DRAFT

The Water Quality of Priority Streams in Pima County

Sonoran Desert Conservation and Comprehensive Land Use Plan
2001

Pima County, Arizona
Board of Supervisors
Ann Day, District 1
Dan Eckstrom, District 2
Sharon Bronson, District 3
Raymond J. Carroll, District 4
Raúl M. Grijalva, Chairman, District 5

County Administrator
Chuck Huckelberry

MEMORANDUM

Date: October 29, 2001

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Water Quality of Priority Streams in Pima County**

Background

In recent months, the Pima Association of Governments has worked with Pima County to address water quality issues related to both the Sonoran Desert Conservation Plan and the Comprehensive Land Use Plan Update. In accordance with the workplan, studies have been forwarded in draft form to complete four tasks: (1) overview of the quality of various water sources; (2) review and summarize existing state and federal regulations; (3) review and compile existing data on water quality requirements of aquatic species; and (4) identify the highest priority watersheds for water quality monitoring and restoration. The attached study compiles water quality data for the streams that have been identified as priorities. The report also assesses land uses and potential pollution sources that might impact the water quality of the highest priority aquatic habitats.

Highest Priority Streams for Monitoring, Management and Restoration

As part of an earlier study entitled *Water Quality Requirements of Native Aquatic Species in Pima County*, Pima Association of Governments created the following list of twenty high priority streams for water quality and quantity monitoring, management and restoration.

1. Agua Caliente Canyon -- More than 1000 acres hydro-mesoriparian habitat; deciduous riparian forest; mesquite bosque; shallow groundwater.

2. Agua Verde Creek -- Intermittent stream flow (15 miles); approximately 300 acres Class A Riparian Habitat; mesquite bosque; shallow groundwater.

3. Arivaca Creek -- Perennial and intermittent stream flow (more than 3 miles); more than 1000 acres hydro-mesoriparian habitat; deciduous riparian forest; shallow groundwater.

4. Bingham Cienega -- Perennial stream flow. Unique marsh environment.

5. Buehman Canyon -- Perennial and intermittent stream flow (more than 7.5 miles); more than 200 acres Class A riparian habitat. Unique Waters designation.

6. Canada del Oro -- Perennial and intermittent stream flow (5 miles); 300 acres hydro-mesoriparian habitat; mesquite bosque.

7. Cienega Creek (lower) -- Perennial and intermittent stream flow (7.5 miles); more than 550 acres hydro-mesoriparian habitat; more than 55 acres Class A Riparian Habitat. Unique Water designation.

8. Cienega Creek (upper) -- Perennial and intermittent stream flow (more than 12 miles); 900 acres hydro-mesoriparian habitat; mesquite bosque; shallow groundwater.

9. Davidson Canyon -- Perennial and intermittent stream flow (2 miles); Class A riparian vegetation; shallow groundwater.

10. Empire Gulch -- Perennial and intermittent stream flow (1.5 miles).

11. Espiritu Canyon -- Perennial and intermittent stream flow (4.5 miles).

12. Florida Canyon -- Intermittent stream flow (more than 3 miles).

13. Mattie Canyon -- Perennial and intermittent stream flow (more than 1.5 miles).

14. Quitobaquito Spring -- Perennial pools and short stream; one native fish species (endemic); small riparian habitat; unique aquatic habitat in Western Pima County.

15. Rincon Creek -- Intermittent stream flow (more than 11 miles); more than 500 acres hydro-mesoriparian habitat; shallow groundwater.

16. Sabino Canyon -- Perennial and intermittent stream flow (more than 18 miles); more than 800 acres hydro-mesoriparian habitat.

17. San Pedro River -- Perennial and intermittent stream flow (12 miles); more than 2300 acres hydro-mesoriparian habitat; deciduous riparian forest; mesquite bosque; shallow groundwater.

18. Santa Cruz River (mid/lower) -- Perennial and intermittent stream flow (22 miles); 3500 acres hydro-mesoriparian habitat; deciduous riparian forest; mesquite bosque.

19. Tanque Verde Creek (upper) -- Perennial and intermittent stream flow (17 miles); more than 1000 acres of hydro-mesoriparian habitat; deciduous riparian forest; mesquite bosque; shallow groundwater.

20. Wakefield Canyon/ Nogales Spring -- Perennial and intermittent stream flow (approximately 2 miles); more than 35 acres Class A Riparian Habitat; series of springs.

Water Quality Data for High Priority Streams

Under Arizona law, water quality standards apply to Pima County's surface water and are based on the designated use of the waterbody. There are seven uses; they range from domestic water source uses to agricultural irrigation or livestock watering uses to aquatic and wildlife uses. While current data indicates that water quality in twelve streams that have been monitored would support the designated use, there is no water quality data available for these streams:

- Agua Verde Creek
- Davidson Canyon
- Rincon Canyon
- Empire Gulch
- Espiritu Canyon
- Florida Canyon
- Mattie Canyon
- Upper Tanque Verde
- Wakefield.

Level of Protection

The study found that most of the priority waterbodies are located at least partly within protected lands and are therefore not as likely to experience significant degradation. Due to current land uses or land uses likely to occur, however, the following streams could be more prone to degradation than the other priority waterbodies in the future:

- Agua Verde Creek
- Rincon Creek
- San Pedro River
- Davidson Canyon

Steps to Ensure Water Quality

The Pima Association of Governments study indicates that a comprehensive effort to ensure the water quality of priority streams in Pima County will involve these components:

- Land use planning to identify which future land uses (including potential pollutant dischargers) are appropriate near the streams;

- Minimization of impacts from existing and future land uses; and

- Regularly-scheduled monitoring to ensure that the quality of the streams is not degraded.

Recommendations

The Pima Association of Governments recommends that the following waterbodies receive first priority for further investigation and monitoring:

- Agua Verde Creek
- Davidson Canyon
- Empire Gulch
- Florida Canyon
- Mattie Canyon
- Rincon Creek
- Wakefield Canyon

The study also recommends that the County consider nominating additional perennial streams for Unique Water status. This status provides protection against water quality degradation.

A surface water can be classified as unique if the nominated body is an outstanding state resource water, based on the following criteria: perennial water; free-flowing condition; good water quality; and is of exceptional recreational or ecological significance.

Several of the priority streams are thought to meet these criteria.

Conclusion

Future studies from the Pima Association of Governments will finalize the workplan through the following tasks:

- Review planning alternatives and identify potential impacts on water quality; and

- Propose mitigation measures to ensure that water quality of priority aquatic habitats is maintained or improved, and propose a water quality monitoring program for the highest priority aquatic habitats

The attached study on the *Water Quality of Priority Streams in Pima County*, along with prior research on the *Water Quality Requirements of Native Aquatic Species in Pima County,* will contribute substantially to the Riparian Element and to the establishment of aquatic species protection measures under the Sonoran Desert Conservation Plan.

Attachment

The Water Quality of Priority Streams in Pima County

Prepared for the Pima County Comprehensive Plan and Sonoran Desert Conservation Plan

DRAFT

October, 2001

Prepared By

Pima Association of Governments

Acknowledgements

PAG would like to thank Maeveen Behan and Julia Fonseca at Pima County for including this project in PAG's work program and the County Administrator's Office for providing the funding to make this project possible.

In addition PAG would like to thank the following people who graciously provided information and input into this project: Dr. Lin Lawson and Kyle Palmer at Arizona Department of Environmental Quality, Bob Lefevre at the United States Forest Service and Jeff Simms at the Bureau of Land Management.

TABLE OF CONTENTS

Table of Contents Continued

LIST OF TABLES

The Water Quality Of Priority Streams in Pima County

Introduction

Background

Pima County is updating the Pima County Comprehensive Land Use Plan as required by the State's Growing Smarter Legislation. Pima County intends to integrate the updated Comprehensive Land Use Plan with the Sonoran Desert Conservation Plan. This combined plan will contain a water quality element to meet the legislated requirement and to ensure the preservation of aquatic species. Pima Association of Governments (PAG) is the state designated Water Quality Planning Agency for Pima County under Section 208 of the Clean Water Act, and at the County's request is assisting in the preparation of the water quality portion of the Plan.

As part of the Plan, PAG recently submitted three draft reports to the County. One report summarized water quality data available for the principal types of water sources in Pima County: groundwater, CAP water, treated wastewater, stormwater runoff, and surface waterbodies such as streams. The second report summarized rules and regulations that protect the water quality of these sources. The third report summarized the water quality requirements of the native aquatic species in Pima County. As an additional part of the water quality element for the Pima County Comprehensive Plan and the Sonoran Desert Conservation Plan, a list of the highest priority streams was identified for water quality and quantity monitoring, management and restoration.

This report compiles the existing water quality data and other pertinent information for the streams that have been identified as priorities. Used in conjunction with the previous water quality reports, this report provides an additional tool for the County in its efforts to develop the water quality plan.

Purpose

The purpose of this report is to compile existing water quality data, identify any water quality impairments, identify any gaps in the available data, and assess land uses through existing literature and aerial photography for the recently identified priority streams in Pima County. In addition, possible protective measures to ensure the water quality of some streams and a water quality monitoring plan are presented.

Limitations

The information provided in this report is limited to the data readily available to PAG staff from published literature and various agencies' monitoring programs. PAG did not

conduct any original research for this project. Information compiled from a previous PAG study and report, *GIS Coverage of Perennial Steams and Intermittent Streams and Shallow Groundwater, January 2000,* was used. Also, PAG's literature and data search were significantly constrained by time and budget limitations. The data used in this study were primarily from ADEQ, USGS, and Pima County Wastewater Management Department. In addition the U.S. Forest Service, BLM and National Park Service were contacted. Other data sets are probably available, but not included in this report.

Priority Streams in Pima County

As part of the water quality element for the Pima County Comprehensive Plan and the Sonoran Desert Conservation Plan, PAG and Pima County staff created a list of the highest priority streams for water quality and quantity monitoring, management and restoration. Stream selection was based primarily on the presence of perennial or intermittent stream flow, the area of riparian habitat, the presence of historic or existing populations of native fish and frog species, and location with respect to other surface water sources and possible wildlife corridors. The potential threat to any individual stream or the fact that an individual stream might already be monitored or protected was not considered when developing the list. Some streams did not have as high habitat value as others but were included because they were considered to be a priority by BLM, USFS, PAG, AGFD, or County personnel. The SDCP Riparian Element report, especially Appendix A1 – Table 1 and the historic occurrence of native fish were used to determine the resources present in and around each stream. Maps showing the stream locations and the adjacent land ownership are included in Appendix A of this report.

The following streams are considered high priority:

Agua Caliente Canyon
Arivaca Creek
Buehman Canyon
Canada del Oro
Empire Gulch
Florida Canyon
Quitobaquito Spring
Sabino Canyon
Santa Cruz River (mid/lower)
Wakefield Canyon
Agua Verde Creek
Bingham Cienega
Cienega Creek (upper and lower)
Davidson Canyon
Espiritu Canyon
Mattie Canyon
Rincon Creek
San Pedro River
Tanque Verde Creek (upper)

Priority Stream Water Quality Monitoring

For the purpose of this report PAG compiled existing water quality data for the selected highest priority streams in Pima County. Data were obtained from ADEQ, USGS, PAG, the BLM, and others. Table 1 lists the highest priority streams, the types of monitoring, sampling frequency, and the agency that collected the data over the past ten years. Given the time and budget constraints of this project, only data that were readily available and easy to locate were compiled. The listed data are not conclusive and data collected for some of the streams prior to the 1990's were not reviewed in cases where more recent data were available. There may be other data sources for these streams that we did not have the resources to locate.

Table 1. Sampling History for the Highest Priority Streams in Pima County

Priority Stream	Data Source(s)	Major Ions	Trace Metals	Nutrients	Field Parameters
Agua Caliente Canyon	ADEQ	4/95	4/95	4/95	4/95
Agua Verde Creek	None	--	--	--	--
Arivaca Creek At Figueroa Creek	ADEQ	12 times between 1990 and 1993	12 times between 1990-1993	12 times between 1990-1993	12 times between 1990-1993
Arivaca Creek at Ruby Road	ADEQ	24 times 1989-1993	24 times 1989-1993	24 times 1989-1993	24 times 1989-1993
Bingham Cienega	PAG	7 times between 1998-2000	7 times between 1998-2000 Al, As, Mn	7 times between 1998-2000	7 times between 1998-2000 for EC, pH, temp.
Buehman Canyon below confluence with Bullock Canyon	ADEQ	4/96 5/00	4/96 5/00	4/96 5/00	4/96 5/00
Buehman Canyon near Redington	ADEQ	9 times between 11/95-7/97	9 times between 11/95-7/97	9 times between 11/95-7/97	9 times between 11/95-7/97
Canada del Oro	ADEQ	Once each year, 1992-1994.	Once each year, 1992-1994	Once each year 1992-1994	Once each year 1992-1994
Cienega Creek (Lower)	Pima County	18 times between 5/87-7/90 at three locations			
	ADEQ	60 times between 5/87-9/98 at six locations	60 times between 5/87-9/98 at six locations	60 times between 5/87-9/98 at six locations	62 times between 5/87-9/98 at six different locations
	PAG	7 times between 1998-2000	7 times between 1998-2000	7 times between 1998-2000	7 times between 1998-2000 for EC, pH, Temp.
Cienega Creek (Upper) below Stevenson Canyon	ADEQ	9/98	9/98	9/98	9/98
Davidson Canyon	None	--	--	--	--
Empire Gulch	BLM	--	--	--	EC, pH, and temperature
Espiritu Canyon	None	--	--	--	--
Florida Canyon	None	--	--	--	--
Mattie Canyon	None	--	--	--	--
Quitobaqutio Spring	US Dept of the Interior	pending	pending	pending	pending
Rincon Creek	None	--	--	--	--
Sabino Canyon below Summerhaven	ADEQ	9 times 11/90-3/92	9 times 11/90-3/92	9 times 11/90-3/92	9 times 11/90-3/92
Sabino Canyon at SCSAB004.39	ADEQ	4/01	4/01	4/01	4/01

Priority Stream	Data Source(s)	Major Ions	Trace Metals	Nutrients	Field Parameters
San Pedro River	PAG	7 times 1998-00	7 times 1998-00	7 times 1998-00	7 times 1998-00 pH, EC, Temp
	ADEQ	Aug 1991	Aug 1991	Aug 1991	Aug 1991
Santa Cruz River at Cortaro Rd.	ADEQ		45 times between 1986-1990		
	USGS	12 times between 1/96-1/97		12 times 1/96-1/97	12 times 1/96-1/97
Santa Cruz at WWTP outfall	Pima County	per NPDES	per NPDES		per NPDES
Tanque Verde Creek (upper)	ADEQ	8/89	8/89	8/89	8/89
	USGS	25 times between 1987-1994	24 times between 1987-1994	16 times between 1987-1994	32 times between 1987-1994
Wakefield Canyon	None	--	--	--	--

Field parameters are generally measured on-site and include pH, dissolved oxygen, electrical conductivity, temperature, and alkalinity. Major ions include the following: sodium, calcium, magnesium, chloride, sulfate, bicarbonate and silica (Hounslow, 1995). Nutrients include the various forms of nitrogen and phosphorous.

Surface Water Quality Standards in Arizona

The Clean Water Act requires that Arizona establish surface water quality standards. These water quality standards define the water quality goals for all surface waters in the state. The standards designate the uses to be protected and prescribe the criteria that Arizona Department of Environmental Quality (ADEQ) determines are necessary to maintain and protect the water quality for its designated use. These standards also provide the regulatory basis for establishing water quality-based discharge limits and controls in NPDES permits (ADEQ, 2000).

The A.A.C. Title 18, Chapter 11, Water Quality Standards apply to all surface water in Pima County. Arizona sets both numerical and narrative water quality standards for each waterbody based on the use of the waterbody. The "designated uses" are specified in the standards or based on the tributary rule. There are seven designated uses:

1) Aquatic and Wildlife. All waterbodies have one of four Aquatic and Wildlife categories and have either Full Body or Partial Body Contact designated use. Warm water aquatic community (A&Ww), cold water aquatic community (A&Wc), effluent dependent water (A&Wedw), and ephemeral flow (A&We).
2) Full Body Contact (FBC)
3) Partial Body Contact (PBC)
4) Fish Consumption (FC)
5) Domestic Water Source (DWS)
6) Agriculture Irrigation (AgI)
7) Agriculture Livestock Watering (AgL)

Surface waterbodies are assessed annually and reported semi-annually to determine if their water quality is sufficient to meet the designated uses. Surface waterbody assessments are primarily made based on chemical water quality data, but other types of data and information are also considered. The following reaches of the priority streams have been assessed by ADEQ and are listed in Appendix B of A.A.R. Title 18, Chapter 11, List of Surface Waters and Designated Uses[1]:

- Agua Caliente Wash, headwaters to the national forest boundary, A&Ww
- Arivaca Creek, tributary to Altar Wash, A&Ww
- Buehman Canyon, headwaters to confluence with unnamed tributary, A&Ww
- Buehman Canyon, below confluence with unnamed tributary, A&Ww
- Canada del Oro, headwaters to Highway 89, A&Ww
- Cienega Creek, headwaters to Interstate 10, Interstate 10 to Del Lago Dam, and below Del Lago Dam, A&Ww
- Davidson Canyon, unnamed spring to confluence with unnamed tributary, A&Ww
- Empire Gulch, below Empire Ranch, A&Ww
- Espiritu Canyon Creek, tributary to Soza Wash, A&Ww
- Mattie Canyon, tributary to Cienega Creek, A&Ww
- Sabino Canyon Creek, headwaters to confluence with unnamed tributary, A&Wc

- Sabino Canyon Creek, below unnamed tributary, A&Ww
- San Pedro River, Redington to the Gila River, A&Ww
- Santa Cruz River, Roger Road WWTP to Baumgartner Road, A&Wedw

[1]The designated uses are currently under revision as part of the triennial review by ADEQ.

Assessments are primarily based on monitoring data but also include other information such as bioassessments, evidence of toxic impacts on fish, fish advisories, and swimming closures. The process involves collecting all available water quality data and information on a waterbody and comparing them to standards or EPA criteria. "Use Support" is based on frequency of exceedances or other information concerning water quality. However, each use and CWA goal has a separate set of standards and criteria to meet.

There are two categories of assessed waters: "monitored" and "evaluated". Monitored is based on current monitoring, within the past five years, with chemical and physical monitoring occurring at least once per quarter for perennial streams, or at least four times in two years for non-perennial streams. Evaluated assessments are based on less data and information. Assessment reliability generally increases with increased quantity and diversity of data; having biological, physical and chemical data is also preferred to chemical data alone (ADEQ, 2000).

There are both numeric and narrative standards based on the water's use by people or animals. Arizona's numeric surface water quality standards, from Appendix B of ADEQ's *The Status of Water Quality in Arizona 305 (b) Report 2000*, are included in Appendix B of this report. Narrative water quality standards supplement the numeric standards and describe the conditions that are needed to maintain and protect aesthetic qualities of water (ADEQ, 2001). Being qualitative, the narrative standards provide blanket protection for all waterbodies regardless of whether or not a particular water quality standard applies to that waterbody (ADEQ, 1996).

Narrative nutrient standards serve to protect waters by limiting pollutants that might be discharged at concentrations that might cause highly productive growth of nuisance plants. To a great extent the presence of bioavailable nitrogen determines the rate of growth. Therefore, attention must be paid to the determination of natural inputs of nitrogen. Nitrate and ammonia occur in precipitation, and nitrate can be found in elevated quantities in spring water and in upwelling areas due to natural nitrification. Indicators of a possible narrative nutrient standard violation are low DO and high pH. Other indications include excessive algae growth, and a biological community with greater numbers of blackflies, snails, leeches and bloodworms, although in effluent dependent waters this condition may be normal (ADEQ, 1996).

The purpose of the narrative toxicity standard is to ensure that a surface water is free from pollutants in amounts or combinations that are toxic to animals, people and other organisms. According to ADEQ's draft guidelines a violation of the standard does not necessarily equal an impairment of uses or warrant addition to the 303(d) list of impaired waters. The draft guidelines indicate that ambient biomonitoring is one of the methods used to determine a waterbody's compliance with the standard. Ambient biomonitoring

will be applied to waters that have the following designations: A&Ww, A&Wc, A&Wedw, FC, Domestic water source (DWS) and ephemeral waters, depending on the uses and the species the water quality standards are intended to protect. In addition, whole effluent biomonitoring (WEB) is used to measure the toxicity of pollutants in effluent discharged to surface water (ADEQ, 2001).

The surface water quality standard rule includes a narrative standard intended to prevent harmful effects of bottom deposits on aquatic life and impairment of recreational uses. Bottom deposits are settleable solids. The narrative standard directly links the bottom deposits to aquatic life impairment. To determine compliance with the standard two basic elements are used: 1) bioassessment procedures for determining whether there is an impairment of aquatic life and 2) diagnostic procedures for determining that the cause of impairment of aquatic life is due to excessive sedimentation or siltation (ADEQ, 2001a).

Another important part of the Arizona Water Quality Standard Rule is the unique water designation. A unique water is one that ADEQ has determined to be an outstanding state resource water. Pima County is fortunate to have reaches in two streams designated as unique: Cienega Creek and Buehman Canyon Creek. Unique waters are given stringent surface water quality protections under the State's antidegradation rule, which states:

"Existing water quality shall be maintained and protected in a surface water that is classified as a unique water ..."(A.A.C., 1996). Once a surface water is classified as a unique water, land use activities in the watershed have to be conducted in a way that prevents the degradation of existing water quality.

Potential Sources of Water Quality Stressors

According to ADEQ, common "stressors", or causes of pollution in Arizona streams, are turbidity, metals, pH, pathogens, pesticides, other inorganics, nutrients, low dissolved oxygen and radiochemicals (ADEQ, 2000).

Turbidity is the most common stressor in Arizona's streams. The turbidity standards were developed to protect against aquatic habitat degradation due to excessive sedimentation and algal blooms. Associated with algal bloom are high nutrient concentrations, low dissolved oxygen, and high pH. In the right combination and conditions these can lead to stress in aquatic organisms and can contribute to fish kills.

