	0.00		598.00	0.00	27.00	14.00
16-16-27aac	Del-Lago #2	650000		ADHS	34723	06/03	09/08			0.000	ERR	0.000		0.00	ERR		0.00	ERR		
16-16-27aac	Del-Lago #2	690106		ADHS	27855	01/00	01/24			0.000	ERR	0.635		108.44	0.00	435.00	551.00	0.79	22.00	13.00
16-16-27aac	Del-Lago #2	720218		ADHS	44760	03/02	03/23			0.000	0.000	0.632		115.33	0.00	430.00	541.00	0.79	33.00	8.00
16-16-27aac	Del-Lago #2	750130		ATL	40446	02/00	02/20			0.000	0.000	0.637		117.83	0.00	425.00	532.00	0.80	34.00	8.00
16-16-27aac	Del-Lago #2	780213		ATL	994-3872	02/13	02/24			0.000	0.000	0.641		284.10	0.00	451.00	715.60	0.63	90.70	14.00
16-16-27aac	Del-Lago #2	810309		ATL	53300	03/11	03/20			ERR	0.000	ERR		140.03	0.00	460.00	582.00	0.79	33.00	14.00
16-16-27aac	Del-Lago #2	840710		ATL	729700	07/11	07/27			ERR	0.000	ERR		179.84	0.00	400.00	501.00	0.80	44.00	17.00
16-17-08b	Colossal Cave	651102			13189	11/09	03/17			0.000	ERR	0.646		298.21	0.00	380.00	527.00	0.72	98.00	13.00
16-17-08b	Colossal Cave	690000		ADHS	27859		01/27			0.000	ERR	0.647		322.44	0.00	375.00	546.00	0.69	111.00	11.00
16-17-08b	Colossal Cave	720103		ADHS	37626		04/03	01/21		ERR	ERR	ERR		0.00	ERR		0.00	ERR	0.00	0.00
16-17-08b	Colossal Cave	760315		ADHS			04/26			ERR	0.000	ERR		210.22	0.00	266.00	461.00	0.58	71.00	8.00
16-17-08b	Colossal Cave	760518		ADHS			06/15			0.000	0.000	0.671		332.84	0.00	422.00	605.00	0.70	130.00	2.00
16-17-08b	Colossal Cave	790606		ADHS			09/10			0.000	0.000	0.764		272.50	0.00	436.00	509.00	0.86	91.00	11.00
16-17-33abb	Cienega	900404		TURNER	14733	04/04	04/11	04/20	20	ERR	0.893	ERR		408.88	0.00		752.08	0.00	111.00	32.00
17-16-10abb	Santa Rita #1	800813								ERR	0.000	ERR		148.39	0.00	350.00	471.00	0.74	38.00	13.00
17-16-10abb	Santa Rita #1	820625								ERR	0.000	ERR		120.68	0.00	405.00	693.90	0.58	26.90	13.00
17-16-10abb	Santa Rita #1	850123								ERR	0.000	ERR		313.62	0.00	368.00	389.60	0.94	125.60	0.00
17-17-01	Pantano Rest Area	761028		ADHS			01/04			ERR	0.000	ERR		0.00	ERR	655.00	0.00	ERR	138.00	20.00
17-17-01	Pantano Rest Area	761030		ADHS			01/04			ERR	0.000	ERR		0.00	ERR	646.00	0.00	ERR	128.00	28.00

Groundwater Quality in Cienega Creek Preserve
LOTUS QA&QC Worksheet (Revised)

