Total Maximum Daily Load For:
Oak Creek- Headwaters to the Verde River
Verde River- Oak Creek to Fossil Creek
Salt River- headwaters to Roosevelt Lake

Parameters: Phosphorous and Nitrogen

September 1987

Open File Report 09-06

NOTE: Since initial publication the contact information has been updated. For more information please contact:

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United States
Environmental Protection
Agency

Regional Administrator
215 Fremont Street
San Francisco CA 94105

Region 9
Arizona, California
Hawaii, Nevada
Pacific Islands

EPA

September 30, 1987

Dr. Gerald Teletzke, Director
Arizona Department of Environmental Quality
2005 N. Central Ave.
Phoenix, AZ 85004

In Reply
Refer to: W-4-2

Dear Dr. Teletzke:

The U.S. Environmental Protection Agency, Region 9 has reviewed Arizona's submission of total allowable daily loadings for the following three stream segments in Arizona:

Oak Creek from headwaters to the Verde River
Verde River from Oak Creek to Fossil Creek
Salt River from headwaters to Roosevelt Lake

Based upon EPA's review of the state's submission, we approve your submission as Total Maximum Daily Loads (TMDLs) pursuant to Section 303(d) of the Clean Water Act. This approval is based upon our determination that these TMDLs are consistent with the purposes of the Clean Water Act and that they implement the applicable water quality standards.

During our review and verification of the TMDLs, the following activities were identified which will require future attention:

1. The State's list of Water Quality Limited (WQL) segments needs to be updated and prioritized. A schedule for developing and updating the TMDLs and Waste Load Allocations/Load Allocations (WLAs/LAs) should also be included.

2. Additional monitoring is necessary to support future TMDL and WLA/LA development and updates. Intensive surveys and more representative flow data for the WQL segments are especially important.

3. The updated procedures for developing TMDLs and WLAs/LAs should be included in the State's revised Continuing Planning Process, due January 1988.

EPA looks forward to working with the State to address future development of TMDLs and WLAs/LAs in Arizona. We all recognize how important these evaluations are to the very important goal of protecting the environment.

Sincerely,

JUDITH E. AYRES
Regional Administrator

cc: Dr. Ron Miller, Office of Water
Jack Bale, Water Assessment Section

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

29 SEP 1987

SUBJECT: Administrative Record for Arizona's Total Maximum Daily Loads and Waste Load Allocations/Load Allocations

FROM: Audrey V. Shileikis, Arizona Project Officer
Lois Epstein, Environmental Engineer
Jacques Landy, Environmental Engineer

TO: File

Introduction

Pursuant to §303(d) of the Clean Water Act (CWA), Arizona is required to establish and document Total Maximum Daily Loads (TMDLs) for its Water Quality Limited (WQL) lake and river segments. WQL segments are those waterbodies that do not meet applicable ambient state and/or federal water quality standards or will not meet such standards after implementation of technology-based effluent limits (CWA §303(d)(1)(A)). TMDLs set load levels that enable WQL segments to comply with water quality standards. Arizona has identified its WQL segments (Appendix A) and submitted to EPA for approval TMDLs for three segments, listed in Table 1. We recommend approval of these TMDLs, submitted to EPA on September 25, 1987 (see Attachment 1). Table 2 lists WQL segments that still require TMDL development or public review prior to submittal of TMDL values to EPA for approval.

This paper is in support of EPA's approval of the TMDLs submitted by Arizona for the three segments in Table 1. The TMDL calculation process used by EPA verifies the values developed by Arizona, because the latter's values are more protective of water quality. All TMDL values submitted by Arizona are based on state water quality standards.

EPA has reviewed existing Waste Load Allocations (WLAs) for the known point sources and has developed estimated Load Allocations (LAs) for the non-point sources along the submitted WQL segments. By calculating WLAs from permitted load limits, EPA was able to ensure that total allowable loads do not exceed their corresponding TMDLs, thus further verifying that submitted TMDLs are protective of water quality.

Methodology

The state's process for TMDL and WLA/LA development is described in their Continuing Planning Process (CPP) document, in accordance with the requirements of 40 CFR 130.7(a). This section describes the steps involved in EPA's verification of Arizona's TMDLs: 1) WQL segment identification, 2) Selection of appropriate water quality model(s), 3) Data collection, 4) TMDL and WLA/LA calculations.

Appendix B lists the references used as guidance and data sources for EPA's review and verification of state TMDLs.

TABLE 1

AZ WQL SEGMENTS WITH TMDLs

Segment	Violated Standards or Threatened Violations	TMDL[1] (kg/day)
Verde River from Oak Creek to Fossil Creek	Phosphorus	11.0
	Nitrogen	54.8
Oak Creek and tributaries to headwaters	Phosphorus	10.9
	Nitrogen	55.5
	Bacteria	--
Salt River and tributaries from headwaters to Roosevelt Lake[2,3]	Phosphorus	148.0
	Nitrogen[4]	--
	Sediments	--

1 TMDLs for bacteria and sediments are not being submitted to EPA. The reasons described on pages 6-7, in the section entitled "Selection of Appropriate Water Quality Model(s)," may be used in support of non-submittal.

2 The phosphorus TMDL for this segment is based on a state-adopted, EPA-approved standard that is less stringent than the federal standard. EPA has not yet withdrawn its federally-promulgated standard.

3 Pinal Creek, a Salt River tributary, is limited for pH, trace metals, and bacteria. TMDLs for these parameters are not addressed in this document.

4 TMDL has not gone through public review and therefore was not submitted for EPA approval at this time.

Sources for WQL Segment List and for Violated Standards or Threatened Violations:

1. January 13, 1987 correspondence from William Blackman, ADHS, to Fred Leif, EPA.
2. CWA §305(b) Reports for 1980-1985.

TABLE 2

SEGMENTS NEEDING FUTURE TMDL DEVELOPMENT

Watson Lake

Luna Lake

Apache, Canyon, Saguaro, and Theodore Roosevelt Lakes

Horseshoe and Bartlett Reservoirs

Willow Creek and Tributaries (Verde Basin)

Bitter Creek

Verde River from Sullivan Lake to Clarkdale

Verde River from Clarkdale to Oak Creek

East Verde River from headwaters to confluence with Verde River

Verde River from Camp Verde to Horseshoe Reservoir

Verde River from Horseshoe Reservoir to Bartlett Reservoir

Boulder Creek from Wilder Creek to confluence with Burro Creek

Colorado River from Imperial Dam to Southerly International Boundary

Sabino Creek

San Francisco River and tributaries from headwaters to Luna Lake

Salt River from Roosevelt Lake to confluence with Verde River

Pinal Creek and tributaries to headwaters

Puerco River from AZ-NM border to confluence with Little Colorado River

Little Colorado River from Puerco River to confluence with Colorado River

Nutrioso Creek

Show Low Creek and tributaries to headwaters

Silver Creek

Rio de Flag

Little Colorado River above Lyman Lake to Amity Ditch Diversion near AZ Highway 273

Little Colorado River at Apache County Road 124 Crossing

Little Colorado River above River Reservoir in Greer, South Fork above South Fork Campground, Water Canyon Creek above National Forest Boundary

FIGURE 1

MAP OF VERDE RIVER BASIN WQL SEGMENTS

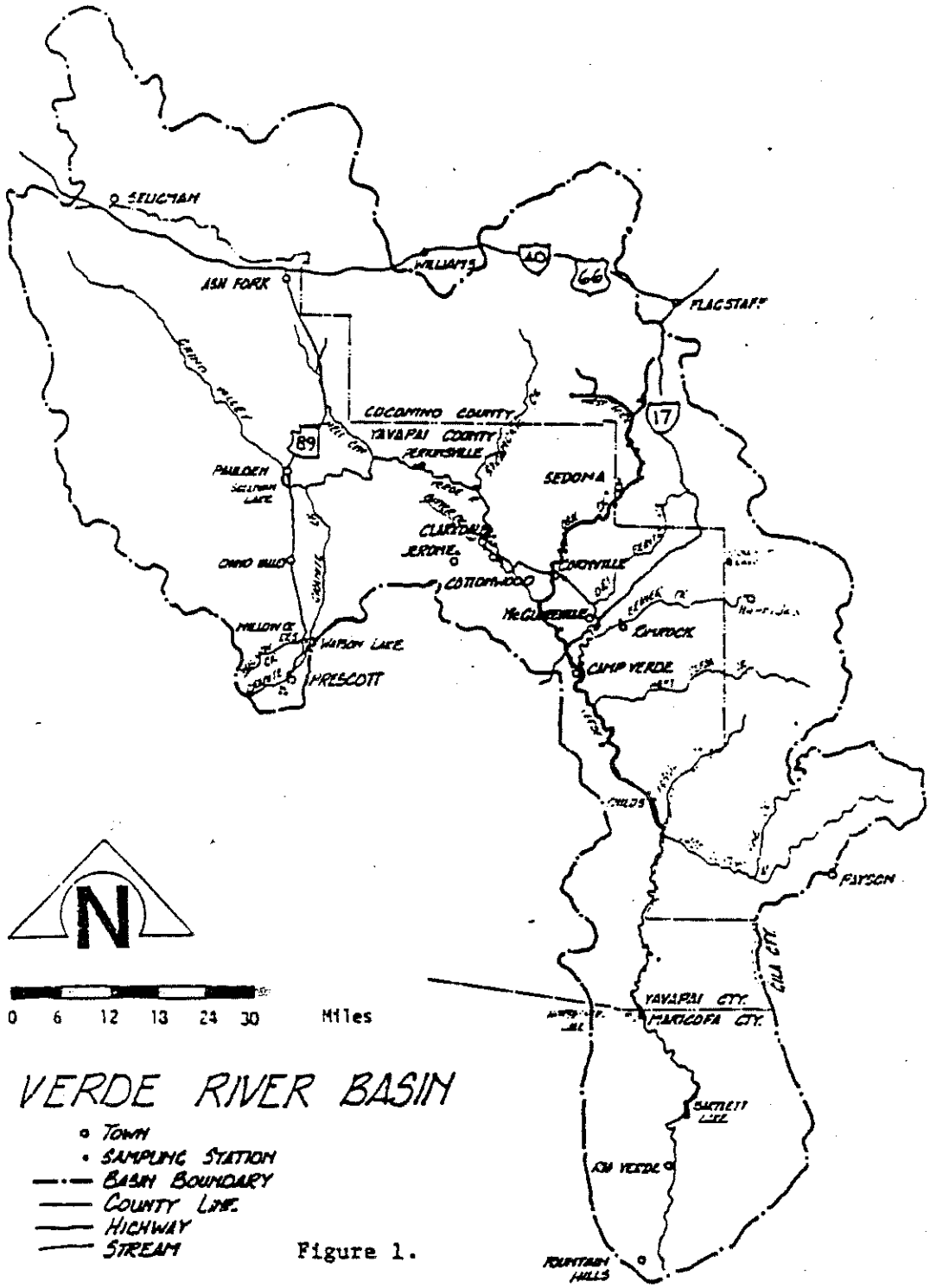
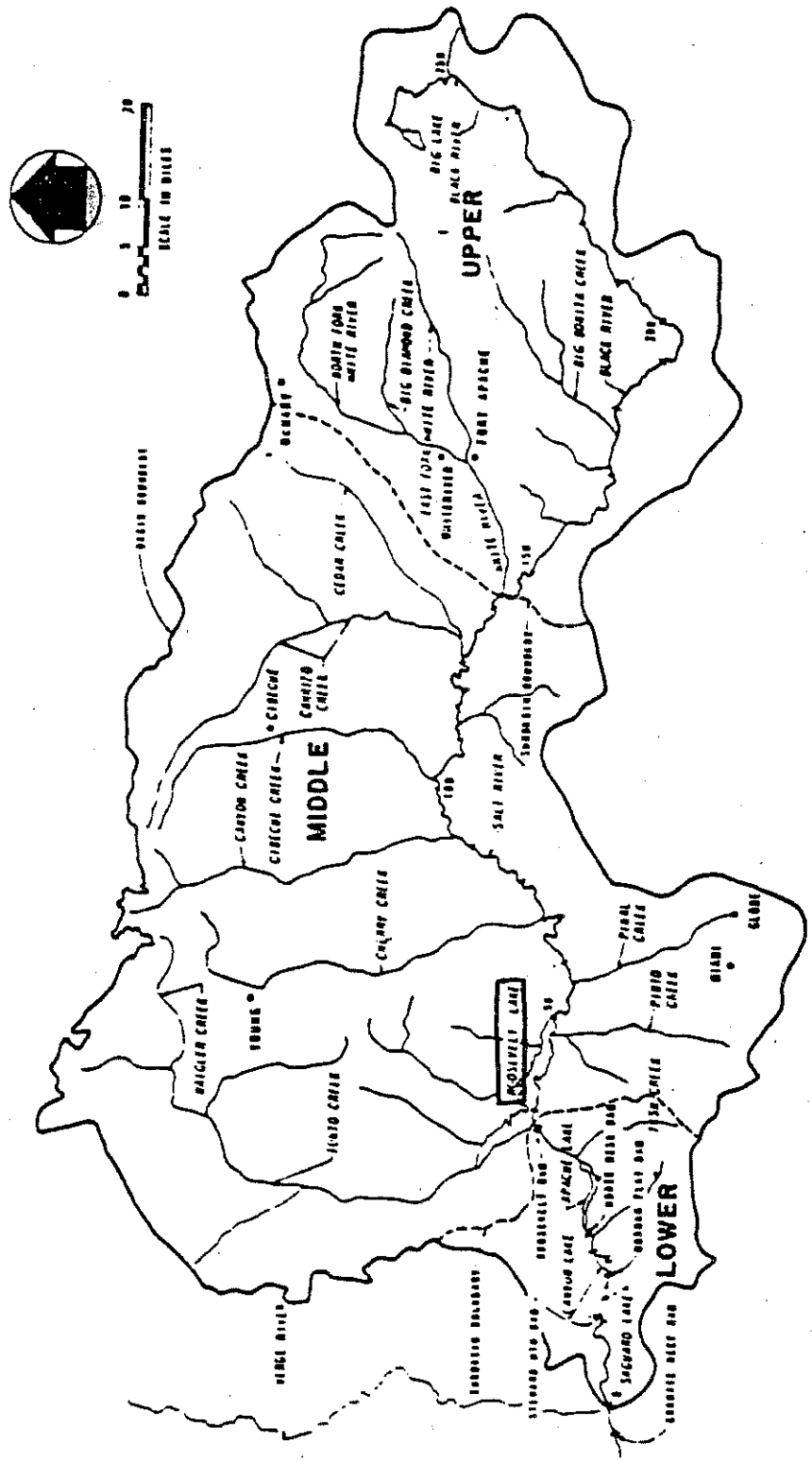


Figure 1.

"From NACOG, 1979A"

FIGURE 2

MAP OF SALT RIVER WQL SEGMENT



1. WQL Segment Identification. Arizona's Department of Environmental Quality (ADEQ) identified 20 WQL segments in the state, through the end of Water Year 1986. EPA refined these segments in four ways during the TMDL verification process: 1) All lake and river reaches were divided into separate WQL segments for chemical/biological fate and transport modelling purposes; 2) The WQL segments with named reaches were correlated with segments listed in the state's water quality standards, Section R9-21, Article 2; 3) Bitter Creek was added to the WQL segment list, based on a literature review of past and present state water quality standards violations; and 4) Pinal Creek was added to the WQL segment list because additional load analyses are needed to address its localized water quality problems. Together, these refinements resulted in a list of 29 segments requiring load analyses. This list is subject to further refinements based on future hydrologic and water quality studies. The state needs to review, update, and rank its WQL segment list and include the new list in its revised CPP.