The major sources of these stressors are, in order of impact: natural sources, agriculture, mining, land development, urban runoff, point sources, septic systems, bank modification and recreation (ADEQ, 2000).

Natural conditions are considered a source of stressors because many of Arizona's soils are highly erodible or have naturally high levels of metals. If a stressor is entirely caused by natural conditions it is not a violation of the water quality standard. Along with natural conditions, mining is a source of metals and low pH.

Both grazing and crop production are probable sources of stressors such as turbidity, boron, selenium, nutrients, fecal coliform and pesticides. Grazing is the predominant land use in Arizona and is the probable source of significant sediment loading.

Urban development also provides stressors to the stream environment. During the urbanization process, lands that were previously vegetated and open are converted to uses that usually increase the amount of impervious surface in an area. This results in increased runoff volume and pollutant loading. Urbanization, in general, typically results in changes to the physical, chemical and biological characteristics of the watershed (EPA, 1999).

Urban development can cause an increase in pollutants that can have a direct impact on water quality. The major pollutants that have been found in runoff from some urban areas include sediment, nutrients, oxygen-demanding substances, heavy metals, petroleum hydrocarbons, pathogenic bacteria, and viruses. To help protect streams from potential water quality degradation from urban non-point source pollution, runoff management goals need to be developed and pursued. These should include maintaining predevelopment hydrologic conditions, minimizing soil erosion and sedimentation, runoff control and maintaining riparian resources (EPA, 1999).

History of Surface Water Quality in Pima County

Reviewing historical water quality data can provide a baseline for interpreting current data and establishing seasonal trends. According to ADEQ, primary sources of historical data include: ADEQ fixed station records, USGS water quality database, Federal water quality database, complaint investigation files, ADEQ groundwater database, and published reports (ADEQ, 1992).

A review of the Arizona Water Quality Assessment 305 (b) Reports for 1990-1996, on file at PAG is summarized below. For regulatory purposes, the most recent (i.e., 2000) 305(b) report gives the most current assessment of the stream condition.

1996

Buehman Canyon from the headwaters to the San Pedro River was sampled between 1991-1993 and was determined to be in full support of its designated use.

The San Pedro River from Hot Springs to Redfield (sampled at the Redington ADEQ fixed station in 1991) was determined to be in full support of its designated use.

In the Santa Cruz-Rio Magdalena-Rio Sonoyta Watershed, the Santa Cruz River from Canada del Oro to Guild Wash was determined to be threatened. This was based on one out of 12 turbidity samples exceeding the standard.

The Canada del Oro from its headwaters to Big Wash was found to be in full support of its designated use based on ADEQ's biocriteria program.

Tanque Verde Creek was determined to be in full support of its designated use based on three sampling events in 1991.

Agua Caliente Wash was determined to be in full support of its designated use based on ADEQ's 1995 biocriteria monitoring program.

Sabino Canyon Creek, from just below Summerhaven to the lower Sabino Canyon was also in full support of its designated use. Samples were collected in 1991 and biocriteria monitoring was done in 1992, 1993, and 1994.

Arivaca Creek was deemed to be in partial support of its designated use based on sampling done between 1991-1993, where it was found that 8 out of 18 samples for DO collected at the Ruby Road fixed station were lower than the standard. At the Headwater Spring sampling location one out of ten of the DO samples were below the standard but the reach was determined to be in full support.

1994

The section of the Santa Cruz River from the Rillito to Canada del Oro was in partial support due to fecal coliform. The section from Canada del Oro to Guild was in partial support due to turbidity.

Canada del Oro, from the headwaters to Big Wash, was considered to be threatened due to phosphate and fecal coliform. Tanque Verde and Cienega Creek were considered to be in full support.

Sabino Canyon Creek was in partial support due to turbidity. ADEQ collected 9 samples between 1990-92; USFS collected 1 sample at two locations in 1991. ADEQ collected 8 samples for a bacteria study only in 1992-93—there were no exceedances.

Arivaca Wash was in partial support due to low DO and fecal coliform. ADEQ collected 56 samples at 3 sampling locations between 1990-93.

1992

Two sections of the Santa Cruz River, from Rillito to Canada del Oro and from Canada del Oro to Guild, were reported as having a use status of "threat". The first section's threat was due to fecal coliform. The second section's threat was for mercury.

Canada del Oro (from headwaters to Big Wash) was listed as partial use support status. The partial support was due to nutrients and metals.

Cienega Creek from the headwaters to the Pantano was deemed to be in full support.

Tanque Verde Creek from the headwaters to the Rillito Creek was also in full support. USFS monitored in 1991 and ADEQ sampled in 1988-89.

Sabino Canyon Creek from the headwaters to Tanque Verde was also in full support. ADEQ had 10 samples from 1990-91 and 8 samples from 1989-90. USFS had 1 sample, 2 locations in 1991.

Arivaca Wash from the headwaters to Puertocito/Altar was classified as "non-support". This was due to DO at the headwater spring. The creek near Ruby Road was in partial support and in full support near the Figueroa Spring sample location.

The San Pedro River near Redington was sampled one time in 1991, had no exceedances and was determined to be in full support.

1991

The general description of the Santa Cruz River Basin explained that low dissolved oxygen was reported in samples collected along Cienega and Arivaca Creeks. The low DO was believed to be due to the samples collected near the spring sources where water is naturally lower in DO.

The Santa Cruz River had samples collected during a flood event that were found to be high in arsenic, cadmium, mercury and lead. It is believed these contaminants were transferred downstream from historic mining sites. This demonstration of periodic contamination resulted in the partial support designation.

1990

Mercury exceedances were found in the Santa Cruz as it flowed through Tucson and therefore, this segment did not meet effluent dominated water quality standards.

Ammonia exceedances were reported along Cienega Creek so that aquatic and wildlife uses were impaired. These exceedances appeared to be related to rangeland management practices and recreation.

The San Pedro River from Redington to the Gila River was classified as partial or non-support due to turbidity, ammonia, mercury, arsenic, boron, copper, manganese, and lead. These were attributed to mining, rangeland, irrigation, and land disposal.

Priority Stream Water Quality and Potential Stressors

Readily available water quality data for each of the designated high priority streams were compiled and reviewed. Some streams had no known water quality data while others have been monitored extensively. In addition to reviewing the water quality data, PAG also looked at land uses and possible threats to the streams. Land ownership is shown on maps in Appendix A. The stream delineations are based on information from the PAG *GIS Coverage of Perennial Streams, Intermittent Streams, and Areas of Shallow Groundwater*, from January 2000. The water quality data for the streams that have been monitored are included in Appendix C.

Agua Caliente Canyon

Agua Caliente Canyon Wash has intermittent flow and is located in an area with over 1000 acres of hydro-mesoriparian habitat, a deciduous riparian forest, a mesquite bosque, and shallow groundwater. This is an historic leopard frog location. This reach of the stream is located partly within the national forest boundary and is therefore relatively protected. A review of 1992 aerial photography of the area shows no built structures near the stream but there is evidence of hiking or livestock trails. This stream is located close to the urban area and might be impacted by recreational uses. Agua Caliente Spring, a rare perennial spring in the Tucson Basin, has perennial flow and potential for restoration projects for both aquatic flora and fauna, but was not included on the SDCP Riparian Element table. Water quality data for the spring are not available at this time. Water quality data are available for Agua Caliente Canyon from the ADEQ database and are included in Appendix C.

Agua Verde Creek

Agua Verde Creek has intermittent stream flow for over 15 miles and is associated with approximately 300 acres of Class A riparian habitat, a mesquite bosque, and shallow groundwater. Leopard frogs and fish exist in this creek

The creek is located in the corridor between the Rincon Mountains and the Santa Rita Mountains. Agua Verde Creek is a tributary of Cienega Creek downstream of the Marsh Station Bridge. Though Agua Verde Creek is not listed in R18-11, Appendix B, it is a tributary to a listed waterbody; therefore water quality standards under R18-11-105 apply. In this case the aquatic and wildlife (warm water) full body contact, and fish consumption standards apply.

In addition, the lower portion of Cienega Creek has been designated as a unique waterbody by the state. Once a surface water is classified as a unique water, land use activity in the watershed must be conducted in such a way that prevents the degradation of existing water quality. Land uses that cause nonpoint source pollution, including cattle grazing, mining, and agriculture, are not exempt from the antidegradation policy.

This reach is just south of the Coronado National Forest Boundary and traverses private, state, and county land in rural Pima County. A number of unimproved roads cross the streambed in this area. Aerial photography from 1992 and topographic maps from 1994 show unimproved roadways and some man-made structures along this reach. Most prominent are stock tanks, water wells, and ranch structures, surrounded by areas showing signs of pedestrian, livestock or off-road vehicle traffic. Land uses that might impact this stream would be ranching and grazing, pumping of the shallow groundwater and water diversion, septic systems and off-road vehicle uses that could result in possible habitat destruction or water degradation.

No known water quality data are available for Agua Verde Creek.

Arivaca Creek

Arivaca Creek has perennial and intermittent stream flow for over three miles through over 1000 acres of hydro-mesoriparian habitat, including a deciduous riparian forest; it is associated with shallow groundwater. This is an historic leopard frog location with native fish establishment potential. Arivaca Creek is one of few perennial water sources in the area and is one of the major tributaries to Brawley Wash, which eventually flows into the Santa Cruz River north of the Pima/Pinal County line. The perennial flow is located near the community of Arivaca and includes the Arivaca Cienega within the Buenos Aires Natural Refuge. There are no records of natural populations of native fish in Arivaca Creek, but in the 1930's there was an attempt to establish Gila topminnow (Pima County, 2000).

This creek flows through the community of Arivaca, is bordered by a main roadway, and is therefore easily accessible. Land uses that might impact the water quality would include accidental or deliberate dumping of hazardous substances, agriculture, grazing or livestock impacts, recreational impacts, water diversion, development (urbanization) and septic systems.

ADEQ has monitoring data for several reaches of Arivaca Creek. ADEQ's stream assessment indicated that the stream was in full support of its use designation and that it had low dissolved oxygen due to the spring source and low flows. Water quality data for Arivaca Creek are included in Appendix C.

Bingham Cienega

The Bingham Cienega has perennial surface water and is a unique wetland environment. The Bingham Cienega supports longfin dace and lowland leopard frogs, a variety of birds, and has native fish establishment potential (PAG, 2001). The area has historically been used for farming and ranching. In 1989, Pima County Flood Control District purchased the 28 acre Bingham Cienega and the surrounding 285 acres for the purpose of restoring natural ecological processes and preventing floodplain development. The area is managed by the Nature Conservancy (PAG, 2001). Because of its protected status, water quality threats are probably minimal. Water quality data for Bingham Cienega are included in Appendix C.

Buehman Canyon

Buehman Canyon has both perennial and intermittent stream flow over more than 7.5 miles, through over 200 acres of Class A riparian habitat. The reach from the headwaters to an unnamed tributary is currently classified as a "Unique Water" by the State. Longfin dace and lowland leopard frogs have been recorded in this stream reach. Transplanted stocks of desert pupfish were in the stream in 1989, but currently their status is unknown (Marsh and Sada, 1993). The area has additional native fish establishment potential.

Most of the perennial and intermittent flow is on private land, owned by The Nature Conservancy, with a small portion on state trust land. Aerial photography from 1992 shows many unimproved roads and trails in and around the perennial and intermittent reaches of this stream. Topographic maps from 1981 show mineshafts and prospecting areas along the stream. The area has been used for recreational purposes such as off-road vehicle riding and hiking. Potential impacts on the stream would be from human disturbance and erosion. Because of its protected status, and its isolated location, water quality threats from future land uses are probably minimal. Water quality data are included in Appendix C.

Canada del Oro

The Canada del Oro has perennial and intermittent stream flow for more than five miles through 300 acres of hydro-mesoriparian habitat and a mesquite bosque. Two native fish species are found here, and it is an historic leopard frog location. Aerial photography from 1995 shows unimproved roads and jeep tracks in the area of this stream. The perennial and intermittent portions of the stream are entirely within national forest land and therefore subject to minimal impacts, which could include recreational impacts from people and possibly livestock impacts.

ADEQ has evaluated this stream and determined it is in full support of its designated use. Data for Canada del Oro are included in Appendix C.

Cienega Creek (lower)

Lower Cienega Creek has perennial and intermittent stream flow (7.5 miles) through more than 550 acres of hydro-mesoriparian habitat, 55 acres of Class A riparian habitat, a deciduous riparian forest, and a mesquite bosque; it is also associated with shallow groundwater. One native fish species and leopard frogs are in the area. Establishment of additional native fish species may be possible. This portion of Cienega Creek has been designated as a "Unique Water" by the state. Pima County Parks and Recreation manage the lower portion of the creek, and PAG has conducted monthly stream flow and well water level monitoring since the late 1980's.

Land in the Cienega Creek basin (both upper and lower Cienega Creek) includes BLM, state, county, and private holdings. Uses include grazing, recreation, transportation corridors, mining, agriculture, and private residences. Much of the basin is part of an open-space network that includes the Cienega Creek Natural Preserve, The Empire-

Cienega Resource Conservation Area, Saguaro National Park and the Coronado National Forest (PAG, 1998).

Various existing and future land uses could adversely affect the quality and quantity of surface water, groundwater, and riparian habitat. Urbanization in the area could lead to increased groundwater withdrawals that might lower the groundwater table in the basin. This could result in diminished perennial stream flow and a loss of riparian vegetation. In addition, a proliferation of on-site residential waste treatment systems, particularly if they are not properly installed or maintained, could lead to a nutrient problem.

Other potential land use impacts include the threat of water degradation from spills or accidental releases of hazardous substances transported through the area on the railroad and Interstate 10. These reaches are easily accessible by road, which increases the likelihood of impact form deliberate dumping of debris or harmful substances. In addition, mining activities could result in stream degradation by increasing turbidity and contributing runoff potentially containing heavy metals. Agriculture uses can lead to the introduction of nitrates and pesticides into the waterway
(PAG, 1998).

This is one of the most extensively monitored streams in Pima County. ADEQ monitored Cienega Creek from Interstate 10 to the Del Lago dam and found it to be in full support of its designated use. Water quality data for Cienega Creek (lower) are included in Appendix C.

Cienega Creek (upper)

The upper Cienega Creek has perennial and intermittent stream flow for more than 12 miles through 900 acres of hydro-mesoriparian habitat, and a mesquite bosque. The creek is also associated with areas of shallow groundwater. Three native fish species and leopard frogs exist in this reach. The upper portions of the basin are included in the Las Cienegas National Conservation Area and are maintained by the BLM.

Uses in the upper portion of the creek include grazing, recreation, and off-road vehicle use, which if not properly managed, could lead to degradation of the stream. As with the lower portion of Cienega Creek, the upper section is also easily accessible by road, increasing the likelihood of illegal dumping of debris and harmful substances into the creek.

ADEQ has evaluated the upper portion of Cienega Creek, from the headwaters to Interstate 10, and found that it is in full support of its designated use. Water quality data for Cienega Creek (upper) are included in Appendix C.

Davidson Canyon

Davidson Canyon has been determined to have both perennial and intermittent stream flows (two miles). The area has Class A riparian vegetation, shallow groundwater, one known native fish species (longfin dace) and leopard frogs. Additional native fish

establishment may be possible. The stream is located in the corridor between Santa Rita Mountains/Sonoita Valley and Rincon Mountains (Pima County, 2000).

The perennial and intermittent reaches of this stream flow through private and state lands before joining with Cienega Creek. This stream is listed in the Water Quality Standards' Appendix B with an A&Ww use designation. Aerial photography from 1992 shows ranches and unimproved roadways in the area of the stream. Also, topographic maps show a pipeline, a power line, and unimproved roads crossing the streambed. Further upstream there are mine shafts and areas where mineral prospecting has occurred. These reaches might be vulnerable to degradation from groundwater pumping and habitat loss, grazing and livestock uses, and future upstream mining (Pima County, 2000).

No known water quality data are available for Davidson Canyon.

Empire Gulch

Empire Gulch has perennial and intermittent stream flow for about one and one half miles. Leopard frogs are known to be in the area. Empire Gulch is also the only location in Pima County where the Huachuca water umbel is currently found. There is the possibility of native fish establishment in the stream. Empire Gulch is listed in the Water Quality Standards as having an A&Ww use designation. This stream is a priority for the BLM. The BLM assumed ownership of the area in 1989 and cattle have been restricted from the Empire Gulch tributary since 1992 in order to allow restoration. This area has been thoroughly documented and monitored since that time. However, water quality has not been measured on a regular basis. Conductivity has been measured at 550 umhos/cm, pH at 7.4, and temperature from 15-17 ° C (at the source) (Simms, 2001).

No additional water quality data are available for Empire Gulch.

Espiritu Canyon

Espiritu Canyon is located in the northeast corner of Pima County and flows from the national forest boundary, through state land, and into City owned land. This stream has documented perennial and intermittent stream flow for over four and one half miles and has leopard frog habitat. Information on shallow groundwater is not available. There is a potential for native fish establishment in this waterbody. Aerial photography from 1992 and the 1994 topographic map show several unimproved roads in and around this stream. The area could be impacted by grazing, off-road vehicle use, and other recreational uses.

No known water quality data are available for Espiritu Canyon.

Florida Canyon

Florida Canyon is an intermittent stream that flows for over three miles. PAG found no information on riparian vegetation or native fish species but leopard frogs are known to be in the area. This is a priority stream for USFS. This reach is entirely on federal land (national forest) and might be impacted by grazing or recreational uses.

No known water quality data are available for Florida Canyon.

Mattie Canyon

Mattie Canyon has perennial and intermittent stream flow for over one and a half miles. There is no riparian vegetation information available for this stream. Gila topminnow (PAG, 2000a) and Gila chub are present in this stream and it has historically been a leopard frog location. This stream is located on BLM land and is a tributary to Cienega Creek. It is not listed in the state's Water Quality Standards. However, since it is a tributary to the upper Cienega Creek it is covered by R18-11-105 and therefore has a use designation of A&Ww. Aerial photography from 1992 and the 1994 topographic map show numerous unimproved roads and trails in and around the perennial and intermittent portions of this stream. The water quality could be impacted by recreational uses and grazing.

No known water quality data are available for Mattie Canyon.

Quitobaquito Spring

Quitobaquito Spring and pool make up a unique aquatic and riparian habitat in Western Pima County, where there are few perennial water sources. The spring is located on the south side of the Quitobaquito Hills, just north of the International boundary. A sample collected by Arizona Department of Water Resources in 1988 had a total dissolved solids (TDS) concentration of 671 mg/l, and average flow from the spring outlets in 1988 was 30 gallons per minute. (ADWR, 2001). The Quitobaquito pupfish, *C. macularius eremus,* is endemic to this area.

The spring and pond are located in the Organ Pipe National Monument and are very near to a major road in Mexico and therefore accessible. Possible impacts to the waterbody would be degradation from dumping or spills of harmful substances, and groundwater pumping south of the border. Aerial photography from 1995 shows a series of unimproved roads around the pond area.

Water quality data from an early aquatic study done at Quitobaquito Spring and Pond are included in Appendix C.

Rincon Creek

Rincon Creek has intermittent stream flow for more than 11 miles through over 500 acres of hydro-mesoriparian habitat, a deciduous riparian forest, and a mesquite bosque; it is associated with shallow groundwater. Leopard frogs and one native fish species exist in the creek.

This stream begins on federal land and then travels through numerous private holdings that are slated for development. Possible impacts on the stream are from urbanization, septic tanks, recreation, and its accessibility to transportation corridors. Groundwater

pumping for development might deplete the local aquifer, which would impact stream flow and local riparian communities.

No known water quality data are available for Rincon Creek.

Sabino Canyon (upper)

Sabino Canyon is a tributary of Tanque Verde Wash in the Santa Cruz River drainage. The creek was determined to have perennial flow for most of the upper portion (PAG, 2000a). The stream flows through over 800 acres of hydro-mesoriparian habitat, a deciduous riparian forest, a mesquite bosque, and is associated with shallow groundwater. Historically, three native fish species and leopard frogs have been found here. This stream may be a possible Gila topminnow reintroduction site

Potential impacts to water quality could come from heavy recreational uses and the introduction of exotic aquatic species.

ADEQ sampled the water in Sabino Creek below Summerhaven for general water chemistry parameters. Recent monitoring of the reach above the east fork of the Sabino Canyon documented that a few isolated ponds had naturally occurring low dissolved oxygen. The reach from the headwaters to the Tanque Verde Creek was assessed by ADEQ and found to be in full support of its designated use. The results from samples collected by ADEQ are included in Appendix C.

Sabino Canyon (lower)

Lower Sabino Canyon, in the Sabino Canyon Recreation Area, has intermittent stream flow to near the confluence with Tanque Verde Creek (PAG, 2000a). A succession of large pools, that sustain populations of Gila chub, can be found year round in this reach. This reach is accessible through the recreation area and is used heavily for recreation. Use impacts to this stream could be recreation, erosion and sedimentation, and the possibility of the release of harmful substances into the water. ADEQ has sampled this reach of Sabino Canyon, and the results are included in Appendix C.

San Pedro River

The San Pedro River in Pima County has perennial and intermittent stream flow (12 miles), through more than 2300 acres of hydro-mesoriparian habitat, a deciduous riparian forest, a mesquite bosque, and an area of shallow groundwater. Historically, 10 native fish species (one native fish species extant), leopard frogs, and pygmy owls have been found here.

The San Pedro River begins in the desert grasslands near Cananea in northern Sonoran, Mexico. It then flows through Cochise, Pima and Pinal counties in Arizona and joins the Gila River. Land ownership within a one mile buffer zone along the San Pedro River from the Arizona-Mexico border north to Redington Arizona is 41% private, 34% BLM, 24% State, and less than 1% United States Army. Since 1988, the BLM lands along the

river from the international border to just below St. David Arizona have been designated as a Riparian National Conservation Area (Weedman, 1996).

Land uses in the watershed include mining, agriculture, grazing, logging, industry, residential and recreational. Some of the known sources that have the potential to impact water quality include groundwater withdrawals for agriculture, municipal uses and sewage effluent (Weedman, 1996). Also much of the river is accessible from transportation corridors, and accidental spills or dumping of hazardous substances could affect water quality.