LOCATION	Well Name	Date (yymmdd)	Anions: Na (mg/l)	K (mg/l)	OH (mg/l)	CO3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	Cl (mg/l)	Cations (meq/l): Ca (meq/l)	Mg (meq/l)	Na (meq/l)	K (meq/l)	Anions (meq/l): OH (meq/l)	CO3 (meq/l)	HCO3 (meq/l)	SO4 (meq/l)	Cl (meq/l)	Sum (me: Cations (meq/l)
16-16-03	Valley Water #1	800801	83.00	0.00		0.00	263.00	360.00	24.00	5.89	2.14	3.61	0.00	0.00	0.00	4.31	7.50	0.68	11.64
16-16-09dcd	Vail School	590210	0.00	0.00		0.00	305.00	170.00	10.00	4.54	2.39	0.00	0.00	0.00	0.00	5.00	3.54	0.28	6.93
16-16-09dcd	Vail School	661104	45.00	0.00		0.00	293.00	136.00	10.00	4.24	2.14	1.96	0.00	0.00	0.00	4.80	2.83	0.28	8.34
16-16-09dcd	Vail School	710423	127.00	0.00		0.00	271.00	150.00	13.00	1.60	1.07	5.52	0.00	0.00	0.00	4.44	3.12	0.37	8.19
16-16-09dcd	Vail School	710920	40.00	0.00		0.00	273.00	125.00	12.00	4.54	1.56	1.74	0.00	0.00	0.00	4.47	2.60	0.34	7.84
16-16-09dcd	Vail School	720420	72.00	0.00		0.00	236.00	134.00	11.00	2.99	1.48	3.13	0.00	0.00	0.00	3.87	2.79	0.31	7.61
16-16-09dcd	St. Rita Church	710920	46.00	0.00		0.00	256.00	95.00	14.00	3.34	1.23	2.00	0.00	0.00	0.00	4.20	1.98	0.39	6.58
16-16-10dcb	Del-Lago	410327	0.00	0.00		0.00	448.00	280.00	21.00	6.69	3.46	0.00	0.00	0.00	0.00	7.34	5.83	0.59	10.14
16-16-10dcb	Del-Lago	590210	0.00	0.00		0.00	373.00	330.00	42.00	7.68	3.29	0.00	0.00	0.00	0.00	6.11	6.87	1.18	10.98
16-16-14ddc	Del-Lago #1	590710	196.00	0.00		0.00	217.00	780.00	38.00	8.28	4.11	8.53	0.00	0.00	0.00	3.56	16.24	1.07	20.92
16-16-14ddc	Del-Lago #1	900327	187.00	8.14		0.00	48.00	833.00	58.00	7.53	4.11	8.13	0.21	0.00	0.00	0.79	17.34	1.64	19.99
16-16-16dcd	Del-Lago #3	810309	111.00	0.00		0.00	261.00	137.00	26.00	1.65	1.15	4.83	0.00	0.00	0.00	4.28	2.85	0.73	7.63
16-16-16dcd	Del-Lago #3	840126	45.00	0.00		0.00	244.00	160.00	8.00	3.94	2.30	1.96	0.00	0.00	0.00	4.00	3.33	0.23	8.20
16-16-16dcd	Del-Lago #3	840928	0.00	0.00		0.00	236.00	0.00	0.00	6.32	0.00	0.00	0.00	0.00	0.00	3.87	0.00	0.00	6.32
16-16-16dcd	Del-Lago #3	840928	0.00	0.00		0.00	262.00	0.00	0.00	10.46	0.00	0.00	0.00	0.00	0.00	4.29	0.00	0.00	10.46
16-16-16dcd	Del-Lago #3	861216	54.00	0.00		0.00	251.00	270.00	26.00	5.69	3.37	2.35	0.00	0.00	0.00	4.11	5.62	0.73	11.41
16-16-17	Vail Jr. High School	670000	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-16-17	Vail Jr. High School	671004	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-16-26ccc		410328	0.00	0.00		0.00	225.00	46.00	27.00	2.30	1.32	0.00	0.00	0.00	0.00	3.69	0.96	0.76	3.61