2. Selection of Appropriate Water Quality Model(s). Since lakes (and reservoirs) have different hydraulic characteristics than rivers, lakes and rivers must have their respective chemical and biological parameters modelled differently. Table 1 contains only river segments; therefore, this document addresses only river water quality modelling methodology.

TMDLs must be established at levels that implement the applicable water quality standards "with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)(1)). For river reaches, this "margin of safety" statement is met by assuming no chemical and/or biological transformations occur within reaches that would decrease input load levels. That is, a mass balance model applies to river reaches, since all input loads become output loads at the downstream portions of such segments. The mass balance model is readily applicable to nutrient (P and N) loads in rivers.

For bacteria standards violations, the state has a policy of applying bacteria standards to the effluent of point source discharges (i.e., at "the end of the pipe"). Arizona's policy of applying an ambient bacteria standard at the end of a pipe constitutes a waste load allocation, designed to achieve the standard.

Further study may be necessary to determine whether non-point sources of bacteria are controllable. To reduce non-point sources of bacteria, such as may be required by developing a LA, best management practices should be imposed if a source is anthropogenic, or a site-specific standard modification should be proposed if a source is natural.

Arizona's ambient water quality standards include limits for turbidity, but not for suspended sediments. Nevertheless, the "Salt River and tributaries from headwaters to Roosevelt Lake" WQL segment

segments listed in Table 1. EPA has not yet withdrawn its federally-promulgated phosphorus standards, which are more stringent than the state phosphorus standards.

For the Verde Basin, EPA verified state TMDLs by comparing them to TMDLs developed using mean annual federal standards. For the Salt River WQL segment, EPA verified the state phosphorus TMDL by comparing it to a TMDL developed using the state-adopted and EPA-approved phosphorus standards. EPA is approving the Salt's state phosphorus TMDL with the recognition that the federal phosphorus standard remains in effect until officially withdrawn.

As stated earlier, EPA calculated WLAs/LAs as an additional means of verifying that the state TMDL submittals are protective of water quality. Since WLAs represent the load contributions from known point sources (see Appendix E), the loads allowed by NPDES permits for the violated parameters must be less than the TMDLs. If this is the case, the remaining loads are apportioned as LAs to non-point sources and/or future point sources. LAs must be met by best management practices along the WQL segments. If WLAs are greater than corresponding TMDLs, reductions in point source loadings are required.

Results

The following sections describe TMDL verification for each of the WQL segments listed in Table 1. See Appendix F for calculation summaries and additional documentation. Each of the following subsections should be read in conjunction with its corresponding table, listed below:

WQL Segment	Table
Verde River from Oak Creek to Fossil Creek	3
Oak Creek and tributaries to headwaters	5
Salt River and tributaries from headwaters to Roosevelt Lake	6

Table 1 contains TMDLs which were submitted to EPA for approval. The associated WLA/LAs, described in the following sections and the corresponding tables, are also presented in the remaining pages of this document. These TMDLs and WLAs/LAs have previously gone through public reviews during the Water Quality Management Planning and the permit issuance processes.

is listed as limited for sediments. It may eventually be possible to address a sediment problem by correlating turbidity standards with generalized source reductions that will enable standard compliance, however, further work is needed in this area. In addition, little data have been collected on the upper Salt River and tributaries. For these reasons, further sediment load analyses will be necessary when data become available.

3. Data Collection. The flow and sampling data for Arizona waterbodies was obtained from STORET and from USGS Water Resources Data Arizona, Water Years 1981-1984 (most recent data were used whenever possible). See Appendices C and D for STORET and USGS flow rate and water quality data.

Comparable STORET data collection time periods for stations along the same reach were used whenever possible, to avoid data skewed because of flood or drought years at only one of the stations along a given reach. Stations defining the boundaries of a river reach were selected based on a literature review of available data quality.

Because of the greater availability of mean flow data, compared to the availability of 7Q10 flow data and the lack of water quality data for the 7Q10 flow condition, mean flow and nutrient concentration data were used to calculate loads in this document. When using USGS data for mean flow rates, long enough measurement periods (i.e., greater than 20 years) were covered so that the values given were representative of mean discharge rates. Additionally, when USGS data were employed, medians of yearly mean discharge values were selected over average discharge values (see Appendix D) because the medians were more likely to be representative of typical yearly flows. In Oak Creek's case, however, the USGS average discharge value for "Oak Creek near Cornville" was used because the STORET data for the other station defining this reach's boundaries only list a mean discharge value.

4. TMDL and WLA/LA Calculations. Applying the mass balance method to calculate loads for the upstream portion of a river reach entails assuming all loading occurs at the lowest portion of the reach. This method produces maximum loads, because no diminution of river segment loads occurs over time. By multiplying mean downstream flow rate by mean annual standards for violated parameters, maximum loads are produced.

Upstream of a given station, the mass balance method described above can be used. For middle portions of rivers, the method must be slightly modified. The load immediately above a reach must be subtracted from the maximum permissible load at the lowest portion of the reach to determine the allowable load within the reach. If a negative TMDL results, upstream load abatement actions are required.

Arizona has adopted and EPA has approved phosphorus standards for several water segments in the state, including all the WQL

WQL Segment: Verde River from Oak Creek to Fossil Creek

TMDL Calculation

Verde River near Cornville (USGS Station 09504200) and Verde River below Camp Verde (USGS Station 09505550) were used to verify the state's TMDL values. The Oak Creek to Fossil Creek portion of the Verde River is, however, longer than the Oak Creek to Camp Verde section. See Appendices C and D for STORET and USGS data on the Cornville and Camp Verde stations. Verde River near Camp Verde (USGS Station 09506000) provides the most recent water quality data for the downstream portion of this WQL segment (see Appendix C). Flow increases downstream in this reach, from 2.1 m^3/sec (STORET) upstream near Cornville to 10.1 m^3/sec (USGS) downstream near Camp Verde.

Applying the federal and state phosphorus standards to the segment's incremental flow increase (assuming the standards are achieved at the upstream boundary) results in a phosphorus TMDL of 45.2 kg P/day using the federal standard and 69.3 kg P/day using the state standard. Without upstream abatement actions that cause the Verde River near Cornville station to meet the federal and state phosphorus standards, lower TMDL values for this segment would be necessary.

Because the upstream nitrogen load does not exceed the state standard (see Appendix C), no upstream abatement actions are required and the mass balance calculation does not utilize the incremental flow increase. By subtracting the upstream load from the maximum allowable downstream load, a nitrogen TMDL of 783.2 kg N/day is obtained. Though this WQL segment is not currently limited for nitrogen (based on most recent available STORET data, i.e., through 1978 for the upstream station), a TMDL value developed in a similar manner should be approvable by EPA.

Comparison to Arizona-Developed TMDLs

The TMDLs developed in Refs. 7 and 9 (pp. 33 and V-15, respectively) are lower than the above-listed values because 7Q10 flow rate at the mouth of Oak Creek was used in the earlier calculations, producing conservative TMDLs. Ref. 7 uses 90th percentile Arizona standards and Ref. 9 uses mean annual Arizona standards. Because it is more appropriate to use the 90th percentile standards with 7Q10 flow rates, the Ref. 7 calculations are more technically correct.

The Ref. 7 TMDL values, 11.0 kg P/day total phosphorus and 54.8 kg N/day total nitrogen, have already been documented and approved through a public process. Thus, though the Ref. 7 calculations produce more restrictive TMDL values (in fact, as stated above, the Ref. 7 TMDLs encompass a longer portion of the Verde River than just the Oak Creek to Camp Verde segment), Arizona has submitted these values to EPA for TMDL approval. The Ref. 7 TMDL values remain in effect until public review and EPA approval of any TMDL revision(s) occurs.

WLAs/LAs

Along this river reach, there is only one point source, with permitted limits of 0.06 kg P/day and 0.17 kg N/day (see Appendix E). Thus, the phosphorus WLA for this WQL segment is 0.1 kg P/day and the nitrogen WLA is 0.2 kg N/day. Corresponding LAs are 10.9 kg P/day and 54.6 kg N/day, respectively.

TABLE 3

WQL Segment: Verde River from Oak Creek to Fossil Creek

Standard Violated	Applicable Standard	Probable Point Sources	Probable Non-Point Sources	Calculated TMDL (kg/day)	AZ TMDL[1] (kg/day)	Existing WLA (kg/day)	Estimated LA (kg/day)
Phosphorus[2]	0.07 mg P/l (Fed., mean annual)	Valley Vista Estates	Failing Septic Systems Agriculture Grazing Erosion	45.2 (as P)			
	0.10 mg P/l (AZ, mean annual)			69.3 (as P)	11.0 (as P)	0.1 (as P)	10.9 (as P)
Nitrogen[2]	1.00 mg N/l (AZ, mean annual)	Valley Vista Estates	Failing Septic Systems Agriculture Grazing Erosion	783.2 (as N)	54.8 (as N)	0.2 (as N)	54.6 (as N)

1 ADHS, Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen (Ref. 7), January, 1981, p. 33.

2 ADHS, Water Quality Assessment for the State of Arizona, Water Years 1984-1985 (Ref. 10), August, 1986, p. 41.

WQL Segment: Oak Creek and tributaries to headwaters

TMDL Calculation

Oak Creek at Red Rock Crossing near Sedona (USGS Station 09504440) and Oak Creek near Cornville (USGS Station 09504500, 15 miles upstream from mouth) were used as data sources for Oak Creek flow rate (see Appendices C and D for STORET and USGS data on these stations). Oak Creek was divided into two portions for TMDL purposes: 1. upper Oak Creek, above Sedona, is a vegetated steep canyon, and 2. lower Oak Creek, below Sedona, is a less steep, wider alluvial plain with more clayey soils and vegetation that is more characteristic of high desert. The yearly baseline discharge rate is relatively constant for Oak Creek above Sedona, unlike most Arizona rivers and streams, because Oak Creek is fed by underground springs[1].

Technically, Oak Creek is currently limited for phosphorus, using EPA's phosphorus standard, but not for nitrogen.[2] By developing TMDLs and WLAs/LAs for both nutrients, future potential for nutrient problems is minimized. Applying the federal and state nutrient standards to the segment's flow rate at Sedona (2.0 m^3/sec, STORET) results in the TMDLs shown in Table 4 for the waters above Sedona. The nutrient TMDLs listed in Table 4 for the waters below Sedona are calculated using the federal and state standards and the incremental flow increase to the mouth of Oak Creek (0.6 m^3/sec, USGS and STORET).

TABLE 4

OAK CREEK TMDL CALCULATION RESULTS

Segment	Phosphorus (kg P/day)	Nitrogen (kg N/day)
Above Sedona:	11.3(Fed.) / 17.3(AZ)	173.3
Below Sedona:	3.2(Fed.) / 4.9(AZ)	48.9
Oak Creek (total):	14.5(Fed.) / 22.2(AZ)	222.2

[1] Personal communication, Richard Wilson, USGS (Tucson), September 8, 1987.

[2] ADHS, Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen, January, 1981, p. 157.

Oak Creek, continued

Comparison to Arizona-Developed TMDLs

The TMDLs developed in Refs. 7 and 9 (pp. 33 and V-15, respectively) are lower than the above-listed values because 7Q10 flow rate at Cornville was used in the earlier calculations, producing conservative TMDLs. Ref. 7 uses 90th percentile Arizona standards and Ref. 9 uses mean annual Arizona standards. Because it is more appropriate to use the 90th percentile standards with 7Q10 flow rates, the Ref. 7 calculations are more technically correct.

The Ref. 7 TMDL values, 10.9 kg P/day total phosphorus and 55.5 kg N/day total nitrogen, have already been documented and approved through a public process. Thus, though the Ref. 7 calculations produce more restrictive TMDL values, Arizona has submitted these values to EPA for TMDL approval. The Ref. 7 TMDL values remain in effect until public review and EPA approval of any TMDL revision(s) occurs.

WLAs/LAs

The permitted point source phosphorus load into this watershed is approximately 7.4 kg P/day and the permitted point source nitrogen load is approximately 53.6 kg N/day (see Appendix E). An estimated 3.4 kg N/day is added to the watershed by a permitted facility without a specific nitrogen load limit. One of the four point sources along this segment is a fish hatchery with variable flow throughput and no control on input source water nutrient concentrations. Thus, it is difficult to determine the exact point source contributions from the fishery and the total point source loads.

The estimated load values result in WLAs of approximately 7.4 kg P/day total phosphorus and approximately 57.0 kg N/day total nitrogen. Currently, the nitrogen WLA is approximately equal to the TMDL and the state nitrogen standard is met along Oak Creek and its tributaries. If the fish hatchery nitrogen load expands to approach the TMDL limit, however, load reduction measures should be implemented to ensure that in-stream nitrogen standards continue to be achieved. LAs for this segment are approximately 3.5 kg P/day and 0 kg N/day.

TABLE 5

WQL Segment: Oak Creek and Tributaries to Headwaters

Standard Violated	Applicable Standard	Probable Point Sources	Probable Non-Point Sources	Calculated TMDL (kg/day)	AZ TMDL[1] (kg/day)	Existing WLA[2] (kg/day)	Estimated LA (kg/day)
Phosphorus[3]	0.07 mg P/l (Fed., mean annual)	Kachina Village CB Real Estate Sedona Venture Page Springs Hatchery	Failing Septic Systems Recreation Wildlife Grazing Erosion Agriculture	14.5 (as P)			
	0.10 mg P/l (AZ, mean annual)			22.2 (as P)	10.9 (as P)	7.4 (as P)	3.5 (as P)
Nitrogen[4]	1.00 mg N/l (AZ, mean annual)	Kachina Village CB Real Estate Sedona Venture Hatchery Page Springs Hatchery	Failing Septic Systems Recreation Wildlife Grazing Erosion Agriculture	222.2 (as N)	55.5 (as N)	57.0 (as N)	0.0 (as N)

1 ADHS, Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen (Ref. 7), January, 1981, p. 33.

2 Approximate values.

3 ADHS, op cit., p. 157.

4 Threatened violation.

WQL Segment: Salt River and tributaries from headwaters to Roosevelt Lake

TMDL Calculation

The Salt River begins at the confluence of the White and the Black Rivers. Three USGS stations are needed for analysis of this river reach: White River near Fort Apache (09494000) records White River flow just above the confluence, Black River near Fort Apache (09490500) records Black River flow just above the confluence, and Salt River near Roosevelt (09498500) records Salt River flow just above Roosevelt Lake (see Appendix D for USGS flow data for these stations). The Salt River is the principal perennial stream flowing into Roosevelt Lake.

Two methodologies were utilized to calculate the phosphorus TMDL for this river reach and the more stringent result (i.e., the lower loading value) was used for comparison to the state phosphorus TMDL. The first methodology used the OECD (1982) Shallow Lakes and Reservoirs Model to determine maximum river load to Roosevelt Lake, as a percent of total lake input flow, based on the state lake phosphorus standard. This model was selected based on the relatively good predictive ability of the model for in-lake phosphorus and chlorophyll a concentrations, using the 1975 phosphorus input load to Roosevelt Lake (see Appendix G). The second methodology used the state river standards and flow rates (i.e., mass balance) to determine maximum river load.

Using the OECD model with in-lake phosphorus concentration set at the mean annual Arizona lake standard, total allowable phosphorus lake load can be computed (see Appendix G). Note that this value can be considered in setting the lake TMDL should Roosevelt Lake be designated by Arizona as a WQL segment for phosphorus. Total river load to the lake may be found by subtracting the direct discharge load into the lake, i.e., negligible permitted phosphorus loading from Roosevelt Lakeview Park (see Appendix E), from total allowable lake load. The National Eutrophication Survey (Ref. 20) reports that Salt River input to Roosevelt Lake represents 78.3% of river inputs to the lake. By multiplying the total river load by 78.3%, the result is the Salt River's contribution to Roosevelt Lake phosphorus load. The phosphorus TMDL by this method is 213.2 kg P/day.