The reach of the San Pedro River in Pima County flows through Redington and is easily reached from Redington Road. This intermittent reach is mostly on private land. The area is used for ranching and recreation. Potential threats to the water quality include grazing, agricultural runoff, off-road vehicle use, septic systems, and the possibility of accidental or illegal dumping due to the close proximity of the road. Aerial photos from 1992 and topographic maps from 1994 show that many unimproved roads, trails, and an underground pipeline traverse the river.

Water quality data for the San Pedro River are included in Appendix C.

Santa Cruz River (mid/lower)

The Santa Cruz River has perennial and intermittent stream flow for over 22 miles through 3500 acres of hydro-mesoriparian habitat, a deciduous riparian forest, and a mesquite bosque.

The Santa Cruz River flows through private, state, and federal lands. It is heavily developed and channelized through Nogales, Sonora and Nogales and Tucson, Arizona. Sewage effluent enters the river from treatment facilities in Nogales and Tucson. The river is associated with a wide variety of land uses which include grazing, mining, urbanization, and groundwater pumping (Weedman, 1996). Native fish species, including Gila chub, desert sucker, Gila topminnow, desert pupfish, Sonoran sucker, and longfin dace were recorded in the Santa Cruz River near Tucson in the past. The last known records of fish in this part of the river were in 1943. Historically, leopard frogs have also been found here.

The effluent dependent reach of the Santa Cruz River downstream from the Nogales International Wastewater Treatment Plant supports native fish populations (longfin dace, desert sucker, Sonoran sucker, and Gila topminnow). Currently there are no native fish documented in the effluent dependent reach of the Santa Cruz River north of the two wastewater treatment plant outfalls in Pima County.

Land uses around the Santa Cruz River from Avra Valley Road to Trico Road include a major transportation corridor, Interstate 10 and the railroad, an active and a closed landfill, industrial area and agriculture. In addition, a number of facilities, both upstream and downstream from Tucson, have NPDES permits allowing discharges into the Santa Cruz River.

Water quality data are available for the effluent dependent reach of the Santa Cruz River below the Roger and Ina Road wastewater treatment plants. ADEQ, USGS, Pima County Wastewater Management Department, and others have monitored this river.

Many different studies have been done on the effluent dependent Santa Cruz River. Concentrations of periphytic chlorophyll- *a* were studied in the Santa Cruz River by the USGS. The results showed that chlorophyll-*a* concentrations from the effluent dependent waters were one to two orders of magnitude greater than at the non-effluent dependent comparison sites. These finding were consistent with other studies and demonstrate the water quality differences of the effluent-dependent waters as compared with water quality at control sites. The effluent dominated reaches showed fewer numbers of aquatic invertebrate species than the comparison sites. The species that were found were those that were more tolerant of waters with organic loading (Gebler, 1998). It is important to note that the comparison reported by Gebler (1998) was between streams that had entirely different sets of standards. The Santa Cruz is an effluent-dependent water, with its own set of standards, whereas the control site was a perennial warm water stream with stricter standards. The most recent data indicate that all of the Santa Cruz River standards are being met.

Water quality data for the Santa Cruz River are included in Appendix C.

Tanque Verde Creek (upper)

Tanque Verde Creek has greater than 17 miles of perennial and intermittent stream flow through over 1000 acres of hydro-mesoriparian habitat, a deciduous riparian forest, a mesquite bosque, and is associated with shallow groundwater. One native fish species and leopard frogs are known to be in this stream. The perennial reach of this stream, located at the Tanque Verde Falls and within the Coronado National Forest, is considered to be a priority for the USFS. This stream is easily accessible from the road that goes through Redington Pass and is a popular recreation area for off-road vehicle use, swimming, and hiking. Aerial photos show numerous trails and unimproved roads on both sides of the streambed. Potential impacts to this stream would be from recreational uses, dumping of hazardous substances and debris and sedimentation. ADEQ evaluated a reach of Tanque Verde Creek from Wentworth Road to Rillito Creek and found it to be in full compliance with its designated use.

PAG was not able to locate any water quality data specific to the upper Tanque Verde Creek. Water quality data from Tanque Verde Creek at Sabino Canyon Road are included in Appendix C.

Wakefield Canyon/ Nogales Spring

This stream has perennial and intermittent stream flow for nearly two miles over 35 acres of Class A riparian habitat. The reach includes a series of springs but no shallow groundwater information is available. This area contains leopard frogs and has potential for native fish establishment. The reaches are located in a corridor between the Whetstone Mountains and the Rincon Mountains. The perennial and intermittent portions of this stream are located on BLM and state owned land adjacent to national

forest land. Review of a 1992 aerial photo showed unimproved roads and a stock tank in the vicinity of the perennial portion of Wakefield Canyon. Land uses that could impact this waterbody include grazing, off-road vehicles and recreation uses.

No known water quality data are available for Wakefield Canyon.

Priority Streams Water Quality Protection and Monitoring

The most effective water quality control plan starts with a watershed protection plan, and the primary purpose of the plan should be to prevent water quality degradation. In fact, state rules (R18-11-107) require that the level of water quality necessary to protect existing uses be maintained and protected. Furthermore, where the existing water quality of a surface water surpasses the applicable standard, the existing quality must be maintained and protected. Only under specific circumstances, and following specific procedures, will the state allow water quality degradation. Given this requirement, it is the responsibility of the government and all property owners involved to ensure the water quality is not compromised.

A comprehensive effort to ensure that the water quality of priority streams in Pima County is not degraded will likely involve three components: (1) land use planning to identify which future land uses (including potential pollutant dischargers) are appropriate near the streams; (2) minimization of impacts from existing and future land uses; and (3) regularly-scheduled monitoring to ensure that the quality of the streams is not degraded. Implementation of these components would involve landowners, land management agencies, regulatory agencies, and planners. Cooperation among different jurisdictions, private and public interests, and various stakeholders would be necessary.

Land Use Planning

The focus of land use planning for maintaining priority streams' water quality should be future point-source and nonpoint-source discharges of pollutants. (Land use planning is also relevant with regard to protection of the *quantity* of flows in streams, but water resources issues are not addressed in this report.) Table 2 is a list of land uses that might be associated with potential point-source or nonpoint-source discharges of pollutants. Careful consideration should be given to land use plans involving one or more of these land uses being sited near a priority stream.

Table 2. Land Uses Affecting Surface Water. From: ADEQ Source Water Assessment Plan and EPA Management Measures for Urban Areas.

Land Use	Type of Contaminant
Landfills	biological, nitrite, nitrate
Septic Systems	biological, nitrite, nitrate, chemical
Wastewater Treatment Plants	biological, nitrite, nitrate
Reuse Irrigation	biological, nitrite, nitrate
Urban Runoff	biological, chemical, sediment
Construction Site Runoff	paints, metals, debris, soil erosion
Transportation corridors (roads)	oil, grease, runoff and dumping
Utility Roads	sediment
Railroads	chemical spills
Golf Courses	SOC
Industry (retail gasoline, dry cleaners)	VOC (via subsurface), spills
Mining Activities	sediment, metals
agriculture	nitrite, nitrate, SOC, sediment
Grazing/feedlots	biological, nitrite, nitrate, soil erosion

Planning for future point-source discharges to streams is accomplished through the Pima Association of Governments Clean Water Act Section 208 Areawide Water Quality Management Plan. Under the Clean Water Act, the discharge of pollutants to surface waters is prohibited without a National Pollutant Discharge Elimination System (NPDES) permit, and a NPDES permit will not be issued for a point source that conflicts with the 208 Plan. Currently, the Santa Cruz River is the only priority stream to which point-source discharges are authorized by NPDES permits. No point-source discharges to priority streams other than the Santa Cruz River are included in the 208 Plan. Through the 208 Planning process, local governments can decide which, if any, point source discharges to priority streams should be allowed in the future.

Land use planning and zoning can provide additional tools to limit point-source discharges to priority streams. For example, an area zoned for industry would presumably be more likely to include point-source discharging facilities. By not planning industrial zones near priority streams, the County could limit the likelihood of future NPDES discharges to these streams without relying entirely on the 208 Planning process.

Planning for land uses that might contribute nonpoint source discharges to priority streams can be accomplished through the County's Comprehensive Land Use Plan and Sonoran Desert Conservation Plan, local cities' and towns' General Plans, and the planning efforts of land owners and land management agencies such as the National Forest Service, Bureau of Land Management, State Land Department, and National Park Service. The County should encourage the responsible entities, when developing long range plans, to consider limiting certain land uses and activities near priority streams if they are more likely to contribute to nonpoint source pollution. In unincorporated areas available for urban and residential development, the County should determine what type

of development is appropriate near priority streams. The effects of infrastructure development (or lack thereof) should also be considered. For example, developments with public sewers, paved roads, and water lines would not have certain impacts that would be associated with residential areas containing a proliferation of septic tanks and private wells. On the other hand, extensive, high-density development that could be spurred by public infrastructure construction could lead to other water quality concerns, such as increased recreational pressures on nearby streams, runoff from parking lots and streets, and increased pollutant loads from home and lawn chemicals.

Impact Minimization

Where potentially-polluting land uses exist, or are planned, in close proximity to priority streams, the impacts of these land uses on the streams' water quality should be minimized. This responsibility falls to regulatory agencies, land management agencies, property owners, permit holders, and lease holders. For discharges that are covered by individual water quality permits, regulatory agencies are responsible for ensuring that the permit holders meet the conditions of the permits, and that permit requirements are sufficient to ensure that water quality is protected. Although this responsibility primarily rests with ADEQ, Pima County has an opportunity to participate through the public review process when notified of ADEQ's intent to issue a permit. In addition, the County has specific authorities that the state has delegated, such as the issuance of permits for on-site waste disposal systems.

Discharges that are not covered by individual permits include discharges from many nonpoint sources. ADEQ has a nonpoint source discharge program whose mission, as stated on the ADEQ web site, is:

> "to preserve, protect, and enhance water quality and public health for the citizens of Arizona by minimizing the impact of pollution discharged to surface water and ground waters from nonpoint sources. The program addresses water pollution from irrigated agriculture, concentrated animal feeding operations, rangelands, agriculture, urban runoff, construction, mining (sand and gravel), and recreation activities. The nonpoint source program depends upon a combination of regulatory controls and cooperatively-based implementation, including use of extensive public outreach and education as well as community-based watershed advisory groups."

The County should have an opportunity to participate in many of this program's activities, including community-based watershed advisory groups addressing priority streams. In addition, the County can implement best manage practices to limit nonpoint source discharges from any lands or facilities it owns.

Monitoring

Any comprehensive effort to protect the water quality of priority streams in Pima County should include a water quality monitoring program for these streams. The monitoring plan should address: (1) where to sample; (2) when to sample; (3) what to sample for;

and (4) how to implement the program. Ideally, given unlimited resources, all of the perennial and intermittent stream reaches in Pima County would be monitored on a seasonal basis every year, for all parameters for which standards have been set for the streams' designated uses. However, because resources for surface water quality monitoring are significantly limited, it is necessary to prioritize.

Because of the lack of water quality data and their priority status, PAG recommends that the following streams receive first priority for further investigation and water quality monitoring:

- Agua Verde Creek
- Davidson Canyon
- Empire Gulch
- Espiritu Canyon
- Florida Canyon
- Mattie Canyon
- Rincon Creek
- Wakefield Canyon

The remaining streams on the list of twenty priority streams should be next in importance, followed by the other perennial and intermittent streams in the County. Ephemeral streams would generally be the lowest priority, because of limited potential to support aquatic species.

At a minimum, each of the twenty priority streams should be sampled at least once to determine if they have the potential to support native aquatic species. It is unlikely that resources will be available to monitor all twenty streams seasonally every year. However, it might be possible to monitor the streams frequently enough to meet ADEQ's definition of "monitored" assessments, which according to the 305(b) Water Quality Assessment report (ADEQ, 2000) are based on data less than five years old, and at least four monitoring events within a year.

Based on how little is known about the water quality requirements of native aquatic species (PAG, 2001), the monitoring at each stream should include all of the parameters and constituents for which a surface water quality standard applies to that stream. If this is not possible, we recommend that, at a minimum, the following field parameters be included in the monitoring program for all streams:

- temperature
- pH
- dissolved oxygen
- electrical conductivity

Where warranted by land uses in the watershed, monitoring for nutrients, trace metals and pesticides would also be a priority, because these are among the most common stressors in Arizona lakes and streams, according to ADEQ's 2000 305(b) report. Bioassessments could supplement or replace the monitoring of field parameters and

chemical constituents in some cases. Turbidity is the most common stressor in Arizona's lakes and streams, and therefore it might be considered a priority for the monitoring program. However, ADEQ notes in the 305(b) report that the standard was derived from standards applied in more humid states, and ADEQ will be working on developing a more appropriate standard for Arizona.

In order to implement the monitoring program, we recommend the following steps:

- Work with ADEQ to identify which priority streams could be included in its ongoing surface water quality monitoring program.

- Work with other entities, including Arizona Game and Fish, the University of Arizona, U. S. Forest Service, Bureau of Land Management, and the U. S. Geological Survey, to discuss any plans they might have for research or monitoring projects that might include priority streams; identify possible cooperative research projects that could involve water quality monitoring at these streams.

- Determine which priority streams are accessible, as far as terrain, vehicular access, and landowner permission to sample.

- Identify and pursue potential funding sources for water quality monitoring.

- Continue to support monitoring of priority streams within County-owned lands.

- If necessary, expand the existing County-supported monitoring program to include any priority streams that will not be monitored by other entities.

Summary and Conclusions

Available water quality data for the high priority streams in Pima County indicate that the overall water quality is good. Of the twenty high priority streams identified in Pima County, twelve are included in the ADEQ 305 (b) Report 2000. Out of these twelve, eleven are in full support of their designated uses. The Santa Cruz River from Canada del Oro to Guild Wash was listed as not in full support of its designated use due to past low dissolved oxygen (DO) readings. However, recent DO data from Pima County Wastewater Management Department indicate that DO levels are currently at levels that would warrant a full support designation. The State will reassess the use support designation in its next 305(b) report.

ADEQ indicates in the 305(b) report that more assessment information is needed for Agua Caliente. In addition, no water quality data are currently available for the following streams: Agua Verde Creek, Davidson Canyon, Rincon Canyon, Empire Gulch, Espiritu Canyon, Florida Canyon, Mattie Canyon, the upper Tanque Verde, and Wakefield. PAG recommends that the following waterbodies receive first priority for further investigation and monitoring:

- Agua Verde Creek
- Davidson Canyon
- Empire Gulch
- Florida Canyon
- Mattie Canyon
- Rincon Creek
- Wakefield Canyon

Most of the priority waterbodies are located at least partly within protected lands, such as National Forests, National Parks, or County preserves, and are therefore fairly unlikely to experience significant degradation. However, Agua Verde Creek, Rincon Creek, the San Pedro River, and Davidson Canyon could be somewhat more prone to degradation than the other priority waterbodies in the future, due to current land uses or land uses likely to occur in the future. In addition, most (if not all) of the waterbodies are located in areas with one or more land uses that present some degree of risk to water quality, including dirt roads, off road vehicle use, other recreational activities, and grazing.

A comprehensive effort to ensure that the water quality of priority streams in Pima County is not degraded will likely involve three components: (1) land use planning to identify which future land uses (including potential pollutant dischargers) are appropriate near the streams; (2) minimization of impacts from existing and future land uses; and (3) regularly-scheduled monitoring to ensure that the quality of the streams is not degraded. Implementation of these components would involve landowners, land management agencies, regulatory agencies, and planners. Cooperation among different jurisdictions, private and public interests, and various stakeholders would be necessary.

The County also might want to pursue nominating additional perennial streams for Unique Water status. This status provides stringent protection against water quality degradation. The State can classify a surface water as unique if it finds the nominated body is an outstanding state resource water, based on the following criteria:

- perennial water;
- free-flowing condition;
- good water quality;
- meets one or both of the following conditions: is of exceptional recreational or ecological significance, or threatened or endangered species are known to be associated with the surface water and the existing water quality is necessary to maintain the species.

Many of the priority streams appear to meet these criteria.

References

ADEQ, 2001. *Narrative Toxicity Standard Implementation Guidelines for Arizona, Draft 2001*

ADEQ, 2001a. *Narrative Bottom Deposit Standard Implementation Guidelines for Arizona, Draft 2001.*

ADEQ, 2000. *The Status of Water Quality in Arizona, Clean Water Act 305 (b) Report, 2000.*

ADEQ, 1999. *Source Water Assessment Plan.* February 1999.

ADEQ, 1996. *Implementation Guidelines for the Narrative Nutrient Standard*

ADEQ, 1996a. *Arizona Water Quality Assessment*, 1996.

ADEQ, 1994. *Arizona Water Quality Assessment.* 1994

ADEQ, 1992. *Arizona Water Quality Assessment.* 1992.

ADWR, 2001. Western Mexican Drainage Basin. From web site: adwr.state.az.us/AZWatrinfo/outsideamas/lovercoloradoriver/basins/we.

Arizona Administrative Code, Title 18, Chapter 11, 1996

AWWA, 1989. AWWA Government Affairs, Drinking Water Quality. AWWA web site, www.awwa.org/govtaff/driwapol.htm.

Berka, C., McCallum, D., Wernick, B., 1995. *Land Use Impacts on Water Quality.* www.ire.ubc.ca/ecoresearch/publica3.html

EPA, 1999. Management Measures for Urban Areas, Chapter 4. www.epa.gov/owow/nps/mmgi/chapter4/ch4-1.html

Gebler, J., 1998. USGS, *Water Quality of Selected Effluent-Dependent Stream Reaches in Southern Arizona as Indicated by Concentrations of Periphytic Chlorophyll a and Aquatic-Invertebrate Communities.*

Hounslow, A., 1995. *Water Quality Data Analysis and Interpretation.* Lewis Publishers.

Marsh, P., Sada, D., 1993. *Desert Pupfish Recovery Plan*, U.S. Fish and Wildlife Service, Albuquerque NM.

Miller, R. and Fuiman, L., 1987. *Description and Conservation Status of Cyprinodon macularius eremus, A New Subspecies of Pupfish form Organ Pipe Cactus National Monument, Arizona.* Copeia, 1987, No.3 pp.93-609.

Pima Association of Governments, 2001. *Bingham Cienega Source Water Study*, February 2001.

Pima Association of Governments, 2000. Lower Cienega Basin Source Water Study, October 2000.

Pima Association of Governments, 2000a. *GIS Coverage of Perennial Streams, Intermittent Streams and Areas of Shallow Groundwater.* January 2000.

Pima Association of Governments, 1998. *Summary and Evaluation of Cienega Creek Surface Water and Groundwater Monitoring Program.* February 1998.

Pima Association of Governments, 1996. *Water Quality Assessment for the Tucson Active Management Area Northwest Replenishment Program Feasibility Study*, June 1996

Pima County, 2000. *Historical Occurrence of Native Fish in Pima County*, December 2000.

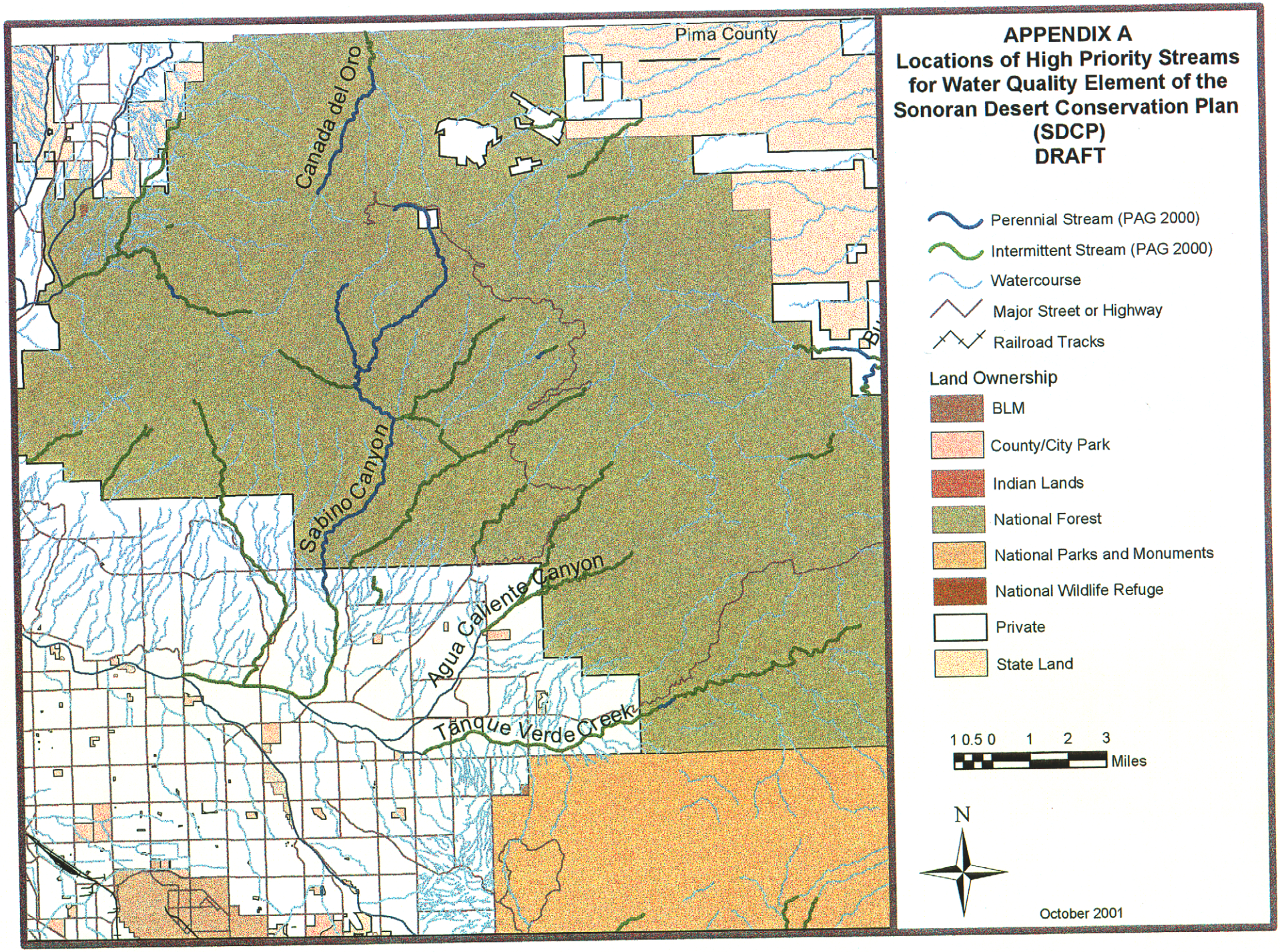
Simms, J., 2001. Personal communication, October 2001.