16-16-27aac	Del-Lago #2	600510	0.00	0.00		0.00	276.00	173.00	32.00	1.70	0.91	0.00	0.00	0.00	0.00	4.52	3.60	0.90	2.60
16-16-27aac	Del-Lago #2	610310	0.00	0.00		2.00	230.00	110.00	28.00	1.50	0.82	0.00	0.00	0.00	0.07	3.77	2.29	0.79	2.32
16-16-27aac	Del-Lago #2	640000	131.00	0.00		0.00	284.00	116.00	26.00	1.35	1.15	5.70	0.00	0.00	0.00	4.65	2.42	0.73	8.20
16-16-27aac	Del-Lago #2	650000	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-16-27aac	Del-Lago #2	690106	121.00	0.00		0.00	268.00	105.00	22.00	1.10	1.07	5.26	0.00	0.00	0.00	4.39	2.19	0.62	7.43
16-16-27aac	Del-Lago #2	720218	110.00	0.00		0.00	266.00	98.00	26.00	1.65	0.66	4.78	0.00	0.00	0.00	4.36	2.04	0.73	7.09
16-16-27aac	Del-Lago #2	750130	102.00	0.00		0.00	268.00	96.00	24.00	1.70	0.66	4.44	0.00	0.00	0.00	4.39	2.00	0.68	6.79
16-16-27aac	Del-Lago #2	780213	66.00	0.00		4.90	438.00	80.00	22.00	4.53	1.15	2.87	0.00	0.00	0.16	7.18	1.67	0.62	8.55
16-16-27aac	Del-Lago #2	810309	111.00	0.00		0.00	261.00	137.00	26.00	1.65	1.15	4.83	0.00	0.00	0.00	4.28	2.85	0.73	7.63
16-16-27aac	Del-Lago #2	840710	78.00	0.00		0.00	222.00	120.00	20.00	2.20	1.40	3.39	0.00	0.00	0.00	3.64	2.50	0.56	6.99
16-17-08b	Colossal Cave	651102	17.00	0.00		0.00	378.00	14.00	7.00	4.89	1.07	0.74	0.00	0.00	0.00	6.20	0.29	0.20	6.70
16-17-08b	Colossal Cave	690000	23.00	0.00		0.00	366.00	25.00	10.00	5.54	0.91	1.00	0.00	0.00	0.00	6.00	0.52	0.28	7.44
15-17-08b	Colossal Cave	720103	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-17-08b	Colossal Cave	760315	19.00	0.00		0.00	334.00	22.00	7.00	3.54	0.66	0.83	0.00	0.00	0.00	5.47	0.46	0.20	5.03
16-17-08b	Colossal Cave	760518	16.00	0.00		0.00	427.00	23.00	7.00	6.49	0.16	0.70	0.00	0.00	0.00	7.00	0.48	0.20	7.35
16-17-08b	Colossal Cave	790606	25.00	0.00		0.00	305.00	38.00	39.00	4.54	0.91	1.09	0.00	0.00	0.00	5.00	0.79	1.10	6.53
16-17-33abb	Cienega	900404	55.00	3.08		0.00	269.00	272.00	10.00	5.54	2.63	2.39	0.08	0.00	0.00	4.41	5.66	0.28	10.64
17-16-10abb	Santa Rita #1	800813	75.00	0.00		0.00	254.00	77.00	14.00	1.90	1.07	3.26	0.00	0.00	0.00	4.16	1.60	0.39	6.23
17-16-10abb	Santa Rita #1	820625	44.00	0.00		0.00	504.00	76.00	30.00	1.34	1.07	1.91	0.00	0.00	0.00	8.26	1.58	0.85	4.33
17-16-10abb	Santa Rita #1	850123	0.00	0.00		0.00	264.00	0.00	0.00	6.27	0.00	0.00	0.00	0.00	0.00	4.33	0.00	0.00	6.27
17-17-01	Pantano Rest Area	761028	43.00	0.00		0.00	310.00	240.00	10.00	6.89	1.65	1.87	0.00	0.00	0.00	5.08	5.00	0.28	10.40
17-17-01	Pantano Rest Area	761030	41.00	0.00		0.00	305.00	246.00	10.00	6.39	2.30	1.78	0.00	0.00	0.00	5.00	5.12	0.28	10.47