The mass balance methodology results in a 108.5 kg P/day federal phosphorus TMDL and a 175.6 kg P/day state phosphorus TMDL. Because the state phosphorus standard for the White and the Black Rivers differs from that for the Salt River, proportional flow rates for the different river portions were used in the mass balance calculation (see Appendix F).

The lower value for the phosphorus TMDL obtained by these two methods represents the more protective, conservative result of TMDL calculations. Thus, the TMDL value for phosphorus is 108.5 kg P/day using the federal phosphorus standard and 175.6 kg P/day using the state phosphorus standards.

Salt River, continued

Comparison to Arizona-Developed TMDLs

The phosphorus TMDL calculated by ADHS is 148.0 kg P/day in Ref. 11 (p. 10-3). This value is more protective than the 175.6 kg P/day phosphorus TMDL calculated using the mean annual state standards, as described above, but it is less stringent than the federal phosphorus TMDL. Because the federally-promulgated standard will be withdrawn, however, the submitted TMDL is approvable by EPA.

WLAs/LAs

The permitted point source phosphorus load into this WQL segment is 7.3 kg P/day and permitted facilities without specific phosphorus load limits contribute an estimated 30.0 kg P/day (see Appendix E). These values result in a phosphorus WLA of 37.3 kg P/day. The corresponding LA is 110.7 kg P/day.

TABLE 6

WQL Segment: Salt River and Tributaries from Headwaters to Roosevelt Lake

Standard Violated	Applicable Standard	Probable Point Sources	Probable Non-Point Sources	Calculated TMDL (kg/day)	AZ TMDL[1] (kg/day)	Existing WLA (kg/day)	Estimated LA (kg/day)
Phosphorus[2]	0.07 mg P/l (Fed., mean annual)	Pinto Valley Copper Co.	Failing Septic Systems	108.5 (as P)			
		Inspiration Copper	Grazing				
	0.12 mg P/l (AZ, mean annual, Salt)	Globe/Holgate	Silviculture				
		Globe/Pinal WWTP	Erosion	175.6 (as P)	148.0 (as P)	37.3 (as P)	110.7 (as P)
		Cobre Valley					
		E. Fork Mission WWTP					
	0.10 mg P/l (AZ, mean annual, White & Black)	Alchesay Hatchery					
		Canyon Creek Hatchery					
		Williams Creek Hatchery					

1 ADHS, Water Quality Management Basin Plan, Salt River Basin, Arizona (Ref. 11), January, 1977, p. 10-3.

2 ADHS, Water Quality Assessment for the State of Arizona, Water Years 1984-1985 (Ref. 10), August, 1986, p. 41.

Conclusion

We recommend approval of the three TMDLs in Table 1, based on our review and verification of the adequacy of the state's TMDL submission, as we have described these procedures in this administrative record.

During our review, we identified several activities that need further state attention: 1) The Arizona WQL segments still requiring development and EPA approval of TMDLs are listed in Table 2. These segments currently have insufficient data (e.g., lack of monitoring stations, inaccurate or outdated data, etc.) to develop TMDLs or they require public review prior to submittal of the values to EPA for approval; 2) The state needs to update and rank its list of WQL segments still requiring TMDL development or revision (40 CFR 130.7). The ranked list of WQL segments still needing TMDL development should be included in the next version of the CPP; 3) Additional monitoring is necessary to support future TMDL and WLA/LA development and updates. Intensive surveys and more representative flow data for the WQL segments are especially important; and 4) The process the state intends to use for future TMDL and WLA/LA development must be documented and included in the CPP. The TMDL process described in this document may be modified, if appropriate, for future TMDL development.

ATTACHMENT 1

AWQU - 690.

AWQU - 512.400

Read 9/2[illegible]
a

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

EVAN MECHAM, GOVERNOR

SEP 2 5 1987

Ms. Patricia Blodgett, Chief
Water Quality Management Section
U.S. Environmental Protection Agency, Region IX
215 Fremont Street
San Francisco, CA 94105

Dear Pat:

This is to transmit a compilation of documentation regarding total allowable daily loadings for three stream segments in Arizona. The enclosure addresses published analyses in the following segments:

Oak Creek from headquarters to the Verde River,
Verde River from Oak Creek to Fossil Creek, and
Salt River from headquarters to above Roosevelt Lake.

The discussion section provides additional information for your consideration. The values presented represent loads derived from published reports that were utilized for nutrients standards adoptions in 1981-1982, not load limit considerations. Incorporation of current conditions and public participation are needed for loading updates. If you have any questions, please contact Jack Bale at (602) 392-4006.

Sincerely,

Ronald L. Miller, Assistant Director
Office of Water Quality

RLM:EKS:ag
Enclosure

INCOMING

ALLOWABLE DAILY LOADING IN ARIZONA STREAM SEGMENTS

September 25, 1987

Introduction

This document presents total allowable daily loadings for nutrients in several Arizona stream segments which have been identified as being water quality-limited. The stream segments are the Verde River from Oak Creek to Fossil Creek, Oak Creek from the headwaters to the Verde River and the Salt River from the headwaters to Roosevelt Lake. The total allowable daily loadings are summarized in Table 1.

Calculations

The loadings for the Verde River from Oak Creek to Fossil Creek segment are 11.0 Kg per day of phosphates as P and 54.8 Kg per day for nitrogen as N. These loadings were derived from the Technical Report On Nutrient Levels in the Verde River Watershed With Recommended Standards for Phosphorous and Nitrogen, 1981. The values were derived from 7 day, 10 year low flows in the Verde River watershed for data prior to 1979, and the Arizona standards (90 percentile limits).

The loadings for Oak Creek from its headwaters to the Verde River are 10.9 Kg per day of phosphates as P and 55.5 Kg per day of nitrogen as N. These loadings were derived from the Technical Report on Nutrient Levels in the Verde River Watershed With Recommended Standards for Phosphorous and Nitrogen, 1981. The values were derived from 7 day, 10 year low flows in the Oak Creek watershed for data prior to 1979, and the Arizona standards (90 percentile limits).

The phosphates loading for the Salt River from the headwaters to Roosevelt Lake segment is 148.0 Kg per day as P. This load is derived from the Water Quality Management Basin Plan, Salt River Basin, Arizona, 1977. The value was derived from the mean annual flow data prior to 1976, and the Arizona standards (annual mean limit for the Salt River above Roosevelt Lake).

Discussion

The flow data used in the derivation of the loadings are approximately ten years old. Recent wet weather may result in higher values for low flows, yielding slightly higher loads. Derivation of point source allocations and nonpoint source allocations is not recommended at this time. In the Oak Creek segment, flow data for the Page Springs Fish Hatchery is inadequate. The impact of upstream point source loadings on the Verde River segment has not been throughly assessed, and the use of mean flow values on the Salt River may not adequately address low flow conditions. The loadings derived from the referenced reports were primarily presented as a basis for water quality standards adoption. Thus, public review has been directed toward stream standards development, not load limit considerations.

In summary, the loading presented in this document do not necessarily reflect current conditions and must only serve as a basis for updating loadings on these stream segments.

TABLE I

TOTAL ALLOWABLE DAILY LOADINGS FOR
SELECTED ARIZONA STREAM SEGMENTS

SEGMENTS	NUTRIENT	LOADINGS
Verde River from Oak Creek to Fossil Creek (1)	Phosphates Nitrogen	11.0 Kg/Day (as P) 54.8 Kg/Day (as N)
Oak Creek from Headwaters to the Verde River (1)	Phosphates Nitrogen	10.9 Kg/Day (as P) 55.5 Kg/Day (as N)
Salt River from Headwaters to Roosevelt Lake (2)	Phosphates	148.0 Kg/Day (as P)

Notes:

(1) SOURCE: Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen, 1981, pg. 33.

(2) SOURCE: Water Quality Management Basin Plan, Salt River Basin, Arizona, 1977, pg. 10-3.

Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen

TABLE 8

Low Flow Total Daily Loads (7 day-10 year)
Low Flow in Verde River Watershed

Segment	Total Phosphates as Phosphate lb/day			Total Nitrogen as Nitrogen lb/day		
	Estimated Background Load	Recommended Additional Load	Total Permitted Load	Estimated Background Load	Maximum Additional Load	Total Permitted Load
Verde River - Clarkdale to Oak Creek	244	89.6	333.6	412	146.3	558.3
(2) Oak Creek	54	19.5	73.5 (A)	81	41.3	122.3 (B)
(1) Verde River - Oak Creek to Fossil Creek	55	19.0	74.0 (A)	77	43.8	120.8 (B)

CALCULATIONS

① VERDE RIVER FROM OAK CREEK TO FOSSIL CREEK

Ⓐ NUTRIENT REPORT → 74.0 LB/DAY AS PO_4

MWT P = 31 so $P = PO_4 WT \times \frac{31}{64+31}$

MWT O_4 = 64

$$74.0 \text{ lb/day} \times \frac{31}{64+31} \times \frac{1 \text{ kg}}{2.2 \text{ lb}}$$

$$= 11.0 \text{ kg/day as P}$$

Ⓑ NUTRIENT REPORT → 120.8 LB/DAY AS N

$$120.8 \text{ lb/day} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 54.8 \text{ kg/day as N}$$

② OAK CREEK FROM HEADWATERS TO VERDE RIVER

Ⓐ NUTRIENT REPORT → 73.5 LB/DAY AS PO_4

$$73.5 \text{ lb/day} \times \frac{31}{64+31} \times \frac{1 \text{ kg}}{2.2 \text{ lb}}$$

$$= 10.7 \text{ kg/day as P}$$

Ⓑ NUTRIENT REPORT → 122.3 LB/DAY AS N

$$122.3 \text{ lb/day} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 55.5 \text{ kg/day as N}$$

FINAL REPORT

WATER QUALITY MANAGEMENT BASIN PLAN

SALT RIVER BASIN, ARIZONA

JANUARY, 1977

THE ARIZONA DEPARTMENT OF HEALTH SERVICES

the Salt River. As described in Chapter 8, most of these pick-ups are related to natural causes. This is especially evident on the Black River where man-made pollution is almost nonexistent. To show the possible impact of man-made pollution, the total loads (as computed in Chapter 9) which could be generated from the Indian reservations are superimposed onto the natural loads. The impact of such loads on the White River are substantial. The maximum loads on the Salt River that could be caused by untreated return flows amount to only 15 percent in 1974 and 30 percent in the year 2000. Such an impact is very small when compared to values exceeding 90 percent as measured in other rivers [10-1]. For comparison, the proposed EPA Standard would yield loads at the several river locations as indicated on Figure 10-1.

Based on the mean annual flow and a nondegredation policy, it is recommended that the total maximum daily load shall not exceed 1,000 pounds of phosphate (PO_4)* at the AZ 288 Highway crossing. The recommended maximum daily load is intended to include existing point, and non-point sources. This does not meet the recently adopted EPA standard, which would allow only 826 pounds of phosphate.

INDIVIDUAL POINT SOURCE LOAD ALLOCATIONS

As mentioned earlier, treatment plant discharges are possible contributors of phosphate loads. Because such discharges are controllable, they are considered point sources.

Despite the relatively small impact from individual treatment plants, it is proposed that only limited amounts of phosphates be discharged to running surface water or impoundments. Such a policy would eliminate any possible aggravation of the current situation. Since most treatment plants either discharge to dry washes or have no discharge at all, few corrective measures will be necessary.

The only treatment plants which will require phosphate removal are located at Roosevelt Lake, Sunrise Park, and Tortilla Flat.

The recommended maximum daily load is intended to include existing point and non-point sources.

*Estimated present mean value

CALCULATIONS

③ SALT RIVER FROM HORSESHOE TO ROOSEVELT LAKE

SALT RIVER BASIN PLAN ⟶ 1000 LBS/DAY As PO4

$$1000 \text{ LBS/DAY} \times \frac{31}{64+31} \times \frac{1 \text{ Kg}}{2.2 \text{ LBS}}$$

$$= 148.0 \text{ Kg/DAY As P.}$$

APPENDICES

AWQU - 690.010

A-2

ARIZONA DEPARTMENT OF HEALTH SERVICES

BRUCE BABBITT, Governor
BOYD DOVER, Acting Director

January 13, 1987

Mr. Fred Leif
Arizona/Nevada/Hawaii Branch
U.S. Environmental Protection Agency
Region 9
215 Fremont Street
San Francisco, California 94105

Dear Fred:

This is to transmit recommended additions to the list of Arizona water quality limited segments in partial fulfillment of FY 87 program plan element 12.B.4. These segments are consistent with 40 CFR 130.2(i) and recent State water quality assessment reports, and will be incorporated into the next update of the continuing planning process.

If you have any questions, please contact E. K. Swanson at 257-2362.

Sincerely,

William C. Blackman, Jr., Manager
Office of Emergency Response &
Environmental Analysis

WCB:EKS:md
Attachments

cc: Norm Weiss
Ronald L. Miller

AWQU - 690.010

ARIZONA'S WATER QUALITY LIMITED SEGMENTS
December 1986

The State water quality management program for surface waters requires the identification of segments that may not meet ambient standards, even after the application of technology-based effluent limitations required by the federal Clean Water Act (CWA). Such waters are to be designated as "water quality limited" (WQL) segments and the subjected waste load analyses for all point sources discharges (40 CFR 130). In 1977, the Arizona Water Quality Control Council identified 15 segments (Table A) which are being addressed by the Department of Health Services' program.

Water quality assessment efforts through Water Year 1986 have identified additional segments that are not meeting surface water quality standards by the application of technology-based discharge limitations (CWA § § 301(b) and 306). The following segments will be added to the Arizona WQL segments list when the State Continuing Planning Process is updated:

SEGMENT	BASIN	REASON
Puerco River from AZ-NM boundary to confluence with Little Colorado River	Little Colorado	Trace metals and Ra-226 violations
Little Colorado River from Puerco River to confluence with Colorado River	Little Colorado	Trace metals and Ra-226 violations
Boulder Creek from Wilder Creek to confluence with Burro Creek	Colorado Main Stem	Trace metals and pH violations
Watson Lake	Verde	Eutrophication
East Verde River from headwaters to confluence with Verde River	Verde	Nutrients violations

Table A

Designated Water Quality Limited Segments by Arizona Water Quality Control Council, 1977

Water Quality Segment Description	River Basin Planning Area
Willow Creek and Tributaries	Verde
Verde River from Sullivan Lake to Clarkdale	Verde
Verde River Clarkdale to mouth of Oak Creek	Verde
Oak Creek and tributaries to headwaters	Verde
Verde River from Oak Creek to Camp Verde	Verde
Verde River from Camp Verde to Bartlett Dam	Verde
Salt River and Lakes and tributaries from Verde River to headwaters	Salt
Little Colorado River and tributaries above Springerville	Little Colorado
Nutrioso Creek	Little Colorado
Show Low Creek and tributaries to headwaters	Little Colorado
Silver Creek	Little Colorado
Rio de Flag	Little Colorado
Colorado River from Imperial Dam to Southerly International Boundary	Colorado Main Stem
*San Francisco River and tributaries from headwaters to just below Luna Lake	Upper Gila
Sabino Creek	Santa Cruz

Notes:

Source: Arizona's Continuing Planning Process by Water Quality Planning adopted by Arizona Water Quality Control Council on October 19, 1977

* - Includes Luna Lake

Table A

Designated Water Quality Limited Segments by Arizona Water Quality Control Council, 1977

Water Quality Segment Description	River Basin Planning Area
Willow Creek and Tributaries	Verde
Verde River from Sullivan Lake to Clarkdale	Verde
Verde River Clarkdale to mouth of Oak Creek	Verde
Oak Creek and tributaries to headwaters	Verde
Verde River from Oak Creek to Camp Verde	Verde
Verde River from Camp Verde to Bartlett Dam	Verde
Salt River and Lakes and tributaries from Verde River to headwaters	Salt
Little Colorado River and tributaries above Springerville	Little Colorado
Nutrioso Creek	Little Colorado
Show Low Creek and tributaries to headwaters	Little Colorado
Silver Creek	Little Colorado
Rio de Flag	Little Colorado
Colorado River from Imperial Dam to Southerly International Boundary	Colorado Main Stem
*San Francisco River and tributaries from headwaters to just below Luna Lake	Upper Gila
Sabino Creek	Santa Cruz

Notes:
Source: Arizona's Continuing Planning Process by Water Quality Planning adopted by Arizona Water Quality Control Council on October 19, 1977

* - Includes Luna Lake

APPENDIX B

REFERENCES

1. ADHS, Final Staff Report, Unique Waters Nomination for Oak Creek and the West Fork of Oak Creek, July, 1984.

2. ADHS, Little Colorado River, Greer Water Quality Survey, May, 1978.

3. ADHS, The Little Colorado River Watershed Above Lyman Lake: Water Chemistry, Nutrients and Nutrient Standards, July, 1982.