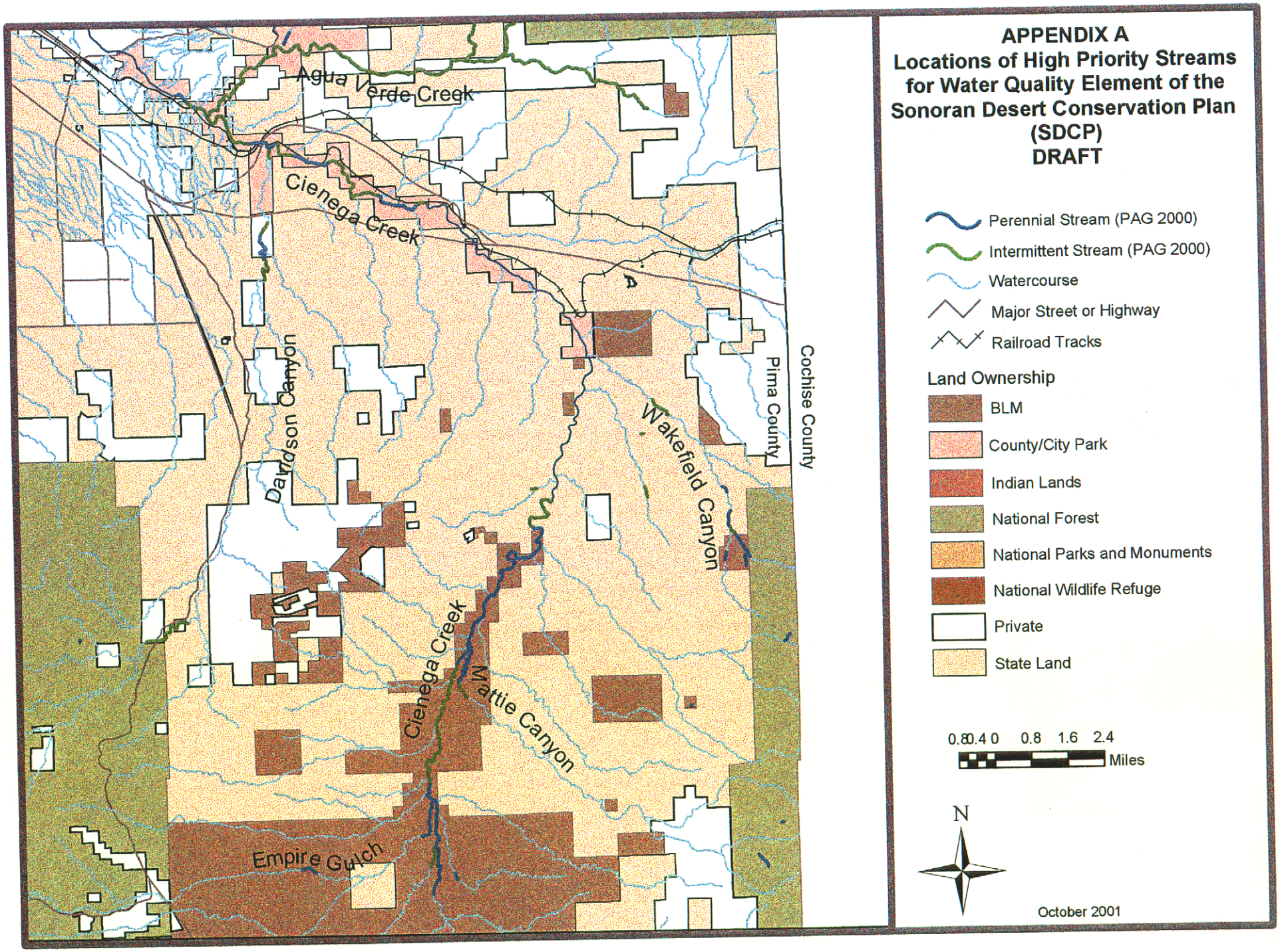
USGS, 2001. http://water.usgs.gov/nwis

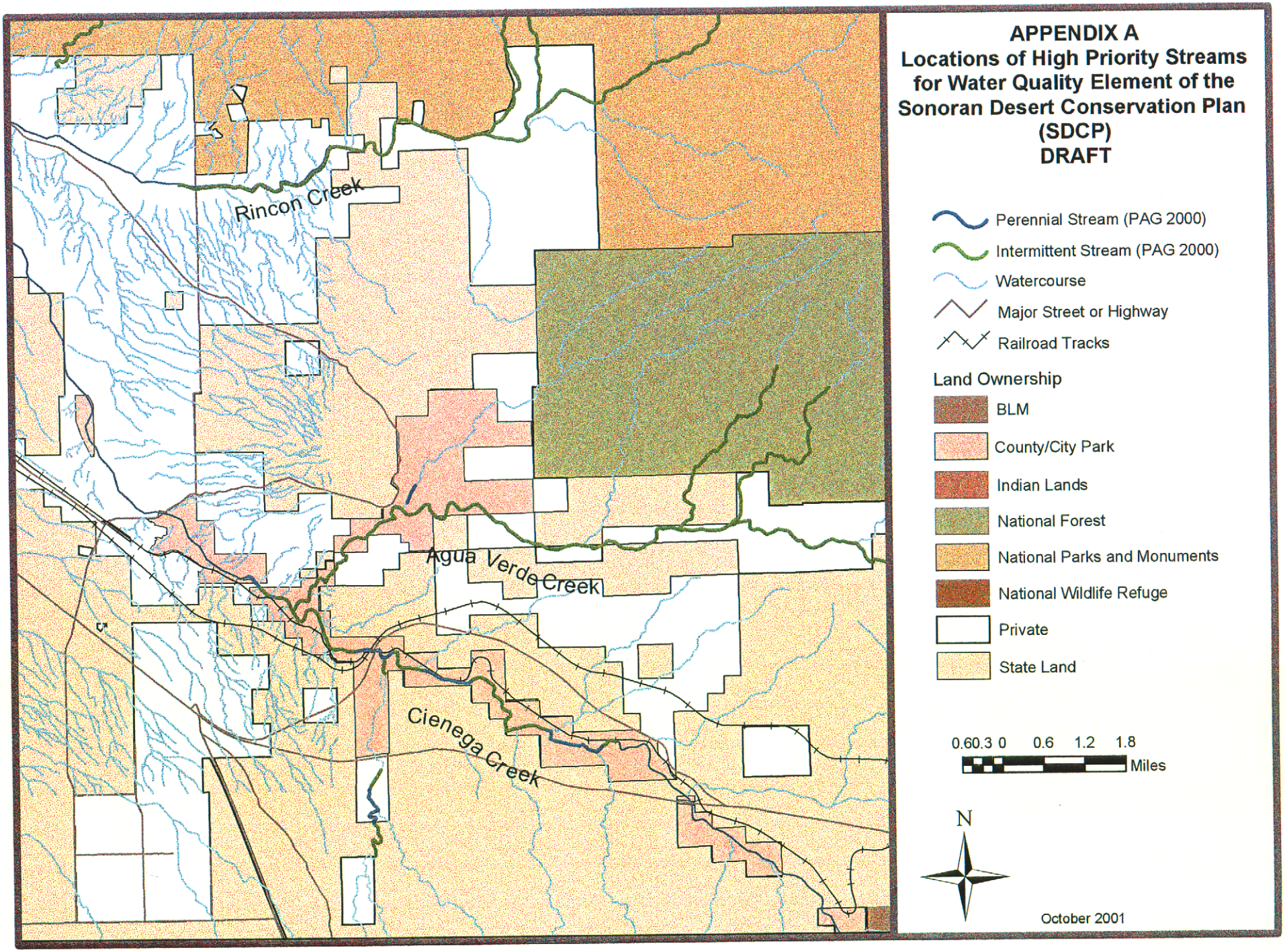
Weedman, D., 1996. Status Review of Gila Chub, *Gila intermedia*, in the United States and Mexico, Technical Report 91, Nongame and Endangered Wildlife Program, Arizona Game and Fish Department.

Appendix A

Priority Streams Land Ownership


Pima County
Canada del Oro
Sabino Canyon
Agua Caliente Canyon
Tanque Verde Creek
APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
1 0.5 0 1 2 3
Miles
N
October 2001


APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Agua Verde Creek
Cienega Creek
Davidson Canyon
Pima County
Cochise County
Wakefield Canyon
Cienega Creek
Wattie Canyon
Empire Gulch
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
0.8 0.4 0 0.8 1.6 2.4
Miles
N
October 2001



APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT

Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks

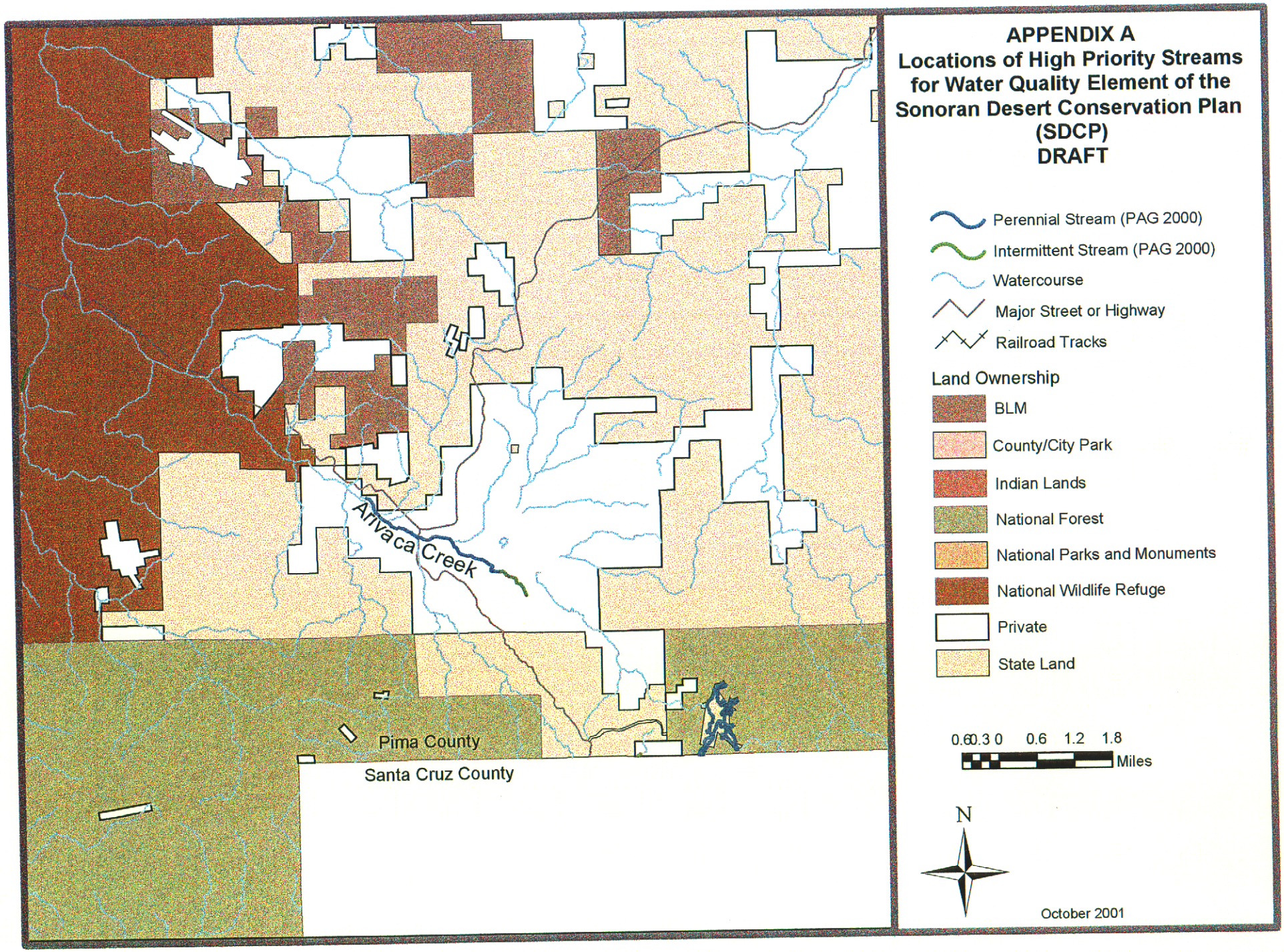
Land Ownership

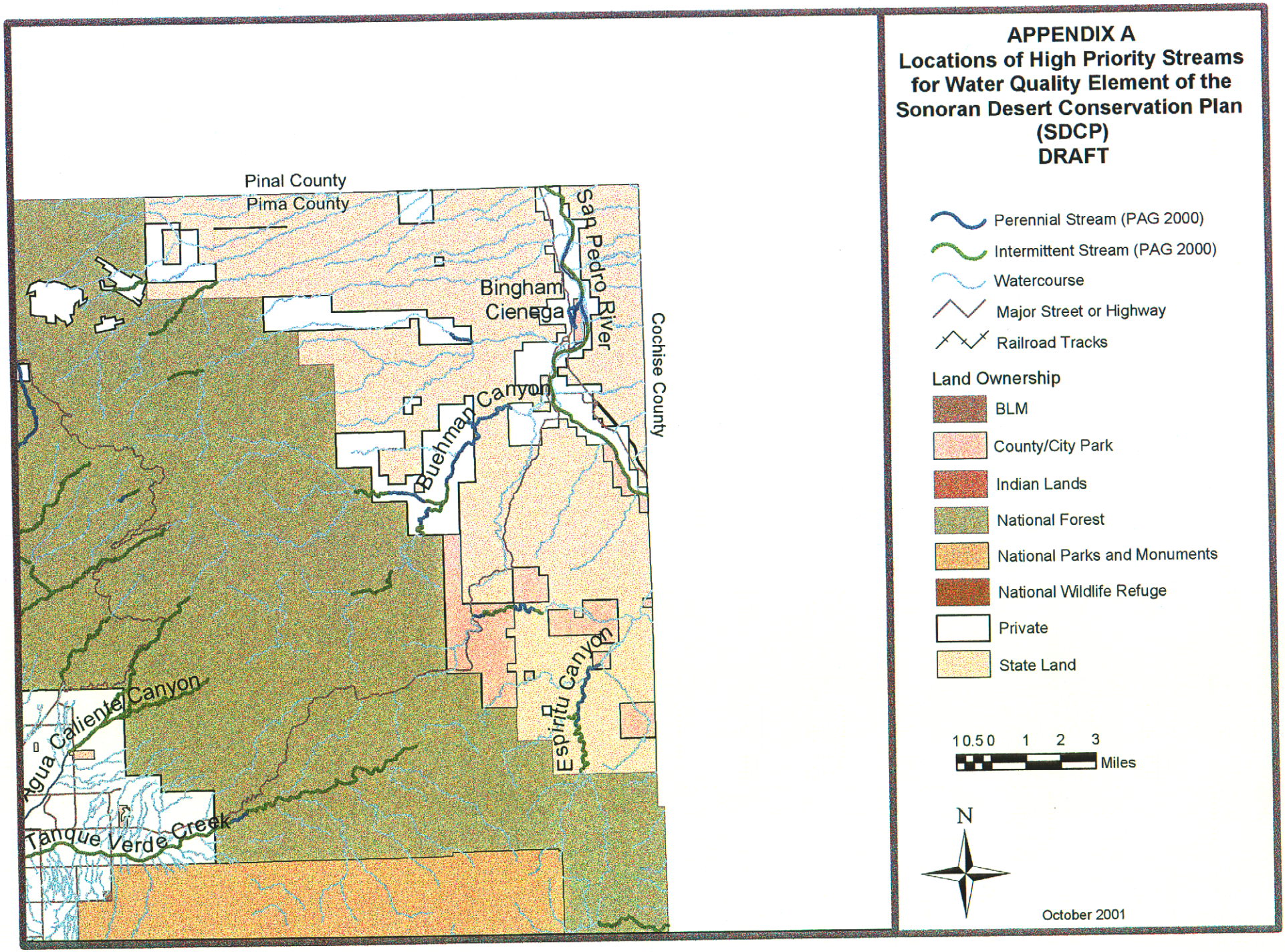
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land