Groundwater Quality in Cienega Creek Preserve
LOTUS QA&QC Worksheet (Revised)

LOCATION	Well Name	Date (yymmdd)	Anions (meq/l)	C/A Ratio	Cations (%meq/l) Ca (%meq/l)	Mg (%meq/l)	Na+K (%meq/l)	Anions (%meq/l) Alk (%meq/l)	SO4 (%meq/l)	Cl (%meq/l)	Comments
16-16-03	Valley Water #1	800801	12.48	0.93	0.51	0.18	0.31	0.35	0.60	0.05	Pressure Tank Sample
16-16-09dcd	Vail School	590210	8.82	0.79	0.66	0.34	0.00	0.57	0.40	0.03	
16-16-09dcd	Vail School	661104	7.92	1.05	0.51	0.26	0.23	0.61	0.36	0.04	
16-16-09dcd	Vail School	710423	7.93	1.03	0.19	0.13	0.67	0.56	0.39	0.05	
16-16-09dcd	Vail School	710920	7.42	1.06	0.58	0.20	0.22	0.60	0.35	0.05	
16-16-09dcd	Vail School	720420	6.97	1.09	0.39	0.19	0.41	0.56	0.40	0.04	
16-16-09dcd	St. Rita Church	710920	6.57	1.00	0.51	0.19	0.30	0.64	0.30	0.06	
16-16-10dcb	Del-Lago	410327	13.76	0.74	0.66	0.34	0.00	0.53	0.42	0.04	
16-16-10dcb	Del-Lago	590210	14.17	0.77	0.70	0.30	0.00	0.43	0.48	0.08	
16-16-14ddc	Del-Lago #1	590710	20.87	1.00	0.40	0.20	0.41	0.17	0.78	0.05	
16-16-14ddc	Del-Lago #1	900327	19.77	1.01	0.38	0.21	0.42	0.04	0.88	0.08	
16-16-16dcd	Del-Lago #3	810309	7.86	0.97	0.22	0.15	0.63	0.54	0.36	0.09	
16-16-16dcd	Del-Lago #3	840126	7.56	1.09	0.48	0.28	0.24	0.53	0.44	0.03	
16-16-16dcd	Del-Lago #3	840928	3.87	1.63	1.00	0.00	0.00	1.00	0.00	0.00	
16-16-16dcd	Del-Lago #3	840928	4.29	2.44	1.00	0.00	0.00	1.00	0.00	0.00	
16-16-16dcd	Del-Lago #3	861216	10.47	1.09	0.50	0.30	0.21	0.39	0.54	0.07	
16-16-17	Vail Jr. High School	670000	0.00	ERR	ERR	ERR	ERR	ERR	ERR	ERR	
16-16-17	Vail Jr. High School	671004	0.00	ERR	ERR	ERR	ERR	ERR	ERR	ERR	
16-16-26ccc		410328	5.41	0.67	0.64	0.36	0.00	0.68	0.18	0.14	
16-16-27aac	Del-Lago #2	600510	9.03	0.29	0.65	0.35	0.00	0.50	0.40	0.10	
16-16-27aac	Del-Lago #2	610310	6.92	0.34	0.65	0.35	0.00	0.55	0.33	0.11	
16-16-27aac	Del-Lago #2	640000	7.80	1.05	0.16	0.14	0.70	0.60	0.31	0.09	
16-16-27aac	Del-Lago #2	650000	0.00	ERR	ERR	ERR	ERR	ERR	ERR	ERR	
16-16-27aac	Del-Lago #2	690106	7.20	1.03	0.15	0.14	0.71	0.61	0.30	0.09	
16-16-27aac	Del-Lago #2	720218	7.13	0.99	0.23	0.09	0.67	0.61	0.29	0.10	
16-16-27aac	Del-Lago #2	750130	7.07	0.96	0.25	0.10	0.65	0.62	0.28	0.10	
16-16-27aac	Del-Lago #2	780213	9.63	0.89	0.53	0.13	0.34	0.76	0.17	0.06	
16-16-27aac	Del-Lago #2	810309	7.86	0.97	0.22	0.15	0.63	0.54	0.36	0.09	
16-16-27aac	Del-Lago #2	840710	6.70	1.04	0.31	0.20	0.49	0.54	0.37	0.08	
16-17-08b	Colossal Cave	651102	6.68	1.00	0.73	0.16	0.11	0.93	0.04	0.03	Tap at Picnic Area
16-17-08b	Colossal Cave	690000	6.80	1.09	0.74	0.12	0.13	0.88	0.08	0.04	
16-17-08b	Colossal Cave	720103	0.00	ERR	ERR	ERR	ERR	ERR	ERR	ERR	
16-17-08b	Colossal Cave	760315	6.13	0.82	0.70	0.13	0.16	0.89	0.07	0.03	
16-17-08b	Colossal Cave	760518	7.67	0.96	0.88	0.02	0.09	0.91	0.06	0.03	
16-17-08b	Colossal Cave	790606	6.89	0.95	0.70	0.14	0.17	0.73	0.11	0.16	
16-17-33abb	Cienega	900404	10.35	1.03	0.52	0.25	0.23	0.43	0.55	0.03	
17-16-10abb	Santa Rita #1	800813	6.16	1.01	0.30	0.17	0.52	0.68	0.26	0.06	
17-16-10abb	Santa Rita #1	820625	10.69	0.40	0.31	0.25	0.44	0.77	0.15	0.08	
17-16-10abb	Santa Rita #1	850123	4.33	1.45	1.00	0.00	0.00	1.00	0.00	0.00	
17-17-01	Pantano Rest Area	761028	10.36	1.00	0.66	0.16	0.18	0.49	0.48	0.03	
17-17-01	Pantano Rest Area	761030	10.40	1.01	0.61	0.22	0.17	0.48	0.49	0.03	