4. ADHS, Nutrient Levels in the Salt River Basin With Recommended Standards for Phosphorus and Nitrogen, September, 1981.

5. ADHS, Oak Creek Water Quality Data Summary and Intensive Survey Design, February, 1983.

6. ADHS, Summary of Oak Creek Water Quality, March to November 1983, December, 1985.

7. ADHS, Technical Report on Nutrient Levels in the Verde River Watershed with Recommended Standards for Phosphorus and Nitrogen, January, 1981.

8. ADHS, Unique Waters Nomination for the West Fork of the Little Colorado River, April, 1983.

9. ADHS, A Wastewater Facilities Plan for the Verde River Basin, Arizona, 1975.

10. ADHS, Water Quality Assessment for the State of Arizona, 1980-1981 (March, 1983), 1982-1983 (May, 1984), 1984-1985 (August, 1986).

11. ADHS, Water Quality Management Basin Plan, Salt River Basin, Arizona, January, 1977.

12. Dillon, P.J. and Rigler, F.H., "The Phosphorus-Chlorophyll Relationship in Lakes," Limnology and Oceanography, Vol. 19, No. 5, September, 1974.

13. Dillon, P.J. and Rigler, F.H., "A Simple Method for Predicting the Capacity of a Lake for Development Based on Lake Trophic Status," Journal of the Fisheries Research Board of Canada, Vol. 32, No. 9, September, 1975.

14. Grieb, T.M., et al., "Development of Empirical Multivariate Relationships for Evaluating Fish Communities in New Cooling Lakes," Technical Report to Electric Power Research Institute, Research Project 1488-1, 1981.

15. Metcalf and Eddy, Inc., Wastewater Engineering: Treatment, Disposal, Reuse, McGraw-Hill, 1979.

Table A

Designated Water Quality Limited Segments by Arizona Water Quality Control Council, 1977

Water Quality Segment Description	River Basin Planning Area
Willow Creek and Tributaries	Verde
Verde River from Sullivan Lake to Clarkdale	Verde
Verde River Clarkdale to mouth of Oak Creek	Verde
Oak Creek and tributaries to headwaters	Verde
Verde River from Oak Creek to Camp Verde	Verde
Verde River from Camp Verde to Bartlett Dam	Verde
Salt River and Lakes and tributaries from Verde River to headwaters	Salt
Little Colorado River and tributaries above Springerville	Little Colorado
Nutrioso Creek	Little Colorado
Show Low Creek and tributaries to headwaters	Little Colorado
Silver Creek	Little Colorado
Rio de Flag	Little Colorado
Colorado River from Imperial Dam to Southerly International Boundary	Colorado Main Stem
*San Francisco River and tributaries from headwaters to just below Luna Lake	Upper Gila
Sabino Creek	Santa Cruz

Notes:
Source: Arizona's Continuing Planning Process by Water Quality Planning adopted by Arizona Water Quality Control Council on October 19, 1977

* - Includes Luna Lake

APPENDIX B, continued

16. NACOG, Oak Creek Water Quality Management Plan, July, 1984.

17. NACOG, Verde River Water Quality Management Study, Report on 1980 Water Sampling Program, March, 1981.

18. OECD, Eutrophication of Waters, Monitoring, Assessment and Control, Paris, 1982.

19. Sommerfeld and Ellingson, Water Quality Analysis of Watson Lake, November, 1984.

20. USEPA, Report on Theodore Roosevelt Lake, National Eutrophication Survey, Working Paper 735, PB 281 516, September, 1977.

21. USEPA, Summary Analysis of the North American (U.S. Portion) OECD Eutrophication Project: Nutrient Loading -- Lake Response Relationships and Trophic State Indices, Rast, W. and Lee, G.F., EPA - 600/3-78-008, January, 1978.

22. USEPA, Technical Guidance Manual for Performing Waste Load Allocations, Book II, Chapter 1 (Streams and Rivers, Biochemical Oxygen Demand/Dissolved Oxygen, September, 1983), Book II, Chapter 2 (Streams and Rivers, Nutrient/Eutrophication Impacts, November, 1983), Book II, Chapter 3 (Streams and Rivers, Toxic Substances, June, 1984), Book IV, Chapter 2 (Lakes, Reservoirs, and Impoundments, Eutrophication, August, 1983).

23. USEPA, Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Parts 1 and 2 (Revised-1985), EPA/600/6-85/002a,b, September, 1985.

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25. Vollenweider, R.A., "Advances in Defining Critical Loading Levels for Phosphorus in Lake Eutrophication," Mem. 1st Ital. Idrobiol., Vol. 33, 1976.

RDE RIVER BASIN

09504200
34 40 58.0 111 57 28.0 2
VERDE R NR CORNVILLE, ARIZ.
04025 ARIZONA YAVAPAI

YPA/AMOUNT/STREAM

112WRD 770125 15060202025 0001,840 ON
0000 FEET DEPTH

	PARAMETER		MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT. NUMBER	WATER		2	1600.000	1.000000	1.000000	1600	1600	77/10/26	81/02/25
00010	WATER	TEMP CENT	WATER		24	16.37500	49.65800	7.046900	27.0	6.0	76/11/04	81/02/25
00020	AIR	TEMP CENT	WATER		2	34.75000	.1250000	.3535500	35.0	34.5	78/07/11	78/08/09
00022	LENGTH	OF EXPOSURE=DAYS	WATER		1	14.00000			14	14	78/05/11	78/05/11
00028	ANALYZE	AGENCY CODE	WATER		19	5185.500	3284E+05	18122.00	80020	1028	76/11/04	81/02/25
00061	STREAM	FLOW, INST-CFS	WATER		22	75.04500	2131.300	46.16500	270	43	76/11/04	78/09/12
				J	1	750.0000			750	750	78/03/22	78/03/22
				TOT	23	104.3900	21842.00	147.7900	750	43	76/11/04	78/09/12
00070	TURB	JKSN	JTU	WATER	19	46.57900	3547.500	59.56100	240.0	3.0	76/11/04	78/08/09
00076	TURB	TRBIDMTR HACH FTU	WATER		1	7.000000			7.0	7.0	78/05/11	78/05/11
00095	CNDUCTVY	AT 25C MICROMHO	WATER		24	546.3800	9288.900	96.37900	640	260	76/11/04	81/02/25
00300	DO	MG/L	WATER		20	9.350000	1.492100	1.221500	11.0	6.8	76/11/04	78/09/12
00400	PH	SU	WATER		24	8.162500	.0372690	.1930500	8.60	7.70	76/11/04	81/02/25
00405	CO2	MG/L	WATER		23	3.621700	2.254500	1.501500	8.3	1.3	76/11/04	78/09/12
00410	T ALK	CACO3 MG/L	WATER		23	251.9100	2200.600	46.91100	280	110	76/11/04	78/09/12
00440	HCO3 ION	HCO3 MG/L	WATER		23	306.9600	3266.200	57.15100	340	130	76/11/04	78/09/12
00445	CO3 ION	CO3 MG/L	WATER		22	.5454600	3.116900	1.765500	6	0	76/11/04	78/09/12
00572	PIGMASS	PERPHYTN G/SQ M	WATER		1	17.60000			17.600	17.600	78/05/11	78/05/11
00573	PIGMASS	PERPHYTN DW G/M2	WATER		1	20.60000			20.60	20.60	78/05/11	78/05/11
00600	TOTAL N	N MG/L	WATER		23	.5065200	.0982690	.3134800	1.50	.09	76/11/04	78/09/12
00613	NO2-N	DISS MG/L	WATER	K	1	.0100000			.010	.010	77/01/14	77/01/14
00618	NO3-N	DISS MG/L	WATER		1	.1800000			.18	.18	77/01/14	77/01/14
00625	TOT KJEL	N MG/L	WATER		23	.3313100	.0445570	.2110900	.790	.030	76/11/04	78/09/12
00626	ORGAN. N	MUD D WT MG/KG-N	WATER		2	99.00000	32.00000	5.656900	103.00	95.00	77/06/21	78/05/11
00630	NO2&NO3	N-TOTAL MG/L	WATER		23	.1756500	.0260350	.1613500	.72	.01	76/11/04	78/09/12
00631	NO2&NO3	N-DISS MG/L	WATER		22	.1686400	.0246320	.1569500	.7	.01	76/11/04	78/09/12
				K	1	.1000000			.1	.1	77/11/30	77/11/30
				TOT	23	.1656500	.0237170	.1540000	.7	.01	76/11/04	78/09/12
00660	ORTHOPO4	PO4 MG/L	WATER		23	.0730430	.0023585	.0485650	.21	.00	76/11/04	78/09/12
00665	PHOS-TOT	MG/L P	WATER		23	.1391300	.0298170	.1726800	.760	.010	76/11/04	78/09/12
00671	PHOS-DIS	ORTHO MG/L P	WATER		22	.0254550	.0002450	.0156530	.070	.010	76/11/04	78/09/12
				K	1	.0100000			.010	.010	77/12/22	77/12/22
				TOT	23	.0247830	.0002442	.0156290	.070	.010	76/11/04	78/09/12
00680	T ORG C	C MG/L	WATER		23	2.504400	3.033200	1.741600	7.8	.7	76/11/04	78/09/12
00720	CYANIDE	CN-TOT MG/L	WATER		23	.0000000	.0000000	.0000000	.000	.000	76/11/04	78/09/12
00721	CYANIDE	SEDMG/KG DRY WGT	WATER		2	.0000000	.0000000	.0000000	.00	.00	77/06/21	78/05/11
00900	TOT HARD	CACO3 MG/L	WATER		24	266.2500	1955.100	44.21600	310	120	76/11/04	81/02/25
00902	NC HARD	CACO3 MG/L	WATER		23	15.13100	437.3000	20.91200	89	0	76/11/04	78/09/12
00915	CALCIUM	CA,DISS MG/L	WATER		24	55.12500	70.72300	8.409700	65.0	28.0	76/11/04	81/02/25

09504440
34 49 28.0 111 48 20.0 2
OAK CREEK AT RED ROCK CROSSING NR SEDONA,ARIZ
04025 ARIZONA YAVAPAI

TYPA/AHAUT/STREAM

112WRD 790116 15060202
0000 FEET DEPTH

	PARAMETER			MEDIUM	RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	WATER		58	14.62100	56.81900	7.537800	28.0	4.5	78/10/11	83/10/06
00020	AIR	TEMP	CENT	WATER		21	19.66700	72.08400	8.490200	34.5	7.0	82/01/15	83/10/06
00025	BAROMTRC	PRESSURE	MM OF HG	WATER		12	664.3300	29.45500	5.427200	670	650	82/10/27	83/10/06
00027	COLLECT	AGENCY	CODE	WATER		24	53689.00	1446E+06	38038.00	80020	1028	81/10/14	83/10/06
00028	ANALYZE	AGENCY	CODE	WATER		60	64221.00	1015E+06	31863.00	80020	1028	78/10/11	83/10/06
00061	STREAM	FLOW,	INST-CFS	WATER		52	70.83100	22633.00	150.4400	1010	13	78/10/11	83/10/06
					J	6	1645.700	4646300	2155.500	5700	272	79/01/17	83/04/25
					TOT	58	233.7500	661870.0	813.5600	5700	13	78/10/11	83/10/06
00070	TURB	JKSN	JTU	WATER		4	4.500000	49.00000	7.000000	15.0	1.0	78/11/15	79/08/11
00076	TURB	TRNSMTR	HACH FTU	WATER		11	2.627300	12.84600	3.584200	13.0	.6	79/10/24	80/09/30
00095	CNDUCTVY	AT 25C	MICROMHO	WATER		58	257.5700	7371.900	85.86000	450	77	78/10/11	83/10/06
00300	DO		MG/L	WATER		50	9.526000	2.174500	1.474600	12.3	7.2	78/10/11	83/10/06
00301	DO	SATUR	PERCENT	WATER		6	104.0000	17.21500	4.149100	112.0	101.0	82/10/27	83/05/23
00340	COD	HI LEVEL	MG/L	WATER		33	21.00000	366.0600	19.13300	83	0	79/10/24	83/10/06
					K	6	10.00000	.0000000	.0000000	10	10	82/06/16	83/06/30
					TOT	39	19.30800	324.4300	18.01200	83	0	79/10/24	83/10/06
00400	PH		SU	WATER		56	8.186900	.1085700	.3295000	8.80	6.90	78/10/11	83/10/06
00403	LAB	PH	SU	WATER		22	8.213600	.0964590	.3105800	8.6	7.2	80/11/20	83/08/29
00405	CO2		MG/L	WATER		10	1.700000	3.808900	1.951600	6.9	.1	78/10/11	79/08/11
00410	T ALK	CACO3	MG/L	WATER		38	125.5800	2106.000	45.89100	190	35	78/10/11	83/10/06
00440	BICO3 ION	HCO3	MG/L	WATER		11	132.9100	4389.700	66.25500	210	43	78/10/11	79/08/11
00445	CO3 ION	CO3	MG/L	WATER		10	.0000000	.0000000	.0000000	0	0	78/10/11	79/08/11
00530	RESIDUE	TOT NFLT	MG/L	WATER		39	42.92300	36036.00	189.8300	1190	0	79/10/24	83/10/06
					K	3	1.333300	.3333400	.5773500	2	1	82/07/13	83/06/30
					TOT	42	39.95200	33517.00	183.0800	1190	0	79/10/24	83/10/06
00572	BIOMASS	PERPHYTN	G/SQ M	WATER		1	.2360000			.236	.236	80/06/10	80/06/10
00573	BIOMASS	PERPHYTN	DW G/M2	WATER		1	.4720000			.47	.47	80/06/10	80/06/10
00600	TOTAL N	N	MG/L	WATER		33	.6263600	.3787700	.6154400	2.70	.04	78/10/11	82/08/12
00605	ORG N	N	MG/L	WATER		1	.7800000			.780	.780	81/03/19	81/03/19
00610	NH3+NH4-	N TOTAL	MG/L	WATER		1	.0100000			.010	.010	81/03/19	81/03/19
00625	TOT KJEL	N	MG/L	WATER		55	.6200000	.3426900	.5854000	2.900	.020	78/10/11	83/10/06
00630	NO2&NO3	N-TOTAL	MG/L	WATER		32	.0406250	.0016448	.0405560	.14	.00	78/10/11	82/08/12
					K	24	.0991660	.0000080	.0028348	.10	.09	78/12/13	83/10/06
00631	NO2&NO3	N-DISS	MG/L	WATER	TOT	56	.0657140	.0017850	.0422490	.14	.00	78/10/11	83/10/06
						28	.0442860	.0017587	.0419370	.1	.0	78/10/11	83/03/08
					K	7	.1000000	9934E-12	.0000996	.1	.1	79/06/13	83/08/29
					TOT	35	.0554290	.0019079	.0436800	.1	.0	78/10/11	83/08/29
00650	T PO4	PO4	MG/L	WATER		3	.1400000	.0048000	.0692820	.18	.06	79/04/18	79/06/13
00660	ORTHOPO4	PO4	MG/L	WATER		31	.0483870	.0013607	.0368870	.15	.00	78/10/11	82/11/30