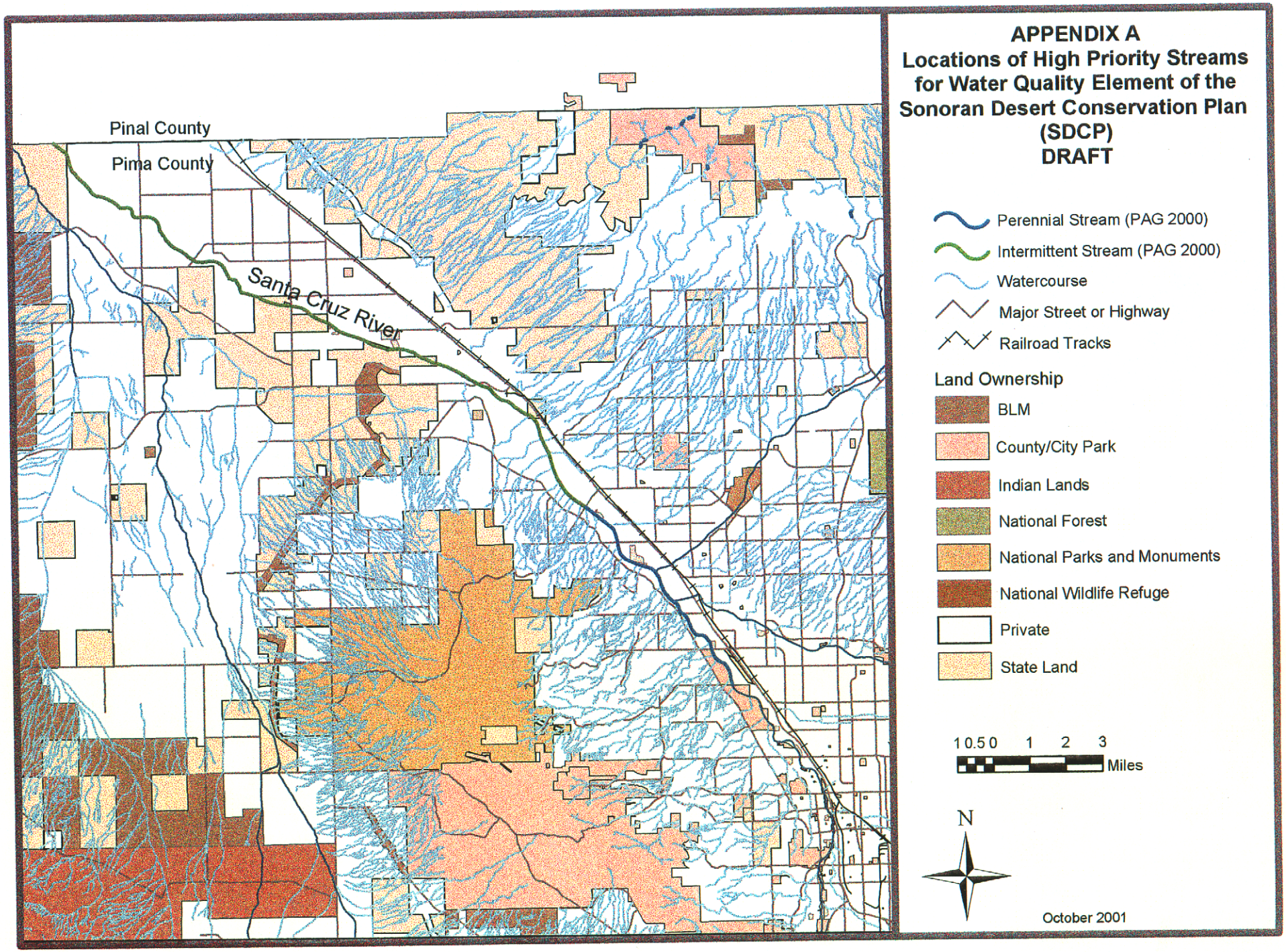
0.60.3 0 0.6 1.2 1.8
Miles

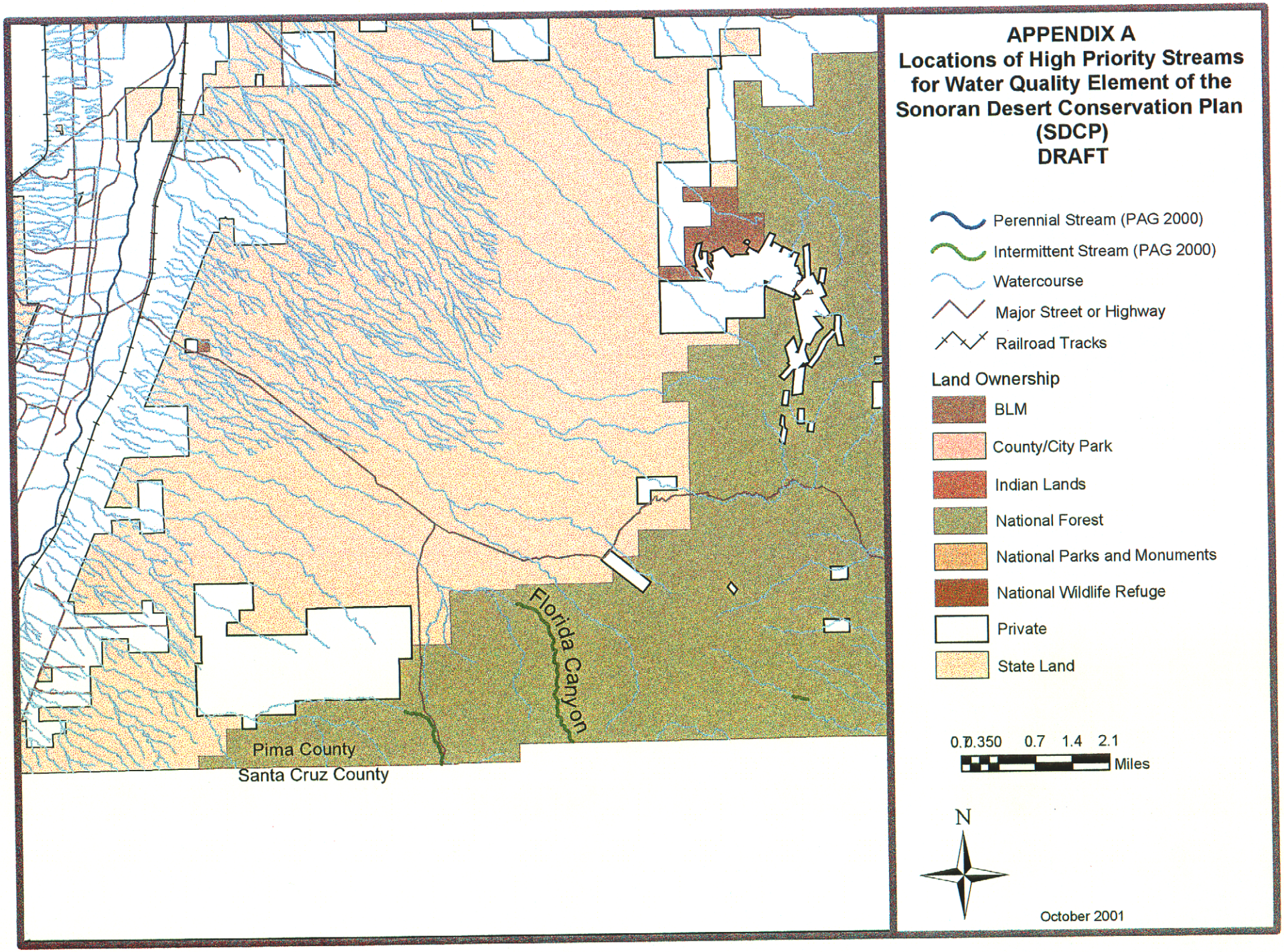
N

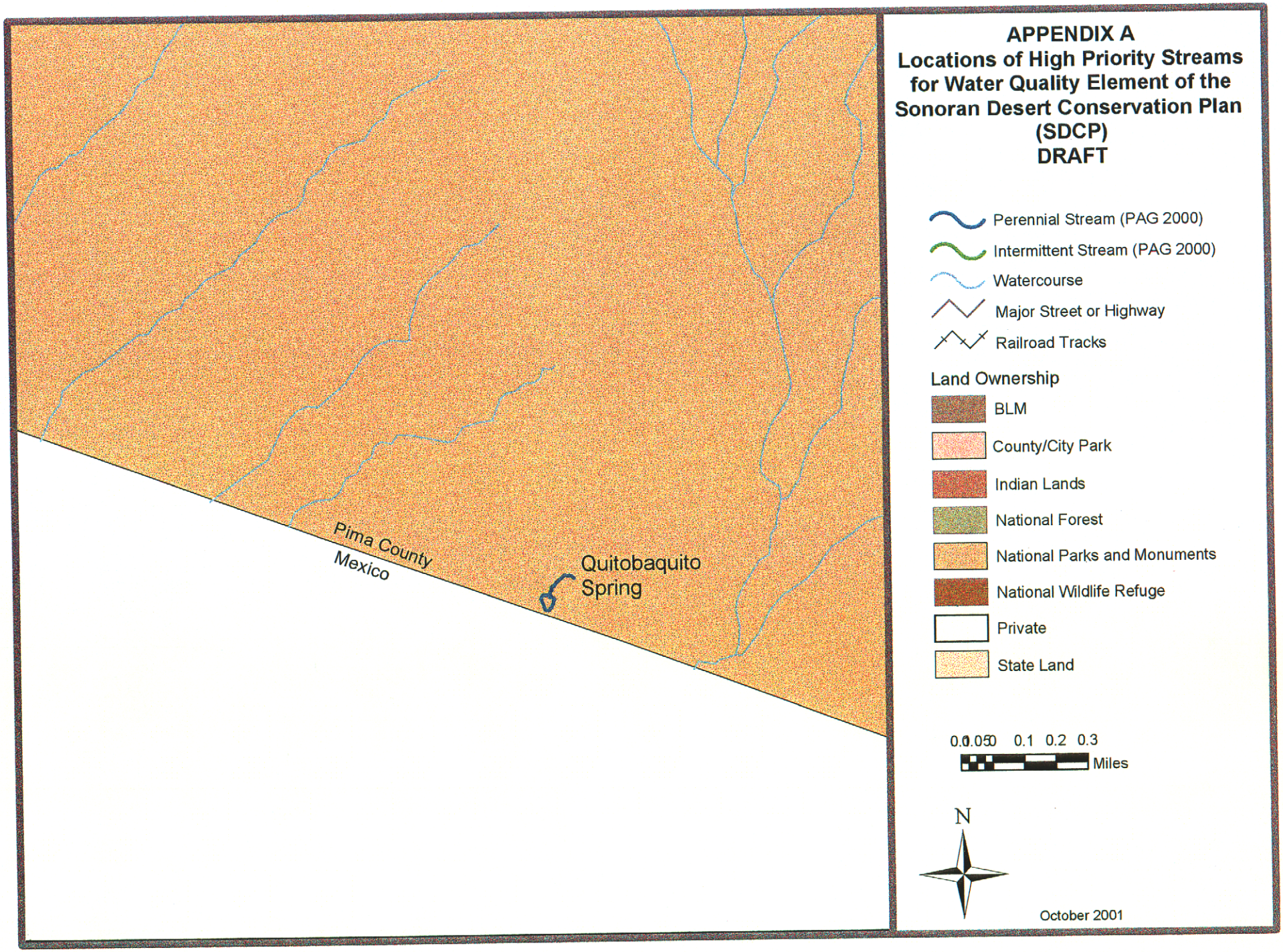
October 2001


APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
Arivaca Creek
Pima County
Santa Cruz County
0.60.3 0 0.6 1.2 1.8
Miles
N
October 2001


APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Pinal County
Pima County
Cochise County
San Pedro River
Bingham Cienega
Buehman Canyon
Agua Caliente Canyon
Tanque Verde Creek
Espiritu Canyon
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
0 0.5 0 1 2 3
Miles
N
October 2001


Pinal County
Pima County
Santa Cruz River
APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
1 0.5 0 1 2 3
Miles
N
October 2001


APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
0 0.350 0.7 1.4 2.1
Miles
N
October 2001
Florida Canyon
Pima County
Santa Cruz County


APPENDIX A
Locations of High Priority Streams for Water Quality Element of the Sonoran Desert Conservation Plan (SDCP)
DRAFT
Perennial Stream (PAG 2000)
Intermittent Stream (PAG 2000)
Watercourse
Major Street or Highway
Railroad Tracks
Land Ownership
BLM
County/City Park
Indian Lands
National Forest
National Parks and Monuments
National Wildlife Refuge
Private
State Land
0.0 0.05 0.1 0.2 0.3
Miles
N
October 2001
Pima County
Mexico
Quitobaquito Spring

Appendix B

Numeric Water Quality Standards
From ADEQ
The Status of Water Quality in Arizona
Clean Water Act Section 305 (b)
Report 2000

APPENDIX B. NUMERIC STANDARDS AND OTHER CRITERIA
Arizona Surface Water Numeric Standards and Other Criteria

PARAMETER	DESIGNATED USE(S)	STANDARD OR ASSESSMENT CRITERIA	CHRONIC STANDARDS
Aluminum (Al)	DWS (SMCL)	50-200 µg/l	
Ammonia (NH3)	A&Wc/A&Ww	Standard varies by temperature and pH., see equations in standards.	
Antimony (dissolved) (Sb)	A&Wc/A&Ww A&Wedw	88 µg/l 1,000 µg/l	30 µg/l 600 µg/l
Antimony (total) (Sb)	DWS FBC/PBC FC	6 µg/l 56 µg/l 140 µg/l	NA
Arsenic (dissolved) (As)	A&Wc/A&Ww/A&Wedw A&We	360 µg/l 440 µg/l	190 µg/l 230 µg/l
Arsenic (total) (As)	DWS/FBC/PBC AGL FC AGI Peeple's Canyon Creek (Unique Waters)	50 µg/l 200 µg/l 1450 µg/l 2,000 µg/l 20 µg/l	NA
Barium (dissolved) (Ba)	FBC/PBC	9,800 µg/l	NA
Barium (total) (Ba)	DWS	2,000 µg/l	
Beryllium (dissolved) (Be)	A&Wc/A&Ww/A&Wedw	65 µg/l	5.3 µg/l
Beryllium (total) (Be)	FC DWS/ FBC PBC	0.21 µg/l 4 µg/l 700 µg/l	NA NA NA
Boron (total) (B)	DWS AGI FBC/PBC	630 µg/l 1,000 µg/l 12,600 µg/l	NA
Cadmium (total) (Cd)	DWS FC AgI/AgL FBC/PBC	5 µg/l 41 µg/l 50 µg/l 70 µg/l	NA
Cadmium (dissolved) (Cd)	A&W	Standard varies by water hardness*, see published standards.	
Chloride (Cl)	DWS	250 mg/l (SMCL)	NA
Chlorine (total residual) (Cl)	A&Wc/A&Ww/A&Wedw FBC/PBC	11 mg/l 14mg/l	5 mg/l
Chromium (total) (Cr)	DWS AgI/AgL	100 µg/l 1,000 µg/l	NA

From: The Status of Water Quality in Arizona Clean Water Act Section 305 (b) Report 2000

Appendix B

Arizona Surface Water Numeric Standards and Other Criteria

PARAMETER	DESIGNATED USE(S)	STANDARD OR ASSESSMENT CRITERIA	CHRONIC STANDARDS
Chromium III (total) (Cr III)	FC FBC/PBC	67,000 µg/l 140,000 µg/l	NA
Chromium (dissolved) (Cr)	Unique Waters standards for: West Fork Little Colorado River, above Government Springs Oak Creek and West Fork Oak Creek	 10 µg/l 5 µg/l	
Chromium III (dissolved) (Cr)	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness*, see published standards.	
Chromium VI (total) (Cr VI)	FBC/PBC FC	700 µg/l 3,400 µg/l	NA
Chromium VI (dissolved) (Cr VI)	A&Wc/A&Ww/A&Wedw/ A&We	16 µg/l 34 µg/l	11 µg/l 23 µg/l
Copper (dissolved) (Cu)	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness, see published standards.	
	DWS PBC/FBC	1,000 µg/l 5,200 µg/l	NA
Copper (total) (Cu)	AgL AgI	500 µg/l 5,000 µg/l	NA
Cyanide (total) (Cn)	A&Wc A&Ww/A&Wedw A&We AgL, DWS FBC/PBC FC	22 µg/l 41 µg/l 84 µg/l 200 µg/l 2,800 µg/l 210,000 µg/l	5.2 µg/l 9.7 µg/l 19 µg/l
Dissolved Oxygen (DO)	A&Ww A&Wc A&Wedw	>6.0 mg/l >7.0 mg/l >3.0 mg/l Applies to 3 hours after sunrise to sunset >1.0 mg/l Applies to 3 hours after sunrise	
	West Fork Little Colorado (Unique Waters) Peoples Canyon Creek (Unique Waters) Cienega Creek (Unique Waters) Bonita Creek (Unique Waters)	no decrease due to discharge	
Escherichia coli	FBC	30-day geometric mean (5 sample minimum) single sample maximum	130 CFU/100ml 580 CFU/100ml
Fecal Coliform	A&Wedw	30-day geometric mean (5 sample minimum) 10% samples for a 30-day period single sample maximum	200 CFU/100 ml 400 CFU/100 ml 800 CFU/100 ml

From: The Status of Water Quality in Arizona Clean Water Act Section 305 (b) Report 2000

Appendix B

Arizona Surface Water Numeric Standards and Other Criteria

PARAMETER	DESIGNATED USE(S)	STANDARD OR ASSESSMENT CRITERIA	CHRONIC STANDARDS
	A&Ww/A&Wc/A&We/A&Wedw/DWS/PBC/AgI/AgL	30-day geometric mean (5 sample minimum) 10% samples for a 30-day period single sample maximum	1,000 CFU/100 ml 2,000 CFU/100 ml 4,000 CFU/100 ml
Fluoride (F)	DWS DWS (SMCL) FBC/PBC	4 mg/l 2 mg/l 8.4 mg/l	NA
Lead (dissolved) (Pb)	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness, see published standards*.	
Lead (total) (Pb)	DWS AgL AgI	50 µg/l 100 µg/l 10,000 µg/l	NA
Manganese (total) (Mn)	DWS AgI FBC/PBC Unique Waters standards for: People's Canyon Creek, Burro Creek, and Francis Creek	4,900 µg/l 10,000 µg/l 19,600 µg/l 500 µg/l	NA
Mercury (dissolved) (Hg)	A&Wc/A&Ww A&Wedw A&We	2.4 µg/l 2.6 µg/l 5.0 µg/l	0.01 µg/l 0.2 µg/l 2.7 µg/l
Mercury (total) (Hg)	FC DWS AgL FBC/PBC	0.6 µg/l 2 µg/l 10 µg/l 42 µg/l	NA
Nickel (dissolved) (Ni)	A&W	Standard varies by water hardness, see published standards*.	
Nickel (total) (Ni)	DWS FC FBC/PBC	100 µg/l 730 µg/l 2,800 µg/l	140 µg/l 400 µg/l
Nitrate (as N) (NO3)	DWS mean value San Pedro (Curtiss-Benson) FBC/PBC	10 mg/l 10 mg/l 224 mg/l	NA
Nitrite (as N) (NO2)	DWS FBC/PBC	1 mg/l 14 mg/l	NA
Nitrogen (total) (N)	See nutrient chart below		
Nitrate/Nitrite (as Total Nitrogen)	DWS	10 mg/l	

From: The Status of Water Quality in Arizona Clean Water Act Section 305 (b) Report 2000

Appendix B

Arizona Surface Water Numeric Standards and Other Criteria

PARAMETER	DESIGNATED USE(S)	STANDARD OR ASSESSMENT CRITERIA	CHRONIC STANDARDS
pH	A&W/FBC/PBC	6.5 - 9.0 OR Maximum change due to discharge 0.5	
	DWS	5.0 - 9.0	
	AgI	4.5 - 9.0	
	Unique Water standards for: Bonita Creek, Cienega Creek, West Fork Little Colorado, Oak Creek, and West Fork Oak Creek	no change due to discharge	
Phosphorus (total) (P)	See nutrient chart below		
Selenium (total) (Se)	A&Ww/A&Wc/AgI	20 µg/l	2 µg/l
	A&We	33 µg/l	NA
	A&Wedw/AgL/DWS	50 µg/l	2 µg/l
	FBC/PBC	700 µg/l	2 µg/l
	FC	9,000 µg/l	NA
Silver (total) (Ag)	DWS (SMCL)	100 µg/l	NA
Silver (dissolved) (Ag)	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness, see published standards*.	
Sulfides (S2)	A&W	0.1 mg/l	NA
Sulfate (SO4)	DWS	250 mg/l (SMCL)	NA
Temperature (maximum increase due to discharge)	A&Wc	1.0 ° C	NA
	A&Ww/A&Wedw	3.0 ° C	
	Unique Water standards for: Bonita Creek, Cienega Creek, West Fork Little Colorado, and People's Canyon	no increase due to discharge	
Thallium (total) (Tl)	DWS	2 µg/l	NA
	FBC/PBC	41 µg/l	
	FC	12 µg/l	
Thallium (dissolved) (Tl)	A&Wc/A&Ww/A&Wedw	700 µg/l	150 µg/l
Total Dissolved Solids (TDS)	DWS mg/l (SMCL)	500 mg/l	NA
	AgI (EPA criteria -- more sensative crops)	1000 mg/l	
	AgI (EPA criteria -- less sensative crops)	2000 mg/l	
	Unique Water standards for: West Fork Little Colorado River, Bonita Creek, & Cienega Creek	no increase due to discharge	NA
	Colorado River:	NA	(flow-weighted average annual)
	below Hoover Dam		723 mg/l
	below Parker Dam		747 mg/l
	at Imperial Dam		879 mg/l

From: The Status of Water Quality in Arizona Clean Water Act Section 305 (b) Report 2000

Appendix B

Arizona Surface Water Numeric Standards and Other Criteria

PARAMETER	DESIGNATED USE(S)	STANDARD OR ASSESSMENT CRITERIA	CHRONIC STANDARDS
Turbidity (NTU)	A&Wc (streams & lakes)	10 NTU	NA
	A&Wedw, A&Ww (lakes only)	25 NTU	
	A&Ww, A&Wedw (streams only)	50 NTU	
	Oak Creek (Unique Waters)	3 NTU change due to discharge	
	Peoples Canyon Creek (Unique Waters)	5 NTU change due to discharge	
	Cienega Creek (Unique Waters)	10 NTU	
	Bonita Creek (Unique Waters)	15 NTU	
Uranium (dissolved) (Ur)	DWS	35 µg/l	NA
Zinc (total) (Zn)	DWS	2,100 µg/l	NA
	AgI	10,000 µg/l	
	FC	22,000 µg/l	
	AgL	25,000 µg/l	
	FBC/PBC	42,000 µg/l	
Zinc (dissolved) (Zn)	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness*, see published standards.	

*Standard is calculated using equations published with the surface water standards (e.g., copper A&Wc acute standard: $e^{(0.9422\,[\ln(\text{hardness})]-1.464)}$. In these equations, hardness (expressed as $CaCO_3$) does not exceed 400 mg/L.

RADIOCHEMICAL STANDARDS		
Radiochemical	Designated Use	Standard (mean value)
Gross Alpha (excluding radon and uranium)	DWS	15 pCi/l
Radium-226 + Radium-228	DWS	5 pCi/l
Strontium 90	DWS	8 pCi/l
Tritium	DWS	20,000 pCi/l

NUTRIENT STANDARDS						
WATERSHED OR SITE SPECIFIC LOCATION	Annual Mean		90th Percentile		Single Sample Max	
Verde River and tributaries -- above Bartlett Lake	P	0.10 mg/l	P	0.30 mg/l	P	1.00 mg/l
	N	1.00 mg/l	N	1.50 mg/l	N	3.00 mg/l

From: The Status of Water Quality in Arizona Clean Water Act Section 305 (b) Report 2000

Appendix C

Water Quality Data

Appendix C. Water Quality Data

Agua Caliente Water Quality Data, sample collected above the National Forest Service Boundary. From ADEQ.

PARAMETER	SAMPLE DATE	RESULT	UNITS	DATA CODE	REPORTING LIMIT
Temperature, Water	4/13/95	14.9	° C		
Specific Conductance, Field	4/13/95	136	umhos/cm		
Specific Conductance	4/13/95	140	umhos/cm		
Oxygen, Dissolved	4/13/95	9.3	mg/l		
Oxygen Dissolved	4/13/95	92	Percent		
pH, Field	4/13/95	7.28	SU		
Alkalinity, Total (mg/l as CaCO3)	4/13/95	36	mg/l		
Alkalinity, Phenolphthalein	4/13/95		mg/l	ND	2.0
Bicarbonate Ion (mg/l as HCO3)	4/13/95	44	mg/l		
Carbonate Ion (mg/l AS CO3)	4/13/95		mg/l	ND	2.0
Residue, Total, Nonfiltrable	4/13/95		mg/l	ND	4.0
Nitrogen, Ammonia, Total (mg/l as N)	4/13/95	0.09	mg/l		
Nitrogen, Kjeldahl, Total (mg/l as N)	4/13/95	0.49	mg/l		
Nitrite + Nitrate, Total (mg/l as N)	4/13/95		mg/l	ND	0.01
Phosphorous, Total (mg/l as P)	4/13/95	0.046	mg/l		
Calcium, Total (mg/l as CA)	4/13/95	10.2	mg/l		
Magnesium, Total (mg/l as MG)	4/13/95	2.9	mg/l		
Sodium, Total (mg/l as NA)	4/13/95	13.7	mg/l		
Potassium, Total (mg/l as K)	4/13/95	1.26	mg/l		
Chloride, Total in Water	4/13/95	5.3	mg/l		
Sulfate, Total (mg/l as SO4)	4/13/95	20.2	mg/l		
Arsenic, Dissolved (ug/l as AS)	4/13/95		ug/l	ND	10
Copper, Dissolved (ug/l as CU)	4/13/95		ug/l	ND	10
Iron, Dissolved (ug/l as FE)	4/13/95		mg/l	ND	0.1
Solids, Total Dissolved	4/13/95	87	mg/l		
Residue, Total, Filtrable (Dried at180C)	4/13/95	108	mg/l		
Mercury, Dissolved (ug/l as HG)	4/13/95		ug/l	ND	.5
Turbidity, Field	4/13/95	1.8	NTU		

ND= not detected

Arivaca Creek at Ruby Road. Data from ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS
Boron (Boron And Borates Only)	Total	11/5/92 --		19	ug/l
Lead And Compounds (Inorganic)	Total	11/5/92 --		29	ug/l
Specific Conductivity	Standard	11/5/92 --		372	umhos/cm
Specific Conductivity	Standard	11/5/92 --		375	umhos/cm
Total Dissolved Solids	Dissolved	11/5/92 --		238	mg/l
Total Suspended Solids	Suspended	11/5/92	K	4.0	mg/l
Dissolved Oxygen	Standard	11/5/92 --		60.6	percent
Beryllium And Compounds	Total	11/5/92	K	0.1	ug/l
Dissolved Oxygen	Dissolved	11/5/92 --		5.20	mg/l
Fecal Streptococci	Total	11/5/92 --		240	cfu/100
Selenium And Compounds	Total	11/5/92	K	5	ug/l
Barium And Compounds	Total	11/5/92 --		27	ug/l
Ammonia As Nitrogen	Total	11/5/92	K	0.2	mg/l
Nitrate + Nitrite	Total	11/5/92 --		1.26	mg/l
Kjeldahl Nitrogen	Total	11/5/92 --		0.2	mg/l
Mercury, Elemental	Total	11/5/92	K	0.2	ug/l
Calcium Carbonate	Total	11/5/92 --		173	mg/l
Temperature	Air	11/5/92 --		15.5	° C
Arsenic, Inorganic	Total	11/5/92	K	5	ug/l
Fecal Coliform	Total	11/5/92 --		6	cfu/100
Temperature	Water	11/5/92 --		16.5	° C
Phosphorus	Total	11/5/92 --		0.056	mg/l
Bicarbonate	Total	11/5/92 --		207	mg/l
Potassium	Total	11/5/92 --		2.09	mg/l
Magnesium	Total	11/5/92 --		6.72	mg/l
Fluoride	Total	11/5/92 --		0.20	mg/l
Turbidity	Total	11/5/92 --		0.60	NTU
Turbidity	Total	11/5/92 --		1.15	NTU
Chloride	Total	11/5/92 --		6.86	mg/l
Strontium	Total	11/5/92 --		203	ug/l
Nitrate	Total	11/5/92 --		1.26	mg/l
Hydroxide	Total	11/5/92	K	4.0	mg/l
Manganese	Total	11/5/92 --		10	ug/l
Sulfate	Total	11/5/92 --		14.0	mg/l
Calcium	Total	11/5/92 --		58.1	mg/l
Sodium	Total	11/5/92 --		13.1	mg/l
Cadmium	Total	11/5/92	K	0.7	ug/l
Carbonate	Total	11/5/92	K	4	mg/l
Antimony	Total	11/5/92	K	60	ug/l
Thallium	Total	11/5/92	K	60	ug/l
Chromium	Total	11/5/92	K	3	ug/l
Flow	Total	11/5/92 --		0.5	CFS
Silver	Total	11/5/92	K	1	ug/l
Copper	Total	11/5/92	K	4	ug/l
Nickel	Total	11/5/92	K	4	ug/l

Arivaca Creek at Ruby Road. Data from ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS
Zinc	Total	11/5/92	--	14	ug/l
Iron	Total	11/5/92	--	40	ug/l
pH	Total	11/5/92	--	7.04	SU
pH	Total	11/5/92	--	7.1	SU

K= Actual value is known to be less than the value given, method detection limit listed in result column.