APPENDIX H

ROUTINE CONSTITUENTS IN GROUNDWATER SAMPLES FROM JUNGLE WELL (D-16-17-35dbc[2])

SUMMARY OF ROUTINE CONSTITUENTS IN GROUNDWATER SAMPLES
FROM WELL (D-16-17)35dbc2 [JUNGLE DOMESTIC WELL]
EMPIRITA RANCH AREA, PIMA AND COCHISE COUNTIES, ARIZONA

DATE SAMPLED	01-25-84	04-20-84	07-26-84	10-29-84	01-29-85	05-06-85	07-09-85	08-08-85	11-05-85
CONSTITUENT									
CATIONS (mg/l)[a]									
Calcium	120.	120.	102.	120.	114.	118.	119.	115.	130.
Magnesium	30.	30.	31.	27.	28.	28.	31.	34.	29.
Sodium	42.	44.	42.	41.	44.	44.	40.	48.	48.
Potassium	4.6	3.4	5.3	3.7	3.4	3.6	3.2	3.4	3.6
ANIONS (mg/l)									
Carbonate	0.	0.	0.	0.	0.	0.	0.	0.	18.7
Bicarbonate	327.	314.	270.	311.	304.	308.	314.	334.	300.
Chloride	8.8	8.1	8.8	8.5	8.1	12.4	11.3	12.7	13.1
Sulfate	220.	230.	235.	212.	220.	220.	225.	236.	240.
Nitrate	8.9	10.6	12.4	8.4	5.3	4.0	5.8	5.3	4.9
Fluoride	0.82	0.67	0.50	0.64	0.58	0.73	0.72	0.84	0.72
pH, Lab	7.4	7.80	7.2	8.1	8.0	8.1	7.8	7.7	8.3
Temperature, Field (degrees Celsius)	---	17	22	22	13	---	---	---	---
Conductance, Field (µmho/cm)[b]	---	900	860	870	935	---	---	---	---
Conductance, Lab (µmho/cm)	910.	925.	930.	1,160.	860.	890.	910.	960.	920.
Total Dissolved Solids (mg/l)	640.	657.	613.	647.	683.	670.	685.	640.	740.

SUMMARY OF ROUTINE CONSTITUENTS IN GROUNDWATER SAMPLES
FROM WELL (D-16-17)35dbc2 [JUNGLE DOMESTIC WELL]
EMPIRITA RANCH AREA, PIMA AND COCHISE COUNTIES, ARIZONA

DATE SAMPLED	02-11-86	05-21-86	11-13-86	02-02-87	05-01-87	08-08-87	11-11-87	02-01-88	04-06-88
CONSTITUENTS									
CATIONS (mg/l)[a]									
Calcium	128.	129.	139.	145.	134.	136.	136.	146.	120
Magnesium	26.	29.	32.	33.	33.	35.	35.	31.	32
Sodium	46.	48.	43.	48.	49.	50.	52.	50.	55
Potassium	3.6	3.5	3.4	3.5	3.7	3.8	3.6	4.0	4.0
ANIONS (mg/l)									
Carbonate	1.7	0.	0.	0.	0.	0.	0.	0.	0
Bicarbonate	316.	327.	326.	342.	333.	340.	335.	335.	253
Chloride	10.6	12.8	11.3	11.0	9.2	10.6	13.1	13.4	12.0
Sulfate	252.	260.	270.	290.	286.	294.	301.	289.	305
Nitrate	4.0	4.0	3.1	2.7	2.7	4.0	3.1	3.5	4.0
Fluoride	0.66	0.65	0.72	0.53	0.73	0.68	0.72	0.58	0.9
pH, Lab	8.2	8.0	8.0	7.8	7.8	8.1	7.7	7.8	8.0
Temperature, Field (degrees Celsius)	---	---	---	---	---	---	---	---	---
Conductance, Field (µmho/cm)[b]	---	---	---	---	---	---	---	---	---
Conductance, Lab (µmho/cm)	910.	940.	950.	960.	980.	990.	1,000.	1,010.	1,030
Total Dissolved Solids (mg/l)	685.	655.	695.	705.	720.	725.	755.	745.	705