DE RIVER BASIN

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VERDE RIVER NEAR CAMP VERDE, ARIZ,
04025 ARIZONA YAVAPAI

PA/AMBNT/STREAM

112WRD 770125 15060203025 0013,610 ON
0000 FEET DEPTH

	PARAMETER		MEDIUM	PNK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER TEMP	CENT	WATER		77	17.53400	57.68200	7.594900	35.0	6.0	76/07/08	84/09/04
00020	AIR TEMP	CENT	WATER		32	23.43400	79.18000	8.898300	41.0	7.0	81/12/23	84/09/04
00025	BAROMTRC PRESSURE	MM OF HG	WATER		24	691.3800	15.39100	3.923200	699	682	82/10/28	84/09/04
00027	COLLECT AGENCY	CODE	WATER		36	38330.00	1599E+06	39994.00	80020	1028	81/10/15	84/09/04
00028	ANALYZE AGENCY	CODE	WATER		83	60985.00	1155E+06	33987.00	80020	1028	76/07/08	84/09/04
00049	SURFACE AREA	SQ. MI.	WATER		22	5024.000	.0000000	.0000000	5024.00	5024.00	76/07/08	80/03/06
00061	STREAM FLOW, INST	CFS	WATER		71	366.4900	575960.0	758.9200	4480	40	76/07/08	84/09/04
				J	4	800.0000	318330.0	564.2100	1500	250	79/02/14	82/01/14
				TOT	75	389.6100	567350.0	753.2200	4480	40	76/07/08	84/09/04
00065	STREAM STAGE	FEET	WATER		24	5.098800	1.372800	1.171700	8.86	3.96	82/10/28	84/09/04
00070	TURB JKSN	JTU	WATER		5	34.80000	2865.700	53.53200	130.0	2.0	77/06/22	79/08/10
00076	TURB TRBTDMTR	HACH FTU	WATER		10	9.870000	189.3300	13.76000	48.0	1.2	79/10/23	80/10/01
00095	CNDUCTVY AT 25C	MICROMHO	WATER		77	650.5500	56722.00	238.1600	1060	115	76/07/08	84/09/04
00300	DO	MG/L	WATER		64	9.407800	2.900800	1.703200	13.0	3.3	77/06/22	84/09/04
00301	DO SATUR	PERCENT	WATER		8	105.0000	27.71400	5.264400	116.0	101.0	82/10/28	83/05/26
00340	COD HI LEVEL	MG/L	WATER		33	24.63600	221.4300	14.88100	56	0	79/10/23	83/10/07
				K	6	10.00000	.0000000	.0000000	10	10	82/04/15	83/06/29
				TOT	39	22.38500	215.0900	14.66600	56	0	79/10/23	83/10/07
00400	PH	SU	WATER		73	8.240400	.0973850	.3120700	9.15	6.40	76/07/08	84/09/04
00403	LAB PH	SU	WATER		49	8.191800	.0245570	.1567100	8.6	7.9	80/10/01	84/09/04
00405	CO2	MG/L	WATER		17	2.958800	2.357600	1.535500	5.3	.1	76/07/08	79/08/10
00410	T ALK CACO3	MG/L	WATER		56	216.7900	5026.900	70.90100	340	52	76/07/08	84/09/04
00440	HCO3 ION HCO3	MG/L	WATER		18	250.8900	10210.00	101.0400	340	63	76/07/08	79/08/10
00445	CO3 ION CO3	MG/L	WATER		17	1.529400	36.64000	6.053100	25	0	76/07/08	79/08/10
00530	RESIDUE TOT NFLT	MG/L	WATER		42	52.16700	7759.900	88.09000	472	0	79/10/23	83/10/07
				K	1	2.000000			2	2	82/07/14	82/07/14
				TOT	43	51.00000	7633.600	87.37100	472	0	79/10/23	83/10/07
00572	BIOMASS PERPHYTN	G/SQ M	WATER		3	17.05300	178.8500	13.37400	30.600	3.860	80/10/01	80/10/01
00573	BIOMASS PERPHYTN DW	G/M2	WATER		3	18.19000	200.7100	14.16700	32.50	4.17	80/10/01	80/10/01
00600	TOTAL N	N	MG/L	WATER	37	.6643200	.2121900	.4606400	2.30	.14	77/06/22	82/12/07
00608	NH3+NH4- N	DISS	MG/L	WATER	1	.1000000			.100	.100	81/06/11	81/06/11
00613	NO2-N	DISS	MG/L	WATER	1	.0000000			.000	.000	81/06/11	81/06/11
00618	NO3-N	DISS	MG/L	WATER	1	.0300000			.03	.03	81/06/11	81/06/11
00625	TOT NFLT N	N	MG/L	WATER	67	.5992500	.1232200	.3510300	2.000	.120	77/06/22	84/09/04
				K	3	.2000000	.0000000	.0000000	.200	.200	84/01/10	84/03/14
				TOT	70	.5821400	.1245000	.3528400	2.000	.120	77/06/22	84/09/04
00626	ORGAN, N DIG D WT	MG/KG-N	WATER		1	310.0000			310.00	310.00	79/06/13	79/06/13
00630	NO2&NO3 N-TOTAL	MG/L	WATER		41	.1161000	.0445890	.2111600	1.30	.00	77/06/22	84/09/04
				K	30	.0993330	.0000065	.0025529	.10	.09	78/12/12	84/07/03

IVER BASIN

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VERDE RIVER NEAR CAMP VERDE, ARIZ.
04025 ARIZONA YAVAPAI

ARNT/STREAM

112WRD 770125 15060203025 0013,610 ON
0000 FEET DEPTH

PARAMETER		MEDIUM		RMK	NUMBER	MEAN	VARIANCE	STAN DEV	MAXIMUM	MINIMUM	BEG DATE	END DATE
NO2&NO3	N-TOTAL	MG/L	WATER	TOT	71	.1090100	.0255520	.1598500	1.30	.00	77/06/22	84/09/04
NO2&NO3	N-DISS	MG/L	WATER		35	.0917140	.0097265	.0986230	.4	.0	76/07/08	84/08/24
				K	10	.1000000	6622E-12	.0000813	.1	.1	76/10/06	83/12/02
				TOT	45	.0935550	.0075280	.0867640	.4	.0	76/07/08	84/08/24
T PO4	PO4	MG/L	WATER		3	.0700000	.0048000	.0692820	.15	.03	79/04/17	79/06/13
ORTHOPO4	PO4	MG/L	WATER		37	.0551350	.0023757	.0487410	.18	.00	76/07/08	82/12/07
PHOS-TOT		MG/L P	WATER		68	.1257400	.1377400	.3711400	3.000	.000	77/06/22	84/09/04
				K	2	.0100000	.0000000	.0000000	.010	.010	82/04/15	84/02/02
				TOT	70	.1224300	.1341300	.3662400	3.000	.000	77/06/22	84/09/04
PHOS-DIS	ORTHO	MG/L P	WATER		40	.0195000	.0002510	.0158440	.060	.000	76/07/08	84/08/24
				K	5	.0100000	.0000000	.0000000	.010	.010	79/06/13	84/02/22
				TOT	45	.0184450	.0002316	.0152190	.060	.000	76/07/08	84/08/24
T ORG C	C	MG/L	WATER		20	7.205000	84.25500	9.179100	43.0	1.7	77/06/22	81/03/24
CYANIDE	CN-TOT	MG/L	WATER		22	.0000000	.0000000	.0000000	.000	.000	77/06/22	80/10/01
CYANIDE	SEDMG/KG	DRY WGT	WATER		1	.0000000			.00	.00	79/06/13	79/06/13
TOT HARD	CACO3	MG/L	WATER		58	265.4100	7976.200	89.31000	370	66	76/07/08	83/03/09
NC HARD	CACO3	MG/L	WATER		30	57.46700	3028.300	55.03000	300	0	76/07/08	82/08/11
CALCIUM	CA,DISS	MG/L	WATER		77	51.10400	200.0200	14.14300	70.0	17.0	76/07/08	84/09/04
MGNSIUM	MG,DISS	MG/L	WATER		77	33.86600	167.8200	12.95500	54.0	5.8	76/07/08	84/09/04
SODIUM	NA,DISS	MG/L	WATER		46	40.80200	401.3700	20.03400	78.00	4.40	76/07/08	84/08/24
SODIUM	ADSRTION	RATIO	WATER		40	1.012500	.1995900	.4467500	1.8	.2	76/07/08	83/03/09
PERCENT	SODIUM	%	WATER		40	24.50000	77.12800	8.782300	49	12	76/07/08	83/03/09
	NA+K	MG/L	WATER		10	47.47000	376.6300	19.40700	72.00	8.70	79/04/17	80/02/13
PTSSIUM	K,DISS	MG/L	WATER		46	3.206500	1.340200	1.157700	5.20	.80	76/07/08	84/08/24
CHLORIDE	TOTAL	MG/L	WATER		49	25.76300	162.0700	12.73100	49	3	76/07/08	84/08/24
SULFATE	SO4-TOT	MG/L	WATER		72	93.12600	2673.100	51.70200	210	7	76/07/08	84/09/04
FLUORIDE	F,DISS	MG/L	WATER		46	.2717400	.0122950	.1108800	.50	.10	76/07/08	84/08/24
SILICA	DISOLVED	MG/L	WATER		46	25.21700	42.04100	6.483900	37.0	11.0	76/07/08	84/08/24
ARSENIC	AS,TOT	UG/L	WATER		24	17.33300	40.14500	6.336000	28	5	77/06/22	81/06/11
ARSENIC	SEDMG/KG	DRY WGT	WATER		1	6.000000			6.00	6.00	79/06/13	79/06/13
BARIUM	BA,TOT	UG/L	WATER		11	245.4600	42727.00	206.7100	800	100	78/11/14	80/10/01
				K	12	100.0000	.0056818	.0753780	100	100	77/06/22	80/08/20
				TOT	23	169.5700	24941.00	157.9300	800	100	77/06/22	80/10/01
BA DUD	DRY WGT	MG/KG-BA	WATER		1	110.0000			110.00	110.00	79/06/13	79/06/13
BORON	B,DISS	UG/L	WATER		46	195.6700	8728.900	93.42900	530	30	76/07/08	84/08/24
BORON	B,SUSP	UG/L	WATER		16	24.37500	1252.900	35.39700	130	0	79/04/17	80/10/01
BORON	B,TOT	UG/L	WATER		23	238.7000	9802.800	99.00900	420	80	77/06/22	80/10/01
CADMIUM	CD,TOT	UG/L	WATER		21	6.190500	231.7600	15.22400	70	0	78/11/14	83/10/07
				K	33	9.757600	152.6300	12.35400	30	1	77/06/22	83/08/30

A VALUE REPORTED IS THE MEAN OF TWO OR MORE DETERMINATIONS.

B RESULTS BASED UPON COLONY COUNTS OUTSIDE THE ACCEPTABLE RANGE.

C VALUE CALCULATED.

D INDICATES FIELD MEASUREMENT.

E INDICATES EXTRA SAMPLES TAKEN AT COMPOSITE STATIONS.

F IN THE CASE OF SPECIES, F INDICATES FEMALE SEX.

G VALUE REPORTED IS THE MAXIMUM OF TWO OR MORE DETERMINATIONS.

H VALUE BASED ON FIELD KIT DETERMINATION; RESULTS MAY NOT BE ACCURATE.

J ESTIMATED VALUE; VALUE NOT ACCURATE.

K ACTUAL VALUE IS KNOWN TO BE LESS THAN VALUE GIVEN.

L ACTUAL VALUE IS KNOWN TO BE GREATER THAN VALUE GIVEN.

M PRESENCE OF MATERIAL VERIFIED BUT NOT QUANTIFIED. IN THE CASE OF TEMPERATURE OR OXYGEN REDUCTION POTENTIAL, M INDICATES A NEGATIVE VALUE. IN THE CASE OF SPECIES, M INDICATES MALE SEX.

N PRESUMPTIVE EVIDENCE OF PRESENCE OF MATERIAL.

O SAMPLED, BUT ANALYSIS LOST OR NOT PERFORMED.

S LABORATORY TEST.

T VALUE REPORTED IS LESS THAN CRITERIA OF DETECTION.

U INDICATES MATERIAL WAS ANALYZED FOR BUT NOT DETECTED. IN THE CASE OF SPECIES, U INDICATES UNDETERMINED SEX.

W VALUE OBSERVED IS LESS THAN LOWEST VALUE REPORTABLE UNDER "T" CODE.

X VALUE IS QUASI VERTICALLY-INTERGRATED SAMPLE.

Z TOO MANY COLONIES WERE PRESENT TO COUNT (TNTC), THE NUMERIC VALUE REPRESENTS THE FILTRATION VOLUME.

09504500 OAK CREEK NEAR CORNVILLE, AZ

LOCATION.--Lat 34 45'52", long 111 53'25", in NW¼SW¼ sec.23, T.16 N., R.4 E., Yavapai County, Hydrologic Unit 15060202, on right bank 250 ft downstream from county highway bridge, 0.2 mi upstream from Page Springs, 4 mi northeast of Cornville, and 15 mi upstream from mouth. Prior to March 18, 1981, at site 250 ft upstream.

DRAINAGE AREA.--357 mi^2.

PERIOD OF RECORD.--July 1940 to September 1945, April 1948 to current year.

REVISED RECORDS.--WSP 1149: 1948(M). WRD Ariz. 1974: 1973.

GAGE.--Water-stage recorder and auxiliary water-stage recorder. Altitude of gage is 3,470 ft, from topographic map.

REMARKS.--Records good. Regulation during low flow by several small diversions for irrigation above station.

AVERAGE DISCHARGE.--41 years, 90.8 ft^3/s, 65,780 acre-ft/yr; median of yearly mean discharges, 74 ft^3/s, 53,600 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 26,400 ft^3/s Feb. 19, 1980, gage height, 16.30 ft, maximum gage height, 16.48 ft, Sept. 5, 1970; minimum discharge, 6 ft^3/s July 27, 1940.

EXTREMES OUTSIDE PERIOD OF RECORD.--Maximum stage since at least 1885, 23 ft in March 1938, from floodmarks (upstream side of bridge).