Arivaca Creek at Figueroa Spring. Data from ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS
Lead And Compounds (Inorganic)	Dissolved	5/10/93	U	10	ug/l
Boron (Boron And Borates Only)	Total	5/10/93	U	100	ug/l
Lead And Compounds (Inorganic)	Total	5/10/93	U	10	ug/l
Specific Conductivity	Standard	5/10/93	--	365	umhos/cm
Specific Conductivity	Standard	5/10/93	--	384	umhos/cm
Beryllium And Compounds	Dissolved	5/10/93	U	0.5	ug/l
Total Dissolved Solids	Dissolved	5/10/93	--	240	mg/l
Alkalinity, Phenolphthalein	Total	5/10/93	U	2	mg/l
Total Suspended Solids	Suspended	5/10/93	--	7	mg/l
Dissolved Oxygen	Standard	5/10/93	--	109.0	percent
Barium And Compounds	Dissolved	5/10/93	--	120	ug/l
Selenium And Compounds	Dissolved	5/10/93	U	5	ug/l
Beryllium And Compounds	Total	5/10/93	U	0.5	ug/l
Mercury, Elemental	Dissolved	5/10/93	U	0.5	ug/l
Dissolved Oxygen	Dissolved	5/10/93	--	9.45	mg/l
Arsenic, Inorganic	Dissolved	5/10/93	U	10	ug/l
Barium And Compounds	Total	5/10/93	--	120	ug/l
Selenium And Compounds	Total	5/10/93	U	5	ug/l
Ammonia As Nitrogen	Total	5/10/93	U	0.1	mg/l
Mercury, Elemental	Total	5/10/93	U	0.5	ug/l
Calcium Carbonate	Total	5/10/93	--	170	mg/l
Kjeldahl Nitrogen	Total	5/10/93	U	0.1	mg/l
Nitrate + Nitrite	Total	5/10/93	U	0.1	mg/l
Arsenic, Inorganic	Total	5/10/93	U	10	ug/l
Temperature	Standard	5/10/93	--	28.0	° C
Stream Width	Standard	5/10/93	--	8.9	FT
Temperature	Total	5/10/93	--	16.0	° C
Strontium	Dissolved	5/10/93	--	270	ug/l
Stream Depth	Total	5/10/93	--	0.55	FT
Manganese	Dissolved	5/10/93	U	50	ug/l
Bicarbonate	Total	5/10/93	--	207	mg/l
Potassium	Total	5/10/93	--	2.76	mg/l
Chromium	Dissolved	5/10/93	U	10	ug/l

Arivaca Creek at Figueroa Spring. Data from ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS
Phosphorus	Total	5/10/93	U	0.1	mg/l
Fluoride	Total	5/10/93	--	0.21	mg/l
Turbidity	Total	5/10/93	--	0.29	NTU
Turbidity	Total	5/10/93	--	0.42	NTU
Antimony	Dissolved	5/10/93	U	5	ug/l
Thallium	Dissolved	5/10/93	U	5	ug/l
Magnesium	Total	5/10/93	--	8.4	mg/l
Chloride	Total	5/10/93	--	12.9	mg/l
Nickel	Dissolved	5/10/93	U	100	ug/l
Strontium	Total	5/10/93	--	270	ug/l
Cadmium	Dissolved	5/10/93	U	1	ug/l
Copper	Dissolved	5/10/93	U	10	ug/l
Sulfate	Total	5/10/93	--	16.1	mg/l
Calcium	Total	5/10/93	--	50.7	mg/l
Flow	Total	5/10/93	--	0.37	FT/SEC
Silver	Dissolved	5/10/93	U	1	ug/l
Flow	Standard	5/10/93	--	1.52	CFS
Sodium	Total	5/10/93	--	17.1	mg/l
Manganese	Total	5/10/93	U	50	ug/l
Iron	Dissolved	5/10/93	U	100	ug/l
Nitrate	Total	5/10/93	U	0.1	mg/l
Carbonate	Total	5/10/93	U	2	mg/l
Chromium	Total	5/10/93	U	10	ug/l
Zinc	Dissolved	5/10/93	U	50	ug/l
Antimony	Total	5/10/93	U	5	ug/l
Thallium	Total	5/10/93	U	5	ug/l
Nickel	Total	5/10/93	U	100	ug/l
Cadmium	Total	5/10/93	U	1	ug/l
Copper	Total	5/10/93	U	10	ug/l
Silver	Total	5/10/93	U	1	ug/l
Iron	Total	5/10/93	U	100	ug/l
Zinc	Total	5/10/93	U	50	ug/l
pH	Total	5/10/93	--	8.15	SU
pH	Total	5/10/93	--	8.25	SU

U= Material analyzed for but not detected, and method detection limit is listed in the result column.

Water Chemistry Summary November 1998- June 2000. From: PAG Bingham Cienega Source Water Study.

Bingham Cienega	11/23/1998	03/19/1999	06/15/1999	09/10/1999	11/20/1999	03/30/2000	06/09/2000
Silicon, dissolved (Si)	15	14	12	14	13	16	17
Aluminum, dissolved	0	0	0	0	0	--	--
Calcium, dissolved	67	67	55	60	63	62	73
Magnesium, dissolved	13	13	10	12	12	12	14
Manganese, dissolved	0.11	0.05	0	0.16	0.19	0.035	0
Potassium, dissolved	0	4.4	0	3.6	3.9	0	0
Sodium, dissolved	45	45	32	42	42	39	38
Arsenic, dissolved	0.0063	0.008	0	0.006	0	0	0.01
Chloride, dissolved	11.3	--	10.2	11	11	10	11
Sulfate, dissolved	69.8	63.7	48.4	53	56	50	50
Fluoride, dissolved	1.1	--	--	1.2	1.3	1	1.1
Alk. as CaCO3	234	238	204	200	220	210	230
Lab TDS	250	320	310	230	250	200	400
Lab Conductivity	580	570	520	590	560	560	600
Lab pH	7.4	7.7	6.9	6.8	7.1	7.3	7.6

Units are in mg/l except for pH (su) and conductivity (mmhos).

Buehman Canyon, above forest service roads 801 & 654 near Redington. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Specific Conductivity	Standard	7/15/97	--	380	umhos/cm	--
Specific Conductivity	Standard	7/15/97	--	399	umhos/cm	--
Total Dissolved Solids	Dissolved	7/15/97	--	270	mg/l	--
Beryllium And Compounds	Total	7/15/97	--	1.6	ug/l	--
Dissolved Oxygen	Standard	7/15/97	--	69.5	percent	--
Dissolved Oxygen	Dissolved	7/15/97	--	5.7	mg/l	--
Nitrate + Nitrite	Total	7/15/97	--	0.34	mg/l	--
Kjeldahl Nitrogen	Total	7/15/97	--	0.74	mg/l	--
Calcium Carbonate	Total	7/15/97	--	170	mg/l	--
Temperature	Air	7/15/97	--	31.5	° C	--
Temperature	Water	7/15/97	--	19.6	° C	--
Bicarbonate	Total	7/15/97	--	210	mg/l	--
Turbidity	Total	7/15/97	--	1.92	NTU	--
Potassium	Total	7/15/97	--	2.3	mg/l	--
Magnesium	Total	7/15/97	--	8.8	mg/l	--
Fluoride	Total	7/15/97	--	2.6	mg/l	--
Calcium	Total	7/15/97	--	52.0	mg/l	--
Chloride	Total	7/15/97	--	10	mg/l	--
Sulfate	Total	7/15/97	--	25	mg/l	--
Copper	Total	7/15/97	--	15	ug/l	--
Sodium	Total	7/15/97	--	22	mg/l	--
pH	Total	7/15/97	--	7.32	SU	--
Alkalinity, Phenolphthalein	Total	7/15/97	--	ND	mg/l	2
Total Suspended Solids	Suspended	7/15/97	--	ND	mg/l	4
Ammonia As Nitrogen	Total	7/15/97	--	ND	mg/l	0.1

Buehman Canyon, above forest service roads 801 & 654 near Redington. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Phosphorus	Total	7/15/97	--	ND	mg/l	0.1
Carbonate	Total	7/15/97	--	ND	mg/l	2
Boron (Boron And Borates)	Dissolved	7/15/97	--	ND	ug/l	100
Lead And Compounds (Inorganic)	Dissolved	7/15/97	--	ND	ug/l	5
Boron (Boron And Borates Only)	Total	7/15/97	--	ND	ug/l	100
Lead And Compounds (Inorganic)	Total	7/15/97	--	ND	ug/l	5
Beryllium And Compounds	Dissolved	7/15/97	--	ND	ug/l	0.5
Barium And Compounds	Dissolved	7/15/97	--	ND	ug/l	100
Selenium And Compounds	Dissolved	7/15/97	--	ND	ug/l	5
Mercury, Elemental	Dissolved	7/15/97	--	ND	ug/l	0.5
Arsenic, Inorganic	Dissolved	7/15/97	--	ND	ug/l	10
Barium And Compounds	Total	7/15/97	--	ND	ug/l	100
Selenium And Compounds	Total	7/15/97	--	ND	ug/l	5
Mercury, Elemental	Total	7/15/97	--	ND	ug/l	0.5
Arsenic, Inorganic	Total	7/15/97	--	ND	ug/l	10
Manganese	Dissolved	7/15/97	--	ND	ug/l	50
Chromium	Dissolved	7/15/97	--	ND	ug/l	10
Antimony	Dissolved	7/15/97	--	ND	ug/l	5
Thallium	Dissolved	7/15/97	--	ND	ug/l	5
Nickel	Dissolved	7/15/97	--	ND	ug/l	100
Cadmium	Dissolved	7/15/97	--	ND	ug/l	1
Copper	Dissolved	7/15/97	--	ND	ug/l	10
Manganese	Total	7/15/97	--	ND	ug/l	50
Silver	Dissolved	7/15/97	--	ND	ug/l	1
Iron	Dissolved	7/15/97	--	ND	ug/l	100
Zinc	Dissolved	7/15/97	--	ND	ug/l	50
Chromium	Total	7/15/97	--	ND	ug/l	10
Antimony	Total	7/15/97	--	ND	ug/l	5
Thallium	Total	7/15/97	--	ND	ug/l	5
Nickel	Total	7/15/97	--	ND	ug/l	100
Cadmium	Total	7/15/97	--	ND	ug/l	1
Silver	Total	7/15/97	--	ND	ug/l	1
Iron	Total	7/15/97	--	ND	ug/l	100
Zinc	Total	7/15/97	--	ND	ug/l	50

ND= not detected

Buehman Canyon, two miles below the confluence with Bullock Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Flow	Standard	5/18/00	--	0.06	CFS	--
Temperature	Air	5/18/00	--	21	° C	--
Temperature	Water	5/18/00	--	21.61	° C	--
Stream Depth	Standard	5/18/00	--	0.3	FT	--
Stream Width	Standard	5/18/00	--	7.5	FT	--
Flow	Total	5/18/00	--	0.03	FT/SEC	--
Lead And Compounds (Inorganic)	Dissolved	5/18/00	--	ND	mg/l	0.0050
Lead And Compounds (Inorganic)	Total	5/18/00	--	ND	mg/l	0.005
Total Dissolved Solids	Dissolved	5/18/00	--	295	mg/l	--
Beryllium And Compounds	Dissolved	5/18/00	--	ND	mg/l	0.0005
Boron (Boron And Borates)	Total	5/18/00	--	ND	mg/l	0.1
Hardness (Caco3 + Mgco3)	Total	5/18/00	--	210	mg/l	--
Selenium And Compounds	Dissolved	5/18/00	--	ND	mg/l	0.005
Alkalinity, Phenolphthalein	Total	5/18/00	--	ND	mg/l	2.0
Beryllium And Compounds	Total	5/18/00	--	ND	mg/l	0.0005
Kjeldahl Nitrogen	Total	5/18/00	--	0.087	mg/l	0.05
Dissolved Oxygen	Dissolved	5/18/00	--	4.44	mg/l	--
Barium And Compounds	Dissolved	5/18/00	--	ND	mg/l	0.10
Mercury, Elemental	Dissolved	5/18/00	--	ND	mg/l	0.0005
Nitrate + Nitrite	Total	5/18/00	--	0.22	mg/l	0.02
Calcium Carbonate	Standard	5/18/00	--	210	mg/l	10
Arsenic, Inorganic	Dissolved	5/18/00	--	ND	mg/l	0.010
Selenium And Compounds	Total	5/18/00	--	ND	mg/l	0.005
Total Suspended Solids	Suspended	5/18/00	--	ND	mg/l	4
Calcium Carbonate	Total	5/18/00	--	210	mg/l	2.0
Mercury, Elemental	Total	5/18/00	--	ND	mg/l	0.0005
Barium and Compounds	Total	5/18/00	--	ND	mg/l	0.1
Ammonia As Nitrogen	Total	5/18/00	--	ND	mg/l	0.02
Arsenic, Inorganic	Total	5/18/00	--	ND	ug/l	0.01
Phosphorus	Total	5/18/00	--	0.029	mg/l	0.02
Bicarbonate	Total	5/18/00	--	260	mg/l	2.0
Fluoride	Total	5/18/00	--	0.68	mg/l	0.20
Potassium	Total	5/18/00	--	2.5	mg/l	0.50
Antimony	Dissolved	5/18/00	--	ND	mg/l	0.0050
Magnesium	Total	5/18/00	--	8.2	mg/l	1.0
Cadmium	Dissolved	5/18/00	--	ND	mg/l	0.0010
Chromium	Dissolved	5/18/00	--	ND	mg/l	0.010
Thallium	Dissolved	5/18/00	--	ND	mg/l	0.002
Chloride	Total	5/18/00	--	8.0	mg/l	1.0
Sulfate	Total	5/18/00	--	21	mg/l	10.0
Copper	Dissolved	5/18/00	--	ND	mg/l	0.010
Silver	Dissolved	5/18/00	--	ND	mg/l	0.001
Calcium	Total	5/18/00	--	71	mg/l	5.0
Nickel	Dissolved	5/18/00	--	ND	mg/l	0.10
Sodium	Total	5/18/00	--	20	mg/l	5.0

Buehman Canyon, two miles below the confluence with Bullock Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Antimony	Total	5/18/00	--	ND	mg/l	0.005
Manganese	Total	5/18/00	--	ND	mg/l	0.05
Zinc	Dissolved	5/18/00	--	ND	mg/l	0.050
Thallium	Total	5/18/00	--	ND	mg/l	0.002
Cadmium	Total	5/18/00	--	ND	mg/l	0.001
Carbonate	Total	5/18/00	--	ND	mg/l	2.0
Chromium	Total	5/18/00	--	ND	mg/l	0.01
Silver	Total	5/18/00	--	ND	mg/l	0.001
Copper	Total	5/18/00	--	ND	mg/l	0.01
Nickel	Total	5/18/00	--	ND	mg/l	0.1
Zinc	Total	5/18/00	--	ND	mg/l	0.05
Iron	Total	5/18/00	--	ND	mg/l	0.1
Turbidity	Total	5/18/00	--	0.54	NTU	--
Dissolved Oxygen	Standard	5/18/00	--	56.5	percent	--
pH	Total	5/18/00	--	6.93	SU	--
Specific Conductivity	Standard	5/18/00	--	460	umhos/cm	--
Specific Conductivity	Standard	5/18/00	--	461	umhos/cm	--

ND= not detected

Water Quality Data for Canada del Oro, South of the Pinal/Pima County Line. From ADEQ

PARAMETER	DATE	RESULT	UNITS	DATA CODE	REPORTING LIMIT	UNITS
Temperature, Water	4/7/94	13	° C			
Temperature, Air	4/7/94	20.3	° C			
Specific Conductance, Field	4/7/94	102	umhos/cm			
Oxygen, Dissolved	4/7/94	9.6	mg/l			
Oxygen, Dissolved	4/14/93	85.6	%			
pH, Field	4/7/94	8.01	SU			
Alkalinity, Total (mg/l as CaCo3)	4/7/94	41	mg/l			
Alkalinity, Phenolphthalein	4/7/94			ND	2.0	mg/l
Bicarbonate Ion	4/7/94	50	mg/l			
Carbonate Ion	4/7/94			ND	2.0	mg/l
Nitrogen, Ammonia, Total	4/7/94	0.31	mg/l			
Nitrogen, Kjeldahl	4/7/94	0.54	mg/l			
Nitrite+Nitrate, Total	4/7/94			ND	0.01	mg/l
Phosphorous, Total	4/7/94	0.069	mg/l			
Hardness, Total	4/7/94	44	mg/l			
Calcium, Total	4/7/94	11.9	mg/l			
Magnesium, Total	4/7/94	3.1	mg/l			
Sodium, Total	4/7/94	8.4	mg/l			
Potassium, Total	4/7/94	1.36	mg/l			
Chloride, Total	4/7/94	2.9	mg/l			
Sulfate, Total	4/7/94	15	mg/l			
Fluoride, Total	4/7/94	0.32	mg/l			
Arsenic, Total	4/7/94			ND	10	ug/l
Barium, Total	4/14/93			ND	100	ug/l
Boron, Total	4/14/93			ND	100	ug/l
Cadmium, Total	4/14/93			ND	1.0	ug/l
Chromium, Total	4/14/93			ND	10	ug/l
Copper, Total	6/1/92			ND	10	ug/l
Iron, Total	4/7/94	520	ug/l			
Lead, Total	4/14/93			ND	10	ug/l
Thallium, Total	6/1/92			ND	5.0	ug/l
Silver, Total	4/14/93			ND	1.0	ug/l
Zinc, Total	4/14/93			ND	50	ug/l
Selenium, Total	6/1/92			ND	5.0	ug/l
Solids, Total, Dissolved	4/7/94	65	mg/l			
Mercury, Total	4/7/94			ND	.5	ug/l
Turbidity, Total	4/7/94	6.4	NTU			
Turbidity, Lab	4/7/94	6.5	NTU			

ND= not detected

Average Values, Water Quality Data for Cienega Creek 1987-1990. (Fonseca et al., 1990) (PAG Summary of Cienega Creek Surface and Groundwater Monitoring Program 1998).