SUMMARY OF ROUTINE CONSTITUENTS IN GROUNDWATER SAMPLES
FROM WELL (D-16-17)35dbc2 [JUNGLE DOMESTIC WELL]
EMPIRITA RANCH AREA, PIMA AND COCHISE COUNTIES, ARIZONA

DATE SAMPLED	08-01-88	02-02-89	05-02-89	08-04-89	11-06-89
CONSTITUENTS					
CATIONS (mg/l)[a]					
Calcium	146.	142	138.	140.	141.
Magnesium	33.	32	32.	32.	31.
Sodium	51.	52	55.	50.	51.
Potassium	4.0	4.0	3.4	3.7	3.7
ANIONS (mg/l)					
Carbonate	0.	0	ND	ND	ND
Bicarbonate	326.	329	318.	322.	323.
Chloride	11.0	8.1	9.9	8.1	14.9
Sulfate	324.	300	304.	312.	284.
Nitrate	4.4	5.3	6.6	6.6	5.3
Fluoride	0.57	0.60	0.63	0.61	0.62
pH, Lab	8.0	7.6	7.9	7.6	7.8
Temperature, Field (degrees Celsius)	---	---	---	---	---
Conductance, Field (μmho/cm)[b]	---	---	---	---	---
Conductance, Lab (μmho/cm)	1,050.	1,010	1,010.	1,000.	1,000.
Total Dissolved Solids (mg/l)	805.	760	735.	730.	760.

[a] mg/l - milligrams per liter

[b] μmho/cm - specific electrical conductance, in micromhos per centimeter

ND - none detected

(Analyses by BC Laboratories, Bakersfield, California)

SUMMARY OF ROUTINE CONSTITUENTS IN SURFACE WATER SAMPLES FROM CIENEGA WASH
DOWNSTREAM FROM THE JUNGLE SITE
EMPIRITA RANCH AREA, PIMA AND COCHISE COUNTIES, ARIZONA

DATE SAMPLED	06-27-85	07-09-85	02-11-86	11-11-87	04-06-88	08-01-88	02-02-89	05-02-89	08-04-89	11-06-89
CONSTITUENT										
CATIONS (mg/l)[a]										
Calcium	162.	141.	132.	135.	125	140.	122	128.	136.	129.
Magnesium	44.	46.	37.	39.	36	26.	33	34.	33.	33.
Sodium	80.	80.	73.	61.	65	46.	59	63.	56.	55.
Potassium	5.2	3.7	3.5	3.5	3.7	7.5	4.0	3.8	4.3	3.5
ANIONS (mg/l)										
Carbonate	0.	0.	0.	0.	0	9.4	0	12.8	ND	ND
Bicarbonate	332.	316.	271.	345.	304	257.	291	273.	329.	316.
Chloride	18.4	15.2	11.3	14.2	13.8	14.2	13.4	12.4	10.6	15.9
Sulfate	460.	420.	400.	330.	320	308.	314	332.	300.	292.
Nitrate	1.3	0.9	0.4	<0.4	<0.4	2.7	0.9	ND	0.9	1.8
Fluoride	0.74	0.84	0.66	0.73	0.63	0.46	0.60	0.69	0.75	0.65
pH, Lab	7.8	7.9	8.0	8.0	8.0	8.2	8.0	8.2	8.1	8.1
Temperature, Field (degrees Celsius)	25	---	---	---	---	---	---	---	---	---
Conductance, Field (µmho/cm)[b]	1,400	---	---	---	---	---	---	---	---	---
Conductance, Lab (µmho/cm)	1,300.	1,200.	1,120.	1,030.	1,060	960.	1,000	1,010.	1,020.	1,010.
Total Dissolved Solids (mg/l)	1,050.	970.	865.	730.	750	750.	740	740.	760.	700.

[a] mg/l - milligrams per liter

[b] µmho/cm - specific electrical conductance, in micromhos per centimeter

< - less than

ND - none detected

(Analyses by BC Laboratories, Bakersfield, California)

ERROL L. MONTGOMERY & ASSOCIATES, INC.
TUCSON, ARIZONA