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 5,730 ft^3/s Dec. 27, 0845 hours, gage height, 8.71 ft, base discharge, 1,300 ft^3/s; minimum daily, 12 ft^3/s, June 23.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1983 TO SEPTEMBER 1984
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	587	33	34	110	36	34	28	28	18	19	27	29
2	236	33	35	89	36	32	28	27	15	20	37	100
3	126	33	47	64	35	31	29	26	13	21	26	40
4	80	32	472	49	35	31	29	25	14	19	22	30
5	86	32	339	43	36	30	29	23	15	17	21	27
6	233	32	195	37	37	30	29	22	17	18	24	25
7	136	32	126	36	40	29	29	22	18	19	20	24
8	93	31	90	36	39	28	28	22	16	19	21	23
9	77	31	74	36	38	28	28	22	17	19	24	22
10	72	31	68	36	39	28	27	22	17	18	148	22
11	64	31	65	36	43	28	26	22	16	18	102	27
12	60	32	64	36	43	29	26	21	14	18	35	27
13	58	32	67	36	41	28	25	21	16	18	34	26
14	56	32	65	36	39	28	25	20	18	22	31	26
15	55	32	59	36	37	28	25	24	18	22	28	25
16	52	32	57	36	38	29	26	23	16	20	25	24
17	52	32	53	36	38	29	25	22	16	18	25	26
18	52	32	36	36	37	29	24	19	17	18	33	25
19	47	33	36	34	37	30	25	19	15	19	30	24
20	42	33	38	35	36	30	25	19	14	22	31	23
21	41	34	37	34	34	29	25	19	14	21	30	22
22	40	35	36	34	36	28	24	18	13	24	27	27
23	39	34	36	35	35	29	23	17	12	23	25	26
24	38	34	33	35	34	29	23	16	14	20	54	24
25	37	33	100	36	34	30	22	17	16	24	40	23
26	36	39	1060	37	34	26	22	15	17	93	31	30
27	35	36	2830	36	35	31	24	13	18	33	31	32
28	35	35	722	36	37	30	25	14	17	28	28	27
29	34	34	332	36	36	28	27	16	16	26	26	24
30	34	34	189	36	---	28	28	15	16	25	25	24
31	34	---	135	36	---	28	---	17	---	25	25	---
TOTAL	2567	989	7530	1284	1075	905	779	626	473	726	1086	854
MEAN	86.0	33.0	243	41.4	37.1	29.2	26.0	20.2	15.8	23.4	35.0	28.5
MAX	587	39	2830	110	43	34	29	28	18	93	148	100
MIN	34	31	33	34	34	26	22	13	12	17	20	22
AC-FT	5290	1960	14940	2550	2130	1800	1550	1240	938	1440	2150	1690

CAL YR 1983 TOTAL 57414 MEAN 157 MAX 2830 MIN 13 AC-FT 113900
WTR YR 1984 TOTAL 18994 MEAN 51.9 MAX 2830 MIN 12 AC-FT 37670

e.--No gage-height record Oct. 10 to Nov. 15.

09505550 VERDE RIVER BELOW CAMP VERDE, AZ

LOCATION.--Lat 34°33'02", long 111°51'02", in SW¼NW¼ sec.5, T.13 N., R.5 E., Yavapai County, Hydrologic Unit 15060203, on downstream side of bridge on county highway, 0.5 mi (0.8 km) southeast of Camp Verde, and 2.2 mi (3.5 km) downstream from Beaver Creek.

DRAINAGE AREA.--4,670 mi^2 (12,100 km^2), approximately (includes 373 mi^2 or 966 km^2 in Aubrey Valley Playa, a closed basin).

PERIOD OF RECORD.--November 1971 to current year.

GAGE.--Water-stage recorder. Datum of gage is 3,045.10 ft (928.146 m) above mean sea level.

REMARKS.--Records good. About 10,000 acres (40 km^2) above station are irrigated by surface water and ground water.

AVERAGE DISCHARGE.--5 years, 332 ft^3/s (9.402 m^3/s), 240,500 acre-ft/yr (296 hm^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 40,600 ft^3/s (1,150 m^3/s) Oct. 20, 1972 (gage height, 18.51 ft or 5.642 m recorded, 19.0 ft or 5.79 m, top of surge in gage well and from profile past gage); minimum daily, 13 ft^3/s (0.37 m^3/s) July 6, 7, 1976.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Sept. 5-6, 1970, reached a stage of about 19.0 ft (5.79 m), estimated on basis of stage of 19.5 ft (5.94 m), from profile past gage (discharge, 43,000 ft^3/s or 1,220 m^3/s). A peak discharge of 97,000 ft^3/s (2,750 m^3/s) was recorded at former gaging station at site 8.5 mi (13.7 km) downstream (below West Clear Creek) on Mar. 3, 1938, and is the highest near this site since at least 1924.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 3,490 ft^3/s (98.8 m^3/s) Aug. 23, gage height, 7.49 ft (2.283 m), base discharge, 3,000 ft^3/s (85 m^3/s); minimum daily, 14.0 ft^3/s (0.396 m^3/s) July 3, 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	131	72	87	88	127	128	91	42	35	19	18	58
2	129	69	88	88	129	137	93	43	38	20	15	32
3	131	68	89	88	136	135	125	41	38	10	22	32
4	119	64	91	88	129	137	123	42	45	16	16	38
5	104	60	93	88	125	131	127	44	46	58	32	44
6	95	61	88	88	136	110	136	44	51	64	25	36
7	87	65	83	88	133	110	340	41	45	42	15	32
8	78	64	85	88	135	113	268	39	50	28	18	25
9	74	65	82	88	134	102	187	40	74	21	35	18
10	71	64	88	94	139	100	133	43	75	14	221	25
11	65	74	88	106	141	121	99	42	52	15	125	42
12	45	77	88	106	142	110	83	37	39	28	100	72
13	45	72	88	106	132	91	76	39	37	36	239	166
14	46	77	88	106	126	93	57	51	37	29	181	289
15	48	78	88	106	129	94	45	77	42	27	195	277
16	48	80	88	106	126	81	42	71	38	24	198	171
17	48	80	88	106	123	100	49	69	31	24	193	136
18	43	80	88	106	121	92	51	50	33	21	191	115
19	44	82	88	106	123	87	55	45	31	75	113	101
20	42	82	88	106	129	94	53	45	30	82	99	74
21	42	82	88	109	119	94	48	44	26	48	90	61
22	49	80	88	136	118	93	45	39	24	40	90	56
23	75	80	88	147	117	81	54	40	27	45	712	53
24	92	80	88	147	126	82	51	46	30	113	450	54
25	97	83	88	144	146	78	56	62	31	95	171	53
26	88	82	88	136	137	102	46	68	33	49	150	52
27	78	81	88	125	136	114	74	54	26	39	176	72
28	80	81	88	125	130	114	77	45	24	33	129	134
29	77	84	88	125	---	112	53	42	25	23	115	138
30	78	88	88	125	---	140	42	45	22	18	102	121
31	80	---	88	125	---	135	---	38	---	21	83	---
TOTAL	2329	2255	2722	3390	3654	3311	2779	1461	1137	1180	3937	3175
MEAN	75.1	75.2	87.8	109	131	107	92.6	47.1	37.9	38.1	127	106
MAX	131	88	93	147	147	140	340	77	75	113	712	889
MIN	42	60	82	88	117	78	42	37	22	14	15	18
AC-FT	4620	4470	5400	6720	7250	6570	5510	2900	2260	2340	7810	6300

CAL YR 1976 TOTAL 97335 MEAN 266 MAX 12800 MIN 13 AC-FT 193100
WTR YR 1977 TOTAL 31330 MEAN 85.8 MAX 889 MIN 14 AC-FT 62140

MEAN 10/77 - 9/78
131 89.4 108 216 1118 5079 353 33.7 19.4 19.3 72.8 37.2

MEAN = 358.1 cfs
11/76 - 9/78

USGS Reference, Jackie, 9/10/87

09505550 VERDE RIVER BELOW CAMP VERDE, AZ

LOCATION.--Lat 34°33'02", long 111°51'02", in SW¼ sec.5, T.13 N., R.5 E., Yavapai County, Hydrologic Unit 15060203, on downstream side of bridge on county highway, 0.5 mi (0.8 km) southeast of Camp Verde, and 2.2 mi (3.5 km) downstream from Beaver Creek.

DRAINAGE AREA.--4,670 mi² (12,100 km²), approximately (includes 373 mi² or 966 km² in Aubrey Valley Playa, a closed basin).

PERIOD OF RECORD.--November 1971 to current year.

GAGE.--Water-stage recorder. Datum of gage is 3,045.10 ft (928.146 m) National Geodetic Vertical Datum of 1929.

REMARKS.--Records fair. About 10,000 acres (40 km²) above station are irrigated by surface water and ground water.

AVERAGE DISCHARGE.--6 years, 378 ft³/s (10.70 m³/s), 273,900 acre-ft/yr (338 hm³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 41,000 ft³/s (1,160 m³/s) Mar. 1, 1978, gage height, 19.41 ft (5.916 m); minimum daily, 13 ft³/s (0.368 m³/s) July 6, 7, 1976, July 9, 10, 1978.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Sept. 5-6, 1970, reached a stage of about 19.0 ft (5.79 m), estimated on basis of stage of 19.5 ft (5.94 m), from profile past gage, discharge, 43,000 ft³/s (1,220 m³/s). A peak discharge of 97,000 ft³/s (2,750 m³/s) was recorded at former gaging station at site 8.5 mi (13.7 km) downstream (below West Clear Creek) on Mar. 3, 1938, and is the highest near this site since at least 1924.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*) and peak discharges above base of 3,000 ft³/s (85 m³/s):

Date	Time	Discharge (ft³/s)	Discharge (m³/s)	Gage height (ft)	Gage height (m)
Feb. 1	0615	3,540	100	8.17	2.490
Mar. 1	1715	*41,000	1,160	19.41	5.916
Mar. 5	2245	14,270	404	12.90	3.932
Mar. 13	0745	4,480	126	8.85	2.697
Mar. 23	0445	8,580	243	10.89	3.319

Minimum daily, 13.0 ft³/s (0.368 m³/s) July 9, 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	107	71	94	115	2690	24000	630	60	20	15	24	25
2	100	72	101	113	1260	25800	897	60	20	15	204	25
3	96	71	94	110	755	23500	1570	60	20	16	123	24
4	81	67	94	110	595	8670	1110	50	20	15	110	27
5	81	66	102	100	450	6730	698	50	20	19	103	34
6	1170	78	96	100	567	10100	486	50	20	18	77	44
7	445	101	104	100	1500	5450	361	40	20	15	72	38
8	206	108	106	100	1440	2750	330	40	20	14	56	34
9	163	101	106	100	1340	1980	326	40	20	13	44	39
10	144	99	106	110	848	1650	442	40	20	13	36	31
11	132	99	106	120	1410	1530	503	40	20	14	47	31
12	123	96	115	134	1080	2590	510	30	18	14	186	30
13	110	95	106	122	801	3410	384	30	21	15	163	34
14	74	96	107	109	783	2940	293	30	21	16	157	34
15	70	90	100	120	735	2260	230	30	22	15	146	36
16	69	90	103	500	579	1490	208	29	22	16	123	44
17	76	88	106	1000	450	1190	195	31	20	21	86	44
18	66	87	106	700	343	1100	176	33	19	20	60	44
19	61	88	106	500	285	1100	158	31	20	22	50	45
20	58	90	105	400	250	1340	140	30	19	21	42	45
21	56	92	106	300	262	1520	130	20	18	25	37	46
22	60	90	106	200	542	4220	120	20	18	28	33	43
23	54	92	106	150	906	5800	110	20	17	27	35	41
24	56	92	107	140	1220	2490	100	20	17	26	32	39
25	53	93	110	120	1100	1580	90	20	17	24	31	39
26	54	93	115	110	1020	1200	90	20	17	26	38	38
27	60	93	122	160	881	1000	80	30	18	24	35	37
28	55	96	127	153	7240	931	80	30	20	26	28	37
29	66	93	122	153	---	808	70	20	20	23	27	35
30	76	95	115	158	---	698	70	20	18	21	25	34
31	76	---	113	249	---	637	---	20	---	22	25	---
TOTAL	4070	2682	3134	6706	41406	157944	10590	1048	582	599	2458	1117
MEAN	131	89.4	108	216	1118	5079	353	33.7	19.4	19.3	79.8	37.2
MAX	1170	108	127	1000	7240	24000	1570	60	22	28	204	54
MIN	53	66	96	100	250	637	70	20	17	13	25	24
AC-FT	8070	5320	6210	13300	82100	313300	21010	2070	1150	1190	4480	2220

CAL YR 1977 TOTAL 58104 MEAN 93.4 MAX 1170 MIN 14 AC-FT 67660
WTR YR 1978 TOTAL 221733 MEAN 607 MAX 24000 MIN 13 AC-FT 439800

09498500 SALT RIVER NEAR ROOSEVELT, AZ

LOCATION.--Lat 33°37'10", long 110°55'15", in SE¼NE¼ sec.9, T.3 N., R.14 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in Tonto National Forest on left bank 100 ft downstream from bridge on State Highway 288, 0.3 mi downstream from Pinal Creek, 1 mi upstream from diversion dam for power canal, 14 mi east of village of Roosevelt, and 17 mi upstream from Roosevelt Dam.

DRAINAGE AREA.--4,306 mi^2.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--January 1913 to current year (monthly discharge only January to September 1913) see WSP 1313.

REVISED RECORDS.--WSP 1049: 1914, 1916, 1918-19, 1926. WSP 1343: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,177.14 ft National Geodetic Vertical Datum of 1929. Prior to 1925, nonrecording gage at diversion dam about 1 mi downstream at different datum. Nonrecording gage at present site and datum 1925 to Jan. 17, 1935. May 20, 1955, to July 30, 1959, supplementary water-stage recorder at diversion dam.

REMARKS.--Records good. Several small diversions for irrigation of about 4,000 acres above station and two trans basin diversions above station, one into basin from Show Low Creek and one out of basin to Willow Creek. Records show inflow to Roosevelt Lake. Tonto Creek also contributes to Roosevelt Lake; see records elsewhere in this report.

AVERAGE DISCHARGE.--71 years, 888 ft^3/s, 643,400 acre-ft/yr; median of yearly mean discharges, 680 ft^3/s, 493,000 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 117,000 ft^3/s Mar. 14, 1941, gage height, 24.4 ft, from rating curve extended above 55,000 ft^3/s on basis of velocity-area studies and float-area measurements at 66,000 ft^3/s and 102,000 ft^3/s; maximum gage height, 29.35 ft Dec. 19, 1978; minimum discharge, 59 ft^3/s all or part of each day, July 1-4, 7-12, 1955.

EXTREMES OUTSIDE PERIOD OF RECORD.--A discharge of about 42 ft^3/s was reported Aug. 5, 1911.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*) and peak discharges above base of 4,000 ft^3/s:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Oct. 2	1800	*59,800	22.9	Sept. 10	2300	4,140	10.20
Dec. 4	2030	6,580	11.35	Sept. 26	2330	4,170	10.22
Dec. 28	1330	6,580	11.35				

Minimum, 131 ft^3/s July 10, gage height, 6.22 ft.

09505550 VERDE RIVER BELOW CAMP VERDE, AZ

LOCATION.--Lat 34°33'02", long 111°51'02", in SW¼NW¼ sec.5, T.13 N., R.5 E., Yavapai County, Hydrologic Unit 15060203, on downstream side of bridge on county highway, 0.5 mi (0.8 km) southeast of Camp Verde, and 2.2 mi (3.5 km) downstream from Beaver Creek.

DRAINAGE AREA.--4,670 mi² (12,100 km²), approximately (includes 373 mi² or 966 km² in Aubrey Valley Playa, a closed basin).

PERIOD OF RECORD.--November 1971 to current year.

GAGE.--Water-stage recorder. Datum of gage is 3,045.10 ft (928.146 m) above mean sea level.

REMARKS.--Records good. About 10,000 acres (40 km²) above station are irrigated by surface water and ground water.

AVERAGE DISCHARGE.--5 years, 332 ft³/s (9.402 m³/s), 240,500 acre-ft/yr (296 hm³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 40,600 ft³/s (1,150 m³/s) Oct. 20, 1972 (gage height, 18.51 ft or 5.642 m recorded, 19.0 ft or 5.79 m, top of surge in gage well and from profile past gage); minimum daily, 13 ft³/s (0.37 m³/s) July 6, 7, 1976.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Sept. 5-6, 1970, reached a stage of about 19.0 ft (5.79 m), estimated on basis of stage of 19.5 ft (5.94 m), from profile past gage (discharge, 43,000 ft³/s or 1,220 m³/s). A peak discharge of 97,000 ft³/s (2,750 m³/s) was recorded at former gaging station at site 8.5 mi (13.7 km) downstream (below West Clear Creek) on Mar. 3, 1938, and is the highest near this site since at least 1924.