Site	Ca dissolved (mg/l)	Mg dissolved (mg/l)	Na dissolved (mg/l)	K dissolved (mg/l)	HCO3 dissolved (mg/l)	SO4 dissolved (mg/l)	CL dissolved (mg/l)	F dissolved (mg/l)
Near Marsh Station	109.28	31.23	58	5.29	227.56	300.47	16.43	0.73
Near Jungle Road	130.57	32.26	57.29	4.14	252	316.14	12.07	0.75
Near Del Lago	125.33	32.78	70.18	5.25	232.33	304.17	19.88	0.67

Cienega Creek at Marsh Station, Below Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Specific Conductivity	Standard	9/28/98	--	980	umhos/cm	--
Specific Conductivity	Standard	9/28/98	--	993	umhos/cm	--
Dissolved Oxygen	Standard	9/28/98	--	97.5	percent	--
Dissolved Oxygen	Dissolved	9/28/98	--	8.13	mg/l	--
Temperature	Air	9/28/98	--	26.0	° C	--
Stream Width	Standard	9/28/98	--	2.8	FT	--
Temperature	Water	9/28/98	--	19.7	° C	--
Stream Depth	Total	9/28/98	--	0.13	FT	--
Turbidity	Total	9/28/98	--	1.04	NTU	--
Flow	Standard	9/28/98	--	0.257	CFS	--
Flow	Total	9/28/98	--	0.53	FT/SEC	--
pH	Total	9/28/98	--	7.92	SU	--
Total Dissolved Solids	Dissolved	9/28/98	--	700	mg/l	10
Alkalinity, Phenolphthalein	Total	9/28/98	--	ND	mg/l	2
Nitrate + Nitrite	Total	9/28/98	--	0.14	mg/l	0.02
Total Suspended Solids	Suspended	9/28/98	--	ND		4
Kjeldahl Nitrogen	Total	9/28/98	--	0.2	mg/l	0.05
Calcium Carbonate	Total	9/28/98	--	290	mg/l	2
Ammonia As Nitrogen	Total	9/28/98	--	ND	mg/l	0.02
Fluoride	Total	9/28/98	--	0.68	mg/l	0.2
Potassium	Total	9/28/98	--	4.2	mg/l	0.5
Bicarbonate	Total	9/28/98	--	350	mg/l	2
Magnesium	Total	9/28/98	--	36	mg/l	1
Sulfate	Total	9/28/98	--	270	mg/l	10
Phosphorus	Total	9/28/98	--	ND	mg/l	0.02
Chloride	Total	9/28/98	--	12	mg/l	1
Calcium	Total	9/28/98	--	130	mg/l	5
Sodium	Total	9/28/98	--	64	mg/l	5

Cienega Creek at Marsh Station, Below Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Carbonate	Total	9/28/98	--	ND		2
Boron (Boron And Borates Only)	Dissolved	9/28/98	--	130	ug/l	100
Boron (Boron And Borates Only)	Dissolved	9/28/98	--	140	ug/l	100
Boron (Boron And Borates Only)	Total	9/28/98	--	150	ug/l	100
Lead And Compounds (Inorganic)	Dissolved	9/28/98	--	ND	ug/l	5
Lead And Compounds (Inorganic)	Dissolved	9/28/98	--	ND	ug/l	5
Lead And Compounds, inorg	Total	9/28/98	--	ND	ug/l	5
Beryllium And Compounds	Dissolved	9/28/98	--	ND	ug/l	0.5
Beryllium And Compounds	Dissolved	9/28/98	--	ND	ug/l	0.5
Barium And Compounds	Dissolved	9/28/98	--	ND	ug/l	100
Barium And Compounds	Dissolved	9/28/98	--	ND	ug/l	100
Selenium And Compounds	Dissolved	9/28/98	--	ND	ug/l	5
Selenium And Compounds	Dissolved	9/28/98	--	ND	ug/l	5
Beryllium And Compounds	Total	9/28/98	--	ND	ug/l	0.5
Mercury, Elemental	Dissolved	9/28/98	--	ND	ug/l	0.5
Mercury, Elemental	Dissolved	9/28/98	--	ND	ug/l	0.5
Arsenic, Inorganic	Dissolved	9/28/98	--	ND	ug/l	10
Arsenic, Inorganic	Dissolved	9/28/98	--	ND	ug/l	10
Barium And Compounds	Total	9/28/98	--	ND	ug/l	100
Selenium And Compounds	Total	9/28/98	--	ND	ug/l	5
Mercury, Elemental	Total	9/28/98	--	ND	ug/l	0.5
Arsenic, Inorganic	Total	9/28/98	--	ND	ug/l	10
Manganese	Dissolved	9/28/98	--	51	ug/l	50
Manganese	Dissolved	9/28/98	--	52	ug/l	50
Manganese	Total	9/28/98	--	64	ug/l	50
Chromium	Dissolved	9/28/98	--	ND	ug/l	10
Chromium	Dissolved	9/28/98	--	ND	ug/l	10
Antimony	Dissolved	9/28/98	--	ND	ug/l	5
Thallium	Dissolved	9/28/98	--	ND	ug/l	2
Thallium	Dissolved	9/28/98	--	ND	ug/l	2
Nickel	Dissolved	9/28/98	--	ND	ug/l	100
Nickel	Dissolved	9/28/98	--	ND	ug/l	100
Cadmium	Dissolved	9/28/98	--	ND	ug/l	1
Cadmium	Dissolved	9/28/98	--	ND	ug/l	1
Copper	Dissolved	9/28/98	--	ND	ug/l	10
Copper	Dissolved	9/28/98	--	ND	ug/l	10
Silver	Dissolved	9/28/98	--	ND	ug/l	1
Silver	Dissolved	9/28/98	--	ND	ug/l	1
Iron	Dissolved	9/28/98	--	ND	ug/l	100
Iron	Dissolved	9/28/98	--	ND	ug/l	100
Zinc	Dissolved	9/28/98	--	ND	ug/l	50

Cienega Creek at Marsh Station, Below Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Zinc	Dissolved	9/28/98	--	ND	ug/l	50
Chromium	Total	9/28/98	--	ND	ug/l	10
Thallium	Total	9/28/98	--	ND	ug/l	2
Nickel	Total	9/28/98	--	ND	ug/l	100
Cadmium	Total	9/28/98	--	ND	ug/l	1
Copper	Total	9/28/98	--	ND	ug/l	10
Silver	Total	9/28/98	--	ND	ug/l	1
Iron	Total	9/28/98	--	ND	ug/l	100
Zinc	Total	9/28/98	--	ND	ug/l	50

ND= not detected

Cienega Creek above Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	REPORTING LIMIT	UNITS
Antimony	Total	9/28/98	ND	--	5	ug/l
Arsenic, Inorganic	Dissolved	9/28/98	ND	--	10	ug/l
Arsenic, Inorganic	Total	9/28/98	ND	--	10	ug/l
Arsenic, Inorganic	Total	9/28/98	ND	--	10	ug/l
Barium And Compounds	Dissolved	9/28/98	ND	--	100	ug/l
Barium And Compounds	Total	9/28/98	ND	--	100	ug/l
Barium And Compounds	Total	9/28/98	--	100	--	ug/l
Beryllium And Compounds	Dissolved	9/28/98	ND	--	5	ug/l
Beryllium And Compounds	Total	9/28/98	ND	--	5	ug/l
Beryllium And Compounds	Total	9/28/98	ND	--	0.5	ug/l
Boron (Boron And Borates Only)	Dissolved	9/28/98	--	140	--	ug/l
Boron (Boron And Borates Only)	Total	9/28/98	--	150	--	ug/l
Boron (Boron And Borates Only)	Total	9/28/98	--	140	--	ug/l
Cadmium	Dissolved	9/28/98	ND	--	1	ug/l
Cadmium	Total	9/28/98	ND	--	1	ug/l
Cadmium	Total	9/28/98	ND	--	1	ug/l
Copper	Dissolved	9/28/98	ND	--	10	ug/l
Copper	Total	9/28/98	ND	--	10	ug/l
Copper	Total	9/28/98	ND	--	10	ug/l
Lead And Compounds (Inorganic)	Dissolved	9/28/98	ND	--	5	ug/l
Lead And Compounds (Inorganic)	Total	9/28/98	ND	--	5	ug/l
Lead And Compounds (Inorganic)	Total	9/28/98	ND	--	5	ug/l
Manganese	Dissolved	9/28/98	ND	--	50	ug/l
Manganese	Total	9/28/98	ND	--	50	ug/l

Cienega Creek above Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	REPORTING LIMIT	UNITS
Manganese	Total	9/28/98	--	67	--	ug/l
Mercury, Elemental	Dissolved	9/28/98	ND	--	0.5	ug/l
Mercury, Elemental	Total	9/28/98	ND	--	0.5	ug/l
Mercury, Elemental	Total	9/28/98	ND	--	0.5	ug/l
Selenium And Compounds	Dissolved	9/28/98	ND	--	5	ug/l
Selenium And Compounds	Total	9/28/98	ND	--	5	ug/l
Selenium And Compounds	Total	9/28/98	ND	--	5	ug/l
Silver	Dissolved	9/28/98	ND	--	1	ug/l
Silver	Total	9/28/98	ND	--	1	ug/l
Silver	Total	9/28/98	ND	--	1	ug/l
Phosphorus	Total	9/28/98	ND	--	0.02	mg/l
Phosphorus	Total	9/28/98	ND	--	0.02	mg/l
Zinc	Dissolved	9/28/98	ND	--	50	ug/l
Zinc	Total	9/28/98	ND	--	50	ug/l
Zinc	Total	9/28/98	ND	--	50	ug/l
Alkalinity, Phenolphthalein	Total	9/28/98	ND	--	2	mg/l
Alkalinity, Phenolphthalein	Total	9/28/98	ND	--	2	mg/l
Calcium Carbonate	Standard	9/28/98	--	450	--	mg/l
Calcium Carbonate	Total	9/28/98	--	280	--	mg/l
Calcium Carbonate	Total	9/28/98	--	290	--	mg/l
Carbonate	Total	9/28/98	ND	--	2	mg/l
Carbonate	Total	9/28/98	ND	--	2	mg/l
Chloride	Total	9/28/98	--	12	--	mg/l
Chloride	Total	9/28/98	--	12	--	mg/l
Fluoride	Total	9/28/98	--	0.68	--	mg/l
Fluoride	Total	9/28/98	--	0.67	--	mg/l
Specific Conductivity	Standard	9/28/98	--	1013	--	umhos/cm
Specific Conductivity	Standard	9/28/98	--	980	--	umhos/cm
Specific Conductivity	Standard	9/28/98	--	1000	--	umhos/cm
Sulfate	Total	9/28/98	--	320	--	mg/l
Sulfate	Total	9/28/98	--	270	--	mg/l
Calcium	Total	9/28/98	--	130	--	mg/l
Calcium	Total	9/28/98	--	130	--	mg/l
Chromium	Dissolved	9/28/98	ND	--	10	ug/l
Chromium	Total	9/28/98	ND	--	10	ug/l
Chromium	Total	9/28/98	ND	--	10	ug/l
Iron	Dissolved	9/28/98	ND	--	100	ug /l
Iron	Total	9/28/98	ND	--	100	ug/l
Iron	Total	9/28/98	ND	--	100	ug/l
Magnesium	Total	9/28/98	--	37	--	mg/l
Magnesium	Total	9/28/98	--	35	--	mg/l
Potassium	Total	9/28/98	--	4.1	--	mg/l
Potassium	Total	9/28/98	--	2.4	--	mg/l

Cienega Creek above Davidson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	REPORTING LIMIT	UNITS
Bicarbonate	Total	9/28/98	--	340	--	mg/l
Bicarbonate	Total	9/28/98	--	350	--	mg/l
pH	Total	9/28/98	--	7.51	--	mg/l
pH	Total	9/28/98	--	7.9	--	mg/l
Total Dissolved Solids	Dissolved	9/28/98	--	720	--	mg/l
Total Dissolved Solids	Dissolved	9/28/98	--	710	--	mg/l
Total Suspended Solids	Suspended	9/28/98	ND	--	4	mg/l
Total Suspended Solids	Suspended	9/28/98	--	5	--	mg/l
Turbidity	Total	9/28/98	--	0.89	--	NTU
Turbidity	Total	9/28/98	--	0.38	--	NTU
Turbidity	Total	9/28/98	--	0.24	--	NTU
Sodium	Total	9/28/98	--	65	--	mg/l
Sodium	Total	9/28/98	--	62	--	mg/l
Temperature	Total	9/28/98	--	20.12	--	mg/l
Dissolved Oxygen	Dissolved	9/28/98	--	5.4	--	mg/l
Dissolved Oxygen	Standard	9/28/98	--	65.1	--	percent
Ammonia As Nitrogen	Total	9/28/98	ND	--	0.02	mg/l
Ammonia As Nitrogen	Total	9/28/98	ND	--	0.02	mg/l
Kjeldahl Nitrogen	Total	9/28/98	--	0.09	--	mg/l
Kjeldahl Nitrogen	Total	9/28/98	--	0.092	--	mg/l
Nitrate + Nitrite	Total	9/28/98	--	0.2	--	mg/l
Nitrate + Nitrite	Total	9/28/98	--	0.16	--	mg/l
Thallium	Dissolved	9/28/98	ND	--	5	ug/l
Thallium	Total	9/28/98	ND	--	5	ug/l
Thallium	Total	9/28/98	ND	--	2	ug/l
Nickel	Dissolved	9/28/98	ND	--	100	ug/l
Nickel	Total	9/28/98	ND	--	100	ug/l
Nickel	Total	9/28/98	ND	--	100	ug/l
Flow	Standard	9/28/98	--	0.35	--	ft/sec
Flow	Total	9/28/98	--	0.34	--	CFS
Stream Width	Standard	9/28/98	--	3.1	--	FT
Stream Depth	Total	9/28/98	--	0.13	--	FT

ND= not detected

Cienega Creek above Stevenson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMITS
Boron (Boron And Borates Only)	Dissolved	9/30/98	--	120	ug/l	--
Boron (Boron And Borates Only)	Total	9/30/98	--	130	ug/l	--
Specific Conductivity	Standard	9/30/98	--	480	umhos/cm	--
Specific Conductivity	Standard	9/30/98	--	474	umhos/cm	--
Lead And Compounds (Inorganic)	Dissolved	9/30/98	--	ND	ug/l	5
Total Dissolved Solids	Dissolved	9/30/98	--	310	mg/l	--
Barium And Compounds	Dissolved	9/30/98	--	180	ug/l	--
Lead And Compounds (Inorganic)	Total	9/30/98	--	ND	ug/l	5
Dissolved Oxygen	Dissolved	9/30/98	--	6.18	mg/l	--
Barium And Compounds	Total	9/30/98	--	180	ug/l	--
Kjeldahl Nitrogen	Total	9/30/98	--	0.13	mg/l	--
Nitrate + Nitrite	Total	9/30/98	--	0.16	mg/l	--
Calcium Carbonate	Total	9/30/98	--	210	mg/l	--
Temperature	Air	9/30/98	--	28.6	° C	--
Stream Width	Standard	9/30/98	--	3.4	FT	--
Temperature	Water	9/30/98	--	18.2	° C	--
Phosphorus	Total	9/30/98	--	0.025	mg/l	--
Stream Depth	Total	9/30/98	--	0.24	FT	--
Bicarbonate	Total	9/30/98	--	260	mg/l	--
Potassium	Total	9/30/98	--	1.8	mg/l	--
Turbidity	Total	9/30/98	--	2.94	NTU	--
Magnesium	Total	9/30/98	--	8.8	mg/l	--
Fluoride	Total	9/30/98	--	0.4	mg/l	--
Turbidity	Total	9/30/98	--	1.4	NTU	--
Chloride	Total	9/30/98	--	7.6	mg/l	--
Manganese	Dissolved	9/30/98	--	ND	ug/l	50
Flow	Total	9/30/98	--	0.88	FT/SEC	--
Flow	Standard	9/30/98	--	0.92	CFS	--
Sulfate	Total	9/30/98	--	33	mg/l	--
Calcium	Total	9/30/98	--	58	mg/l	--
Nickel	Dissolved	9/30/98	--	ND	ug/l	100
Sodium	Total	9/30/98	--	46	mg/l	--
Manganese	Total	9/30/98	--	ND	ug/l	50
Nickel	Total	9/30/98	--	ND	ug/l	100
pH	Total	9/30/98	--	7.94	SU	--
Total Suspended Solids	Suspended	9/30/98	--	ND	mg/l	4

Cienega Creek above Stevenson Canyon. From ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMITS
Ammonia As Nitrogen	Total	9/30/98	--	ND	mg/l	0.02
Carbonate	Total	9/30/98	--	ND	mg/l	2
Beryllium And Compounds	Dissolved	9/30/98	--	ND	ug/l	5
Selenium And Compounds	Dissolved	9/30/98	--	ND	ug/l	5
Mercury, Elemental	Dissolved	9/30/98	--	ND	ug/l	0.5
Arsenic, Inorganic	Dissolved	9/30/98	--	ND	ug/l	10
Beryllium And Compounds	Total	9/30/98	--	ND	ug/l	5
Selenium And Compounds	Total	9/30/98	--	ND	ug/l	5
Mercury, Elemental	Total	9/30/98	--	ND	ug/l	0.5
Arsenic, Inorganic	Total	9/30/98	--	ND	ug/l	10
Chromium	Dissolved	9/30/98	--	ND	ug/l	10
Thallium	Dissolved	9/30/98	--	ND	ug/l	5
Cadmium	Dissolved	9/30/98	--	ND	ug/l	1
Copper	Dissolved	9/30/98	--	ND	ug/l	10
Silver	Dissolved	9/30/98	--	ND	ug/l	1
Iron	Dissolved	9/30/98	--	ND	ug/l	100
Zinc	Dissolved	9/30/98	--	ND	ug/l	50
Chromium	Total	9/30/98	--	ND	ug/l	10
Thallium	Total	9/30/98	--	ND	ug/l	5
Cadmium	Total	9/30/98	--	ND	ug/l	1
Copper	Total	9/30/98	--	ND	ug/l	10
Silver	Total	9/30/98	--	ND	ug/l	1
Iron	Total	9/30/98	--	ND	ug/l	100
Zinc	Total	9/30/98	--	ND	ug/l	50

ND= not detected

Chemical Constituents in Water at Quitobaquito, Arizona. From Description and Conservation Status of *Cyprinodan macularius eremus*. A New Subspecies of Pupfish from Organ pipe Cactus National Monument, Arizona. Miller and Fuiman, 1987.

*Parameter	Quitobaquito Pond, 1982,	Quitobaquito Pond, 1963,1964	Quitobaquito Spring, 1982	Quitobaquito Spring, 1963-64
TDS	820		670	
TSS	<10		<10	
pH	9.22		8.07	
HCO3	220	411	300	316-402
F	4.9	5.3	4.1	4.3
Cl	190	383	150	148-318
PO4	<0.50		<0.50	
NO3	<0.50		9.9	
SO4	110	100	95	71-91
Na	230	350	188	191-284
K	3.1	7.0	2.7	4.5-6.0

No units were included in the journal article for this data, convention is mg/l for these parameters except pH, which is in standard units.

Sabino Creek below Summerhaven. Data from ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Specific Conductivity	Standard	3/17/92	--	111	umhos/cm	--
Total Dissolved Solids	Dissolved	3/17/92	--	94	mg/l	--
Total Suspended Solids	Suspended	3/17/92	--	6	mg/l	--
Fecal Streptococci	Total	3/17/92	--	2	CFU/100	--
Calcium Carbonate	Total	3/17/92	--	38	mg/l	--
Fecal Coliform	Total	3/17/92	K	2	CFU/100	--
Temperature	Water	3/17/92	--	3.0	°C	--
Bicarbonate	Total	3/17/92	--	46	mg/l	--
Potassium	Total	3/17/92	--	1.23	mg/l	--
Magnesium	Total	3/17/92	--	2.5	mg/l	--
Chloride	Total	3/17/92	--	4.6	mg/l	--
Turbidity	Total	3/17/92	--	8.5	NTU	--
Calcium	Total	3/17/92	--	13.4	mg/l	--
Manganese	Total	3/17/92	--	70	ug/l	--
Carbonate	Total	3/17/92	--	1	mg/l	--
Sodium	Total	3/17/92	--	5	mg/l	--
Iron	Total	3/17/92	--	590	ug/l	--
pH	Total	3/17/92	--	7.36	SU	--
Alkalinity, Phenolphthalein	Total	3/17/92	--	ND	mg/l	2
Kjeldahl Nitrogen	Total	3/17/92	--	0.19	mg/l	--
Ammonia As N	Total	3/17/92	--	ND	mg/l	0.1
Nitrate + Nitrite	Total	3/17/92	--	ND	mg/l	0.1
Phosphorus	Total	3/17/92	--	ND	mg/l	0.1
Fluoride	Total	3/17/92	--	ND	mg/l	0.2
Sulfate	Total	3/17/92	--	ND	mg/l	10

Sabino Creek below Summerhaven. Data from ADEQ

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Borates Only)						
Lead And Compounds	Total	3/17/92	--	ND	ug/l	10
Beryllium And Compounds	Total	3/17/92	--	ND	ug/l	0.5
Barium And Compounds	Total	3/17/92	--	ND	ug/l	100
Selenium And Compounds	Total	3/17/92	--	ND	ug/l	5
Mercury, Elemental	Total	3/17/92	--	ND	ug/l	0.5
Arsenic, Inorganic	Total	3/17/92	--	ND	ug/l	10
Strontium	Total	3/17/92	--	ND	ug/l	100
Chromium	Total	3/17/92	--	ND	ug/l	10
Antimony	Total	3/17/92	--	ND	ug/l	5
Thallium	Total	3/17/92	--	ND	ug/l	5
Nickel	Total	3/17/92	--	ND	ug/l	100
Cadmium	Total	3/17/92	--	ND	ug/l	1
Copper	Total	3/17/92	--	ND	ug/l	10
Silver	Total	3/17/92	--	ND	ug/l	1
Zinc	Total	3/17/92	--	ND	ug/l	50

ND= not detected, K= Actual value is known to be less than the value given

Water Quality Data for Sabino Canyon, Site # SCSAB004.39, In Recreation Area. From ADEQ

PARAMETER	SAMPLE DATE	RESULT	UNITS	DATA CODE	REPORTING LIMITS
Stream Width	04/18/01	39.7	FT		
Temperature, water	04/18/01	15.4	° C		
Flow, Stream instantaneous	04/18/01	29.53	CFS		
Depth of stream (mean)	04/18/01	1.33	FT		
Specific Conductance, Field	04/18/01	53	umhos/cm		
Specific Conductance	04/18/01	56	umhos/cm		
Oxygen Dissolved %	04/18/01	96.7	percent		
pH, FIELD	04/18/01	6.9	SU		
Alkalinity, Total (mg/l as CaCO3)	04/18/01	13	mg/l		
Bicarbonate ion	04/18/01	16	mg/l		
Carbonate ion	04/18/01		mg/l	ND	2.0
Nitrogen, Ammonia, Total	04/18/01		mg/l	ND	0.020

Water Quality Data for Sabino Canyon, Site # SCSAB004.39, In Recreation Area. From ADEQ