EXTREMES FOR CURRENT YEAR.--Maximum discharge, 3,490 ft³/s (98.8 m³/s) Aug. 23, gage height, 7.49 ft (2.283 m), base discharge, 3,000 ft³/s (85 m³/s); minimum daily, 14.0 ft³/s (0.396 m³/s) July 3, 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	131	72	87	88	127	128	91	42	35	19	18	58
2	129	69	88	88	129	137	93	43	38	20	15	32
3	131	68	89	88	136	135	125	41	36	14	22	32
4	119	64	91	88	129	137	123	42	45	16	16	38
5	104	60	93	88	125	131	127	44	46	58	32	44
6	95	61	88	88	136	110	136	44	51	64	25	36
7	87	65	83	88	133	110	340	41	45	42	15	32
8	78	64	85	88	135	113	268	39	50	28	18	25
9	74	65	82	88	134	102	187	40	74	21	35	18
10	71	64	88	94	139	100	133	43	75	14	221	25
11	65	74	88	106	141	121	99	42	52	15	123	42
12	45	77	88	106	142	110	83	37	39	28	100	72
13	45	72	88	106	132	91	76	39	37	36	239	166
14	46	77	88	106	126	93	57	51	37	29	141	889
15	48	78	88	106	129	94	45	77	42	27	195	277
16	48	80	88	106	126	81	42	71	38	24	198	171
17	48	80	88	106	123	100	49	69	31	24	193	136
18	43	80	88	106	121	92	51	50	35	21	131	115
19	44	82	88	106	123	87	55	45	31	75	113	101
20	42	82	88	106	129	94	53	45	30	82	99	74
21	42	82	88	109	119	94	48	44	26	48	90	61
22	49	80	88	136	118	93	45	39	24	40	90	56
23	75	80	88	147	117	81	54	40	27	45	712	53
24	92	80	88	147	126	82	51	46	30	113	250	54
25	97	83	88	144	146	78	56	62	31	95	171	53
26	88	82	88	136	147	102	46	68	33	49	150	52
27	78	81	88	125	136	114	79	54	26	39	136	72
28	80	81	88	125	130	114	77	45	24	33	129	136
29	77	84	88	125	---	112	53	42	25	23	115	138
30	78	88	88	125	---	140	42	45	22	18	102	121
31	80	---	88	125	---	135	---	38	---	21	83	---
TOTAL	2329	2255	2722	3390	3654	3311	2779	1461	1137	1180	3937	3175
MEAN	75.1	→ 75.2	87.8	109	131	107	92.6	47.1	37.9	38.1	127	106
MAX	131	88	93	147	147	140	340	77	75	113	712	889
MIN	42	60	82	88	117	78	42	37	22	14	15	18
AC-FT	4620	4470	5400	6720	7250	6570	5510	2900	2260	2340	7810	6300

CAL YR 1976 TOTAL 97335 MEAN 266 MAX 12800 MIN 13 AC-FT 193100
WTR YR 1977 TOTAL 31330 MEAN 85.8 MAX 889 MIN 14 AC-FT 62140

MEAN 10/77 - 9/78
131 89.4 108 216 1118 5079 353 33.7 19.4 19.3 72.8 37.2

MEAN = 358.1 cfs
11/76 - 9/78

USGS Reference, Jackie, 9/10/87

09505550 VERDE RIVER BELOW CAMP VERDE, AZ

LOCATION.--Lat 34°33'02", long 111°51'02", in SW¼NW¼ sec.5, T.13 N., R.5 E., Yavapai County, Hydrologic Unit 15060203, on downstream side of bridge on county highway, 0.5 mi (0.8 km) southeast of Camp Verde, and 2.2 mi (3.5 km) downstream from Beaver Creek.

DRAINAGE AREA.--4,670 mi² (12,100 km²), approximately (includes 373 mi² or 966 km² in Aubrey Valley Playa, a closed basin).

PERIOD OF RECORD.--November 1971 to current year.

GAGE.--Water-stage recorder. Datum of gage is 3,045.10 ft (928.146 m) National Geodetic Vertical Datum of 1929.

REMARKS.--Records fair. About 10,000 acres (40 km²) above station are irrigated by surface water and ground water.

AVERAGE DISCHARGE.--6 years, 378 ft³/s (10.70 m³/s), 273,900 acre-ft/yr (338 hm³/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 41,000 ft³/s (1,160 m³/s) Mar. 1, 1978, gage height, 19.41 ft (5.916 m); minimum daily, 13 ft³/s (0.368 m³/s) July 6, 7, 1976, July 9, 10, 1978.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Sept. 5-6, 1970, reached a stage of about 19.0 ft (5.79 m), estimated on basis of stage of 19.5 ft (5.94 m), from profile past gage, discharge, 43,000 ft³/s (1,220 m³/s). A peak discharge of 97,000 ft³/s (2,750 m³/s) was recorded at former gaging station at site 8.5 mi (13.7 km) downstream (below West Clear Creek) on Mar. 3, 1938, and is the highest near this site since at least 1924.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*) and peak discharges above base of 3,000 ft³/s (85 m³/s):

Date	Time	Discharge (ft³/s)	Discharge (m³/s)	Gage height (ft)	Gage height (m)
Feb. 1	0615	3,540	100	8.17	2.490
Mar. 1	1715	*41,000	1,160	19.41	5.916
Mar. 5	2245	14,270	404	12.90	3.932
Mar. 13	0745	4,480	126	8.85	2.697
Mar. 23	0445	8,580	243	10.89	3.319

Minimum daily, 13.0 ft³/s (0.368 m³/s) July 9, 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	107	71	94	115	2690	24000	830	60	20	15	24	25
2	100	72	101	113	1260	25800	697	60	20	15	204	25
3	96	71	94	110	755	23500	1570	60	20	16	123	24
4	61	67	99	110	593	8670	1110	50	20	15	110	27
5	61	66	102	100	450	8730	898	50	20	19	103	34
6	1170	78	96	100	567	10100	486	50	20	18	77	44
7	445	101	104	100	1500	5450	561	40	20	15	72	38
8	206	108	106	100	1440	2730	530	40	20	14	56	54
9	163	101	106	100	1340	1960	526	40	20	13	44	39
10	144	99	106	110	848	1650	442	40	20	13	36	31
11	132	99	106	120	1410	1530	503	40	20	14	47	31
12	123	96	115	134	1080	2590	510	30	18	14	186	30
13	110	95	106	122	801	3410	389	30	21	15	163	34
14	74	96	107	109	763	2940	293	30	21	16	157	34
15	70	90	100	120	735	2260	230	30	22	15	146	36
16	69	90	103	500	579	1490	208	29	22	16	123	44
17	76	68	106	1000	450	1190	195	31	20	21	86	44
18	66	87	106	700	343	1100	176	33	19	20	60	44
19	61	88	106	500	285	1100	150	31	20	22	50	45
20	58	90	105	400	250	1340	140	30	19	21	42	45
21	58	92	108	300	262	1520	130	20	18	25	37	46
22	60	90	106	200	542	4220	120	20	18	28	33	43
23	59	92	106	150	906	5800	110	20	17	27	35	41
24	56	92	107	140	1220	2490	100	20	17	26	32	39
25	53	93	110	120	1100	1580	90	20	17	24	31	39
26	59	93	115	110	1020	1200	90	20	17	26	38	38
27	60	93	122	100	881	1000	80	30	18	24	35	37
28	55	96	127	133	7240	931	80	30	20	26	28	37
29	66	93	124	153	---	808	70	20	20	23	27	35
30	78	95	115	158	---	698	70	20	18	21	25	34
31	76	---	113	249	---	657	---	20	---	22	25	---
TOTAL	4076	2682	3334	6706	41408	157944	10590	1044	582	599	2258	1117
MEAN	131	89.4	108	216	1118	5079	353	33.7	19.4	19.3	72.8	37.2
MAX	1170	108	127	1000	7240	24000	1570	60	22	28	204	54
MIN	53	66	96	100	250	657	70	20	17	13	25	24
AC-FT	8070	5320	6610	13300	82100	313300	21010	2070	1150	1190	4480	2220

CAL YR 1977 TOTAL 54109 MEAN 93.4 MAX 1170 MIN 14 AC-FT 67860
WTR YR 1978 TOTAL 221733 MEAN 607 MAX 24000 MIN 13 AC-FT 439800

09498500 SALT RIVER NEAR ROOSEVELT, AZ

LOCATION.--Lat 33°37'10", long 110°55'15", in SE¼NE¼ sec.9, T.3 N., R.14 E. (unsurveyed), Gila County, Hydrologic Unit 15060103, in Tonto National Forest on left bank 100 ft downstream from bridge on State Highway 288, 0.3 mi downstream from Pinal Creek, 1 mi upstream from diversion dam for power canal, 14 mi east of village of Roosevelt, and 17 mi upstream from Roosevelt Dam.

DRAINAGE AREA.--4,306 mi^2.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--January 1913 to current year (monthly discharge only January to September 1913) see WSP 1313.

REVISED RECORDS.--WSP 1049: 1914, 1916, 1918-19, 1926. WSP 1343: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 2,177.14 ft National Geodetic Vertical Datum of 1929. Prior to 1925, nonrecording gage at diversion dam about 1 mi downstream at different datum. Nonrecording gage at present site and datum 1925 to Jan. 17, 1935. May 20, 1955, to July 30, 1959, supplementary water-stage recorder at diversion dam.

REMARKS.--Records good. Several small diversions for irrigation of about 4,000 acres above station and two trans basin diversions above station, one into basin from Show Low Creek and one out of basin to Willow Creek. Records show inflow to Roosevelt Lake. Tonto Creek also contributes to Roosevelt Lake; see records elsewhere in this report.

AVERAGE DISCHARGE.--71 years, 888 ft^3/s, 643,400 acre-ft/yr; median of yearly mean discharges, 580 ft^3/s, 493,000 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 117,000 ft^3/s Mar. 14, 1941, gage height, 24.4 ft, from rating curve extended above 55,000 ft^3/s on basis of velocity-area studies and float-area measurements at 66,000 ft^3/s and 102,000 ft^3/s; maximum gage height, 29.35 ft Dec. 19, 1978; minimum discharge, 59 ft^3/s all or part of each day, July 1-4, 7-12, 1955.

EXTREMES OUTSIDE PERIOD OF RECORD.--A discharge of about 42 ft^3/s was reported Aug. 5, 1911.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*) and peak discharges above base of 4,000 ft^3/s:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Oct. 2	1800	*59,800	22.9	Sept. 10	2300	4,140	10.20
Dec. 4	2030	6,580	11.35	Sept. 26	2330	4,170	10.22
Dec. 28	1330	6,580	11.35				

Minimum, 131 ft^3/s July 10, gage height, 6.22 ft.

GILA RIVER BASIN

09490500 BLACK RIVER NEAR FORT APACHE, AZ

LOCATION.--Lat 33°42'46", long 110°12'40", in NW¼ sec.12, T.4 N., R.20 E. (unsurveyed), Gila County, Hydrologic Unit 15060101, on downstream side of first pier from right on highway bridge, 5 mi upstream from confluence with White River and 14 mi west of Fort Apache.

DRAINAGE AREA.--1,232 mi^2.

PERIOD OF RECORD.--October 1912 to December 1915, September 1916, October 1917 to January 1918, April 1918, October 1957 to current year. Monthly discharge only for some periods, published in WSP 1313.

REVISED RECORDS.--WSP 1313: 1914-15, drainage area.

GAGE.--Water-stage recorder. Altitude of gage is 4,345 ft, from river-profile map. November 1912 to July 1918, nonrecording gages or water-stage recorders at several sites within 1 mi of present site at various datums.

REMARKS.--Records good. One transbasin diversion for industrial and municipal use (see record of Willow Creek diversion from Black River, near Morenci). Negligible storage in several small recreational lakes.

AVERAGE DISCHARGE.--~~36 years~~ (water years 1913-15, 1958-84), 412 ft^3/s, 298,500 acre-ft/yr; median of yearly mean discharges, 320 ft^3/s, 232,000 acre-ft/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 44,200 ft^3/s Oct. 2, 1983, gage height, 24.80 ft, from rating curve extended above 8,500 ft^3/s on basis of slope-area measurements at gage heights 22.33 ft and 24.80 ft; minimum daily, 11 ft^3/s July 6, 1974.

EXTREMES FOR CURRENT YEAR.--Maximum discharge (*), from rating curve extended above 8,500 ft^3/s as explained above, and peak discharges above base of 1,000 ft^3/s:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Oct. 2	0900	*44,200	24.80	Dec. 28	2130	5,260	9.27
Dec. 3	0645	3,650	7.97	Aug. 12	0515	1,810	6.08
Dec. 5	0015	2,740	7.06	Aug. 17	2215	3,580	7.89

Minimum, 26 ft^3/s June 24, 25, gage height, 1.40 ft.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1983 TO SEPTEMBER 1984
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	18600	195	140	830	231	173	459	315	67	50	64	250
2	30000	184	434	730	230	182	434	317	64	46	66	715
3	11200	175	2590	726	234	196	406	292	61	39	60	316
4	5050	171	1700	639	235	218	378	269	58	38	97	227
5	3250	176	1710	579	232	241	372	255	55	34	299	178
6	2320	168	801	563	238	256	367	250	53	42	169	145
7	1890	163	535	732	245	241	387	249	51	38	124	120
8	1360	155	428	758	249	226	414	251	48	39	103	103
9	1260	153	373	739	252	231	483	242	45	41	90	92
10	1060	158	331	696	250	247	465	226	42	39	120	85
11	899	164	302	624	246	276	443	213	39	32	240	83
12	774	151	282	557	243	319	435	202	37	35	725	102
13	673	139	272	505	228	376	448	190	36	36	278	118
14	601	133	275	494	224	454	457	184	36	39	187	117
15	542	127	265	513	232	566	461	173	34	54	173	137
16	446	115	239	450	230	705	462	166	30	44	177	157
17	379	119	229	418	219	716	463	177	29	47	922	153
18	344	119	222	422	224	684	458	181	28	39	1020	135
19	327	123	212	371	215	662	450	159	27	116	326	123
20	300	138	204	318	208	606	439	142	27	77	425	141
21	385	158	200	304	216	576	424	128	28	66	335	153
22	438	209	202	286	203	582	414	119	29	82	257	141
23	352	204	196	282	188	582	370	110	28	220	210	125
24	301	167	188	263	188	536	326	101	26	117	185	137
25	275	151	188	243	181	497	294	93	27	108	278	124
26	277	169	200	238	177	475	282	87	34	98	285	128
27	262	187	1140	233	177	486	292	82	50	101	266	147
28	242	169	4130	230	167	509	300	78	61	81	239	201
29	228	147	2940	225	166	478	301	74	49	76	270	284
30	220	140	1370	226	---	522	301	72	49	78	243	239
31	223	---	991	231	---	525	---	69	---	76	251	---
TOTAL	84478	4727	23288	14425	6328	13343	11985	5466	1248	2028	8485	5176
MEAN	2725	158	751	465	218	430	400	176	41.6	65.4	274	173
MAX	30000	209	4130	830	252	716	483	317	67	220	1020	715
MIN	220	115	140	225	166	173	282	69	26	32	60	83
AC-FT	167600	9380	46190	28610	12550	26470	23770	10840	2480	4020	16830	10270

CAL YR 1983	TOTAL	396940	MEAN	1088	MAX	30000	MIN	61	AC-FT	787300
WTR YR 1984	TOTAL	180978	MEAN	494	MAX	30000	MIN	26	AC-FT	359000

GILA RIVER BASIN

1981 WY pub. 1983

213

09494000 WHITE RIVER NEAR FORT APACHE, AZ

median of yearly mean frds

LOCATION.--Lat 33°44'11", long 110°09'58", in SE¼ sec.32, T.4 N., R.21 E. (unsurveyed), Gila County, Hydrologic Unit 15060102, in Fort Apache Indian Reservation, on right bank 2,200 ft downstream from highway bridge, 4.5 mi upstream from confluence with Black River, and 11 mi west of Fort Apache.