PARAMETER	SAMPLE DATE	RESULT	UNITS	DATA CODE	REPORTING LIMITS
Nitrite, Nitrogen, Total	04/18/01		mg/l	ND	0.050
Nitrate, Nitrogen, Total	04/18/01	0.061	mg/l		
Nitrite+Nitrate, Total	04/18/01	0.061	mg/l		
Phosphorous, Total	04/18/01		mg/l	ND	0.020
Hardness, Total as mg/l CaCO3	04/18/01	18	mg/l		
Calcium, Total	04/18/01	5.3	mg/l		
Sodium, Total	04/18/01		mg/l	ND	5.0
Potassium, Total	04/18/01	0.71	mg/l		
Chloride in water, Total	04/18/01	3.4	mg/l		
Sulfate, Total	04/18/01	4	mg/l		
Arsenic Dissolved	04/18/01		ug/l	ND	10
Arsenic, Total	04/18/01		ug/l	ND	10
Barium, Dissolved	04/18/01		ug/l	ND	100
Barium, Total	04/18/01		ug/l	ND	100
Beryllium, Total	04/18/01		ug/l	ND	0.50
Boron, Total	04/18/01		ug/l	ND	100
Cadmium, Dissolved	04/18/01		ug/l	ND	1.0
Cadmium, Total	04/18/01		ug/l	ND	1.0
Chromium, Total	04/18/01		ug/l	ND	10
Copper, Dissolved	04/18/01		ug/l	ND	10
Copper, Total	04/18/01		ug/l	ND	10
Iron, Total	04/18/01	260	ug/l		
Lead, Total	04/18/01		ug/l	ND	5.0
Manganese, Total	04/18/01		ug/l	ND	50
Thallium, Total	04/18/01		ug/l	ND	2.0
Silver, Dissolved	04/18/01		ug/l	ND	1.0
Silver, Total	04/18/01		ug/l	ND	1.0
Zinc, Dissolved	04/18/01		ug/l	ND	50
Zinc, Total	04/18/01		ug/l	ND	50
Antimony, Total	04/18/01		ug/l	ND	5.0
Selenium, Dissolved	04/18/01		ug/l	ND	5.0
Selenium, total	04/18/01		ug/l	ND	5.0
Hardness, Ca, Mg Calculated (mg/l as CaCO3)	04/18/01	19	mg/l		
TDS (Elect-Conductivity)	04/18/01	33.7	mg/l		
Mercury, Dissolved	04/18/01		ug/l	ND	0.50
Turbidity, Field, NTU	04/18/01	3.44	NTU		

ND= not detected

San Pedro River Water Quality Data From PAG Report---Bingham Cienega Source Water

San Pedro River	11/23/1998	03/19/1999	06/15/1999	09/10/1999	11/20/1999	03/30/2000	06/09/2000
Silicon, dissolved	14	13	13	13	12	15	15
Aluminum, dissolved	0	0	0	0	0	--	--
Calcium , dissolved	65	74	52	55	73	58	68
Magnesium, dissolved	15	17	14	16	16	16	15
Manganese, dissolved	0	0.01	0	0	0	0	0
Potassium , dissolved	0	4.6	0	6.6	4	0	0
Sodium , dissolved	50	56	51	56	56	56	60
Arsenic , dissolved	0.0054	0.005	0	0.005	0	0	0
Chloride, dissolved	15	--	17.2	19	19	18	17
Sulfate, dissolved	81.8	89.8	92.5	99	100	83	85
Fluoride , dissolved	0.8	--	--	0.8	1	1	1
Alk. as CaCO3	230	224	212	180	250	230	230
Lab TDS	370	370	390	300	340	250	390
Lab Conductivity	590	630	620	670	630	610	680
Lab pH	8.2	8.6	7.9	8	8	8	8

All results are in mg/l except pH (su) and conductivity (mmhos).

Water Quality Data for San Pedro River Near Redington. From ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMITS
Boron (Boron And Borates Only)	Total	8/13/91	K	100	ug/l	--
Lead And Compounds (Inorganic)	Total	8/13/91	--	5	ug/l	--
Specific Conductivity	Standard	8/13/91	--	550	umhos/cm	--
Specific Conductivity	Standard	8/13/91	--	590	umhos/cm	--
Alkalinity, Phenolphthalein	Total	8/13/91	--	0.5	mg/l	--
Total Dissolved Solids	Dissolved	8/13/91	--	340	mg/l	--
Total Suspended Solids	Suspended	8/13/91	--	80	mg/l	--
Dissolved Oxygen	Standard	8/13/91	--	109.9	percent	--
Dissolved Oxygen	Dissolved	8/13/91	--	7.20	mg/l	--
Fecal Streptococci	Total	8/13/91	--	128	CFU/100	--
Beryllium And Compounds	Total	8/13/91	K	5	ug/l	--
Ammonia As Nitrogen	Total	8/13/91	K	0.03	mg/l	--
Selenium And Compounds	Total	8/13/91	K	5	ug/l	--
Barium and Compounds	Total	8/13/91	--	99	ug/l	--
Nitrate + Nitrite	Total	8/13/91	--	0.40	mg/l	--
Mercury, Elemental	Total	8/13/91	K	0.2	ug/l	--
Kjeldahl Nitrogen	Total	8/13/91	--	0.3	mg/l	--
Calcium Carbonate	Total	8/13/91	--	183	mg/l	--
Temperature	Standard	8/13/91	--	33.0	° C	--

Water Quality Data for San Pedro River Near Redington. From ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMITS
Fecal Coliform	Total	8/13/91	--	60	CFU/100	--
Arsenic, Inorganic	Total	8/13/91	K	5	ug/l	--
Stream Width	Standard	8/13/91	--	16.7	FT	--
Temperature	Total	8/13/91	--	32.0	° C	--
Phosphorus	Total	8/13/91	--	0.09	mg/l	--
Stream Depth	Total	8/13/91	--	0.24	FT	--
Bicarbonate	Total	8/13/91	--	183	mg/l	--
Magnesium	Total	8/13/91	--	12.9	mg/l	--
Carbonate	Total	8/13/91	--	0.5	mg/l	--
Hydroxide	Total	8/13/91	--	0.5	mg/l	--
Fluoride	Total	8/13/91	--	0.82	mg/l	--
Potassium	Total	8/13/91	--	4.4	mg/l	--
Strontium	Total	8/13/91	--	600	ug/l	--
Calcium	Total	8/13/91	--	57.4	mg/l	--
Manganese	Total	8/13/91	--	77	ug/l	--
Flow	Total	8/13/91	--	1.11	FT/SEC	--
Flow	Standard	8/13/91	--	4.60	CFS	--
Chloride	Total	8/13/91	--	15	mg/l	--
Turbidity	Total	8/13/91	--	37	NTU	--
Sodium	Total	8/13/91	--	46.0	mg/l	--
Chromium	Total	8/13/91	K	10	ug/l	--
Antimony	Total	8/13/91	K	50	ug/l	--
Sulfate	Total	8/13/91	--	87	mg/l	--
Thallium	Total	8/13/91	K	5	ug/l	--
Iron	Total	8/13/91	--	2160	ug/l	--
Cadmium	Total	8/13/91	K	5	ug/l	--
Copper	Total	8/13/91	K	10	ug/l	--
Silver	Total	8/13/91	K	10	ug/l	--
Nickel	Total	8/13/91	K	20	ug/l	--
Zinc	Total	8/13/91	--	14	ug/l	--
Ph- field	Total	8/13/91	--	8.40	SU	--
Ph-lab	Total	8/13/91	--	8.2	SU	--

K= Actual value is known to be less than value given, method detection limit is listed in result column.

Nutrient Parameters from the Santa Cruz River at Cortaro Road, 1997 From USGS on-line database.

Parameter	Dates sampled	Result Range
Nitrogen, Ammonia, Dissolved	2/22/96-1/16/97	1.0-34.0 mg/l
Nitrite, Dissolved	2/22/96-1/16/97	0.7-0.98 mg/l
Nitrogen Ammonia + organic dissolved	2/22/96-1/16/97	20-38 mg/l
Nitrogen Ammonia + organic, total	2/22/96-1/16/97	22-38 mg/l

Nutrient Parameters from the Santa Cruz River at Cortaro Road, 1997 From USGS on-line database.

Parameter	Dates sampled	Result Range
Nitrite + Nitrate, Dissolved	2/22/96-1/16/97	0.09-1.5 mg/l
Phosphorous, Total	2/22/96-1/16/97	3.4-5.2 mg/l
Phosphorous, Dissolved	2/22/96-1/16/97	2.8-4.2 mg/l

Total number of sampling events: 12

Major ions from the Santa Cruz River at Cortaro Road, 1997 From USGS on-line database.

Parameter	Sample Date Range	Result Range
Bicarbonate, Dissolved, Field	2/22/96—1/16/97	268—340 mg/l
Calcium, Dissolved	2/22/96—1/16/97	40—46 mg/l
Magnesium, Dissolved	2/22/96—1/16/97	5.5—6.8 mg/l
Sodium, Dissolved	2/22/96—1/16/97	100—120 mg/l
Potassium, Dissolved	2/22/96—1/16/97	13—15 mg/l
Chloride, Dissolved	2/22/96—1/16/97	76—95 mg/l
Sulfate, Dissolved	2/22/96—1/16/97	82—110 mg/l
Fluoride, Dissolved	2/22/96—1/16/97	0.5—1.0 mg/l
Silica, Dissolved	2/22/96—1/16/97	34—38 mg/l

Total number of sampling events: 12

Summary of Dissolved Oxygen Field Measurements in the Santa Cruz River. Data from Pima County Wastewater Management Department, 2001.

Sample Location	Sample Date	# of Miles downstream from Roger Rd WWTP	# of Miles downstream from Ina Road WPCF	Dissolved Oxygen (mg/l)
SC-01	1/24/01	0.60	--	5.36
	8/13/01			5.47
SC-02	2/28/01	2.93	--	8.43
	8/13/01			4.83
SC-03	1/24/01	5.93	0.08	7.49
	2/28/01			10.13
	8/13/01			5.18
SC-04	8/13/01	7.70	1.85	3.28
SC-05	1/24/01	8.94	3.09	5.36
	8/14/01			4.83
SC-06	8/14/01	10.02	4.17	5.05
SC-07	1/24/01	12.11	6.26	6.81
	8/17/01			4.56
SC-08	2/13/01	13.23	7.38	6.58
	5/10/01			7.08

Summary of Dissolved Oxygen Field Measurements in the Santa Cruz River. Data from Pima County Wastewater Management Department, 2001.

Sample Location	Sample Date	# of Miles downstream from Roger Rd WWTP	# of Miles downstream from Ina Road WPCF	Dissolved Oxygen (mg/l)
	8/16/01			4.31
SC-09	2/13/01	16.65	10.80	6.73
	5/10/01			8.99
	8/16/01			8.51
SC-10	2/13/01	17.93	12.08	7.92
	5/10/01			8.97
	8/16/01			7.88

Note: Samples are collected as a grab sample from a free flow portion of the stream. Each sample location is adjacent to groundwater monitor well locations.

Physical Properties of water in the Santa Cruz River at Cortaro Road, USGS on-line database.

Parameter	Sample Date Range	Result Range
Temperature, Water	2/22/96—1/16/97	17.5—29.7 °C
Specific Conductance	2/22/96—1/16/97	956—1063 µmhos/cm
Oxygen, Dissolved	2/22/96—1/16/97	2.0—3.7 mg/l
pH, Field	2/22/96—1/16/97	7.4—7.8
Alkalinity	2/22/96—1/16/97	220—279

Number of sampling events: 12

Santa Cruz River at Cortaro Road, Water Quality. Data from ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Boron (Boron And Borates Only)	Dissolved	9/22/93	--	340	ug/l	--
Boron (Boron And Borates Only)	Total	9/22/93	--	390	ug/l	--
Specific Conductivity	Standard	9/22/93	--	1130	umhos/cm	--
Specific Conductivity	Standard	9/22/93	--	124	umhos/cm	--
Total Dissolved Solids	Dissolved	9/22/93	--	713	mg/l	--
Total Suspended Solids	Suspended	9/22/93	--	29	mg/l	--
Dissolved Oxygen	Standard	9/22/93	--	50.0	percent	--
Dissolved Oxygen	Dissolved	9/22/93	--	4.01	mg/l	--
Ammonia As Nitrogen	Total	9/22/93	--	16.4	mg/l	--
Nitrate + Nitrite	Total	9/22/93	--	1.16	mg/l	--
Kjeldahl Nitrogen	Total	9/22/93	--	21.1	mg/l	--
Calcium Carbonate	Total	9/22/93	--	204	mg/l	--

Santa Cruz River at Cortaro Road, Water Quality. Data from ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Calcium Carbonate	Total	9/22/93	--	204	mg/l	--
Stream Width	Standard	9/22/93	--	15.7	FT	--
Temperature	Air	9/22/93	--	22	° C	--
Strontium	Dissolved	9/22/93	--	660	ug/l	--
Manganese	Dissolved	9/22/93	--	50	ug/l	--
Phosphorus	Total	9/22/93	--	4.97	mg/l	--
Temperature	Water	9/22/93	--	22	° C	--
Bicarbonate	Total	9/22/93	--	249	mg/l	--
Stream Depth	Total	9/22/93	--	0.5	FT	--
Potassium	Total	9/22/93	--	16.9	mg/l	--
Magnesium	Total	9/22/93	--	18.1	mg/l	--
Fluoride	Total	9/22/93	--	0.52	mg/l	--
Turbidity	Total	9/22/93	--	13.8	NTU	--
Turbidity	Total	9/22/93	--	19.3	NTU	--
Strontium	Total	9/22/93	--	640	ug/l	--
Flow	Standard	9/22/93	--	18.88	CFS	--
Calcium	Total	9/22/93	--	58.3	mg/l	--
Manganese	Total	9/22/93	--	70	ug/l	--
Iron	Dissolved	9/22/93	--	100	ug/l	--
Chloride	Total	9/22/93	--	121	mg/l	--
Flow	Total	9/22/93	--	2.25	FT/SEC	--
Sulfate	Total	9/22/93	--	209	mg/l	--
Sodium	Total	9/22/93	--	148	mg/l	--
Silver	Total	9/22/93	--	1	ug/l	--
Copper	Total	9/22/93	--	17	ug/l	--
Iron	Total	9/22/93	--	460	ug/l	--
Zinc	Total	9/22/93	--	70	ug/l	--
pH	Total	9/22/93	--	7.38	SU	--
pH	Total	9/22/93	--	7.79	SU	--
Alkalinity, Phenolphthalein	Total	9/22/93	--	ND	mg/l	2
Carbonate	Total	9/22/93	--	ND	mg/l	2
Lead And Compounds (Inorganic)	Dissolved	9/22/93	--	ND	ug/l	5
Lead And Compounds (Inorganic)	Total	9/22/93	--	ND	ug/l	5
Beryllium And Compounds	Dissolved	9/22/93	--	ND	ug/l	0.5
Barium And Compounds	Dissolved	9/22/93	--	ND	ug/l	100
Selenium And Compounds	Dissolved	9/22/93	--	ND	ug/l	5
Beryllium And Compounds	Total	9/22/93	--	ND	ug/l	0.5
Mercury, Elemental	Dissolved	9/22/93	--	ND	ug/l	0.5
Arsenic, Inorganic	Dissolved	9/22/93	--	ND	ug/l	10
Barium And Compounds	Total	9/22/93	--	ND	ug/l	100
Selenium AndCompounds	Total	9/22/93	--	ND	ug/l	5
Mercury, Elemental	Total	9/22/93	--	ND	ug/l	0.5
Arsenic, Inorganic	Total	9/22/93	--	ND	ug/l	10
Chromium	Dissolved	9/22/93	--	ND	ug/l	10
Antimony	Dissolved	9/22/93	--	ND	ug/l	5

Santa Cruz River at Cortaro Road, Water Quality. Data from ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Thallium	Dissolved	9/22/93	--	ND	ug/l	5
Nickel	Dissolved	9/22/93	--	ND	ug/l	100
Cadmium	Dissolved	9/22/93	--	ND	ug/l	1
Copper	Dissolved	9/22/93	--	ND	ug/l	10
Silver	Dissolved	9/22/93	--	ND	ug/l	1
Zinc	Dissolved	9/22/93	--	ND	ug/l	50
Chromium	Total	9/22/93	--	ND	ug/l	10
Antimony	Total	9/22/93	--	ND	ug/l	5
Thallium	Total	9/22/93	--	ND	ug/l	5
Nickel	Total	9/22/93	--	ND	ug/l	100
Cadmium	Total	9/22/93	--	ND	ug/l	1

ND= not detected

Tanque Verde Creek at Sabino Canyon Road. From ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Specific Conductivity	Standard	8/1/89	--	99.9	umhos/cm	--
Boron (Boron And Borates Only)	Total	8/1/89	K	100	ug/l	--
Specific Conductivity	Standard	8/1/89	--	110	umhos/cm	--
Alkalinity, Phenolphthalein	Total	8/1/89	--	0.5	mg/l	--
Lead And Compounds (Inorganic)	Total	8/1/89	K	2	ug/l	--
Total Dissolved Solids	Dissolved	8/1/89	--	90	mg/l	--
Total Suspended Solids	Suspended	8/1/89	--	5	mg/l	--
Dissolved Oxygen	Standard	8/1/89	--	95.9	percent	--
Ammonia As Nitrogen	Total	8/1/89	--	0.25	mg/l	--
Beryllium And Compounds	Total	8/1/89	K	5	ug/l	--
Dissolved Oxygen	Dissolved	8/1/89	--	6.6	mg/l	--
Selenium And Compounds	Total	8/1/89	K	5	ug/l	--
Barium And Compounds	Total	8/1/89	K	20	ug/l	--
Nitrate + Nitrite	Total	8/1/89	K	0.06	mg/l	--
Mercury, Elemental	Total	8/1/89	K	0.2	ug/l	--
Kjeldahl Nitrogen	Total	8/1/89	--	0.5	mg/l	--
Calcium Carbonate	Total	8/1/89	--	32	mg/l	--
Arsenic, Inorganic	Total	8/1/89	K	5	ug/l	--
Temperature	Total	8/1/89	--	30.5	°C	--
Stream Width	Standard	8/1/89	--	22	FT	--
Phosphorus	Total	8/1/89	--	0.12	mg/l	--
Stream Depth	Total	8/1/89	--	0.31	FT	--
Bicarbonate	Total	8/1/89	--	32	mg/l	--

Tanque Verde Creek at Sabino Canyon Road. From ADEQ.

PARAMETER	TYPE OF SAMPLE	SAMPLE DATE	DATA CODE	RESULT	UNITS	REPORTING LIMIT
Fluoride	Total	8/1/89	--	0.12	mg/l	--
Carbonate	Total	8/1/89	--	0.5	mg/l	--
Hydroxide	Total	8/1/89	--	0.5	mg/l	--
Magnesium	Total	8/1/89	--	1.8	mg/l	--
Potassium	Total	8/1/89	--	2.1	mg/l	--
Chloride	Total	8/1/89	--	3.7	mg/l	--
Turbidity	Total	8/1/89	--	4.8	NTU	--
Manganese	Total	8/1/89	--	11	ug/l	--
Calcium	Total	8/1/89	--	11.2	mg/l	--
Strontium	Total	8/1/89	--	70	ug/l	--
Flow	Total	8/1/89	--	0.94	FT/SEC	--
Flow	Standard	8/1/89	--	6.26	CFS	--
Sodium	Total	8/1/89	--	6.6	mg/l	--
Antimony	Total	8/1/89	K	10	UG/L	--
Sulfate	Total	8/1/89	--	13	MG/L	--
Chromium	Total	8/1/89	K	20	UG/L	--
Cadmium	Total	8/1/89	--	5	UG/L	--
Thallium	Total	8/1/89	K	5	UG/L	--
Copper	Total	8/1/89	K	10	UG/L	--
Silver	Total	8/1/89	K	10	UG/L	--
Nickel	Total	8/1/89	K	30	UG/L	--
Iron	Total	8/1/89	--	204	UG/L	--
Zinc	Total	8/1/89	--	18	UG/L	--
pH	Total	8/1/89	--	7.6	SU	--
pH	Total	8/1/89	--	8.4	SU	--

K= Actual value is known to be less than the value given, method detection limit is listed in the result column.

Nutrient Parameters from the Tanque Verde Creek. From USGS on-line database.

Parameter	Dates sampled	Result Range
Nitrogen, Ammonia, Dissolved	1/5/1991-9/3/1994	0.01-.5
Nitrite, Dissolved	1/5/1991-9/3/1994	<0.01-0.02
Nitrogen Ammonia + organic, total	1/5/1991-9/3/1994	0.2-1.1
Nitrite + Nitrate, Dissolved	1/5/1991-9/3/1994	0.077-0.37
Phosphorous, Total	1/5/1991-9/3/1994	0.02-0.59
Phosphorous, Dissolved	1/5/1991-9/3/1994	<0.01-0.29

Total number of sampling events: 7

Major ions from the Tanque Verde Creek. From USGS on-line database.

Parameter	Sample Date Range	Result Range
Bicarbonate, Dissolved, Field	7/7/1990-9/3/94	15-68
Calcium, Dissolved	7/7/1990-9/3/94	4.3-25
Magnesium, Dissolved	7/7/1990-9/3/94	1.0-4.6
Sodium, Dissolved	7/7/1990-9/3/94	4.1-10
Potassium, Dissolved	7/7/1990-9/3/94	0.7-6.5
Chloride, Dissolved	7/7/1990-9/3/94	2.1-7.2
Sulfate, Dissolved	7/7/1990-9/3/94	4.5-13
Fluoride, Dissolved	7/7/1990-9/3/94	<0.1-.2
Silica, Dissolved	7/7/1990-9/3/94	6.3-15

Total number of sampling events: 12

Physical Properties of water in the Tanque Verde Creek. From USGS on-line database.

Parameter	Sample Date Range	Result Range
Temperature, Water	7/7/1990-9/3/1994	9.0-23.5
Specific Conductance	7/7/1990-9/3/1994	47-290
Turbidity	7/7/1990-9/3/1994	5.2-1200
pH, Field	7/7/1990-9/3/1994	6.2-8.55
Alkalinity, total	7/7/1990-9/3/1994	12-56

Total number of sampling events: 13