DRAINAGE AREA.--632 mi^2.

PERIOD OF RECORD.--October 1917 to September 1918 (published as "at Wanslee's Ranch"), October 1957 to current year. Monthly discharge only for some periods, published in WSP 1313.

REVISED RECORDS.--WRD Ariz. 1971: 1967(M).

GAGE.--Water-stage recorder. Datum of gage is 4,365.99 ft National Geodetic Vertical Datum of 1929. Oct. 12, 1917, to Aug. 31, 1918, nonrecording gage at site 2,100 ft upstream at different datum.

REMARKS.--Records good. Small diversions above station for irrigation of about 1,460 acres. Negligible storage above station in several small recreational lakes.

AVERAGE DISCHARGE.--28 years, 201 ft^3/s, 145,600 acre-ft/yr. 25 years median of yearly means 170 45 or 4.81 m^3/sec 123,000 acre-f

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 14,600 ft^3/s Dec. 18, 1978, gage height, 15.71 ft, from rating curve extended above 7,800 ft^3/s on basis of slope-area measurement of peak flow; no flow July 18-21, 1963.

EXTREMES FOR CURRENT YEAR.--Maximum independent discharge (*) and peak discharges above base of 1,000 ft^3/s:

Date	Time	Discharge (ft^3/s)	Gage height (ft)	Date	Time	Discharge (ft^3/s)	Gage height (ft)
Oct. 2	0900	*9,410	12.56	July 29	1400	1,350	5.22
Dec. 27	1400	1,940	6.09	Aug. 11	1515	1,490	5.44
July 21	0630	1,450	5.37	Aug. 18	2245	1,640	5.66

Minimum daily, 32 ft^3/s June 23, 24, July 6, 10.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1983 TO SEPTEMBER 1984
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4350	137	106	284	150	126	243	336	95	33	138	333
2	6100	134	192	265	153	131	232	368	89	33	120	303
3	3050	132	311	246	151	137	223	364	85	38	110	250
4	1790	129	316	232	151	144	218	357	79	38	110	200
5	1210	153	257	223	157	143	218	369	73	33	130	170
6	886	135	146	247	162	136	241	402	68	32	130	149
7	682	130	136	270	163	135	290	419	63	34	115	134
8	574	128	134	279	166	142	308	416	59	34	110	124
9	518	123	125	278	162	143	365	406	54	34	115	114
10	432	118	119	263	165	149	344	402	49	32	130	108
11	367	114	115	245	158	157	324	395	44	34	180	218
12	318	110	115	233	142	170	327	385	39	35	130	223
13	286	106	114	223	149	182	335	386	35	46	130	160
14	258	102	110	228	159	209	347	348	35	44	145	167
15	236	98	108	210	147	255	368	323	35	40	120	192
16	217	92	106	198	145	280	389	331	35	39	250	186
17	205	91	104	205	148	283	411	290	35	38	367	182
18	190	99	103	184	136	281	424	257	38	121	366	226
19	181	101	100	162	140	264	430	234	37	80	392	220
20	252	94	99	165	132	253	430	216	34	60	508	189
21	234	146	100	150	127	258	408	194	35	170	379	189
22	199	112	99	168	136	266	368	179	33	185	322	170
23	177	109	95	152	130	257	332	160	32	250	351	186
24	173	103	94	149	125	239	316	145	32	210	400	170
25	172	113	99	147	127	233	319	139	35	180	416	155
26	171	115	139	145	124	229	327	131	39	135	384	197
27	167	106	843	144	121	247	319	125	57	114	300	304
28	159	99	759	138	125	236	307	118	52	120	372	311
29	152	96	424	140	126	251	304	111	45	176	301	273
30	147	98	344	142	---	259	314	106	38	120	272	237
31	143	---	311	145	---	242	---	101	---	113	284	---
TOTAL	24006	3423	6223	6260	4177	6437	9781	8493	1479	2651	7577	6040
MEAN	774	114	201	202	144	208	326	274	49.3	85.5	244	201
MAX	6100	153	843	284	166	283	430	419	95	250	508	333
MIN	143	91	94	138	121	126	218	101	32	32	110	108
AC-FT	47620	6790	12340	12420	8290	12770	19400	16850	2930	5260	15030	11980

CAL YR 1983	TOTAL	156971	MEAN	430	MAX	6100	MIN	78	AC-FT	311400
WTR YR 1984	TOTAL	86547	MEAN	236	MAX	6100	MIN	32	AC-FT	171700

APPENDIX E

WASTE LOAD ALLOCATION DATA

WQL Segment: Verde River from Oak Creek to Camp Verde

Effluent Permit Limits

Permitted Point Source	Flow (m^3/day)	Tot. P(kg P/day)	Tot. N(kg N/day)
Valley Vista Estates	57	0.06	0.17

WQL Segment: Oak Creek and tributaries to headwaters

Effluent Permit Limits

Permitted Point Source	Flow (m^3/day)	Tot. P(kg P/day)	Tot. N(kg N/day)
Kachina Village	680	2.0	3.4[1]
CB Real Estate	8	-	-
Sedona Venture	285	0.03[2]	0.3[2]
Page Springs Fish Hatchery	53,300[3]	5.33[4]	53.3[5]
Total[6]	54,273	7.4	57.0

1 Calculated using approximate discharge concentration of 5 mg N/l reported in 1985-86.

2 Effective 6/1/88.

3 Approximate discharge rate. Not specified in permit.

4 Calculated using 0.1 mg P/l permit discharge limitation and approximate discharge rate.

5 Calculated using 1.0 mg N/l permit discharge limitation and approximate discharge rate.

6 Further study is needed to verify loads and standards compliance.

APPENDIX E, continued

WQL Segment: Salt River and tributaries from headwaters to Roosevelt Lake

Permitted Point Source	Effluent Permit Limits Flow (m^3/day)	Tot. P(kg P/day)	Tot. N(kg N/da
Inspiration Copper	133	0.01	0.13
Globe/Holgate	757	0.479[1]	0.356[1]
Globe/Pinal WWTP	4,542	29.5[2]	136.3[3]
Cobre Valley	72	0.041[1]	0.274[1]
East Fork Mission	60.6	0.006	0.03
Alchesay Fish Hatchery	38,230	4.0	19.0
Canyon Creek Fish Hatchery	13,381	1.6	8.0
Williams Creek Fish Hatchery	17,033	1.7	8.5
Total Permitted	74,208.6	7.3	35.7
Total Estimated	-	30.0	136.9
Total	74,208.6	37.3	172.6
To Roosevelt Lake:			
Roosevelt Lakeview Park	26.5	0.0008	0.008

[1] Estimated loading using USEPA Report on Theodore Roosevelt Lake, National Eutrophication Survey, Working Paper 735, PB 281 516, September, 1977, pp. 15-16.

[2] Calculated using approximate discharge concentration of 6.5 mg N/l.

[3] Estimated loading based on treatment plant effluent quality (30 mg N/l), Metcalf and Eddy, Inc., Wastewater Engineering: Treatment, Disposal, Reuse, McGraw-Hill, 1979, p. 702.

WQL Segment: Verde River from Oak Creek to Fossil Creek

Standards Violated: Phosphorus } 305(b), 1986, p.41
Nitrogen }
Mercury - 305(b), 1983, p.43

Probable Sources

Viol. Standard	Point	Non-Point
Nutrients (P and N)	Camp Verde Sanitary District Valley Vista Estates	Failing septic systems Agriculture Grazing Erosion
Mercury	Unknown	Unknown

Results

	Mean Flow	Mean tot. P (mg P/ℓ)	Mean tot. N (mg N/ℓ)
Verde River near Cornville (09504200)	75.045 cfs 2.1 m³/sec	0.13913 (23 obs.)	0.50652 (23 obs.)
Verde River below Camp Verde (09505550)	358.1 cfs 10.1 m³/sec	—	—
Standards	-	0.07 (Fed.) / 0.10 (AZ)	1.00 (AZ)

Phosphorus TMDL = (10.1 - 2.1 m³/sec) (0.07 or 0.1 mg/ℓ) = 45.2 kg P/day (Fed)
= 69.3 kg P/day (AZ)

Nitrogen TMDL = (10.1 m³/sec)(1.00 mg/ℓ) - (2.1 m³/sec)(0.50652 mg N/ℓ)
= 783.2 kg N/day

Mercury TMDL = (10.1 - 2.1 m³/sec)(0.0002 mg/ℓ) = 0.1 kg N/day

AZ TMDLs:	Tot. P (kg/day)	Tot N (kg/day)
Ref. 7 (Oak Creek to Fossil Creek)	10.9	54.8
Ref. 9 (Oak Creek to East Verde)	2.7	27.2

Documentation

River flow rates from STORET and USGS (Water Resources Data Arizona, Water Years 1977, 1978), 11/76 - 9/78.

Both sets of AZ TMDLs developed using 7Q10 flow rate at mouth of Oak Creek. Ref. 7 uses 90th percentile AZ standards and Ref. 9 uses mean annual AZ standards.

WQL Segment: Oak Creek and tributaries to headwaters

Standards Violated: Phosphorus - Ref. 7, p. 157
Nitrogen - potential violation, Ref. 1, p. 5
Bacteria - Ref. 1, p. 5

Probable Sources

Viol. Standard	Point	Non-Point
Nitrogen	Kachina Village CB Real Estate Sedona Ventures Page Springs Fish Hatchery	Failing septic systems Recreation Wildlife

Bacteria: Same as above plus development and livestock (both below Sedona)

Results

	Mean Flow	Mean tot. P stand. (mg P/l)	Mean tot. N stand. (mg N/l)
Oak Creek at Red Rock Crossing near Sedona (09504440)	70.631 cfs 2.0 m^3/sec	0.07 (Fed.) / 0.10 (AZ)	1.00 (AZ)
Oak Creek near Cornville (09504500)	90.8 cfs 2.6 m^3/sec	0.07 (Fed.) / 0.10 (AZ)	1.00 (AZ)

Above Sedona: Phosphorus TMDL = (2.0 m^3/sec)(0.07 or 0.1 mg P/l) = 11.3 kg P/day (Fed) = 17.3 kg P/day (AZ)
Nitrogen TMDL = (2.0 m^3/sec)(1.00 mg N/l) = 173.3 kg N/day

Below Sedona: Phosphorus TMDL = (2.6 - 2.0 m^3/sec)(0.07 or 0.1 mg P/l) = 2.2 kg P/day (Fed) = 4.9 kg P/day (AZ)
Nitrogen TMDL = (2.6 - 2.0 m^3/sec)(1.00 mg N/l) = 48.9 kg N/day

AZ TMDLs:	Tot. P (kg P/day)	Tot. N (kg N/day)
Ref. 7, p. 33 (for oak creek in total)	10.9	55.5
Ref. 9, p. V-15 (for Sedona to Verde River)	3.6	35.4

Documentation

River flow rate for station 09504440 from STORET for complete record period (10/78 - 10/83). River flow rate for station 09504500 from Water Resources Data Arizona, Water Year 1984, USGS, 1985; average discharge for 41 years used. Note that baseline flow at Sedona is relatively constant because Oak Creek drains the subsurface for a large area in Arizona (Richard Wilson, USGS)

Both sets of AZ TMDLs developed using 7Q10 flow rate at Sedona. Ref. 7 uses 90th percentile AZ standards and Ref. 9 uses mean annual AZ standards.

Because AZ TMDLs (Ref. 7) are lower, these values are being submitted for approval. These break down to:

	Tot. P (Kg P/day)	Tot. N (Kg N/day)
Above Sedona:	8.5	43.3
Below Sedona:	2.4	12.2

WQL Segment: Salt River and tributaries from headwaters to Roosevelt

Standards Violated: Phosphorus, nitrogen - 305(b), 1986, p. 41
Sediments - 305(b), 1986, p. 41
Bacteria, metals in Pinal Creek/Miami Wash - 305(b), 1984, p. + 305(b), 1986

Probable Sources

Viol. Standard	Point	Non-Point
Nutrients	Pinal Valley Copper Co (recent permit) Inspiration Copper Holgate Globe/Pinal WWTP Cobre Valley East Fork Mission WWTP Alchesay Fish Hatchery Canyon Creek Fish Hatchery Williams Creek Fish Hatchery	Failing septic systems

Results

	Mean flow	Mean total P stand. (mg P/l)	Mean total N stand. (mg N/l)
Salt River near Roosevelt (09498500)	680 cfs 19.3 m³/sec	0.12 (AZ)	0.60 (A
White River near Fort Apache (09494000)	170 cfs 4.8 m³/sec	0.10 (AZ)	0.50 (AZ
Black River near Fort Apache (09490500)	320 cfs 9.1 m³/sec	0.10 (AZ)	0.50 (AZ

Phosphorus TMDL = (5.4 m³/sec)(0.12 mg P/l) + (13.9 m³/sec)(0.10 mg P/l) = 175.6 kg P

Nitrogen TMDL = (5.4 m³/sec)(0.60 mg N/l) + (13.9 m³/sec)(0.50 mg N/l) = 878.4 kg

See also Appendix F for OECD lake modelling results.
OECD-produced phosphorus TMDL = 213.2 kg P/day
OECD-produced nitrogen TMDL = 799.8 kg N/day

AZ TMDL: Ref. 11, p. 10-3 Total P = 148.6 kg P/day (AZ)

Documentation

River flow rates from Water Resources Data Arizona, Water Year 1989, USGS, 1987. Median of mean flows used.

Direct discharge into Roosevelt Lake, used in OECD river load calculation, is only from Roosevelt Lakeview Park and is negligible.

AZ TMDL developed using mean annual flow at AZ Highway 288 crossing and the mean annual Federal standard.

Roosevelt Lake, 1975 data

MODEL		TOTAL PHOSPHORUS (mg/l)	TOTAL CHLOROPHYLL A (ug/l)	
Observed	(MEAN ANNUAL)	0.020	4.073	
Vollenweider (1976)		0.059		
Dillon & Rigler (1975)		0.070	63.093	(for SPRING P conc.)
Rast & Lee (1978)		-	6.875	(for MEAN ANNUAL P conc.)
			7.930	(for SUMMER and MEAN ANNUAL P)
Grieb, et al. (1981)				
a. Nutrient Limited, F>0.5		-	5.431	(maximum)
b. Light Limited, F<0.5		-	4.640	(maximum)
c. P or Light Limited, F<0.5		-	5.493	(maximum)
d. N and Light Limited, F<0.5		-	3.977	(maximum)
e. P Limited, F>0.5		-	3.641	(maximum)
f. P Limited, F>0.8		-	8.096	(maximum)
OECD (1982)				
a. All Lakes		0.044	4.017	(average)
			10.789	(maximum)
b. Shallow Lakes and Reservoirs		0.037	4.668	(average)
			10.125	(maximum)
c. All Lakes Except if N/P < 10		0.044	3.945	(average)
			10.645	(maximum)

LAKE DATA

L =	P Loading (g/m^2-yr) =	2.08
Q =	Outflow (m^3/yr) =	9.0E+08
A =	Surface Area (m^2) =	60700000
z =	Mean Depth (m) =	28
R =	Retention Coefficient =	0.506748
P =	Q/V, Flushing Rate (1/yr) =	0.525938
V =	Volume (m^3) =	1.7E+09

	TOTAL NITROGEN (mg/l)
OECD (1982)	
Observed	0.040
All Lakes	0.478

NL = N Loading (g/m^2-yr) = 11.17